THURSDAY, NOVEMBER 20, 1879

THE DOUBLE STARS

A Handbook of Double Stars. By Edward Crossley, F.R.A.S., Joseph Gledhill, F.R.A.S., and James M. Wilson, M.A., F.R.A.S. (London: Macmillan and Co., 1879.)

Double Star Observations made in 1877–78 *at Chicago with the* 18½-*inch Refractor of the Dearborn Observatory, &c.* By Sherburne Wesley Burnham, M.A. (From *Memoirs* of the Royal Astronomical Society, vol. xliv.)

IT cannot be said that a special work upon the double and compound stars has not been long a desideratum. Of the various branches of astronomical science the study of the double stars appears to have formed one of the most attractive to amateurs generally; so far as the reduction of the observations is concerned it involves little calculation, and the observations themselves are not laborious but admit of being proceeded with at intervals of leisure, with comparatively moderate appliances, at least in a large number of cases. Many of our amateurs have their daily duties and occupations in other lines, and seek relief in their evenings from the monotony of routine; the observation of the double stars upon a well-arranged list perhaps offers as favourable opportunities for rendering themselves really useful and for doing really good work in astronomy without the labour of one kind or another involved in several other classes of observation as it is possible to find.

The branch of astronomy to which we are referring has progressed as rapidly as others, and the observations of double stars and particulars relating to them have been scattered through a large number of astronomical publications, to consult which involves a great outlay of time and trouble, even if they are accessible without difficulty. The main purpose of the volume before us has been to present the great majority of measures of some twelve hundred double stars in a convenient form, with notes bearing upon binary character or other peculiarity, or, speaking generally, to furnish a history of each star. Part I. is introductory or explanatory, containing a brief historical notice and reference to those astronomers who have been most occupied upon the double stars, with particulars of the instruments employed, the adjustments of the equatorial, the micrometer and methods of observing with it, forms for registering measures and similar details. Part II., which possesses considerable value, treats of the calculation of the orbits of the revolving double stars, and in this division of the work the authors have been fortunate in being assisted by Dr. Doberck, who has a greater experience in this direction than any other astronomer of the day, and who has contributed in so important a degree to advance our knowledge of the elements of these revolving suns. Sir John Herschel's graphical process for determining the apparent orbit which is still of such material assistance towards more refined investigation is explained and illustrated (which is better still) by an application to Castor. This is followed by the calculation of an orbit by analytical methods, applied to σ Coronæ, the different steps being clearly defined, but these methods are necessarily much more laborious, and at present we do not seem to get the full advantage in many cases that might be expected from them. It will be no fault of Dr. Doberck's if the computer does not succeed in obtaining elements upon the principles he so well explains, which will continue to represent the motion of the star. Other causes frequently operate, however, which appear to render elements less satisfactory for *prediction* than might be expected, considering the refinement used in their calculation. The comparison of Dr. Doberck's orbit of σ Coronæ with observation affords a very close agreement. In the next three chapters Mr. Wilson enters upon relative rectilinear motion, the effect of proper motion and parallax on the observed angles and distances of a star optically double, and the errors and combination of observations.

Part III., "the Catalogue and Measures," prepared by Mr. Gledhill, is that which will be most frequently consulted. Considerable care appears to have been taken in the selection of the objects, and in the collection of the measures by various observers. A great amount of trouble must have been expended upon this portion of the volume, which is well brought up to date, and few facts of importance bearing upon the history of any object appear to have been overlooked, though such omissions must almost necessarily occur sometimes in a work of this character. There has evidently been the wish to make this part of the work as useful as possible to the amateur. Perhaps in a short supplement to another edition it may be desirable to reproduce the double star measures with the Königsberg heliometer, collected in vol. xxxv. of the Observations at that Observatory, the more especially as these volumes of observations have but a small circulation in this country; we miss most of these measures in the "Handbook."

An appendix contains the positions and measures of two hundred of Mr. Burnham's new double stars, placed at the service of the authors by the discoverer. Part IV. is bibliographical, and supplies a list of the principal works and papers relating to double stars and upon various forms of micrometer.

The volume is one which may be expected to find its way to the shelves of most amateurs and students of astronomy.

Mr. Burnham's important contribution to vol. xliv. of the *Memoirs* of the Royal Astronomical Society, contains (1) a catalogue of 251 new double stars with measures, and (2) micrometrical measures of 500 objects, amongst them some very difficult ones and a number of evident binaries.

At the time the Chicago Astronomical Society was organised in 1862, Messrs. Alvan Clark and Sons had still in their possession an object-glass of 18½ inches aperture, which was then the largest in the world. Steps were taken to secure it, and, thanks to the energy of the Hons. Thomas Hoyne and J. Young Scammon, the latter of whom has been president of the Society from its organisation, the glass was secured for Chicago, and by means of a public subscription 18,000 dollars were raised for its complete mounting, and Mr. Scammon contributed 30,000 in addition for the building. Fortunately an observer equal to the use of so fine an instrument was at hand, and latterly Mr. Burnham has devoted it to the discovery of new double stars and the revision of an extensive list of known ones which appeared most deserving of attention. He remarks: "My work has been wholly a labour of love. During the business hours of every day I have been otherwise fully occupied, and hence my observations have been prosecuted often at the expense of rest, sleep, and recreation. I submit the results to the Royal Astronomical Society as the first contribution of the great equatorial of the Dearborn Observatory." Mr. Burnham had however published, between 1873 and 1877, *nine* smaller lists of new double stars, containing 482 in all; the present catalogue brings up the number to 733; indeed, his energy and success have been alike extraordinary.

In looking over this tenth catalogue of new doubles, many objects are noted which deserve more or less attention. η Piscium, a star of the fourth magnitude, has a companion of the eleventh at a distance of one second, and "there is no known pair among stars of this magnitude or brighter, with so close and minute a companion." Three stars have been found near the celebrated variable, *Algol*, all three closer than Schröter's companion; one of 12·5m. is distant only 10″·6 on an angle of 115°. There are also three new doubles amongst the Pleiades, and a much nearer companion to *Aldebaran* than that observed by Herschel and Struve. In an object in R.A. (1880·0), 21h. 1m. 25s., and Decl. +43° 12′, Mr. Burnham finds the most minute close pair known and terms it "a curiosity in double stars, if for no other reason;" it is too small for Argelander's *Durchmusterung;* the components are about equal and near 11m., distance 0″·4. There are two faint companions to Herschel's "Garnet-star" in Cepheus, and not the least interesting addition is a *comes* of 12·5m. preceding nearly on the parallel, by 0″·7, the star 85 Pegasi, which has large proper motion and a sensible parallax according to the investigations of Prof. Brünnow at Dunsink; as Mr. Burnham remarks the physical connection or otherwise of the faint star should be soon decided.

In the second catalogue, as we have stated above, there are many binary systems, the Chicago observations either confirming previous deductions or indicating new objects in motion. Mr. Burnham doubts the duplicity of *Atlas Pleiadum*, though Struve considered that confidence might be placed in his measures of 1827, an inference somewhat supported by Dr. Hartwig's observation on the occultation of the star by the moon in 1876. An examination of the interior of the trapezium of Orion, afforded not the slightest suspicion of any additional stars, and hence Mr. Burnham concludes that several faint objects supposed to have been seen within it, with smaller telescopes, have no real existence, and he expresses the same opinion as to recent suspected companions of the Pole-star. He shows good reason for inferring that one of the components of Σ 1058 is variable; the brighter star is missing in more than one catalogue where it might be expected to be found, and in 1878 a thorough search did not reveal any double star near its place, but in the early part of the present year he has been more successful and has measured the star on two nights, when the magnitudes were respectively 8 and 11. A reference to Mr. Burnham's notes will afford a number of other objects to which special interest attaches.

OUR BOOK SHELF

The Saidapet Experimental Farm Manual and Guide. By C. Benson. (Madras, 1879.)

THIS volume is published by the direction of the Madras Government, and consists of a Report by the Superintendent of the more important results obtained at the experimental farm since its commencement in 1865. An agricultural college has been recently added to the farm establishment, but this educational work lies beyond the scope of the present volume. Of the value of the work done on this experimental farm there can be no question; the Government money spent on it has been well laid out. If the miserable and profitless native systems of agriculture are to be improved, and the land made capable of supporting the rapidly increasing population, it must be by the adoption of the methods here recommended.

In the native agriculture the soil is stirred to the depth of 3 inches only, manure is seldom employed, and grain crops are generally the only ones cultivated; the land is thus reduced to its lowest limit of productiveness. Irrigation is also most wastefully conducted. Eight to twelve feet of water are consumed in the production of a single crop of paddy, the ground being turned into a swamp, and frequently becoming a source of disease to the surrounding population.

The improvements recommended are in the first place a deeper cultivation of the soil, by which its porosity and water-holding power would be increased, and the root development of the crop favoured. An English plough is said to cost twenty-five times the price of a native implement, but the work done is so superior that the increased outlay will be repaid during a single year's cultivation of twenty acres. Many soils also require draining. The rainfall in India is at certain times of the year extremely heavy (16 inches have been recorded at Saidapet in twenty-four hours); on such occasions undrained land becomes for a long period unworkable, and much precious time is lost. Judicious drainage will not diminish the water holding power of heavy land, but rather increase it by promoting the disintegration of the subsoil. Drainage is also greatly needed in many cases for irrigated land; without this the water may become stagnant and its good effect greatly diminished.

The next improvement demanded is the adoption of a proper rotation of crops, in which fodder crops should hold an important place. The experiments have shown that a large number of excellent fodder crops exist, which can be cultivated if need be all the year round. The fodder crops most strongly recommended are cholum (*Sorghum vulgare*), and guinea grass (*Panicum jumentorium*). Sugar cane, where well manured, affords an immense amount of excellent fodder. Paddy may also be often usefully cut while green, and a good supply of fodder thus obtained when the quantity of water available is too small to carry the crop to maturity. Horse gram (*Dolichos uniflorus*) may also be grown with advantage as a fodder crop, and four or five cuttings may be obtained in the year. Being a leguminous plant, rich in nitrogen, it is of great use in bringing poor land into condition, and may be ploughed in as a green manuring with excellent effect.

One great object of the growth of fodder crops is to enable the farmer to raise the condition of his soil by applications of organic manure; to increase the amount of humic matter in the soil is a most important step towards amelioration in such a climate as that of India. The fodder crops should be consumed by cattle, kept, at least during the night, in loose boxes, and the manure thus obtained returned to the land. Other manures recommended are steeped cotton-seed, salpetre, bones, and lime.

Until the condition of the land is raised by proper cultivation and manuring, a large number of improvements must remain impossible. Superior grain crops, and superior varieties of rice and cotton, can only be grown on good soil; on poor soil they at once deteriorate. The same may be said of live stock: the miserable native breeds are accustomed to starve during a part of every year; such treatment would be fatal to better animals. Until good fodder crops are grown, any permanent improvement in the breeds of farm animals is impracticable.

We might easily extend our notice of this useful volume; it is full of practical information, and must prove of great value to all engaged in agricultural operations in India.

R. W.

Grundriss der chemischen Technologie. Von Dr. Jul. Post. Part ii. (Berlin: Robert Oppenheim, 1879.)

WE have already noticed the first part of Dr. Post's excellent manual of chemical technology (see vol. xvi., 83), which made its appearance towards the end of 1876. Unfortunately, the completion of the work has been delayed by the severe and prolonged illness of the editor. The first portion was mainly confined to a description of the modes of manufacture of crude or intermediate products; the second part treats of the finished or final products. Objections might, doubtless, be raised against such a mode of treatment, but we question if, on the whole, a more systematic method of dealing with so complex a subject as chemical technology could have been devised. The entire work forms unquestionably one of the most, if not *the* most, complete repertorium of the existing processes of industrial chemistry that we know of in any language, and as such we can confidently recommend it to the notice of our chemical manufacturers. Dr. Post has been assisted by an excellent band of collaborators, many of whom are recognised as authorities on the subject of their respective communications. A due amount of space is usually devoted to a consideration of the theory of the various processes when this has been at all worked out; and the description of the mode in which these processes are actually carried into operation is facilitated by numerous diagrams and plans. Dr. Post is to be congratulated on the completion of an exceedingly useful work.

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.*]

The November Meteors

THE cloudless sky from the morning of the 12th to the 15th, with the total absence of moonlight, afforded a most favourable opportunity for the observation of the meteors of the Lion. A constant watch was kept up at this observatory from 10 P.M. until daybreak of the 13th, 14th, and 15th, and the results show that the Leonids were considerably in excess of what they had been during the last few years.

The total number of meteors observed was 309, and out of these 104 radiated from the Lions, and 56 clearly indicated five principal radiant points. Four of the radiants were situated near the stars ϵ, γ, δ, and η Leonis, and the fifth was just below (31) Leonis Minoris. The position of this east point was very clearly marked by a stationary meteor of the 1st magnitude. Eighty-six of the meteors were of the 1st or 2nd magnitude, and nine others were brighter than 1st magnitude stars. The largest number of Leonids seen during a single hour was fifteen, from 4 to 5 A.M., on the 14th.

S. J. PERRY

Stonyhurst Observatory, November 18

The Platysomid Fishes

I AM very sorry to find that my esteemed friend Prof. H. Alleyne Nicholson has, in the new edition of his "Manual of Palæontology" (vol. ii. p. 138, *note*) committed the mistake of quoting me as his authority for elevating the Platysomid fishes to the "rank of a distinct division of Ganoids." No such proposition occurs in the unpublished paper to which he refers, which was written to follow up the views which I expressed in my account of the structure of the Palæoniscidæ (Palæontographical Society, 1877), as to the abolition of the sub-order "Lepidopleuridæ," necessitated by the demonstration of the fact that the Platysomidæ as a *family* are not really allied to the Pycnodontidæ, but are on the other hand so closely linked by ties of structure to the Palæoniscidæ, that, wherever the latter family is placed, thither the Platysomidæ must follow.

My paper on the "Structure and Affinities of the Platysomidæ" was read before the Royal Society of Edinburgh on May 5 of this year, and will in a few weeks appear in the forthcoming fasciculus of that Society's *Transactions*. Prof. Nicholson's mistake as to my views is obviously due to his having only had, and that on one single occasion, a very hurried glance over my proof-sheets.

R. H. TRAQUAIR

8, Dean Park Crescent, Edinburgh, November 12

Voice in Fish

THE question as to whether fish have any so-called voice or means of intercommunication having some interest for your readers, I may relate that about six years ago, while engaged in a survey of the Disang iver in Eastern Asam, I had occasion to sound by a line the depth of a pool called the "Deo Dubé" (or deep of the Demon).

While seated in a small *Rob Roy* canoe and very slowly drifting on the pool, I became aware of a number of large Mahsír (*Barbes macrocephalus*) moving about in the water below and around me. Sitting perfectly still I had the pleasure to see them gradually approach the surface and move about me at a foot or so distant, passing alongside, under and round the canoe carefully examining it, bow and stern specially. It may not be easy to guess a fish's *thoughts*, but from the manner in which they examined my symmetrical and grey coloured canoe they appeared to think it might possibly be a huge fish, and dead of course.

While watching their movements I was aware of a peculiar "cluck," or percussive sound—frequently repeated, on all sides, and coming from below, but close to me. Eventually I found that this was made by the Mahsír, and one—passing close along on my right, by itself, made several *distinct* sounds as it went on—that seemed answered by others to the left. If seated, say on the bank, the sound would be loud enough to be heard at 40 feet distance.

A large bivalve also is common in some parts of Eastern Asam that sings loudly in concert. A small *ant* also makes a peculiar thrice-repeated noise by scraping in unison on the dry leaves of its nest if it is disturbed.

S. E. PEAL

Silurian Fossils in the "Lower Old Red Sandstone" of the Curlew Mountain District

YOUR correspondent in NATURE, vol. xxi. p. 32, on the above subject has evidently misunderstood the notice (NATURE, vol. xx. p. 641). The rocks in question, though belonging to what is generally known as the "Old Red Sandstone," contain Silurian fossils, which confirms the opinion of myself and others that the lower Old Red should be regarded as the upper part of the Silurian formation.

G. HENRY KINAHAN,
President of the Royal Geological Society of Ireland

Dublin, November 17

The Paces of the Horse

A GOOD many ingenious contrivances have lately been invented by which to find out the true movements of the feet of the horse in its various paces, notably that described in "A Study on Locomotion" which appeared in NATURE, vol. xx. pp. 434, 468, 488.

My object in writing this letter is to challenge the assumption of all these experimenters that their diagrams should constrain artists to correct their representations of animals in motion.

When, for instance, Prof. Marey says of his diagrams, "these pictures are correct as regards the position of the members; it would be the artist's duty to add elegance of form," it is apparent to me that such a division of labour would never produce a picture. Take Fig. 16, for instance, representing the true position of the legs in galloping, and I venture to say no amount of elegance added would convey an idea of what the animal was doing.

I submit that the error which leads the experimenters so far is forgetting that the mechanism of the human eye has as much to do with the matter as the movements of the horse's feet.

Confining my argument to the gallop, I contend that the conventional extended attitude is true artistically, though it never actually takes place whilst the horse is at this pace. The eye (as is sufficiently proved by the need of machinery for finding out the actual motions of horses' feet) does not obliterate and receive impressions sufficiently quickly to trace the three paces in the gallop; but it can note the fact that at some moment during each bound, each of the four reach this extreme point. Now the feet are twice as long at this point as at any other, that is to say, the passing out over and returning along the last inch is for the eye a pause at the extreme. It is no more doubtful that a galloping horse should be painted as it usually is, than that a swinging pendulum can only be suggested by drawing it at one or other extreme of its excursion. An artist could no more use Prof. Marey's diagrams in the way it is assumed he should, than he could represent a rolling wheel if he took no liberties with the apparent position of the spokes; but confined himself by remembering their true places and numbers, which of course are the same as when the wheel is at rest.

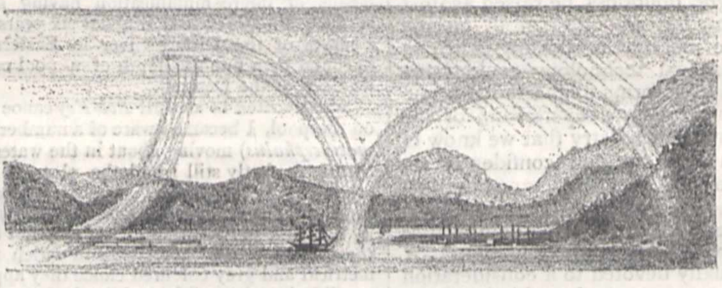
It is true that a galloping horse might also be represented with all its legs gathered under it, but this is not done, because, as I agree with Prof. Marey, "it is the artist's duty to add elegance of form;" whilst I dissent from him when he allows himself to be convinced that "the greater part of the horses [of Phidias] are represented in false attitudes" because the odograph says so.

