THURSDAY, JULY 8, 1886

THE ETIOLOGY OF SCARLET FEVER

A REPORT has just been issued by the Medical Officer of the Local Government Board, the importance of which, as regards the etiology and prevention of a widespread infectious disease, deserves the most careful attention of sanitary officers and the general public alike. Hitherto the general assumption prevailed that infection with scarlet fever has always had its origin from the human subject, that is to say, that scarlet fever is always transmitted to the human subject from a human being affected with the malady, either by direct contagion in its wider sense, or through milk, cream, &c., previously contaminated with the contagium derived from a human source. In the present Report we have an account of an extensive outbreak of scarlet fever in the north of London at the end of last and the beginning of the present year amongst the consumers of milk derived from a particular farm at Hendon. The first part of the Report of the Medical Officer contains an account by Mr. W. H. Power, Inspector to the Medical Department of the Local Government Board, of an investigation into this outbreak, and the evidence brought forward by Mr. Power is absolute and conclusive: it proves by a chain of circumstantial evidence as complete as can be wished, that this particular outbreak of scarlatina was transmitted by milk which could not have been previously contaminated from a human source.

Moreover, Mr. Power proves that certain milch cows recently added to the dairy and affected with a particular malady were the source from which the contagium had been derived; further, that as this malady once introduced by a few cows into the dairy spread to other milch cows, so the amount of milk containing the contagium, and also the number of cases of scarlatina amongst the consumers, increased, and as the milk-supply was discontinued so the spread of scarlet fever abated.

The malady with which the cows were affected consisted chiefly in a particular kind of ulceration of the teats and udder, and perhaps some slight cutaneous disorder. As regards the general health, the feeding and milking capacity, the cows seemed to present very little alteration.

The second part of the Report contains an account, by Dr. Klein, of the minute pathology and etiology of this cow disease. In the first place, Dr. Klein ascertained that the local disease on the teats and udder is inoculable in its specific characters into healthy calves; secondly, that the cows affected with the local disease of the udder and teats were at the same time affected with a disease of the viscera, as proved by the *post-mortem* examination, in many respects similar to a mild form of scarlet fever in the human subject.

From the ulcers of the cow Dr. Klein isolated by cultivation a streptococcus or chain-micrococcus, possessed of distinct and special characters, both as to morphology and mode of growth in various nutritive media, particularly in milk: in this latter it grows in a peculiar manner, and very luxuriantly. With artificial cultures of this streptococcus a disease was produced in calves by subcutaneous inoculation which bears a striking resemblance to scarlet fever in man. The conclusion is thus forced on us that this streptococcus is identical with the materies morbi; further, that the scarlatina produced in the human subject by the consumption of milk from the Hendon farm was an experiment, carried out on a large scale, of infection with a cultivation in milk of the above streptococcus; and lastly, that the milk of the cows affected with the specific ulcers of the teats and udders became charged with the contagium by the hands of the milker during the act of milking. Although there are many details still wanting to complete the research, particularly those regarding the transmissibility of scarlatina from the human subject to the cow, there is sufficient evidence at hand already to warrant the hope that by a proper and effectual mode of superintending milk-farms it will be possible to considerably limit this dire scourge. A suggestion that at once presents itself is this: granted that the above-mentioned streptococcus is the real cause of the malady, there is no reason to doubt that boiling the milk would effectually destroy its life and infective power, just as is the case with all micrococci. True, the danger to contract scarlatina would hereby not be altogether annihilated, since cream cannot thus be disinfected, and since scarlet fever can unquestionably be contracted from a human source, but it must be obvious from this conclusive Report that milk *per se* coming from an infected cow plays a considerable *rôle* in conveying scarlatina from the cow to the human subject.

OILS AND VARNISHES

Oils, Resins, and Varnishes. Edited by James Cameron, F.I.C. (London: J. and A. Churchill, 1886)

THIS work, according to the preface, is intended to be "a hand-book useful to all interested in oils and varnishes, and especially to analysts, pharmacists, manufacturers, and technological students." The editor further states that in preparing this volume he used the information in Cooley's "Cyclopædia," which he has "supplemented from the latest publications." The modern literature of oils and varnishes exists chiefly in the form of workshop recipes, in trade journals, technological dictionaries and pharmaceutical publications, and if anybody ever wanted to know anything about the useful and heterogeneous products comprised under these terms he not unfrequently found it necessary to waste a good deal of time in hunting up the required information. This last addition to Messrs. Churchill's Technological Hand-books will therefore be valuable to those engaged in several distinct branches of industry, and the editor has certainly displayed considerable judgment in the selection and arrangement of the scattered materials which he has brought together in this little volume of some 370 pages in length.

Chemically speaking the word "oil" has no precise meaning. It seems in fact that an oil may be anything that is not water, since we have oils among such distinct families of organic compounds as the alcohols, acids, aldehydes, hydrocarbons, &c. Thus in Chapter I., on the "Chemistry of Oils," these compounds are in the first place classed under the usual heads of "fixed" and "volatile." Animal and vegetable fixed oils being generally ethereal salts of glycerol and acids of the fatty and oleic series, we have in this chapter brief descriptions of glycerol (nitroglycerol and dynamite), the fatty acids from butyric upwards, and the acrylic series from oleic acid upwards. The descriptions of the acids are concisely given, and their occurrence, preparation, and physical properties briefly described. Of the chemistry of the higher homologues of the acids of these series but little is known, and the name of the acid which heads each paragraph is simply followed by its empirical formula. This treatment is all that is necessary in such a work as the present, but it will certainly occur to the more advanced chemical readers that a very wide field of investigation is offered to those who interest themselves with the question of isomerism among these complicated compounds. Considering the cheapness and abundance of the commoner animal and vegetable oils in daily use it does appear somewhat remarkable that more work has not been bestowed upon them by scientific chemists, and that the information which we have concerning them should be almost confined to their commercial testing and valuation.

Animal oils, fixed and volatile, are described in the second chapter, the former being divided into animal oils proper (butter-fat, lard, neat's foot, tallow, &c.), fish oils (cod-liver, seal, sperm, whale, &c.), and insect oils (niin, ant-grease, &c.). Among the volatile oils of this class we have bone-oil, castoreum, and civet oils (animal), and ambergris (fish). The third and fourth chapters are devoted to vegetable oils, a list of 19 drying and 23 non-drying oils being given. Linseed and olive oils, the most important members of this group, naturally claim the largest amount of space, and the technology of these products is well treated of. The volatile vegetable oils are very fully dealt with, no less than 56 pages being devoted to their consideration. After a description of the various methods of extraction by distillation, solvents, &c., the oils themselves are described individually according to their vegetable sources, the botanical names of the class and order being followed by a descriptive list of the oils obtained from each group of plants. Thus under *Aurantiaceæ* we have the oils of bergamot, cedrat, citron, lemons, limes, neroli, and orange; under *Caryophyllaceæ*, cajeput and clove oils, and so forth.

In the fifth chapter, empyreumatic, medicated, mixed, and perfumery oils are treated of. We give a specimen of the editor's conscientiousness in his description of medicated oils:—"EARTHWORM OIL. *Syn. Oleum lumbricorum* (E. Ph. 1744). Washed earthworms, ½ lb.; olive oil 1½ pint; white wine, ½ pint. Boil gently till the wine is consumed, and press and strain." We are not informed what special merit is possessed by this gruesome concoction, but it was no doubt applied in good faith in the last century. Under "mixed oils" will be found a collection of strange mixtures, some of which might have formed ingredients in that "charm of powerful trouble" brewed by the witches in Macbeth. The familiar "nine oils" of the past generation of housewives, and even furniture oil, find place herein, together with some three dozen others. Chapter VI. contains an account of waxes, which are classed as animal, vegetable, and artificial, a useful method of distinguishing these substances by their behaviour with chloroform concluding the section.

The seventh chapter, a somewhat lengthy one, is devoted to mineral oils, viz. those obtained by the distillation of shales, coal, lignite, and peat, and those found naturally formed in various parts of the world. The treatment of coal-tar and the petroleum industries are well described, and the chapter concludes with sections on the storage of petroleum and the construction of petroleum lamps. Oil refining is treated of in the eighth chapter, which is a short one—almost too short considering the large number of processes which are now or have been formerly in use. The methods for refining tallow, wax, petroleum, and resin oil are included in this chapter, besides the purification and bleaching of animal and vegetable oils proper.

The longest chapter in the book is the ninth, which extends to 109 pages, and is devoted to the important subject of the testing of oils. This chapter is certainly a good one, both for thoroughness and the arrangement of its contents. Thus the testing of an oil may have for its object, the determination of purity, the lubricating efficiency, or the illuminating value. The purity may be ascertained by chemical or physical tests, both of which methods are very fully and lucidly treated of for each class of oils. Among physical tests are described the various methods of determining the specific gravity and melting point, cohesion figures, &c. The descriptions of the latter, which are quoted from a paper by Miss Crane, would have been of more value if figures had been given. The chemical tests, qualitative and quantitative, are given with great completeness. A figure of Abel's petroleum tester and the method of using it as prescribed by the Act of Parliament finds place in this section. For testing the lubricating value the machines of Stapfer, Thurston, and Bailey are described and figured; for viscosity the apparatus devised by Lamansky, and by Townson and Mercer; and for fluidity the apparatus of Bailey is also described and figured. The section on illuminating efficiency is not so full, and might be advantageously expanded in a future edition.

Chapter X. is devoted to resins and varnishes, and the last chapter contains descriptions of Mills' bromine absorption process and Hirscholm's method of testing resins. The appendix contains some useful tables of prices, of the amount and value of the export of seed oils during 1882, 1883, and 1884, and of the production of shale oil in the United Kingdom during the last five years.

From the foregoing epitome of the contents it will be seen that the volume, although a small one, gives a most comprehensive view of the subject of which it treats, and the amount of useful information which has been condensed into this small compass is mainly due to the concise mode of treatment which the editor has adopted. We can certainly recommend it to those for whom it is written.

R. MELDOLA

HARTLAUB ON THE MANATEES

Beiträge zur Kenntniss der Manatus-Arten. Von Dr. Clemens Hartlaub (Bremen). Separatabdruck a.d. *Zoologischen Jahrbüchern*, Band I. (1886.)

AMONGST other interesting articles with which Dr. Spengel's new zoological journal has commenced its career is one by Dr. Clemens Hartlaub (son of the veteran ornithologist of the same name) which deserves special attention, as devoted to a somewhat neglected and imperfectly known group of the class of mammals—the Manatees or "sea-cows," as they are popularly called. The Manatees constitute, as is well known, one of the three modern representatives of the formerly more extensive order of Sirenians, or "Herbivorous Cetaceans," as they are sometimes, though not very correctly, denominated; for it is doubtful whether they have any near relationship to the true Whales. One of these three forms—the *Rhytina stelleri*—is already extinct; the other two—the Manatee and Dugong—are rapidly diminishing in numbers before the advancing tide of civilisation, and it is highly desirable that full details of their structure and habits should be obtained and recorded before they are "improved" off the face of the earth.

Dr. Hartlaub, having examined the skulls and other specimens of Manatees preserved in the various museums of the Continent, presents us with a *résumé* of his investigations in two well-ordered and well-illustrated essays. In the first of these he describes the skull of the African Manatee (*Manatus senegalensis*), and compares it bone by bone with that of the American *M. latirostris*, fully establishing the specific difference of the two forms, which has been doubted even by some of our most recent and best authorities.[1] In the second memoir he describes for the first time the skull of the South American *Manatus inunguis*, a species absolutely ignored by the great majority of naturalists, and shows its distinctness from *M. latirostris*.

It is hardly necessary even to recapitulate the points of difference between these three forms of Manatees, which Dr. Hartlaub has given at full length in these memoirs, and which seem to be sufficiently obvious on reference to his well-drawn figures. But a few words may be added on the geographical distribution of the three living Manatees, so far as this is at present known to us.

The African Manatee inhabits the west coast of that continent from the Senegal down to the Quanza, and penetrates up the larger rivers far into the interior. In the Senegal it has been recorded by Adanson, in the rivers of Liberia by Büttikofer, in the Niger and Benué by Barth and Vogel, in Gaboon by Du Chaillu, in the Lower Congo by Johnston and Pechnel-Loesche, and in the Quanza by Monteiro. Whether the "*Charuf el bachr*," or water-sheep, ascertained to exist in the Uelle by Schweinfurth, which is probably the same as the supposed Manatee found in the Shari and Lake Tchad by Barth and other travellers, should be referred to *Manatus senegalensis*, or is even a Manatee at all, remains an interesting subject for future inquiry. But it seems tolerably certain that some sort of Sirenian inhabits the inland basin of Lake Tchad, and the probability is that it will turn out to be a *Manatus*.

In America the exact boundaries of the two species, *Manatus latirostris* and *M. inunguis*, cannot yet certainly be stated, owing to the confusion that has hitherto existed between these two forms. But it is certain that the Manatee occurs on the Atlantic coast of America from 25° N.L. to 19° S.L., and that those of the Antilles, the Gulf of Mexico, and Surinam, are referable to *M. latirostris*. On the other hand, *M. inunguis* is only certainly known from the Amazons and its tributaries, where it was first discovered by Natterer. Dr. Hartlaub is inclined to believe that the Manatee of the coast and rivers of South-East Brazil must be likewise *M. inunguis*, but this does not seem to be probable. It is more likely, we think, to turn out that one species is found all along the Atlantic sea-board, penetrating only slightly up the rivers, while the other is confined to the interior, and is a purely fresh-water species.

[1] Cf. Flower, "Catalogue of Vertebrates" in the Museum of the Royal College of Surgeons, part 2, p. 528, 1884.

OUR BOOK SHELF

Infant-School Management. By Sarah J. Hale. (London: Stanford, 1886.)

THIS is one of the best books on infant-school management that we have seen; the authoress knows exactly the kind of information infants can most readily assimilate, and how best to impart it; while on the other hand she is fully aware how dangerous and worse than useless the forcing process is.

The second part of the book consists of sketches of lessons in natural history, natural phenomena, food-plants, and common objects; and if science is to be taught in all our infant schools in the manner our authoress suggests, we may look forward to a largely increased taste for science in the rising generation.

Here is an extract from the introduction to the second part showing the method of teaching which she recommends:—

"In every case the teacher must bring plenty of illustration to bear upon the lesson. In natural history *the real animal* or a good picture, and if possible, some thing or things that it furnishes us with, as, for instance, the fur of the otter, the shell of the tortoise, the quills of the porcupine. Also the teacher should carefully provide herself with pictures of animals which afford strong contrasts to the one with which she is dealing, as well as those which bear some general resemblance to it, that she may exercise the *discriminative* as well as the *assimilative* faculty of her pupils. In all object lessons, various specimens of the object should be produced for examination and description; the little ones themselves must do the main part of the latter under the teacher's guidance, for these lessons are not only to enable the children to form new ideas, but they are also intended to train them in giving expression to such ideas. The teacher must make good use of the black-board, and should practise drawing objects, so that she may illustrate with facility and precision any particular point of her lesson which can be so illustrated. All the materials, pictures, diagrams, &c., which the teacher provides from time to time, should have their place in the school museum ready for future needs, and the children should be encouraged to bring contributions to such a museum, particularly such as the lessons they receive may suggest. Object-lesson cards, pictures, and all illustrations should be carefully used, and when not in use, have their proper places on wall or shelf. The teacher should arrange all specimens in the museum, and have each addition neatly labelled and catalogued."

A Year in Brazil. By Hastings Charles Dent, C.E., F.L.S., F.R.G.S. With 10 Full-page Illustrations and 2 Maps. (London: Kegan Paul, Trench, and Co., 1886.)

THIS is a very interesting account of a year's sojourn in an interesting country, and although the author went out for a special purpose, to survey for a railway, every moment of his spare time was taken up in making collections and taking notes in most of the branches of natural history. The scientific interest of the book is mainly confined to the notes on animals, birds, reptiles, insects, and the parasitic torments of Brazil, notes on botany and on geology, together with a discussion of the theory of evolution and observations made on protective colouring and mimicry.

With reference to the theory of evolution the author states that he has constantly endeavoured to oppose it, on the ground apparently put forward by theologians many years ago before they knew what the theory really was; and we think that if our author will continue his scientific studies a little longer he will probably find that the arguments he uses against it are really not in point.

The Colloquial Faculty for Languages. By Walter Hayle Walshe, M.D. Second Edition. (London: Churchill, 1886.)

THIS is a book full of pleasant gossip round the central idea embodied in its title; hence we have essays on the nature of genius, the conditions regulating colloquial faculty, and the causes of variety of colloquial faculty and faculty for translation.

In the chapter on composition in foreign tongues it is pointed out that the man of science proves now and then well capable of wrestling effectively with the humorist on his own ground of the *literæ humaniores*, and gives as an example Herbert Spencer's *exposé* of abounding errors in a passage from Addison quoted by Matthew Arnold, as an example of classical English.

We gather from our author that the English race is not the most gifted with the colloquial faculty, and a remark of Prince Bismarck's is quoted that he had always found that an Englishman who could speak good French was a doubtful character.

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 insure the appearance even of communications containing interesting and novel facts.*]

Periodicity of Glacial Epochs

PERMIT me to ask, as a matter of international comity in science, the help of my learned British colleagues in the following matter.

I am just now occupied upon a work treating upon the periodicity of glacial epochs, a question which has already been broached by me in previous writings several years ago. The cause of this phenomenon being attributed by the astronomers, as well as by the majority of geologists, to the displacement of the perihelion, whose cycle is 21,000 years, it follows that, according to the actual position of this point, the ice now covering the Antarctic regions had its maximum of intensity at about the year 1250 of our era. For the same reason, the ice of the boreal hemisphere must have offered at this same epoch its minimum of intensity. Consequently the latter must have been increasing since the close of the thirteenth century, while the former must have been receding. The researches of European geologists must have shown a marked extension of the glaciers of Spitzbergen, Greenland, &c., since the beginning of the fourteenth century, and a recession of vegetation from the latitude of Sicily to the Polar Circle. But we in France are not informed of what has happened in the southern hemisphere since the arrival of the first navigators. I would therefore, in the name of science, beg of any British officers, consuls, or scientific observers who are, or may have been, collecting facts at stations near the South Pole, in Patagonia, New Zealand, Tasmania, and elsewhere, to communicate to me directly, or through your columns, any information they may have upon this subject. I wish to know whether, since the first arrival of Europeans in those regions, the ice-field has shown a recessive movement, accompanied by an inverse tendency of vegetation.

Tarascon, Ariège, June 27 ADOLPHE D'ASSIER

Evidence of Man and Pleistocene Animals in North Wales prior to Glacial Deposits

SOME of the results recently obtained during the researches carried on at the Tremeirchion caves under the superintendence of Mr. E. Bouverie Luxmoore and myself, seem to me of so much importance that I have thought it advisable to communicate them, in anticipation of the full report which will be presented to the British Association, especially as an important section is now exposed, and may be examined by any one desiring to do so, which will probably have to be covered before the end of the summer.[1]

In continuing our explorations this year, by means of a grant from the British Association, we found that the Cae Gwyn Cave (described in my paper in the *Quart. Journ. Geolog. Soc.* for February last) had come to an abrupt termination in a plateau of Glacial deposits. On further examination it was found that this must have been the main entrance into the cavern when it was occupied by the Pleistocene animals, and that the Glacial beds in and upon it must have been deposited subsequent to the occupation by the animals. As in the other parts of the cavern, the cave-earth at the entrance—a brown sandy clay, contained fragments of a stalagmite floor and of stalactites along with angular fragments of limestone. The bones also occurred at all angles, showing that the contents had been greatly disturbed by water action. The bone earth was covered over at the entrance and for some distance inwards by a few feet of stratified sand, containing well-scratched boulders, and it, as well as the sand, was traced for a distance of fully 6 feet beyond the entrance under the series of Glacial deposits, shown in the section.

