THURSDAY, MARCH 13, 1890.

GERMAN CONTRIBUTIONS TO ETHNOLOGY.

Ethnographische Beiträge zur Kenntniss des Karolinen Archipels. Von J. S. Kubary. 1 Heft, mit 15 Tafeln. (Leyden: P. W. M. Trap, 1889.)

SINCE 1868, when Herr Kubary first entered upon a course of inquiry among the Polynesians, which he had undertaken for the Godeffroy Museum in Hamburg, to which institution he was then officially attached, he has made the archipelago of the Carolines the chief seat and object of his observations. These islands, lying between 5° and 10° N. lat., midway between the Ladrones and New Guinea, and stretching from 138°–160° E. long., have been visited by few white men excepting the traders who occasionally touch there for purposes of barter, or with the object of securing workmen for some more or less remote labour-market on terms of hire which are usually misunderstood by the natives themselves. To this drain on the numbers of able-bodied men, and to continual tribal wars among the different members of the group, the rapid diminution of the population of the Carolines is probably mainly due. In some of the islands the author found that the once numerous families of the kings or chiefs had either wholly died out in recent years, or were only represented by a single male descendant, who, in the absence of any other woman of pure native race, would have to take a half-sister for his wife, if he would avoid the alternative of making a prohibited exogamic marriage.

The probably imminent extermination of these Northern Polynesians gives more than common interest to Herr Kubary's narrative of his long sojourn in the island Yap, and in the Pelew group, or Western Carolines, where he had the good fortune to obtain previously-unknown information regarding the various indigenous moneys in use, and thus to establish the hitherto unsuspected fact that among these people a carefully-adjusted and rigidly-prescribed monetary system has been long in force. Thus in the island of Yap he found that each distinct kind of money could only be used for specially-defined purposes, the form known as *gau*, which consists of strings of equally-sized polished disks of the spondylus, constituting what we may term the gold of the district. This is not current among the general public, but is carefully accumulated by the chiefs, who keep it in reserve to be exchanged with other chiefs for canoes or weapons of all kinds, to be used when they are preparing to make, or to resist, a hostile attack. This spondylus currency has considerable ethnological interest, for we find that the shell can only be procured to the east or the north of Yap, and that it is traditionally the most ancient form of money in use in that and some of the neighbouring islands, while its discovery in old graves of chiefs in the Ladrones seems to point to a common origin of the natives of the latter group and those of the Carolines. Next in value is the *palan*, which consists of round disks of arragonite of various degrees of thickness, which is obtained by the people of Yap at considerable risk and with much labour from certain islands of limestone-formation in the Pelew group. The supply of this money in Yap is mainly dependent on the enterprise of the young men of the villages, who, from time to time combine together to procure a canoe, in which, with the consent of their chief, they repair to the arragonite rocks to extract as much of the stone as their boat will hold. On returning to their native village, they are bound to present their chief with all the larger blocks, after which they dispose of the remainder to the villagers at the rate of the market value of the stone, which is estimated according to its width. Thus, while a fragment measuring an inch or two in diameter is the recognized price of a basket of *taro*, consisting of a definite number of roots, the scale of values rises gradually until it requires a mass six feet in width to purchase a good-sized canoe, or a *gau*-belt adorned with two whale's teeth, which ranks in the eyes of a Yap dandy as the most precious of all personal ornaments. The arrival of a cargo in which there are several of these exceptionally large blocks, is generally soon followed by the breaking out of hostilities between the village chief and his neighbours, as the former seldom loses a chance of making speedy use of these sinews of war; and hence perhaps *palan* is popularly known as "men's money." Next in value to it comes *yar*, which consists of small threaded nacreous shells that serve as small change, and are known as "women's money."

In the Pelew Islands, another form of money, known as *audouth*, is current, whose origin and history are unknown, although the traditions regarding it suggest that it may have been obtained through early trading relations between these islands and remote eastern and western nations. *Audouth* is divided into numerous groups, consisting of coloured or enamelled beads or disks, some of which present a vitreous or earthy character, recalling objects of Chinese or Japanese art; while others, to judge by the coloured illustrations in Herr Kubary's work, are almost identical with the glass beads still largely manufactured in Venice. Each variety of bead has a fixed place on the scale of values, which, beginning from the *taro*-basket unit, gradually rises, until it finally reaches so large an amount that each of the still existing forty or fifty beads, which rank as the highest in the series, and which are all accumulated in the hands of one or two of the kings, actually represents a sum equal to ten or twelve pounds sterling. The extremely limited number of the *audouth*-beads, and the obligation of making payments with only specially prescribed forms of these coins, have led to the establishment of a regularly organized system of loans. By the rules of this system, a man who requires to make a payment in a coin of which he is not possessed, and who has to borrow it from his chief, or some neighbour, is compelled to give in pledge certain definite objects, only redeemable by repayments at fixed periods and rates of interest, while he is, moreover, obliged to refund his debt in the same coin which he originally borrowed.