W. G. SIMPSON

Edinburgh, November 12

A Curious Rainbow

I SEND you a rough sketch of a curious rainbow group seen in Gareloch about 8.25 A.M. on October 20. I would have written sooner but I delayed till I had obtained sketches from several different sources. I only saw the junction of the two bows at C, that being the only part of Row Bay visible from my standpoint, but several observers saw the whole group as I have drawn it. The sea was quite glassy, so that the inverted rainbow A must have been formed by the sun's rays reflected from the water. The wind was just beginning to rise and some scudding showers were passing up from the Firth of Clyde from the south-west,



Road to Kilcreggan. Roseneath. Row Point. Pier. Row.
A B C D

but the bay was quite calm. The bow D was perfectly full and bright, while B died away at its highest point. I can only imagine that B was formed by light reflected by some bright cloud, but I did not observe any bright enough. The view is nearly north-west. As I have never even among our Scottish hills seen such a combination of rainbows, I think the description may have some interest for some of your readers. The hill to the right is Knapps Hill, and is 2,000 feet high and three and a half or four miles distant.

J. B. HANNAY

Woodbourne House, Helensburgh, November 4

How Snakes shed the Skin

IN NATURE, vol. xx. p. 530, Dr. H. F. Hutchinson, amid some interesting facts about snakes, says: "I have never witnessed the process of skin-shedding, nor, I believe, has any observer." The Doctor then ventures an ingenious, though incorrect, hypothesis of his own. In the *American Naturalist* for January, 1875, *i.e.*, vol. ix. No. 1, under the title, "The Pine Snake of New Jersey," I gave an article embodying the results of several years' study of *Pituophis melanoleucus*, in which the process of exuviation is described as witnessed by myself. Herewith is an abstract. The few words interpolated for the sake of clearer exposition are put in brackets.

Near the close of September, 1873, at 1 P.M., looking into the box, I saw that the female snake had started the skin from her head. It was a little torn at the snout, and I found that the head and a little of the neck were denuded. The denuding process was going on, but very slowly. Doubtless the chief difficulty was in starting the skin, and I felt sorry that I did not see the start. The neck was very slowly becoming divested of the old cuticle, which, at first glance, had a sort of back-creeping aspect. What surprised me was the fact that there was not the least friction in the process; that is, there was no rubbing against any exterior object. It really did look as if an invisible power was drawing the skin back upon itself. [Looking closely, I caught the secret. There was a systematic alternate swelling of the body at the neck of the skin, thus stretching it, and making a shoulder in front of the neck, each swelling pushing the loosened skin a little backward.] The old skin at this time is very moist and soft, and any swelling of the body stretches and loosens it. So soon as the exuviation has reached the part of the body containing the larger ribs, this doffing of the old suit proceeds more rapidly, and with a singular system. It is done just in this way: Exactly at the place where the skin seems to be moving backward, a pair of ribs expands. This action enlarges or puffs out the body, and by stretching loosens the skin at that place. In this movement both ribs in the pair act at the same time, just as the two blades of the scissors open together. Now comes a second movement of this pair of ribs, in which action the two ribs alternate with each other. One of them—say the one on the right side—is pushed forward and made to slip out of and in front of the constriction made by the swelling, when it immediately works backward, that is, against the neck of the double receding skin. Now the left rib makes a like advance, and in a similar manner presses backward. [Thus for every increment of exuviation, or backward movement of the inverting skin, three actions occur with rhythmic method; the expanding of one pair of ribs, the intumescence of the body at that spot, and the pushing back of the skin by the alternate action of each rib.] Thus the final action of each pair of ribs is not synchronous, but alternate, and has a notable sameness of movement and result with that of the alternate hitching of each side of the mouth when swallowing a large prey. Indeed, swallowing, with a serpent, is a misnomer, for that laborious hitching is not more a pushing of the prey down the gullet than a drawing of the body over it. The Western man said he always felt better after getting himself round a good beef-steak. With the serpent this is a literal fact; it puts itself outside of its victim. So with that singular costal action it seems to push the skin backward; but this is an illusion, for it actually pushes itself forward, pulling the skin out as itself advances out of the skin, thus with each movement or advance lengthening the inverted cuticle behind; that is, the old hose everts or evolves itself forward, though it appears as if by some occult force to be pulled on itself backward.

The ribs of a serpent, which extend nearly throughout its whole length, are very much smaller near the neck and near the tail. At both these parts exuviation is much slower than where the larger ribs have play in the process. This rib action produced an automatic movement of the snake on the floor of its box, and across the folds of its companion, which kept as still as if it were dead. This involuntary movement of the reptile's body was almost imperceptible. All told, it might have been through two feet of linear space. But the exuviated skin was nearly six feet long. This movement seemed much greater than it really was. It was emerging from a tubular case, which was doubling upon itself for a while, the inner or unevolved part shortening as it moved forward with the body; the outer, or evolved part lengthening as it moved backward from the body. The cast-off skin is presented inside out, so that every scale is now seen on its under or concave side, and this is also true of the eye-scales. To all this there is one exception: the last scale of the tail is a hollow pyramidal or four-sided spike. This, for plain reasons, is not everted. When the shedding has reached this scale a sharp shake of the extremity is sufficient, and the uneverted spike is left inside of its everted skin. The entire process of exuviation, allowing five minutes for the part that I did not witness, took thirty-five minutes.

Let me add that in poor health a snake has a hard time in getting off its old coat. I could detail an instance wherein the process took three months. The old skin adhered stubbornly to the new one, and was only removed by friction and by tearing off mere bits at a time. SAMUEL LOCKWOOD

Freehold, New Jersey, U.S.

The "Hexameter," Πᾶσα δόσις ἀγαθὴ . . .

THERE is an obstacle in the way of regarding this passage (James i. 17) as a hexameter quoted by the Apostle from some poet, as the late lamented Prof. Clerk Maxwell is reported in Mr. Garnett's interesting notice of his life, work, and, not least, his character, to have suggested. The final syllable of δόσις is short, as the accentuation of πρᾶξις and similar verbal nouns proves. *Arsis*, as in "Βέλος ἐχεπευκές," Il. α, 51, can hardly be pleaded. J. J. WALKER

University Hall, W.C., November 17

THE SWEDISH NORTH-EAST PASSAGE EXPEDITION[1]

DURING the wintering of the *Vega* large quantities of the bones of the whale were found on the beach. These at first were supposed to be the remains of whales that had been killed by the natives or by American whalers. On examination it was found that they must be sub-fossil. This was confirmed by the natives, who stated that no whale had driven on land in the memory of man. The remains were found to belong to four or five different species, of which *Balena mysticetus*, or a nearly allied type, was the most common.

Prof. Nordenskjöld investigated the formation of the strata of frozen earth several hundred feet thick which occur in Siberia as in Polar America. Along the coast of Siberia there is a stratum of water resting on the bottom of the sea which is several degrees below the freezing-point, so that a flask of the comparatively fresh surface water, when sunk into this stratum, begins to freeze. Stuxberg observed that the trawl-net often froze fast to the bottom. This was accounted for by the freezing of the fresh water which the net carried down with it from the surface. Nordenskjöld thinks that the mud carried down by the rivers into the sea as it sinks to the bottom carries with it fresh water adhering to the minute particles, and that this fresh water, like that carried down by the net, freezes at the bottom, forming thus a frozen stratum, which increases year by year until it reaches an enormous thickness. He is of opinion that a portion of the earthy layers of Siberia was formed in this way, although, he adds, he by no means considers this the only way in which such formations arose.

Along the whole coast, from the White Sea to Behring's Straits, no glacier was seen. During autumn the Siberian coast is nearly free of ice and snow. There are no mountains covered all the year round with snow, although some of them rise to a height of more than 2,000 feet. With one exception there were no rocks along the coast precipitous enough to be suitable breeding-places for sea-fowl, but a large number of these birds were seen during spring flying farther to the north.

During the voyage of the *Vega* from her winter quarters through Behring's Straits and farther south, Nordenskjöld searched for a tribe called Onkilon, said to be allied to the Eskimo, but without success. He found only reindeer-owning Tchuktches, and supposes that the name Onkilon, given by Wrangel to the old tribe inhabiting the coast and driven out by the Tchuktches, is probably related to the name Ankali, given by the reindeer-owning Tchuktches to the coast Tchuktches. Nordenskjöld states that English authors who refer Eskimo and Tchuktches to the same origin are mistaken. It was found that the inhabitants on the American side are pure Eskimo, with whom it was possible to carry on barter by means of the list of Eskimo words published in "Arctic Geography and Ethnology," London, 1875; but that the language spoken by the Tchuktches, of which Lieut. Nordquist collected about 1,000 words, is quite different, and probably allied to that of the Iranian races. On the other hand there is a complete correspondence between the household furniture of the Tchuktches and the Eskimo. It may be safely affirmed, he says, that these two neighbouring races have a greater number of identical articles in their tents than of common words in their languages.

The hills at Cape York on the American side were found to consist of crystalline schists without organic remains. Among the natives, who were Eskimo, there was a Tchuktch woman who said that Tchuktch tribes were settled on the American side between Point Barrow and Cape Prince of Wales. The Eskimo used, along with breechloaders, revolvers, and axes obtained from the Americans, bows and arrows, bone boat-hooks, and various stone implements. They were friendly and agreeable, and less given to brandy than the Tchuktches. There did not appear to be any chief among them. Complete equality prevailed, and the standing of the women did not appear to be inferior to that of the other sex. Among the stone implements were found arrow-heads and other articles of a species of nephrite so closely resembling the well-known nephrite from High Asia, that these implements were supposed to have actually come from that region.

A warm current, as in Europe, was found to flow along the north-western coast, and to create there a far milder climate than that which prevails on the Asiatic side. The limit of trees therefore lies a good way to the north of Behring's Straits, while the whole of the Tchuktch Peninsula appears to be devoid of trees. This is the case also with the land along the coast at Port Clarence, but a short distance inland there were bushes two feet high. Vegetation was generally luxuriant, and a great number of species were identical with, or nearly allied to, those of the Scandinavian north, among others the *Linnea*. Notwithstanding the luxuriance of the vegetation, the land invertebrates were much poorer in species than in the north of Norway. Thus only from ten to twenty kinds of beetles could be found, principally *Harpali* and *Staphylini*, and of land and fresh-water mollusca only seven or eight species. The avifauna was also rather scanty, and the dredgings in the harbour at Port Clarence, on account of the unfavourable nature of the bottom, yielded only a small number of animal and vegetable species.

The *Vega*, crossing to the Asiatic side, anchored in Konyam Bay on July 28. On the north shore of this Bay Dr. Kjellman added seventy species of flowering plants to the collection he had previously made. Here, too, were

[1] Continued from p. 40.

found the first land mollusca on the Tchuktch Peninsula. Nordenskjöld considers it probable that on the southern part of this peninsula there was in former times a little inland ice. On July 31 the *Vega* was anchored at St. Lawrence Island. Drift ice was seen for the last time. The quantity of ice carried by the Polar current through Behring's Straits is very inconsiderable, and it has evidently been for the most part formed along the coast. Not a single iceberg was visible, the whole of the ice seen being level and rotten "year's ice." St. Lawrence Island is inhabited by Eskimo, who having frequent intercourse with the Tchuktches, have adopted some of their words. The prevailing rock is granite, weathering readily, and thus giving origin to a very fruitful soil. Vegetation was exceedingly luxuriant, and rich collections of land and marine animals, lichens, and algæ were made.

The *Vega* next anchored off Behring Island on August 14. This island belongs to Russia, but the American Alaska Company has acquired the right of hunting, and maintains a station where skins, principally those of the *Otaria ursina*, are purchased. Between 50,000 and 100,000 of these animals are killed yearly on this and the neighbouring Copper Island. They yield the brown "sealskin" so much in fashion in recent years. Behring's Island is supposed to have been visited first by Behring, who, after being shipwrecked, died there in 1741, survived, however, by many of his companions, among others, by the talented naturalist Steller, who described the natural history of the island in a masterpiece that has seldom been surpassed. Since Steller's time great changes have taken place. The *Canis lagopus* then occurred in incredible numbers. Now they are so uncommon that not one was seen, and those that remain are not dark blue, but white, the skins being of little value. On the neighbouring Copper Island dark blue foxes are still found in considerable abundance. In 1741-42 Stellar and his companions killed here about 700 sea-otters. This animal, famous for its precious fur, is now quite extinct on Behring's Island. Of the sea-lion (*Otaria stelleri*), formerly abundant, only single specimens are to be found along with the sea-bear (*Otaria ursina*) on the rocky shores of the island, and the great sea-cow, the most remarkable of all the mammals formerly belonging to Behring's Island, is now completely extinct. Steller's sea-cow (*Rhytina stelleri*) was of a brownish colour, covered with hair which grew on a hide resembling the bark on an old oak. Its length, according to Steller, was sometimes as much as thirty-five feet and its weight nearly 50,000 lb. The female yielded abundance of milk, which, along with the flesh, resembled, and were even, according to Stellar, superior to those of the cow. The sea-cow fed on the abundant algæ along the coast in great herds. According to Middendorf, the last sea-cow was killed in 1768. Nordenskjöld, however, found a "creole" of mixed Russian and Aleutian blood, whose father had come to the island in 1777, and remembered the killing of sea-cows while they fed on seaweed at low water for the first two or three years (1779 or 1780) after his arrival. Nordenskjöld also found two men who had seen, about twenty-five years ago, a large animal corresponding to Steller's sea-cow. He also obtained two complete skulls of the animal and a quantity of bones sufficient to fill twenty-one large boxes and barrels. The sea-bear (*Otaria ursina*) is the only large animal that exists on the island in about as large numbers as in Steller's time. It is "preserved" by the Alaska Company, only a limited number being killed yearly.

The vegetation on Behring's Island was found to be exceedingly luxuriant, and the sea in its neighbourhood one of the richest in algæ in the world. Forests of algæ, sixty to a hundred feet high, grew in favourable situations, rendering dredging exceedingly difficult. Some of the algæ are used by the natives as food.

The small streams swarmed with a number of different kinds of fish, among them a species of *Coregonus*, a little *Salmo fario*, a middle-sized salmon with nearly white flesh and a purple skin, and another of the same length, but very thick, and with a hump on its back. Other species of salmon with deep red flesh are found in the larger rivers. Leaving Behring's Island on August 19, the *Vega* reached Yokohama on September 2 in good order and with every man on board in excellent health. There had not been a trace of scurvy during the whole voyage.

GALILEO AND THE APPLICATION OF MATHEMATICS TO PHYSICS[1]

II.

In dealing with the falling body I had to ask you to think what is the speed at any moment of a body which is changing its speed every moment, every half moment, every hundredth part of a moment or what we call continuously. It is easy to see that it has *some* speed at every point, and that the speed at every point is quite definite. I indicated a way in which we could fix this approximately, by taking the average speed over short intervals. A similar question is raised in considering the path of the projectile. Its direction changes from point to point. The bullet is shot towards the east, and, for the sake of picturing its path, I imagine the lines vertically upward to be called northwards, as on a vertical map. At first the particle starts off, let me say, in a direction N.N.E. When it has reached the top of its path it is going horizontally—due east—when it has got back to the level the Northing has been turned into Southing, and it is going S.S.E. In its upward motion it changes continuously from N.N.E. to E. At a certain position it is half a point more to the east and less to the north; further on, a point more; further on again, the Northing has disappeared. The path has curved away; it is curving away at every point of it. A particle moving at a uniform rate in a circle changes its direction; but at every point the amount of curvature or immediate bending away from the direction in which the particle moves at any moment is the same. In a small circle the curve bends away faster than in a larger one from the line which represents the direction of motion at any point, but in each separate circle the measure of bending must at every point be the same. How will it be in a different kind of curve, such as an ellipse, or the path of a projectile, a parabola? As the speed of falling changes from moment to moment continuously, the curvature changes from moment to moment.

In solving the problems of falling bodies and of projectiles, Galileo was essentially applying the principles of the Differential or Fluxional or Indivisible Calculus. If pure mathematics had attracted him as strongly as its application to physics, he would have thought these problems out, and would have founded the Fluxional Calculus, which is the glory of Newton and of Leibnitz. No doubt the world saw more in his great astronomical discoveries; in the telescope, which brought the moon thirty times nearer, and showed its mountains and the jagged edges of its gibbous side; in the discovery that Venus waxes and wanes with phases like the moon; in the four satellites of Jupiter, the famous Medicean stars, which showed the most restless activity of revolution round their central orb—an activity unprecedented in celestial bodies and discomposing to the Peripatetics, whose stately order of the heavens could not tolerate stars which behaved like sky rockets—of the curious double satellite of Saturn, which sometimes was even more bewildering, and went out altogether. It was the Ring, and Galileo gave what we now recognize as a very fair picture of it. No wonder that the man who first made the

[1] An Introductory Lecture, by William Jack, M.A., LL.D., F.R.S.E., Professor of Mathematics in the University of Glasgow, formerly Fellow of St. Peter's College, Cambridge. Continued from p. 43.

telescope a practical instrument could not lay it aside till he had exhausted what it had to tell him, or that his whole thoughts were turned from the mathematical and apparently abstract entities which we have been describing to discuss the system of the universe in the new light he had brought to bear on it. Yet the choice he made has proved to be wrong. It was through the door of mathematics—not through the tube of the telescope—that the discoveries of the true system of the universe were destined to pass. Galileo's facts made it practically certain that the Copernican theory was right, and that the sun was the centre of the orbit of each of the planets. Kepler enlarged these statements, establishing, by a patient industry that was never surpassed, that the orbits are ellipses nearly circles, with the sun in one focus—that the line drawn from sun to planet sweeps over equal areas in equal times—that the square of the time taken to describe a planet's orbit, divided by the cube of its mean distance from the sun, is a fraction which is the same for every planet of the system. Till Newton appeared to interpret them, these results were only statistical facts; and Newton himself could throw no light on them till he had invented the Fluxional Calculus and discovered the properties of an abstract fluent quantity, such as a speed or a curvature, which is continuously changing.

And yet how near Galileo came to the secret! We have seen that he was in fact compelled to deal with the fundamental problems of the Fluxional Calculus in discussing falling bodies and projectiles. It was his famous scholar Cavalleri whose Calculus of Indivisibles foreshadowed the Fluxional Calculus of Newton. It is difficult to say how much of Cavalleri's views were developed out of the note-books of his master's lectures and out of his own consideration of the problems that master had triumphantly solved. Like many of Galileo's pupils, he had published works of his own, in which it was doubtless difficult to separate what was original from what was borrowed. From about 1592 till about 1638—forty-six years—Galileo had published scarcely anything except on the planetary system. The inclined planes, the falling bodies, the pendulums, the cycloids, were so many problems worked out in his youth—during the early years of his professoriates at Pisa and Padua—scattered in students' note-books, and germinating in students' minds throughout the world. It was so with his theory of projectiles; and Cavalleri, who was one of his old students and his successor at the University of Padua, published the theory of projectiles without referring it to its real author. Challenged by Galileo, he allowed his obligations frankly, and their friendship was not interrupted. Cavalleri published his theory of indivisibles in Galileo's old age (1635), calling it "Geometria indivisibilibus continuorum nova quadam ratione promota," after he had apologised for his former awkward error. The shape of the new theory was Cavalleri's own—the impulse came almost certainly from the discoverer of the true theory of falling bodies and of projectiles.