In digging outside the entrance, the floor of which is 20 feet below the surface of the field, it was soon found that we could not extend our researches outwards, owing to the nature of the lower deposits, chiefly sands and gravels, without making an opening into the field. By the kindness of the owner, Mr. Edwin Morgan, a shaft was allowed to be dug in front of the opening, about 9 feet across at the surface and over 5 feet at the bottom. This shaft was subsequently widened at the bottom, in consequence of some falls, and the lower part, except at one point, had to be carefully faced with timber. The upper part of the shaft is now much widened and sloped. To make it certain that the Glacial deposits are continuous from the shaft in a westerly direction, I had the beds probed at different points for a distance of about 70 feet; and subsequent examination showed clearly that there is here an extensive terrace of drift reaching to heights of between 400 and 500 feet above Ordnance datum. The section was carefully taken at two different points in the shaft by Mr. C. E. de Rance, F.G.S., of the Geological Survey, and myself, and in doing so we found well-scratched boulders in each of the deposits. Among the boulders found are granites, quartzites, flint, felstones, diorites, volcanic ash, Silurian rocks, and limestone. Silurian rocks are most abundant. It is clear that we have here some rocks from northern sources along with those from the Welsh hills, and the manner in which the limestone at the entrance to the cavern is smoothed from the north would indicate that to be the main direction of the flow. A small but well-worked flint flake was dug up from the bone earth on the south side of the entrance on June 28, in the presence of Mr. G. H. Morton, F.G.S., of Liverpool, and myself. Its position was about 18 inches below the lowest bed of sand. Several teeth of hyæna and reindeer, as well as fragments of bone, were found at the same place, and at other points in the shaft teeth of rhinoceros and a fragment of a mammoth's tooth. One rhinoceros tooth was found at the extreme point examined, about 6 feet beyond and directly in front of the entrance. It seems clear that the contents of the cavern must have been washed out by marine action during the great submergence in mid-Glacial time, and that they were afterwards covered by marine sands and by an upper boulder-clay, identical in character with that found at many points in the Vale of Clwyd, and in other places on the North Wales coast.

The facts obtained seem to me to prove conclusively that man and the Pleistocene animals must have lived in parts of the North Wales area, and have occupied some of the caverns, before the period of the great submergence indicated by the Moel Tryfaen and other high-level sands; hence certainly before the Upper Boulder-Clay was deposited. HENRY HICKS

[1] Tremeirchion is about four miles from St. Asaph, and less than two miles from Bodfari Station on the Chester Mold, and Denbigh line.

Ampère's Rule

BEGINNERS are certainly, as Herr Daehne says (NATURE, June 24, p. 168), liable to get a little "mixed" in reference to the above *mem. technica*; chiefly, I think, for want of some idea sufficiently prominent to fix itself on the mind to the exclusion of others.

I have found the following slight modification of the original rule pretty easily remembered and applied.

It may be taken as agreed—

(1) That the *head* is more important ("more worthy," as the old grammars put it) than the *feet*.

No one except an acephalous mollusk will deny this; and *it* is not a fair judge.

(2) That the *right* hand is more important than the left hand.

The left-handed people are a mere minority (and a nuisance at cricket); and minorities are, according to modern Radical ideas, "une quantité négligeable."

3. That the N-seeking pole is that part of the compass-needle to which attention is mainly directed.

Now,—If a person places himself so as to face the needle, and a current goes from HEAD to foot, the N-SEEKING pole moves to his RIGHT hand.

This is practically the form in which the rule is given in Prof. Balfour Stewart's "Lessons in Physics." One of the small articulated wooden figures used as models in drawing is very useful for illustrating the above rule. Its right arm may be stretched out sideways at right angles to the body, and it may then be held close to the wire in various positions; paper arrows being tied to the latter, to mark direction of current.

Eton College H. G. MADAN

Halos

As the atmosphere appears recently to have reassumed in a marked degree some of the peculiar conditions which pertained to it during the time of the great sun-glows, I have thought it worth while to send you notes from my diary of some effects observed by me:—

June 14.—Between 10 and 11 a.m. Complete solar halo of a coppery colour. It lasted more or less distinctly for some time, and gradually faded. I saw no trace of mock suns.

June 23.—Between 10 and 10.30 p.m. there was a curious pearly green light in the north-north-east, and some peculiar pearly green clouds (?) floated from north to west. At first I thought this was an auroral display, but probably it was due to the same cause as the "glows."

June 15, 23, 30, July 1, 2, and 3.—After-glows of the usual pinkish hue. J. H. A. JENNER

4, East Street, Lewes, July 3

The Microscope as a Refractometer

I HAD no idea that the short paper you did me the honour to print on this subject would have led any one to suppose that a claim was made for the discovery of a new principle in physics, or that the microscope was to be used for the first time in questions on refraction.

In so short a space it was impossible to tell over again the tale of progress in this branch of physical optics, and to signalise every worker in the field by name. So much has already been done in the perfecting of optical instruments, that the utmost one can now hope to do is, by a slight improvement here and there, to render them still more serviceable.

All that was claimed as new in my paper of June 17 was—

(α) The use of the marked slip, structure of cell, superposed cover-glass.

(β) The measurement of the linear distances between the images by a finely graduated "fine adjustment" screw.

(γ) The use of an objective of high amplifying power (a 1/20-inch homogeneous immersion may be used if the shoulder-pieces of the cell are made with talc, and the cover-glass very thin).

It is of course possible that one or all of these details is not new; but, in spite of the authorities quoted by Dr. Gladstone to show the previous employment of the microscope in questions of refraction, I still maintain their claims to novelty to be valid; and, even supposing they are not new (which has yet to be shown), my greatest offence is that of independently arriving at a previously known method. And, considering the attention that our most eminent physicists have bestowed upon the subject, the wonder is that this has not more frequently been the case.

As to the efficiency of the method, the only objections urged against it by Dr. Gladstone are: (1) its results cannot be relied upon beyond the third decimal figure; (2) the temperature of the drop of fluid under examination cannot be taken.

As to the first objection, if we take μ_1, μ_2 as the tabulated indexes of refraction of two known substances, δ as representing the difference of distance between the images of the marks viewed through them, and measured by the fine adjustment, μ and d the corresponding symbols for the fluid under examination, we have the following equation to determine μ:—

$$\frac{\mu_2 - \mu_1}{\mu - \mu_1} \times \frac{\mu}{\mu_2} = \frac{\delta}{d}.$$

And I see no more reason to limit the exactness of this to the third decimal figure than in the formula used with the hollow prism. Moreover, if a vernier is attached to the fine adjustment the result may be relied upon with still greater accuracy.

(2) As to the temperature. In the case of most fluids this may be taken from the bottle containing the fluid; no grave scientific error will arise from the difference in temperature of a drop of fluid in contact with glass on the stage of the microscope and the same fluid in a glass bottle by its side. In the case of ethers, &c., the cell may be temporarily sealed.

As to the practical use of the method, the opinion of so known an expert as Dr. Gladstone is of the greatest weight, but as any recognition of the novelty of my method escaped acknowledgment in his notice, I may still hope that its practical use escaped observation also. So thin a stratum of fluid is employed that the index of refraction of black ink may be obtained, a result which would puzzle any one to arrive at who restricted himself to the use of the hollow prism.

That the microscope has been previously used for experiments in refraction no one ever doubted; if Dr. Gladstone, before writing, had had the time to go step by step through my method, he could scarcely have refrained from acknowledging that in its essentials it was hitherto unpublished.

GORDON THOMPSON

St. Charles's College, Notting Hill, July 3

The Bagshot Beds

As you have given publication (NATURE, July 1, p. 210) to the abstract of the paper recently read by Messrs. Monckton and Herries before the Geological Society, in which they assert that their object was to "disprove" the view lately propounded by me, as to the relation of the Bagshot Beds of the London Basin to the London Clay, perhaps you will kindly afford me space to point out to the readers of NATURE (1) that these authors have ignored, in dealing with the question, whole chapters of the evidence upon which my view is based—evidence which is continually accumulating, as two forthcoming papers (one in the press for the *Proc.* Geol. Assoc., the other in the hands of the editor of the *Geol. Mag.*) will make manifest enough; (2) that in directing their attention merely to sections at the outcrop of the beds they have added little, if anything, substantially, to that on which the old view was based, while the lithological distinctions of the Upper and Lower Bagshot Beds (where the latter have been for ages undergoing oxidation) are not sufficiently marked to furnish, in disconnected sections, evidence which can be anything more than, to say the least, equivocal. A. IRVING

Wellington College, Berks, July 3

The Enemies of the Frog

IN connection with this subject the following incident may be of interest to some of your readers. One day, near the kitchen area, an unusual noise was heard: it seemed like the mewing of a cat combined with a well-sustained whistle. On going to the spot, it was found that the noise proceeded from a cat and a frog, but it was difficult to decide from *which* of the two. Every time the cat touched the frog the sound was produced and the frog hopped away. The cat exhibited in his attitudes and motions a sort of enjoyment mingled with awe. He would just touch the frog very gently with the tips of his paws, then watch it most attentively, and when the frog would emit its peculiar loud squeak—not the usual croak—he would give a sudden bound, as if both surprised and amused; but he never attempted during the whole of the proceedings, which lasted about a quarter of an hour, to bite the frog. The frog was removed quite uninjured, but apparently exhausted either by fear or by muscular exertion. T. MARTYR

St. Joseph's College, Clapham, S.W.

Hybrids between the Black Grouse and the Pheasant

IN Yarrell's "British Birds," 4th ed. vol. iii. p. 69 *seq.*, a number of hybrids between the cock pheasant and the gray hen are enumerated as having occurred in England. Being desirous to give a life-sized and coloured figure of such a hybrid in my forthcoming work on the black grouse, the capercailzie, and their allies, I wish to borrow a specimen for a short time, and, as my endeavours to procure one have so far been unsuccessful, I beg to make this known through your widely read journal, hoping that some fortunate possessor may be kind enough to communicate with me concerning his willingness to lend me a specimen for the said purpose. A. B. MEYER

Royal Zoological Museum, Dresden, July 5

THE FINSBURY TECHNICAL COLLEGE CONVERSAZIONE

THE annual *conversazione* given by the students of the above College as the closing event of the session came off on Friday evening, July 2, and proved in every way a success. The large number of interesting objects brought together for exhibition certainly speaks well for the activity of the various committees which were intrusted with the work of organisation, and at the same time indicates how widely spread is the interest shown in the welfare of the College by the different firms of manufacturers who contributed to the exhibition. The electrical department exhibited in action most of the apparatus used for educational purposes in the College. In this department also were exhibits of apparatus and models by Messrs. Woodhouse and Rawson, the Electric Apparatus Company, Messrs. Mayfield's vacuum-tubes, and other electrical and physical apparatus made by this firm. The exhibits in the chemical department were especially numerous and representative of chemical technology in most of its branches. In the way of apparatus Messrs. Cetti, of Brooke Street, exhibited barometers, thermometers, vacuum-tubes, &c.; Messrs. Townson and Mercer showed a new carbonic acid generator, Schutzenberger's gas apparatus, filter pumps, nickel crucibles and basins, Pasteur flasks, inland revenue stills, Abel's petroleum testing apparatus, &c.; and Mr. B. Redwood lent a set of viscometers. Fine chemicals were exhibited by Messrs. Hopkin and Williams, and a splendid set of alkaloids and other products by Messrs. Howard of Stratford. Messrs. Pontifex and Wood exhibited sets of pigments and the materials used in their manufacture, Mr. C. Richardson a set of specimens illustrating the manufacture of cements, Mr. Ashley samples of English and foreign lubricating oils, and Messrs. J. and L. Cripps the materials and finished products representing the manufacture of size, glue, and gelatine. Glass manufacture was represented by a set of tools and specimens from the Whitefriars glass-works (Messrs. Powell). Messrs. Field showed a fine series of waxes and other materials used in candle-making, and a good exhibition was made also by Price's Patent Candle Company. The manufacture of soap was illustrated by a very complete set of specimens contributed from Messrs. E. Rider Cook's works at Bow and by Messrs. Knight, &c. Cotton seed and its products were shown by Messrs. W. and W. H. Stead of Blackwall and Liverpool. The specimens and diagrams sent by Gaskell, Deacon, and Co., of Widnes, gave an excellent idea of the alkali manufacture in this country.

The collection of coal-tar products was especially rich, specimens having been sent by the Badische Company, the Hoechst Colour Works, Messrs. Brooke, Simpson, and Spiller, the British Alizarine Company, and Messrs. Burt, Boulton, and Haywood. The latter firm exhibited a splendid model of their timber creosoting plant. Amongst other tar products was a set of preparations of the new sweetening substance, saccharine, sent by Dr. Fahlberg. The Broadburn Oil Company showed a very complete set of shale products. The sugar industry was represented by a set of polarimeters, models and specimens, exhibited by Mr. Newlands of the Clyde Wharf Sugar Refinery, and by the Beetroot Sugar Association. In the course of the evening Prof. S. P. Thompson gave a lecture on waves of light, and Mr. John Castell-Evans discoursed on explosives. The entertainment was on the whole highly creditable to the College, and many of the firms who sent objects for exhibition have signified their approval by presenting their exhibits to the establishment as lecture specimens.

THE RECENT DISCOVERIES AT TIRYNS [1]

THE excavations made during the last two years at Tiryns, by Dr. Schliemann and Dr. Dörpfeld, have thrown new light on what has been hitherto an almost unknown period of Greek history—that far-off time, more remote even than the age of the Homeric poems, when Hellenic civilisation had not yet emerged from its Oriental cradle, nor developed its highly cultured systems of social and political government out of the splendid but semi-barbarous tyrannies of Western Asia Minor.

The literature of Greece has made us familiar with the later times, when the individual was for the most part merged in the State, and when the wealth and artistic skill of each city was devoted to public uses, such as the Council-chamber, the Agora, or the stately temples of the gods, rather than to the luxury of any one person.

But at Tiryns a very different picture is presented to us: we see a single autocratic chieftain, ruling in a sort of feudal state, and occupying a magnificent palace, surrounded by the humbler dwellings of his circle of retainers; while, instead of the utmost resources of the architect, the sculptor, and the painter being lavished on the shrine of the presiding deity, a mere open-air altar is dedicated to the god, and it is the chieftain's house which is decked out with the splendours of gilt bronze, marble sculpture, and painted walls.

The rock in the marshy plains of Argolis, on which stands the citadel of Tiryns, is about three miles distant from the Gulf of Nauplia, and commands an extensive view reaching from Argos, with its rich olive-groves, to Mycenæ on its lofty crags, and, between the two, the once prosperous sea-port of Nauplia, by the blue waters of its sheltered bay.

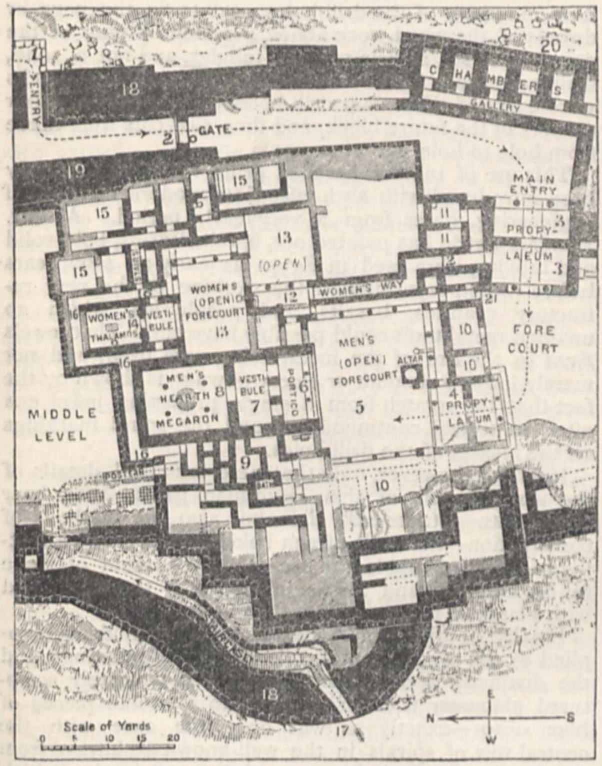
The massive fortification wall which surrounds the Tirynthian Rock was an object of wonder and admiration in the earliest historic times of Greece: its enormous stones keenly aroused the Greek imagination, and created legends which attributed them to mysterious Cyclopean builders, and peopled the walls with the demi-gods of the heroic age, such as Perseus and Heracles, whose early youth was fabled to have been spent in the Tirynthian city—the *Τίρυνς τειχιόεσσα* of Homer's "Iliad." This wonderful wall, some stones of which are no less than 11 feet long and 4 feet thick, was originally nearly 50 feet high at its loftiest part, measuring from its base outside: inside the city the height was very much less, as its lower part acted as a retaining wall, which kept up the loose earth which formed a level interior surface above the irregular contour of the rock.

The southern part of the Acropolis wall, where it incloses the great palace, is a very complicated structure,

[1] "The Prehistoric Palace of the Kings of Tiryns." The results of the latest excavations, by Dr. Henry Schliemann. The preface by Prof. F. Adler, and contributions by Dr. Wm. Dörpfeld. With 188 woodcuts, 24 plates in chromolithography, 1 map, and 4 Plans. (London: John Murray, 1886).

containing long rows of small vaulted chambers averaging about 14 feet by 12, all opening into a long vaulted passage, the whole formed in the thickness of the wall itself, which at some places consists of nearly 40 feet of masonry. Two stories of these chambers existed, one above the other: the lower story is of solid stone masonry, built of large hammer-dressed blocks, bedded in clay cement. The upper tier of chambers was built of sun-baked bricks, like the upper part of the wall round Athens, carefully protected from the weather by coatings of very hard durable stucco. This top story of rooms opened into a long open *loggia* or colonnade, with a flat roof supported by a range of wooden columns, each on a stone footing block.

The columns themselves are of course no longer in existence, but their size and positions are clearly shown



PLAN OF THE PALACE MEASURED BY DR. DÖRPFELD.

