THURSDAY, NOVEMBER 30, 1881

ANTI-VIVISECTION *versus* HUMANITY

THE physiology of the brain is a subject which has long been matter of much speculation and of some experiment, but till twelve years ago little was known about it. The experiments of Flourens and others had taught us something about the functions of the cerebellum, and Broca's observations on disease had led him to localise speech in the third left frontal convolution; but with these exceptions the functions of the different parts of the cerebrum were almost entirely unknown; although, as a whole, it was regarded as the organ of thought. The experiments of Fritsch and Hitzig, published in 1870, showed that the cortex of the brain could be excited by galvanic currents, although mechanical irritation seemed to have no effect upon it. When certain parts of the cortex were thus irritated in the dog, definite movements of the paws ensued.

In a series of experiments published in the West-Riding Asylum Reports for 1873, Dr. Ferrier confirmed these results, and greatly extended them by experimenting on guinea-pigs, rabbits, and cats, as well as by investigating more fully and precisely the various areas in the brain of the dog. Dr. Ferrier's most brilliant discoveries were due, however, to the happy thought of using monkeys as the subject of experiment. For though a general resemblance can be traced between the functions of different parts of the brain in rabbits or dogs, and in man, yet the brains of these animals are so little developed in comparison with that of man, that exact and definite conclusions regarding the human brain cannot be drawn from experiments on them. Monkeys resemble man more closely than quadrupeds in the more or less erect posture which they tend to assume, in the use of their hands and fingers as prehensile instruments, and even in their muscles of expression. Their brain, though less complicated than that of man, still corresponds closely with it in the general arrangement of the convolutions, and even in many details.

Dr. Ferrier's experiments were performed by anæsthetising the animal and removing a part of the skull so as to expose the brain. The animal was then allowed to recover either partially or completely from the anæsthetic. On the brain being stimulated by touching it with the wires of a battery at various points of its surface, definite movements resulted. A touch on one part, for example, would cause the animal to stretch out its paw as if to grasp some fruit, on another to raise its hand to its mouth, as if to convey the food into it, and another to move its mouth and tongue as if chewing. These motor areas were chiefly around the fissure of Rolando, towards the anterior part of the brain. Stimulation of the posterior parts appeared to cause sensation (not pain), a touch on one part causing the animal to look round as if it saw something unusual, on another to prick up its ears as if it heard something, and on others to move the nostrils and mouth as if it perceived some unusual smell or taste. Destruction of the surface of the brain at the parts whose stimulation caused movement resulted in the impairment or loss of the power of executing the corresponding movement voluntarily, and where stimulation caused sensation the destruction of the part diminished or destroyed the corresponding sensation of hearing, sight, or touch.

These experiments might seem at first sight necessarily to involve the infliction of great pain, and some unthinking people have loudly cried out against what they call horrid cruelty, and have denounced the experiments in no measured terms; yet the fact is that the animals experimented on suffer very little pain, and probably a single sportsman in a day's pheasant-shooting inflicts more pain than Dr. Ferrier has done in the whole course of his researches. Every one will understand this who has seen a child hurt its finger and cry bitterly for a few minutes, and then run cheerily about as soon as the wound was bound up.

The painful part of Dr. Ferrier's experiments, viz. the exposure of the brain, was performed under anæsthetics, and when the animals were allowed to recover they exhibited no signs of pain. Stimulation of the surface of the brain, even on the sensory areas, does not seem to cause pain. The effect of stimulating the motor areas and thus causing movements of the limbs in monkeys, appears to be simply to excite their wonder and curiosity at the extraordinary circumstance of their limbs moving independently of their volition.

The localisation of function in the brain is of exceeding interest as a simple addition to our knowledge of the wondrous mechanism of the body, but it is also of very great use in practical medicine. By means of it we are able to say, with considerable certainty, that the lesions which give rise to particular groups of symptoms are situated at this or that point in the brain. Ferrier found, for example, that stimulating one part of the brain would cause movements of the hand, ending in clenching of the fist, and if the stimulation were continued for a long time other muscles were involved, until at last the animal fell into an epileptic fit. Previous to Ferrier's researches we were in the dark regarding the origin of epileptic fits in man, but now when we find a fit beginning with clenching of the fist we can with considerable certainty localise the cause of it in a definite region of the brain. Not unfrequently epilepsy comes on after a blow or fall on the head, and may continue for months or years, completely ruining the patient's prospects, and perhaps ultimately destroying his intellect. In such cases the disease has been cured by the removal of the injured portion of skull; but before the researches of which we have been speaking showed how to localise the injury, this was impossible, except immediately after its infliction, and while the evidences of its position were unmistakable. Now, however, thanks to Dr. Ferrier, it is possible to operate successfully long after the injury, as the following case, which we extract from the *British Medical Journal*, will show:—

"A child, aged seven, received a blow from a poker; it produced no external wound, and no scar or depression of bone remained. A year later the child had an epileptic fit, and continued to have fits daily for about seven years, with occasional periods of exacerbation, at which time the fits increased to twenty or thirty a day. At the end of this time Dr. Ferrier was asked to see the child in consultation; tenderness was found over the right parietal region, with loss of power in the left hand and indistinct utterance from loss of muscular power in the lips. Trephining was decided upon, and Dr. Ferrier pointed out that the seat for trephining should be rather low down, to correspond to the centres for the arm and lips, which seemed affected. This was done; for eight weeks after the operation the child was free from fits, and at the periodical exacerbation the fits returned with always diminishing severity."

We have given only one instance, but Dr. Echeverria has collected 165 cases of traumatic epilepsy, of which 64 per cent. were cured by trephining. Nor is it only in epilepsy that operative procedure, directed by the knowledge gained from Dr. Ferrier's researches, is useful. In abscess of the brain it guides the surgeon's knife to the spot where the pus has accumulated, and even when disease is due to tumours, it indicates their site, and enables them to be removed and the patient cured, as in a case reported in the *Glasgow Medical Journal*. It opens a new region in the treatment of diseases of the brain, of which it is impossible at present to see the limits; and when we consider how recently the discoveries have been made it seems extraordinary that they should have already been productive of so much benefit. Operations on the head are not however to be rashly undertaken, and in Dr. Ferrier's first experiments he found that injury to the brain was apt to spread beyond the primary limits of the lesion. Prof. Yeo therefore commenced a series of experiments for the purpose of discovering how far improved methods of operating would obviate the risk incurred in such operations, and his attempts have been very successful. These operations were carried out with a proper licence and certificate under the Vivisection Act. Dr. Ferrier embraced the opportunity of observing these animals, and aided Prof. Yeo by his advice, so that each experiment was utilised for the purpose of increasing our knowledge of localisation, and thus aiding diagnosis, as well as of improving the mode of treatment. For these observations he was summoned before the police-court last week by the Society for the Protection of Animals from Vivisection, on what grounds it is difficult to see. Though the summons was dismissed by the magistrate, the prosecution no doubt caused much worry to Dr. Ferrier, and might have caused expense, were it not that the British Medical Association took up and defended the case, in order to show its appreciation of the value of Dr. Ferrier's services both to medical science and suffering humanity. It is now about five years since the Vivisection Act was passed, and the late prosecution of Dr. Ferrier, while it shows how carefully the Act has been observed by physiologists, affords evidence that an Act which purported to be for the prevention of the abuse, is being converted into an instrument of annoyance to those who are best qualified for the use of experiments on animals. At the time the Act was passed many persons objected to it, on the ground that it was quite exceptional to legislate against an abuse which had never been proved to exist in this country. It has been shown by many statements made in the medical journals within the last few months that the Act is being administered in such a manner as seriously to interfere with the progress of science; and it seems not unlikely that the present insult to one of their number may rouse the medical profession to combined agitation against restraints on research for the acquisition of that knowledge which may enable them to lessen the sufferings or save the lives of their patients.

EGYPT OF THE PAST

The Egypt of the Past. By Erasmus Wilson, F.R.S. (London: Kegan Paul, Trench, and Co., 1881.)

THE increased interest taken in Ancient Egypt has produced of late two new histories in English, and two in French and German. The English histories are last in the field, and are those of Prof. Rawlinson and Sir Erasmus Wilson. These histories are not really the work of Egyptologists or experts like that of Brugsch Pacha and M. Maspero, but are attempts to produce readable works for popular purposes by writers interested in Egypt or writers of history, and have consequently all the merits and defects of that kind of way of treating the subject.

The present article is devoted to a consideration of the work of Prof. Wilson, which has last appeared, and is exclusively devoted to history. It comprises the history from the oldest days, the first appearance of the primitive Egyptian, the aboriginal of the Nile, till the last of the Pharaohs, the miserable Nectanebo, who abandoned his country, but not his wealth, to the foreigner B.C. 345, and from that time till to-day a foreigner, in accordance with the law of monarchical nations, has ruled the country with the usual results.

The question of the first man of the Nile has not yet been settled, and he was probably one of those types which have disappeared from view altogether, and belongs to the fossilised remains of the planet. But history has little to seek about the prehistoric races and evidence of an antecedent state of dawning civilisation; flint weapons are very scanty and obscure, and do not aid the solution of the problem. The obscure period of "the followers of Horus" has no historical or chronological importance, and belongs to the hazy epoch known as mythical and immeasurable. Actual history, but not positive chronology, begins with Menes, and the facts ascribed to Menes are, according to historical criticism, such as can be accepted as credible.

It has been agreed to designate as the Old Empire that part of Egyptian history which glides from the first to the sixth dynasty. This comprises the Pyramid-builders, most, if not all, of whose geometric sepulchres are situated in the plains of Memphis and its vicinity on the western bank of the Nile. Although no pyramid can be identified with any king of the first dynasty, and the names of monarchs are known only from official lists and after-recollections, a monument of the second dynasty from a private tomb is in the Ashmolean Museum at Oxford, and shows that the civilisation at that remote period had attained the same excellence as at the fourth. It was under this dynasty that the worship of animals—an African idea—arose, and if the pyramid of Sakkarah, with its numerous chambers, was, as supposed, an early sepulchre of the Apis, that edifice must have been erected under the second dynasty, with all its geometric regularity and architectural knowledge, four centuries after Menes. Certainly writing, sculpture, painting, the arts and sciences had attained a great advancement and development. Still further advancement is visible under the third dynasty, and in the tombs which lie around the Pyramid at Meidoom sculpture had then reached a high excellence, and the portrait of the individual as well executed as the

Roman sculptor could produce it. The men were painted a kind of copper colour, the women yellow, like the Semitic races. The red tint appears later, and the lips at all periods seem to show that an infusion of black blood even at the earliest age had been transfused into the Egyptian race. Senefru or Senophris had already conquered the Arabian Peninsula of Mount Sinai and worked the turquoise mines of the Wady Magarah. Besides turquoise, however, copper slag has been found at the spot, but the *mafk*, an obscure word, sometimes apparently used for a light blue colour, is decidedly not copper. The Great Pyramids, however, are the work of the subsequent dynasty, whose history is chiefly an account of Pyramids and their construction, with an occasional notice of their builders, and the present work judiciously gives the history without the fallacious theories which have found favour with credulous enthusiasts.

Although iron weapons have not been found of the age of Cheops, a sheet of this metal was discovered in one of the air-passages, and a copper tool in another, and the name of one of the monarchs, Merba, "lover of metal," or "iron," occurs amongst the kings of the first dynasty. Except for monumental remains the history of the fourth dynasty is unimportant, although it kept up the conquests and mines of the Wady Magarah, and architecture and technical arts improved, while sculpture and portraiture continued their unrivalled career. With the fifth dynasty the interest begins to thicken, the Pyramids are no longer dumb stones unable to explain their appearances on the great Memphite plains. The presence of pyramids and obelisks had shown that there was a religious system; the inscriptions in the Pyramid of Phiops at Sakkarah, and those of his successor, show that the myth of Osiris and the cosmogonic ideas connected with it had already developed, while the passage of the soul along the starry heavens, and the constellations, especially Orion and the dog-star, prove that the eschatological notions of the period differed exceedingly from those of subsequent periods, while the ethical writers of the period herald the advent of philosophy. The sixth dynasty, the inscriptions on the pyramids of which have been recently discovered, follow the same ideas as the fifth dynasty. Sir Erasmus Wilson has now been able to avail himself of these recent discoveries of the texts of the tombs. After the sixth dynasty lists perhaps supply the succession, but there is a monumental gap till the eleventh, and thence from the twelfth—a fair succession. Thebes, Tanis, and Heliopolis supplant Memphis.

The fifth dynasty had no very important history, and that of the sixth only acquires importance from its enrolling negro troops for the purpose of its northern wars, and the religious inscriptions recently discovered in its Pyramids throw light not only on the earlier religion, but on the antiquity of the worship of the gods and their relative place in the religious system. The first dynasty after the sixth which has any history is undoubtedly the twelfth, although the tenth attempted to reach Punt or Somali, or Cape Guardafui—early evidence no doubt of sea-going ships on the Red Sea and eastern coast of Africa. The history of the twelfth dynasty, its obelisks, labyrinth, Lake Moeris, is well and fairly given, but no additional light is thrown on the period already well known from the monuments and the Turin Canon, and the Sallier and Berlin papyri. On the north this dynasty did not penetrate farther than the peninsula of Mount Sinai, transferring their search for turquoises and metals from the Wady Magarah to the Sarabout El Khadem in the vicinity. Distinguished as it is by the advance in the arts and sciences as manifested in the tombs of Memphis, Abydos, and Eileithyia, its principal features were the undying thirst for gold, and constant search for slaves in the South amongst the Negroes, and its fortifications over the South and North against Negroes and Asiatics. There is a fair account of the twelfth dynasty, but the history of that period is capable of some expansion. The obscure subsequent dynasties, especially the Shepherd rulers, various monuments and statues of whom have been found at Tanis, and are described in the writings of De Rougé and Mariette, are fairly given. Some further information might perhaps have been added, but there is enough to satisfy the lambent curiosity of the general reader. The history of the eighteenth dynasty is well known, and although the rich discovery of mummies at the Deir-el-Bahari has not added one iota to this period, it has confirmed some old ideas. It is certain that the queen of Aahmes I., called Aahmes Nefertari, "the good companion of Aahmes," was unequivocally black, and no sacred office could possibly wash that Æthiopian white. Black she was always painted, and an Erastian priesthood never attempted to whiten her face. The throne of Egypt under this dynasty was occupied not by one, but by a succession of mulattos, and there was no deficiency either of courage or intelligence in the monarchs who raised Egypt to the highest pitch of glory, and stretched the boundaries to the Euphrates, if not to India itself. Egypt, in fact, always had a great infusion of Nigritic blood in its population, more Semitic perhaps on the East and European on the West, but undoubtedly very Nigritic on the South, where the miscegenation with the black races prevailed. The princes of Æthiopia, scions of the royal family, were no doubt at this time red Egyptians in their parentage; but there were then, as now, two kinds of Negroes, the black and the copper-coloured. Many of the male contemporaries of Cheops have a chocolate hue, which hardly agrees with a Caucasian origin. Sir Erasmus Wilson seems puzzled about the inscription at the base of the obelisk of Hatasu at Karnak; it did not dovetail in with chronological theories, so Lepsius assigned it to the "blundering stonecutter"; but later explanations solved the seven months, by showing that the kings dated their regnal years from their accession, and that the date of the accession fell within the seven months, and the seven months were in two regnal years, and that it was unnecessary to add twelve months to the calculation. This has been generally accepted by scrupulous chronologists only too anxious to play at figures, and it appears a natural one. No one need marvel at the rapidity of the work, as the wishes of tyrannical princes have always been carried out with a marvellous rapidity, without the least consideration for human life, much less of toil. The grandeur of the works of Thothmes III. at Karnak, his obelisks and his exploits, are given, but the ingenious capture of Joppa by a stratagem worthy of the pen of Polyænus, and the countries where Thothmes hunted the elephant, are not pointed out. India has been suggested, and nearer than India on his eastern frontier he could not have found herds of this animal, while the Rutennu, a very Indo-Chinese looking race, brought as tribute to Egypt, in the reign of the great conqueror, the *white* elephant, painted red and white, with gilded ears and toes. Had the fame and terror of the Egyptian conqueror reached the confines of Burmah, and the princes of Indo-China propitiated the Egyptians with that expensive present, a white elephant. All this occurred about 1600 B.C., and eight centuries later, in the reign of Shalmanser II., the elephant, as a rare animal, figures on the obelisk found at Nimroud depicted in a style far inferior to the Egyptian. The mutilated mummy of Thothmes has been found at the Deir-el-Bahari, and all that remains is inadequate to give an idea of his person. His successors came into conflict with the Khita, the supposed Hittites, but so did the Ptolemies long after the Hittite kingdom is supposed to have been extinguished. The account of the Pharaoh Khuenaten and the obscurity which prevails about the succession after that heretic, might have been enlarged, and a little more said about the Pharaoh Horus and the historical difficulties about his reign. The hypothesis of Brugsch Pacha, that he reigned twenty-one years, is plausible to superficial observation, but not acceptable on deeper reflection; but these are Egyptological points not in the absolute province of an historian, unless on separate independent philological research. The theory of Brugsch Pacha, that the invasion of Egypt by the Libyans was accompanied, not by Greeks and the people of the Isles, but by Colchian tribes from the Caucasus, although supported by ingenious philological reasons, is not accepted by Ebers and others, and is not entertained in the work. This account of the nineteenth dynasty and the route of the Exodus, it has been already pointed out, does not correspond with the physical conditions of the country or the late surveys, but then the original error is due to the French engineer whose hypothesis was too hastily seized on and proved with too much special pleading. The history of the twenty-first dynasty is only imperfectly known, but here the recent discoveries have thrown additional light on this obscure period. The mummies at the Deir-el-Bahari have aided in the determination of the succession, and it is evident that these high priests were not only descended from the Princes of Æthiopia, who, originally appointed by the Pharaohs, maintained a kind of hereditary succession, but also belonged to the black races, the flesh of Pinotem II. being unusually brown, and revealing a Nigritic descent, there was a strange similarity with the features of Khuenaten, who also probably appertained to the same race. The hypothesis that Shishak was an Assyrian king or prince is not confirmed by the annals of Assyria nor Nimroud, whose Egyptian name Namruth is supposed to have the meaning in the Æthiopian dialect of Panther. But the name of Nimroud is not yet identified either in the Assyrian or Babylonian, and although the names of Assyrian persons mentioned in Egyptian have little resemblance with those given by the Assyrians themselves, still ingenuity might convert Pul Ashar-nes into Assur-Nazir-Pal, who ruled some time about the period. The Æthiopian dynasty is given with some detail, but there is some difficulty about the Æthiopian Piankhi, who conquered the supposed dodekaroty or rulers, who presided over Egypt according to the Assyrian annals, and whose names are recorded on the historical cylinders of Assurbanihabla, or Assur-banipal, and enter into Egyptian history. The position of Piankhi is placed immediately before the twenty-sixth dynasty, on account of his having for antagonist Tefnekht or Tnephakhthus, the father of Bokkoris, king of the twenty-fourth line. But Piankhi's name occurs amongst the kings of the twenty-first dynasty, and Piankhi may have been placed too low in the series. The Æthiopian invasion of Egypt is amply detailed in the Assyrian annals, but the information of the Egyptian monuments about Sabaco and Tirhakah is scanty.

The "Egypt of the Past" may be safely commended to the general reader as containing in a lucid form all the contributions of monumental sources to Egyptian history; it is not too long nor detailed, and is in a portable form. The plates are very well executed, especially the woodcuts; the coloured lithographic ones are gaudy and hazy in the style of Turner, but as that is supposed to represent a kind of aërial perspective of the highest order, it will no doubt commend itself to æsthetic minds. It is, however, a good work, and well got up.