We owe the theory of indivisibles to Cavalleri, and not to Galileo, partly, no doubt, because for the greater portion of his manhood his astronomical discoveries, and the discussions they brought with them, filled Galileo's mind almost exclusively; partly because for the last five-and-twenty years of his life most of his thought had to be spent on his relations with the Church, to which he was sincerely attached. In 1616 he was warned that the Copernican hypothesis was to be considered as false. Religious persecutions were not then unknown in Protestant countries, and people were tortured for witchcraft as well as heresy. But it was reserved to the Catholic Church in Italy to erect the Aristotelian doctrines and the Ptolemaic system into an article of faith. A century after Luther shook the world at Wittenberg, had brought dreadful days for mathematicians, physicists, and reformers, in Italy. When Galileo was a youth of twenty-three, two years before he was called to be professor at Pisa, Barozzi, who had occupied himself at Venice with the discussion of the asymptotes of curves, was believed to be guilty of dealing in sorcery and witchcraft, of casting lots, and of causing the drought which reigned in the Island of Cyprus. He was condemned by the Inquisition in 1587, partly because he had a great number of curious books and a wonderful collection of astronomical and mathematical instruments. Porta, the famous author of the "Magia Naturalis"—the reputed discoverer of the *camera obscura*,—was summoned to Rome to give an account of his opinions. Giordano Bruno was burned at Venice in 1600, hardly less for his daring speculations in religion than because he had attacked Aristotle and adopted the system of Copernicus. The aged Archbishop of Spalatro, de Dominis, to whom Newton attributes the successful explanation of the colours of the rainbow, died in 1624 in the prisons of the Inquisition, and all that death had left to the mercies of his persecutors was publicly committed to the flames. The skies of Italy were black with the smoke of these burnings, the air was heavy with suspicion and terror. The Inquisition tried men for heresies which had been denounced by unknown enemies, and the processes of moral and intellectual torture to which it subjected those who were brought before its tribunals were only more oppressive because the secret of their details was closely kept. Galileo wrote a letter to his friend and pupil the Jesuit Castelli, in 1614, copies of which were privately circulated, but which was not printed till twenty years later. In that noble writing he lays down with equal firmness and clearness the broad lines with separate scientific and religious thought, and shows himself deeply penetrated with religious as with scientific faith. A Jesuit father denounced it, another preached against him as a witness for the Copernican system. Though the great works he had hitherto published, that on the Solar Spots and the "Nuncius Sidereus" had neither of them committed their author to the Copernican theory of the universe, the Church resolved to anticipate and to forbid the support by the most illustrious of living astronomers of doctrines, which, whatever else might be said of them, were clearly fatal to the authority of the Peripatetics.

Galileo went to Rome (in 1616) to struggle for as much liberty as could be saved, but he was deeply disappointed with the result. He retracted nothing, because he had neither been tried nor convicted, but the officers of the Inquisition waited on him, and left him an official warning that it was not permitted to teach that the sun was the fixed centre of our system, and that the earth revolved around it. Silence was imposed on him; and it was only after the new Pope was appointed, who, as a Cardinal, had opposed the promulgation of this warning, that he ventured again to think of publishing his views. The book in which they appeared in 1632 was a three-cornered dialogue between a Ptolemaist and a Copernican, with a third person acting as a kind of half intelligent chorus. The arguments of the Ptolemaist were, of course, the weaker, as in Galileo's hands it was impossible that it should be otherwise. To secure the *imprimatur* of the censorship, he prefixed this statement to the book—"Within the last few years a salutary edict was promulgated at Rome, in which, in view of dangerous scandals, silence was enjoined on the supporters of the Pythagorean doctrine of the movement of the earth. Some have been rash enough to say that this dogma was not arrived at after a judicious examination, but was promulgated in passion and in ignorance, and it has been asserted that people utterly without practice in astronomical observations ought not to attempt, by a premature prohibition, to clip the wings of speculation. Hearing these complaints my heart burned within me, and I could not keep silence. Having been fully informed of this wise decision, I resolved to appear publicly before all the world, and to testify to the truth. I was at Rome at the time. I was listened to and praised by the most eminent prelates, and was at once acquainted with this decree. My purpose in this book is to show foreign nations that in Italy, and especially in Rome, as much is really known about these matters as anywhere else. I have gathered together my speculations on the Copernican system to show that all these things were known before the condemnation, and that we owe to Italy not merely doctrines for the salvation of their souls, but ingenious discoveries to delight the minds of men." The elaborate and somewhat overstrained courtesy of this preface availed as little to save its author from the terrors of the Inquisition as the imprimatur of the Papal censorship which he had procured beforehand. The Pope looked on the *soi-disante* hypothetical presentation of Copernicanism as a mere pretence. I need not repeat the well-known story of the great man's sufferings. After long months of mental torture, he was dragged before the sacred tribunal, and compelled to confess that he had been criminally negligent in stating too cogently the arguments for the Copernican system in the eagerness of intellectual debate, and in not sufficiently guarding the hasty reader against the force of arguments for what the Church had pronounced to be dangerous heresy. At the age of seventy the greatest discoverer—the most distinguished man in Europe—was threatened with torture to extract from him, if possible, the confession that he had had a malicious intention of unsettling men's faith in divine truth. It had been privately decided by the Pope that if the threat of torture failed, the Inquisition was not to proceed to the last extremity. Galileo knew nothing of this, but the threat did fail. For his rashness he was sent to the prisons of the Inquisition. He was released in a few days, but he was ordered to confine himself within four walls and his successive places of seclusion were marked out for him. His visitors were noted, and he was warned that an imprudent word might bring him back to the dungeons from which he was only respited on his good behaviour. Private orders were given to the censorship throughout Italy that he was not to be permitted to publish anything, not even to re-issue the treatises which first made him illustrious. It was a living death to which his judges had consigned him, and he was reduced to permit his friends to publish surreptitiously across the Alps the book which summed up the long work of his life in Mathematics, in Mechanics, in Hydrostatics, in Physics, so far as Physics were then possible. His greatest work, the "Discorsi e Dimostrazioni Matematiche," "on two new sciences," appeared in France, and, to save him from the risk of torture, the miserable pretence had to be put forward even there, that the manuscript had been taken away by one of his friends. In 1637, in his seventy-third year, he lost his eyesight; in 1641 he died.

The eight years during which the broken-hearted old man, from whose outward eyes the light of that universe, which he had done more than all his predecessors to reveal to men, was fast fading, were the most memorable in the history of modern science. Much of the work he published in them had previously been scattered over Europe by his pupils, but none of them all had his mighty sweep of thought, his noble style, his all-illuminating insight. Had his enemies succeeded in silencing him, had he been handed over to the rack at seventy, or prevented, as they meant he should be, from speaking once more *urbi et orbi*, for fear his words might shatter the system of Ptolemy or put an end to that worship of a traditional philosophy which he had conquered, and which was struggling to strangle him in its death throes, the world might have waited a century longer for Torricelli and Pascal, for Newton and Laplace. In these last years he is greater and maturer than ever. Banished from the skies by the jealousy of philosophers and priests, he comes back to earth and lays deep and sure those foundations of mechanics without which it was impossible to carry further the science of the heavens. His watchword was that phenomena must first be measured before the attempt to explain or to co-ordinate them. Physics and Astronomy can rest only on mathematics, and the secrets of that hand which laid the foundations of the world in measure are only to be learned by patient and exhaustive observation, and by thought built upon and not preceding it.

Let me give you one last illustration of his method in his invention of a heat measurer. Every one seems to know what is heat and what is cold. They are among the most familiar of our sensations. But my sensations may differ from yours. I may pronounce a body hot which you may call cold; and before Galileo's time there was no apparent way of settling the dispute except by declaring it a matter of taste, and agreeing to differ. He invented a measuring instrument—the progenitor of our thermometers. Imagine a flask with a bulb blown out at the end of it, and a long tube of uniform bore for a neck, such as we see in a thermometer. Let the bulb be partly filled with coloured water. Put the finger at the end to keep the water in; turn the tube upside down so that the bulb is at the top and the tube vertical. Plunge the end of the tube in a vessel of water, and then remove the finger. All the coloured water will not flow down into the vessel. If the bulb is surrounded by something warmer than itself, the level will fall till it nearly reaches the water in the basin; if it is surrounded by something colder, the level will rise. Galileo had found a phenomenon accompanying an increase or diminution of heat as unvaryingly as a shadow follows its substance. Like the shadow, this new phenomenon is measureable, and though it was too soon to say that the rise or fall in the tube was in any exact proportion to the diminution or increase of the surrounding heat, it was easy to establish the fact that a rise always meant a diminution and a fall an increase. It was not given to Galileo to discover those properties of air and gases which turn the thermoscope into the air thermometer, the most sensitive and accurate of heat measurers. Had he known them, he was far enough in the way which his pupil Torricelli followed to have discovered the barometer also, and to have measured the weight of a column of that great atmospheric ocean at the bottom of which man lives as the Bathybius is supposed to live at the bottom of the watery deeps. Even there his sagacity had divined the necessity of applying measurement to that horror of a vacuum which before his time had only been a philosopher's name for our ignorance of a cause.

I have certainly failed in my object to-day if I have not conveyed to you two truths which lie at the basis of modern science. It is the *first*, perhaps, with which I have most to do as a teacher, and you as students of pure mathematics. The sciences of measurement, the methods of measurement—sciences and methods which are abstract in form, but which are constantly applied to concrete things,—are the true keys to the sciences of experiment. It was in the apparently intricate abstractions of continuous change of velocity and of curvature, in the apparently curious considerations of the science of indivisibles, the beginnings of which we owe to Galileo, that Newton found that secret of the universe which transformed the life-long labours of Kepler, the great statist of astronomy, into the law of gravitation. The fascinations of astronomy, and the fatal chains which hung about his later life, like those which Samson had to bear when he made mirth for the Philistines, combined to deprive Galileo of the honours which awaited Newton. But that lesson need not be lost to us. My *second* lesson is that measurement—measurement even in its simplest form, mathematics, or, if you choose, arithmetic,—lies at the root of all our knowledge of nature.

If I have one word more to say about the great Florentine to my students, it will not be of the pity of it all, of the terror and the tragedy in which his life closed;

it will be to ask them to remember that he proved, what the greatest men have always proved, that it is possible to conciliate the most magnificent knowledge of mathematics or of any abstract science with all the culture of the time. Galileo was an admirable writer; he was a great musician; he studied Ariosto and Dante with intense love; he amused himself with comedy; he distinguished himself in painting. It is the commonplace of the history of great men—a commonplace better illustrated perhaps by the great names of Italy than by those of any other country—that greatness is scarcely compatible with a narrow concentration of intellect, even to one great family of subjects. Many of her great mathematicians were sculptors, painters, poets, masters of expression. But if the story of Galileo's life should guard you from falling into the Scylla of the eager student who thinks that he must dwarf his nature if he hopes to attain to eminence in a special subject—an error to which the pressure of our times renders him more and more liable—it is equally certain to save him from the Charybdis of the *dilettante* who forgets to choose that one of the objects attainable within the little compass of a man's life which is most suited to his faculties, and in attaining which he is most likely to succeed. Galileo repressed none of his great powers, and denied himself none of the intellectual delights which few men of his day were so able to enjoy. But the obstinacy with which he followed after mathematical and physical truth, from the day when he first listened, as a truant medical student, at the key-hole of a lecture-room to the professor of mathematics teaching the Grand Duke's pages, to that, nearly sixty years after, when the worn-out shell which had suffered so much was laid in that last darkness of the grave, warns us that greatness is never, and, I may add, success is seldom, won without an unfaltering perseverance in the pursuit of the main object of life. The last wish of the venerable old man, whose heart suffered as much from the cruelty which had cut him off, in a sense, from the outward communion of the faithful, as his intellect did when he was compelled, on his knees, to deny what he had proved to be the true system of the universe, was refused him. The Church below refused him burial in the Santa Croce at Florence, but it could not prevent the eyes that old age and suffering had blinded to the delights of his Italian earth from opening on the splendours of an immortality which no man has better earned.

WHO WAS PRINCE ALUMAYÛ?

SOME of our contemporaries, referring to the recent death of King Theodore's son, Prince Alumayû, speak of him as if he were an African of the ordinary Negro type. This is perhaps on the whole a fair gauge of the popular ideas still prevalent regarding the natives of the Dark Continent. Yet, though the standard is not of a high order, it must be confessed that in the present case some little confusion might well be pardoned, considering the many difficulties attaching to the subject of Abyssinian ethnology. Indeed it would be no easy matter even for a sound ethnologist to answer the question off-hand, who was Prince Alumayû? To do so accurately implies a clear knowledge of a very complicated problem, to the elucidation of which a few lines may be welcomed by the readers of NATURE, in connection with an event of some political importance and presenting a very striking parallel in more than one respect to the death of the late Prince Louis Napoleon in Zululand.

It may at once be stated that, whatever else he may have been, the young "Ethiopian," as he has been called, was in no sense an African Negro, and that matters will be much simplified if the "Negro question" be dismissed altogether from the present discussion. There no doubt is some true Negro blood in the lowlands, especially towards the south-west frontier bordering on Senaar; but in the Abyssinian highlands proper the Negro element seems never at any time to have been present, and at any rate King Theodore of Amhara was no more of Negro stock than are the Rajputs of Northern India. The types have nothing in common except the outward element of colour, though even here great differences prevail, and many of the Abyssinians, especially the women, are very fair. In all other respects—physique, language, mental qualities—the divergence is fundamental.

This statement applies not only to the ruling peoples of Tigré, Amhara, and Shoa—the "Habesh" proper—who are intruders, but also to the true aborigines whether settled or nomad, and who may, for convenience, be here collectively grouped as Agaü, the 'Αγαῦ of Cosmas (about 520 A.D.). The Habesh belong to the Himyaritic branch of the great Semitic family, and must have found their way into the country from the south-western parts of Arabia many hundred years before the Christian era. The Agaü are a section of the Hamitic family intermediate between the Gallas and Somâli of the south, and the Bisharas or Bejas and Egyptians further north. But Semite and Hamite, both originally no doubt one, are themselves mere varieties of the great "Caucasian" type, of which the Aryans are a collateral branch. It follows therefore that Abyssinia is peopled exclusively by races fundamentally distinct from the African Negro, and remotely allied to the fair European stock. Hence Prince Alumayû's affinities are, not with the black inhabitants of the Dark Continent, but with the light, swarthy, and dark peoples of Europe, South-Western Asia, and Northern India.

It will now be more easy to determine his position in the Abyssinian family itself. Although in this area the fundamental elements, as shown, are two only, Hamite and Semite, the intermingling of these elements, continued during a period of probably not less than four thousand years, and taking place under ever-varying conditions, has resulted in no little confusion, and the perplexity has in this case been further intensified by the elements of speech and religion. Thus, the Amharic people, for instance, are usually classed as "Habesh" proper, because of their language; for Amharna, notwithstanding many serious differences, is no doubt fundamentally related to the Tigrâi, the purest representative of the old Ghêz (Himyaritic), extinct since the fourteenth century. But it might not be difficult to show that the bulk of the Amharic[1] nation are ethnically of Agaü stock, though now speaking a modified Ghêz dialect imposed upon them by the conquering Semites from the north. At the same time the dominant race in Amhara is no doubt still more akin to the Semites than to the subject race. Hence the late Prince Alumayû, belonging to the royal blood of Amhara, must, on the whole, be regarded as of Habesh (Himyaritic) stock as well as speech.

Religion has been mentioned as a source of confusion, and an obvious case in point are the mysterious Falashas, who, because professing the Jewish faith, are popularly supposed to be of Hebrew nationality. Fortunately, Mr. Edward Hine has not yet got hold of them, and they have consequently not yet been identified with any of the lost tribes. Nevertheless, their position is sufficiently curious and interesting, though it may now be stated with some confidence that they are neither Jews, Israelites, nor Semites. In speech and physique they are a distinct branch of the Agaü (Hamitic) family, and can no more be converted into descendants of Abraham by the practice of maimed Abrahamitic rites than the adoption of Islám can transform the Chinese Panthays into Koreish Bedouins.

The subjoined scheme of the various races now in possession of the Habesh highlands may help to clear up

[1] The very word *Amhara* has been identified with the *Hamra*, the chief Agaü nation in the Takazzé valley and province of Lasta, Tigré.

the obscurity attaching to the subject of Abyssinian ethnology:—

Table of Abyssinian Races

Hamites. (Agaü Stock.)	*Mixed.*	*Semites.* (Himyaritic Stock.)
Aghagha, prov. Aghaumêder.	(Hamites & Semites.)	Tigré, N. and E. of River Takazzé.
Hamra, prov. Lasta, S. Tigré.	Bogos, extreme N.E.	Samhar, on coast near Massowah.
Falasha, mainly in Semyen.	Gongas, about Gojam.	Shoho, S.W. of Massowah.
Kwara, W. and N. of Aghaumêder.	Gurâgwe, extreme S.	Menza, N. of Hamasen.
Khamant, chiefly in Dembea.	Kunama, N.W. towards Taka.	Habab, Bediuh, Takwé, Marea, Barea, — N. & N.E. frontiers Tigré.
Fighen, S.W. from Lake Tsana.	Shoa, S.E. corner.	
Zalan, chiefly in N. Amhara.	Amhara, between the Takazzé and Abai.	
Witos, about Lake Tsana (?).	King Theodore.	
	Prince Alumayû.	

Of the languages three only are of any literary or political interest: *Ghêz*, still surviving as the language of the liturgy and Sacred writings, though scarcely understood even by the clergy; *Tigrâi*, its purest modern representative, current throughout the kingdom of Tigré and generally north and east of the Takazzé; *Amharna*, spoken with considerable dialectic variety in Amhara and Shoa. All are written in a peculiar syllabic character showing certain affinities to the Himyaritic rock inscriptions of Marah and other parts of South Arabia. Amharic employs seven additional letters for sounds not occurring in Ghêz or Tigrâi, making with the vocal modifications a total of 249 distinct symbols. This was the language of Prince Alumayû.

A. H. KEANE

COLOUR-VISION AND COLOUR-BLINDNESS

AS the notices of these subjects which have recently appeared in NATURE appear to me to do scant justice to the received theory, will you permit me to call attention to a portion of the evidence on which this theory rests?