1, Main gate in outer wall; 2, inner gate; 3, main propylæum; 4, inner propylæum; 5, court of the men with surrounding cloister, 6, aithousa, or portico; 7, prodomos, or vestibule; 8, men's hall; 9, bath room and small chambers; 10, chambers round the court; 11, guard-room by the propylæum; 12, passage from propylæum to the women's part; 13, 13, courts of the women; 14, women's hall; 15, chambers of the women's part; 16, 16, passage from the women's part to the outer postern; 17, postern door, approached by rock-cut steps; 18, outer wall of Acropolis; 19, inner wall of entrance passage; 20, outer wall with rows of chambers; 21, side entrance to men's court.

by the stone base on which each stood. These extensive series of chambers in the wall of Tiryns served, no doubt, to accommodate the garrison of the place—exactly as was the case in the Phœnician cities of Thapsus and Carthage. The enormous number of 24,000 men are said to have had lodging in the walls of the Carthaginian Acropolis (Appianus of Alexandria, "Hist. Rom.," i. p. 220), and recent discoveries have shown that this statement may very possibly have been no exaggeration.

More than a third of the whole Acropolis of Tiryns was occupied by the palace of its ruler—a very complicated building designed with much architectural skill, and showing complete uniformity of design combined with very distinct adaptation to a clearly defined purpose.

With the exception of three very narrow posterns, there is only one entrance into the citadel; and this is very skilfully contrived so as to make its defence as easy as possible.

After breaking through the outer gate, which was commanded by a tower on the right or unshielded side of the enemy, the assailants would have found themselves in a narrow passage with massive walls on both sides, and strong inner gates at each end; and in this cramped space would be subjected to a heavy fire of missiles poured down upon them from all sides.

After passing the inner gate in a southern direction, a handsome propylæum or porch was reached: this was decorated on both sides by a portico of two columns *in antis*, and is very similar in plan to the propylæum of the sacred inclosure at Eleusis—a work of the fifth century B.C. (See the accompanying woodcut of the plan.)

After passing through an open court, a second propylæum of similar design was reached, and then the visitor found himself in the cloistered court of the men's part of the palace. In the central open space stands the altar to Zeus Herkeios, which is frequently named in the Homeric poems, built over a small pit cut in the rock, into which would fall the blood and ashes from the burnt offering on the altar above. Opposite the entrance to the court is the great hall or Megaron (about 40 feet by 32), approached through an open-columned portico and an inner vestibule. The roof of the hall was partly supported on four wooden columns, which appear to have carried an open "lantern," formed to carry off the smoke from the fire, which burnt on a round hearth in the middle of the room; very much as was the case in the hall of a mediæval house or college.

On the west side of the hall of the men are a number of small chambers—probably the sleeping-apartments of the bachelor members of the family. One small room, about 12 feet by 10, is of extraordinary interest. It is evidently a bath-room; its floor is formed of one enormous slab of stone, carefully chiselled so as to drain out at one point where a stone drain-pipe is carried through the wall, and so into the main drain of the house.

The bath itself, in size and form very like a modern one, was of terra-cotta decorated with a spiral ornament in red.

The walls of the bath-room were lined with wooden planks about 10 inches wide; their lower ends were fastened by wooden dowels to the stone flooring block, the edge of which all round the room is raised slightly where the wood wall-lining rested on it: evidently in order that water splashed on the stone floor might not soak under the wood lining; a piece of refinement which shows much thought and labour spent on matters of detail.

The eastern half of the palace consists of the apartments reserved for the women and the married members of the chief's family. This also has a hall with a central hearth, and is approached through a single vestibule from another open court. The smaller rooms, of which there are a great many, on this side appear to have been two stories high: traces of the staircase still exist.

Though a separate group of apartments appears to have been provided for the women, yet they were by no means shut off from ready access either to the outer world, or to the men's part of the house. There are at least three ways by which the women's rooms could be reached: one from the side of the outer propylæum, another through the court of the men, and lastly a long passage leads round the back of the men's hall to the long flight of rock-cut steps leading down to the postern in the semicircular bastion. Another door at a higher level gave direct communication between the hall of the men and the apartments of the women.

The walls of this palace were built of roughly-dressed stone bedded in clay up to a height of about 2 feet above the ground: the rest of the wall was of sun-dried brick; the whole was then covered inside and out with three coats of stucco made of lime mixed with sand, gravel, and broken pottery, a mixture which set nearly as hard as stone, and must have been a most perfect protection even in the stormiest weather. Finally, where the stucco was to be painted a thin coat of pure lime was applied as a ground for the colours, which consisted of red, yellow, and brown ochres, with charcoal-black and lime-white; and lastly, blue and green *smalti* or pigments, made of powdered glass. All these colours were of the most durable sort, and could be applied, as appears to have been done at Tiryns, on freshly-laid stucco—true *fresco*.

The painted decorations are of the very highest interest, and very characteristic examples of primitive art, which show strong traces of Egyptian or Phœnician influence. Some of these wall-paintings are evidently copied from textile patterns, and, though rudely executed, have much true decorative value. Woven stuffs such as were made in Egypt are imitated by the painter, and even the fringes are carefully copied. Other pictures, of which only fragments remain, had large figures of animals or men with wide-spreading wings, the feathers of which are painted in alternating colours in a very brilliant and skilful way. These show strong signs of Phœnician influence. The most remarkable and best preserved of all is a picture of a bull galloping at full speed, on whose back a man is riding in an acrobatic sort of way, holding on by one of the bull's horns. The whole is painted with much vigour, and with a rapid sweeping touch of the brush, which shows considerable practice and skill on the part of the painter.

Some parts of the palace were evidently decorated in a much more magnificent and costly way—that is, the walls were lined with wooden boarding, and on this were nailed plates of gilt bronze beaten into *repoussé* reliefs—very similar probably in style to the ninth century gates of Shalmaneser II., now in the British Museum, and other bronze reliefs found at Olympia. Many small fragments of these gilt metal linings were found in the burnt debris of the palace; and there is little doubt that the wooden columns in the hall and its portico must once have been cased with similar metal sheathing: very like the bronze-cased wooden column which was found some years ago among the ruins of Khorsabad.

Nothing could exceed the splendour of this mode of wall-decoration—the whole surface enriched with its gleaming reliefs would appear one mass of shining gold, and we know now that the gold and silver walls of the Homeric palace of Alcinous were not merely the offspring of a poet's fancy. Fragments were discovered by Dr. Dörpfeld of another extremely sumptuous method of architectural decoration—a frieze about 20 inches deep sculptured in alabaster with a rich and minutely worked pattern of rosettes and geometrically treated flowers, thickly studded with carefully cut bits of jewel-like transparent blue paste or glass. The effect of these deep-blue jewels flashing light from the contrasting creamy white of the alabaster must have given a most striking effect to the room which was adorned in so costly a way, especially if the wall below the frieze were one of those which were coated with the gold reliefs.

Nor was the colour confined to the walls: even the floors were decorated with simple patterns in brilliant blue and red, applied after the design had been indicated by lines incised on the surface. These floors were made of strong lime and gravel concrete carefully laid in three or four layers, each of finer material than the one below—a method exactly similar to that described by Vitruvius and used so skilfully by the Roman builders.

A very interesting point about the Tirynthian palace is its very careful method of drainage, partly with neatly fitted clay drain-pipes, and partly with large culverts built of rough stone and puddled inside with clay: this latter form was used for the main drains, while the branches which led to it were of pipes square in section, each length of clay pipe being narrowed at one end so as to fit closely into the next. All the open courts were well paved with concrete, which was laid so as to fall to a surface-gully, down which the rain-water passed, first through a clay pipe, then into the main stone drain, and so into a series of cisterns, where it was stored for use during a siege.

Much manual skill and great variety of tools were used by the masons who worked the stones for this building. Pointed hammers were used for the rough work, and chisels for the ashlar stone: the large thresholds of the various doorways were cut with a saw, with which emery must have been used, as its marks show that each stroke of the saw cut a considerable depth into the stone. Hollow drills set with some kind of hard jewel were also used here: in many of the drill-holes used to fix the pegs or dowels of the wood-work above, the stone stump of the core still exists, showing that a tubular, and not a solid, drill was used. Some of the large quoins or angle blocks were quarried thus—four drill-holes were sunk at the four corners of the future block, and then saw-cuts were made from hole to hole.

This use of tubular jewelled drills, which has recently been introduced with such effect into modern methods of engineering, dates from a very early period. As Mr. Flinders Petrie has pointed out, jewelled drills, both solid and tubular, were used in Egypt as early as 4000 years before Christ, especially in the working of the very refractory granites, basalts, and porphyries, which no unaided metal tools could possibly have cut. That jewels *fixed* in the rim of the metal tube were used, and not merely loose corundum or emery-powder, is shown by the fact that the scratch from a single projecting jewel can often be traced continuously round the spiral markings on the insides of the drill-holes.

It is not, however, only the mere technical details of the workmanship of this Tirynthian palace that bear strong witness to its early date, but also the methods of construction—the walls of sun-baked bricks set on a footing of stuccoed rubble, the use of wood instead of stone for the columns, and the magnificence of the walls lined with plates of bronze, *repoussé* and gilt.

Finally, nothing can be clearer than the evidence supplied by the semi-Oriental style of the wall-paintings, and the distinctly archaic character of the delicately sculptured alabaster frieze, studded with gem-like pieces of blue *κύανος*—exactly as was once the case with the central row of spirals in the well-known architrave from the doorway of the "Treasury of Atreus" in the British Museum, the remote antiquity of which is disputed by no one. In fact the methods of execution, the system of its construction, and the style of its decoration all combine to show that we owe to Dr. Schliemann and Dr. Dörpfeld the discovery of an almost new phase of prehistoric Greek art. J. H. M.

ON VARIATIONS OF THE CLIMATE IN THE COURSE OF TIME[1]

IF we examine the meteorological charts of Norway we observe at once what a great influence the sea and the mountains exercise over the climate in various parts. Nearly all the climatological lines run more or less with the shape of the coast, so that we encounter far greater variation when proceeding from the centre coastwards

[1] The following is a short abstract from various papers, viz.: "Essay on the Immigration of the Norwegian Flora during Alternating Rainy and Dry Periods" (Christiania, 1876). "Die Theorie der wechselnden kontinentalen und insularen Klimate," in Engler's *Botanische Jahrbücher*, ii. (Leipzig, 1881). "Ueber Wechsellagerung und deren mutmassliche Bedeutung für die Zeitrechnung der Geologie und für die Lehre von der Veränderung der Arten," in *Biologisches Centralblatt*, iii. (Erlangen, 1883). "Ueber die wahrscheinliche Ursache der periodischen Veränderungen in der Stärke der Meeresströmungen" *l.c.* iv. (Erlangen, 1884).

than from south to north. In keeping with the same are the variations of the flora.

The plants of Norway may be divided into certain groups of species, the species belonging to the same group having a somewhat similar extension, whilst each of these groups of species is confined to special climatological conditions, and is only found in those parts where such prevail. The Norwegian flora is in the main monotonous. On the mountains large areas are covered with only a few lichens, mosses, and heather, or copses of dwarf birch, juniper, and willows ; lower down the forests are formed of birch, fir, and spruce, and have a monotonous flora, viz., heather and lichen in the fir forests, "blue" berries and a few kinds of moss in the spruce forests, whilst the west coast is covered with heather, and the numerous marshes with a vegetation, poor in species, of a few mosses and Carices.

But in spite of this general monotony of the flora of the mountain wastes, with their grayish-yellow lichens, grayish-green and green copses of willows or dwarf birch, there are certain places, particularly on slaty ground, where a rich vegetation may be found. It consists of small perennial plants some inches in height, and which are particularly distinguished by their copiousness of flowers, which are very large in proportion to the size of the plant, and have very pure and lovely colours. Outside Norway we also encounter these plants in Arctic regions, and the Alpine flora of these slaty tracts is therefore of Arctic character. But not all slate mountains have such a varying flora. The coast climate is, in consequence of the mild winters, when the temperature frequently changes, destructive to these plants, which shoot at a very low degree of heat. It is for this reason that, when we mark those places on the map which have a rich Alpine flora, they lie scattered as oases over the land with great spaces between them, but always sheltered from the sea-winds, *i.e.* on the east or north-east side of the highest mountains and greatest glaciers, which act as barriers against the mild climate of the coast. In these places the botanist may fancy himself transferred to Spitzbergen or North Greenland ; he finds the principal plants encountered there, and if we follow the Arctic flora to Spitzbergen we find that here also it shuns the sea, and is most copious in the bottom of the fjords.

In the lower districts, sheltered from the open sea, we find in favourable spots another group of plants which also shun the coast, and which thrive on loose slates and warm limestone cliffs, or in screes of different kinds of rock, under precipitous mountains, facing the sun. These screes are generally full of bare boulders at the bottom, but in the finer debris higher up grows a wreath of green underwood, formed of tender deciduous trees and shrubs, hazel, elm, lime, maple, dog-roses, *Sorbus Aria*, *Prunus avium*, wild apple, &c., as well as a number of highly-scented Labiatæ, several Papilionaceæ, grasses, and a great number of other plants, together forming that part of the Norwegian lowland flora which shuns the open sea-coast, and prefers the fjords and the sunny valleys. But even this flora has a scattered extension. It is richest in the tracts around Christiania, and becomes poorer westwards along the coast, disappearing almost entirely on the coasts of the province of Bergen ; but at the bottom of the Sogne and Hardanger, and along the Throndhjem fjords we find the same flora, and that in spite of these parts being entirely separated by enormous mountains.

Near the open sea the flora becomes poorer in species, most of those characteristic of the interior disappearing, whilst their number is not by far made up by those belonging to the coast. Here we shall only name a few of the coast plants, such as the holly, the ivy, and the foxglove, whilst in place of the *Primula veris* of East Norway we have the *Primula acaulis* of the west coast. In the woodless tracts of the coast the heather predominates, and besides the ordinary common one we find two other species. This group of plants belongs exclusively to the south and west coasts, and is hardly found north of the Throndhjem fjord. Most of its species are not found near Christiania, but they reappear in the south of Sweden. Some, however, are in Scandinavia only found on the west coast of Norway, and we must travel to the Faroe Islands, Scotland, England, and Belgium to re-encounter them.

We have thus seen that the Norwegian flora consists of groups of species which make different demands as to climate. If we were to colour a map according to the places where certain groups are most copious, we should at once discover that they had a scattered distribution. We should find the same colour here and there, in smaller or larger patches, but those of the same colour would be separated by great spaces of a different tint.

At one time botanists were satisfied with explaining the distribution of species through soil and climate, but as the study of their appearance proceeded it was discovered that there were great gaps in the extension of many. And these gaps were often so great that scientific men were obliged to resort to explaining the same by maintaining that such species were created in places far apart. But since the doctrine of the origin of species by descent has been accepted, such an explanation must be rejected. There remains, therefore, only two ways in which to explain these things. Either wind, animals, or sea-currents are capable of carrying the seed of plants at once across such large areas that the gaps in the extension can be explained by the means of transport at work at present, and there are even those who still believe that this is the case. In certain instances this explanation is indeed the only one possible, when, for instance, it concerns the flora and fauna of the oceanic islands which have never been connected with the great continents, and still have species more or less related to those of the mainland. But such a sudden migration is very improbable, and may even be dispensed with altogether, as we shall presently show, when it is necessary to explain such gaps in the extension of whole groups of species as those we have pointed out above in the flora of Norway.

We have, besides, another explanation of this problem, first advanced by Mr. Edward Forbes, who maintained, in common with most modern botanists, *that the climatic variations of the past are reflected in the fauna and flora of the present*. He was, we believe, the first *savant* who demonstrated that the Glacial Age has left its distinct mark on the flora of the present day. Arctic species are found on mountains in temperate climates. During the Glacial Age these species grew in the plains at lower latitudes, but as the climate became milder they receded gradually to the far north and the high mountains. In the warm plains they had to give way to the new immigrants, and this is the reason of our discovering hyperborean plants on the mountains of Europe.

If now we were to apply this explanation to the scattered extension of the species in Norway, we must bear in mind that the distances here are smaller, although at times there are several degrees of latitude between the places where the same appear. We must, therefore, see if an acceptable explanation of the extension of the Norwegian flora can be made by means of geology, and if the same be supported by other circumstances.

It is not long since, geologically speaking, that the Scandinavian peninsula was covered with an inland ice, stretching right out to sea, above which only solitary mountain-tops rose, like the "nunataks" in Greenland. It is evident that the majority of the present flora could not then exist in Norway ; but the present flora is older than the Glacial Age, which is conclusively proved by specimens from the same being found in coal strata older than that period. Thus yew, fir, and spruce, hazel, willow, &c., have been found in old peat-bogs of England and Switzerland, for instance, which are covered by the bottom moraine of the inland ice. The present Norwegian flora, therefore, must have lived in other countries which were free from ice during the Glacial Age, and immigrated to Norway as the climate became milder and the ice receded. This is the reason of Scandinavia having no peculiarly characteristic species, *because the flora has immigrated from outside countries, and the time is so short since it settled in the country that it has not yet had time to produce new species.*

If we may now apply the geological theory of explanation to the flora, we come to the conclusion that the immigration took place during repeated changes in the climate. After several thousands of years with a severer climate which favoured the immigration and extension of northern and eastern species, other thousands of years followed with a milder climate. During this period fresh immigrants came from the south and south-west, compelling the older flora to retreat. In this manner the climate must have changed several times since the Glacial Age, and the distribution of the plants must have changed in accordance therewith. The periods of variation are reflected in the present flora, and it is the former which have led to the great gaps in the extension of coast as well as inland plants. The sunny screes, the slate districts, and the moist coast tracts are asylums where the different floras have found refuge. In the intermediary parts they have been dislodged by the newcomers. But certain species, being indifferent to the variations, extended constantly, at the expense of others, *and this is the reason of the Norwegian flora being so monotonous.*

In order to test the accuracy of this assertion we shall first turn to the peat-bogs and examine their structure. We shall, for comparison's sake, also examine the Danish ones, which are well known from the researches of Prof. Steenstrup.

In the forest and mountain districts of Norway there are innumerable marshes. In the forest districts most of them are now comparatively dry, the heather and wood covering parts of the bog, and on the surface of the latter tiny mossy knolls are often found, in the middle of which stands the old stump of a tree. An examination of the structure of the peat layers—which is easily made with a bore—shows that previous to the present time, when the surface is generally more or less dry, there was a period when the bog was much more watery. Under the present conditions the growth of the peat is arrested, at all events in dry places. But just below the lichen and heather-covered surface we find on boring a pure, unmixed white moss (Sphagnum). It is this moss in particular which has formed the peat in the Norwegian bogs; and in the upper layers—only one or two feet from the surface—flint implements from the Stone Age are often found. At the period this upper layer of Sphagnum was formed the bogs were woodless because they were too watery. We see, therefore, that the peat in these bogs has not grown very much within historical times, and that the layer of stumps of trees, which are found on the surface in the knolls, indicates an arrest of the growth of the peat, the duration of which may probably be measured by many hundreds, perhaps by thousands, of years. It might be argued that the present drier state of the bogs was simply due to the circumstance that the peat had grown so high that the moisture had run off. But this is not an acceptable explanation, because if we bore deeper in the peat we find that the oldest bogs are built of four layers of peat, *and between these stand three layers of stumps, so that these bogs are for the fourth time covered with trees since they began to form.* And as most of the bogs, if not all, are at present drier than they were before, the theory of merely local variations of the moisture is also insufficient to explain the phenomena. It remains, therefore, only to assume *that periods of dry and wet have alternated during ages.* The peat layers generally belong to the latter, and the stump layers speak of drier periods, when the bog was covered with trees.