OUR BOOK SHELF

Natural Philosophy for London University Matriculation. By Edward B. Aveling, D.Sc. (London: Stewart and Co., 1881.)

WITH text-books innumerable devised specially for their use, it would be remarkable if candidates for the London matriculation should fail in natural philosophy. That so large a proportion should fail in this subject, as is the case, must be due not to the quantity, but to the quality of their sources of instruction. What then must be said of a teacher who takes upon himself to venture on the scene with an inferior and trashy work in which all the worst blunders of the exploded text-books of a past date are reproduced? Although the writer of the book lying before us professes his indebtedness to the excellent manuals of Dr. Wormell and Mr. Philip Magnus, and to the invaluable assistance of his friend Mrs. Annie Besant, he cannot be congratulated on his success in following in the tracks of his predecessors. His book is, in fact, a cram-book of the worst and weakest type. The barest minimum of the subject divided into the inevitable Statics and Dynamics constitutes the programme; Optics and Heat being somehow thrown in along with Moving Bodies as divisions of the latter of these two branches.

Passing over the Introduction, we arrive at the heading "Definition and Divisions," where the serious business of teaching natural philosophy begins with the words: "From its earliest years a child is surrounded by a world of beauty and of mystery," and the author proceeds anon to advance grave arguments for the conclusion "force, then, is the cause of motion." After this it is not very surprising to read (p. 165) that as the "phrase 'change of velocity' is cumbersome, it is replaced by the exceedingly important word 'acceleration.'" And then, as if the author were not sure whether to give us too little or too much in his definitions, we are told in the very next sentence: "Acceleration is the change of velocity per unit of time *that occurs in a unit of time*"! That this is no mere *lapsus calami* is clear from the next page, where it is twice stated that acceleration is the "change of velocity per second *that occurs in one second*." Yet the author expressly states that "variable acceleration is not within our ken in this book." The Second Law of Motion is given in the imperfect Whewellian instead of the perfect Newtonian form, in which all the best treatises on dynamics have given it since the salutary return to Newtonian precision was inaugurated by Thomson and Tait. On p. 198 the author proposes to measure gravity on an Atwood's machine, with a falling mass of one centigramme. Did he ever try the experiment? On p. 241 the student is told that the Torricellian vacuum is to be found in the space left by the mercury at the top of a *thermometer*! Under the heading of Calorimeters (which instruments, by the way, are nowhere described) the novice is informed that "Joule established the fact that 772 pounds of mass falling through one foot give out a thermal unit"; from which it would appear that heat is the product of a mass into a length. Bad as this is, it is pardonable beside a passage in the introductory part of the book (p. 10), in which the reader is assured that a force generates heat at the point of its application when the point of application does not move forward. One grows weary of gathering from the rank crop of blunders; but a final example—the very last sentence of the book—shows the accuracy of our author's physical knowledge as displayed in his theory of dew. "A tarpaulin spread over the ground, or nature's tarpaulin of clouds, will *reflect* the *radiating rays* (sic) of heat, and under the tarpaulin or clouds dew is not deposited."

"Let me start," says Dr. Aveling (p. 6), "with two truisms—(1) That no book is worth reading that is not worth analysing; (2) that the ideas enunciated by a teacher, either by voice or pen, are not thoroughly the ideas of the learner until they have been expressed again in his own words. If, therefore, that which I am about to write is in any sense useful, it will be worth the while of the student to make analysis thereof." What if the student's analysis throw unexpected light on the first of these truisms? S. P. T.

Der Völkergedanke im Aufbau einer Wissenschaft vom Menschen, und seine Begründung auf ethnologische Sammlungen. (Berlin, 1881.)

Die Vorgeschichte der Ethnologie. (Berlin, 1881.)

THESE two pamphlets, by Prof. Adolf Bastian, are written to promote the doctrine he is never weary of teaching, that the scientific method of studying man is the museum-method of collecting and classifying his results, whether these be weapons or idols, or myths or superstitions, or what not. When in a group of such things there comes into view a common principle or thought, this is a *Volksgedanke*, a manifestation of the popular mind, a definite something for the science of man to occupy itself about. It was the desire to get at such general principles of human action that led the late Prof. Waitz to compile his Anthropology, and Prof. Bastian has gathered, in the many volumes he has published, an even vaster museum of human facts. In the first-named of the two publications above, the reader will find collections of evidence as to many of the problems which are now occupying the minds of anthropologists, such as the primitive relations of the sexes, the development of the family and of property, and the belief in ancestral and patron spirits. The few lines of comment with which the author links together his pages of citations are of especial value, as giving his judgment of the meaning of the facts. In the second pamphlet the author traces the growth of anthropological museums out of the old cabinets of curiosities. Neither treatise is well suited to quote passages from, as these lose their value when disconnected from the rest, like single specimens taken out of the museum. Now and then Prof. Bastian makes a sort of holiday digression, for instance where he collects page upon page about modern European miracles, relics, and pilgrimages, about which he truly says, "the nature-peoples, with their rude, clumsy fetishes, are no match for the subtleties of super-refined civilisation" E. B. T.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Telescopic Definition in a Hazy Sky

THE diminution of star disks during temporary haze or even by a thin passing cloud has been particularly noticed by Sir John Herschel. The effect of this haze is apparently to diminish the intensity of diffraction phenomena. The markings on the full moon have never been seen so blackened and distinct as through the haze of a London fog. On one occasion a very gentle east wind brought down a London fog to Reading. That evening the air was extremely still, but embrowned with the haze. Castor bore a magnifying power of 600 with a Wray $5\frac{1}{4}$ achromatic. The object-glass was being adjusted to the axis of the tube. Finally an intense jet black ring was seen to surround each star of this celebrated double, supplemented with one bright perfectly defined diffraction-ring, then a fainter ring at a further distance could be descried. The perfection of this definition has never since been attained. The haze had settled down into still air. The eastern breeze had died away. The brown fog remained in the sky; diffraction assumed its most perfect form. The moon bore any power I could muster with absolutely steady definition. These states of the atmosphere are extremely rare. I can now record a repetition of this wonderful steadiness. On November 9 Col. Abadie, Mr. Maunsel, and myself, were observing Saturn with an $8\frac{1}{2}$ Calver mirror. The crape veil and belts were well shown with the pale blue Polar cap. Ball's division was intensely black. The outer ring was narrow, and its dark grey tint contrasted strongly with the brilliant whiteness of the inner ring. I was greatly astonished, however, to descry Encke's division on the outer ring usually called A. The shadows of the ball were well marked. The eastward shadow much stronger than the western. A very brilliant narrow band edged the northern belt near the plane of the rings. The inner edge of the ring B projected a thin shadow on the ball. A lady who had no previous knowledge of the belts, entering the observatory last night, said they appeared to consist of several fine lines of parallel bands separated by very fine brighter bands. At 11 p.m. there was a very wide narrow halo round the moon. Saturn appeared much bedimmed, and Jupiter shorn of his brilliance. Yet Col. Abadie writes: "Jupiter was a sight to be remembered. The distinctness of all the belts was enhanced by bright zones; one to the north of the uppermost belt was particularly to be noticed. The clouds between the equatorial belts changed in appearance from being very fleecy to a long wavy appearance" (we were observing about three hours). The moon was too dim for observation. Encke's division is so seldom seen in my experience, its appearance in the field of so small a telescope was a matter of great surprise; and but for the concurrent testimony of two others for about a space of three hours, I certainly should have greatly doubted the accuracy of the observation. At all events, it is a valuable demonstration of the value of the *chiaro-oscuro* in astronomical research.

Eastbourne, November 16 G. W. ROYSTON-PIGOTT

The Morteratsch Glacier

DURING my stay in the Engadine this summer I took the opportunity of making a few observations relative to the movement of the Morteratsch Glacier, which may be of interest to some of your readers. These observations were taken *inside* the artificial cave of the above glacier in preference to the surface, as I thereby obtained a more direct measurement with a fixed point, as will be shown presently, and greater protection for the provisionary stations, made in the ice, against disturbances of fluctuating temperatures or the curiosity of visitors. The arrangement was very simple, namely: in the roof of the cave 2—$\frac{3}{4}$ in. round staves 2 feet long were fixed, at a relative angle of 45°, in such a way, that they prevented each other from dropping out, and were further clamped together by a small metal band, from which a plumb-bob was suspended. Below this, on the floor of the cave, was a boulder, firmly embedded in the earth, and unaffected by the ice; this constituted my fixed point, a line being cut on it to correspond with the centre of the bob. In this way any movement of the staves with the ice could easily be measured off. The following are some of the results obtained, and I would draw special attention to the fact that, although the valley narrows considerably towards the snout end of the glacier, and in consequence one would expect an increase in the flowing speed, the observations prove a decrease in speed to nearly one-third. Movement in cave from August 1 to September 18, or forty nine days, max. ·354 in., min. ·093 in., mean ·176 in. per day. (The surface movement taken at side of glacier, three-eighths of a mile from snout, up the valley, amounted to ·516 in. per day.) End of glacier receded in the same time 19 ft., or 4·65 in. per day. Ice advanced $8\frac{1}{4}$ in.; total loss in length 18 ft. $3\frac{3}{4}$ in., or nearly 4·5 in. per day. I must add that the point of observation was fixed at 40 ft. from the entrance, as beyond that and further in the cave the floor formed part of the glacier, and no fixed station could be found. Also, the surface friction of the ice on the shore—both at the side of the glacier, where the surface measurements were made, and at the cave—was considered about equal, and could therefore not account for the great difference of movement. HUGO LEUPOLD

November 10

Arctic Research

WITH reference to a letter in your number of this week (NATURE, vol. xxv. p. 53), in which it is stated that the Arctic shores trending north with a *western* aspect, are most encumbered with ice, and that those with an *eastern* aspect are most free from ice; I beg to suggest that, in order that your readers may not be misled on a point of geographical interest, you would do well to insert the following extract from the writings of Sir Edward Parry:—

"I will mention a circumstance which has particularly forced itself upon my notice in the course of our various attempts to penetrate through the ice in these regions; which is that the eastern coast of any portion of land, or what is the same thing, the western sides of seas or inlets, having a trending at all approaching to north and south, are, at a given season of the year, generally more encumbered with ice than the shores which have an opposite aspect. The four following may be adduced in illustration of this fact, and cannot but appear somewhat striking when considered in viewing a map which exhibits the relative position of the shores in question.

"It is well known that, in the extensive northern sea reaching from latitude 60° to 80°, bounded on the east by Lapland and Spitzbergen, and on the west by Greenland; the whole of the latter coast is blocked up by ice throughout the summer, so as to make it at least a matter of no easy enterprise to approach it, while the navigation of the eastern portion of that sea may be easily performed without difficulty, even to a very high latitude, and at an early part of the season. A second equally well-known instance occurs in the navigation of Davis Strait, which, from about Resolution Island, in latitude $61\frac{1}{2}$°, to the parallel of at least 70, is usually inaccessible as late as the month of August, and a great deal of it, in summer, is not accessible at all; while a broad and navigable channel is found open on the eastern side of the strait (that is, on the western coast of Greenland) many weeks before that time. We experienced a third and very striking example of this kind in coasting the eastern shore of Melville Peninsula in the years 1822 and 1823, the whole of that coast being so loaded with ice as to make the navigation extremely difficult and dangerous. Now, on the eastern side of Fox Channel, there is reason to believe, as well from the account of that navigation in 1631, and that of Baffin in 1615, as from our own observations, that there is little or no ice during the summer season. The last instance of the same kind which I shall mention is that of Prince Regent's Inlet, and of which the events of this voyage furnish too striking a proof, the ice appearing always to cling to the western shore in a very remarkable manner, while the opposite coast is comparatively free from it.

"These facts, when taken together, have long ago impressed me with the idea that there must exist in the Polar regions some general motion of the sea towards the west, causing the ice to set in that direction, when not impelled by contrary winds or local and occasional currents, until it butts against those shores which are actually found to be most encumbered by it."

I need only add that all subsequent observation has confirmed the accuracy of Sir Edward Parry's general rule; to which of course there are exceptions caused by the action of local currents and winds. CLEMENTS R. MARKHAM

21, Eccleston Square, November 19

Curious Formations of Ice

DURING a botanical expedition recently made to Gangotri Glacier I noticed, early on the morning of October 6, some very beautiful and curious formations of ice, which must have been formed during the previous night. It was freezing hard when I left my camp, after an early breakfast. The small pools beside the river were completely frozen over, and the smooth boulders of granite were coated with thick flakes of ice, which greatly increased the difficulty and danger of walking. Ascending a steep grassy slope (a favourite feeding-ground at this time of the year for barhal, or Himalayan sheep), I found the ground clothed over with small masses of pure white ice, very like mushrooms at a distance; I cannot give a better description of their general character than to liken them to a certain kind of thin, wafer-like cylindrical biscuit, which is sometimes eaten as an accompaniment of ices, only they were pure white and not cylindrical, but rather funnel-shaped, the larger opening being uppermost. In most cases there were two to four of these funnels, forming clusters round the lower portion of the stems of a species of Polygonum, which was abundant in this part of the valley, in an extremely dried-up condition. I should be glad to know if this curious kind of ice structure has been observed elsewhere.

Saharunpore, N.W.P., October 31 J. F. DUTHIE

Meteor

A MAGNIFICENT purple meteor was observed here on November 15, at 5h. 54m. p.m. G.M.T., by the Rev. A. Corti and one of the assistants of the Observatory. When first seen below β Aurigæ it was not very bright, but as it was passing through the constellation Lynx its brilliancy increased until it outshone Jupiter. Its shape was at first round, but, when it had passed near ϕ Ursæ, it burst into three pieces between γ and χ Ursæ, the largest of the three pieces being closely followed by the other two, which were as bright as first-magnitude stars. They all disappeared near η Ursæ, the total arc described being more than 70°. The meteor was visible for seven seconds, and left a long train, which soon disappeared. The velocity of the meteor decreased gradually as it approached its bursting point.

S. J. PERRY

Stonyhurst Observatory, Whalley, November 17

AT a quarter to five yesterday afternoon, when the sun had scarcely set and no star was visible, I and another inhabitant of this place saw a large blue meteor issue from a height of twenty degrees above the north-west horizon, and fall in a sharp curve for, say fifteen degrees, until it disappeared behind some woods. In falling it scattered large fragments behind it, but retained its nucleus, beside which Mars looked quite sickly. How vivid must the meteoric light have been! M. L. ROUSE

Sunnymead, Chislehurst Common, November 21

I OBSERVED a fine meteor last night at 1·3 a.m. It came into sight so closely in the neighbourhood of a brilliant white star, which I took to be Sirius, that, as it shot in an apparent straight line, or segment of a very large arc, across the sky, midway between Orion, then due south, and the horizon, the momentary illusion to the eye was that the star, which it equalled in magnitude and brilliancy had left its place and travelled west.

Bregner, Bournemouth, November 18 HENRY CECIL

ABOUT 5.45 on the evening of the 15th inst. a meteor, larger than Jupiter, but not so bright, appeared under Capella, and took a horizontal course, till it disappeared at about the same distance below the terminal star in the tail of Ursa Major. I never saw so long a flight. Twice in its course it disappeared or became very faint. Near the end it broke into two, the second part following the former. At any computation of its distance its flight in the upper regions of the atmosphere must have been in an enormously extended path. My son, who was with me, conjectured that its disappearance might be owing to its passing through a deep trough, or hollow of a wave, in the surface of the atmospheric ocean; in which the diminution of the friction might occasion a loss of incandescence; a suggestion rather favoured by the repetition of the phenomenon. Perhaps the meteor was only making ducks and drakes.

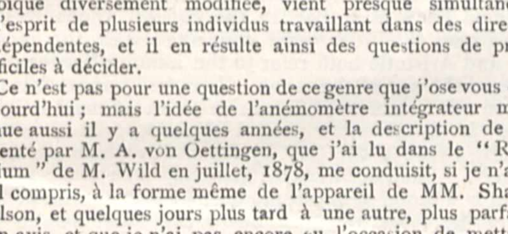
Rainhill, November 17 HENRY H. HIGGINS

Integrating Anemometer

J'AI lu avec beaucoup d'intérêt la controverse suscitée dans les colonnes de votre estimable journal, à propos de "l'Anémomètre Intégrateur" présenté par M. Hele Shaw et le Dr. Wilson à la dernière réunion de "l'Association Britannique." Il arrive souvent, dans l'histoire des inventions, qu'une même idée, quoique diversement modifiée, vient presque simultanément à l'esprit de plusieurs individus travaillant dans des directions indépendentes, et il en résulte ainsi des questions de priorité difficiles à décider.

Ce n'est pas pour une question de ce genre que j'ose vous écrire aujourd'hui; mais l'idée de l'anémomètre intégrateur m'était venue aussi il y a quelques années, et la description de celui inventé par M. A. von Oettingen, que j'ai lu dans le "Repertorium" de M. Wild en juillet, 1878, me conduisit, si je n'ai pas mal compris, à la forme même de l'appareil de MM. Shaw et Wilson, et quelques jours plus tard à une autre, plus parfaite à mon avis, et que je n'ai pas encore eu l'occasion de mettre en pratique. C'est celle dont les organes les plus essentiels ont été représentés dans les figures ci-jointes.

Un disque (roller) vertical A peut, comme dans l'instrument de MM. Shaw et Wilson, prendre la même orientation que la girouette et au même temps tourner sur son axe horizontal avec une vîtesse proportionelle à celle du vent. Sur ce disque s'appuit une sphère B, de poids et dimensions convenables, qui est aussi soutenu lateralement par quatre disques verticaux N., E., S., W., situés à angle droit entre eux. Le disque A fait mouvoir la sphère B dans le même plan vertical, et celle-ci les quatre disques lateraux; de sorte que, si les points de contact de ces disques avec la sphère ont lieu sur l'équateur dont le pôle est le point de contact du disque moteur, la vîtesse totale de celui-ci s'y trouvera decomposée dans les directions fondamentales N., S., E., W. Dès lors il suffira de munir chaque disque N., E.,



Projection verticale. Projection horizontale.

S., W., ou bien deux disques quelconques adjacents, d'un compteur spécial, pour obtenir les composantes cardinales du vent.

Cet anémomètre intégrateur sera, comme ceux de MM. Shaw et Wilson et de M. Burton, plus simple que celui de M. von Oettingen, et en outre son action deviendra, pour ainsi dire, indéfinie, la transmission du mouvement s'y effectuant au moyen d'une sphère. Cette transmission se fait ici par *roulement sans glissement*, ce qui n'a pas lieu dans le système de M. von Oettingen, où cette circonstance constitue un grave défaut.

Pour ne pas prolonger trop cette lettre, je n'insisterai plus sur mon anémomètre, dont les indications peuvent être obtenues de diverses manières, et dont le mécanisme est susceptible de recevoir plusieurs applications.