The *Philosophical Transactions* for 1860 contain a paper by Prof. Clerk Maxwell, in which actual measurements are given of the quantitative relations between various colours, some of the observations having been taken by persons of normal vision, and others by a colour-blind person. The instrument of observation consisted of a species of spectroscope with three parallel slits, the widths of these slits, and also the distances between them being variable at pleasure. By this means three overlapping spectra are obtained, and any three spectral colours can be mixed in any proportions. The observations showed that any four colours as presented to the eye in a given spectrum are connected with each other by a definite colour-equation, such as—

$$3A + 4B = 2C + 6D,$$

which means that if the four colours A, B, C, D, as they exist in the given spectrum, are increased in intensity threefold, fourfold, twofold, and sixfold respectively, and then mixed two and two, the mixture $3A + 4B$ will present exactly the same appearance as the mixture $2C + 6D$. This is only another way of saying that colour as seen by normal vision contains three independent variables, or requires three numbers for its specification. Any three colours of the spectrum will serve as the three specifying elements; for example, if we employ A, B, and C to specify D, the specification will be—

$$D = \tfrac{1}{2}A + \tfrac{2}{3}B - \tfrac{1}{3}C.$$

Here we have one coefficient (that of C) with the negative sign. The three primary colours are defined to be those which will always have positive coefficients when they are employed as the specifying elements. In plainer words, all other colours can be exactly imitated by mixtures of the primaries, whereas, in the above example, the colour D cannot be imitated by a mixture of A, B, and C.

The points of the spectrum at which the three primary colours are found, will not necessarily be the points which most strongly excite the three elementary colour-sensations respectively. On the contrary, as a matter of fact, the two extreme sensations (called by Maxwell the *red* and the *blue*) are very feebly excited at the parts of the spectrum where they are purest, namely, at the extreme ends of the spectrum; and the middle sensation, which is largely adulterated with the other two even at the point where it is purest (namely, at a point in the olive green, which is, accordingly, one of the three primaries), has not a maximum of intensity at this point, but increases in intensity as the brightest part of the spectrum is approached, and attains its maximum (for the solar spectrum obtained with a flint glass prism), somewhere between the fixed lines E and D. The determination of the position of the middle primary in the spectrum, was made with considerable precision in the paper referred to; but the faintness of the two extremities of the spectrum rendered wide slits necessary in examining these regions, and thus introduced inaccuracy in determining the positions of the two extreme primaries, which in later publications Prof. Maxwell places at the very extremities of the spectrum.

The latter part of the paper of 1860 consists of a postscript containing observations made by a colour-blind person. The colour-equations found by direct observation are given, and are shown to agree with the supposition that the observer's vision was dichroic, the sensation corresponding to the extreme red being absent. The curves of intensity for each of the two elements in the vision of the dichroic observer are given, side by side with the three curves of intensity for the vision of a trichroic observer, all these being directly calculated from the observations, and the two dichroic curves appear to be practically identical with two of the three trichroic curves.

Dr. Pole's objection to the received theory appears to me to have no force except in so far as it is an objection to a name. The colour which the colour-blind see in the less refrangible half of the spectrum appears to be due to the excitement of the middle one of the three elementary sensations of trichroic vision. Persons of normal vision never get this sensation without large adulteration, and hence ordinary language contains no appropriate name for it.

Prof. Hering's theory of colours, as expounded by Dr. Pole (NATURE, vol. xx. pp. 479, 480) seems inconsistent with the fact (established by the observations of Prof. Maxwell, Lord Rayleigh, and other competent observers) that there is one definite colour-equation between any *four* colours. For Prof. Hering's theory assumes four elements of colour-sensation, R, G, B, Y, such that

$$R + G = 0, B + Y = 0.$$

It would follow that, with the help of the minus sign, all colours could be specified in terms of R and B, and hence by writing down the specifications of any three colours, and employing the ordinary processes of elimination, a colour-equation could be obtained between the three colours. Prof. Hering's theory then leads to the result that there is a definite colour-equation between any *three* colours; in other words, that when any three colours are given it is possible to imitate one by a mixture of the other two. This result is so utterly opposed to fact, that a theory which leads to it cannot stand for a moment.

J. D. EVERETT

SOME OBSERVATIONS ON FLEUSS'S NEW PROCESS OF DIVING AND REMAINING UNDER WATER

I HAVE recently had two opportunities of seeing a new process of diving and of remaining for a long time under water, called, after its inventor, Fleuss's process. The peculiarity of it is that the diver takes down with him such a good and wholesome supply of air-food, that he is quite independent of any supply from above, so that there is no pumping required, and, indeed, no help whatever, except a signal-man and cord.

The experiment is being shown daily at the Royal Polytechnic Institution, and I am indebted to the managers for giving me the earliest notice of it, and for offering me every facility for observation. I am equally indebted to Mr. Fleuss for his readiness to carry out my wishes, and I am sure the readers of NATURE will be interested with the facts I have now to offer them.

Mr. Fleuss, the inventor of the apparatus, is a young Englishman, twenty-eight years of age, who has served, I believe, as an officer in the P. and O. Company's service. He has constructed the apparatus himself in a skilful but not very ornamental fashion, and he is his own diver. He went down in the apparatus, like a brave man, first himself, and he only, up to the present, has been down in it. He is a short slight man, of fair complexion, and very pleasing expression. He has a quiet and resolute enthusiasm which is quite refreshing.

The dress in which he descends under water is like an ordinary diver's dress. A helmet, a breast-plate, and the common water-tight armings and leggings. He bears on his shoulders a weight of 96 lbs., and his boots are weighted to 20 lbs. At twelve feet depth he moves comfortably in the water under this pressure. From the helmet there proceeds a light cord for signalling to the signaller above.

Before the helmet is fixed and the mask closed, it is seen that he wears, firmly tied over his mouth and nose, an ori-nasal mouth-piece, from which a breathing-tube of an inch bore proceeds downwards. This mouth-piece is, in appearance, just like the chloroform mouth-piece invented by the late Dr. Sibson, and afterwards added by Dr. Snow to his chloroform inhaler. For many years I used invariably the same kind of mouth-piece for administering volatile anæsthetics, but Fleuss's fits much closer, and is fixed more firmly.

When he is on the floor of the tank, Fleuss moves about as he pleases, apparently without any impediment whatever. He can pick up coins, he can sit down, and he can even lie down and get up again, a feat, I believe, entirely novel in diving. He breathes, he assures me, just as easily as when he is in the air and quite as freely, and from what I observed when he came out of the water from a long immersion, I have no doubt as to the correctness of his statement. He has some means of disposing of the products of respiration as well as of getting a continuous supply of air for respiration, since there is no escape of expired air from him into the water.

On the first occasion on which I witnessed the experiment Mr. Fleuss remained in the water twenty minutes. He came out quite free of any oppression. His pulse was steady, his breathing free, and his complexion natural. This was considered a short experiment, and on Saturday last, November 15, therefore, I asked to see it prolonged to an hour and to be allowed to follow it through all its stages. The request was immediately granted.

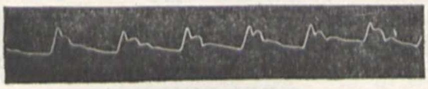
The diving-dress was adjusted on Saturday, at 6.33 P.M., and then Mr. Fleuss began to breathe from the apparatus. At this time his temperature was quite natural and his pulse was beating steadily at 68 per minute; the pulse was of good strength and tone. The temperature of the air was 51° F.; of the water, at the upper surface, 49° F. Fleuss said it was colder lower down, but the difference was not determined. He descended at 6.40 and remained under the water, at a depth of twelve feet, precisely one hour, namely, until 7.40 P.M. He walked about the greater part of the time, picked up pennies, and once or twice partly reclined on the floor of the tank. At the end of the hour he gave the signal to come up, the cold of the water having caused great numbness in his hands; he walked up the steps, carrying the heavy weights (116 lbs.) briskly, and was relieved, after a short delay, first of his helmet and then of his mouth-piece. At this point I found his pulse to be beating at 120 per minute and somewhat feeble, but the face was clear of any sign of asphyxia, though it was a little pale. His breathing was quite free. He attributed the quickness of the pulse to the labour of carrying the weights up the ladder, and no doubt correctly. Seven minutes later, the dress having been removed and warm clothing put on, I found the pulse to be ninety per minute, and the temperature of the body, taken from the mouth, to be 94° F., rather more than 4° below the natural standard. At twenty minutes later, that is to say, at twenty-seven minutes after release from the water, the pulse was eighty per minute, while the temperature had risen to 96° F.

At this stage I took an observation of the pulse with the sphygmophone. The three natural sounds were perfectly clear and in regular order, but the first or percussion impulse sound was extremely tremulous; the second or recoil sound was slightly tremulous; the third was clear.

I next took a sphygmographic reading of the pulse, in which all the events belonging to the natural pulse were distinctly marked. The impulse stroke was short, as was also the first descending stroke; the second ascending stroke was decisive, and the intervening lines between the third and the recurrence of the percussion stroke were shorter than is natural to Mr. Fleuss, as will be seen from the comparison of the two annexed sphygmographic tracings, 1 and 2.

1. Pulse tracing after one hour's immersion in water at 49° F. Temperature of mouth 96°, pulse beat 80 per minute. November 15, 8.15 P.M.

For the sake of comparison I took a subsequent tracing of Mr. Fleuss's pulse on the morning of Monday, November 17, after breakfast. His pulse was at 68 per minute, the same as it was on Saturday just before he entered the water. It will be seen to be a pulse naturally slow and steady, but not very powerful.



2. Tracing of pulse in its natural or ordinary condition under the same pressure. Beats 68 per minute. November 17, 10.30 A.M.

At fully seven minutes after his release from the water the pulse had come down to sixty-eight beats per minute, and the temperature had risen to 97° F. Ten minutes later still the temperature was 97°·6 F., eight-tenths of a degree below the natural. At this time my observations ceased.

The facts above narrated prove that, without assistance from above, a man who has had no previous experience of diving or of remaining under water can take down with him sufficient oxygen to live there easily for an hour. Mr. Fleuss assured me—and I see no reason to doubt him—that but for the cold he could have remained another hour and a quarter, and that he could easily arrange to remain four hours. Depth would make, he said, no difference as to breathing within the apparatus.

The mode by which the breathing is effected remains a secret, but is, he says, extremely simple. At my first observation, when he was under water twenty minutes only, I thought it possible that he carried down sufficient compressed air to live upon, and that he had a means for allowing the expired air to escape into the water. The later experiment shows me that this view was wrong. He could not carry down in the dress sufficient air to last him over an hour, and he does not seem to give out the expired air. I have no knowledge from him or any one how he breathes in the dress, and although I see how it could be effected, I think it right to leave it to Mr. Fleuss himself to describe the principle of his invention whenever he thinks, from his experiments, the fitting time has arrived.

In whatever way Mr. Fleuss gets breathing-room under the water, he has, without a doubt, achieved a great practical success. He has learned how to live independently for a long time shut off from all external access of air. He has learned, if I may so say, to become artificially amphibious, and if his plan succeeds, the cumbrous diving-pumps are done away with and the art of diving is vastly simplified.

Again, if he can live so long on the small reserve which he carries down with him in his dress, he has only to enlarge the dress, to expand it, that is to say, into a submerged vessel, to be able to go anywhere under the sea and do with intelligence what is now left to unintelligent mechanism. What such an intelligent direction might do with torpedoes it is not at all pleasant to contemplate.

The plan may be used for the purposes of deep-sea exploration, and the suggestion I made respecting my Salutlanders, that they sought for discoveries on the floors of the great oceans, may be so much nearer to accomplishment than the time which I assigned to it, that I may haply live to have the return laugh at what was called "the most visionary of speculative fancies." It is equally probable that the aëronaut may be able to rise much higher than he has yet done in this dress, or in a car specially constructed on a similar plan.

The apparatus may almost certainly be applied at once to another service very different in kind and on land instead of water. When a man can move about with an air-supply in his pockets, so to speak, he can go into fire as well as water. In a fire-proof non-conducting dress, provided with Fleuss's breathing apparatus, a fireman could enter a burning house, and without danger of suffocation go wherever the weight of his body could be borne.

Lastly, in wells charged with foul air, or in mines charged with choke-damp and other poisonous gases, the Fleuss apparatus will, I feel certain, prove of the greatest practical service, and I am happy in being the means of introducing it at length to the notice of my *confrères* in science.

BENJAMIN WARD RICHARDSON

NEW GUINEA[1]

BEFORE us lies one of the earliest published maps in which New Guinea is laid down. It belongs to Huygen van Linschoten's book of East Indian voyages, and was published in the year 1595, being derived largely from Portuguese sources. The map is turned on one side as compared with our present ones, so that at the top, on one hand, appears Japan, strangely shaped, and with the names of the cities curiously spelled, Meacum (the capital, Miaco, Kioto) and Tochis (Tokio?): whilst on the other hand lies New Guinea. At the foot of the map are Sumatra and the Bay of Bengal, and on the left hand China stands prominently upwards from the base of the map, with a camelopard walking about in its midst, regardless of the rules of geographical distribution. The north point lies to the left hand of the map, and the south to the right. New Guinea is represented as a very large and elongate island, the south coast being drawn without definite outline as unexplored, but with the Aru Islands duly shown lying off it. The great island is marked "Os Papvas," and at its eastern corner is the inscription "Hic hibernavit Georgius de Menezes." Although Antonio d'Abreu and Francisco Serraõ possibly sighted the New Guinea coast in 1511, Dom Jorge de Menezes must be regarded as the actual discoverer of the island. He was driven by the prevailing monsoon out of his course far to the eastward, when attempting to reach the Moluccas, from Malacca, by a new route round the north of Borneo in August, 1526. Having thus reached an island lying off the coast of Papua, he had to "winter" there, that is to say, to wait for the periodical change of the monsoon. According to Oscar Peschel, the island at which he remained, and which was called Versija, was very possibly one of those lying off Geelvink Bay. It is remarkable how very slowly our knowledge concerning New Guinea grew through the explorations of successive voyagers, since the time of Menezes until within the period of the last ten years, and even now it is quite startling to pick up a small octavo volume and find it jauntily entitled "A Few Months in New Guinea," as if New Guinea were as familiar and accessible a place as say Iceland or Norway, about which such little books are commonly written by enthusiastic tourists.

We are sorry, indeed, that Mr. Stone's book is so little, and would have been glad if it had been three times as long, and he had given us further details of all kinds

FIG. 1.—Vahu, a Motu youth.

concerning his most interesting sojourn amongst the Motu people of the coast, whose God dwells out over the sea, and the mountain-dwelling Koiaris, who believe the dread "Vata" inhabits the mountain summits.

It is close to the east end of New Guinea, and on its southern shore beneath the Owen Stanley range of mountains that the Motu country lies. Mr. Stone first made an excursion from Cape York, in the small mission steamer *Ellengowan*, up the Maikasa or Baxter River, the mouth of which, on the New Guinea coast, lies due north of the Cape, just on the opposite side of Torres Straits. The river was traversed for sixty-four miles, but then forked, and since both channels were too narrow for the steamer to turn in, further progress was stopped. At this distance even from the river's mouth, native plantations of yams, sugar-cane, and tobacco were found. A further distance of twenty-six miles was traversed in a small boat, and large numbers of the recently-discovered species of Bird of Paradise, *Paradisea raggiana*, were met with. The bird does not croak like the Great Bird of Paradise of the Aru Islands, "wauk wauk," but utters "a peculiar whistle resembling that of a man to his dog," and must

[1] "A Few Months in New Guinea." By Octavius C. Stone, F.R.G.S. (London: Sampson Low and Co., 1880.)

thus in its note come very near its more distant ally, the Rifle Bird of Cape York and New Guinea (Ptilorhis). As the small boat returned to the steamer it was greeted by the sweet strains of a "barrel-organ," brought in the hope that it "might please some of the natives." It is really appalling to realise that a "barrel-organ" has penetrated sixty-four miles up a river in New Guinea; and though we heartily wish the organs and their grinders were all in New Guinea, yet, did we regard matters from a missionary and philanthropical point of view, we should

Fig. 2.—Burning pottery in Anuapata.

have thought twice before attempting to demoralise the musical ears of the poor Papuans with such an instrument; or, perhaps, knowing the high ability of the Papuan race, we should have expected such a course to evoke hostility rather than to conciliate. But the missionary charm did not work; the natives kept well away from the barrel-organ: only one was sighted, and he promptly fled.

After a return to Cape York, Mr. Stone, with three assistant natural history collectors, Messrs. Hargrave,

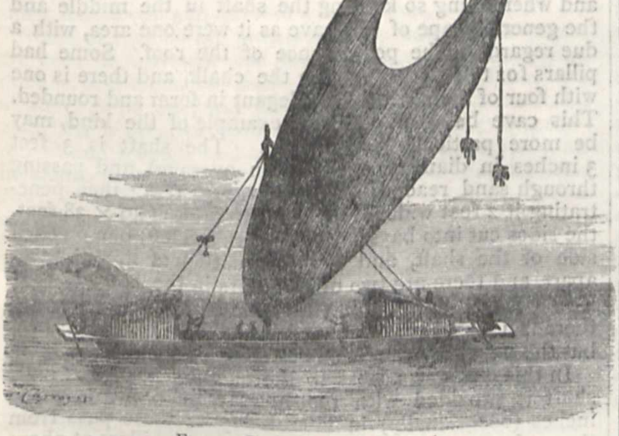


Fig. 3.—Trading canoe or lakatoi.

Petterd, and Broadbent, proceeded again to New Guinea in the *Ellengowan*; and after touching on the way at Roro or Yule Island, where the natives cultivate fields of from five to thirty acres in extent, inclosed by fences six feet high; and at Purok on the main land, where the natives have a large circular market-place cleared of grass and trees, and periodically used by surrounding tribes, arrived at Anuapata (Port Moresby) amongst the Motu people on October 29, 1875. The arrival of the white men was not greeted with pleasure by the natives, because many of them had lately died of the measles introduced by the missionaries. The party at once erected their tent, and, proud of their nationality, and apparently taking a leaf out of Mr. Stanley's book, hoisted a union-jack at each end of the roof, and on a pole in front a banner with "Excelsior" upon it, thus apparently intimating that they intended to climb the neighbouring mountains if they could. They were soon beset by the natives, whose constant cry, corresponding to that of "bacshish," or the Fuegian "yammerschooner," is "kuku lasi"—"Won't you give me some tobacco?" The Motu people have an insatiable appetite for *trade* tobacco. In the evening there was a tremendous hubbub round the tent, and a hostile demonstration caused partly by a Polynesian Christian teacher, who, left in charge of the tent, had pointed a gun at would-be intruders, but also partly because the natives were not pleased at the white men persisting in remaining in their country contrary to their wish, and very naturally so, after the experience of the measles. But the natives were luckily afraid of the dark, and were frightened into submission by a display of rockets and of the power of dynamite. As a sort of set-off for thus frightening them almost out of their lives, great care was taken that they should not be corrupted by Sunday trading.

The natives have dogs which, like the Australian dingo, do not bark. The author wishes he had had a bulldog with him, for he describes the natives as "expert thieves, inveterate liars, and confirmed beggars," and feels sure

Fig. 4.—Native cradle.

that a dog which could bark would frighten them out of their wits. They ran away from a sheep landed from the *Ellengowan*. They have strict commercial instincts, and would "see you starve before they gave you food." Everything has to be bought with "trade gear." The natives are not cannibals, but were evidently acquainted with cannibalism, for, being firmly persuaded that all the tinned meats consumed by the white men consisted of human flesh, they expressed great disgust at the cannibal practices of their visitors. It is delightful to find the Papuan thus turning the tables on the pioneers of civilisation.