Of these four layers of peat, which in some places measure upwards of twenty-six feet in thickness, only the two youngest inclose, as far as the researches in Norway go to show, remains of foliferous trees sensitive to cold. And this justifies the assumption that they correspond to the four layers which Steenstrup has shown in the bogs of Denmark, and which appear like geological strata with distinct fossils, viz., the aspen, the fir, the oak, and the black alder. This comparison of the peat layers of Norway and Denmark is further supported by the circumstance that layers of stumps are also found in the Danish bogs, and here, too, they stand between the peat layers of the various periods. They indicate long periods, during which also the Danish bogs were dry and partly covered with forests when the peat ceased to grow. But during these dry times the flora was changed through the immigration of new species, and when a wet time again set in, it was other trees which grew around the bogs, and which spread their boughs, leaves, and fruits over the watery bog, and the remains of which were buried by the growing layers of peat.

In this manner the structure of the peat confirms the conclusion to which the distribution of the flora pointed, and if we take the fossil plants and marine shells to our aid we may explain the gaps in the extension of the species without assuming long transports of seed.

In the freshwater clay of Scania and Seeland, Prof. Nathorst has discovered numerous remnants of Arctic plants. This clay lies *below* the peat. When it was deposited in the cavities of the old bottom moraines of the inland ice, not only the dwarf birch, but even hyperborean plants, such as the Arctic *Salix polaris* and others, flourished in the southernmost parts of Scandinavia: *therefore the Arctic flora was the first which immigrated into Scandinavia.* It entered whilst the climate was very severe; but the climate became milder and more moist; the peat began to form; then the aspen and birch entered, and, later on, under varying conditions of moisture, the fir and the spruce, with the flora of the mountains and forest glens, a series of species which have not yet been mentioned, viz. Mulgedium and Aconitum, many great ferns and grasses, wood-geraniums, and lychnis, &c. But the climate became warmer and warmer; and finally the foliferous trees, more sensitive to cold, entered, viz. the hazel, the lime, the ash, the oak, the maple, and a number of others from warmer regions. In the province of Bohus quantities of stones of sweet cherries are found in many places, in peat, where this tree is now extinct; and in the Norwegian peat-bogs hazel-nuts are very frequent in a certain layer, not only in the interior of the great coniferous forests, where not a single hazel-tree is found, but even in the heathery, woodless coast-lands. It will, therefore, be seen that the hazel and the sweet cherry were then very plentiful, and from this we may justly conclude that the trees, and shrubs, and herbs which thrive in their company were also once far more plentiful than at present. *It is this flora which has found an asylum in the above-mentioned screes.*

Following the period when Southern Norway was covered with foliferous forests to a far greater extent than now came a warm and moist one, in which the peat again began to grow. At that time the coast oak (*Quercus sessiliflora*) was far more frequent than at present, judging by the evidence of the peat-bogs, and at that time, the shell deposits inform us (as shown by Prof. M. Sars), the present marine animals of the west coast were found in the Christiania fjord. *And there is every reason to assume that the present flora of the west coast immigrated thither at that period from the south of Sweden along the Christiania fjord to the west coast.*

New changes again set in, with new immigrants, and finally came the present age with its comparatively dry climate. But all these events are prehistoric, as is shown by the stone implements lying in the uppermost peat layer, close under the surface.

Thus, the remains of plants and animals in clay, peat, and shell deposits inform us *that the gaps in the extension of the species in Norway may be explained by the varying events of times long gone by.*

Since the Glacial Age the relation between sea and land in Norway has changed. Formerly the sea was in some places upwards of 600 feet higher than at present.[1]

The clay at that time deposited on the sea-bottom, and the shell deposits formed near the shore, contain, as Profs. M. Sars and Kjerulf have taught us, remains of Arctic animals even in the southernmost parts of the country. There is a difference of opinion between *savants* whether this alteration of the shore-line is due to a rising of the land or the sinking of the sea, or to both. There is further some dispute about the manner in which the level became altered, some maintaining that it took place suddenly at intervals, whilst others believe that it is the result of a gradual and continuous process. The marks left by the sea seem at first glance to corroborate the first of these theories. Thus, in the lower parts of our valleys we find along the river-courses terraces of sand, pebbles, and clay, one behind and above the other right up to the highest old shore-line. The terraces, of which Kjerulf, pre-eminently amongst others, has given us particulars, have an even surface and a steep declivity outwards against the mouth of the valley. They contain sometimes remains of sea animals. Under a higher level of the sea the river carried down sand and gravel to its mouth, just as in the present day banks and bars are formed at the estuary of our rivers. And the terraces seem to indicate that the changes in the level were broken by periods of rest. During the latter the river had time to form a bank, which rose comparatively rapidly; the next period of rest gave occasion to the formation of another terrace, and so on. But this theory has to combat many obstacles, because the terraces lie often, as Prof. Sexe has shown, even in valleys situated near each other, *at different elevations.* The professor is of opinion that step-like terraces may be formed even under a gradual and steady rising, if the carrying-power of the river is subjected to changes. Our theory may therefore probably also be applicable for explaining the terraces, because, if long periods with milder climate have alternated with others whose climate was more severe, it is evident that the volume of water, and thus the carrying-power of the current, may have altered. Perhaps the rivers have at certain times carried down floating ice, at others not, and the thaw in the spring must have increased the carrying-power. We can thus understand why the corresponding terraces in valleys near each other do not always lie at the same elevation. Their rivers differ in size, and when the carrying-power diminishes a big river will retain the strength to form a terrace longer than a small one.

Besides these terraces, which are particularly conspicuous in the short steep valleys on the west coast of Norway, and on account of their regularity must excite the admiration of every one who sees them, there are other equally striking marks of the old sea-levels, viz. the so-called "Strandlinjer"—shore-lines—which are known chiefly through the researches of Prof. Mohn and Dr. Karl Pettersen.

When travelling through the fjords and sounds, particularly in Northern Norway, one sees here and there horizontal lines drawn along the mountain-sides, sometimes several hundred feet above the sea. They are not always equally marked, but appear often remarkably clear; sometimes they look like roads or railway-lines. They are always horizontal, or nearly so, and must, therefore, be remains of an old sea-shore. Often two parallel lines are seen running one above the other in the same place; and on closer inspection it will be discovered that they are hollowed out of the rock itself. They have a surface sometimes many feet broad, and are bounded behind by a more or less steep mountain-wall, forming thus horizontal incisions in the same. The shore-lines have also been brought to prove that the rising was broken by periods of rest, during which the sea had time to hollow out the rock; but I am of opinion *that they could be formed, too, under a gradual rising, if the climate be subjected to periodical changes.* The shore-lines belong to the northern parts of the country and the deep fjords, where the winter cold is more severe, and they are only found in districts where there is a tide. They seem to have been blasted out by the influence of the cold. At high tide the sea-water fills the holes and fissures in the rock, and when the tide recedes it is left in the same. In severe winters the water will freeze, and thus burst the rock. During the rising of the land, shore-lines will be broken out in this manner, as long as the erosion is able to keep pace with the rising. When the climate becomes milder, a time will come when the erosion is unable to continue. Then the shore-lines will be lifted up above the level of the sea, and out of the reach of the blasting influence of the water. If next, after thousands of years, when the land has perhaps risen fifty or a hundred feet, a period follows with a severer climate, a new shore-line is formed below the former.

The shell-banks, too (*i.e.* deposits of shells of marine animals living in shallow water near the shore) lie, as Kjerulf has shown, in the Christiania fjord at different levels, the oldest at heights of from 540 to 350 feet, and the youngest between 200 and 50 feet above the present level of the sea. But between 350 and 200 feet none has been found. In the neighbouring Swedish province of Bohus they are found at all elevations, even between 350 and 200 feet, and it must therefore be assumed that local causes, as, for instance, the ice formation in the more closed Christiania fjord, destroyed the shell-banks when they reached the shore-line, at a period when the land lay 350 to 200 feet lower in relation to the sea than at present. According to the evidence of the peat-bogs, there is reason to believe that this part of the rising occurred under a more severe climate.

It is therefore seen that all the facts which have been advanced in order to prove that the rising was broken by periods of rest may be easily explained, *if we assume that the land rose gradually and steadily under periods alternating with milder and severer climates.*

The University, Christiania A. BLYTT

(*To be continued.*)

[1] The depth of the peat in the parts which were formerly below the sea increases with the height above its surface, because the formation of the peat commenced long before the lowest-lying parts had risen above the surface From the remains of plants found in the various peat layers we may therefore learn how the Norwegian flora was composed during the various phases of the rising of the land.

HYPERTRICHOSIS

I THINK all naturalists, and anthropologists in particular, will be interested in the cases of human hypertrichosis now on view at the Egyptian Hall, Piccadilly. I myself spent two hours with them on Saturday last.

This family of hairy people have been at the Court of Burmah for four generations. Crawfurd saw Mahphoon, the old woman now exhibited, an infant in 1827; the family was described by Col. Yule in his narrative of a Mission to the Court of Ava in 1855.

It is singular that the hypertrichosis of Mahphoon's grandparent should be continued not only to herself but to her son, Moung Phoset, also exhibited, inasmuch as one of the parents has always been an ordinary comparatively hairless Burman, so far as the face and body are concerned.

Mahphoon is now an old blind woman, but very lively, full of fun, and an inveterate chewer of betel; her face and ears are entirely covered with hair, particularly thick on the nose. Her son, Moung Phoset, is more hairy on the face and ears than his mother—probably her locks are somewhat thinned by age—his forehead is densely clothed with hair, which, when combed over his face, entirely hides his features, the hair being 12½ inches in length; he parts it over the eyebrows and passes it behind his ears; it is also very long on the nose, and being parted in the middle and falling over the cheeks gives his face a most remarkable resemblance to that of a Skye terrier. The suggestion was so strong on my mind that I could scarcely divest myself of the canine idea.

The whole of his body is clothed with soft hair some inches in length, but I am informed that he has usually had this cut from time to time, so that its natural length is not apparent. The hair of Moung Phoset and of his mother Mahphoon is very soft and wavy, of a brown colour, and utterly unlike the coarse black hair of the ordinary Burman.

Capt. Paperno, who obtained them, and has been fifteen years in Burmah, informs me that the dentition of all these hairy people has been imperfect, whilst their less hairy brethren and sisters have had perfect teeth.

I have examined a cast of Moung Phoset's mouth. In the upper jaw he has but two canines and two large incisors, in the lower jaw two canines and four small incisors; the premolar and molar teeth are quite absent.

A nephew of Mahphoon, who is exhibited with them, has the appearance of an ordinary Burman only.

I believe that it is owing to the enterprise of Mr. Farini that we are enabled to see this singular family in London.

They are both far more hairy than Krao, who was exhibited in London some time since, and is now at Paris in good health; she was obtained from a district east of Burmah, and north of Siam; the features of the Burman family are so obscured by hair that I could not ascertain whether there was any resemblance to those of Krao, nor even whether they were Mongoloid.

Moung Phoset has been well educated, writes fluently in the Burman character and language, and possesses considerable power in the delineation of objects; like many Burmans he is tattooed from below the waist to above the knees.

I have seen a photograph of a brother of Mahphoon now dead; he was quite as hairy as his sister, but the peculiarity did not, I understand, extend to the whole of the family.

J. JENNER WEIR

Chirbury, Beckenham, Kent

NOTES

PREPARATIONS are being made by Parisian men of science for the celebration of the 100th anniversary of the birth of M. Chevreul, on August 31 next.

A REGULATION as old as the French Academy of Sciences has just been broken through in Paris. Women have hitherto been excluded from the sittings of the Academy, but at the meeting of the 28th ult. the interdiction was raised in favour of Mdlle. Sophie Kowlewska, Professor of Mathematics at the University of Stockholm, and daughter of the eminent palæontologist. Admiral Jurien de la Gravière, who presided, welcomed her in graceful terms, and said that her presence should be a cause of pride and pleasure, not only to the mathematicians present, but to the whole Academy. As she entered, the whole of the members rose to salute her. She took her place between Gen. Faye and M. Chevreul.

ACCORDING to official decree, the Tokio University and the Imperial College of Engineering having been amalgamated into the Imperial University of Japan, they now cease to exist. The new University comprises five colleges or sections: (1) Law; (2) Medicine; (3) Engineering; (4) Literature; (5) Science. Each of these, as well as the whole institution, is placed under a Japanese director. The director of the Science College is Prof. Dairoku Kikuchi, a Cambridge Wrangler, and the same gentleman is acting for the present as head of the Engineering College also. The large and splendid buildings erected for the Engineering College—the finest pile of European edifices in Japan—will, it is said, be used in future as a school for the children of nobles.

HERR FENNEMA, a mining engineer at Buitenzorg, in Java, has made some observations on the recent volcanic eruptions in that island which are of interest as setting at rest a matter on which some doubt has existed. On the authority of Junghuhn, the general belief has been that in historic times all the volcanoes of Java (and of Sumatra it may be added) had thrown out solid matter only, and never those streams of lava which are so characteristic of most eruptions. But a careful examination of Smeru and Lemongau during the catastrophe of April last year shows that this notion must be abandoned as incorrect. The former is not only the highest but also the steepest in Java. From 700 to 1400 metres the slope is about 6°, up to 2100 it is 20°, and from 2100 to 3671 metres it is more than 30°. For a considerable way from the summit the striking cone consists wholly of the detritus thrown out regularly by the almost uninterrupted activity of the crater. Up to April 1885 the existence of torrents of lava was unknown. On the 12th-13th of that month a stream appeared on the south-eastern side, and forced the residents on the plantations lower down to fly. The stream increased for several days, until it reached a height on the mountain-side of about 2100 metres from the level of the sea. The loss of life was due to the avalanche of stones sent down the steep sides of the mountain by the stream. Similarly, at the same time, Lemongau threw out a lava stream, but there was a curious difference between this and the one issuing from Smeru—the latter was andesitic in its character, while the former was basaltic.

WE have received from Mr. Henry Farrar, 6, Hanway Street, W., photographs, seven in number, selected from a very extensive collection taken by a native of India, Lala Deen Diyal. One consists of the whole view of the rapids of Chichai waterfall, near Reira, which are 400 feet deep; another, a river view at Indore. The photographs themselves are exquisite; in looking at some of them one might imagine one's self in the tropics surrounded by the wonderful vegetation of that region. The tone of them is very fine, especially in the one "Channel below the Keuli waterfall, near Reira," the velvety appearance of the vegetation on the hillsides is in strong contrast with the sharp and clear detail of the white and waterworn stones in the river bed. To the various lovers of nature as well as students of art and archæology a possibility of getting quite perfect photographs of the natural and artistic wealth of India at a low price should be very welcome.

IT is stated that the explorations for coal conducted by Dr. Warth in the Salt Range in the Punjab have proved so satisfactory that the Government is now arranging for the practical working of the seams. Dr. Warth estimates that over one million tons are underlying the plateau at Dundote. The coal is not of the first quality. It contains iron pyrites and is very friable, but it is believed that it will be very useful for the North-Western railways.

WE have received several communications relating to the letter signed "P." in NATURE for May 27, p. 76, on "Male Animals and their Progeny." Mr. Arthur Nicols has noticed several times a common cock marshalling a brood of chicks, picking up food for them, calling them together on the approach of danger, and even "brooding" them at night. A case was communicated to him a few years since by Dr. James Gale, in which a turkey cock incubated six fowl's eggs during the whole period, successfully producing three chickens, and continuing to treat them with all the care of a hen. The hen turkey with which he had been mated was unfortunate in her brood, and this circumstance appears to have impelled him to take possession of the fowl's eggs. Besides the fact that in a considerable number of species the male not only takes his turn at incubation, but continues, equally with the female, to feed the young after they have left the nest, we have the case of the male emu, who performs the task of incubation alone. The male ostrich, too, as observed in a semi-domestic state, undertakes a large, and sometimes it would seem the entire, share of nidification. When the pair of Apterix in the Zoological Gardens nested, the male alone sat assiduously during fifteen weeks on the two eggs, which, however, proved infertile. A correspondent from Melksham also records a case in which a bantam cock brought up a brood of chickens, the mother having died when they were two days old. Mr. Hyde Clarke quotes instances of similar care bestowed by male dogs and cats in Turkey on the young.

THE curious case of the emu is described in a letter from Mr. Alfred Bennett, who had an opportunity of watching the habits of this bird, which was, during several seasons, successfully bred by his father in Surrey. The hen bird, says Mr. Bennett, begins to lay about the end of October or beginning of November, and as each brood consists of twenty eggs or more, laid at intervals of two days, the process takes about six weeks. Before it is completed, the cock bird begins to sit. The eggs laid subsequently are deposited by the hen by the side of her mate, who puts out his foot and draws them under him. As soon as the eggs begin to hatch it is necessary to isolate the hen, as she fights furiously with her mate, and would to all appearance kill the chicks if she were allowed to get at them. The whole of the tending of the young is performed by the male bird.

AN opah, or king-fish (*Zeus luna*), which is an exceedingly rare fish, was recently captured off the Shetland Islands and brought to the Colonial and Indian Exhibition for inspection. The specimen, which is in perfect condition, measures about 5 feet in length, and weighs 160 pounds. The colours of the sides and back are dark green intermingled with gold and purple, while the irides are red. The opah seems to possess peculiar migratory propensities, being found at various parts, even in Eastern seas. The habits of this fish seem to be little known, but Mr. W. August Carter, of the Colonial and Indian Exhibition, states that, according to inquiries and investigations he has made, the opah varies its diet according to the locality it inhabits, and that when visiting the British Islands it feeds chiefly upon herrings and cuttlefish.