Si vous croyez que les lignes précédentes contiennent quelqu'idée nouvelle et utile, je vous prie de vouloir bien les insérer dans votre estimable journal. En attendant je vous remercie d'avance, et veuillez aussi, Monsieur, agréer l'assurance de ma plus haute estimation. V. VENTOSA

Madrid, le 5 novembre

Geological Results of the Late Gales

THE late gales have had a very powerful effect in redistributing the beach-deposits along our coasts, and though many well-known geological sections have no doubt been covered up in consequence, many new ones have at the same time been brought to light. In this neighbourhood, for instance, at Whitley-by-the-Sea, near Tynemouth, a section of the highest interest to local geologists has been uncovered within the last few weeks, showing a well-marked uncomformity within the Coal-measures, which I, for one, although familiar with the place for years, was totally unaware of, and which, if ever observed before, has certainly never been recorded. For some time to come the section will probably remain exposed at low tides, as the sand which formerly concealed it has been entirely swept away. I will not weary your readers with a detailed description of the section, which will, in due time, be more appropriately published elsewhere, but merely beg to record the observation as an example of the kind of new matter that many geologists resident on or near our coasts will probably come across by searching along the cliff-bases just now. G. A. LEBOUR

November 15

The Recent Weather

AT 11 o'clock last night two thermometers outside stood at 66°·75. It was pitch dark, and blowing fresh from south-southwest. When last tested, these thermometers were not ·25 of a degree in error. Was such a temperature ever registered at such an hour on the 13th November before in Great Britain or Ireland? RICHARD M. BARRINGTON

Bray, Co. Wicklow, Ireland, November 14

Dipladenia amabilis

IF it is not already well known, it may interest some of your readers to hear that flowers of the *Dipladenia amabilis* last for a much longer time when placed in water if their tubes be also filled. Even when "too utterly weary" they can be revived in the manner I have mentioned. This may have reference to the fact that these flowers, unlike many creepers, generally turn upwards, and would therefore be likely to catch rainwater.

AMY MULHOLLAND

High Elms, Hayes, Kent, November 13

"The Lepidoptera of Ceylon"

WITH reference to the remarks of Dr. H. Trimen (vol. xxv. p. 32) to this work, now in course of publication under the patronage of the Ceylon Government, of which Parts I. and II. only had then reached him, and especially to the "protest" which he "feels bound to enter" against the name of the artist as there printed at the foot of the several plates, I may be allowed to state that the *original drawings* made by the native artist, Mr. W. de Alwis (representing about 350 species, or one-third only of the number of Ceylon Lepidoptera known to the author, and that will eventually be figured in this work), which Dr. Trimen states are in the Colombo Museum, were copied by his brother, Mr. George de Alwis, for Sir William H. Gregory, whilst Governor of the Island. These copies are in the author's hands, and it is from them, wherever a suitable figure is available, as well as from specimens of the actual species there represented, that the drawings, and afterwards the lithographing the figures on the stone, were made. The artist's name, as there printed on the several plates of the work, is consequently perfectly correct. In due course, Part IV.—completing vol. i. of this work—will reach Ceylon, wherein the preface is printed, and Dr. Trimen will there see that the native artist to whom he so specially refers, receives the necessary acknowledgment of his labours from the author. F. MOORE

Penge, S.E.

A GLIMPSE THROUGH THE CORRIDORS OF TIME[1]

I.

YOUR Committee has done me much honour by inviting me to deliver the first lecture in this large and very beautiful hall. In accepting the task I was aware that it involved a great responsibility, but I had various grounds of encouragement. I remembered that I was not coming among you as a stranger, and I knew that I had a subject worthy of a memorable occasion. I would I were

[1] Lecture delivered at the Midland Institute, Birmingham, on October 24, 1881, by Prof. Robert S. Ball, LL.D., F.R.S., Andrews Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland. Contributed by the Author.

equally confident of my ability to do justice to so noble a theme.

The lecture bears the somewhat poetic title of "A Glimpse through the Corridors of Time." A poetic title has been chosen, because if I can properly exhibit the subject you will see that it appeals powerfully to the imagination as well as to the reason. I shall invite you to use your imagination to aid in looking back into the very remotest recesses of antiquity. And when I speak of antiquity I do not mean the paltry centuries with which our historians have to deal. The ancient days to which I refer are vastly anterior to those of the "grand old masters" and those of the "bards sublime." Nor do we even allude to the thousands of years which have elapsed since Babylon and Nineveh were splendid and populous cities Even the noble pyramids of Egypt are but of yesterday when compared with the æons of years which must pass before our review.

The most ancient human monuments that now exist cannot, I suppose, be more than a few thousand years old. Five thousand years nearly exhausts all historical time. Ten thousand years certainly does. Though we have no earlier historical record, yet other records are not wanting. Geology tells us that ten thousand years is but a mere moment in the span of the earth's history. We learn from geology that even the career of man himself has lasted far more than ten thousand years. Yet man is but the latest addition to the succession of life on the earth. For the chronology of the earlier epochs of the earth's history we require majestic units to give adequate expression to our dates. Thousands of years are not sufficient, nor tens of thousands, nor hundreds of thousands. The course of geological time is to be reckoned in millions of years.

The corridors of time through which I wish to give you a glimpse are these dignified millions. Yet our retrospect will only extend to a certain definite epoch in the past history of our earth. We speak of nothing anterior to the time when our earth assumed the dignity of maternity, and brought forth its first and only child. We shall trace the development of that child which, though millions of years old, is still in dependence on its parent. We shall describe the influence of the parent over the child and the not less remarkable reaction of the child upon the parent. We shall foreshadow the destiny which still awaits the mother and child when millions of years shall have elapsed.

At the time of its birth the earth was not as we see it now, clothed with vegetation and teeming with animal life. It was a huge inorganic mass, too hot for life, perhaps hot enough to be soft or viscid, if not actually molten. The offspring was what might be expected from such a parent. It was also a rude inorganic mass. Time has wrought wondrous changes in both parent and child. Time has transformed the earth into an abode of organic life. It has transformed the earth's offspring into our silvery moon.

It will be my duty to sketch for you the manner in which these changes have been brought about. To a great extent we can do this with no hesitating steps, we are guided by a light which cannot deceive. It is the light of mathematical reasoning. These discoveries are of an astronomical character, but they have not been made by telescopes. They have been made by diligent labours of the most abstruse kind. The mathematical astronomer sits at his desk, and not in an observatory. He has in his hand a pen and not a telescope. Before him lies a sheet of paper and not the starry heavens. He is no doubt furnished with a few facts from observation. It is his province to interpret those facts, to inform them with life, and to infer the unknown from the known. It is thus discoveries are made which are the sublimest efforts of human genius.

The argument on which I invite you to follow me is founded on a very simple matter. Many of those present go every summer to the sea-side. Those who do so are well acquainted with the daily ebb and flow which we call the tides. Even the children with their spades and buckets know how the flowing tide will fill their moats dug in the sand and inundate their mimic castles. In the ebb and flow of the tide we have a mechanical engine of mighty power. I hope this evening to point out the wonderful effect which tides have had on the earth in times past, as well as the effect they will exercise in the future. It is the tides which are to reveal to us a glimpse through the Corridors of Time.

The cause of the ebb and flow of the tide has long ceased to be a mystery. In the earliest times it was noticed that the tides were connected with the moon. Pliny and Aristotle both refer to the alliance between the tides and the age of the moon. It is well known that the tides on our coasts sometimes rise to an unusual height. Those who dwell on low ground adjoining tidal rivers are painfully aware of this fact by the floods which are often produced. Such occurrences generally take place at the time of new moon or of full moon. At first quarter or last quarter the tides are even below the usual height. A fisherman who has to regulate his movements by the tides will know full well that at certain times the tides rise higher and fall lower than at other times. He brings his boat out on the falling tide, he brings it back on the rising tide, and when making the harbour after a night's fishing, it would be natural to hear him say "Oh, we shall run in easily this morning, there is a strong tide, the moon was full last night." Or if he had to cross a dangerous bank he would soon learn the difference between the spring tide and the neap. Fishermen are not much addicted to abstract reasoning. For many centuries, perhaps indeed for thousands of years, observant men might have known that the moon and the tides were connected. But they did not know any reason why this connection should exist. I daresay they did not even know whether the moon was the cause of the tides or the tides the cause of the moon.

Nor is it easy to explain the tides. We were all taught that the moon makes the tides. Yet I can imagine an objector to say, If the moon makes the tides, why does it give Bristol a splendid tide of 40 feet, while London is put off with only 18? The true answer is that the height of the tide is largely affected by local circumstances, by the outline of the coasts, by estuaries and channels. It is even affected to some extent by the wind. Into such details, however, I do not now enter: all I require is that you shall admit that the moon causes the tides, and that the tides cause currents. In some few places the currents caused by the tides are made to do useful work. A large reservoir is filled by the rising tide, and as the water enters it turns a water-wheel. On the ebbing tide the water flows out of the reservoir, and again gives motion to a water-wheel. There is here a source of power, but it is only in very exceptional circumstances that such a contrivance can be worked economically. Sir W. Thomson, in his address to Section A of the British Association at York, went into this question in its commercial aspect. At present, however, we may say that the power of the tides is as much wasted as is the power of Niagara. Perhaps when coal becomes more scarce, and when the means of distributing power by electricity are more developed, the tides and the great waterfalls will be utilised; but that day will not be reached while coal is only a few shillings a ton.

Though we have not yet put the tides into harness, yet tides are not idle. Work they will do, whether useful or not. In some places the tidal currents are scouring out river-channels; in others they are moving sandbanks. From a scientific point of view the work done by the tides is of unspeakable importance. To realise the importance, let us ask the question, Whence is this energy derived with which the tides do their work? The answer seems a very obvious one. If the tides are caused by the moon, the energy they possess must also be derived from the moon. This looks plain enough, but unfortunately it is not true. Would it be true to assert that the finger of the rifleman which pulls the trigger supplies the energy with which the rifle bullet is animated? Of course it would not. The energy is derived from the explosion of the gunpowder, and the pulling of the trigger is merely the means by which that energy is liberated. In a somewhat similar manner the tidal wave produced by the moon is the means whereby a part of the energy stored in the earth is compelled to expend itself in work. I do not say this is an obvious result. Indeed it depends upon a refined dynamical theorem, which it would be impossible to enter into here.

But what do we mean by taking energy from the earth? Let me illustrate this by a comparison between the earth rotating on its axis and the fly-wheel of an engine. The fly-wheel is a sort of reservoir, into which the engine pours its power at each stroke of the piston. The various machines in the mill merely draw off the power from the store accumulated in the fly-wheel. The earth is like a gigantic fly-wheel detached from the engine, though still connected with the machines in the mill. In that mighty fly-wheel a stupendous quantity of energy is stored up, and a stupendous quantity of energy would be given out before that fly-wheel would come to rest. The earth's rotation is the reservoir from whence the tides draw the energy they require for doing work. Hence it is that though the tides are caused by the moon, yet whenever they require energy they draw on the supply ready to hand in the rotation of the earth.

The earth differs from the fly-wheel of the engine in a very important point. As the energy is withdrawn from the fly-wheel by the machines in the mill, so it is restored thereto by the power of the steam-engine, and the fly runs uniformly. But the earth is merely the fly-wheel without the engine. When the work done by the tides withdraws energy from the earth, that energy is never restored. It therefore follows that the energy of the earth's rotation must be decreasing, This leads to a consequence of the most wonderful importance. It tells us that the speed with which the earth rotates on its axis is diminishing. We can state the result in a manner which has the merits of simplicity and brevity.

"The tides are increasing the length of the day."

This statement is the text of the discourse which I am to give you this evening. From this simple fact the new and wondrous theory of tidal evolution is deduced. A great scientific theory is generally the outcome of many minds. To a certain extent this is true of the theory of tidal evolution. It was Prof. Helmholtz who first appealed to what tides had already done on the moon. It was Prof. Purser who took an important step in the analytical theory. It was Sir William Thomson's mathematical genius which laid the broad and deep foundations of the fabric. These are the pioneers in this splendid research. But they were only the pioneers. The great theory itself is chiefly the work of one man. You are all familiar with the name he bears. The discoverer of tidal evolution is Mr. G. H. Darwin, Fellow of Trinity College, Cambridge.

It would be impracticable for me now to go into the actual mathematical calculations. I shall rather endeavour to give you an outline of this theory, shorn of its technical symbols. I think this can be done even though we attempt to retain the accuracy of mathematical language. Nor would it be fair to throw on Mr. Darwin or the other mathematicians I have named the responsibility for all I am going to say. I must be myself responsible for the way in which those theories are set forth, as well as for some of the deductions made from them.

At present no doubt the effect of the tides in changing the length of the day is very small. A day now is not appreciably longer than a day a hundred years ago. Even in a thousand years the change in the length of the day is only a fraction of a second. But the importance arises from the fact that the change, slow though it is, lies always in one direction. The day is continually increasing. In millions of years the accumulated effect becomes not only appreciable but even of startling magnitude.

The change in the length of the day must involve a corresponding change in the motion of the moon. This is by no means obvious. It depends upon an elaborate mathematical theorem. I cannot attempt to prove this for you, but I think I can state the result so that it can be understood without the proof. If the moon acts on the earth and retards the rotation of the earth, so, conversely, does the earth react upon the moon. The earth is tormented by the moon, so it strives to drive away its persecutor. At present the moon revolves round the earth at a distance of about 240,000 miles. The reaction of the earth tends to increase that distance, and to force the moon to revolve in an orbit which is continually getting larger and larger.

Here then we have two remarkable consequences of the tides which are inseparably connected. Remember also that we are not enunciating any mere speculative doctrine. These results are the inevitable consequence of the tides. If the earth had no seas or oceans, no lakes or rivers; if it were an absolutely rigid solid throughout its entire mass; then these changes could not take place. The length of the day would never alter, and the distance of the moon would only fluctuate between narrow limits.

As thousands of years roll on, the length of the day increases second by second, and the distance of the moon increases mile by mile. These changes are never reversed. It is the old story of the perpetual dropping. As the perpetual dropping wears away the stone, so the perpetual action of the tides has sculptured out the earth and moon. Still the action of the tides continues. To-day is longer than yesterday; yesterday is longer than the day before. A million years ago the day probably contained some minutes less than our present day of twenty-four hours. Our retrospect does not halt here; we at once project our view back to an incredibly remote epoch which was a crisis in the history of our system.

Let me say at once that there is great uncertainty about the date of that crisis. It must have been at least 50,000,000 years ago. It may have been very much earlier. This crisis was the interesting occasion when the moon was born. I wish I could chronicle the event with perfect accuracy, but I cannot be sure of anything except that it was more than 50,000,000 years ago.

I do not admit that there is anything discreditable about this uncertainty. Do you not know that our historians, who have records and monuments to help them, are often in great confusion about dates? I am not going to find any fault with historians. They do their best to learn the truth; but I cannot help reminding you that they are often as much in the dark about centuries as the astronomers are about millions. Take, for example, the siege of Troy, which Homer has immortalised, and ask the historians to state the date of that event. Some say that the siege of Troy was 1184 B.C., others that it was 900 B.C.; both are equally uncertain. Schliemann says that he found the remains of the town burned down, but that no one knows who did it or when it was done. Others, again, say that there was never any siege of Troy at all.

A recent instance which has attracted great and deserved attention is Schliemann's discovery at Mycenæ of what he considers to have been the tomb of Agamemnon. The tomb certainly did contain the remains of some mighty man, if we may judge by the 100 lb. weight of gold ornaments which were found there. Most people think that these tombs, whosever they were, date from at least 1000 B.C. On the other hand, some very high authorities regard the monuments as the tombs of northern invaders who came into Greece 500-600 A.D. Here then we have a range of some 1500 years for the date of the tombs, and no dates between these two are possible. I am sure I do not pretend to decide between them, or even to have an opinion on the subject; but I cannot help saying that in one respect the astronomers are better off than the historians. The historians cannot even agree whether Schliemann's gold ornaments are B.C. or A.D. Astronomers are, at all events, certain that the date of the moon's birth was before the present era.

At the critical epoch to which our retrospect extends, the length of the day was only a very few hours. I cannot tell you exactly how many hours. It seems, however, to have been more than two and less than four. If we call it three hours we shall not be far from the truth. Perhaps you may think that if we looked back to a still earlier epoch, the day would become still less and finally disappear altogether! This is however not the case. The day can never have been much less than three hours in the present order of things. Everybody knows that the earth is not a sphere, but that there is a protuberance at the equator, so that, as our school books tell us, the earth is shaped like an orange. It is well known that this protuberance is due to the rotation of the earth on its axis, by which the equatorial parts bulge out by centrifugal force. The quicker the earth rotates the greater is the protuberance. If, however, the rate of rotation exceeds a certain limit the equatorial portions of the earth could no longer cling together. The attraction which unites them would be overcome by centrifugal force, and a general break up would occur. It can be shown that the rotation of the earth when on the point of rupture corresponds to a length of the day somewhere about the critical value of three hours, which we have already adopted. It is therefore impossible for us to suppose a day much shorter than three hours. What occurred prior to this I do not here discuss.

Let us leave the earth for a few minutes, and examine the past history of the moon. We have seen the moon revolves around the earth in an ever-widening orbit, and consequently the moon must in ancient times have been nearer the earth than it is now. No doubt the change is slow. There is not much difference between the orbit of the moon a thousand years ago and the orbit in which the moon is now moving.

But when we rise to millions of years the difference becomes very appreciable. Thirty or forty millions of years ago the moon was much closer to the earth than it is at present; very possibly the moon was then only half its present distance. We must however look still earlier, to a certain epoch not less than fifty millions of years ago. At that epoch the moon must have been so close to the earth that the two bodies were almost touching. I daresay this striking result will come upon many with surprise when they hear it for the first time. It was, I know, with great surprise that I myself read of it not many months ago. But the evidence is unimpeachable, and it is indeed wonderful to see how such information has been gained by merely looking at the ripples of the tide.

Everybody knows that the moon revolves now around the earth in a period of twenty-seven days. The period depends upon the distance between the earth and the moon. The time and the distance are connected together by one of Kepler's celebrated laws, so that, as the distance shortens, so must the time of revolution shorten. In earlier times the month must have been shorter than our present month. Some millions of years ago the moon completed its journey in a week instead of taking twenty-eight days as at present. Looking back earlier still, we find the month has dwindled down to a day, then down to a few hours, until at that wondrous epoch when the moon was almost touching the earth, the moon spun round the earth once every three hours.

It would require the combined powers of a poet and a mathematician to pourtray the scene with becoming dignity. I have only promised to give you that glimpse along the Corridors of Time which I have myself been able to obtain. The scene is laid in the abyss of space; the time is more than 50,000,000 years ago; the *dramatis personæ* are the earth and the moon.

In those ancient times I see our earth to be a noble globe, as it is at present. Yet it is not partly covered with oceans and partly clothed with verdure. The primæval earth seems rather a fiery and half-molten mass, where no organic life can dwell. Instead of the atmosphere which we now have, I see a dense mass of vapours in which perhaps all the oceans of the earth are suspended as clouds. I see that the sun still rises and sets to give the succession of day and of night, but the day and the night together only amount to three hours instead of twenty-four. Almost touching the chaotic mass of the earth is another much smaller and equally chaotic body. Around the earth I see this small body rapidly rotating. The two revolve together as if they were bound by invisible bands. This smaller body is the moon. Such is the picture which I wish to present to you as a glimpse through the Corridors of Time.

I have hitherto refrained from introducing any merely speculative matters. If we can believe anything of mathematics, anything of dynamics, we must admit that the picture I have attempted to outline is a faithful portrait. The only uncertain elements are the date and the periodic time. I do however now propose to venture on one speculation in which Mr. Darwin has indulged. I propose to offer a suggestion as to how a small body came into this most remarkable position close by the earth, and how its motion was produced.