The Motu people seem on the whole very much bored by the presence of the missionaries, excepting when a chapel is formally opened, and there is a big feast in consequence. As they cannot dispose of their teachers in the usual way, perhaps in secret they pray for help to the cassowaries of which the author saw the foot-prints in the neighbourhood, for these voracious birds are, as the naturalist knows, far more at home in New Guinea than at Timbuctoo; but possibly even New Guinea cassowaries would require the traditional condiment, and matters have not as yet reached the hymn-book stage in Papua. A very amusing account is given of a missionary religious service at Anuapata. It appears that there are bold and contumacious sceptics amongst the Motu people who refuse to assimilate the Jewish cosmogony, and do not mind expressing their opinions freely in public.

"The service was held beneath a roof thatched with grass, supported on posts, open on each side, and fitted at one end with a low stage and reading-desk. Previously to the present occasion not more than two or three natives had ever attended, but, attracted, no doubt, more by curiosity than by any religious feeling, no less than three hundred, including men, women, and children, were now present, three-fourths of whom were compelled from want of space to remain outside. They appeared to know they ought to be quiet, and some of the eldest seemed to be listening, but the greater part were looking around them and evidently inattentive, apparently taking no interest in the proceedings. The small boys amused themselves by flinging pebbles at one another, making grimaces, or pulling a stray dog's tail, and sometimes the word koi-koi, meaning 'lie,' would be heard in reference to something the missionary was saying."

The Motu people express surprise in a curious and interesting way, namely, by drawing in their lower jaw and clicking their upper teeth with the thumb-nail of the right hand, very much the same gesture as the old European "biting of the thumb." They also express surprise by smacking their lips. The women are expert makers of pottery. The clay is worked into shape by hand over an earthenware mould, of course without any wheel appliance. The upper and lower halves of a vessel are made separately and afterwards joined. The pots are baked in an open fire on the sea-beach. They are of a brick-red colour when baked, and are made of three forms—the "ura," or cooking-pot, the "hordu," or water-pitcher, and the "nao," or bowl.

The natives start in every November with large cargoes of this pottery on a trading expedition a distance of two hundred miles up the coast; three or four of the largest canoes are lashed firmly side by side with rattans, and the compound craft thus produced is termed a lakatoi; some of these lakatois are propelled by a dozen square sails and others by a single huge elliptic-shaped sail, which is extremely picturesque in appearance, but the cause of the peculiar form of which seems very uncertain.

In return for the pottery the natives receive sago, yams, taro, sweet potatoes, betel-nuts, and sugar-cane. The record of the undertaking of systematic long voyages, such as these by savages, is a very valuable fact, and helps to account for a rapid spread of cultivated plants, such as tobacco, for example, which doubtless originally reached New Guinea from America through Europeans. Whilst waiting for a start at Anuapata, the crews of the six lakatois from the neighbouring villages, composing the trading fleet, held regattas almost every day to while away the time and get into training. A terrible wailing was made by the womenkind on the day of actual departure, and many embraces between husbands and wives took place upon the beach, and there was much rubbing of noses; the women escorted the lakatois some distance in single canoes.

The mothers rock their babies by swinging them in a net bag suspended from a beam beneath the verandah, and the babies are often carried in these bags.

We cannot follow the author further in his account of the Motus, nor cite any of his interesting experiences amongst the Koiaris. The book is well illustrated throughout, and at the end is a short Motu dictionary, and shorter tables of eight other Papuan languages. The Motu people have a name for every different plant and bird, and for all the conspicuous stars. Numerals are given up to a million. We should almost be inclined to doubt the Motu conception of so high a number; possibly there may be some mistake in the matter. In the Koitapu language the numerals for eight and nine appear to be formed by subtraction from ten, and to mean (ten) less two and (ten) less one, as in the Admiralty Island language. The personal names for women are amusing indeed, the first two are probably intended as complimentary, but the remaining three can hardly have such a meaning; those cited by the author, when translated, mean "pig," "thief," "hungry," "frightened," and "bad."

A list of birds drawn up from the author's important collection by Mr. Bowdler Sharpe closes the book. The author seems to have little or no knowledge of natural history, since he repeatedly speaks of a Dugong as "a large *fish*," and further describes it as a "finny monster," and he imagines that the pig was introduced into New Guinea by Capt. Cook. His descriptions of birds, insects, and other animals seen are, however, interesting throughout the book. He gives some valuable information about the pigs. Some are kept tame by the natives, and some of them are very fine and fat; when young they are striped longitudinally, yellow, brown, and black, every other stripe being black; the stripes blend to a general dark brown tint as the animals get older. It is interesting to find that the Papuan pig exhibits the same markings as the European young wild boar so plainly. The natives have an ingenious way of catching the wild boar. When the boar charges, after being slightly wounded with a spear, a net with a very wide mesh set on a hoop-like frame is pushed over his head as he rushes forward. He gets his neck into one of the meshes, and with the large hoop about his throat, is helpless, and then easily killed.

We commend Mr. Octavius Stone's book to all classes of readers: there is not a dull page in it.

VERTICAL SHAFTS IN THE CHALK IN KENT

THE deep caves in the chalk in Kent while preserving a general form in a limited area, present certain differences amongst themselves, which enable us to trace something of their history as to time and object.

Those now most easily examined are the latest and best constructed. Though they are not dug at the present day here, there are many old ones that have been worked for chalk. These are distinguished by their irregular shapes and very wide shafts.

But there are fine examples now open of which North Kent has many having these general characters—a deep shaft, penetrating the soils (Woolwich pebble beds, Thanet sands and gravels) above the chalk, then the chalk itself from 2 to 5 feet, and widening out into a cave in the latter, mostly without effort at burrowing laterally, and when doing so keeping the shaft in the middle and the general shape of the cave as it were one area, with a due regard for the permanence of the roof. Some had pillars for this purpose left in the chalk, and there is one with four of them which are elegant in form and rounded. This cave being an excellent example of the kind, may be more particularly described. The shaft is 3 feet 3 inches in diameter (a common average), and passing through sand reaches the chalk at 51 feet; then penetrating it 2 feet widens out into an area of 49 × 38 feet, the sides cut into bays. Two pillars are left, one on each side of the shaft, and in continuation of it, still 3 feet apart, and there are two other pillars in the eastern part. The western part having no pillars has fallen in, and there is a large mound of sand and rubbish in the centre—but the height of the cave is 20 feet, perhaps 22 feet.

In this case the access to the chamber is perfect: the shaft is provided with foot-holes from 6 inches to 20 inches (occasionally) in lateral depth; these pass from the surface to the bottom of the central pillars at about 18 inches apart and opposite to each other, and it was easy a few years ago to descend and ascend without assistance, unless perhaps with that of a stick across the mouth of the shaft. Some of the shafts have foot-holes only to the point where they widen out below, when recourse was had to a pole or rope, of course.

Most of the caves are simpler than this, and the commonest form is a mere beehive sort of widening.

All these open caves appear to have been dug with iron picks.

At Greenhithe one has been lately found containing a large quantity of Romano-British pottery, but it was dug with metal implements, probably of iron.

There are two caves at Crayford within 3 feet 3 inches of each other; they are exposed in the side of a chalk-pit connected with the brick-fields. One of them measured, from the surface to the chalk, about 18 feet; thence to the floor, 17 feet 6 inches. The floor was of flints, about 6 inches thick, which had been taken up at one part and piled in a heap on the other side of the cave; about a quarter of the area, an irregular oval of 18 feet diameter, had been so treated. From this floor rose an obtuse cone of sandy clay 6 feet high, washed in very slowly and evenly by the rain. In the cone were found flint flakes, and one worked scraper with a rough core, from which flakes had been chipped, but no pottery. Above this, coarser soil and lumps of chalk, with several sorts of broken pottery, very coarse, black, spongy pot, scarcely baked, containing a large quantity of crushed shells not calcined, and a few pieces of pot made with coarsely-pounded chalk—all these either without ornament or only finger-nail marked; then finer pot of Roman moulds, and fine black ware, with a Samian plate. All were accompanied by large quantities of the bones of domestic and food animals for about a foot, then coarse earth and bones to the surface.

From about the period of the Roman deposit until now we know the value, and it would not be excessive to date the commencement of the deposit of mud and the abandonment of the cave perhaps at half that period earlier.

On the walls of this cave there are no marks of the implement by which it was excavated, and the conclusion is that the blocks were prised out.

The cave adjoining this fell in early and was soon obliterated.

Before knowing of these caves flint flakes and two "pot boilers" were found on the surface.

Clusters of these pits are either huddled into small areas sometimes or are spread out into lines, and they are frequent in spots which, from the supply of water, must have been thickly wooded, and so difficult of access, or from the bleakness of the situation unlikely to be noticed.

There is a cluster at Bexley of thirty-five in about three and a half acres, and another of forty-four.

Some pits which are mostly filled up now, in the woods, are part of a system and are connected by banks and ditches, and the same banks with earthworks which are of a late stone age, and also with clusters of hut circles, and there is great probability that they served two uses—retreat and storage, and as pitfalls, as to the last with an ingenious contrivance in one instance for driving animals down a deep covered way, either past a pit or, by an arrangement of a simple barrier, shunting them into it for the use of the camp.

F. C. SPURRELL

PROF. GEIKIE ON THE GEOLOGY OF THE FAR WEST

ON Monday the 10th inst. Prof. Geikie reopened the class of geology in the University of Edinburgh by giving an account of his recent exploration of the western territories of North America. There was a large attendance of students and others.

The Professor, in the outset, reminded his students that last session he pointed out the remarkable lessons to be learned from the geology of the western regions of North America, more particularly in reference to the changes which had taken place on the surface of the earth from ordinary atmospheric causes. It was with special reference to those changes that he took a journey to the West. Had geology begun in those western territories, instead of among the old broken, gnarled, and contorted rocks of Europe and the east of America, its progress, at all events in some departments, would have been far more rapid than it had been. He had three objects in the expedition:—(1) To study the effects of atmospheric and river erosion upon the surface of the land; there being no region where these lessons could be learned with more wonderful impressiveness than in those great plateaux and table lands. (2) To mark the relation which the structure of the rocks underneath bore to the form of the surface. In this country and in Europe generally one was continually brought face to face with evidence of dislocations, protrusion of igneous rocks, contortions, and other complicated forms of geological structure which, save to experts in the subject, made it often difficult to realise how much of the present irregularity of the surface should be attributed to unequal waste by ordinary atmospheric causes, and how much to the direct effects of underground movements. The Western States and Territories of North America over which the strata, for thousands of square miles, retained their original horizontality, presented remarkable facilities for the investigation of this subject, and had already, in the hands of King, Hayden, Powell, Dutton, and others, furnished ample materials for satisfactory discussion. (3) To watch with his own eyes some of the last phases of volcanic action. He had been familiar with the phenomena of active volcanic vents as displayed in Italy and the Lipari Isles; but he was anxious to see some of those marvellous evidences of the gradual decay of a vast volcanic area so well displayed in the famous region of the Yellowstone. The Professor went on to give a brief account of his journey. He stated that he was accompanied throughout by a former student of the class, Mr. Henry Drummond, F.G.S., whose constant hearty co-operation had been one main element in the success of the expedition. His route first lay westwards by railway into Colorado. In crossing the prairies towards the Rocky Mountains he noted, in the few sections that occurred, soft grey cretaceous or tertiary clays and marls. Getting down at some of the stations, and looking at the ant-hills and burrows of the prairie dog, he found that the surface of the prairies was veneered with a thin coating of a pinkish, fine-grained sand, sometimes approaching to gravel, its colour being due to the presence of a great many small pieces of fresh felspar. It was clear that this mineral, as well as the quartz and occasional fragments of topaz, which he saw, did not belong to the strata on which they lay. In going west, the grains of sand, getting coarser, assumed the form of distinct pebbles, till, when he reached the mountains, they became huge blocks and boulders, evidently derived from the heights beyond. The cause of this wide diffusion of sand and gravel over the prairies was constantly present to his mind during the rest of the journey, and he took occasion on returning eastward to halt and make a more detailed examination of the subject.

The term "Rocky Mountains," he remarked, was a singularly unfortunate designation, under which had been included a great many independent and totally distinct mountain ranges. On most maps of North America a continuous line of lofty ridge was inserted down the axis of the continent and marked "Rocky Mountains." But no such ridge existed. The great plateau had been wrinkled by innumerable meridional folds which, dying out, were replaced by others. Some of these folds formed notable ranges of mountains with wide basins or plateaux between them. It was thus possible to cross the axis of the continent without traversing any mountains, rocky or otherwise. The line of the Union Pacific Railroad followed one of these natural routes. At its highest point (upwards of 8,000 feet), so little did the landscape suggest the altitude, that it had been found desirable to erect there a wooden placard with the title "Summit of the Rocky Mountains."

Crossing the Missouri River at Kansas City, and striking westwards to Denver, the Professor said he halted for a little while on the flanks of the great mountain range that formed the colossal bulwarks of the parks of Colorado. As seen from the prairies they rose in a picturesque line of peaks, visible in the clear atmosphere of these regions at an incredible distance, and looking at first like mere low islets, the greater part of their bulk being still hidden beneath the sea-like surface of the prairie. Composed of crystalline rocks these crests had been pushed as a great wedge through the cretaceous and tertiary rocks of the prairies, and had carried those rocks up with them in a grandly picturesque curve along their flanks. An excursion into some of the gorges or cañons by which the flanks of these mountains are trenched, brought to notice some interesting facts connected with the surface erosion of the district. He then found the source of the pink felspar sand of the prairie; it had been borne down from this region, where great masses of pink granite, grey gneiss, and other crystalline rocks formed the core of the mountains, and were visibly crumbling into the same kind of pink sand and gravel. He found that the mountains had been covered with glaciers which had gone out into the plains and shed their huge horse-shoe shaped moraines where now everything was parched and barren.

Having crossed the watershed of the continent, he struck westward into the Uintah Mountains, one of the few ranges in that region that had an east and west direction. This range had been visited by Hayden, had been mapped by Clarence King and his associates, and its eastern end had been carefully examined by Powell. It formed one of the most remarkable elevations in North America. Unlike the other mountainous high grounds it possessed no great central core of crystalline azoic rocks, but consisted of a vast flattened dome of red sandstones, dipping steeply down beneath mesozoic rocks on either flank. The precise geological age of these sandstones had been a matter of dispute. King had regarded them as carboniferous. In their lithological characters they much resemble some of the old red sandstone of Scotland, while some of the more compact portions, recalled the red Cambrian sandstones of Applecross and Assynt. One feature of surpassing interest in the Uintah Mountains was the evidence of enormous denudation, continued through a protracted cycle of geological time. The horizontality of the strata along the central parts of the range was such that terrace above terrace could be traced by the eye for miles around any commanding peak. The rocks there had escaped crumpling and fracture to a remarkable degree. It could therefore be seen that the deep gullies and clefts, the yawning precipices and cañons, the wide corries and vast amphitheatres by which the surface was so broken up had been produced not by underground disturbances but by erosion at the surface. Most of this tremendous denudation had doubtless been effected by ordinary atmospheric action. The speaker described the disintegrating effects of the remarkable daily vicissitudes of temperature in this region, the action of wind, as well as of melting snow, and occasional torrents of rain. But he showed that the mountains had also nourished large glaciers, and that these, filling up the main valleys had protruded into the plains beyond. They had left behind them numerous lake basins, some ground out of the horizontal sandstones, others dammed up by fallen moraine *débris*.

Striking into one of the valleys, he found it crossed by beautiful horse-shoe moraines that had once formed a succession of lakes, of which the sites were now occupied by meadows. In these and other high grounds, however, it was the beaver, which, by its dams, converted even the small streams into a succession of shallow lakes. In most of these valleys there were hundreds of acres of bog land entirely due to the damming of the water by the beavers. The Uintah Mountains were flanked by ranges of low and sometimes fantastic hills, *mesas* or terraces, and isolated *buttes* or outliers, included under the general term "mauvaises terres" or "bad lands." This designation referred to the fact that the ground was everywhere crumbling down under the action of the weather, and nothing would grow upon it. The strata of these bad lands were flat or nearly so, and showed their lines of bedding with singular precision along the faces of the crumbling cliffs and slopes. They had an arid and almost ghastly aspect, grey, verdigris green and yellow, as they rose out of the sandy wastes at their base. It was from these strata that Prof. Marsh had obtained some of the marvellous reptilian and other forms which he had described from the eocene and cretaceous rocks of the West. Prof. Geikie narrated a ride through the forest lands of the mountains, and gave an account of how the party, benighted away from camp, had to pass the night without food on the bare ground, and how the forest around them caught fire.

The journey to the Yellowstone region was one of great tediousness and discomfort. Having letters from the Secretary of War and the Quartermaster-General of the United States, the party received every attention at Fort Ellis, where a pleasant day or two were spent, examining with the officers of the garrison the geology of the district. From this point the journey was performed on horseback and with a pack train of mules, the officer in command at Fort Ellis having furnished an outfit, scout and escort. The Professor gave a narrative of the traverse of the Yellowstone country, dwelling specially on the evidences of former successive periods of volcanic eruption, and on the proofs of intense glaciation to be observed in the ascent of the valley of the Yellowstone River. The tokens of a long period of volanic activity contemporaneous with the operations of the river, resembled those of Auvergne, but on a much larger scale. The mountains around consisted mainly of crystalline rocks such as gneiss, schist, and granite. The volcanic action appeared to have been chiefly confined to the valley. Sheet after sheet of lava had been poured out, and these, one after another, had been cut through by the river. The edges of some of the lava plateaux could now be seen crowning the summits of steep slopes or even cliffs far above the level of the stream below. So great had been the general erosion that no distinct craters remained now visible. But what appeared to be the stumps of some of these, filled up with a coarse volcanic agglomerate, were here and there observed. The lavas offered a vast and tempting field of investigation, presenting as they did a great number of petrographical varieties. Some of the obsidians were particularly interesting in their pumiceous and spherulitic characters. The Grand Cañon of the Yellowstone, cut out of these volcanic masses, was described as perhaps the most marvellous piece of mineral colour anywhere to be seen in the world. It had been cut out of tuffs and lavas, showing sulphur yellow, verdigris or emerald, green, vermilion, crimson, and orange tints, so marvellous that, if transferred to paper or canvas they would be pronounced incredible and impossible; the lecturer said he had spent a day in making a careful water colour study of this cañon, but he hardly expected to get any of his friends to believe in the truthfulness of his colouring.