IN one of the Courts of the Colonial and Indian Exhibition is a very fine raven, presented by the Maclaine of Lochbuie. This bird, on account of its sagacity, creates much amusement and interest amongst visitors. On being fed it partakes of so much of the food as it requires, then hides the remainder in certain parts of its habitat beneath pieces of paper and other articles that happen to be about. As many as four hiding-places are made use of by the raven for storing its food, which it exhumes when desirous of feeding. It is a curious fact that the raven only resorts to such stratagems when being watched by the public, at other times this sagacious bird consumes its meals in their entirety at one time.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. Albert Thorne; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. S. R. Hicks; a Prairie Wolf (*Canis latrans* ♀) from Winnipeg, presented by Mr. Gerald F. Talbot; a Common Fox (*Canis vulpes*), British, presented by Mr. A. Browning Priestley; a Brown Bear (*Ursus arctos*) from Asia, presented by Capt. Asher Smith; a Stein-bok Antelope (*Neotragus tragulus*) from South Africa, presented by Mr. W. J. Robertson; two Violaceous Night Herons (*Nycticorax violaceus*) from South America, presented by Dr. A. Boon, F.R.C.S.; a Mona Monkey (*Cercopithecus mona*) from West Africa, a Grey Squirrel (*Sciurus cinereus*) from North America, a Greater White-crested Cockatoo (*Cacatua cristata*) from Moluccas, deposited; six —— Sousliks (*Spermophilus* ——), five American Flying Squirrels (*Sciuropterus volucella*) from North America, two Glass Snakes (*Pseudopus pallasi*) from Dalmatia, purchased; two Mule Deer (*Cariacus macrotis* ♀ ♀), a Yak (*Poephagus grunniens* ♀), four Long-fronted Gerbilles (*Gerbillus longifrons*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

METHOD OF CORRECTING FOR DIFFERENTIAL REFRACTION IN DECLINATION.—Mr. McNeill, of the College of New Jersey, Princeton, has published in the *Astronomische Nachrichten*, No. 2735, a method of correcting micrometer observations for refraction which was devised originally for the diagonal-square micrometer, but is applicable also to the ring micrometer and others of the same class. In this method the correction to the difference of declination is not determined separately, but the true difference is directly determined, the corrections being applied to the logarithms in the course of the computation. Mr. McNeill shows that if we apply the number given by

$$M\kappa(\tan^2 \zeta \sin^2 q + 1)$$

to the logarithm of the half chord traversed by the star, and the corresponding number deduced from

$$M\kappa(\tan^2 \zeta \cos^2 q + 1)$$

to the logarithm of the apparent distance, measured on a circle of declination, from the point of reference in the micrometer, the result obtained will be the true distance corrected for refraction. In the above expressions M is the modulus of the common system of logarithms, κ the constant of differential refraction, ζ the true zenith distance, and q the parallactic angle. It is then only necessary to tabulate the expression

$$M\kappa\{\tan^2 \zeta \cos^2(p - q) + 1\}$$

with arguments $p - q$ and ζ, adding subsidiary tables giving barometer and thermometer factors, in order to obtain the quantities required (by making p alternately $= 90°$ and $= 0°$) to correct the micrometer observations for differential refraction in declination. This Mr. McNeill has done, and his tables will doubtless be of much use to observers using the class of micrometer to which the method is applicable.

NEW MINOR PLANET.—A new minor planet, No. 259, was discovered by Prof. C. H. F. Peters, Clinton, New York, on June 28. Minor planet No. 253 has been named Mathilde.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *JULY* 11–17

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 11

Sun rises, 3h. 58m.; souths, 12h. 5m. 12·6s.; sets, 20h. 12m.; decl. on meridian, 22° 6′ N.: Sidereal Time at Sunset, 15h. 30m.

Moon (three days after First Quarter) rises, 15h. 49m.; souths, 20h. 38m.; sets, 1h. 22m.*; decl. on meridian, 15° 14′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 17	13 51	21 25	17 0 N.
Venus	1 32	9 30	17 28	20 42 N.
Mars	11 8	17 2	22 56	1 59 S.
Jupiter	10 31	16 42	22 53	1 22 N.
Saturn	3 30	11 39	19 48	22 25 N.

* Indicates that the setting is that of the following morning.

Occultation of Star by the Moon (visible at Greenwich)

July	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
17	B.A.C. 7097	6	3 44	4 55	130 323

Variable Stars

Star	R.A.	Decl.				
	h. m.	° ′			h. m.	
U Cephei	0 52·2	81 16 N.	July	13,	23 52	*m*
U Libræ	14 34·0	17 10 S.	,,	15,		*M*
δ Libræ	14 54·9	8 4 S.	,,	17,	22 14	*m*
U Coronæ	15 13·6	32 4 N.	,,	15,	0 40	*m*
U Ophiuchi	17 10·8	1 20 N.	,,	12,	1 26	*m*
		and at intervals of			20 8	
X Sagittarii	17 40·4	27 47 S.	July	17,	2 0	*M*
W Sagittarii	17 57·8	29 35 S.	,,	16,	0 0	*M*
U Sagittarii	18 25·2	19 12 S.	,,	16,	2 0	*m*
R Lyræ	18 51·9	43 48 N.	,,	13,		*M*
T Sagittarii	19 9·7	17 10 S.	,,	12,		*M*
R Sagittarii	19 10·0	19 30 S.	,,	12,		*M*
δ Cephei	22 24·9	57 50 N.	,,	15,	3 0	*M*

M signifies maximum; *m* minimum.

GEOGRAPHICAL NOTES

THE report published by Lieut. von Nimptsch, of the German army, gives some very interesting details of the journey he made with Herr Wolff, a traveller in the service of the Congo Free State, and which has resulted in the discovery of a river likely to be of material value to traders with the Congo. The Congo, in its course from the south-east, makes a very wide bend to the north, and then descends again to the Atlantic, a very large tract of country being embraced in this curve. Within this is the River Kassai, which Lieut. von Nimptsch regards as being "of even greater importance to commerce than the Congo itself." Describing their journey he says that, as far as Luebu, the Kassai flows through wide plains, well adapted for cultivation and pasturage, and forests of palms and gutta-percha trees. There are many villages on the banks, and the travellers met with great civility in all of them save one, the inhabitants of which fled at their approach. "One tribe," adds Lieut. von Nimptsch, "was remarkable for its joviality. The natives accompanied the steamer in their canoes, and when we could, organised dances and songs in our honour." There is a great deal of ivory all along the Kassai, and large pieces of the finest quality were readily given in exchange for empty boxes and tins. They discovered several affluents of the Kassai, and they calculated that they were navigable for a distance of 250 miles. "But the most important affluent," the report goes on to say, "is that which Herr Wolff explored in the steamer *Vorwarts* during the months of February and March. He ascended this stream to a distance of 430 leagues from its mouth, and one of its northern affluents brought him to within a week's march of Nyangwé. He might have gone still further had his steamer not met with an accident, for there are no cataracts in this river. All this network of navigable water, extending over more than 3000 miles, is most admirable, and in future it will be possible to travel eastward from the Atlantic, reaching Nyangwé and then Lake Tangyuteka by leaving the Congo at the mouth of the Kassai, without being obliged to ascend the whole of the former stream, thus avoiding the Stanley Falls."

A TELEGRAM from Zanzibar, of the 30th ult., states that Dr. Fischer had returned there. He has not succeeded in rescuing Herr Junker, the African traveller, who, when last heard of, was in the region north of Uganda.

A VERY interesting discussion which took place at the St. Petersburg Society of Naturalists after the reading of a paper by Prof. Beketoff on the South Russian steppes as compared with those of Hungary and Spain is now summed up in the *Memoirs* of the Society (vol. xxv. 2). The Russian steppes between the Pruth and Don, although belonging to the great "steppe region" of Grisebach, differ, however, from the remainder of the region inasmuch as they support agriculture without irrigation. They are akin, in this relation, to the Hungarian *puzhtas*. Being comparatively well watered, they belong more to Europe than to Asia, while those beyond the Don and the Volga bear a truly Asiatic character. As to the *disiertos* of Spain, they are more akin to the deserts of Africa than to the steppes of either Central Asia or Europe; they have, however, some likeness to those of Transcaucasia. As to the causes of the want of forests in the Russian steppes, Prof. Beketoff explained it by the circumstance that, being covered with salt-clays, after the emergence from the sea, they were, first, inappropriate to the growth of forests. As the surface, however, lost by and by its salt and became covered with grasses, masses of ruminants were attracted into the region, and these ruminants prevented the appearance of trees, destroying them as soon as they appeared; the climate being most unfavourable for the spreading of forests, the ruminants were also an important factor in the prevention of their appearance. The American buffaloes are an instance of the same influence. Dr. Woeikof fully confirmed the view taken by Prof. Beketoff, but pointed out that the burning of the steppes by man played also a most important part in the prevention of the appearance of forests. In America he was told of several instances where the trees began to grow as soon as the burning of prairies was stopped. Cattle are surely a great enemy of appearing forests. The very dry season of 1857 partly destroyed the cattle in Texas, and partly compelled to send it away to the mountains, and immediately the *Mesquita* began to spread in the prairies. It had time to take root before the cattle were brought back, and now it grows freely. The same has been seen on the *llanos* of Venezuela. The continuous wars and requisitions have led to a notable diminution of cattle, and now we do not find the boundless steppes of former times; there are at least bosquets of trees. Mr. Jonas supposes that this change has even slightly modified the climate. Prof. Sovyetoff supported the same views, pointing out that cattle are an enemy not only of forests, but also of the grass covering of the steppes. He mentioned an instance of a large estate of 800,000 acres of virgin steppes in Taurida, where nearly half a million of sheep are grazing. The grass vegetation on these steppes has become strikingly poor, so that the cattle-owners calculate that for each sheep they must have 4·6 acres of grazing-land, 21·6 acres for each head of horned cattle, and 27 to 32 acres for each horse. The black-earth soil, when continually trampled on by the sheep, hardens as well as a clay soi would harden; the soil is thus no more aërated, and becomes unable to support a rich grass vegetation.

THE *New York Times* announces that Lieut. Schwatka, the Arctic explorer, has accepted a commission from that paper to explore the southern coast of Alaska and to attempt an ascent of Mount St. Elias, the highest peak on the North American continent. Mr. William Libbey, Professor of Geography at Princeton College, has undertaken the charge of the scientific portion of the expedition, which left Port Townsend on the 14th inst.

THE three papers contained in the current number of the *Proceedings* of the Royal Geographical Society are of exceptional value and interest. Mr. James W. Wells describes the physical geography of Brazil in its broad features. He shows that the idea fostered by most maps that Brazil is a very mountainous country is wholly erroneous, and that it is mainly a vast plateau, excavated into numerous valleys by denudations, with relatively few purely mountain chains. As shown by the map accompanying the paper, the four main physical features of the country are (1) the vast, low-lying, flat plains of the Amazons, and the flat, grassy plains of the Paraguay; (2) the elevated highlands that extend over the greater part of the empire; (3) the higher lands constituting the watersheds of the principal rivers; and (4) the groups of mountain ranges consisting of primitive rocks of purely upheaved strata. Mr. Wells then takes the three great hydrographic sections of Brazil, and treats of each in turn. Mr. Hosie describes one of the many journeys which he made through South-Western China while residing as agent at Chungking, the particular journey selected being one which carried him over new ground. A map which is appended shows the vast area covered by Mr. Hosie in his various journeys throughout Sze-chuan, Yunnan, and Kweichow provinces, and the very interesting observations on trade, present and prospective, in these regions show that his commercial duties have not been forgotten in the ardour of exploration. Mr. Bourne writes a paper on Diego Garcia, the principal of the Chagos Islands, which have recently received much attention on account of their position near the Red Sea route to Australia. The writer visited this remote spot to study the fauna and flora, and to make a collection of the corals of this part of the Indian Ocean.

THE SUN AND STARS[1]

VIII.

FOR the purpose of this lecture I have ventured to make a revision of the classification which has been suggested by Dr. Vogel. I should tell you, with reference to this question of classification, that Rutherford started it; then the German physicist, Prof. Zöllner, recommended a certain line of arrangement which practically had been adopted by Father Secchi. I afterwards saw grounds for saying that that line of arrangement, or sequence, was apparently a very just one, because it seemed, from some considerations I brought forward, that it really arranges the stars in the order in which the various phenomena would be produced in the atmosphere of any one of them; that is to say, that it was a true evolutionary line starting from the conditions of highest temperature. Others have followed in the same track since, including Dr. Vogel; but, so far as I can make out, any credit which is due to the existing arrangement is due to Father Secchi and to Prof. Zöllner.

I will give you the arrangement, which I think will perhaps bring the facts in the most clear way before you.

We have, then, the first class of stars with broad absorption-lines and very few of them, and a remarkable absence of general absorption at the blue end of the spectrum. Next we have a second class, in which the lines are more numerous, and they are thinner. In this class come our sun, Arcturus, Aldebaran, and Capella.

Then we pass from absorption-lines altogether, and in the third class we have stars with flutings, of which the darkest part and sharpest edge of the fluting lie towards the violet part of the spectrum. Of these stars we have α Herculis and α Orionis as examples.

Then we have another set of fluted stars in which the opposite holds good. The darkest part and sharpest edge of the fluting are to the right, towards the red end of each fluting. And the stars of this class are faint.

In those four classes we nearly exhaust all those forty or fifty millions of stars in the heavens which shine, and which we can study by means of a telescope.

Afterwards we come to stars with bright lines, or the fifth class; and this we must divide into two—A and B.

In sub-class A the bright lines are always lines of hydrogen, such as we have in the chromosphere of the sun. Many of these stars, as we shall see by and by, which are characterised by such a spectrum as this are variable stars; not all.

In sub-class B the lines are not lines of hydrogen, and I may say that up to the present moment the origin of these lines is not known. There are, I think, at the present moment about half a dozen stars known with spectra of this character.

So much, then, for a general view. We have four classes of stars determined by absorption—two, line absorption; two, fluting absorption; first, broad lines; second, thin lines; first, flutings with the sharp dark edge to the left; then, flutings with the sharp dark edge to the right. Then in the last class we leave absorption-lines altogether and get to bright lines, and we get two sub-classes—those which obviously contain incandescent hydrogen, and those which as obviously contain something else.

Just a word or two on each of these two classes.

The stars with dark thick lines can be best shown by this diagram, which I owe to the kindness of Dr. Huggins. You

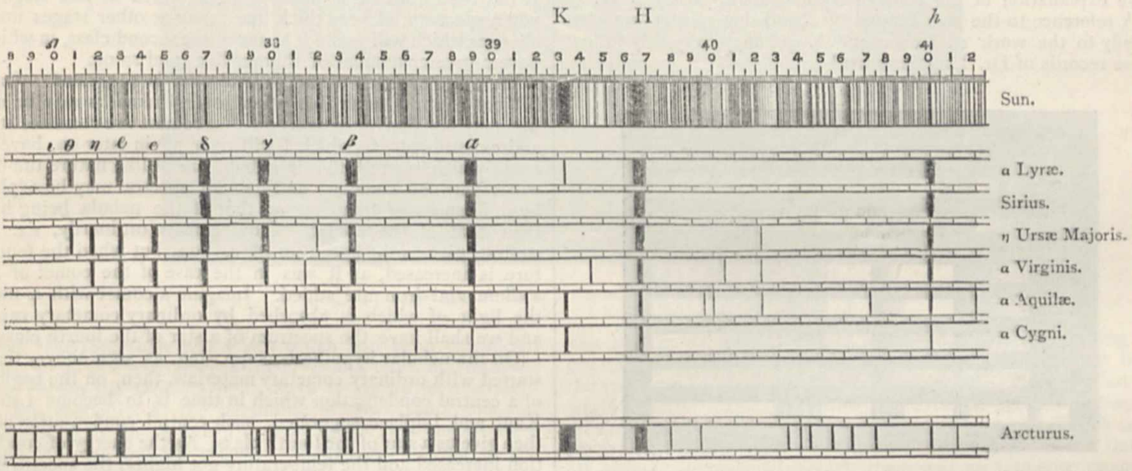


FIG. 22.—Stellar spectra (Huggins). In this diagram the spectrum of the sun is given at the top so that the spectra of the stars can be compared with it. The spectra of the stars are reduced from photographs, and the order of arrangement has been determined by the gradual thinning of the chief lines.

will see the difference between the thick absorption-lines and the thin ones, and you will remember that although stars may have the absorption-lines of identical wave-lengths, the thickness of these lines in the different stars may vary from one star to the other. Then we have the solar spectrum, the thickest lines of which are H and K, already referred to, in the ultra-violet portion.

The remarkable thing about the stars of the first class is that in some of them H is seen alone. In others H is seen with K thin, and in others H is seen with K almost as thick as itself. These lines are supposed to be due to the absorption of calcium. When calcium was studied in the laboratory a good many years ago, it was found that, at the temperature of the electric arc, the important brilliant line of calcium—the line which outshone all the others—was in the blue part of the sprectrum, and that the two lines which are most important, the two broadest lines, in the solar spectrum, are hardly seen at all in the spectrum unless the temperature of a very powerful induction coil be employed. Under these circumstances one may get the same relative importance given to the lines H and K in the violet which one gets with regard to the line in the blue as seen ordinarily, but only when the most tremendous means available to us are taken to secure what we consider to be the highest temperature.

On that ground it was prophesied that if the spectra of stars were ever photographed, probably some might be found hot enough to deal with those bright lines, H and K, in exactly the same way that the electric spark did; that is to say, that as in our laboratories we can get at a high temperature H and K obviously more brilliant than the blue line, whereas at low temperatures H and K are not seen at all, so we may anticipate similar results in the stars; if we can get stars very much hotter than any electric spark which we can obtain here, we might get H and K in different proportions, or each seen alone.

Now you see that prophecy has been fulfilled in this respect—that there are stars in which we get H alone without K, and we get different proportions of K added, as you can get different proportions of milk and sugar in a cup of tea.

Nor is that all. I am bound to tell you one other very curious fact. Since it was obvious when these stars were photographed that we were really photographing the result of an increased temperature; another prophecy was hazarded, and that was, that when, during an eclipse, the very brightest portion of the sun's atmosphere should be photographed in the ultra-violet and violet the spectrum would probably be very closely represented by the spectrum of these hottest stars. These photographs by

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes. Continued from p. 207.

Dr. Huggins of course only include the violet and the ultra-violet.

This is the place to tell you that in the eclipse of 1882 most of these lines which you see in the spectrum of Sirius and α Lyræ—lines which are entirely cloaked in the ordinary spectrum of the one, and in most of the other stars—was actually photographed in the hottest part of the sun's atmosphere during that eclipse; so that you see that there were two prophecies with regard to this set of lines, both of which were fulfilled.

Now, when in science a working hypothesis suggests a certain result under certain conditions—enables us to prophecy in fact, and the prophecy comes true (that is essential)—we have a right to believe that the hypothesis may be well founded.

Those, therefore, who hold that these differences are due to temperature, have considered their opinions to be considerably fortified by those two fulfilments of prophecy to which I have referred.

You see in the diagram that although in the upper spectra representing Sirius and α Lyræ the lines are very thick, as those particular lines thin out other lines come in; so that in passing down the diagram from the upper horizon to the lower one, we get two conditions of things—one which we leave when we get few lines thick, and another which we reach where we get a very considerable number of lines thin, as many people believe because these substances gradually, by reduction of temperature in the atmosphere of the star, have gone into combination with themselves or something else, and formed other more complex bodies, which give us of course new lines practically at the expense of the old ones. There then we get on that diagram representing a part of Dr. Huggins's magnificent work, the possible explanation of the passage from Class I. to Class II.

A reference to the two classes of absorption-spectra we owe chiefly to the work of Dunér and Vogel may very fitly follow these records of Dr. Huggins's work.

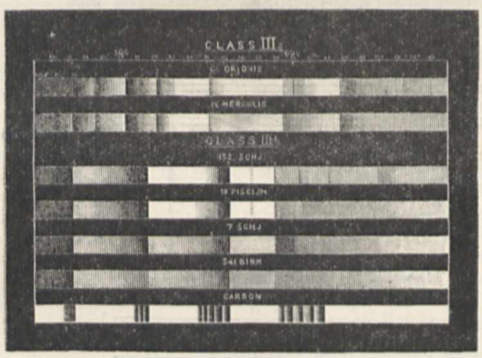


FIG. 23.—Dunér's spectra of Class III. compared with carbon.

I did not tell you (there was no necessity for it at the time) that one of the rarest substances apparently in the atmosphere of the sun at the present time is carbon. There is a possible trace of carbon in the sun's atmosphere I think, but the assertion depends upon the existence of a single fluting, so far as observations go, in the ultra-violet part of the spectrum.