We have hitherto been guided by the unerring light of dynamics, but at this momentous epoch dynamics deserts us, and we have only probability to guide our faltering steps. One hint, however, dynamics does give. It reminds us that a rotation once in three hours is very close to the quickest rotation which the earth could have without falling to pieces. As the earth was thus predisposed to rupture, it is of extreme interest to observe that a cause tending to precipitate such a rupture was then ready to hand. It seems not unlikely that we are indebted to the sun as the occasion by which the moon was fractured off from the earth and assumed the dignity of an independent body. It must be remembered that the sun produces tides in the earth as well as the moon, but the solar tides are so small compared with the lunar tides, that we have hitherto been enabled to neglect them. There could however have been no lunar tides before the moon existed, and consequently in the early ages before the moon was detached the earth was disturbed by the solar tides, and by the solar tides alone.

The primæval earth thus rose and fell under the tidal action of the sun. Probably there were no oceans then on the earth; but tides do not require oceans, or even water, for their operation. The primitive tides were manifested as throbs in the actual body of the earth itself, which was then in a more or less fluid condition. Even at this moment bodily tides are disturbing the solid earth beneath our feet; but these tides are now so small as to be imperceptible when compared with the oceanic tides.

(*To be continued.*)

SOME "GUESSES AT TRUTH" OF THE EMPEROR KHANG-HI

KHANG-HI or Khang-hsi, one of the greatest of Chinese emperors, and indeed of Asiatic rulers, was born in 1653 and ascended the throne in 1661. For sixty-one years he ruled his vast dominions with vigour and success. His biographers, the Jesuit missionaries, whom he treated with unusual consideration, represent him as a Chinese Admirable Crichton—man of letters, *savant*, philosopher, politician, philanthropist, and warrior. In his early years he showed the utmost ardour for study, and the love of learning continued with him until his death. When the Jesuits taught European astronomy he did not hesitate to place himself under them as a student. He has left behind him works on most branches of human knowledge, extending over a hundred volumes. The fourth part contains his observations on natural history and physics. It was translated into French by Père Amiot, and partially published at Paris towards the end of the last century in the *Mémoires concernant les Chinois*, and is to be found in the fourth volume of that series. We here extract and summarise a few of the Imperial opinions. To use the words of the translator, "If our scholars find nothing to learn there, they will at least see that there is not so much ignorance amongst foreign nations as is generally believed." We follow the Emperor's language as far as possible.

Earthquakes.—Some years ago, when reading for instruction, as well as to foster my love of truth and reason, I had the curiosity to examine into the causes of earthquakes. One writer says that they come from air confined in the bowels of the earth, seeking to burst its prison and make an aperture for itself. An earthquake hardly ever extends more than ten leagues in area, although its effects may be felt over a hundred leagues. The manner in which a shock is felt on the surface depends on the nature of the ground through which it is transmitted. When the air [within the earth] is exhausted by a great shock there is no danger of another for some time; but a weak shock is almost always the prelude to another. In the dynastic history of Song it is stated that earthquakes are produced by the struggles of the *Yang* [1] against obstacles within the earth; while another work attributes them to the efforts made by the *Yang* and *Yin* to separate from each other. The countries north-west of China are very subject to earthquakes, ten years scarcely ever passing without one. The reason of this is that these districts contain vast sandy tracts where there is little rain, and the air within the earth is therefore keener and more vigorous. Earthquakes, on the other hand, which take place in countries adjoining the sea are less violent, for the earth is humid, and softens the air. People accustomed to the sea assert that there is no wind before an earthquake, and that at such times experienced pilots get as far off from the land as possible. This shows that the shocks are caused wholly by air.

Volcanoes.—An ancient writer states that a certain mountain in Yunnan was called the fire-mountain, because flames came from an opening in it. Some modern critics have accused this historian of lying; but volcanoes do certainly exist. They are mentioned in the records of the Song dynasty, and in other books. In the country of the Mongols flames are thrown up in many places. The fertility of the soil is much increased by these fires, for the people sow their grain near them, and reap a bountiful harvest in a few months.

Form of the Earth.—It seems evident from tradition and records that the North Pole has always remained in the same position. But what is the shape of the earth? Europeans, who are great travellers, say that it is round, and astronomy confirms this. One philosopher says that it is very old, and compares it to the yolk of an egg. How many things there are which we do not understand, but which will be known to future ages! We know the extent of our knowledge from ancient books, and so it will be with posterity from our books.

The Mariner's Compass.—The magnetic needle always declines a little. It cannot point directly to the south. This declination is uncertain, and does not depend always on the country. In the twenty-second year of my reign (1683) it declined three degrees at Peking, but only two and a half at present. The declination may be towards the east in one province, and towards the west in another. One of the Song letters says that this depends on the manner in which the needle is magnetised; but then why should the same needle vary in different years? Moreover, each compass should have its own declination, and there should be some which do not decline at all. Can it be that there is some accidental cause which is peculiar to each country? I believe Europeans say the needle turns towards the north; the ancients say that it is towards the south. Which is right? Neither party says why, and therefore no more is learned from one than from the other. However the ancients are the earliest recorders, and the more I see the more convinced I am that they understood the workings of nature.

Sound and Tones.—Nothing is apparently more simple than the theory of sound; but nothing is really more difficult or complicated. Sound conveys to the mind the developed ideas of others. The pleasure derived from music is half way between that felt at the art and the grosser voluptuousness of the senses. People possess ears without reflecting why, or what services they render and pleasures they procure. For myself, I have always been struck with the manner in which the tone of voice expresses the most varied emotions of the mind. It is not necessary to see the face, or even to hear the words spoken; the tone alone is sufficient to tell how the speaker is moved. It is with the voice as with beauty, the impressions made by it vary according to the person. There are people whose voices go straight to the heart, and are sufficient of themselves to inspire friendship or love. This fact, it is certain, is part of a theory of which we as yet know little. I have read many works on the theory of echoes. The ignorant account for them by fables, and the learned give rules. I think the vibrations of two loud chords struck in unison should serve to explain the reason of echoes heard in valleys and from the walls of buildings.

The simpler the laws of nature and the more sublime, the farther they are from our comprehension; my own thoughts are most frequently those of doubt. I turn away from those who pretend to explain everything and wait for an explanation of the concord of the cords of the *king* [1] with the flute, the different sounds of a hundred instruments, and the numerous voices that find their way into the air, bearing to our ears an indefinable sense of harmony. Awaiting this I say to myself with the ancients, "That which is nearest us is most remote from our comprehension." My ignorance on these matters has never troubled me, because it is no obstacle to that great duty to flee the evil and do that which is good.

Climate.—The effect of climate on the inhabitants of a country as well as on its productions is very great. The men of the south are women compared with those of the north. Vigour of body imparts vigour of mind. When our court was in the south the increase of riches consequent on its sojourn there caused luxury, effeminacy, and a corruption of manners which almost changed the men into women, so enslaved and delicate did they become in this prosperity. Now that it is in the north, they have become firmer, more active, and more regular. Naturalists and astrologers are equally mistaken when they judge of the character, genius, inclinations, and customs of men according to climate and the stars. My Tartars are Tartars, as regards manner of life, as much in the southern provinces as in the north, and people from the south retain their habits when they come to the north. The history of each province exhibits *savants*, literary men, artists, warriors, and monsters alike. Man is man everywhere, and there is often as much difference between the people in one town as between those in provinces distant from each other. Leou-chi has truly said, "No climate tames the tiger, or gives courage to the rabbit."

Winds.—The proverb says that the wind which blows is the same a hundred leagues away, but the rain which falls is not the same ten leagues off. Why should this be? One can only reason on facts after knowing them, and I know that the statement respecting the wind is not always correct, for there have been different winds at the same time in the provinces of Pechili and Shantung, which adjoin each other. It seems to me that winds depend on the nature of a country. One writer says that they depend on the motions of the stars, and that therefore they never cease, although at one time they may be more violent than at another, according as they are more or less impelled towards the earth. Moreover, the change in the direction of the wind comes from the same cause. The air being confined between the earth and the higher spheres, escapes where it can; and possibly the difference between a high and a low wind may be explained in this way. Another ancient writer says that the quarter from which the winds come depends on the season, and that they pass directly from one cardinal point to another. All

[1] *Yang* and *Yin*, the dual powers which, united, Chinese philosophers regard as forming, directing, and modifying all things: the male and female principles.

[1] *King*, a sort of dulcimer made of glass or stone.

other winds are temporary and accidental. I have paid particular attention to this matter, and I find the usual wind in Peking is from the south-west, and that other winds do not continue for any length of time. From the *Y-king* it appears that was the same in the most ancient times. It is a fact, attested by the daily record of our observatory here, that the wind does not remain long in any of the four cardinal points, as asserted by the writer above mentioned. Whatever be the causes of the different directions of the wind, it is certain that there are local and temporary, as well as general and universal ones. These can only be discovered by a multitude of observations. Again, why is it that when the wind blows, ice melts first at the water's edge, unless it be that the wind has penetrated the water? A more singular fact still is that there are some winds which are only felt in deep water. The history of the Yuen dynasty affirms that people bathing have become icy cold from a wind of which they have become suddenly sensible.

Thermal Springs.—Nothing is truer than that mineral waters are very efficacious in curing several maladies. They are better for those past forty years of age than for younger persons. Hot baths enfeeble and exhaust the latter, because, the blood still possessing all its force, they cause fermentation and perspiration, which disorder and injure the constitution. At a more advanced age, on the other hand, they revivify the blood and clear the bones, nerves, and tissues of the body from the impurities which years bring in their train. Baths should not be taken for some time after eating, and one should be careful of exposure to the air after them. I mention this because everything affecting the health of mankind interests me. It is clear that the heat, smell, taste, and medicinal virtues of thermal springs are the effects of a mixture of foreign substances in the water. But what are these substances? In what quantity and proportion are they present? This has not been sufficiently examined. Whenever I meet a mineral spring on my journey I examine it by means of an alembic, and by the alum, sulphur, or metal found there I know its properties. In this respect we must not follow the ancients. They decided superficially by the taste, smell, or colour. I wish these waters were studied better, as then it would be known what diseases they were best suited to cure.

We have not space to give any more of the Emperor's observations. Those translated above are sufficient to show his love of knowledge, and his desire to benefit his subjects by utilising the results of research. Some of his remarks are almost epigrammatic, and with a few of them we will bring this article to a close.

"Lying is the first resource of ignorance; but what shall we do when we do not know the truth? Be silent."

"I love to admire the manner in which nature confounds our ideas of the greatness of human industry, and baffles all the resources of our penetration. How difficult it is to admire worthily! Is not a small insect, a blade of grass, more worthy of our admiration than any production of human hands?"

"We spoil children by our puerile cares for their health. We have, alas! too many wants; why should we increase them?"

"Heaven provides for the wants of men according to the places in which they live."

"I prefer to procure a new species of fruit or of grain for my subjects than to build a hundred porcelain towers."[1]

"Every one desires health and loves life, but no one practises temperance and frugality. They invent pleasant remedies which they imagine will cause them to digest. Eat little, and you will digest much."

"I attribute my good health to the fact that I drink nothing but water, which I distil myself."[2]

[1] For a description of the celebrated porcelain tower of Nanking, see Williams's "Middle Kingdom," vol. i. p. 82. It should be added that this remarkable work was destroyed during the occupation of the city by the Taipings, and it may be said of it now, *etiam pereunt ruinæ*.

[2] The absence of any system of drainage in Chinese cities should be remembered here.

ON THE EVOLUTION OF ANTLERS IN THE RUMINANTS

THE development of antlers in the Ruminants to which Sir John Lubbock alluded in his address to the British Association at York, confirms the truth of the doctrine of evolution in so clear a way that it is well worthy of being laid before the readers of NATURE, although I have already brought it in part before the Geological Society in 1877 (*Quart. Journ. Geol. Soc.* xxxiv. 419), and published it in outline three years later, in my work on "Early Man in Britain, and His Place in the Tertiary Period." The results of an inquiry to which I was led by a systematic study, extending over several years, of the more important collections of fossil mammalia in Britain, France, and Italy, may be summed up as follows:—

In the Middle Stage of the Meiocene the cervine antler consists merely of a simple forked crown (*Cervus dicroceros*), which increases in size in the Upper Meiocene, although it still remains small and erect, like that of the roe. In *Cervus Matheroni* it measures 11·4 inches, and throws off not more than four tynes, all small (Fig. 1).

The deer living in Auvergne in the succeeding or Pleiocene age present us with another stage in the history of antler development. There for the first time we see antlers of the axis and Rusa type larger and longer and more branching than any antlers were before, and possessing three or more well-developed tynes (Figs. 2, 3, 4, 5).

Deer of this type abounded in Pleiocene Europe, and I have examined their remains from the Red Crag of Norwich and of Suffolk, from various localities in Middle and Southern France, from Italy, and even from the little Island of Capri. They belong to the Oriental division of the Cervidæ, and their presence in Europe confirms the evidence of the flora brought forward by the Count de Saporta, that the Pleiocene climate of Middle Europe was warm. They have probably disappeared from Europe in consequence of the lowering of the temperature in the Pleistocene Age, while their descendants have found a congenial home in the warmer regions of Eastern Asia.

In the latest stage of the Pleiocene—the Upper Pleiocene of the Val d'Arno—the *Cervus dicranios* of Nesti (Fig. 6) presents us with antlers much smaller than those of the Irish elk, but so complicated as almost to defy description. This animal survived into the succeeding age, and is found in the pre-glacial forest bed of Norfolk, being described by Dr. Falconer under the name of Sedgwick's Deer (*C. Sedgwickii*).

The Irish elk, moose, stag, reindeer, and fallow deer appear in Europe in the Pleistocene age, all with highly complicated antlers in the adult, and the first possessing the largest antlers as yet known. Of these the Irish elk disappeared in the Prehistoric age after having lived in countless herds in Ireland, while the rest have lived on into our own times in Euro-Asia, and, with the exception of the last, also in North America.

From this survey it is obvious that the cervine antlers have increased in size and complexity from the Mid-Meiocene to the Pleiostocene age, and that their successive changes are analogous to those which are observed in the development of antlers in the living deer, which begin with a simple point and increase in number of tynes till their limit of growth be reached. In other words, the development of antlers indicated at successive and widely separated pages of the geological record is the same as that observed in the history of a single living species. It is also obvious that the progressive diminution of size and complexity in the antlers from the present time back into the early Tertiary age shows that we are approaching the zero of antler-development in the Mid-Meiocene age. I have been unable to meet with a trace of any antler-bearing ruminant in the Lower Meiocenes either of Europe or of the United States.

Nor are we left without direct evidence on this point. The discoveries in the Mid-Meiocene shale of Sansan in the South of France, published by Prof. Ed. Lartet in 1839 and 1851, and those made in New Mexico, Colorado, and Nebraska, and published by Prof. Cope in 1874–1877, present us with a series of antlers in which the burr is conspicuous by its absence. Still more recently, in 1878, similar specimens (*Procervulus*) have been described by Prof. Gaudry ("Les Enchainements," p. 87) from the Mid-Meiocene strata of Thenay in the valley of the Loire. In all these cases the bony prolongation of the frontals—for antler it can hardly be termed—is small, erect, and variously branched, is persistent through life, and probably, as Prof. Cope suggests, was covered, as in the giraffe, and on young growing antlers, with skin.

In some, however, of Prof. Cope's specimens a well-marked burr is to be seen on some of the tynes (The United States Geogr. Survey, Part II. vol. iv. Palæontology, Pl. lxxx., 3*b*, 4*a*), due perhaps to an accidental stripping of the velvet, and consequent inflammation, resulting

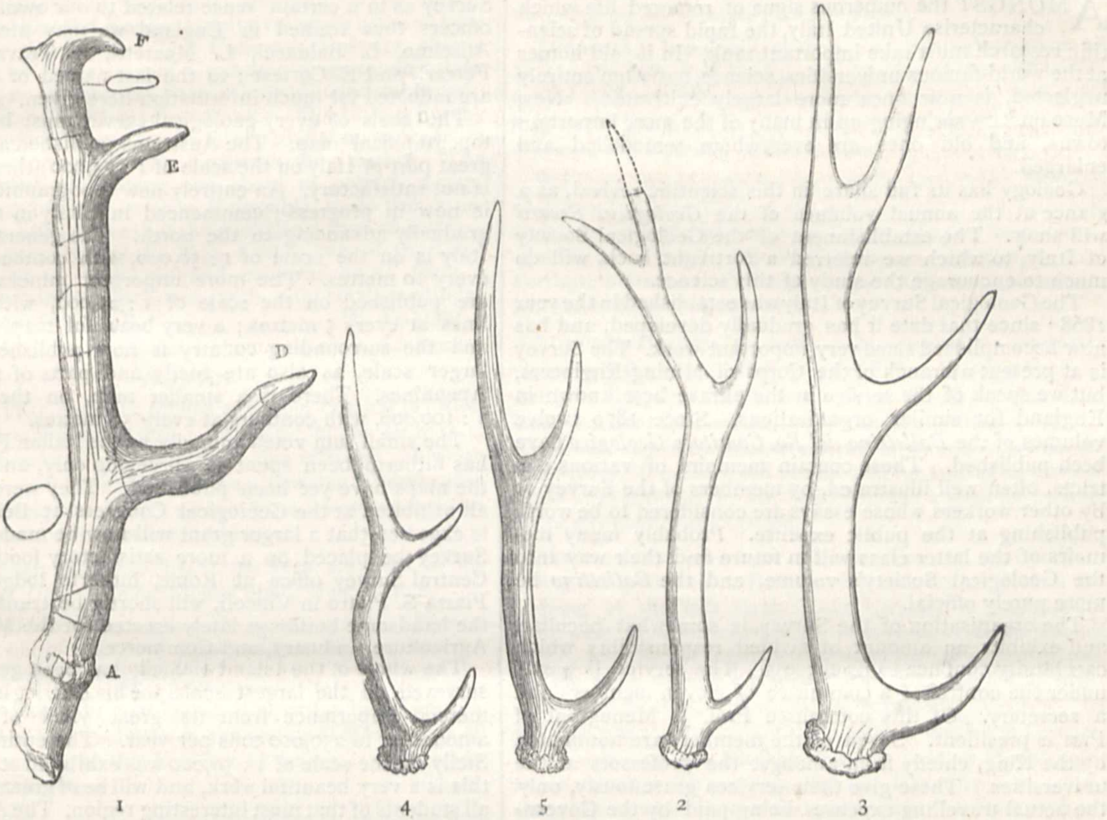


Fig. 1.—*Cervus Matheroni*, Gerv., Upper Meiocene, Mont Léberon (¼) Fig. 2.—*C. perrieri*, Cr. and Job., Upper Pleiocene, Mont Perrier (⅙). Fig. 3.—*C. issiodorensis*, Cr. and Job., Upper Pleiocene, Mont Perrier (⅙). Fig. 4.—*C. etueriarum*, Cr. and Job., Upper Pleiocene, Mont Perrier (⅙). Fig. 5.—*C. pardinensis*, Cr. and Job., Upper Pleiocene, Mont Perrier (⅙).

in the death of the bony tissue above it. We may therefore conclude that this singular *Procervulus* type was the starting-point of the antlered Ruminants both in the Old and the New Worlds. In both, moreover, it is associated with the *Dicroceros* type. The two phases of antler development in the Mid-Meiocene age in Europe, and probably at the same age in North America, are represented by living deer, first by the transient condition of the

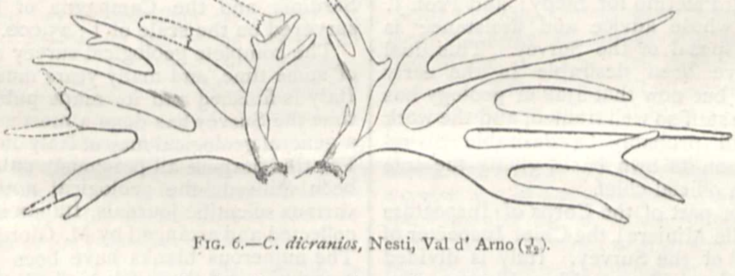


Fig. 6.—*C. dicranios*, Nesti, Val d' Arno ($\frac{1}{12}$).

young antler in the velvet, and secondly by the second antler in most species, and by the simple-forked upright antler of the adult muntjac.