In his comments on the singular fact that the unclothed, tattooed natives of a remote Polynesian archipelago should possess well-organized systems, based on fixed principles, not only for regulating loans, but also for conducting exchange and barter on equitable terms, Herr Kubary adduces apparently good grounds for assuming that the people have derived these methods, together with the principal features of their political and social institutions, through their early acquaintance with the higher civilization of the great Malayan States, with whose inhabitants they probably share one common origin. Like these races, the people of the Carolines attach an extraordinary importance to money, which is made the pivot on which everything in the State turns. Thus, the sole penalty for all crimes and misdemeanours is a fixed payment in some definite form of money; and, as among our own northern ancestors, every injury done to man or beast has its recognized price, while every act or event in a man's life from his birth to his death, and beyond it, is charged with a definite payment. Similarly, the favour of the gods in sickness, and the good-will of a chief, would seem to be regarded as only attainable by money offerings to priests or rulers. Strangely enough, however, the chiefs themselves are compelled to make certain prescribed payments in their various transactions with the people, by which means an excessive accumulation of money in the hands of a few is prevented, and a free circulation of the various coins insured; and thus, these uncivilized Polynesians have attempted, after their own fashion, to solve a problem involved in the question of capital and labour.

The author's copiously illustrated descriptions of the dwellings and other buildings erected by the islanders show how closely they approximate in structure and ornamentation to the Malayan type. The arrangements of the interior, however, where the quiet and solitude of the owner of a house are provided for by various portions of the building being tabooed to all strangers, and at certain times to the women and children of the family, afford strong evidence that in their social usages the people have been strongly influenced, probably in recent ages, by intercourse with Polynesians occupying the remoter eastern archipelagoes. This is shown by the uniformity in various practices followed both by the natives of some of the Carolines, and those of other far distant groups.

Nothing, however, is more remarkable than the diversity presented by contiguous islands, for while in the one we find some form of textile art or some method of elaborate tattooing, characteristic of the inhabitants of a far distant archipelago, not a trace of either is to be met with in the neighbouring islands. Even more inexplicable are the differences in stature, appearance, and general physical character among the natives of one island, or one group; and hence it is impossible to arrive at any firmly-based conclusions as to the true ethnic history of the present occupants of the Caroline archipelago.

Herr Kubary has devoted much attention to the study of the various maladies from which the natives suffer, with a view of determining how far these are indigenous or imported; and, while he highly commends the patience under suffering of these gentle, unsophisticated natives, he shows that various specific forms of disease, which are usually malignant among civilized communities, here present a benign character. His remarks on this subject are full of interest, as are also his descriptions of the various local remedies employed, among which it would appear that some possess such well-marked specific properties as to merit the careful attention of our own pharmacologists.

The present volume, which is to be followed by a further series of Herr Kubary's contributions, is edited by Dr. Schmeltz, on behalf of the directors of the Imperial Museum of Ethnology in Berlin, where the most valuable of the author's collections are deposited.

ENGLISH AND SCOTTISH RAILWAYS.

The Railways of England. By W. M. Acworth. Second Edition. (London: John Murray, 1889.)

The Railways of Scotland. By W. M. Acworth. (London: John Murray, 1890.)

BEYOND the comparatively small railway circle, there are many persons who take great interest in the railway system of this country. Any particularly fast train is carefully noted, and compared detail for detail with its predecessor; and its particular virtues are pointed out. To such persons the works before us will be most welcome. To railway men we need only say that not to read these books will be a great loss and a mistake. Mr. Acworth has evidently had excellent opportunities for observation, and he has not failed to make good use of the chances thus obtained for careful study of the many different phases of railway life. The author confesses to have written anonymously not a few criticisms on the management of certain English railways, which were meant to be particularly scathing. In the present books we can find nothing of the kind; in fact, in most cases the author uses language of almost unvarying panegyric, even the hunting-ground of the "Flying Watkin Express" coming in for nothing but praise. This is certainly as it should be, for those who know anything of the subject are aware that the English railway system taken as a whole is second to none in the world, either in management, rolling-stock, or permanent way.