Now in these two classes of stars, Class III*a*. and Class III*b*. of Vogel, which I have called Class III. and Class IV. to make things easier, in the former we get a spectrum which at present has not been investigated; and we cannot say to what substances the absorptions in stars (there are hundreds of them mind you) which give you that spectrum is due.

But with regard to the stars of the latter class (and there are hundreds of them) they give us absorptions about which there is no question whatever. There the light of the star, instead of being absorbed by iron vapour, by hydrogen vapour, by calcium vapour, and by nickel, and by cobalt vapours and the like, as in the atmosphere of our sun, is absorbed by carbon vapour, and carbon vapour almost pure and simple, for when you have taken these big flutings out of the spectrum, there is little left—which means that when you get rid of the absorption of carbon in the atmosphere of those stars there is very little absorption left. I mean that the remaining spectrum is very simple.

I have already pointed out that it is fair to say that if our sun were hotter its absorption would more resemble the spectrum of its hottest portion, and there we have the spectra such as Dr. Huggins photographed for us in Class I. and Class II. I have just told you that there we really do get the same lines as in our sun during an eclipse, when we can best get at the spectrum of the hottest portion.

Are we to suppose then that if our sun was very much cooler than it is we should get the spectrum of carbon developed in this enormous way? That is a question which at present it is not possible to answer. It is quite probable, but then if that be so, you will see two things: first, that the carbon, *if it exists as such* in such enormous quantities in the sun at the present moment, must be so far outside the region of high temperature that it cannot absorb in that manner. The second point is that it cannot be that particular substance which gives us the continuous spectrum in the photosphere, because if it were we should be certain, I think, to get more indications of bright carbon vapour, both in the spectrum of sunspots and in the spectra of prominences than we do, so that although these stellar spectra may set us thinking about the sun, they are rather more important to us at the present moment for telling us what possibly is not rather than for what probably is.

With regard to the stars with bright lines, the only point that I need make about them now is that it is most important that every endeavour should be made to determine the origin of those bright lines which, as I have already pointed out to you, are not coincident with the lines of hydrogen. But I would rather say what I have to say on that subject in connection with the next part of the comparison which we are making.

In the spectra which have already been indicated to you nothing has been said about change of star-light except at long periods. It has been hinted that possibly a star which at one stage gives you a spectrum of very thick lines, may at other stages undergo changes which will make it a star of the second class, in which we have a greater number of thinner lines and so on.

Here the question of stellar evolution is suggested. On this subject I cannot enter, but a few general remarks may be made. We may say that we now know that comets are clouds of stones, and experiments, to which I will refer again later on, have been made which suggest that if nebulæ are of like nature the differences between cometary and nebular spectra may be explained by differences of temperature, that of the nebula being higher than that of the comet. Now comets ordinarily, *i.e.* when coolest, give us the spectrum of carbon, but when the temperature is increased, as it was in the case of the comet of 1882, sodium and iron are added. Imagine a comet with a nucleus the light of which is absorbed by ordinary cometary vapours, and we shall have the spectrum of a star of the fourth class.

On the nebular hypothesis, supposing, as seen above, that we started with ordinary cometary materials, then, on the beginning of a central condensation which in time is to become a star, as Kant and Laplace suggested, such central condensation should then give us a star of the fourth class. As the energy of condensation increased and the temperature got higher, the spectra would change through the third and second classes, till ultimately, when the temperature was highest, the first class spectrum would be reached. On the slackening down of the temperature of the now formed star, the spectra of the second, third, and fourth classes would then be reproduced, but, of course, now in the direct order.

Nothing so far has been said about changes which instead of taking millions and perhaps billions of years can be undergone in a few days, or weeks, or months.

Careful observations in the heavens have shown a great many years ago that a large number of stars are subject to a considerable change in their brilliancy. The most important work which has been recently done in what we may call the philosophy of variable stars we owe to the diligence of Prof. Pickering of Harvard Observatory in the United States. He has proposed a classification of variable stars, and for the purpose of this lecture I have just to make a slight alteration in his classification, as I did in the other one. First I will tell you broadly what the classification is, and then I will describe as briefly as may be some of the more important details which are of the greatest moment and interest. There is a whole mine of interest here which of course I cannot touch in the time at my disposal.

The first class of these variable stars then may fitly form what are called temporary or new stars—stars which as we have had evidence during the last few years—in 1866 and 1876, and at the end of last year, suddenly burst into visibility in the heavens as if they were new creations, last for a certain time, and then die away. These stars have bright lines in their spectra.

The second class gives us those bodies which, although form do not appear and disappear with any suddenness comparable to that, yet indicate that there is something very extraordinary going on in them. They also belong to our fifth class of stellar spectra. They have bright lines as well as absorption-lines. These bright lines, however, only last for a short time; but bright lines there are.

Next we get stars not so interesting from the large point of view, in which we get considerable changes in their luminosity extending over very long periods, but their spectrum apparently does not change to any great extent. At least, no change of the spectra of these stars has yet been recorded.

After these, in Class IV. we get small irregular changes, and in fact, Dr. Gould—and there is no greater authority than he—says that every star in the heavens undergoes some slight change in its light at some time or other, but at all events those stars in Class IV. have undergone sufficient change to find themselves recorded among suspected variables, while the change actually has been so irregular that one has really practically not known to what class to assign them; and therefore they have a class of their own.

The next class of variables I will, on Dr. Pickering's authority, define as eclipsed stars: that is to say, in this class the change of light does not come from anything in the star itself, but from something that is happening outside it. What is happening you will see by and by.

Now with regard to our first class—the new stars. The accompanying diagram will give an idea of what has been recorded with regard to them. The information which the diagram affords will also give a pretty fair comparison between these variables and the other classes.

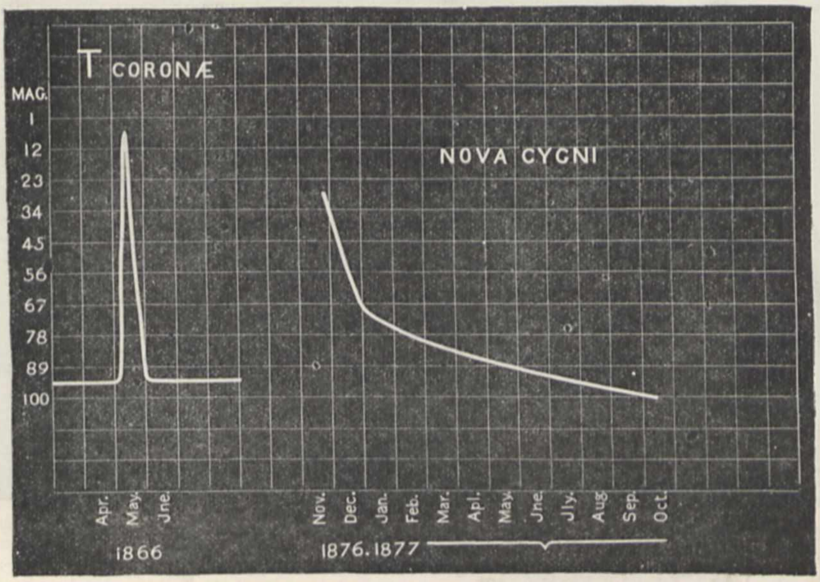


FIG. 24.—Light curves of T Coronæ and Nova Cygni.

In the year 1866 there was a star which had been chronicled for many years as a star between the ninth and tenth magnitudes; for this reason till 1866 its light curve is shown as a straight line. But suddenly, at the beginning of May 1866, this star suddenly burst up into a star of very nearly the first magnitude—between the first and the second. Many observations, as you may imagine, were made on it, and among them Dr. Huggins turned the spectroscope to it, and it was found that the difference between the star when it was between the first and second magnitude, and when it was between the ninth and tenth magnitude, was that in its spectrum when it was most brightly shining we got the spectrum of incandescent hydrogen. We had, in fact, the spectrum of the chromosphere of the sun. It was called "a world on fire." But you know that even the sun is not a world on fire. If it were, and if it were made of the best Welsh coal, we are told that it would last only a few thousand years. But at all events, whatever happened, there was an immense quantity of hydrogen suddenly rendered incandescent, which radiated its light to us.

Almost as suddenly this star went down again, and by the

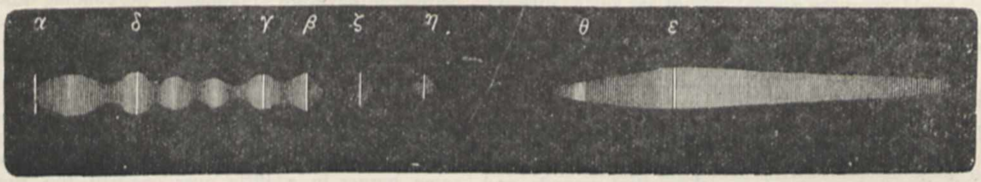


FIG. 25.—Cornu's spectrum of Nova Cygni.

end of the month it had become a ninth or tenth magnitude star, and went about its ordinary business just as if the incident had never happened to it.

Take the next star in 1876, ten years afterwards. It was called a new star—Nova in Cygnus. The point about this one is that it began suddenly as a star of between the third and the fourth magnitudes. It had had no former history. It had never been mapped. It did not visibly rise to the position of a third or fourth magnitude star from a lower level as the other one had done, but it burst out suddenly. Note the difference in its subsequent history. Its light curve, instead of going suddenly down as the one in Corona did in 1866, goes down gently, and takes nearly a year to get to the tenth magnitude. When it got to the tenth magnitude what happened to it? It gave the spectrum of a nebula. It had ceased to be a star. An interesting point is to inquire—unfortunately we shall never now know—whether or not that mass of matter did not exist as a nebula before 1876.

I have stated that, following close upon the publication of Dr. Vogel's paper on the new star, another paper announced the fact that the new star had put on the appearance presented ordinarily by the so-called planetary nebulæ.

Of all the lines chronicled by Cornu and Vogel during its stellar stage, only one remained, that, namely, which the latter observer showed to be constantly increasing in brightness while all the rest were waning, and which, moreover, was coincident in position in the spectrum with that observed in the majority of the nebulæ.

The observations of such rare phenomena as the so-called new stars are of such vast importance, and will no doubt ultimately provide us with a clue to so many others of a different order, that we may well congratulate ourselves that this Nova was so well watched, and that there is such perfect completeness and unity in the chain of recorded facts.

It should have been perfectly clear to those who thought about such matters that the word star in such a case is a misnomer

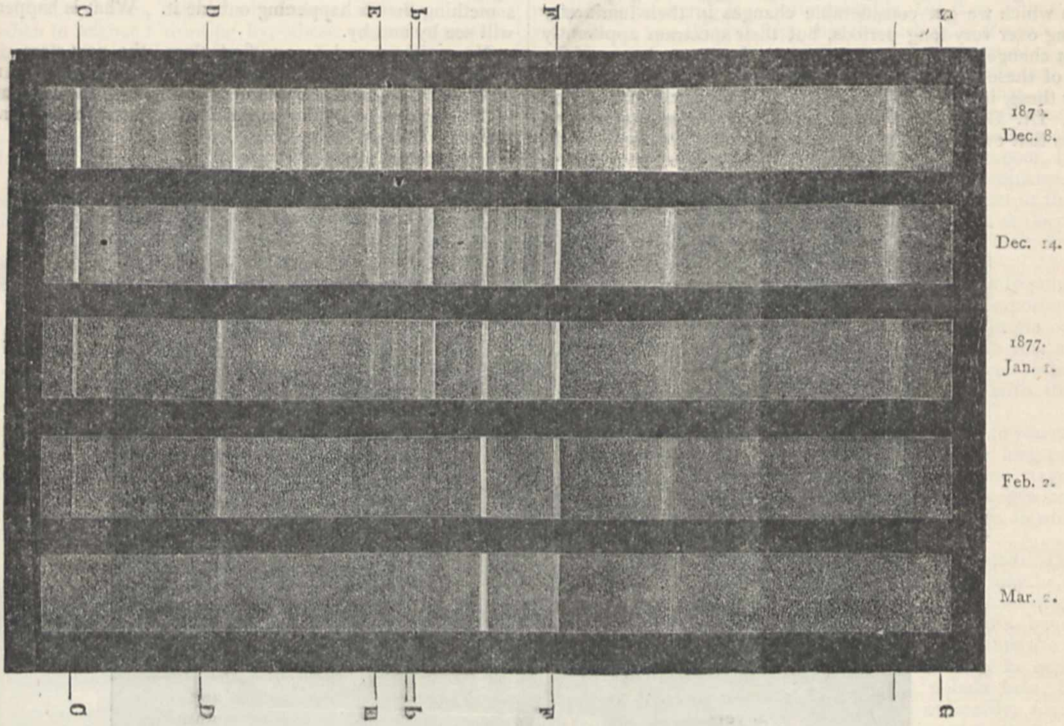


Fig. 26.—Vogel's spectrum of Nova Cygni.

from a scientific point of view, although no word would be better to describe it in its popular aspect. The word is a misnomer for this reason. If any star, properly so called, were to become "a world on fire," were to "burst into flames," or in less poetical language, were to be driven either into a condition of incandescence absolutely, or to have its incandescence increased, there can be little doubt that thousands or millions of years would be necessary for the reduction of its light to the original intensity.

Mr. Croll has shown that if the incandescence observed came for instance from the collision of two stars, each of them half the mass of the sun, moving directly towards each other with a velocity of 476 miles per second, light and heat would be produced which would cover the present rate of the sun's radiation for a period of 50,000,000 years.

A very different state of affairs this from that which must have taken place in any of the Novas from the time of Tycho to our own, and the more extreme the difference the less can we be having to deal with anything like a star properly so called.

The very rapid reduction of light in the case of the new star in Cygnus was so striking that I at once wrote to Mr. Hind to ask if any change of place was observable, because it seemed obvious that if the body which thus put on so suddenly the chromospheric spectrum were single, *it might only weigh a few tons or even hundredweights*, and being so small might be very near us. No motion, however, was perceptible, and Dr. Ball has since stated that he could detect no parallax.

We seem driven, then, from the idea that these phenomena are produced by the incandescence of large masses of matter, because if they were so produced, the running down of brilliancy would be exceedingly slow. J. NORMAN LOCKYER

(*To be continued.*)

FLAME CONTACT, A NEW DEPARTURE IN WATER HEATING[1]

IT is my intention to prove to you on theoretical grounds, and also by experimental demonstration, in such a manner as will admit of no possible doubt, that the present accepted system of water heating, by gaseous or other fuel, is a very imperfect means for an end, and is, both in theory and practice, essentially faulty. My statements may appear bold, but I come prepared to prove them in a manner which I think none of you will question, as the matter admits of the simplest demonstration. I will, in the first place, boil a specified quantity of water in a flat-bottomed vessel of copper; the time required to boil this you will be able to take for yourselves, as the result will be visible by the discharge of a strong jet of steam from the boiler. I will then take another copper boiler of the same form, but with only one-half the surface to give up its heat to the water, and will in this vessel boil the same quantity of water with the same burner in a little over one-half the time, thus about doubling the efficiency of the burner, and increasing the effective duty of the heating surface fourfold, by getting almost double the work from one-half the surface.

The subject is a comparatively new one, and my experiments are far from complete on all points, but they are sufficiently so to prove my case fully. As no doubt you are all aware, it is not possible to obtain flame contact with any cold, or comparatively cold, surface. This is readily proved by placing a vessel of water with a perfectly flat bottom over an atmospheric gas-burner: if the eye is placed on a level with the bottom of the vessel a clear space will be seen between it and the flame. I cannot show this space on a lecture-table to an audience, but I can prove its existence by pasting a paper label on the bottom

[1] A Paper read by Thomas Fletcher, F.C.S., at the Gas Institute Meeting, London, June 9.

of one of the boilers, and exposing this to the direct impact of a powerful burner during the time the water is being boiled, and you will see that it comes out perfectly clean and uncoloured. Now it is well known that paper becomes charred at a temperature of about 400° F., and the fact that my test-paper is not charred proves that it has not been exposed to this temperature, the flame being, in fact, extinguished by the cooling power of the water in the vessel. I need hardly remind you that the speed with which convected or conducted heat is absorbed by any body is in direct ratio to the difference between its own temperature and that of the source of heat in absolute contact with it; and therefore, as the source of the heat taken up by the vessel is nothing but unburnt gases, at a temperature below 400° F., the rate of absorption cannot, under any circumstances, be great, and the usual practice is to compensate for this inefficiency by an enormous extension of surface in contact with the water, which extension I will prove to you is quite unnecessary. You will see I have here a copper vessel with a number of solid copper rods depending from the lower surface; each rod passes through into the water space and is flattened into a broad head, which gives up its heat rapidly to the water. My theory can be stated in a few words: The lower ends of the rods, not being in close communication with the water, can, and do attain, a temperature sufficiently high to admit of direct flame contact, and as their efficiency, like that of the water surface, depends on the difference between their own temperature and that of the source of heat in absolute contact with them, we must, if my theory is correct, obtain a far greater duty from them. I do not wish you to take anything for granted, and although the surface of the rods, being vertical, can only be calculated for evaporating power at one-half that of a horizontal surface, as is usual in boiler practice, my margin of increased duty is so great that I can afford to ignore this, and to take the whole at what its value would be as horizontal surface, and still obtain a duty 50 per cent. greater from a surface which is the same in area as the flat-bottomed vessel on the fire side, but having only one-third the surface area in contact with the water. I do not, of course, profess to obtain more heat from the fuel than it contains, but simply to utilise that heat to the fullest possible extent by the use of heating surfaces, beyond comparison smaller than what have been considered necessary, and to prove not only that the heating surfaces can be concentrated in a very small area, but also that its efficiency can be greatly increased by preventing close water contact, and so permitting combustion in complete contact with a part of the heating surface. I will now boil 40 ounces of water in this flat-bottomed copper vessel, and, as you will see, sharp boiling begins in 3 minutes 15 seconds from the time the gas is lighted. The small quantity of steam evolved before this time is of no importance, being caused partly by the air driven off from the water and partly from local boiling at the edges of the vessel owing to imperfect circulation. On the bottom of this vessel is pasted a paper label which you will see is untouched by the flame owing to the fact that no flame can exist in contact with a cold surface.

It may be thought that, owing to the rapid conducting power of copper, the paper cannot get hot enough to char. This is quite a mistake, as I will show you by a very curious experiment. I will hold a small plate of copper in the flame for a few seconds, and will then hold it against the paper. You will see that, although the copper must of necessity be at a temperature not exceeding that of the flame, it readily chars the paper. We can, by a modification of this experiment, measure the depth of the flameless space, as the copper, if placed against the paper before it has time to be previously heated, will, if not thicker than 1/40 inch, never become hot enough to discolour the paper, showing that the flame and source of heat must be below the level of a plate of metal this thickness.