The antlers also of the adult fallow deer (*C. dama*) present variations which can, in my opinion, only be accounted for by the doctrine of evolution. The ancestral form appears in the Pleistocene age in Britain, and is characterised by antlers palmated in front, instead of behind the beam, as in the normal living species, from which I defined it under the name of *C. Browni*, after its discoverer at Clacton in Essex. It occurs also in the gravels of the Thames Valley at Acton. Sir Victor Brooke has pointed out that some three or four specimens out of the vast number of antlers of the living form which he has examined possess exactly the same character. Its appearance in the living form may be explained by the hypothesis of a reversion similar to that by which from time to time a horse is born with three toes, due to its descent from a three-toed ancestor. W. BOYD DAWKINS

THE GEOLOGICAL SURVEY OF ITALY

AMONGST the numerous signs of renewed life which characterise United Italy, the rapid spread of scientific research must take important rank. In its old homes at the world-famous universities, science, not often entirely neglected, is now once more largely cultivated. New Museums are springing up in many of the more important towns, and old ones are everywhere remodelled and enlarged.

Geology has its full share in this scientific revival, as a glance at the annual volumes of the *Geological Record* will show. The establishment of the Geological Society of Italy, to which we referred a fortnight back, will do much to encourage the study of this science.

The Geological Survey of Italy was established in the year 1868; since that date it has gradually developed, and has now accomplished some very important work. The Survey is at present a branch of the Corps of Mining Engineers, but we speak of the service in the phrase best known in England for similar organisations. Since 1870 twelve volumes of the *Bollettino del Ro. Comitato Geologico* have been published. These contain memoirs of various districts, often well illustrated, by members of the Survey or by other workers whose essays are considered to be worth publishing at the public expense. Probably many memoirs of the latter class will in future find their way into the Geological Society's volume, and the *Bollettino* be more purely official.

The organisation of the Survey is somewhat peculiar, and exhibits an amount of divided responsibility which can hardly conduce to its success. The service is partly under the control of a committee of eleven members and a secretary. Of this committee Prof. J. Meneghini of Pisa is president. Seven of the members are nominated by the King, chiefly from amongst the professors at the universities. These give their services gratuitously, only the actual travelling expenses being paid by the Government. The remainder are official members, and some of them are in other ways connected with the Survey.

Each member of the committee has a certain amount of influence in the control of the Survey within his own district; he is supposed to be consulted upon all questions relating to classification, naming of fossils, &c., but the surveyors are really responsible to the official chief of the Survey, M. G. Giordano. Three members of the Scientific Committee take the chief share in the direction. These are Prof. J. Meneghini for Tuscany and Rome; Prof. G. Cemmellaro of Palermo for Sicily; and Prof. J. Capellini of Bologna, whose advice and assistance is always freely at the disposal of the Survey. This dual government might have been desirable in the early stages of the Survey; but now that Italian geology has made such progress, the staff so well trained, and the work so far advanced, it will probably be desirable to reorganise the Survey upon its own basis, giving the sole responsibility to its own official chief.

The surveying staff is part of the Corps of Inspectors of Mines (Ingegneri delle Miniere), the Chief Inspector of which is also the Chief of the Survey. Italy is divided into eight mineral districts—Turin, Milan, Vicenza, Florence, Ancona, Naples, Caltanissetta, Iglesias (Sardinia). The Inspectors of Mines have duties very similar to those of officers holding a like position in England. They visit and report upon mines in cases of accidents, and when any important changes take place in the working of the mines they may be called on for advice. The engineers are chosen from students trained in one of the seven engineering schools of Italy (Turin, Milan, Padua, Bologna, Pisa, Naples, Palermo). They then go for two years to a foreign mining school (Berlin, Freiberg, London, or Paris). Those engineers who are to serve on the Geological Survey Staff receive additional instruction for this purpose. Till now this extra training has generally been obtained from the Geological Survey of England, so that we may regard the Italian Survey as in a certain sense related to our own. Of the officers thus trained in England we may mention M. Anselmo, L. Baldacci, L. Mazzetti, R. Travaglia, De Ferrari, and E. Cortese; to the last named of these we are indebted for much information here given.

The basis of every geological survey must be a good topographical map. The Austrians published a map of a great part of Italy on the scale of 1 : 75,000; this however is not satisfactory. An entirely new topographical survey is now in progress; commenced in Sicily in 1862, it is gradually advancing to the north. The general map of Italy is on the scale of 1 : 50,000, with contour lines at every 10 metres. The more important mineral districts are published on the scale of 1 : 25,000, with contour lines at every 5 metres; a very beautiful map of Rome and the surrounding country is now published on the larger scale, as also are Sicily and parts of the N.W. Apennines. There is a smaller map, on the scale of 1 : 100,000, with contours at every 50 metres.

The small sum voted annually by the Italian Parliament has hitherto been spent in surveying only, and none of the maps have yet been published. They were however all exhibited at the Geological Congress at Bologna. It is expected that a larger grant will now be made, and the Survey be placed on a more satisfactory footing. The Central Survey office at Rome, hitherto lodged in the Piazza S. Pietro in Vincoli, will shortly be transferred to the handsome buildings lately erected for the Ministry of Agriculture, Industry, and Commerce.

The whole of the Island of Sicily has been geologically surveyed on the largest scale. This district is of commercial importance from its great yield of sulphur, amounting to 250,000 tons per year. The entire map of Sicily on the scale of 1 : 50,000 was exhibited at Bologna; this is a very beautiful work, and will be of great service to all students of that most interesting region. The Apennines north of Pisa are also surveyed on the scale of 1 : 25,000. This district is of great importance from the marble quarries of Carrara, Massa, &c., the yield of which is 150,000 tons per year. Great uncertainty has long been felt as to the geological age of the Carrara marble; it contains no fossils, and its exact relation to adjacent formations has hitherto been doubtful. It has at various times been referred to many different geological horizons; but now the geological surveyors seem definitely to have fixed its position in the Trias. The mineral districts of Sardinia and the Campagna of Rome have also been surveyed on the scale of 1 : 25,000.

The complete geological survey of a country is a work of some time, and many years must elapse before that of Italy is finished and its maps published. In the meantime the Survey has done a most useful work in preparing a general geological map of Italy on the scale of 1 : 500,000. For this purpose all previously published information has been utilised; the geological notices scattered through various scientific journals, Italian and foreign, have been collected and arranged by M. Giordano and his colleagues. The numerous blanks have been filled up by special researches; and the result is a valuable and beautiful map, which will shortly be published. It was desired to issue a reduction of this on the scale of 1 : 1,000,000, but as no topographical map on this scale exists, a French map was adopted, engraved on the scale of 1 : 1,111,111 (or 1 decim. to a degree). This map was corrected where necessary, and was published in time for the meeting of the Congress at Bologna. The map is issued in two editions, one with hill-shading and one without. The only general map previously published was that of Collegno, in 1846, on the scale of 1 : 2,000,000. A glance at the two maps will show the immense advance which has been made in our knowledge of Italian geology since that date.

The map in question is coloured in accordance with the scheme recommended by the Italian Map Committee of the International Geological Congress. The Italian committee (like the English) prefer to retain some shades of red for the Trias. The Congress however, chiefly influenced by the wishes of Germany, proposes to colour this violet, as the natural base of the Secondary series ; the Jurassic beds being coloured blue. The Italian Survey is desirous of adopting for its future maps the scheme of colouring upon which the Congress may decide. The Indian Survey also, being now about to publish a connected series of maps, wishes, if possible, to do the same.

We have little doubt that the geological map of Europe, now being prepared by the Map Committee of the Congress, will be so drawn up and coloured as to form a scheme of colours which can, with only small modifications, be adopted by all. W. TOPLEY

NOTES

A COMMITTEE has been formed at Reggio (Emilia) to collect funds for establishing a fitting monument to the memory of the Padre Secchi, in the form of a fine refractor, of which the objective is to have 70 centimetres diameter. Reggio thus follows the example of Arcetri, where a fitting scientific monument has been erected to the memory of Galileo.

THE Honorary Degree of LL.D. has been conferred by the University of Cambridge on Thomas Sterry Hunt, F.R.S.

M. COCHÉRY intends to spend the surplus of the Electrical Exhibition, which is said to exceed 16,000*l.*, in establishing a research laboratory for electricity.

M. PAUL BERT, the new French Minister for Public Instruction, is said to be a candidate, in the section of Medicine, to fill the place vacated in the Academy of Sciences by the recent death of Dr. Bouillaud.

IT is painful to have so often to animadvert on what must look like parsimonious treatment of science on the part of our Government. Its almost contemptuous treatment of the Electrical Exhibition and of the British Commissioners has called forth the strongest criticism ; and under our Geographical Notes to-day will be found another instance of a similar kind. Lord Aberdare, who, as president of the Geographical Society, went to the recent Venice Congress as commissioner of that body, referred "to the miserable show made by this country at the Exhibition, which was solely due to the parsimony of the Treasury, who did not even pay the travelling expenses of the British Commissioners, and merely sent 100*l.* to the Vice-Consul at Venice for petty disbursement." Of course our Government had no intention of insulting the Congress and the Geographical Society; but such treatment of an International Congress on the subject in which this country is so practically interested, must seem strange to good-mannered foreigners. Our Government ought really to consider earnestly their position to such enterprises as those referred to ; it is too late in the day for even England to despise anything that tends to the promotion of science.

A BRILLIANT *fête* was given at Berlin on the evening of November 19 in honour of Prof. Virchow, in the Hall of the Rathhaus, which was handsomely decorated for the occasion. About 1000 persons were present, chiefly belonging to the scientific and medical world. Prof. Bastian presided, and after calling for cheers for the Emperor, he presented the title deeds of the Virchow Institute for promoting anthropological studies, according to Prof. Virchow's own directions, and for which a sum of 70,000 marks has been collected from the various countries of Europe. Speeches were then made by the leaders of the thirty deputations present, which included representatives of the medical faculties of Aberdeen, Basle, and Charkoff, and the medical societies of St. Petersburg, Vilna, &c. Finally, a deputation from Schivelbein, in Pomerania, Prof. Virchow's native town, presented congratulations to the Professor, who returned thanks with great emotion. A supper followed, and the guests did not separate till a late hour.

THE death is announced, at the age of eighty-three years, of M. Camille Sébastien Nachet, the founder of the well-known firm of Nachet et Fils, opticians, Paris. M. Nachet, during his long career, did much for the improvement of the manufacture of lenses, and especially of microscopes.

WE regret to announce the death of Dr. Karl Peters, Professor of Mineralogy and Geology at Graz University, and author of numerous scientific papers, who died at Graz on the 7th inst., aged fifty-seven years. The death is also announced of Dr. Karl Fortlage, Professor of Philosophy at Jena University, at Jena on November 8, aged seventy-five.

THE Paris Municipal Commission has resolved to illuminate successively the Council Hall with five different electric lights, to determine the price of each, and make a choice amongst them. These five have been selected out of all the systems exhibited. The Swan and Brush systems are two of those selected for the competition. Electricity will be also used for moving an elevator of the kind exhibited by Mr. Muirhead, and a press for printing the papers used by the Council.

EARTHQUAKES have been rather prevalent on the Continent during the past week. Between five and six o'clock on the morning of the 16th three shocks were felt in Switzerland. Two were of some violence at Mendrisio, in the canton of Tessin, and one less severe in Berne and the Bernese Oberland. On the same morning, at seventeen minutes past five, a slight earthquake shock was felt at Naples, lasting three seconds. Its direction was south-east. At dawn a shock was felt at Cosenza. Two shocks were also felt throughout the province of Catanzaro at six o'clock in the morning. On the 18th at five a.m. several smart shocks were felt over the greater part of Eastern Switzerland. The centre of the disturbance seems to have been in the canton of Zürich and the Oberland of St. Gall, where the oscillations were very marked and frequently repeated. Shocks were also felt on the Friday night along the Valley of the Lower Rhine, at Coblentz, Bonn, Cologne, Aachen, Elberfeld, Barmen, Crefeld, Essen, Düsseldorf, and Duisburg, a distance of over 100 miles. There were two violent vertical shocks lasting five seconds, then wave-like tremors in the direction of north-west to south-east.

OUR Vienna Correspondent writes that shocks of earthquake occurred at Izentes and at Izarvas (Hungary) on October 28, at 4 a.m. On November 5 shocks were experienced at different places in Carinthia, viz. at Klagenfurth a perpendicular shock was felt at 9.37½ a.m. ; it was followed by slight undulatory movements in the direction west-east, lasting four seconds. At Moosberg and Patermon several shocks were felt at 9.45 a.m. ; direction, south-west to north-east. The shock was also felt at Villach at 9.40 a.m. ; direction, south-north ; at Ober-Vellach at 9.40 a.m., south-north. At Emünd four shocks occurred ; the first, at 10.5 a.m., being so severe as to cause people to rush out of their houses in fright, chimneys were thrown down and the walls of some houses damaged ; duration, four seconds ; direction, north-south. At Spital (on the Drou) also four shocks were felt ; duration, nine seconds ; direction, from east-west. From Sachsenburg and Reichenan also the occurrence of shocks is reported at 9.30 a.m. at the former, and 9.45 a.m. at the latter place : the movements lasted from four to five seconds; direction, north-east to south-west. The centre of the earthquake mentioned above seems to have been in the neighbourhood of the Millstädt Alp. At the same time earthquake-shocks were felt at Stuben, Langen, Pöhtnen, Flirsch in Vorarlberg, and at Murau and Obdach in Styria. In Switzerland shocks of earthquake occurred on November 14, at 3.35 a.m., at Villeneuve, Rivaz, Bouveret, and between five and six o'clock in the morning at Seewen, Berne and its environs.

A CORRESPONDENT of the Swiss *Bund*, writing from Vevey, says that on the morning of the 14th a large meteoric stone, which seemed to come from a point in the Hautler directly over the mountains on the Savoyard side of the Laste, fell with a tremendous report in the market-place of Vevey. It was sufficiently large to have crushed any house upon which it might have chanced to alight.

DR. T. S. COBBOLD exhibited (at the Linnean Society's meeting, November 5) under the microscope about a hundred eggs of *Bilharzia hæmatobia*. They were taken from a gentleman who had just arrived from Egypt, and who was the victim of hæmaturia, supposed to have been contracted during a shooting expedition. By adding water nearly all the eggs were hatched during the meeting of the Society, and a rare opportunity was thus afforded of witnessing the behaviour of the newly-born ciliated animalcules.

THE first step in the construction of a line of telegraph in China has been taken. On September 19 the line between Shanghai and Chinkiang on the Yang-tsze River was opened, and congratulatory telegrams exchanged between the authorities in the two places. The remainder of the line to Peking was expected to be completed within two months after that date. The cable, about two miles in length, was successfully laid across the Yang-tsze, and the line on the north of the river is now being rapidly pushed forward, following the line of the Grand Canal. Several other short cables will have to be laid across the larger creeks before the work is completed. With the exception of a line a few miles in length, between Woosung and Shanghai, which is the property of the Great Northern Telegraph Company, this is the first telegraph line laid in the Chinese Empire. When popular prejudice is once overcome, the extent to which telegraphs may be employed in China is incalculable.

IT is stated that the Chinese Government have taken measures for the immediate removal of the bar at the mouth of the Shanghai River, which has so long been a serious obstruction to navigation. At certain states of the tide ocean-going steamers are forced to remain in an exposed situation outside this bar, and all the efforts of the Foreign Ministers and mercantile communities to obtain its removal have been hitherto ineffectual. This is another example of the change which is coming over the Chinese counsels. *Apropos* of this we may mention that the ninth vessel constructed by the Chinese has just been launched at the Kiangnan Arsenal. It is a screw steamer of about four hundred tons, and is intended for the repression of smuggling and piracy. The vessels already built at the Arsenal are two frigates, four gunboats, a sailing ship, and an ironclad.

AMONG the numerous publications of the Imperial Maritime Customs of China, none are of more general interest than the half-yearly reports of the Customs medical officers. They deal, as might be expected, with various forms of disease among foreigners in China. The twenty-first number has recently been published. The writers are scattered all over the vast empire of China, from Newchwang in Manchuria to Canton, at various stations on the Yangtsze, and in Formosa. The latest issue contains papers on *Filaria sanguinis hominis* in Southern Formosa, on *Trichinia spiralis* in Chinese pork, and on skin diseases. This last is especially important, as one of the principal objections to Mongol immigration is the quantity of disease which follows. The Hawaiian Archipelago is said to suffer severely from diseases such as leprosy, small-pox, syphilis, measles, &c., which are all foreign to the islands, and have been introduced wholly by the immigrants. These papers certainly deserve more attention than they seem as yet to have received in this country.

THE disordered condition of the domestic affairs of Turkey has not prevented the Government finding leisure for the reform of its system of weights and measures. The new system which will replace the old clumsy method of computation will come into force on March 1 next, old style. It is strictly metrical, and applies to measures of length, square measure, and capacity. The measure of length will be based upon the archine, which is exactly equal to the French metre.

IN sinking for a stand-pipe for boring operations, the *Colonies and India* states, the Kilcunda (Victoria) coal prospecting party found the skeleton of a kangaroo at a depth of 28 feet. Instructions were given by the Mining Department to preserve the entire skeleton, and the jawbone was sent to Prof. M'Coy, who states that it belongs to a new species of an extinct genus of kangaroo, and indicates that the deposit which was found is of the pliocene tertiary age. The Professor says the discovery is a very interesting one, and will form a valuable addition to the public collection.

ON October 10 a fine fata morgana was observed at Rügenwalde (Pomerania). During the afternoon of that day a northern village with snow-covered roofs, from which icicles were hanging, was seen for about an hour. Human forms are also said to have been distinctly recognised. It is believed that Nexö, on the Island of Bornholm, was the village reflected.

AT the last meeting of the Linnean Society Mr. Frank Crisp was elected treasurer, and Sir John Kirk a member of the Council, to fill vacancies caused by the death of the late Mr. F. Currey.

THE great lava flow from the Mauna Loa (Hawaii), which lasted no less than nine months, has at last stopped. It began on November 5, 1880, and until August 31 last the lava had run a distance of 96 kilometres, from the summit of the volcano (which measures 14,000 feet in altitude) down the eastern slope, almost as far as the sea-coast. The town of Hilo was in the most threatening danger of being destroyed. Fortunately the force of the eruption was exhausted and the flow of lava stopped within a few thousand yards from the town. This eruption was the most colossal one ever recorded in Hawaii.

THE report of the Indian Commissioners shows the present number of Indians in the whole country, exclusive of Alaska, to be 261,912, all of whom, except 15,416, are more or less in charge of agents of the Government.

THE Conservatoire des Arts et Métiers of Paris has been removed from the Department of Trade and the Colonies and transferred to the Ministry of Fine Arts. The reason of this change is obviously the intention of developing technical education among French working men.

THE flashing system of telegraphy has been so successful in Tunis that the insurgent Arabs are powerless to stop regular correspondence between the several corps of the French army. The same system is used in Oran, province Algeria, in the pursuit of Bou Amena.