During the ascent of the Yellowstone Valley the evidence of former extensive glaciation was abundant and conclusive. The party had hardly been in the valley a quarter of an hour when they descried, not far above the upper end of the first or lowest cañon, a large block among some mounds in the centre of the plain. This proved to be an erratic of coarse granitoid gneiss, lying among many others of smaller size. The mounds, manifestly moraines, curved in vast crescents across the broad plain of the Yellowstone. Further mounds and scattered blocks were noted in the ascent of this great expansion of the valley. On reaching the entrance of the second cañon, the Professor found it most exquisitely glaciated from bottom to top. It reminded him of the wonderful ice-polished precipice on the left bank of the Aar glacier, above the Grimsel. It was clear, therefore, that not only was this second cañon old; it was older than the glacial period; it had supplied a channel for the glacier that ground its way out from the mountains. Endeavouring to estimate the minimum thickness of the ice, he traced with the eye the glaciated surfaces up to the summit of the declivity—a height of at least 800, perhaps 1,000 feet,—and they evidently went still higher. In going further up the valley, he found that the blocks of granite and gneiss, dropped by the glacier as it melted, went far above 1000 feet. He got them on the shoulders of one of the great hills overlooking the valley 1,600 or 1700 feet above the plain. The ice, therefore, must have been not less than 1,600 or 1,700 feet thick, and must have passed across intervening ridges into adjacent valleys. It thus appeared that not only did glaciers occupy the valleys of this region, but that some of them were of such thickness as to deserve the name of ice-sheets, covering the whole surrounding region.

Leaving the Yellowstone Valley, the party struck through the forest, and after a two days' ride reached the Upper Fire-Hole Basin of the now famous geyser region. Prof. Geikie gave a general sketch of the aspect of this district, and described the operations of one or two of the geysers which he witnessed. After the long ride through an arid region and dusty wastes, he tried hard here to get a pool to wash in, but could find nothing below 212°, and the only chance of getting a warm bath was to find some hole where the water had had time to cool after flowing out of the hot crater. The whole ground was honey-combed with holes, each filled with gurgling boiling water. One geyser, affectionately and gratefully known as "Old Faithful," went off with wonderful regularity every 63 minutes; the others were more capricious. The singular depositions round the orifices of eruption and round the margins of the pools on the cones were referred to, and among other interesting phenomena an account was given of the "Devil's Paint Pot," a mud geyser, throwing out white and brilliantly-coloured mud, boiling like a great vat of rather thick pasty porridge, and surrounded with small mud cones, each of which had formerly been a point of emission.

In quitting the Yellowstone region, it was impossible not to reflect with admiration upon the labours of the explorers who had first made known the wonders of this remote and inaccessible region. The Reports of Hayden and his associates were found to be most trustworthy and useful. Nor could one forget the sagacity with which Hayden proposed, and the enlightened liberality with which Congress enacted, that for all time the Yellowstone Region should be a tract set apart as a national park for the instruction and recreation of the people.

On the way out of the mountains by Henry's Lake and the head of the Snake River branch of the Columbia River, the travellers came upon a party of armed Indians, who explained that they were out of their reservation on their way to a council of Indians in Montana. As the great outbreak of the White River Utes, who killed Major Thornburgh and his men, took place only about ten days or so later, and as there was then some excitement among the tribes to the West, the geologists, though pleased at the time to have seen the noble red man in his war-paint among his native wilds, came to think that on the whole they might congratulate themselves on having seen no more of him. Only last year the Yellowstone country was dangerous from roving bands of Indians, several lives having been lost in it. Leaving the Indians, who pursued their northward course in a bee-line, the travellers held westward along the edge of the vast basalt plateau of the Snake River—one of the most extensive lava fields in the world. A great plain, thousands of square miles in extent, had there been deluged with dark basalt. No cones or eminences appeared from which the lava migh have been poured. Perhaps the eruptions took place from open fissures. Here and there later cones had risen upon the plain, belonging, doubtless, to some of the later stages of the volcanic activity. Some of these cones still retained well-shaped craters.

Reaching eventually the basin of the Great Salt Lake, one of the first geological features that struck the travellers was the evidence of the former vast expansion of the Salt Lake. Lines of terrace ran as prominent features along the sides of the mountains, the highest of them standing at a height of nearly 1000 feet above the present level of the lake. Striking into some of the cañons descending from the Wahsatch Mountains into the Salt Lake Basin, Prof. Geikie found the rocks smoothed, polished, and striated by the glaciers that had come down from the heights and had brought with them great quantities of moraine matter. Mounds of rubbish blocked up the valleys here and there, and some of them he observed to descend to the level of the highest terrace. Hence when the Salt Lake extended far beyond its present area, and was about 1000 feet deeper than now, the glaciers from the Wahsatch Mountains reached its edge and shed their bergs over its waters. Bones of the musk-ox had been found in one of the terraces, showing that an arctic fauna lived in this region during these cold ages.

On his return journey the Professor resumed the examination of the surface deposits of these prairies. Coming out of the Colorado Mountains, he noted, in connection with the gravel formerly observed, great quantities of a peculiar grey clay or *loess* inter-stratified with the gravel, and here and there containing a small terrestrial shell (*Succinia vermeta*). It was a freshwater deposit, one that had been swept by the waters coming down from the mountains over the prairie. It might be regarded as marking one of the phases in the period during which the gravel and sand were being thrown down. Tracing the gravel mounds over an extensive tract, he found that they had been deposited irregularly, as might have been the case from the action of water escaping tumultuously and interruptedly from the melting ends of the ice. The water currents would traverse the plain now in one direction, now in another. The whole prairie, for many leagues east from the mountains, must have been flooded with water derived from the melting ends of the great glaciers.

By these successive floods the gravel and sand were spread out irregularly over the plain, and during the same prolonged period of ablation of the ice there were here and there greater streams or periods of more muddy water, when the fine grey loess was diffused over the flats, as has taken place in the valleys of the Danube and Rhine. No doubt some of the fine detritus may be travelling eastward still, for though the rainfall over much of the prairie country is exceedingly slight, it may suffice to give the fine particles of sand and gravel an intermittent movement to lower levels.

NOTES

WE take the following from the *Times*:—The medals awarded and recommended by the Council of the Royal Society for the present year are: The Copley medal to Prof. Rudolph J. E. Clausius, of Bonn, for his well-known researches upon heat; the Davy medal to Mr. P. E. Lecoq de Boisbaudran for his discovery of gallium; a Royal medal to Mr. William Henry Perkin, F.R.S., for his synthetical and other researches in organic chemistry; and a Royal medal to Prof. Andrew Crombie Ramsay, F.R.S., for his long-continued and successful labours in geology and physical geography. These medals will be presented at the anniversary meeting of the Society, on December 1, when Mr. W. Spottiswoode will deliver his first annual address as president.

THE following is the list of office-bearers to be proposed at the annual meeting of the Royal Society of Edinburgh, on November 24:—President, the Right Hon. Lord Moncreiff; Vice-presidents, the Right Rev. Bishop Cotterill, Principal Sir Alexander Grant, Bart., David Milne Home, LL.D., Sir C. Wyville Thomson, LL.D., Prof. Douglas Maclagan, M.D., Prof. H. C. Fleeming Jenkin, F.R.S.; General Secretary, Prof. Tait; Secretaries to Ordinary Meetings, Prof. Turner, Prof. Crum Brown; Treasurer, David Smith; Curator of Library and Museum, Alexander Buchan, M.A.; other Members of Council, Prof. Rutherford, Dr. R. M. Ferguson, Rev. W. Lindsay Alexander, D.D., Dr. Thomas A. G. Balfour, J. Y. Buchanan, Rev. Thomas Brown, Robert Gray, Dr. William Robertson, Prof. Campbell Fraser, Prof. Geikie, Rev. Dr. Casenove, David Stevenson, M. Inst. C.E.

A GRAND diploma of honour has been granted by the Jurymen of the Champs Elysées Exhibition to the Signal Corps of the United States for its magnificent set of maps. No other public institution has sent anything to compete with so formidable an opponent.

ABOUT thirty members of the Academy of Sciences have memorialised M. Jules Ferry, the Minister for Public Instruction, in order to obtain a promotion in the Legion d'Honneur on behalf of M. Henry Giffard, the inventor of the injector and the originator of many interesting experiments in aëronautics. M. Giffard was created a Chevalier about eighteen years ago.

PROFESSORS A. WINNECKE (Strassburg) and G. B. Schiaparelli (Milan) have been nominated correspondents of the physico-mathematical class of the Royal Academy of Sciences of Berlin.

THE magnificent series of scientific collections at Dresden have recently been further enlarged by the addition of an ethnographical and anthropological museum. Many of the objects now exhibited in the lecture-hall of the "Zwinger" had accumulated since the year 1857, and the director, in due recognition of the important position now occupied by ethnography and anthropology in the list of natural sciences, has recently made considerable purchases for the opening of the new museum. The director in question is the well-known New Guinea traveller, Dr. A. B. Meyer, under whose able superintendence the Dresden Zoological Museum is also placed.

WE are glad to receive from Mr. E. W. Lewis his "Lectures on the Geology of Leighton Buzzard and its Neighbourhood," which were given to the Working Men's Club of that town. We should like to see lectures of this kind become more and more common; it is a good method of exciting an interest in science and of encouraging the study of local natural history; it is certainly much better than giving a *rechauffée* of scientific text-books.

AT the meeting of the India Council, last week, a final decision was come to regarding the disposal of the India Museum. The Museum will be taken over, as is proper, by the Lord President, and will be administered by the South Kensington authorities. Important collections in illustration of the Indian building art of antiquity, and of the economic, mineral, vegetable, and animal productions of India will therefore now be from time to time sent to the great centres of the United Kingdom. The botanical part has been intrusted to the authorities at Kew. A grant of 2,000*l*. has been made for the enlargement of the Kew Museum on that account, and a small annual sum will be allowed for contingent expenses and to secure the services of an expert cryptogamist in connection with the collection. In its economic section the India Museum was little more than a very costly duplicate of Kew, which it could never approach in encyclopædic completeness, and it will necessarily be of incalculable benefit to the India Office to keep its economic collections for the future at Kew, where they will be in charge of the first English botanists. In fact, the Indian Secretary will now always have the assurance that the reports on Indian products forwarded by him to the local Governments in India have not only been carefully prepared by his own officers, but are supported by the best scientific advice in this country. The Kew authorities, in continuation of a scheme set on foot by Dr. Forbes Watson, the late Reporter on Products, have undertaken to supply out of their surplus stores samples of Indian articles to any museums in our larger manufacturing and commercial towns which will undertake the cost of suitably exhibiting them to the public. As to the zoological collection, it has always been understood that it would be transferred to the British Museum on the completion by the trustees of their new Natural History Museum at South Kensington. The Buddhistic sculptures will also be taken by the British Museum.

THE *Times* Naples correspondent, writing under date November 8 and 10, states that Vesuvius, which for some time had been capricious in its action, had for a week previously hoisted its red flag. This arises from a small eruptive cone which has sprung up in the centre of the large crater of 1872, and which now rises a few metres above its border. To compare great things with small, the appearance of the summit is that of a small cup in the centre of an immense saucer. The saucer is almost full of lava, which, says the *Osservatorio Vesuviano*, or Prof. Palmieri, has run over the side since October 30, and continues its downward progress on the side of the cone. It is fortunate, says the *Osservatorio*, that on the side on which they are constructing the funicular railway there is a considerable cavity which is not yet filled, so that hopes are entertained that some time will elapse before the lava presents itself in that direction. It may happen, too, adds Palmieri, that an eccentric eruption may occur which will prevent the accumulation of more material. It is thought that a crisis in the history of the mountain is approaching; either there will be a great discharge, such as will terrify the neighbourhood, or, as is more likely, there will be an overflowing of lava, covering the cone with a mantle of fire, and silently inflicting more destruction on property than a grand eruption. Vesuvius has been in an active state now for several years, and Prof. Palmieri has from the first prophesied that the eruption would consist in the overflowing of lava. On the 10th Vesuvius was covered with snow down to its middle, a rare thing so early in the year.

THE juvenile lectures of the Society of Arts will be given this year by Mr. W. H. Preece, on "Wonders of Sound" and "Wonders of Light." The dates for his lectures are December 30 and January 6.

THE French Minister for Commerce has sent to the Academy of Sciences a request to know whether a *diagometer* can be relied upon for ascertaining whether olive oil has been adulterated by common seed oil, and in what proportion. Prof. Palmieri, the director of the Vesuvian Observatory, sent M. Dumas a pamphlet published at the expense of the Chamber of Commerce of Naples nine years ago, showing that the problem had been solved by this apparatus. The principle is the same as the bifilar magnetometer, also invented and designed by Palmieri.

WE have received programmes of the new session of the numerous societies united together under the name of the Cumberland Association for the Advancement of Literature and Science. The programmes of lectures and ordinary meetings are fairly divided between the two fields. The continued prosperity of this provincial association for culture is exceedingly gratifying.

THE Pacific Steam Navigation Company have begun to use the electric light in the illumination of the saloons on board their steamers.

WE are glad to be able to acknowledge the receipt of the Report of the Sheffield meeting of the British Association. This early publication is decidedly a mark of progress.

FOR the first time in its history the Paris Academy of Sciences has regular archives. More than seven hundred cases are filled up with scientific memoirs and documents from the end of the seventeenth century to the present time. Scientific papers left by Réaumur and Ampère are a part of this unexampled collection.

THE bequest of the late Mr. John Miers, F.R.S., to the British Museum, consists of his herbarium of South American plants which he made during his long stay in that country; original drawings and the manuscripts of his published works; and some unpublished manuscripts. Among the more important of his unpublished manuscripts is a list of the native names of the plants. The extent of the herbarium is about 20,000 sheets, on which the specimens are carefully mounted, and as it includes the type specimens figured in Mr. Miers's publications, the acquisition to the Museum is of great value. The cases in which the collection was kept form part of the bequest. It was only last year, when nearly ninety, that Mr. Miers published his "Apocynaceæ of South America," with general remarks on the whole family. The work, which was of 277 quarto pages, was illustrated by 35 plates. The "Contributions to Botany," published in three volumes in 1861, 1869, and 1871, were illustrated by 153 plates, and contained 940 quarto pages of letterpress. All the originals of these are included in the collection sent to the British Museum. There are also a large number of other drawings and sketches of dissections.

ON October 10 a large balloon fell on a farm in the town of Milwaukee, U.S. The air-ship was picked up and temporarily stored in a warehouse. On the 11th an inspection of the canvas was made, to ascertain whether it was the *Pathfinder*, a balloon in which Prof. Wyse had ascended some days previously in company of a gentleman, and had not been heard of since. It was proved that this balloon had been liberated on Thursday, October 7, at six in the evening, at Waukosha in Wisconsin, and had been wandering in the atmosphere. Before being discovered in Milwaukee, it had been seen coming from Lake Michigan in an opposite direction to where Waukosha lies. The body of Prof. Wyse has not been recovered, but the gentleman who had ascended with him was found drowned and naked. It was supposed he had prepared to escape by swimming, and precipitated himself into the water.

THE Manchester Field Naturalists and Archæologists send us an interesting and varied Report for 1877. It contains an account of the numerous excursions made and the papers read at the Society's meetings.

THE several stations of meteorology which have been established in several parts of Paris, according to a vote of the Municipal Council, have been in complete operation for a few months. Startling differences have been occasionally discovered between the readings taken by the several observers at a distance of a very few miles.

THE *éloge* on M. Thiers was pronounced by M. Henry Martin before the French Institute on November 13. M. Marmier returned thanks in the name of the Académie Française. The lecturer made allusion to the studies of M. Thiers in astronomy under the guidance of M. Leverrier, and in chemistry, of M. St. Claire Deville. It was stated that many experiments were made by the late President of the French Republic in the last years of Napoleon III.'s rule. These experiments were conducted in the laboratory of the École Normal Supérieure, rue d'Ulm.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. L. H. Ruegg; a Banded Ichneumon (*Herpestes fasciatus*) from West Africa, presented by Mr. H. L. Cocksedge; a Mace's Sea Eagle (*Haliaëtus leucoryphus*) from India, presented by Capt. Butler; a Pomatorhine Skua (*Stercorius pomatorhinus*), British, presented by Mr. F. L. Smith; a Woodcock (*Scolopax rusticola*), British, presented by Mr. J. Pollard; a King Penguin (*Aptenodytes pennanti*) from the Staten Islands, Cape Horn, a Cinereous Vulture (*Vultur monachus*), Europe, a Downy Owl (*Pulsatrix torquata*) from South America, deposited; a Water Rail (*Rallus aquaticus*), British, an Anaconda (*Eunectes murinus*) from South America, purchased.

OUR ASTRONOMICAL COLUMN

THE BIELA COMET METEORS.—Assuming, as some astronomers will probably be inclined to do, that Biela's comet has now lost the cometary form in which it presented itself to us from 1772 to 1852, and that its constitutuent particles, or whatever we may term them, are drawn out into a stream or band, beyond the circumstance of a great aggregation having been encountered by the earth on the evening of November 27, 1872, we are ignorant of the position of any other centre or centres of condensation that may exist, and even of the real extent of that which has been observed, along the comet's track; and hence it is desirable that a watch for the Biela meteors should be maintained during the whole of the last week in the present month. We are not assuming as a consequence of the disruption of Biela's comet before it was generally observed in 1846, that such is the actual condition of its constituent parts; Mr. Pogson's observations of a cometary body at Madras in December, 1872, require that such an assumption should be taken at present *cum grano*, but under any circumstances observations about the time when the earth approaches nearest to the orbit of the comet this year, will possess great interest, and we hope there may be an effective organisation of observers. In 1852, when the comet was last observed, its period of revolution, in the instantaneous ellipse at perihelion, was 2,417½ days; the effect of planetary perturbation thence tended to increase the period, so that in January, 1866, the latest time to which the calculations have been carried, the revolution extended to 2,445 days, according to Michez and Clausen. If this were about the period of the meteoric mass which the earth encountered on November 27, 1872, it is very doubtful if we shall be in proximity to it again during the present century; nevertheless, as above remarked, we do not know its extent along the orbit, and other aggregations may exist. A body moving in the orbit of Biela, and approaching the earth at this date, would be at a distance of about 1·4 from the planet Jupiter in September, 1878, and there might be very sensible effect upon the period of revolution.

A NEW NEBULA.—Dr. Tempel states that on September 19 he found a new nebula which, from his description, appears to be nearly as bright as an average second-class of Sir W. Herschel, and is therefore deserving of attention on the score of possible variability, since in these days we hardly expect to meet with many unknown second-class nebulæ visible in European latitudes. Dr. Tempel mentions that there is a central glimmer as from very minute stars: it is about one minute in diameter, and its position for the beginning of the present year is in R.A. 22h. 41m. 25s., N.P.D. 102° 27'·1: it is very little fainter than the nebula II. 744. He adds that he has often sought for the nebula No. 49 of Auwers, which should be near the new one, but has only found in its assigned position a star of 12m., which has a very faint companion. Auwers 49 is the object observed as a star 11·5m. on October 8, 1855, in one of the Markree zones, and called "nebulous;" position for 1850 in R.A. 22h. 52m. 35s., N.P.D. 101° 19'·9. The late Mr. Edward Cooper had so unfavourable an opinion of the climate in his locality for astronomical purposes (perhaps from long experience of the skies of Italy), that probably he would not have been surprised at the discovery of any number of "nebulous" objects at Markree; but the four volumes of positions of small stars for which astronomers are indebted to him, sufficiently illustrate the good work that may be effected by well-directed energy and skilful arrangement, even in such a climate as we remember to have heard him describe that of Sligo. Pons expressed his fear that the second comet of 1826 would be "drowned in Eridanus," as the sky had been overcast ever since it entered this constellation; on which Mr. Cooper ("Cometic Orbits," p. 152) is tempted to remark that, had Pons "written from the interior of Ireland, there would have been little to fear, for he might have made quite sure of it!"