In repeating this experiment I must caution you to use flour paste, not gum, which is liable to swell and force the paper past the limit of the flameless space, and also to allow the paste to dry before applying the flame, as the steam formed by the wet paste is liable also to lift the paper away and force it into the flame. I will now take this vessel, which has only one-half the surface in contact with the water, the lower half being covered with copper rods, 3/16 inch diameter, ½-inch centres apart, and 1½ inch long, and you will see that with the same burner as before, under precisely the same conditions, sharp boiling takes place in 1 minute 50 seconds, being only 13 seconds more than half the time required to produce the same result with the same quantity of water as in the previous experiment. Although the water surface in contact with the source of heat is only one-half that of the first vessel, and the burner is the same, we can see the difference not only in the time required to boil the 40 ounces of water, but also in the much greater force and volume of steam evolved when boiling does occur. With reference to the form and proportions of the conducting rods, these can only be obtained by direct experiment in each case for each distinct purpose. The conducting power of a metallic rod is limited, and the higher the temperature of the source of heat, the shorter will the rods need to be, so as to insure the free ends being below a red heat, and so prevent oxidation and wasting. There are also other reasons which limit the proportions of the rods, such as liability to choke with dirt and difficulty of cleaning, and also risk of mechanical injury in such cases as ordinary kettles or pans; all these requirements need to be met by different forms and strengths of rods to insure permanent service, and, as you will see further on, by substituting in some cases a different form and type of heat conductor. To prove my theory as to the greater efficiency of the surface of the rods in contact with the flame as against that in direct contact with the water, I have another smaller vessel which, including the rods, has the same total surface in contact with the flame, but only one-third the water surface as compared with the first experiment. Using again the same quantity of water and the same burner we get sharp boiling in 2 minutes 10 seconds, being an increase of duty of 50 per cent., with the same surface exposed to the flame. The rods in the last experiment form two-thirds of the total heating surface, and if we take, as I think for some careful experiments we may safely do, one-half the length of the rods to be at a temperature which will admit of direct flame contact, we have here the extraordinary result that flame contact with one-third of the heating surface increases the total fuel duty on a limited area 50 per cent. This really means that the area in contact with flame is something like six times as efficient as the other. In laboratory experiments it is necessary not only to get your result, but to prove your result is correct, and the proof of the theory admits of ready demonstration in your own laboratories, although it is unfit for a lecture experiment, at all events in the only form I have tested it. If you will take two ordinary metal ladles for melting lead, cover the lower part of one of these with the projecting rods or studs and leave the other plain, you will find on melting a specified quantity of metal in each that the difference in duty between the two is very small. The slight increase may be fully accounted for by the difference in the available heating surface reducing the amount of waste heat passing away, and this proves that flame-contact, and therefore quick absorption of heat, takes place on plain surfaces as soon as these are above a certain temperature, which, in a metal ladle, very soon occurs. What the temperature is which admits of flame-contact I have, as yet, not been able to test thoroughly, and it will need some consideration how the determination of this is to be correctly made; at the same time it is a question in physics which should be capable of being answered.

Let us now take the other side of the question. If the efficiency of a surface depends on flame contact, there must of course be flame, or at least gases of an extremely high temperature, and we therefore cannot expect this extraordinary increase of efficiency in any part of our boiler except where flame exists, and if these projectors are placed in a boiler, anywhere except in contact with flame, their efficiency must be reduced to that of ordinary heating surface. They are, of course, useful, but only in the same way as ordinary flue surface. When we come to boilers for raising steam, which have to stand high pressures, we come to other difficulties of a very serious nature, which require special provision to overcome them. To put such rods as I have referred to in a boiler-plate necessitates the plate being drilled all over with holes, causing a dangerous source of weakness, as the rods cannot be used as stays; further than this, they would render really efficient examination a matter of extreme difficulty, and would be liable to give rise to frequent and almost incurable leakages; but there is, fortunately, a very simple way to overcome this difficulty. I have found that rods or points, such as I have described, are not necessary, and that the same results can be obtained by webs or angle-ribs rolled in the plates. My experiments in this direction are not complete, and at present they tend to the conclusion that circular webs, which would be of the greatest efficiency in strengthening the flues, are not so efficient for heating as webs running lengthwise with the flue, and in a line with the direction of the flame. This point is one which I am at present engaged in testing with experimental boilers of the Cornish and Lancashire types, and as, with gas, we have a fuel which renders every assistance to the experimenter, it will not take long to prove the comparative results obtained by the two different forms of web. Those of you who have steam-boilers will, no doubt, know the great liability to cracking at the rivet-holes in those parts where the plates are double. This cracking, so far as my own limited experience goes, being usually, if not always, on the fire side, where the end of the plate is not in direct contact with the water—where it is, in fact, under the conditions of one of the proposed webs —I think we may safely come to the conclusion that this cracking is caused by the great comparative expansion and contraction of the edge of the plate in contact with the fire; and it will probably be found that if the plates are covered with webs the whole of the surface of the plates will be kept at a higher and more uniform temperature, and the tendency to cracks at the rivet-holes will be reduced. This is a question not entirely of theory, but needs to be tested in actual practice.

There is another point of importance in boilers of the locomotive class, and those in which a very high temperature is kept in the fire-box, and this is the necessity of determining by direct experiment the speed with which heat can safely be conducted to the water without causing the evolution of steam to be so rapid as to prevent the water remaining in contact with the plates, and also whether the steam will or will not carry mechanically with it so much water as to make it objectionably wet, and cause priming and loss of work by water being carried into the cylinders. I have observed in the open boilers I use that when sufficient heat is applied to evaporate 1 cubic foot of water per hour from 1 square foot of boiler surface, the bulk of the water in the vessel is about doubled, and that the water holds permanently in suspension a bulk of steam equal to itself. I have, as yet, not had sufficient experience to say anything positively as to the formation or adhesion of scale on such surfaces as I refer to, but the whole of my experimental boilers have up to the present remained bright and clean on the water surface, being distinctly cleaner than the boiler used with ordinary flat surfaces. It is, I believe, generally acknowledged that quick heating and rapid circulation prevents to some extent the formation of hard scale, and this is in perfect accord with the results of my experiments. The experiments which I have shown you I think demonstrate beyond all question that the steaming-power of boilers in limited spaces, such as our sea-going ships, can be greatly increased; and when we consider how valuable space is on board ship, the matter is one worthy of serious study and experiment. It may be well to mention that some applications of this theory are already patented.

I will now show you as a matter of interest in the application of coal gas as a fuel how quickly a small quantity of water can be boiled by a kettle constructed on the principle I have described, and to make the experiment a practical one I will use a heavy and strongly-made copper kettle which weighs 6½ lbs., and will hold when full one gallon. In this kettle I will boil a pint of water, and, as you see, rapid boiling takes place in 50 seconds. The same result could be attained in a light and specially-made kettle in 30 seconds, but the experiment would not be a fair practical one, as the vessel used would not be fit for hard daily service, and I have therefore limited myself to what can be done in actual daily work rather than laboratory results, which, however interesting they may be, would not be a fair example of the apparatus in actual use at present.

THE CRATERS OF MOKUAWEOWEO, ON MAUNA LOA [1]

DURING last year I was engaged for many months in surveying lands on Mauna Hualalai and Mauna Loa, in Hawaii, and in that way had an opportunity of making investigations of craters and lava flows that may be of interest to those studying volcanic phenomena.

It would seem that, as the best histories are those written long after the events which they record, when all the reports of eye-witnesses can be carefully examined, so the best descriptions of volcanic action may be obtained long after eruptions, by carefully investigating the records indeliby inscribed in the rocks.

The ascent of Mauna Loa is so seldom made that a brief account of my excursions may be interesting.

[1] By J. M. Alexander, from the *Hawaiian Commercial Advertiser* of October 1885.

On September 1, 1885, I set out in company with Mr. J. S. Emerson, of the Hawaiian Government Survey, to ascend that mountain from the table-land east of Hualalai, along the south side of the lava-flow of 1859, which, as many will remember, was visited by a party from Oahu College. We were provided with mules for riding and pack-donkeys, and accompanied by several natives, including a so-called guide, who lost himself and delayed us over a day in searching for him.

Our route led first through a narrow belt of forest, consisting of mamane, ohia, and sandalwood trees; then through a scanty vegetation of ohelos and the beautiful *Cyathodes Tameiameiæ*, and at last beyond the limits of vegetation, without a vestige even of moss or lichen, over a wonderful and awful billowy waste of "pahoehoe" lava, traversed by tracts of "aa" and deep chasms.

At about two-thirds of the distance towards the summit we passed the rugged crater hill from which the outbreak of 1859 had issued, and here our path was strewed with pumice and "Pele's hair" from that eruption. There was an enormous quantity of lava poured forth from the small fissure of this crater, forming a stream from half a mile to two miles wide, and reaching nearly thirty miles to the ocean at Kiholo. Lower down I counted eighteen species of ferns and a dozen kinds of phenogamous plants already growing on this flow. In this vicinity the caverns contained many carcasses of wild goats. In one further south I counted eighty of their skeletons and decaying bodies. They had probably leaped in for shelter, and had been unable to leap out.

When near the summit our guide warned us to descend, because of an approaching storm; but Mr. Emerson and I, anxious to accomplish the object of our journey, set out without him through the driving rain that soon turned into hail and then into snow, marking our route with flags so that we might be able to find our way back. In a short time we reached the brink of the vast crater of Mokuaweoweo, filled with fog and surrounded by frightful precipices. Along this brink were numerous deep fissures filled with ice and water, the beginning of cleavage for avalanches into the crater. Here, and for a quarter of a mile below, we observed many rocks of a different kind from the surface lavas, solid, flinty fragments of the foundation walls, weighing from fifty pounds to a ton, which had formerly fallen down upon the crater floor and had afterwards been hurled out during eruptions. I noticed similar rocks around the summit craters of Hualalai. It would be unsafe to approach the crater at this place during eruptions, when such brickbats were flying.

We returned to our camp about noon, and sent the poor animals, which had stood all night in the icy wind tied to jagged rocks, in the care of the guide down the mountain; and with the help of one native, with much difficulty, carried a tent and supplies to the summit.

At evening the fog lifted and gave us a glimpse of the craters. Immediately below us lay the central crater, surrounded by almost perpendicular walls, with a pahoehoe floor streaked with grey sulphur cracks, from hundreds of which there issued columns of steam, and with a still smoking cone in the south end. Beyond this central crater on the south rose a high plateau, and beyond this plateau still further south we saw an opening into another crater small and deep. In the opposite direction, north of the central crater, appeared another higher crater like an upper plateau, from which a torrent of lava had once poured into the central crater, and north of this again another crater, like a still higher plateau, from which also lava had flowed south.

Thus it was evident, as appeared more clearly by subsequent investigation, that Mokuaweoweo is not simply one crater, but a series of four or five craters, the walls of which have broken down, so that they have flowed into each other.

The crater of Haleakala, on Maui, was probably formed in a similar manner out of several ancient craters which have broken into each other. These vast chasms may well be called calderas, as has been recommended by Captain Dutton. On Hualalai there is a series of craters having the same relative position as those of Mokuaweoweo, and crowded so close together as to be almost broken into one. On the older mountains, like that of West Maui, such congeries of craters have evidently formed the starting-points for deep valleys, which the rain torrents, leaping down their lofty walls, have torn out through concentric layers of lava to the sea. Just before sunset we saw the splendid phenomenon of the "Spectre of the Brocken" (Hookuaka), our shadows on the mist, encircled with rainbows, over the black inferno.

We erected a survey signal for determining the location and height of the summit, and also of an important land boundary in the crater, viz. the corner where the four lands of Keauhou, Kahuku, Kapapala, and Kaohe meet, which is at the cone in the central crater. We then descended the mountain, carrying more weight than was agreeable, until we were met by our natives bringing up our mules, for which we had signalled by fires. On the way down a violent thunderstorm was raging below us, while we were above in clear air. On my next trip up this mountain I found a tree on the slope below completely rent to splinters, and parts of it thrown several rods, by the lightning of this storm.

During the next month I ascended the mountain again, this time carrying an excellent engineer's transit. As I had no guide, I marked most of the way up by strips of cloth fastened to rocks to find the way back; and taught by our former experience, I took a donkey-load of fuel, as well as a load of grass for making a spherical survey signal, which served me several nights as a bed. When about half-way up the mountain, one of our pack-donkeys broke into a lava cave, and slid downwards nearly out of sight. It was extricated with great difficulty by a direct upward lift with ropes. I then sent one of my men down the mountain with the donkeys, retaining the other man with me. The first night on the summit was uncomfortable enough for us, with a storm from the north. At midnight we observed with a lighted candle that the roof of the tent was a-sparkle with icicles, and on touching it found it frozen stiff as a bullock's hide. In the morning we found a beautiful sheet of snow an inch thick over the tent and over all the ghastly blackness of the rocks. Every morning of our stay upon the mountain we found the water frozen in our kettles, and hoar-frost on the rocks.

In the clear frosty air I was able with my transit to take the bearings of a dozen survey signals on the slopes and summit of Hualalai.

The new spherical signal which I had erected was afterwards accurately determined by observations from more than twenty stations on Mauna Kea, Hualalai, and in South Kona, and thus a trigonometrical station was at last located on the very summit of Mauna Loa.

On the second day I descended from the west brink of the crater down the track of a high avalanche of rocks upon the second plateau, and again from this plateau by the path of another avalanche into the central crater, stepping cautiously down upon the black floor of the crater, lest it should break under our weight. We found this caution unnecessary, for much of the crater bottom proved to be the most solid kind of pahoehoe.

Here we stood as on the congea'ed surface of a tossing sea that had dashed its fiery surf thirty feet up on the surrounding walls. We travelled directly south for the cone, the boundary corner, which I was to locate, erecting two flags about 2500 feet apart for the ends of our base-line. In some places, where there appeared to have been violent action, the lava broke under our feet, letting us down into caverns. In some large tracts the pahoehoe was covered with pumice, indicating the violence of the former surging and tossing of the lava, for pumice and other light lavas seem to be the froth and foam of the fiercest eruptions. Just before reaching the cone we came to a deeper basin, twenty or more feet below the rest of the crater bottom and about 400 feet wide, covered with the most friable lava, swollen upwards as though raised by air-bubbles, and this basin extended in a lava flow to the north-east along the side of the crater.

Probably this was the place of the last eruption, and of most of the eruptions of this central crater. We found the cone to be composed of pumice and friable lava still hot and smoking, and very difficult to ascend, but we succeeded in climbing to its top, 140 feet high, and in setting up a flag there for the boundary corner. We then descended between the east and west peaks of this cone over huge rocks and deep chasms.

From the fact that this cone is represented on Mr. J. M. Lydgate's map of 1874, I conclude that it has been of long continuance, probably composed of the cinders of successive eruptions, and that the deep basin to the windward of it, like Halemaumau in Kilauea, has continued many years, and is situated at the great central volcanic throat of the mountain.

I then returned to the second plateau to the north, and thence clambered out to the east of Mokuaweoweo by the extremely interesting route of a former cataract of lava from the summit into the crater, the swift downfall of which had turned its lava almost into pumice, and the black, shining spray of which lay spattered on the surrounding rocks.

Further south I observed the course of two other cataracts, which had poured directly into the central crater. At the summit I found the deep fissure from which the outbreak had come that caused these cataracts, and ascertained that it had also poured an immense stream north upon the first plateau and thence south to the central crater. Crossing from this place to the north over the first plateau I suddenly came to a frightful circular crater in the bed of the plateau, apparently 600 feet deep and 1000 feet wide, with a cone in its centre still smoking. We were obliged to hurry with exhausting speed over rough lava in order to reach our tent before night.

The next day we took the transit to the stations in the crater, and the next we surveyed with it along the western brink to the extreme south end, where we looked down into the south crater, which is about 800 feet deep and 2500 feet wide. The length of the whole chasm, or "caldera," I have ascertained to be about 19,000 feet, the greatest breadth 9000 feet, and the greatest depth 800 feet. The area is three and six-tenths square miles. A map of these craters has been sent to the Government Survey Office.

On the south-west side, near the junction of the central crater with the south plateau, I found that there had been another eruption, from fissures that were still smoking, and that this eruption had poured an immense stream southward towards Kahuku, and had also poured cataracts into the south crater from all sides.

I had everywhere observed that there had been great flows from the summit brink down the mountain, and had wondered at the thought of the vast chasm having filled up and overflowed its brim.

This, however, turned out to be an incorrect view. The flows have not been from the lowest parts of the brim, but from some of the highest, which could not have been the case in an overflow.

The walls of the craters are largely composed of loose, old, weather-beaten rocks, and large tracts of the plateau are composed of old pahoehoe that has not been overflowed for ages, which would not be the case if the craters filled and overflowed.

These outbreaks from fissures around the rim indicate that the lava has rather poured into the crater than out of it; and that it has poured from such fissures in vast streams down the mountain-side. What enormous quantities of lava may flow from such small fissures is illustrated by the flow of 1859. The question arises, How has the lava risen high enough to pour in extensive eruptions through these fissures, almost a thousand feet above the bottom of the crater, without rising in the crater and overflowing it? The same question has often been asked in respect to the rise of liquid lava to the summit of Mauna Loa without overflowing the open crater of Kilauea, 10,000 feet below.

We have seen that it is not because the lava in Mokuaweoweo is lighter than that in Kilauea that it rises so much higher. In fact, it is as solid there as in Kilauea. The explanation has occurred to me that molten lavas rise the higher the smaller the conduits in which they rise from their subterranean reservoirs.

An illustration is afforded by the "spouting horns" on the sea-coast, where the ocean, rushing into caverns of rock, drives columns of water through small openings to the height of forty or fifty feet above high-water mark. We see another illustration in water conveyed in pipes, which jets the higher the smaller the orifice.

However violent the subterranean pressure may be, Kilauea does not overflow, but only rages the more fiercely, because its passage from the chambers below is so large. But through the vast mountain of Mauna Loa there is no doubt a constricted conduit leading upward; and there must be still smaller conduits to the fissures on the summit rim. On this theory, the molten lava rises higher through Mauna Loa than in Kilauea, because Mauna Loa has the smaller throat.

It is therefore by no means certain that there is no subterranean connection between the two volcanoes.

Another vexed question, of which several solutions have been proposed, is the mode of formation of the two strongly contrasted forms of lava known as "pahoehoe" and "aa." The former term is applied to tracts of comparatively smooth and uniform lava, as though it had cooled while flowing quietly; the latter to tracts of broken lava, as though it had cooled when tossing like an ocean in a storm, and had then been broken up by earthquakes. As Mr. Brigham states, "No words can convey an idea of its horrible roughness and hardness."

My own belief is that "aa" has been formed simply by obstructions breaking the quiet flow of molten lava. Every observer has noticed that "pahoehoe" contains ducts and air-chambers, having an upper crust contorted into the shape of the waves and ripples of the flowing lava. The liquid lava has evidently flowed in these ducts and chambers, and at last flowing out has left them empty with glazed interior surfaces. In like manner torrents of lava have poured through caverns down the mountains to the sea, and flowing out have left the innumerable caves, smooth and shining within, to be found all over the island. Now, when there are obstructions on the earth's surface or meeting flows, this system of ducts is broken up, and fragments of lava are carried along on the surface, piling up higher than the adjacent "pahoehoe," like ice-packs in rivers, and sometimes rolling immense boulders twenty and thirty feet high, which now stand on the "aa" with the drip glistening over them. This theory is confirmed by the fact that "aa" is always higher than the adjoining "pahoehoe," and also by the fact, which I especially noticed in the flow of 1859, that wherever there are open spaces in lava flows (kipukas), the old lava under the flow is found to be "pahoehoe" under "pahoehoe" and "aa" under "aa."