THE *Journal* of the North China branch of the Royal Asiatic Society for 1880 contains a long paper by Dr. Bretschneider, o the Russian Legation at Peking, on Early European Researches into the Flora and Fauna of China, and one by Dr. Bushell, of the British Legation, on the Coins of the Present Chinese Dynasty.

An interesting cave has recently been discovered in the Bela Lime Alps, which form the north-eastern part of the Tatra Mountains. From the Kotlin valley the cave can be reached in about an hour. During August and September last the inhabitants of Bela thoroughly investigated the cave. The entrance is formed by a shaft about fifteen metres long and only one metre wide. After having passed this torches must be lighted. The cave contains fine white stalactites and stalagmites, large subterranean lakes and ponds, which obtained for it the name of "Seehöhle" (lake cave). A number of bones of prehistoric animals were found. It appears however that the cave was known to the neighbouring inhabitants about the years 1713 and 1731, and was then forgotten. German names with these figures underneath were in one part found scratched upon the rock.

On September 1 an Aëronautical Society was founded at Berlin under the presidency of Dr. Wilhelm Angerstein. The new Society grows rapidly, and it is the intention of the Committee to hold an aëronautical exhibition next year.

The additions to the Zoological Society's Gardens during the past week include a Moustache Monkey (*Cercopithecus cephus* ♂) from West Africa, presented by Mr. Frank G. S. Laye; a Bonnet Monkey (*Macacus radiatus* ♀) from India, presented by the Rev. R. H. Manley; two Herring Gulls (*Larus argentatus*), European, presented by Mrs. Greaves; two Chilian Sea Eagles (*Geranoætus melanoleucus*) from South America, a Red-breasted Merganser (*Mergus serrator*), a Guillemot (*Uria troile*), a Bar-tailed Godwit (*Limosa lapponica*), British, purchased.

GEOGRAPHICAL NOTES

On Monday week Lord Aberdare opened the fifty-second session of the Geographical Society with a brief address, in which he dealt first with the expedition of Dr. Matteucci and Lieut. Massari across Africa. He next referred to the geographical papers read at the York meeting of the British Association, and afterwards dwelt at some length on the International Geographical Congress at Venice. According to Lord Aberdare's view it is a great mistake to mix up exhibitions with these congresses, as, owing to international jealousies, it becomes necessary to withdraw the best men from the sections of the congress to serve on the juries of the exhibition. Lord Aberdare referred particularly to the miserable show made by this country in the Exhibition, which was solely due to the parsimony of the Treasury, who did not even pay the travelling expenses of the British Commissioners, and merely sent 100*l*. to the Vice-Consul at Venice for petty disbursements! The latter part of the address was chiefly devoted to the Arctic expeditions of the *Jeannette* and the *Eira*, and we are glad to notice that so much confidence is felt regarding the safety of Mr. Leigh Smith's party. Mr. F. A. A. Simons afterwards read a paper of considerable geographical interest on the Sierra Nevada de Santa Marta and its watershed, and he certainly has thrown much light on this almost unknown region, *i.e.* in the north-west corner of South America. The water-system, which Mr. Simons was at much pains to explain clearly, consists of the Rio Cesar, with its affluents, the Rio Rancheria and others falling into the Caribbean Sea, and the two large rivers which form the Grand Cierraga. Mr. Simons, who has spent some three and a half years in the country in natural history researches, has already contributed to the Geographical Society's *Proceedings* a paper on the topography of the Sierra Nevada, so that its geography can now be well understood through his labours.

Some further details of the interesting discoveries made by the search ship *Rodgers* in and about Wrangel Land are given in the *Times*. It appears that the *Rodgers*, after leaving St. Lawrence Bay, passed through Behring Straits, and effected a landing on Herald Island on August 24. Having left records of her visit there, she steamed for Wrangel Land, which she reached on the evening of August 26. Finding a safe harbour, she despatched parties to the eastern and western coasts in search of cairns or traces of the *Jeannette*. Capt. Berry, who commanded the land party, reached a mountain 2500 feet high, from which he saw open water around the island everywhere, except between the west and south-south-west, where a high mountain seemed to terminate the land. Master H. S. Waring went round the eastern coast and northern side, and being blocked by ice had to return by land to the ship. Ensign Hunt went by the western coast and reached the ice which had blocked Waring, and found it impenetrable. He had passed to the northern side, and could see Waring's position, so that the entire island had thus been skirted. No traces of the *Jeannette* were found. The *New York Herald* correspondent says that he was "surprised to see the ice moving constantly to the westward along the shore, where, according to a natural supposition, the wind would blow it off. Sometimes when he went to bed he would see the pack ice filling the sea as far as the eye could reach, and the next morning when he went on deck he would behold a vast expanse of open water." Wrangel Land is now said to be about sixty miles long, and there is a current at the northern end of it running to the north-west, at the rate of about six knots an hour. At the south-east of the island the ice was observed to be drifting in a northerly direction, at the rate of about two miles a day. From all this it is inferred that the *Jeannette*, which was last seen in September, 1879, steaming towards Wrangel Land, did not reach that island, and that either she was caught in the pack, and is being carried by the current in a northerly direction, at about the 172nd meridian, or that, finding the sea open, as the *Rodgers* did, she has been induced to leave the land, and has taken advantage of open leads through the ice, and has sailed northwards into unknown space. Efforts are still being made to search for her or her crew if they have abandoned their ship. The *Rodgers* will winter at St. Lawrence Bay off Kotzebue Sound, on the Alaska coast, and will in the spring make further search. The American observation party have reached Point Barrow, where they will winter, and where they will have opportunity of searching among the wreckage, which is so often washed on that shore, for any records of the missing ship.

Lieut. A. Hovgaard, who was on Prof. Nordenskjöld's staff in the memorable *Vega* expedition, is trying to start an expedition in search of the *Jeannette*. Hovgaard thinks of sailing in the same track which was pursued by the *Vega*, in order to prove that the Kara Sea is perfectly navigable, if the necessary precautions are taken. He intends to winter at Cape Chelyuskin, in order to make scientific and principally meteorological observations. He has already received numerous contributions for this purpose from his Danish compatriots.

Count Waldburg-Zeil has safely returned from his Arctic expedition, which had for its object the establishment of a regular steamship service between Bremen and Siberia. His ship *Luise* encountered considerable difficulties; nevertheless the Count is of opinion that a regular service will be possible and remunerative. The *Dallmann*, the second ship of the Count's expedition, was left behind at the Yenisei estuary, where it will remain during the winter.

The German paper *Ausland* publishes a letter from the German traveller Dr. B. Hagen, dated from Tandjong Morawa, to which he had returned from his excursion into the interior of Sumatra. He travelled through the Northern Batta districts, hitherto almost entirely unknown, and then across the plateau of Northern Tobah as far as the great Tobah Lake. The traveller was well received everywhere, and only the eternal wars between the several villages impeded and delayed his progress. His collections of anthropological, ethnographical, zoological, and particularly of botanical specimens are very large. The fauna and flora on the Tobah Plateau, as on all tropical high plateaux (such as Java, and even in Japan), resemble those of Europe.

News from Zanzibar state that the Belgian expedition under Mr. Rogers left for the Congo on October 20 last, 135 natives accompanying it.

Under the Chefoo Convention, negotiated by Sir Thomas Wade with the Chinese authorities in 1876, it was agreed that a British officer could reside at Chung-king, in Sze-chuan, on the upper waters of the Yangtsze. The gentleman at present stationed there, Mr. E. H. Parker, of H. M.'s Consular Service in China, seems to have made good use of the opportunities thus afforded him of investigating this comparatively little-known district. Under the title of "Short Journeys in Sze-chuan," he has contributed to recent numbers of the *China Review* an account of his travels in the province, together with observations on its trade, customs, geography, &c.

THE PRESSURE ERRORS OF THE "CHALLENGER" THERMOMETERS[1]

I.

I. *The Pressure-Corrections supplied to the "Challenger" along with the Thermometers*

WHEN I was first asked to examine the thermometers I judged, from the appearance and nature of the protection over the bulbs, that very slight corrections only would be required, even for the greatest pressures to which they had been exposed. But Sir Wyville Thomson told me that a correction of at least half a degree Fahr. had been assigned for them for every mile under the sea. This correction had been given him by Capt. Davis of the Admiralty, who had in his experiments[2] the assistance and advice of such exceedingly able experimenters as the late Prof. W. Allen Miller and others.

Hence, although it appeared to me at first sight incredible that any such correction should be required for thermometers with protected bulbs, I considered it absolutely necessary to try Capt. Davis' experiments over again, under the same conditions as those which he had adopted in conjunction with Prof. Miller. My object was, of course, to find out whether I could again obtain these results, and, if I could obtain them, to discover what were the causes which led to their being so exceedingly different from what I should have expected. I felt assured that the results were much too large;—and I had therefore, if I could reproduce them, to trace the various possible causes of divergence between the results of experiments conducted in a hydrostatic press and of other similar experiments made at the same pressures in the deep sea.

Half-a-degree Fahrenheit per mile of depth may seem to be a matter of very little consequence; but when we recollect that some of the *Challenger* soundings were made at depths nearly approaching six miles, we find that we have sometimes to deal with a correction of 3° F., enough to modify seriously our theories of ocean circulation. For it can never be too strongly impressed on the student of science that there is no such thing as greatness or smallness in itself; what is very small relatively to one class of quantities may be very great relatively to another and different one. All the temperature differences, except near the surface of the sea, though important in their consequences, are very small relatively to differences of temperature in the atmosphere; but, just because they are so small, small errors in the determination of their values are important:—thus it was imperative to decide whether the corrections assigned by Capt. Davis are necessary.

At first sight one might think that by far the best way of conducting an inquiry of the kind would be to carry it out under circumstances nearly the same as those of the *Challenger* observations. No doubt, if we had at hand a coal-pit or mine-shaft full of water, and of six miles or so in depth, we might make the experiments without the aid of presses, and under circumstances far more favourable than those in which I was obliged to operate. The reasons for this statement will appear presently. There are great objections to making test-observations at sea. The *Challenger* observations themselves had, of course, to be made at sea, but to make under similar circumstances experiments for the purpose of determining corrections would be a perfectly hopeless attempt. The circumstances under which thermometers are let down and drawn up again at sea are extremely unfavourable to accuracy of observation. I had, therefore, to content myself with such conditions as could be procured by means of hydrostatic presses.

II. *Construction of the Thermometers.*—I will now say a word or two about the construction of the thermometers themselves; and I shall thus have an opportunity of pointing out some of the peculiarities of construction to which I have traced the greater part of the very large effects obtained by Capt. Davis, and given by him as corrections which required to be made.

The *Challenger* thermometers are all of the Six pattern: there is a highly expansible liquid in the large bulb, which projects to a certain extent into the narrow U-tube. Then there is a column of mercury occupying the bend of the U and part of each stem. Above that, on the maximum side, there is some more of the sensitive liquid; and at the ends of the mercury column are the maximum and minimum indices, each containing a piece of steel, so that they can be set by means of an external magnet. The large bulb on which the temperature effects are mainly produced is protected by an exterior shell of glass strong enough to resist a pressure of at least 5000 fathoms of sea-water; that is to say, approximately, somewhere about six tons weight per square inch. This external shell is nearly filled with alcohol. The main difference between this and the first invented form of protected thermometer, which (so far as I know) was introduced by Sir William Thomson,[1] is simply that the bulb only is protected, the stem being exposed, and therefore the effects produced directly by compression are due solely to the stem of the instrument: unless, indeed, there be a strain produced on the protected bulb (altering its volume) by the wry-neckedness of the protecting shell.

Now, as a rule, till quite recently, practical workers in glass supposed that no effect at all would be produced by pressure upon an ordinary thermometer stem, simply because the external diameter is so much greater than the internal; and, in fact, so little was the nature of the effects of hydrostatic pressure known to practical glass-blowers that one of Mr. Casella's workmen undertook in 1869 to furnish Capt. Davis with thermometers whose bulbs should be so thick as to "*defy compression*"! It will be seen presently that such an idea is entirely absurd:—that, however thick is an unprotected thermometer, it will still have its indications altered by compression, and very nearly as much as a thinner one, unless that be extremely thin. So far as the *Challenger* instruments are concerned, the only effect that can be expected to be produced directly by pressure is the diminution of the bore and length of the narrow tube, and the consequent forcing of the liquid which occupies it to fill a greater length in it. I made at starting a rough calculation of the amount of effect of this kind which was to be expected; taking average data as to the compressibility and rigidity of glass. I found it to be a small fraction only of a degree for each ton-weight of pressure, except on those thermometers which had very short degrees. It was clear to me, therefore, that (unless the wry-neckedness already mentioned was the cause) the larger part of Capt. Davis' result was not due to pressure directly.

III. *Wholly Protected Instruments. Their Defect.*—For the purpose of comparison with the *Challenger* instruments, so far as regards the effect on the unprotected stem, Sir Wyville Thomson sent me two mercury thermometers constructed after Sir William Thomson's device. In these instruments the whole, bulb and stem alike, is inclosed in a strong glass tube, nearly filled with alcohol. The effects of pressure on these instruments were very much smaller than on the thermometers of the *Challenger*. This result was so unexpected that I at first thought it due to defects in the new instruments. But, as will be seen later, it is quite consistent with the final result of my investigations. It is, however, very difficult to obtain good results from these instruments under the circumstances in which I was working. Their recording adjustment is constructed on a new plan, in which a little portion of mercury is detached from the rest; and separated from it by a small quantity of air, which does not move it until compressed to a definite amount. To set the index before an observation, the instrument has to be swung round somewhat sharply at arm's length. It was scarcely ever possible under these circumstances to adjust it to the temperature of the water in the press. The indices in the *Challenger* thermometers, on the other hand, consist each of a piece of enamel with a couple of hairs attached to it so as to fix itself in the tube and retain a record of the observation. They have also a little piece of needle inside, and can thus be moved from the exterior by means of a horse-shoe magnet, so that the adjustment can be made at pleasure, and without any alteration of the temperature. The thermometers are plunged for some hours in the water in the press, and the indices are set in an instant while the instrument is partially lifted out for the purpose. With the other instruments one might spend days before he could get them

[1] By Prof. Tait. Abridged by the Author from a forthcoming volume of the Reports of the Voyage of H.M.S. *Challenger*, by permission of the Lords Commissioners of H.M. Treasury.

[2] "On Deep-Sea Thermometers," by Capt. J. E. Davis, R.N. (*Proceedings* of the Meteorological Society, April 1871).

[1] "The Effect of Pressure in Lowering the Freezing-point of Water experimentally demonstrated," by Prof. W. Thomson (*Proc. R.S.E.*, February 1850). See also the paper by Parrot (1833) quoted below. In this a protected thermometer was undoubtedly employed; but the protecting sheath was part of the wall of the compression apparatus and was not attached to the thermometer itself. From a reference in this paper I was led to consult Lenz' observations on deep-sea temperatures. He appears to have measured these temperatures by bringing to the surface, with great care, a considerable quantity of water from each depth. There was a thermometer in the collecting apparatus, with a bulb of extra thickness; but no recording index was employed, so as to show what was its indication under pressure.

introduced, except after special cooling, into the press with the index suitably adjusted to the temperature of the water. The whole difficulty might have been avoided by putting an exceedingly small piece of iron or steel wire above the index, to be acted on by a sufficiently powerful magnet.

Thus, although these instruments are absolutely perfect so far as regards immunity from pressure (and in other essential respects which will be mentioned later), it is not easy to work with them under the circumstances of this investigation.

IV. *Individual Peculiarities of some of the "Challenger" Thermometers.*—The *Challenger* thermometers are not all exactly similar to one another. Some of them have their degrees very much longer than others; others have the extraordinary peculiarity that the degrees upon the maximum side are nearly half as long again as those on the minimum side, and sometimes it is the reverse. In one of the instruments which was occasionally used in the deep sea, the length of a single degree on the maximum side is only about three-fourths of a millimetre, and thus a reading to a tenth of a degree is not to be looked for. But on account of this unexpected peculiarity this particular instrument was of use, as will be seen later, in demonstrating that the effects produced in the press were due partly to heating, partly to compression. Several instances of useful peculiarities of a similar character were detected, and utilised.

In fact, the instruments cannot be said to do more than furnish rough and ready means of approximating to temperatures within about a quarter of a degree, or in the most favourable circumstances a tenth of a degree Fahrenheit. Had they been more nearly what would be called "scientific" instruments, they might have altogether failed on account of the rough treatment to which they were necessarily subjected during use. Letting them down into the sea presents in general no great difficulties, but when they have to be hauled on board again they are subject to jerks and shocks, and sometimes swing through large arcs at the end of the lead line. Such misadventures are unavoidable at sea, and are excessively unfavourable to accurate results, because the index is necessarily not fitted so tightly in the stem that it may not in a few oscillations be sensibly displaced. And there is a defect inseparable from the use of movable indices:—viz. that the reading of the mercury column is sensibly different according as the index is, and is not, in contact with it. The capillary convexity affects the maximum and minimum indices in *opposite* ways.

Further, I may observe (though it does not affect my work) that in these thermometers the scale is at some distance from the mercury in the stem, and no provision is made for avoiding parallax or personal equation. By merely altering the position in which one holds the thermometer, it is possible to read the temperature whether by the mercury column or the end of the index next it, to an amount different in some of the thermometers by as much as a quarter of a degree, and in the great majority of them by as much as a tenth. Thus if we get readings consistent within a tenth of a degree we get all that the instruments are capable of furnishing. I have therefore always read the thermometers in exactly the same position and (when so much accuracy was attainable) only to the nearest tenth of a degree. And I have always made my comparisons between successive positions of the index; the only readings of the mercury directly being taken roughly to find whether any permanent temperature-change had been produced in the water of the press by pressure or otherwise, during the course of an experiment.

A great many different materials were tried for the framing of the thermometers: and vulcanite was finally chosen, having been found to answer the purpose exceedingly well. Wood warped, and metal was unsuitable for various reasons. It is rather curious to find, as will be seen below, that this substance was one of the main causes of the very large amount assigned to the pressure-correction.

V. *Capt. Davis' Mode of Testing; and his Correction for the Maximum Side.*—It is necessary to look somewhat closely into the mode in which Capt. Davis conducted his experiments, in so far at least as it differs from the one I afterwards employed; in order that we may be able to form an idea how, with nearly all the facts before him, he yet failed to get their proper interpretation. Take, for instance, the way in which he attempted to determine the correction which is due to the heating of water by compression. This, of course, affects the thermometers while in the hydrostatic press, but *not* when they are let down into the sea. When the water in the press is compressed with the thermometers in it, it becomes hotter as the pressure increases (so long at least as its temperature is above 4° C. or 39°·2 Fahr. that of its maximum density). This is quite analogous to the heating of air in a cylinder when a piston is suddenly forced down; when, as every one knows, tinder can be kindled by the heat developed. So water is heated by compression, but not to anything like the same extent. But it is necessary to remark that the amount of heating of water by a given compression depends in a very curious manner upon the original temperature of the water. For water taken at its maximum density is neither heated nor cooled by compression, but it is heated by compression if it is at a temperature higher, and cooled if it is at a temperature lower, than that of the maximum density. One set of Capt. Davis' observations were made in water at temperatures near, but under, the maximum density point: in which, therefore, very little effect can be produced, even by very great pressure (and that little should be cooling, not heating), and he combined these with a number of other observations made at temperatures approaching 55° F., in which a comparatively large amount of heating is produced even by moderate pressures. The average of the results of these determinations was taken, but, unfortunately, Capt. Davis struck out before taking the average all those observations which appeared to give much larger effects than the others, taking them as being obviously erroneous.