THE SATELLITES OF MARS.—Both satellites of Mars have been observed with the Washington refractor; the measures of *Deimos* commenced on October 13, clouds interfering on the 10th, when it was first seen, and those of *Phobos* on the 12th. The correction required to the periodic time of *Deimos*, as determined by Prof. Asaph Hall from the observations of 1877, is so small that it will only be certainly ascertained from an exact discussion of the measures at this opposition; the periodic time of *Phobos* requires to be diminished 1·074s., or the corrected period is 7h. 39m. 13·996s.

Phobos and *Deimos* are also under observation with the Ealing reflector.

PHYSICAL NOTES

THE *Scientific American* describes a self-resonant tuning-fork, the invention of the indefatigable Edison. It consists of a tube of thick bell-metal closed at one end, and sawed down longitudinally nearly to the closed end, thus making two "prongs" united to a common base. To tune the prongs into unison with the column of air between them, the tube is put into a lathe and turned thinner and thinner until unison is reached. But how such forks are made of any precise pitch, or how the inclosed air-column contrives to vibrate in spite of the long lateral cuts, our contemporary does not vouchsafe to inform us. There are not many organ-pipes that would resound to their proper note with a saw-cut incised down them front and back.

FOR observation of atmospheric electricity M. Mascart (*Journ. de Phys.*, October) uses a Thomson electrometer connected with a vessel having continuous outflow of water. The deflections of the needle are transmitted every two and a half minutes to a pencil which records them on a sheet of paper. The series of traces forms a curve, not continuous, indeed, but nearly so. This apparatus was put in action at the College of France in the end of February this year, and the curves obtained during the following five months present several interesting features. The potential of the air is shown to be generally positive, with more or less rapid variations. In bad weather the curves become more irregular; rain nearly always produces very great negative deflections. The change of sign appears before the rain comes, and sometimes rain is followed by very high positive indications. There are also some very rare cases of positive rains, and of great negative deflections without apparent rain in the neighbourhood. (This predominance of negative electricity in rain clouds M. Mascart regards as an important point in the question of the origin of atmospheric electricity.) Neglecting accidental variations, one is struck by the fact that the electricity is much more uniform at night and more variable by day. The potential is also considerably higher at night than in the day. The maximum seems to occur about 9 or 10 P.M.; the curve descends slowly towards 6 A.M., then more rapidly; reaches a minimum about 3 P.M., and then rises again in a nearly uniform manner. The indications by the curves are confirmed by numerical tables of monthly averages of eight daily observations at three hours' interval. The results thus obtained are in contradiction with ideas commonly adopted. M. Mascart remarks that the continuous maximum of positive electricity observed at night may be of an exceptional character, owing to the anomalous season; He also suggests the possibility of previous observations having been vitiated through defective insulation.

THE influence of changes of temperature and pressure on double refraction has been recently investigated by Herr Pfaff, of the Erlangen Society of Physics and Medicine, and with (briefly) the following results:—In crystals of the rhombohedric system, when the temperature is raised, double refraction diminishes in quartz, but increases in vesuvianite, beryl, and apatite; it is not changed in Iceland spar (perpendicular to the principal axis), carbonates of iron and of magnesia, tourmaline, mellite, ferrocyanide of potassium, zircon, and cassiterite. In the orthorhombic system it increases in the case of arragonite (perpendicular to the median line), celestine (parallel to P); it diminishes in topaz, celestine, and heavy spar (perpendicular to the median line). In the clinorhombic system it diminishes in adularia (parallel to the median line) and mica; it increases in gypsum (parallel to the primary cleavage), remains constant in anhydrite, topaz, arragonite (inclined to the median line), witherite, carbonate of lead, adularia parallel to M), and the anorthic crystals, albite, oligoclase, labrador, anorthite, axinite, cyanite, and sulphate of copper. Pressure on the whole surface produces the same effect as a lowering of temperature in carbonate of magnesia, Iceland spar, celestine, gypsum, and heavy spar; the others do not present any modification, even those which, like topaz and vesuvianite, are very sensitive to variations of temperature.

PROF. REITLINGER and Dr. Urbanitzky have recently presented to the Vienna Academy the first portion of a memoir "On the Phenomena of Geissler Tubes under External Action," giving in more developed form, an investigation, of which they had already published some results. Various interesting experiments are described, *e.g.*, with reference to the attractions and repulsions of the light columns in Geissler tubes, and a possible joint action of the electrostatic and dynamic states in these, the authors hung a strip of tinfoil (15 ctm. long) from a platinum electrode at the top of a tube, 20 ctm. long, connected with a mercury pump (the second electrode being a straight platinum wire). Before rarefaction commenced the strip flew to the side, immediately the Ruhmkorff was set in action. But on rarefying, this phenomenon became less pronounced, till at 7 mm. the strip hung freely down in the middle. When in this state, it was attracted by a shellac rod rubbed with cloth, and repelled by a glass rod rubbed with amalgam (if the strip was connected with the positive pole, conversely in the other case); but these actions diminished as the rarefaction proceeded, becoming hardly perceptible at 4 mm. with the strip positive, and even at 6 mm. in the other case. A good conductor brought near caused attraction at all degrees of rarefaction in one case; but this, too, disappeared in the other. An experiment showing how the action of static electricity on a conductor is arrested when the latter is made a carrier of dynamic electricity, was made by bringing a rubbed glass or vulcanite rod near the strip, which thereupon went from the vertical to an inclined position. On sending through it the induction current (in either direction) the strip recurred at once to the vertical and remained there.

M. NIAUDET has lately constructed for Prof. Stefan, of Vienna, a Gramme magneto-electric machine, in which the permanent steel magnets are of circular form, instead of the usual elongated horse-shoe shape. The soft iron cheeks which embrace the rotating armature are also of a peculiar form. The new machine is much more compact than those hitherto constructed, and gives very satisfactory results.

A VERY singular theory of electricity and magnetism has recently been put forward by M. Bjerknes, who endeavours to explain the various phenomena upon mechanical principles. If a number of spherical bodies are plunged in an incompressible liquid, in the midst of which they execute isochronous vibrations, they are found to exercise certain forces upon one another. These forces may be either attractive or repulsive, according to the nature of the motions executed. Thus the actions exercised by an electrified particle may be illustrated by a pulsating sphere, that is to say, one which periodically increases in volume. A sphere vibrating to and fro similarly represents a magnetic particle. Unfortunately, however, the theory, to be applicable to electric and magnetic phenomena, would require the forces to act just in opposite directions to that which is found to be the case; for with M. Bjerknes' spheres the like poles attract, while the dissimilar poles repel. Experimentally, the attractions and repulsions thus theoretically deduced have been observed by means of an ingenious apparatus constructed for the inventor in Sweden. The pulsating bodies are a species of elastic capsule suspended from knife-edges by a hollow tube, by means of which the air is forced into and out of the capsule in rapid alternations. The vibrating bodies are little spheres set in motion by delicate levers. The mechanism is in each case driven by a pulley turned by hand. The liquid in which they are immersed is water, and the resultant attractions and repulsions are very clearly demonstrated.

M. GERNEZ has been studying the little-known phenomena of evaporation and distillation under the influence of electrification, discovered by the Abbé Nollet in 1746. The results of M. Gernez's observations have been communicated by him to the Physical Society of Paris, and are of considerable interest. Two concentric tubes communicating with one another above only are filled with a liquid to a common level. Sparks from a Holtz machine are then passed across the intervening air, when it is found that the level rises at the negative and falls at the positive pole. There is, therefore, apparently an actual transport in the direction conventionally agreed upon as the direction of the current. M. Gernez is inclined to attribute this phenomenon to an electrical transport of the liquids along the moistened surfaces of the tubes. Pure alcohol distils over thus at a rate three times as great as that of water, but a mixture of alcohol and water in equal parts at a less rate than pure water. The rapidity of the distillation is increased by the addition of any soluble salt or of a few drops of sulphuric acid or of ammonia solution. No appreciable amount of distillation takes place with bisulphide of carbon, tetrachloride of carbon, or with turpentine. M. Gernez, however, does not think that there is any assignable relation between the conductivity of a liquid and its rate of electro-convective evaporation; nor does he think that there is any necessary connection between this phenomenon and that discovered by Porret of the electric endosmose of liquids across diaphragms of various kinds.

GEOGRAPHICAL NOTES

AT the last meeting of the Russian Geographical Society, in the section of Physical Geography, M. Rylcke communicated the results of his precise measurements on the levels of the Baltic and of the Black Sea. These measurements were begun in 1877, by order of the General Staff, according to the resolutions of the Brussels Congress. Accurate measurements in the ports of the Baltic have proved undoubtedly that the level of the sea at Cronstadt is, by nearly two feet, higher than at Reval, and that its height decreases regularly from north to south, this conclusion being fully supported by Prussian measurements at Memel and at Kiel. For a comparison of the level of the Baltic with that of the Black Sea the necessary computations are not yet advanced enough to yield trustworthy results.

IN his last paper on the Agomes Islands (*Isvestia*, 1879, p. 37) M. Miclucho-Maclay says that here he happened to determine the dimensions of the heads only of fourteen men, and that the so-called "index of the breadth" varied from 69·6 to 81·3; it was thus nearly the same as on the Taui Islands (70·5 to 84·5), where the traveller has done no less than 119 measurements, and does not much differ from what was seen of the Papuans of New Guinea, whose "index" varies from 62·0 to 86·4. According to this wide variation of the "indexes," M. Maclay affirms that we have no right to describe the heads of Melanesians as well as those of the Papuans as dolichocephalic, but rather as mezocephalic; and that the form of the head must not be considered as a proof of a race-distinction between Negritoes and Papuans, as both Melanesians and Papuans display an obvious tendency to brachycephalism, whilst this last was formerly considered as a distinctive feature of the Papuans from the natives of the Philippine Islands. He considers also that within the same races we shall always find both forms of heads, and that a true classification of human races cannot be established on this sole feature; it must be based on a thorough study of the whole of the comparative anatomy. A few measurements on living subjects, however accurate, cannot give the necessary solid bases for a scientific classification.

ACCORDING to a telegram received in Paris from Sierra Leone, two Frenchmen, MM. Zweifel and Moustier, have at length discovered the sources of the River Niger, a feat which has hitherto baffled all explorers. The party appear to have been recently instructed by their employer, M. Verminck, of Marseilles, to explore the Niger for both scientific and commercial purposes; and accordingly, starting from Sierra Leone and following the course of the Rohelle, they reached the foot of the Kong Mountains. By adroit treatment of the hostile tribes at this point, where foreigners had always been refused passage, they were allowed to pass the mountains and explore the three streams which, uniting after a short distance, form the River Niger.

BEFORE concluding his recent explorations in South America, Dr. Crevaux made two attempts to ascend the Iça or Putumayo tributary of the Amazon. Having failed the first time, he ascended the main stream to Tabatinga, on the frontier of Peru and Brazil, and then returned to Para. He there obtained means to enable him to carry out his original intention, and at the second attempt succeeded in ascending the Iça to Cuembe, to the north of Cotopaxi, on the frontier of Bolivia and Ecuador. Starting from this place on May 16, Dr. Crevaux reached the foot of the Andes in eight days. Thence continuing his route towards the north, he arrived at the sources of the Japura after sixteen hours' march. After experiencing great hardships, and hostility on the part of the natives, he reached the Amazon again on July 9, arriving at Para on July 24. He has brought back with him much information interesting alike from a geographical and ethnographical point of view, as well as a collection of plants, which are expected to prove useful as medicines.

IN publishing an interesting letter from its special correspondent with the Russian expedition against the Tekke Turkomans, the *Daily News* states that the "nature of the ground along the course of the Attrek from the Caspian Sea has never been accurately described from personal observation." Without wishing to undervalue this and other letters from the same source, we may be permitted to point out that the ground had been previously examined by a party under General Llomakin, and that Sir Henry Rawlinson, in his paper on the "Road to Merv," read before the Geographical Society on January 27, quoted at length from Russian newspapers a description of this very route by a member of the expedition. A summary of the letters, giving an account of this expedition, which had been addressed to the *Moscow Gazette*, also appeared in NATURE, vol. xix. p. 271.

A LETTER from Herr Hildebrandt, dated Nossibé (Madagascar), states that he has visited Beravi, where the unfortunate traveller, Dr. Chr. Rutenburg, was murdered some time ago. Hildebrandt erected a stone monument on the spot; the body, however, could not be found, in spite of the most assiduous inquiries, the murderers having thrown it into a mountain torrent. Hildebrandt has photographed the spot, and sends a copy to Bremen, accompanied by the last diary and stenographical notes of Rutenburg.

THE Geographical Society of Algiers has nominated for its president M. MacCarthy, an explorer of the Algerian Sahara, who is settled in Algiers, and has been appointed librarian of the National Library of Algiers. This Society has been divided into three sections: Political Geography, Economical Geography, and Physical Geography.

THE Belgian African Society has received letters from Zanzibar, according to which MM. Popelin and Van der Heuvel had arrived at Mpwapwa on August 15 and at Chunyu on September 2. They were to leave the latter place on September 3, and to penetrate into the Ugogo district. At Mpwapwa they met the elephant caravan led by Carter. Each elephant carried about 10 cwt. The march was performed most satisfactorily. In the districts where the tsetse flies abound, the animals were often covered by them without feeling any the worse for it. Only one elephant died through change of nourishment, the whole caravan being fed with what the country offered. M. Dutalis, who suffered from a severe attack of fever, has returned to Europe.

THE Geographical Society of Munich has conferred the title of Honorary Members upon Prof. Nordenskjöld, Dr. Joseph Chavanne (Vienna), and Dr. Emil Holub (Prague). The reception of the latter upon his return to Prague was most enthusiastic. He had been absent for over seven years. The Vienna Geographical Society has elected the following gentlemen as Honorary Members:—Prof. Ujfalvy (Paris), General Kauffmann (Tashkend), Dr. E. Holub (Prague), and Prof. Arendts (Munich). The last-named gentleman has also been nominated Corresponding Member of the Paris Society for commercial geography.

A GENERAL "Geographentag" will be called at Berlin during the summer of 1880. Its special object will be the consideration of plans for the formation of a great German "Gesellschaft für Erdkunde." The idea is not a new one, but projects for the new General Society have already been mooted upon several occasions. At the recent Karl Ritter celebration at Berlin, a "commission" was appointed and charged with the working out of certain preliminaries referring to the subject. The commission is formed of Dr. Nachtigal (Berlin), Prof. Neumayer (Hamburg), Prof. Bruhns (Leipzig), Prof. Rein (Marburg), and Dr. Roth (Dresden)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—In a congregation held on Tuesday, November 18, the amendments to the proposed statute to confer degrees in natural science were taken into consideration. The proposed statute made Greek an optional subject in the natural science curriculum. It appeared from counsel's opinion that the proposed degree would not carry with it the rights and privileges of the master of arts degree. On the latter ground opposition was made to the statute by a considerable portion of those engaged in teaching natural science at Oxford. Prof. Odling had issued a memorandum, extensively signed by residents interested in science, in which he had explained his reasons for opposing the statute. The statute, by completely separating the faculties of arts and natural science, would allow no honour student in one faculty to become an honour student in the other without beginning in the new faculty *ab initio;* and no honour student in the faculty of natural science could fall back, as at present, on the ordinary pass degree. The broader question of lowering the value of natural science degrees by putting them on a different footing from degrees in arts, was not discussed in congregation on Tuesday; but Dr. Magrath's amendment to reject the whole statute except the preamble, was passed by a vote of fifty-four against forty-eight. The whole subject will thus have to be rediscussed on a future occasion.

The examination in the Honour School of Natural Science will commence next Monday, November 24.

CAMBRIDGE.—The Cambridge women students add no unimportant quota to the numbers in residence, numbering something lik 160 or 170 this term. At Girton College there are over fifty students, including about six of the first year who purpose studying natural science. They have a good chemical laboratory, under Miss Herschel's superintendence, also a library which includes many valuable presents of books and apparatus. There are now eleven lecture- and class-rooms, and a good hospital and nurse's room have been built, capable of being entirely detached from the rest of the College. Miss Tomlinson's success in winning an entrance scholarship at the London School of Medicine for Women, and entering for the London Medical Examinations, will doubtless tend to show that a Cambridge course in science is no bad preparation for women as well as men before proceeding to medical degrees.

The Newnham College Association will shortly have two houses of residence facing one another, together with a complete set of lecture-rooms and a chemical laboratory. There are eighty-two students in residence at Cambridge who have come for the lectures to women, besides about twenty who attend the lectures each term, being residents, school-mistresses, &c. Miss Lawrence, who gained marks equivalent to a second-class when informally examined in the last Natural Sciences Tripos, remains in residence, and demonstrates for the lady-students who attend Dr. Michael Foster's and Mr. Balfour's lectures. Mr. Vines's lectures on Vegetable Physiology are open to ladies who obtain special permission.

Mr. Freeman, of St. John's College, has given to the Women's Association a quantity of valuable electrical apparatus which will be used in giving instruction in experimental physics. Mr. R. T. Wright, on leaving Cambridge, resigns his active work for the Association as secretary, and pending the formation of the Newnham College Company, Miss M. G. Kennedy is appointed secretary to the Association for the remaining period of its existence. Nine scholarships have been awarded by the Association on the last higher local and other examinations, and over 700*l.* thus given or lent to students in one year. About 1,000*l.* has been paid to the Association during the year by students attending its lectures. As soon as the memorandum and articles of association of Newnham College are complete, a copy will be kept by Mrs. Bateson at St. John's Lodge, for inspection by any member of the existing Association.

A noteworthy entertainment of the British Medical Association by Cambridge University, town, and county, may be expected next August, when Prof. Humphry will preside. The president's position will be very conspicuous, for he is now, by Mr. Lestourgeon's retirement, senior surgeon and clinical lecturer on surgery to the Cambridge (Addenbrooke's) Hospital and Medical School, as well as professor of anatomy. A public meeting was held on Friday, the 14th, in the Cambridge Guildhall, at 2.30, under the presidency of the Vice-Chancellor (Dr. E. H. Perowne, Master of Corpus Christi College), when Dr. Humphry made a statement of the objects of the Association and the proposed arrangements for the meeting. His son, Mr. A. P. Humphry, one of the Esquire Bedells, is honorary secretary of the Local Executive Committee. Most probably at least a thousand members will attend the meeting. Dr. Michael Foster will deliver the address in Physiology, and Mr. Timothy Holmes that on Surgery. Dr. Paget, Regius Professor of Medicine, will preside over the section of Medicine, he having been president of the Association itself when it last met in Cambridge; and Sir James Paget will be president of the newly constituted section of Pathology. Dr. J. B. Bradbury is to deliver the address in medicine at the meeting; he holds the Linacre Lectureship, delivering lectures on pathology, is medical lecturer of Gonville and Caius College, and one of the physicians to Addenbrooke's Hospital, and took a distinguished position in the Cambridge Natural Sciences Tripos.