While surveying the region I was extremely interested in the arrangement of the craters; and now having determined the situation of more than fifty of them on Mauna Loa, Hualalai, and Mauna Kea, I have ascertained that there is a method in their arrangement. They are not arranged relatively to the mountain on which they are situated, but relatively to the points of the compass. There seems to have been a series of nearly parallel fissures through which these craters have risen, in lines running from S. 40° E. to S. 60° E. There are a few arranged in lines running N. 50° E.

It has been remarked by Mr. W. T. Brigham that, while the general trend of the Hawaiian group and of the major axis of each island is N. 60° W., there is no crater on the islands whose major axis is parallel to this line. "On the contrary," he continues, "a very interesting parallelism is observed among all the craters, and invariably the longest diameter is north and south." It would be more correct to say that the major axes of the great craters are generally at right angles to the general axis of the group, *i.e.* about N. 30° E. Haleakala and the ancient Kipahulu caldera appear to take the other direction, but the statement is certainly true of the great calderas of Kilauea and Mokuaweoweo, which have other points of resemblance.

Thus in both the highest walls are on the western side, and in both the action is working towards the south-west, as is indicated by the fact that the north-east craters are nearly filled up, while the deepest and active craters are in the south-west end of the caldera.

It has been shown by Prof. Dana and other geologists that the principal mountain-ranges of the globe, as well as the main coast-lines and chains of islands, take the two directions just mentioned, "which are in general tangential to the Arctic and Antarctic circles." Thus it appears that the laws in accordance with which the volcanic forces are now operating in these islands are the same as those by which all the grand features of our world have been established, and possibly related to the laws of crystallisation which pervade the mineral kingdom; and thus we perceive a unity in the processes of the globe.

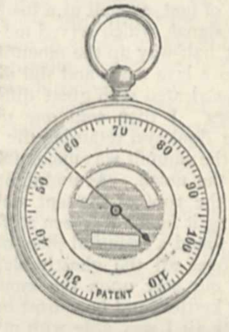
In conclusion, I would remark that to my mind the most plausible theory to account for volcanic action is that of Mallet, that the contraction of the earth's crust continually going on under the power of gravitation causes as much internal heat as would be required to cause a similar expansion. Prof. Dana has remarked that "the fact is well established that motion in the earth's rocks has been a powerful source of heat," and that the annual crushing of not over one-sixth of a cubic mile of rocks in the earth would cause all the volcanic phenomena of the world. This theory has the beauty of attributing all these phenomena to a single cause, and of thus suggesting the thought of the one great Power above the inexplicable forces of gravitation, who continues all the forces of the universe.

IMMISCH'S THERMOMETER

THIS instrument depends for its action upon the opening and closing of a minute volute Bourdon tube, which for this purpose is filled with expansive liquid and hermetically sealed. One end of the tube is fixed, and the free end is brought into contact with the short arm of a lever, the long arm of which forms a rack gearing with a pinion which carries the pointer. The position of the tube with regard to the short lever-arm is such that for ordinary purposes the divisions on the dial are equal, while for clinical use the scale is an increasing one, in order that near blood-heat the divisions become wider to permi of a fraction of a degree being read off accurately.

The success which these instruments meet with is owing principally to their sensitiveness, accuracy, and non-liability to get broken. If they should meet with an accident they can be easily repaired.

The appellation "metallic" does not seem to be a happy one for these thermometers, as they are likely to be confounded with the unsuccessful attempts which have been made to produce instruments for similar purposes by means of bi-metallic laminæ. The defects of the latter are the extremely small *vis viva* avail-



able for the work of multiplying the small motion of the laminæ, and the liability to not return to precisely the same point after being subjected to extremes of temperature. In this latter respect there is a double security with the instrument which is the subject of this notice. The tube is in itself a very flexible spring, the motion of which does not overreach the limits of perfect elasticity, and its position at any given time is determined by the volume of the liquid, which, of course, remains always a constant quantity whatever the volume may be. As the tube is absolutely full, it must of necessity always accommodate itself to the volume and correctly indicate the temperature.

As regards accuracy, we are informed that upwards of 500 have already been tested at Kew—we have ourselves seen the certificates of the last group of two dozen clinical ones, and they give the remarkable results of perfect accuracy at 66 per cent. of the points tested, and of no error greater than $0^{\circ}\cdot 2$ at any point on any one of the twenty-four thermometers.

SCIENTIFIC SERIALS

Rendiconti del Reale Istituto Lombardo, May 13.—On the theory of waves, by Prof. E. Beltrami. The author presents some considerations which place in a clearer light the process by which F. Neumann deduces the laws of Fresnel from the fundamental equations of elasticity.—Dynamics of moving systems which preserve their mutual affinity, by Prof. C. Formenti.

Rivista Scientifico-Industriale, May 31.—Maximum and relative humidity of the atmosphere, by Prof. Paolo Cantoni. Hygrometric tables of mean annual moisture, recorded at thirty meteorological stations in various parts of Italy, show that the average of maximum and relative humidity increases from north to south, from elevated to low-lying stations, and from inland to maritime districts.—On the persistence of the mathematical figure of the earth throughout the geological epochs, and on the constitution of the terrestrial crust, by Prof. Annibale Riccò. A summary is given of M. H. Faye's views on this subject already published in the *Comptes rendus* of the French Academy (March 22 and April 5, 1886), the author concluding that the mathematical figure of the globe, as represented by the surface of oceans, has not been perceptibly modified by the geological forces associated with the cooling process.—On the permanent magnetism of steel at various temperatures, by Prof. Poloni. It is shown that at the temperature of 180° C. the well-known law of magnetic distribution in steel bars no longer holds good when the bars have been magnetised without being first subjected to great variations of temperature and kept free from telluric action by being held in a vertical position.

SOCIETIES AND ACADEMIES

London

Royal Microscopical Society, June 9.—Rev. Dr. Dallinger, F.R.S., President, in the chair.—Mr. G. F. Dowdeswell described a preparation of the microbe of rabies in the spinal cord of a rabid dog, which he exhibited × 400. — Prof. F. Jeffrey Bell exhibited a specimen (received from Prof. McIntosh) of a very young starfish, in a stage so early as to show clearly the knob-like portions of the larval organ. Prof. McIntosh has been giving some of his knowledge and skill to fishing observations, which had been rendered possible by the facilities afforded by an enlightened Fishery Board in Scotland.—Mr. F. R. Cheshire exhibited a device for the better examination of Bacteria in culture tubes, the cylindrical form of the tube so distorting the appearance of the contents that it was almost impossible to make any observations upon them under the microscope. The first plan adopted was that of placing the tube in a trough of water and then looking at it through the front of the trough. This was found to diminish the aberration very much, but it did not get rid of it altogether, and was, therefore, only available under very low powers. Water having a refractive index of about 1·333 and alcohol of about 1·374, by adding water to alcohol a mixture having a refractive index of anything between the two could be obtained according to the proportions used. Gelatine has a refractive index rather higher than that of water, and the interposition of a cylinder of glass added something to this. The trough which he employed had a front of rather thin glass, the bottom being sloped in such a way as to cause a tube placed in the trough to lie always near to the front. The tube to be examined was placed in the trough with some water, and then alcohol was added until the proper density was arrived at, and by this means it was quite possible to use a ⅛-inch objective effectively.—Prof. Bell, at the request of the President, gave an account of what he regarded as the most extraordinary biological fact brought to light during the last twenty-five years—that of a third eye at the top of the head of certain lizards.—Mr. Crisp called attention to a new lamp for the microscope which had been sent for exhibition by Mr. Curtis, and which was so cheap and simple that it seemed likely to become the lamp of the future. It was founded on the lamp originally devised by Mr. Nelson.—Mr. A. Brachet's communication suggesting the use of a hyperbolic lens for the field-lens of the eye-piece was read. Mr. Brachet claimed that thereby the diaphragms in the eye-piece and objective could be dispensed with, and the image much improved.—Dr. Crookshank read a paper on photo-micrography, which was illustrated by the exhibition of a large number of prints, negatives, &c. Mr. Glaisher, President of the Photographic Society, said he had examined Dr. Crookshank's exhibits, and thought they were certainly very beautiful productions. He had for many years taken a great interest in the subject of photography, and had looked to it with hopes which had been more nearly fulfilled than ever before by the specimens before them. He had heard the paper with great pleasure, and could only express his admiration of it, believing as he did that it held out great promise for the future.—Mr. F. Enock exhibited sketches of some of his slides, the various parts being numbered and named and accompanied by a short explanation. It is intended to issue sketches of all the mouth organs of British bees and other interesting insects.

Mineralogical Society, June 22.—Mr. L. Fletcher, President, in the chair.—Mr. Andrew Taylor was elected a Member.—The following papers were read :—C. O. Trechmaine, Ph.D., on barytes from Addiewell, West Calder, N.B.—Prof. E. Kinch, on plattnerite.—F. H. Butler, M.A., on dufrénite.—R. H. Solly, on anglesite from Portugal ; and on apatite from Cornwall.—Mr. R. Simpson (visitor) exhibited a very large rolled crystal topaz from Tasmania.—Several interesting specimens were re-exhibited by the President, Mr. Rudler, and others.

Paris

Academy of Sciences, June 28.—M. Jurien de la Gravière, President, in the chair.—On the theory of minima surfaces, by M. G. Darboux. The results hitherto arrived at in the study of minima surfaces lead naturally to the inquiry here instituted regarding the determination of all minima algebraic surfaces contained in a given algebraic curve, or, more generally, to determine all the minima algebraic surfaces inscribed in a given algebraic curve.—On the subject of certain circumstances presented by the movement of the hydro-extractor, by M. de Jonquières. The author deals with the normal case (omitted by Poinsot), in which the movement of precession is complicated and rendered irregular by movements of nutation.—On a process by means of which the oscillations of an absolutely free pendulum may be mechanically counted, by M. M. Deprez. The principle is described of an apparatus not yet constructed, which is intended to record the number of vibrations without exercising any mechanical influence on the pendulum. Without this condition the results would be worthless, as the vibrations, instead of being effected under the influence of gravitation alone, would be affected by the action of a force of unknown magnitude. The problem is solved by the aid of optics, light being the only agent which exercises no mechanical action on the bodies exposed to its influence.—On the persistence of voluntary movements in bony fishes after removal of the cerebral lobes, by M. Vulpian. The author's experiments with carp fully confirm Steiner's recent conclusions regarding the persistence of the voluntary movements in fishes thus operated upon. They also show that the faculty of sight is unaffected by the operation, as already proved by the author in 1864.—On the normal metronome, by M. Saint-Saens. Owing to the defective character of this instrument, it is found to be of little practical service to musicians. Hence the Academy is urged to supply a normal metronome mathematically regulated which, before being issued to the public, should be tested and stamped like all diapasons, weights, and measures. The matter was referred by the President to the Section for Mechanics and Physics.—On the extension of a theorem of Clebsch relating to curves of the fourth degree, by Prof. Sylvester.—A fresh series of experiments on the automatic action of the regulating apparatus constructed at the Aubois sluice, by M. A. de Caligny.—On the fluorescence formerly attributed to yttria, by M. Lecoq de Boisbaudran. By recognising the complex character of yttria and announcing the existence of new elements characterised by fluorescent bands at first attributed to yttria (NATURE, June 17, pp. 160–62), the author considers that Mr. Crookes has implicitly adopted the opinion always held by him regarding the true character of these bands. But from the fresh experiments here described it is pointed out that further interesting studies will have to be made in order thoroughly to elucidate the subject.—Remarks accompanying the presentation of a work entitled "Cosmogonic Hypotheses : an Inquiry into the Modern Scientific Theories on the Origin of Worlds, with a Translation of Kant's 'Theory of the Heavens,'" by M. Wolf. In writing this work the author's object has been to show that the theory of Laplace, completed by the labours of M. Roche and other *savants*, still answers best to the conditions required of a cosmogonic hypothesis. He claims to have met all the objections urged against it, and especially that of M. Faye regarding the pretended necessity of a retrograde rotation of the planets.—Report on M. Poincaré's memoir entitled "Influence of the Moon and Sun on the Northern Trade-Winds," by the Commissioners, MM. d'Abbadie and Mascart. With certain reservations this memoir is recommended to the favourable consideration of the Academy. It shows that there is some truth in the popular opinion respecting the influence of the moon on the weather, but that this influence should be referred not to the new, but to the waning phases of the moon, while account should also be taken of the antagonistic influence of the sun.—Action of an electric current on anhydrous hydrofluoric acid, by M. H. Moissan.—On the flow of gases in the case of a permanent *régime*, by M. Hugoniot. It is shown that M. Hirn's experiments in no way contradict either the kinetic theory or the laws of hydrodynamics, and, so far from refuting, actually confirm the well-known formula of Weisbach or Zeuner.—On the condensation of vapours, by M. P. Duhem.—On the coefficient of self-induction in the Gramme machine (three illustrations), by M. Ledeboer.—On the spectra of didymium and samarium, by M. Eug. Demarçay. Some fresh results are described, which the author has obtained from the study of the photographed absorption-spectra of various products of the fractionation of didymium and samarium.—On a new double iodide of copper and ammonia, by M. A. Saglier. The process is explained by which the author has obtained this new compound, whose formula is $2NH_3Cu_3I_2$, as shown by the following figures:—

	Found			Theory
Copper	24·66	24·61	...	24·84
Iodine	66·03	65·91	...	66·27
Ammonia	8·58	8·66	...	8·88

—On the synthesis of an inactive terpilenol, by MM. G. Bouchardat and J. Lafont.—Action of anhydrous baryta on methylic alcohol, by M. de Forcrand. From the author's experiments it follows that whenever the solution of baryta takes place in methylic alcohol in the presence of a trace of water, which it is very difficult to avoid, the resulting compound should be $C_2H_4O_2,BaO,H_2O_2$.—Action of heat on the acetones, by MM. P. Barbier and L. Roux. The paper deals fully with the mode of decomposition which these substances undergo when subjected to the influence of red heat.—Decomposition of pilocarpine, by MM. E. Hardy and G. Calmels.—Researches on the development of beetroot, by M. Aimé Girard. Here the author studies more especially the tap-root and radicules, concluding that the saccharine matter is formed, not in the underground, but exclusively in the overground parts of the plant.—On the functions of the ovoid gland, of Tiedemann's bodies, and Poli's vesicles in the Asteridæ, by M. Cuénot.—On the conjunctions of the ciliated Infusoria (*Colpidium colpoda*, *Paramecium aurelia*, and *Euplo'es patella*), by M. E. Maupas.—On the classification of the Thaliaceæ and some other groups of Ascidians, by M. F. Lahille.—Note on the *Amphistegina* of Porto Grande, St. Vincent Island, by M. de Folin.—On the functions of the cephalic fossettes in the Nemertæ, by M. Remy Saint-Loup.—Researches relative to the influence of the nerves on the production of lymph, by M. Serge Lewachew.—On the anatomic constitution of the Ascidians attached to the rare American plant *Heliamphora nutans*, Benth., By M. Ed. Heckel.—On the presence of a line of erratic boulders stranded on the coast of Normandy, by M. Ch. Vélain.—On the eruption of Etna during the months of May and June, by M. H. Silvestri. The discharge during twenty days of activity has been approximately estimated at 66,000,000 cubic metres.

BERLIN

Physiological Society, May 28.—Dr. Virchow made a report of his investigations into the capillaries of the vitreous body and their environment. The vitreous body, which must no longer be regarded as a tissue, but as an organ, showed different structural relations among the different groups of animals, and, in the case of fishes and the frog, was distinguished by its strong bounding cuticle, on which the capillaries formed an object of interesting examination. In regard to the structure of the capillaries the speaker had come to the conviction that they consisted of a fundamental membrane which was occupied with cells. The environment of the capillaries formed lymph-spaces, which had not yet, however, manifested themselves as standing in continuous connection with one another. On the cuticles inclosing the lymph-spaces lay cells displaying a great multiplicity in form and arrangement among the different kinds that had been examined.—Prof. Munk attacked the position taken up at the last sitting of the Society by Prof. Christiani respecting the possibility of seeing after excision of the greater brain. He challenged his opponent to show to the Society or the Association of Naturalists for this year a rabbit that was able to see after the removal of the greater brain.—Dr. Benda exhibited a series of preparations of the central nervous system which were coloured in accordance with the hæmatoxyline method as modified by him. There were in particular three advantages distinguishing his hæmatoxyline colouring from that of Weigert's: (1) the axial cylinders of the nerve fibres in the brain came out more distinctly, and their connection with the ganglia cells was directly demonstrated. (2) The structure of the ganglia came out more distinctly. In the case of those ganglia which remained clear after the hæmatoxyline colouring, there appeared with great constancy in the fibrous framework, dark concretions, which might perhaps be interpreted as a special structure, though the speaker was not yet prepared to decisively maintain that assumption as fact. (3) With still more reservation would he present the third result, which came to light in a particular structure of the medullary sheath. On the transverse section radiate drawings were seen to proceed from the axis cylinder towards the neurilemma. These markings ramified, and perhaps formed the protoplasmatic scaffold within which was deposited the fluid nerve-medulla. The speaker next described more minutely his method of proceeding—hardening with picrin acid, washing out with alcohol, laying in paraffin, treating with a sulphate of iron, colouring with hæmatoxyline, washing out with solution of alum or with a diluted acid. In conclusion Dr. Benda gave a theory of hæmatoxyline colouring, which ranged itself close in order with the colouring with logwood customary in technics. In both cases the colouring-matter was applied as lac, the tissue being first saturated with the mordant, and then impregnated with the colouring-matter, which formed in the tissue lacs insoluble in water and alcohol, and only in part capable of being resolved through washing out with the mordants or with acids. Or the colouring-matter might be used in the way of ink, which formed precipitates with the tissues.

BOOKS AND PAMPHLETS RECEIVED

"Annual Report of the Smithsonian Institution for the Year 1884" (Washington).—"The Gothic of Ulfilas," by T. le M. Dowse (Taylor and Francis).—"Recherches pour établir ses Rapports avec la Côte de France," by Prince A. de Monaco (Gauthier-Villars, Paris).—"Monthly and Yearly Means, Extremes and Sums for the Years 1883, 1884, 1885" (Tokio).—"Aus dem Archiv der Deutschen Seewarte," 7 Jahrgang, 1884 (Hamburg).—"Reichenbachia, Orchids Illustrated and Described," part 1, May, by F. Sander (Sander and Co., St. Albans).—"Encyklopædie der Naturwissenschaften," Erste Abth. 45, 46, und 47, Lief.; Zweite Abth. 34, 35, und 36, Lief. (Trewendt, Breslau).—"Mémoires du Comité Géologique, St. Petersburg," vol. ii. No. 3.—"Bulletins du Comité Géologique, St. Petersburg," v. Nos. 1 to 6.—"Bibliothèque Géologique de la Russie," i., 1885.—"Physiological Laboratory Notes," by S. W. Holman (Cushing, Boston).—"Annotated Catalogue of the Published Writings of Chas. A. White," by J. B. Marcow (Washington).

CONTENTS

PAGE