When we sift out from the observations all those made nearly at any one temperature we find they agree fairly enough with the theoretical result of the compression. But observations made at different temperatures were included in the group from which the average effect was deduced. Such an average has no physical meaning.

Capt. Davis concluded from two sets of observations, one at 55° F. and the other about 39° F., that little attention need be paid to the heating of water by compression, and thus that the effect observed in the hydraulic press was due mainly to direct pressure, and would, of course, be experienced by the thermometers when they were let down into the sea.

The officers who managed the thermometers of the expedition, were, in consequence, furnished with corrections for each thermometer, all of the order already indicated, *i.e.* about half a degree for each mile under the surface of the sea. These corrections were, of course, for the *maximum* side of each instrument.

VI. *Consequent Correction for the Minimum Side.*—Looking at the thermometers, it seemed to me perfectly evident that this correction, if it was to be applied at all, must be applied in very nearly the same amount both to the maximum index, for which it was determined, and also to the minimum. Any difference between these two must be due solely to the effects of temperature upon the column of mercury which lies between the two indices, and of pressure on the tube containing that mercury. Unless the heating effect were *confined* to the space between the indices, the former is provided for by the graduation of the instrument itself; and it was quite certain that the two together could not produce an effect amounting to more than a small fraction of the degree and a half for three tons pressure.

Therefore, as all the readings of the *Challenger* thermometers were taken from the minimum index, they were subject, according to my interpretation of Capt. Davis' results, to a correction of very nearly half a degree Fahr. for every mile of depth.

Now, even if the heating effect on the water in the press had been correctly determined, the result would have led to a deduction of at the utmost only about one-fourth of the whole correction, thus still leaving a very formidable correction indeed.

VII. *Theoretical Determination of the Direct Effect of Pressure. Experimental Verification.*—I therefore calculated the effect of pressure on a thermometer tube, assuming the best data for the compressibility and the rigidity of glass. The result, so far as is required for the present argument, is that the internal capacity of a glass tube (whose walls are thick in comparison with the diameter of the bore) is reduced by about 1-1000th part for each ton weight (per square inch) of pressure applied from without; the ends being closed. Hence, if such a tube be partly filled with mercury, with an index above it; the index should be displaced by 1-1000th of the length of the column of mercury for each ton weight of pressure applied to the outside of the tube.

I tried the experiment with a thermometer tube, the length of the mercury column being as nearly as possible a metre, and I found for every ton-weight of pressure to which the tube was exposed the index was displaced by one millimetre, the 1-1000th part of the length of the column precisely, being far more nearly than I had expected the result I had already calculated from theory. Since, then, there is only a change of one-thousandth in the length of the column, it is quite obvious that the amount of effect produced upon the column of mercury in the *Challenger* thermometers (which is not above a sixth or a seventh of a metre in length at the utmost), that is to say, the whole correction-difference between the maximum and minimum indices is a matter of a sixth or seventh of a millimetre; or in general very nearly the same fraction of a degree of the scale. Thus it is proved that the correction supplied by the Admiralty, if it is to be applied at all, ought to be applied almost in its entirety to the minimum index.

VIII. *The Aneurisms. Their Object and Effects.*—There is another peculiarity of the *Challenger* thermometers, which leads to a slight—but only a slight—modification of this statement, viz. that at the lower end of each of the two vertical columns there is an aneurism on the tube. These form a sort of secondary bulb, making the tube faulty again after the primary bulb has been protected. Their effect is slightly to increase the effective length of the column of mercury.

I learned from Sir George Nares that the object of these aneurisms, and of another which is situated close to the bulb, is to prevent the indices from being jammed at the bends of the stem, or forced into the bulb, when the instrument is exposed to very high or very low temperatures. They seem to be in every respect objectionable, especially as the necessity for them would be entirely removed by adding an inch or two to the length of the instrument; or, if they must be retained, by *protecting* them and using more powerful magnets. Their presence produces an effect large compared with their apparent importance. The sketch below represents, on a large scale, one of the most highly developed of the more effective of these aneurisms, that which is situated close to the main bulb of the instrument.

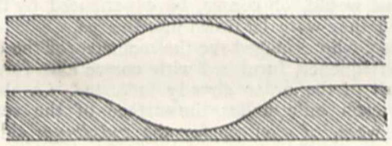


FIG. 1.—The chief Aneurism.

By reason of the convexity of the thermometer tube the diameter of the bore appears from the outside to be considerably larger than it really is. In fact a very simple geometrical construction shows that the ratio of its apparent diameter to its real diameter is that of the refractive index of glass to unity, *i.e.* it appears to be about 1·6 times its actual diameter. So that even when the aneurism, and the liquid filling it, appear to occupy the whole diameter of the tube, they only occupy $\frac{1}{1{\cdot}6}$ or about two-thirds, so that even in this extreme case the walls of the aneurism are not usually very thin. The percentage diminution of volume of the middle portion of the aneurism is in such a case (roughly) 50 per cent. greater than that of the unaltered tube.

The real mischief done by the aneurism is not due mainly to thinness of the walls and consequent greater liability to distortion by pressure; it is due to the fact that the aneurism, in consequence of its greater section, contains a much larger quantity of mercury than does an equal length of the tube; and therefore that a small percentage diminution of its volume will produce a marked displacement by the outflow into the narrow tube. Several of the aneurisms I have measured produce a disturbance of the index corresponding to that produced by at least five times their own length of the tube.

In some of the more exaggerated ones it actually produces an effect on the maximum and minimum index equal to that due to the extension of very nearly one-half of the mercury column in the thermometer. But this, though easily remediable, is not a defect of much consequence.

IX. *Imploding and Exploding of the Thermometer Bulbs.*—In connection with the breaking of some of the thermometers, as a result of pressure whether in the press or in the sea, it may be well to describe the curious nature of the effects produced by pressure upon the material of a tube, according as the pressure is applied from without or from within.

First, with regard to the thermometers themselves, which are exposed to external pressure, but have comparatively very slight pressure applied in the interior of their bore; and second, the corresponding effect when pressure is applied, as in the press itself, from the inside and tends to stretch the walls. [This second case has occurred with one or two of the *Challenger* thermometers also. Its source is usually defective strength of the terminal bulb of the maximum end of the tube. This bulb implodes, then the pressure is applied to the *interior* of the protected bulb, which, in its turn, explodes.]

In the diagrams below, the first three figures refer to part of the walls of the glass tube, which is exposed to pressure from the outside, but has no corresponding pressure applied within.

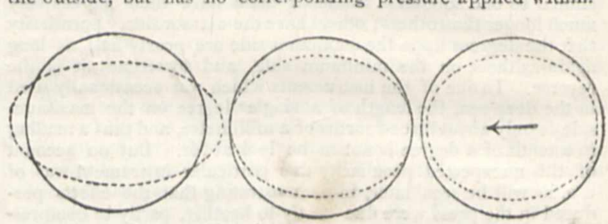


FIG. 2.—Distortion due to external pressure.

The effects of pressure indicated are those in a transverse section of the tube. The circles represent (on a large scale) transverse sections of very small spherical elements of the glass wall of the tube, the first close to the outside, the second in the middle of the wall of the tube, and the third close to the inner surface. The ellipses which are drawn along with the circles represent (of course, with much exaggeration) the corresponding transverse sections of the ellipsoids into which the spheres are distorted by the external pressure. The sphere near the outside is compressed in all directions, but much less in a radial direction than it is in a direction perpendicular to the former. The greatest amount of compression is tangential as it were, and the circular section of the sphere has been compressed into an ellipse which has a major axis in the radial direction very nearly equal to its original length, while the minor axis is very considerably reduced. The second figure refers to a small spherical portion inside the glass wall originally situated at a distance from the axis equal to 1·6 times the internal radius of the tube. (It is curious that the number 1·6, though obtained from a totally different source, should be so nearly the same as that already quoted as the refractive index of the glass.) The little spherical element at that place suffers no radial compression, but there is considerable tangential compression. Close to the interior surface of the glass tube we find large compression in a tangential direction and actual extension in the radial direction. These diagrams have been purposely exaggerated to make the effects visible. They represent what would be the effect of a pressure of 650 tons weight per square inch, provided glass could stand such a pressure and still continued to follow Hooke's law; and the outer radius of the tube has been taken as 2·2 times the inner. But they give all that is really required, viz. the *character* of the distortion at different points in the wall of the tube.

The next three figures represent the corresponding changes in

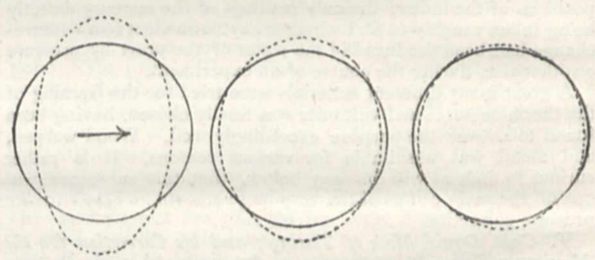


FIG. 3.—Distortion due to internal pressure.

spherical elements of the same cylindrical tube exposed to pressure from within. All portions of the tube are now extended tangentially and compressed radially, but the amount is greater on each layer as it is nearer the interior surface.

It is now easy to see how it is that a glass tube is broken by the application of pressure from without. The effect is, of course, produced first at the interior surface. For the compression is the same for every portion of the glass, but it is accompanied by shear, which increases towards the inner surface; and it is probably the resulting extension which produces the effect. But when a tube is exposed to pressure from the interior there is dilatation of the walls, which aids the shear. Thus we see why a thin tube is so much more capable of resisting external than internal pressure. It is probable that, in the case of glass, the element which first gives way is not so much crushed as torn asunder. If so, the tube which is compressed from without is in a much more favourable condition for resisting than that in which the pressure is applied internally. For, in the first, the whole substance of the walls is compressed, and thus the linear extension produced by the shear is in part counteracted. In the second, the whole substance is expanded, and the linear extension due to the shear is aided. As will be seen in Appendix A, the case of very thick tubes is considerably different.

X. *Description of the Apparatus for applying Pressure.*—Sir Wyville Thomson handed over to me, with the thermometers, a press which was made for him before he started in the *Challenger*, and which he had carried all round the world; but when we made some preliminary experiments with it, we found it to be objectionable in many ways. It was in the first place not safe at high pressures, although an attempt had been made to strengthen it by surrounding it with massive rings of Swedish iron. As the experiments had to be conducted in college, and to a great extent by students who volunteered their services, this was a fatal defect; though I believe that the danger from the bursting of a hydrostatic press has been usually very much exaggerated. The bursting of the cylinder itself would probably be unattended with danger; but some of the nuts and connecting pieces had occasionally been projected with great violence.

A slight numerical calculation shows that a cubic foot of water at a pressure of one ton weight to the square inch is capable of doing only about 1210 foot lbs. of work in expanding, the reason being that although the pressure is intense, the amount of compression it produces is exceedingly small. But a cubic foot of air at a pressure of a ton weight to the square inch is capable of doing nearly 1300 times as much work in expanding. Hence the danger of having large quantities of air in the press before the compression is begun.

Another defect of the apparatus was the comparatively small interior bore, which did not admit of the proper carrying out of my scheme for measuring pressures—the Bourdon gauge having shown itself quite untrustworthy. Besides, two thermometers, at most, could be exposed to pressure simultaneously, even when no gauge was inserted along with them.

The apparatus which Sir Wyville Thomson finally obtained from the Woolwich gun factories, through the intervention of the Admiralty, was in fact a Fraser gun with a few adaptations made to suit it to the purposes of the investigation. The gun was made of a cylinder of mild steel, round which were shrunk two successive wrought-iron coils. The effective interior is 4½ inches in bore, and nearly 4 feet long.

This cylinder was guaranteed to be safe under pressures up to 18 or 20 tons weight per square inch, and we have for various purposes already worked up to pressures of 11 and 12 tons.

The rest of the apparatus, to fit it for our immediate purpose, consisted of a tightly-fitting steel plug which was forced into the upper end of the cylinder after the thermometers and other apparatus had been inserted, and the whole had been filled with water. The plug was forced down by the weight of an assistant standing on it, while a stop-cock at the bottom of the cylinder was kept open for the escape of water, until a massive steel key could be put in through a slot in the side of the cylinder to lock the plug in its definite position.

To the lower end of the steel cylinder were adapted a series of fittings by means of which it could be connected with a powerful force-pump, and simultaneously with a gauge whose construction will be afterwards described. The gauge enabled the experimenters to know at every stage of the operation what amount of pressure had been reached in the interior of the cylinder. The pump was worked at first by hand. Of late a more powerful pump has been procured, and it can be fitted when necessary to the gas-engine of my laboratory.

Only one real difficulty was met with in working this apparatus; viz. the difficulty of making the plug fit perfectly tight. At first, when it came from Woolwich, the plug was finished by a piece of leather in the form of a cup; but this was found to leak seriously even at very moderate pressures, so that even the comparatively small pressure of a ton weight per square inch was unattainable.

But by taking off the leather from the plug and furnishing it with a ring of steel turned into cup form with an exceedingly thin and sharp edge, on the same principle as that on which the piston of the pump was constructed, this difficulty was completely got over. The flexible steel edge was pressed against the interior of the tube more forcibly the greater the applied pressure, and it was found that the apparatus was then, except under the most unfavourable circumstances, perfectly tight, at least so far as the plug was concerned. Very great care was, however, requisite in cleaning the plug and the upper part of the bore of the cylinder before each experiment. The smallest fragment of cotton-waste, getting behind the edge of the cup, almost invariably produced serious leakage when high pressure was applied. The cup form was objectionable for one reason, that it always took down a considerable quantity of air, of which it was impossible to get rid. This difficulty was overcome by putting into the cup a quantity of tallow which completely filled it up and projected considerably below it, so that the apparatus, when pressure commenced, contained at the most a few small air bubbles only.

Later, when I found it was impossible to obtain certain necessary data, on account of the slowness with which pressure was got up in so large an apparatus, I procured a very much smaller apparatus of similar character, in which the cylinder was only an inch in bore, and rather less than a foot in effective interior length. With this apparatus two or three strokes, only, of the pump were required to get up the desired pressure, and there was the great additional advantage that temperatures could be independently measured by means of thermo-electric junctions. [This could not be done in the large cylinder without seriously affecting its strength, and rendering it at the same time almost unmanageable.]

(*To be continued.*)

TRANSFORMATION OF OLD COINS IN A LAKE

M. DAUBRÉE read an interesting paper on this subject at the Paris Academy of Sciences on October 17.

In the commune of Flines-les-Roches, canton of Douai, there is a small lake of very limpid water, known as the Mer-de-Flines. It is of circular shape, and about 300 m. in diameter; its surface remains stationary in position, and neither springs supplying it, nor any outlet, are apparent. The depth at the centre has not been determined. There are fishes in the lake, and the water attracts numerous bathers. Among other shells on the banks, one observes many specimens of *Unio*. The water rests on Tertiary strata of the Landenian formation, consisting of sand and gravel, with dark ashes and pyrites.

According to the researches of MM. Termink and Loustan, this lake appears to have been, in ancient times, a place of sacred resort, and various precious objects were thrown into it, as an offering doubtless to some divinity. Numerous coins, more especially, have been recovered, along with statuettes of bronze and much pottery *débris*. Of the coins, some are Gaulish, but the majority are Roman, of the time of the early Empire. They are mostly bronze, but some are of gold.

Some remarkable changes have occurred in many of these coins, and have been brought to the notice of the French Academy by M. Daubrée. The coins have been attacked and are completely enveloped with a crystalline substance formed at their expense. Their general aspect recalls that of the coins incrusted with metallic minerals, found in various thermal springs, notably at Bagnères-de-Bigorre, at Bourbonne-les-Bains, and at Baracci in Corsica.

An extremely fine external pellicle, of the brass-yellow colour which characterises chalcopyrite, first attracts notice. But the incrustation is mostly formed, to a depth of 2 mm., of a dark crystalline substance, with metallic lustre, consisting of sulphide of copper, and it is to it that the crystalline forms belong, which one might be apt, at first sight, to attribute to yellow sulphur.

The central part consists of a laminated substance. Here and there may be observed small dark hexagonal metallic crystals, in which one can see the characteristic striæ of chalcocite. The same substance forms small brilliant leaves, alternating with the dark leaves, on which appear some deposits of bright green. Heated in a tube, the crystalline substance gives a very slight sublimate of sulphur, which apparently results from the mixture of a little pyrites. The sulphide contains neither tin nor zinc.

The form of the exterior substance is that of hexagonal plates bearing truncated pyramidal faces inclined about 127° to the base. The cleavage is basic. This latter character and the absence of macles appear to indicate the variety of chalcocite called *cuprein* by Breithaupt.

All these coins were buried in a dark brown mud, containing numerous shells, many of which have been involved in the sulphurated deposits. From analysis of a sample of the water obtained at 6·70 m. depth, it appears that, as in the thermal springs above referred to, there are no sulphides, but merely sulphates, which organic matters reduce to the state of sulphides.

The novelty in production of the chalcocite in question arises from its occurrence apart, seemingly, from thermal springs, and at a lower temperature than in the cases hitherto known.

OUR ASTRONOMICAL COLUMN

The Great Comet of 1861.—The long series of observations of this splendid comet has been very ably discussed, with the view to the determination of the most probable orbit, by Heinrich Kreutz, a pupil of Prof. Schönfeld of Bonn, and the investigation is made the subject of an inaugural dissertation in July, 1880.

The comet was discovered on May 13 by Mr. John Tebbutt of Windsor, N.S.W., but the first accurate observations for position were made at the Observatory of Sydney on May 26. On June 10 it was observed at Santiago di Chile, and on the following day at Rio de Janeiro. European observations commenced on June 30, and were continued until May 1, 1862, the later places being obtained by M. Otto Struve with the 15-inch refractor at Pulkowa: the comet was not followed at other observatories beyond February 3, when Prof. Julius Schmidt last observed it at Athens. The number of separate observations collected for the determination of the orbit exceeds 1150, and these extend, as will be seen, over a period of 11½ months, in which the comet traversed an orbital arc of more than 155°. Seeling's ellipse (period 419⅓ years) is adopted in the calculation of an accurate ephemeris for the whole extent of visibility, and the observations, freed from the effects of parallax and aberration, are compared with this ephemeris for the formation of normal places. The best available positions of the comparison-stars were previously brought to bear upon the observations, so that they have received at the hands of M. Kreutz a general revision and rectification, proportional weights being applied after a criticism of the observations at the different observatories, forty-one in number. Thus thirty-one normal positions between 1861, May 28, and 1862, April 23, were formed. The next step was the calculation of the planetary perturbations for the whole interval, and it was found that the attraction of Venus, the Earth, Jupiter, and Saturn were alone sensible; June 12 was taken for the commencement of the perturbations. The normal places being corrected for their effect, sixty-two differential equations were formed, and their solution by the method of least squares gave the definitive corrections required by Seeling's orbit, which it may be stated proved sufficiently near the truth to render provisional correction unnecessary. The orbit which the comet was describing on June 12, or about the perihelion-passage in 1861, is thus found to be as follows:—

Definitive Elements of the Great Comet of 1861.

Perihelion passage, 1861, June 11·543949 M.T. at Berlin.