The volume on the railways of England deals principally with the railways terminating in London. An historical sketch of the early railways is given, and we find, besides much useful matter, many amusing anecdotes. The author deals at length with the change wrought by the introduction of railways in the various trades affected by the withdrawal of the stage-coach, and the consequent loss of trade to many towns and villages on the old turnpike roads, as well as the birth of new trades and occupations caused by the advance of the railway system.

The London and North-Western Railway is the first one noticed, in Chapter II. The territory of this railway extends from London in the south to Carlisle in the north, and from Cambridge in the east to Swansea and Holyhead in the west. The description naturally begins at Crewe, for at this station are the main locomotive and other works of the Company, employing about 6000 men. Here also are the head-quarters of the locomotive staff, under Mr. F. W. Webb, the able mechanical superintendent. The author gives an excellent description of the works, and the many special manufactures carried on. The illustration of the Webb transverse steel sleeper shows how a steel sleeper can be designed to suit the English mongrel-sectioned rail known as the "Bullhead." It is a pity some enterprising railway manager in England does not give the Indian all-steel permanent way a trial, viz. a Vignoles or flanged rail with a transverse steel sleeper formed out of a ribbed plate, with lugs or clips formed out of the solid to take the rail flange, and fastened with a steel key. In this system there is nothing that can get loose, and excellent results are obtained in India, where several millions are now in use.

In Chapter IV. we find the Midland Railway thoroughly discussed. The growth of this enterprising and pushing Company is carefully and vividly delineated. This large system, like most others, is the result of the amalgamation of many small companies, and, under an enlightened management, it has long been considered the most progressive railway in this country. The author gives a capital description of this large system, and many interesting statistics. Among the many special details, perhaps the Lickey incline on the Birmingham and Gloucester section is of most interest. On this incline, having a gradient of 1 in 37, the traffic has always been worked by locomotives, even in the days when stationary engines were used to haul the trains out of Euston Station and Lime Street Station at Liverpool; and further, in these early days (1839), the English-built locomotive was unable to be of much use on this incline, and some American locomotives were imported and succeeded in working the traffic. Derby is the "Crewe" of the Midland. Here the Company builds the locomotives, carriages, and most of the waggons. The travelling public owe much to the Midland Company. On this line the author tells us most of the new departures in rolling-stock and details were originally tried, the Pullman car and many other equally important novelties, down to the diminutive but most useful apparatus, the sand-blast, for sanding the rails under the treads of the driving-wheels of the locomotive. The effects of this apparatus are very interesting, and its use is becoming universal. So much does it add to the effectiveness of a single-wheeled locomotive that it is possible to use it on trains in place of the four-coupled engine, a saving evident to those familiar with the subject. The single-wheeled engines, running at high speeds, are more free; which means less wear and tear to the engine itself, and probably the permanent way. With an express train the sand-blast apparatus uses about nine ounces of sand per mile, giving a continuous supply to the driving-wheels; and, be the rails ever so greasy, the wheels seldom slip half a turn. The testing of the materials used at Derby Works appears to be very efficient; the steel, particularly for plates, axles, tyres, &c., being thoroughly tested by tensile and bending tests, and by chemical analysis.

Chapter V. deals with the Great Northern, North-Eastern, and Manchester, Sheffield, and Lincolnshire Railways. In any description of the Great Northern system it would be impossible to pass over the splendid running of the Company's express trains. Some of these are, without doubt, the fastest in the world. The 105¼ miles between Grantham and London are continuously "done" in 117 minutes, or at the rate of 54 miles per hour; and both up and down trains are known to get over 60 consecutive miles in as many minutes. On one occasion, the author states, the 105¼ miles were "reeled off" in 112 minutes—a result worthy of Mr. Stirling's splendid locomotives. The description of driving the "Flying Scot" is very true, and we are glad to observe that the author combats the nonsense written to the daily press concerning the drivers and firemen of the Scotch expresses "being paralyzed with fear at the awful speeds." No two men are prouder of their positions, nor would they exchange into any other link. Their position is, in fact, the blue ribbon of the foot-plate.

In dealing with the North-Eastern Railway, the author gives much useful information on the subject of the compound locomotive. The locomotive superintendent of that railway, Mr. T. W. Worsdell, uses probably the best arrangement of cylinders, &c., possible to fulfil the many conditions under which a satisfactory locomotive must be constructed, and the results obtained appear to point to a great saving in fuel. We would commend to our readers the description of the snow-block on this railway in the year 1886; it is well written.