Mr. G. B. Atkinson, Trinity Hall, Cambridge, has been appointed secretary of honour examinations.

We are glad to learn that mathematics and geology are now studied by more students who enter the Cambridge Higher Local Examinations. In the examination in mathematics in June, the candidates showed better style and appreciation of mathematical ideas. All the subjects gain favourable reports, and in astronomy one candidate did remarkably well. The work in the differential and integral calculus was good, the introduction of this paper having been successful. In botany there was much guesswork and little evidence of histological work by candidates. One of the candidates, placed first in zoology, sent up admirable work in botany. Some candidates did very well in practical chemistry. The examiner's report on physiology, now first introduced as a separate subject, is on the whole favourable; only one set of papers on physics was sent up. In 1879, Group C (Mathematics) had 60 candidates, of whom 19 failed and 8 obtained a first class; in Group E, 73, of whom 35 failed and 4 obtained a first class.

The Report of the Board of Natural Sciences Studies, which we referred to last week, was rejected by 46 to 26 votes. Prof. Paget and Mr. Bettany issued a fly-sheet complaining that the subjects of examination were now too numerous and extensive; encouraging candidates to an injurious amount of memory-work in attaining "general knowledge and proficiency;" and that there should now be a Biological and a Physical Tripos. Mr. Sedley Taylor and Mr. Vines, as well as Prof. Dewar and Mr. Balfour, object to the advance of human anatomy to so conspicuous a place in the Tripos Dr. Humphry considers the recognition of human anatomy in the Tripos not greater than it deserves. However, he would now prefer a "Medical Tripos."

SCIENTIFIC SERIALS

Journal of Anatomy and Physiology, Normal and Pathological, vol. xiv. part i., October.—Drs. Gibson and Malet, on a pre-sternal fissure, uncovering the base of the heart, pl. 1. —Dr. W. Ostler, case of congenital and progressive hypertrophy of the right upper extremity.—Prof. Flower and Dr. Garson, the scapular index as a race character in man.—Dr. W. Allen, the varieties of the atlas in the human subject and the homologues of its transverse processes, pl. 2.—Prof. Cleland, note on the foregoing.—Dr. Creighton, the infection of the connective tissue in scirrhous cancers of the breast.—Dr. Watson, the homology of the sexual organs, illustrated by comparative anatomy and pathology.—Prof. Bridge, on the pori abdominales of vertebrata.—Prof. Turner, on the pori abdominales in some sharks.—Prof. Turner, a description of a cleft sternum.—Dr. J. Barlow, the physiological action of ozonised air.—Prof. Charles, on the mode of propagation of nervous impulses.—Dr. Cook, on a logwood staining solution.—Dr. Dobson, case of the development of hair on the eyeball of a dog.—Dr. Osler, on Giacomini's method of preserving the brain.—Anatomical notes.

THE recent numbers of the *Scottish Naturalist*, which has now been in existence for nine years, show no falling off from the interest of the earlier ones. In addition to the descriptive papers and lists of localities in the various departments of natural history, we find in the last number a paper on the Gaelic names of plants, one on the effects of the past winter and present summer on hard-wooded plants, and one on the auriferous quartz of Wanlockhead. The list of Scottish insects by experts in the various sections of entomology is still continued in each number. The number for October contains an appreciative notice of the late excellent naturalist, Sir Thomas Moncreiff, Bart., president of the Perthshire Society of Natural Science.

Royal Society of Tasmania, Papers and Proceedings of, for 1877.—Hobart Town, 1878.—Among the more important papers are the following:—F. W. Hutton, on some South Australian Polyzoa (describes several new species from the shores of St. Vincent's Gulf).—Rev. J. E. T. Wood, census, with brief descriptions of the marine shells of Tasmania and the adjacent islands.—Rev. W. W. Spicer, on alien plants.—Rev. J. E. T. Woods, on Australian Siphonaria (describes a new species, *S. zonata*).—M. Allport, on the present stage of the salmon experiment (November 12, 1877).—Baron Ferd. von Mueller, contributions to the phytography of Tasmania, in which he adds a few more plants to his previous enumeration and effects a few changes in nomenclature; there is added a note on *Phyllota* (*Pultenaea*) *diffusa*.—Rev. J. E. T. Woods, on some new Tasmanian marine shells (describes several new species).—The meteorology of Hobart Town, January to December, 1877. In January apricots and Jargonelle pears were ripe, the general apple and pear crop in February. Leaves commenced to fall in March; the chrysanthemums were in flower in April; Lachenalia and Photinia in May; crocuses and *Pyrus japonica* in June; almonds in full bloom in July; trees breaking into leaf in August; horse chestnut in flower in September; mulberry and lime trees in leaf in October; cherries and strawberries ripe in November; currants and gooseberries in December.

Morphologisches Jahrbuch, Band 5, Heft 3.—Dr. G. Born, on the nasal cavity and tear passages in the amniotic vertebrates, pls. 23-24.—L. Graff, on *Geonemertes chalicophora*, a new land Nemertine, pl. 25-27. This new species was found in the earth of a flower-pot in the palm-house at Frankfurt. The larger specimens were 12 mm. in length and $\frac{3}{4}$ mm. in breadth; they are of a milk-white colour. A list of the land nemertines now known is appended, these being the original species of the genus described by Semper, *G. palæensis*, and *Tetrastemma agricola*, of Willemoes-Suhm.—M. v. Davidoff, on the comparative anatomy of the posterior limbs in fishes, pl. 28-31, to which is appended a note by the editor, Prof. Gegenbaur, on the limb question.—Notice of Schneider's "Comparative Anatomy."

Journal of the Russian Chemical and Physical Society.—The last number of this journal contains a paper by Prof. Butleroff, on the present meaning of the chemical theory.—The conclusion of the researches, by M. Lebavin, on the nucleine of milk.—On derivates of the fumaric and maleic acids, by M. Ossipoff.—On cholécamphoric acid, by M. Latchinoff.—On a new alkali derived from quinine, by MM. Wischnegradsky and Prof. Butleroff.—On the theory of dispersion of light, by M. Cheboueff.

SOCIETIES AND ACADEMIES

London

Mathematical Society, November 13.—Mr. C. W. Merrifield, F.R.S., president, in the chair.—The treasurer's and secretaries' reports were read.—The new council was elected, the only changes in which were the substitution of Messrs. Leudesdorf and Lloyd Tanner, in the place of Dr. Spottiswoode, P.R.S., and Prof. H. J. S. Smith, F.R.S., the retiring Members.—The Chairman briefly, but in feeling terms, alluded to the losses the Society had recently sustained by the deaths of such accomplished mathematicians as Prof. Clifford, Sir J. G. Shaw Lefevre, and Prof. J. Clerk Maxwell.—The following communications were made to the Society:—(1) On the binomial equation $x^p - 1 = 0$, trisection and quartisection, Prof. Cayley, F.R.S.—(2) On cubic determinants and other determinants of higher class, and on determinants of alternate numbers, Mr. R. F. Scott.—(3) On a problem of Fibonacci's, Mr. S. Roberts, F.R.S.—(4) Notes on a class of definite integrals, Mr. T. R. Terry. (1) was principally concerned with the presentation in a simplified form of results given in Reuschle's "Tafeln complexer Primzahlen welche aus Wurzeln der Einheit gebildet sind" (4to, Berlin, 1875), and in Jacobi's "Canon Arithmeticus" (4to, Berlin, 1839). (2) was on a branch of determinants which has received but little attention in this country. Mr. Lloyd Tanner communicated a paper on the subject to the Society at its June meeting in the present year. Amongst Continental papers are memoirs by Armenante, Padova, and Garbieri (in the *Giornale di Matematiche*), Dahlander and A. de Gasparis. (3) was an account and extension of work done in the Diophantine Analysis by Fibonacci, and recently by Genocchi. (4) The integrals considered were

$$\int_0^\pi \frac{\cos^p x\, dx}{(1 - 2a\cos x + x^2)^n} \text{ and } \int_0^\pi \frac{\sin^{2p} x\, dx}{(1 - 2a\cos x + a^2)^{n+p}},$$

where p is a positive integer and n any real quantity, positive or negative, integral or fractional.

Geological Society, November 5.—Henry Clifton Sorby, F.R.S., president, in the chair.—Henry Bruce Armstrong was elected a Fellow of the Society.—The following communications were read:—On the probable temperature of the primordial ocean of our globe, by Robert Mallet, F.R.S. According to the latest hypotheses as to the quantity of water on the globe, its pressure, if evenly distributed, would be equal to a barometric pressure of 204·74 atmospheres. Accordingly water, when first it began to condense on the surface of the globe, would condense at a much higher temperature than the present boiling-point, under ordinary circumstances. The first drops of water formed on the cooling surface of the globe may not impossibly have been at the temperature of molten iron. As the water was precipitated, condensation of the remaining vapour took place at a lower temperature. The primordial atmosphere would be more oblate and less penetrable by solar heat than the present, and the difference of temperature between polar and equatorial regions would be greater; so that, in the later geologic times, ice may have formed in the one, while the other was too hot for animal or vegetable life. Thus, formerly the ocean would be a more powerful disintegrant and solvent of rocks, mineral changes would be more rapid, and meteoric agencies would produce greater effects in a given time.—On the fish-remains found in the cannel coal in the middle coal-measures of the West Riding of Yorkshire, with the description of some new species, by James W. Davis, F.G.S.—On the skull of *Argillornis longipennis*, Owen, by Prof. R. Owen, C.B., F.R.S. In this paper the author described a fragmentary cranium from the London clay of Sheppey, from which it was procured by Mr. W. H. Shrubsole, who also furnished him with the humerus described in a former paper under the name of *Argillornis longipennis*.[1] In the present specimen the lower jaw and the fore-part of the upper jaw are deficient. The author described the characters presented by the specimen in detail, and stated that, like those of the humerus previously described, they seemed to approximate the fossil most nearly to the albatross among existing birds, although, like *Odontopteryx*, it differed from *Diomedea* and also from the cormorant and the totipalmates generally, in the absence of the basirostral external nares and of the supraorbital gland-pits. The present fossil differs from *Odontopteryx* in having the fore-part of the frontal broader and the upper tract of the bill less defined, as also in some other characters; but no comparison of the palatal structure can be made upon the existing specimens. In point of size, taking the albatross as a term of comparison, this skull may well have belonged to a bird with wings of the extent indicated by the humerus already described; and the resemblance of the skull to that of the albatross would also seem to be confirmatory of the specific collocation of the two specimens. The presence of four small pits or perforations on the only part of the alveolar border which appears to be uninjured, leads the author to conjecture that the bird may have been dentigerous.

Physical Society, November 8.—Prof. W. G. Adams in the chair.—The first paper read was on an analogy between the conductivity for heat and the induction balance effect of copper-tin alloys, by W. Chandler Roberts, F.R.S. Mr. Roberts traced a remarkable resemblance between a curve representing the induction balance effect of the copper-tin alloys published by him in June last, and the curve of Calvert and Johnson for the conductivity of heat, and on the other hand he showed that the induction curve does not agree with Matthiessen's curve for the electric conductivity of the same alloys. The author showed that the two alloys which occupy critical points of the curve ($SnCu_3$ and $SnCu_4$) are of much interest. Possibly both are chemical combinations, and the wide difference in the position they occupy probably marks a difference of allotropic state. For the solution of such questions, however, Mr. Roberts considered that we might look with confidence to Prof. Hughes' beautiful instrument, which, he hopes, will also help us to determine whether the relation between conductivity for heat and electricity is really as exact as it has hitherto been supposed to be. As supplementary to this subject Dr. O. J. Lodge stated that he had compared the conductivity of six bars of the tin-copper alloys, as measured by the balance and by the Wheatstone-bridge, and found them to agree very closely. The bridge results confirmed the resemblance traced by Mr. Roberts. Prof. Hughes expressed his opinion that existing tables of conductivity were erroneous. They disagreed among themselves

[1] *Quart. Journ. Geol. Soc.*, vol. xxxiv. p. 124.

and the induction-balance showed that it was difficult to get two pieces of the same metal exactly alike; hence the variation of specific conductivity results.—Prof. Ayrton stated that at a former meeting he had suggested that the electric inertia of the different specimens of metal tested might cause the difference between the results obtained by the Wheatstone Bridge and the induction-balance. Calculation had since led him to the conclusion that the inductive effect is not proportional to the resistance of the metal tested, but to an expression in which the resistance is an exponential. Prof. Hughes replied that as the inductive effect of the metal was destroyed by cutting it so as to interrupt the circuit in it, it was reasonable to suppose that the said effect was due to induced currents circulating in the metal, and therefore was proportional to the conductivity of the metal.—Capt. Armstrong exhibited a standard Daniell cell formed of a porcelain vessel with a porous partition dividing it into two compartments. In one the zinc plate was immersed in a solution of sulphate of zinc, in the other the copper-plate in a solution of sulphate of copper. To use the cell as a standard, it was only necessary to connect the two liquids by a cotton string moistened with water. This arrangement prevented mixing of the liquids, as the string could be withdrawn after use. The resistance was high, but it was a constant standard of electromotive force.—Prof. Guthrie mentioned that Prof. Pirani, of Melbourne, in a letter to him had pointed to the fact that when a dilute acid was being electrolysed, the positive electrode, if made of iron, became incandescent below the surface of the liquid. Prof. Guthrie had found this to be true not only for iron but for other metals, and that it could hardly be due to oxidation, because it took place not only at the cathode or positive electrode, where oxygen was evolved, but also at the anode where hydrogen was evolved. The incandescence appeared to him to be due to resistance. The author exhibited certain experimental results. The positive electrode when immersed in the electrolyte was seen to get red hot and to vibrate rapidly. As the liquid heated the red glow became fainter. The negative electrode, on the other hand, emitted a bright light, accompanied by a noise. The light was tinged with the characteristic colour of the flame of the metal of which it was composed; in the case of a copper electrode, for example, it was greenish. These effects were shown by Prof. Guthrie with iron, copper, and platinum electrodes, in dilute sulphuric and dilute nitric acid. In reply to Prof. Adams, Prof. Guthrie said he had not yet examined the flame by the spectroscope; and in reply to Prof. Foster he stated that the battery power used was fifty Grove's cells. He asked for suggestions as to the cause of the phenomenon.

PARIS

Academy of Sciences, November 10.—M. Daubrée in the chair.—M. de Lesseps stated that a corps for boring operations had been sent out to Panama, and he was going out in a month with a commission of selected engineers of various countries. He applied for a committee to formulate a programme of observations that might be useful to science.—Climatological conditions of the years 1869 to 1879 in Normandy, and their influence on ripening of the crops (first note), by M. Mangon. The observations were made at Saint-Marie-du-Mont (Manche), a few kilometres from the sea. The exceptional character of 1879 in temperature and rainfall is shown by numerical data (the relation to the crops being reserved for another paper).—On a new species of the genus *Anomalurus*, by M. Milne Edwards. The animal was in a collection formed at the Gaboon, by M. Leglaize. It is remarkable for its beauty of colours, and the author calls it *A. erythronotus*. It is like *A. fraseri* in general proportions, but is easily distinguished. The discovery raises to six the number of representatives of *Anomalurus*; all belong to the west of tropical Africa.—On the presence, in surface layers of the ground, of fecundated winter-eggs of phylloxera, by M. Boiteau.—On the results of treatment of phylloxerised vines with sulpho-carbonate of potash, and on the mode of use of this agent, by M. Mouillefert.—The satellites of Mars in 1879, by Mr. Hall.—Determination of the figure of apparent repose of an inextensible cord in motion in space; conditions necessary for its production, by M. Léauté.—On the thermal absorbent and emissive power of flames, and on the temperature of the voltaic arc, by M. Rossetti. For 0·01 m. of any flame traversed by radiation from a flame of the same nature, the coefficients of transparence and of absorption are represented, respectively, by 0·865 and 0·135 m. A thickness of 1 m. renders a flame almost completely athermanous for rays from another like flame. The absolute thermal emissive power of white gas flames (or the intensity of radiation of such flames of indefinite thickness, compared with that of soot at a temperature equal to the mean temperature of the flame), is equal to unity; that of a Bunsen flame 0·3219. A large number of experiments gives about 3900° C. as the maximum temperature of the positive polar carbon extremity, and 3150° for the negative; for the voltaic arc, between these, a temperature of about 4800° (with any intensity of current or thickness of arc).—Researches on the passivity of iron, by M. Varenne. Fuming nitric acid does not act on iron and render it *passive*, so that it is not attacked by dilute nitric acid. The author describes various experiments throwing light on the case. It appears that any agitation in the neighbourhood of the passive metal, whether by a shock or a vibration, or by a current of gas (very weak it may be) as from spongy platinum placed at the bottom of the vessel of dilute acid, in which the passive iron is hung, abolishes the passivity. The gaseous sheath formed on the iron seems to be the obstacle to attack. It is more adherent on a smooth surface, and on a specimen of great molecular condensation than on one rugous and less compact. *In vacuo* the sheath, and with it the passivity, disappear.—On alcoholic fermentation, by M. Cochin. He concludes from experiment that yeast does not produce a soluble alcoholic ferment.—Complementary note on calcination of the *vinasses* (or spent-wash) of beetroot, by M. C. Vincent. A reply to MM. Duvillier and Buisine.—On the organisation and the cellular form in certain kinds of mosses (*Dicranum* and *Dicranella*), by M. Heckel.—On the resistance of sheep of Barbarine race to inoculation with *charbon*, by M. Ollive. He affirms the generality of this character. During the eight years he has lived in Mogador he has never met with any case of the disease.—On the rhythmic excitability of the muscles and their comparison with the heart, by M. Richet. For the heart, as for the muscle of a claw of the cray-fish, contraction (systole) exhausts the muscular element, which then ceases to contract; but it is restored very quickly, and it is during the period of exhaustion (diastole) that the reparation takes place. The cause of rhythm is the same in both heart and muscle—rapid exhaustion and rapid reparation.—Comparison of the action of various curares on the smooth and striated muscles, by M. De Lacerda. They differ in intensity of action on these muscles, not in the nature of the action.—On medullary osseous abscesses, by Dr. Chassargnac.—M. Larrey presented Dr. Bateman's work on Darwinism demonstrated by language, and gave an *aperçu* of it.—M. Chasles presented (from Prince Boncompagni) a photolithographed copy of a long letter from Gauss to Mdlle. Sophie Germain, a student of the École Polytechnique.

CONTENTS