Longitude of perihelion	249° 4′ 58″·7	M.Eq. 1862·0
,, ascending node ...	278 58 53·4	
Inclination	85 26 15·3	
Eccentricity	0·9850773	
Perihelion distance	0·8223838	
Semi-axis major	55·1096±0·0330	
Period of revolution	409·40±0·367 Julian years.	

It will be remarked that the probable error of the resulting period is strikingly small.

M. Kreutz defers for the present an examination of the possible effects of planetary perturbation during the last revolution, in view of identifying the comet amongst those observed in the fifteenth century. If, however, the perihelion passage occurred in the winter it is by no means certain that the comet would be sufficiently conspicuous and favourably placed to be remarked in Europe. The following figures will afford an idea of the difficulty that would attend observations in these latitudes during the winter season. Assuming the comet to have been in perihelion twenty days earlier we have these positions for the respective dates (Eq. of 1861):—

	R.A. °	Decl. °	Distance from Earth.	Intensity of light.
Oct. 20	239·7	−17·3	1·53	0·52
Nov. 20	257·0	−20·2	1·77	0·39
Dec. 20	274·1	−20·8	1·88	0·35
Jan. 20	291·5	−19·3	1·86	0·36
Feb. 20	308·5	−15·8	1·70	0·42

In 1861, when the comet appeared as bright as a star of 4·5 mag., the intensity of light was 1·5, and it was just perceptible to the naked eye, when the intensity had descended to 0·4, but there was still a tail of 2½ degrees to distinguish it from a star, which would hardly be the case in the winter.

The Satellites of Mars.—In No. 2934 of the *Astronomische Nachrichten*, Prof. Asaph Hall has given data for ephemerides of the satellites of Mars at the opposition of 1881. The N.W. elongations take place with the following values of *u*, corresponding to the argument of latitude:—

Nov. 22	331°·7	Dec. 4	330°·3	Dec. 16	327°·1
26	331·4	8	329·4	20	325·8
30	331·0	12	328·3	24	324·5

From Prof. Hall's values of *u* it will be found that true N.W. elongations of *Deimos* occur Nov. 26·4411, Dec. 1·4886, Dec. 6·5350, and S.E. elongations Nov. 24·5480, Nov. 28·3340, Nov. 29·5957, and Dec. 3·3793 Greenwich times. On November 26 the distance of *Deimos* from the centre of the primary at elongation is 48″·7.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

Cambridge.—The last report of the Higher Local Examinations shows that in Group E (Natural Science subjects) there was a falling off of ten candidates and of two first classes this year. The examiners in Geology and Zoology give a generally favourable report. In Chemistry the practical work done was inferior, and common simple salts were not known by sight. Physiological Botany was little known; and the same remarks applied to Histology in the paper on Animal Physiology. In Group D, Political Economy showed much success, especially among some of the better candidates.

Dr. Latham and Mr. D. McAlister have been appointed members of the State Medicine Syndicate; and Mr. McAlister has been also appointed a member of the Board of Medical Studies.

SOCIETIES AND ACADEMIES

London

Linnean Society, November 17.—Sir J. Lubbock, Bart., in the chair.—Sir John Kirk, K.C.M.G., was elected a Councillor, and Mr. Frank Crisp Treasurer, in place of Mr. F. Currey, deceased.—Mr. George Murray exhibited (for Col. Turberville), a bough of *Pinus pinaster*, with suppressed internodes of the lateral branches, the result of injury to the axis from which they sprang.—De Francis Day showed examples of the stomach of the pilchard, with special reference to points in their digestion. Within the pyloric division of the stomach a membranous envelope incloses the food, the latter composed of the Zoëa stage of crustaceans. What peculiar function the sausage-shaped nerves serves in the economy of digestion is uncertain.—Mr. R. J. Lynch exhibited and read a short note on the contrivance for self-fertilisation in *Roscoea purpurea*, which to some extent resembles that of *Salvia* by modifications of anther and filament.—Sir John Lubbock, Bart., then read his ninth communication on the habits of ants, bees, and wasps. He detailed experiments proving that bees prefer blue flowers to those of other colours. But again if bees have so much to do with the origin of flowers, how is it there should be so comparatively few blue ones? Sir John suggests that all flowers were originally green, and then passed through white or yellow, and generally red, before becoming blue. Ants, he stated, may live seven or eight years.—Mr. C. B. Clarke described a Hampshire orchis not represented in English botany. This pale, flesh-coloured, or yellow orchis he demonstrates is the true *O. incarnata*, Linn., and not that figured by Syme and Babington, which is the *O. latifolia*, Linn.—Prof. Cobbold described a new entozoon from the ostrich, named by him *Strongylus Douglasii*. It is said to prove destructive to ostrich chicks at Grahamstown and elsewhere in South Africa. The worm somewhat resembles certain free nematodes, and bears few eggs.

Mathematical Society, November 10.—S. Roberts, F.R.S., president, in the chair.—At this, the annual meeting, the treasurer read his report, from which it appeared that the Society was in a very flourishing condition. The following gentlemen were elected on the council of the present session:—President—S. Roberts, F.R.S. Vice-presidents—Dr. Hirst, F.R.S., and J. W. L. Glaisher, F.R.S. Treasurer—C. W. Merrifield, F.R.S. Hon. Secretaries—Messrs. M. Jenkins and R. Tucker. Other members—Prof. Cayley, F.R.S., Sir J. Cockle, F.R.S., H. Hart, Prof. Henrici, F.R.S., A. B. Kempe, F.R.S., Prof. Rowe, R. F. Scott, Prof. H. Smith, F.R.S., H. W. Lloyd Tanner, and J. J. Walker. Mr. W. W. R. Ball, Fellow of Trinity College, Cambridge, and the Rev. G. Pirie, Professor of Mathematics in the University of Aberdeen, were elected Members of the Society. The following communications were made:—Note on the limit to the number of different proper fractions whose denominators are less than x, where x is large, by Messrs. Jenkins and Merrifield, F.R.S.—On the oscillations of a viscous spheroid, by Prof. H. Lamb, Adelaide.—A geometrical representation of a system of two binary cubics and their associated forms, by W. R. W. Roberts.—On the infinitesimal bending of surfaces of revolution, by Lord Rayleigh, F.R.S.—On tangents to a cubic forming a pencil in involution, by R. A. Roberts.—Note on Landen's theorem, by Prof. Cayley, F.R.S.

Chemical Society, November 17.—Dr. Gilbert, F.R.S., in the chair.—It was announced that a ballot for the election of Fellows would take place at the next meeting, December 1.—The following papers were read:—Aluminium alcohols, Part II. Their products of decomposition by heat, by J. H. Gladstone and A. Tribe. The authors have studied the bodies formed when aluminic ethylate, aluminic phenylate, aluminic paracresylate, aluminic thymolate, aluminium, α naphthylate, and aluminium β naphthylate are decomposed by heat. The C_nH_{2n+1} series yields the corresponding ethers, alcohols, and olefines, the C_nH_{2n-7} series yields the corresponding ethers and alcohols, together with some new crystalline bodies which are probably ketones.—On the chemical action of decomposing vegetable matter on the rock-forming sediment of the Carboniferous period, by E. Wethered. The author points out that the rocks immediately overlying the coal are in nearly all cases argillaceous, and that in the few cases where arenaceous rocks occupy that position they have a well-marked tendency to become more argillaceous as they come into contact with the coal. He proves by analysis that the chief difference in chemical composition between the two rocks is that the argillaceous rocks contain much more alumina, and concludes that this difference in chemical composition is due to the carbonic acid evolved by the decaying vegetation, decomposing all the silicates but that of alumina.—On α and β amylam, by C. O'Sullivan. The author has exhausted various grains, barley, wheat, rye, &c., with alcohol. The residue was then treated for some time with water at 40°, and the process repeated until nothing further was dissolved. The solution was filtered, evaporated, and precipitated with alcohol. The precipitate consisted of α and β amylam. These bodies were very carefully purified; the latter is soluble in cold, the first only in hot water. They have the composition of starch, but furnish apparently dextrose at once when treated with acid, without the previous formation of dextrin or any other substance. Their optical and chemical properties are fully given in the paper.—On the action of oxides on salts, Part IV. Potassic chlorate and ferric oxide, by E. J. Mills and G. Donald. The authors conclude that the action of ferric oxide on potassic chlorate resembles its action on potassic carbonate to a certain extent, that the chemical change has nothing abnormal or peculiar in its features, and that the name catalysis ceases to have any reason for its existence.—On the steeping of barley, by E. J. Mills and J. Pettigrew. The authors have compared the effects produced by steeping barley in water, and in water containing gypsum and calcium carbonate. The general effect of a calcium solution is to retain the nitrogenous matter in the grain, but to increase the total amount of extract. They attribute the value of the Burton water to the nitrates which it contains, and the consequent stimulating effects it produces in germination.

Zoological Society, November 15.—Prof. W. H. Flower, F.R.S., president, in the chair.—Prof. Newton, F.R.S., exhibited a specimen of *Emberiza rustica* recently shot on the coast of Yorkshire.—The Rev. Canon Tristram exhibited and made remarks upon skins of a darter and a pigmy cormorant procured in June of this year on the Lake of Antioch.—Mr. Sclater exhibited a specimen of the glossy ibis (*Plegadis falcinellus*) belonging to Sir Henry Mildmay, Bart., which had been shot in Hampshire in September last.—A communication was read from MM. L. Taczanowski et J. Stolzmann on the habits and various plumages of the rare humming-bird, *Loddigesia mirabilis*.—Communications were read from M. L. Taczanowski, C.M.Z.S., on two nearly allied species of humming-birds of the genus *Steganura* from Peru, and on a new species of *Mustela* from North-eastern Peru, which he proposed to call *Mustela Stolzmanni*.—Mr. W. A. Forbes read notes on the structure of the palate in the trogons (*Trogonidæ*), and on the systematic position of *Eupetes macrocercus*.—A communication was read from Mr. E. P. Ramsay, C.M.Z.S., containing an account of the true habitat of *Pycnoptilus floccosus*, Gould.—A communication was read from Mr. E. L. Layard, F.Z.S., containing a note on the South African mollusk, *Cœliaxis Layardi*, of Angas.—A communication was read from Mr. Edgar A. Smith, F.Z.S., containing notes on the shells of the genus *Chilina*, with a list of the known species.—Mr. Arthur G. Butler, F.Z.S., read a paper on some butterflies from Japan, with which were incorporated notes and descriptions of new species by Montague Fenton.—Mr. H. J. Elwes, F.Z.S, read a paper on the butterflies of Amoorland, Japan, and Northern China.

Physical Society, November 12.—Prof. Fuller, vice-president, in the chair.—Mr. W. D. Niven was elected a Member.—Mr. Lewis Wright then read a paper on some spirals observed in crystals, illustrating the relation of their optic axes. After remarking that the relation of the axes in uni-axial and bi-axial crystals had always been an interesting subject, he observed that if we took any uni-axial and a single axis of any bi-axial which had little or no axial dispersion, and polarised and analysed each circularly, we ultimately got similar phenomena. This is illustrated by calcite and a single axis of sugar, each giving, when thus treated, unbroken circular rings. From this it might be hastily inferred that a single axis of a bi-axial resembled in character the axis of a uni-axial, but this was not the view of those who framed the theory of double refraction in crystals. Fresnel finally framed the conception of three elasticities in three rectangular directions. If all were equal, there was no double refraction; if only two were equal, there was a single optic axis in the direction of the third; and if all were unequal, there were two optic axes. According to this theory the axis of the calcite did *not* resemble in character a single axis of the sugar or other bi-axial, but was a limiting case in which *both* such axes coincided. This was illustrated by the beautiful experiment of Prof. Mitscherlich applying heat to a crystal of selenite, and thereby altering the respective elasticities. The two axes gradually approached until they coincided and the crystal became uni-axial, after which, on heating the crystal still more, the axes re-opened in a direction at right angles to the former, thus proving Fresnel's theory. A point still to be illustrated was that the axis of a uniaxial did retain, or still embraced within itself in some visible form, characteristics of the two axes thus brought into coincidence. Sir George Airy had discovered the double spiral in quartz. Uniaxial calcite showed a double spiral; and biaxials gave a single spiral. Mr. Wright repeated Prof. Mitscherlich's experiment, with Airy's additional method of analysis; the spirals being first shown perpendicularly arranged above each other. Gradually they approached until they resembled those of the calcite, and finally opened out again horizontally. All through there was a double spiral, and a single one could only be got by separating a single axis. The axis of a uniaxial always preserved what might be called its "twin" or "double" character. This experiment was the ocular demonstration sought that the axis of a uniaxial, as a limiting case, did contain or retain elements capable of being made visible. It further showed the reason of the double spiral discovered by Sir George Airy in quartz. This crystal evidently was able to show its own spirals, which, of course, are double. It was shown that as the convergence of the rings was increased these spirals became as numerous and definite as in the calcite. There was however a crucial test of this view: for if it were correct we could combine the two properties of the quartz, artificially as it were, since many fluids also possess rotary power. If therefore we took a column of such fluid of sufficient length and an ordinary uniaxial crystal, the fluid would represent the axial properties of the quartz, and the crystal the other properties, and the two ought to give similar spirals. In fact the fluid should replace the quartz successfully in all these experiments. By means of a column of oil of lemons 200 millimetres in length, and crystals of calcite, sugar, topaz, and nitre, Mr. Wright showed this to be the case. Finally he demonstrated that the same phenomena held good through all the ordinary analogies with, or artificial substitutes for, natural crystals, the figures being produced with a circular chilled glass in parallel light, and also with an artificial uni-axial crystal made of crossed mica films, after Norremberg, and an artificial quartz made of superimposed mica films, after Reusch, in convergent light. All the figures were projected by the electric camera to a size 8 feet in diameter. All Mr. Wright's experiments went to illustrate the truth of Fresnel's theory.—Mr. C. V. Boys then read a paper on the prevention of the bursting of water pipes. Mr. Powell had proposed the use of pipes of elliptical or other round section, and Mr. Mangnal of Manchester had independently hit on the same idea. Such a pipe would become rounder in section when the water froze and expanded. A round pipe tends to become thinner at its weak parts on expanding under the pressure. With an elliptical pipe, the force required to alter the shape of its section is greater as the section is more circular, therefore the effect produced by a change of shape at any place makes that place stronger. A round pipe is in a state of unstable, and an elliptical pipe in a state of stable, equilibrium, and changes its form uniformly from end to end. Hence if a portion only of such a pipe is exposed to the cold, the whole is effective, and it will require a proportionally greater number of frosts to make the pipe round. Inspection would show if the pipes were becoming round, and then they could be squeezed back to their original shape. Mr. Boys had demonstrated these inferences by experiment with Mr. Powell. Messrs. Powell, Rigby, and Co. of Piccadilly made these pipes.—Mr. J. Macfarlane Gray drew attention to some apparent discrepancies in the constants employed by Regnault in his work on "The Physical Properties of Steam."

PARIS

Academy of Sciences, November 14.—M. Wurtz in the chair.—The following papers were read:—Researches on electrolysis (continued), by M. Berthelot. He illustrates the "principle of minimum electromotive force in electrolyses," in virtue of which electrolytic decomposition occurs as soon as the sum of energies necessary is present. It is distinctly verified wherever there is no polarisation of electrodes.—The maritime laboratories of Banyuls-sur-Mer and Roscoff, by M. de Lacaze-Duthiers. The Roscoff station has had increasing success: 38 have worked at it this year, as against 27 in 1880 (there are 25 at present). The number of foreigners is eight. A large fish-pond has been added, and Government has provided a vessel for dredging. Banyuls-sur-Mer was fixed on for a winter station. The author gives particulars of what is to be called the *Arago Laboratory*, &c., which will be ready early next year. He has received 48,000 francs. The Mayor of Banyuls has opened a subscription for a dredging vessel.—Observations on the second volume of M. Fontaine's Universal History; the Iranians, by M. de Lesseps.—On the working zone of anæsthetic agents, and on a new process of chloroformisation, by M. Bert. With increasingly-strong mixtures of an anæsthetic vapour and air, a point is reached at which an animal in such an atmosphere is made insensible, and another point at which it is killed. The interval between these is the *zone maniable*, or working zone. M. Bert used chloroform, ether, amylene, bromide and chloride of ethyl, and the animals were dogs, mice, and sparrows. Under these conditions the fatal dose is precisely double the anæsthetic dose. (In the case of protoxide of nitrogen the ratio is one to three.) The zone is much greater for ether than for chloroform. Animals anæsthetised in the way indicated remain perfectly quiet and need no attention. In the common way of applying chloroform, with a compress, the limits of the working zone may be exceeded on either side. Chloroform acts, not by the quantity respired, but by the proportion in which it exists in inspired air. The author applies the mixture through a tube and a small mask. The anæsthetic dose for man has yet to be determined.—Synthesis of azotised colloids, by M. Grimaux. Proteic matters he defines as azotised colloids breaking up, through hydration, into amic acids, carbonic acid and ammonia, and from this his method of synthesis is derived. He combined aspartic anhydride with urea.—Crystallographic observations on a variety of natural blende, by M. Hautefeuille.—Observations of Schäberle's comet (*c* 1881) at Rio Janeiro Observatory, by M. Cruls.—On the theory of motion of celestial bodies, by M. Callandreau.—On certain series for development of the functions of a variable, by M. Halphen.—Equality of mean sinking produced by two equal loads (each at points where the other is deposited) arbitrarily distributed along two concentric surfaces on a horizontal ground, or on a horizontal circular plate having the same centre as these circumferences, and supported or secured throughout its contour, by M. Boussinesq.—On the maximum yield of which two given dynamo-electric machines are capable, when used for transport of force, by M. Lévy.—Researches on the absorption spectrum of our atmosphere at Paris Observatory, by M. Egoroff. He describes the absorption of strong electric light by the air-layer between Mont Valérien and the Observatory, observed on eleven evenings. It is probable that, after aqueous vapour, air is the only strongly absorbent substance.—On the electrolysis of water (continued), by M. Tommasi. All metals except gold and platinum, being able to combine with the oxygen of water under action of the voltaic current, are capable, when positive electrodes, of decomposing water by action of a single (zinc copper or zinc carbon) element. He here shows that the decomposition will occur if one of the two electrodes is aluminium, zinc, or carbon. He opposes some of M. Berthelot's views.—On the reversibility of the electro-chemical method for determination of systems of equipotential or discharge, by M. Guébhard.—On the magnetic properties of the nickelised iron of Santa Cattarina, Brazil, by M. H. Becquerel. There is great increase of magnetism after heating followed by cooling, and the author got a like result with pure nickel crystallised in the cold state; but not with pure iron. The native iron must have crystallised at a low temperature.—On the proportions of carbonic acid in the high regions of the atmosphere, by MM. Müntz and Aubin. The observations, made on the Pic du Midi (2877 m.) gave 2·86, which is extremely like the figure got on the plain of Vincennes, and similar figures were got in two Pyrenæan valleys.—On the post-embryonal development of Diptera, by M. Viallanes.—The pourridium of vines of Haute-Marne, produced by *Ræsteria hypogæa*, by M. Prillieux.—Bauxites, their age and origin; complete diffusion of titanium and vanadium in rocks of primordial formation, by M. Dieulafait.

VIENNA

Imperial Academy of Sciences, November 3.—L. T. Fitzinger in the chair.—The following papers were read:—A. D'Albert Adamkiewicz, on the blood-vessels of the spinal cord of man, Part II. The vessels of the spinal marrow.—E. Heinricher, contributions to the teratology of plants.—E. Tangl, on nucleus and cell division in the formation of pollen of *Hemerocallis fulva*, L.

CONTENTS

PAGE