With reference to the electric lighting of trains on the Glasgow underground section of the North British Railway, it should be noted that the current is taken off the third insulated rail, not by a brush, as stated by the author, but by means of a wheel in a swing frame under each coach. This wheel runs on the central elevated and insulated rail, and each coach is electrically independent of any other. The system appears to work very well. To the Manchester, Sheffield, and Lincolnshire Railway the author gives little attention, for reasons stated on p. 193. Probably no line in this country is more handicapped by heavy gradients on its main line, and the locomotive stock has had to be designed to satisfy the conditions, more especially on the section between Manchester and Sheffield. The late Mr. Charles Sacré, the eminent engineer and locomotive superintendent of that railway, designed some particularly fine four-coupled bogie engines for the passenger service, and his goods engines did good work on the heavy sections.

The Great Western Railway loses nothing by the description given in Chapter VI. This historical line is well described, and the "battle of the gauges" thoroughly gone into. It is to be regretted that some compromise was not made between the rival gauges; for it is now evident that the four feet eight and a half inches gauge—the standard one in this country—is not wide enough. Locomotives and rolling stock have grown so much that locomotive engineers are in difficulties when trying to design more powerful engines. Take, for instance, the Indian or the Irish broad gauge; in these cases the engines are not limited in width so much, and can have ample bearing surfaces; as well as, for inside cylinder engines, crank axles not tied down by considerations of cylinder centres and the like. A ride on the "Dutchman" express locomotive is well enough described to make many young locomotive engineers long to have shared with the author that thoroughly enjoyable experience. The Severn Tunnel is well treated in this chapter. Chapter VII. deals with the South-Western Railway, and the following one gives much useful information of that model of all southern railways—the London, Brighton, and South Coast Railway. In noticing the latter we cannot but express our regret for the loss that Company and locomotive engineering generally have sustained by the recent death of Mr. William Stroudley. Without doubt one of our ablest railway engineers, he brought the designing of locomotives and rolling-stock to the highest pitch; his engines are patterns to be used with advantage, and their coal consumption is the lowest on record. Chapter IX. describes the South-Eastern and Chatham Railways; and the volume concludes with Chapter X., on the Great Eastern Railway. These last chapters lack none of the interest to be found in the earlier ones in the book.

The second volume, on Scottish railways, is merely a continuation of the first, and is written in the same lucid style. Its most interesting part is a description of the Forth Bridge. Mr. Acworth gives a good account of the bridge and the earlier schemes proposed for crossing the Forth.

Mr. Acworth has written two most interesting books, which will be of great use to all in any way connected with, or interested in, the British railway system.

N. J. L.

DISEASES OF PLANTS.

Diseases of Plants. By Prof. H. Marshall Ward, F.R.S., M.A. (London: Society for Promoting Christian Knowledge.)

THIS little book is an excellent popular introduction to the study of the diseases of plants, in so far as they are due to the attacks of parasitic Fungi or similar organisms. The author, who has made this field of research especially his own, succeeds in being intelligible and interesting to ordinary readers, without in any degree sacrificing the scientific character of his work.

The book is illustrated by fifty-three woodcuts, which have been very well selected, many of them from the author's own papers. In certain cases, however, the engraving leaves something to be desired, and scarcely does justice to the original figures.

An introductory chapter explains what is here meant by disease in plants, namely "those disturbances of the structure and functions of the plant, which actually threaten the life of the plants, or at least their existence as useful objects of culture." The two factors of disease, the external cause on the one hand, and the condition of the patient on the other, are clearly distinguished.

The second chapter gives a general account of Fungi as saprophytes and parasites. Mucor is described as an example of the former, and vine-mildew (*Peronospora viticola*) of the latter group.

The succeeding nine chapters, forming the bulk of the book, are occupied with the consideration of special diseases.

First comes the "damping-off" of seedlings, a disease only too well known to gardeners, due to the attacks of various species of Pythium. The whole life-history of the parasite is described. In Fig. 9 it is a pity that the point of attachment of the antheridium is not more clearly shown.

Next, we have an account of the very interesting disease of cabbages and other Crucifers, known as "fingers and toes," "club-root," &c. Here the cause of the mischief is a Myxomycete, and this is the only case of a non-fungoid disease described in the book. Happily, a satisfactory cure can here be prescribed.

Chap. v. is on the potato-disease. An account of the normal mode of nutrition of the plant in health is introduced in order to show the exact nature of the deadly injury which is wrought by the Phytophthora. As a preventive measure, the selection of resistant varieties of the potato is especially recommended. Chap. vi. is devoted to the "smut" of corn. The cause of the frequent failure of protective dressings applied to the ripe grain is discussed. If, however, as Jensen believes, the ovule may be infected at the time of flowering, an altogether new light is thrown on this question.

After a chapter on the disease known as "bladder-plums," caused by the yeast-like Fungus Exoascus, we come to the lily-disease. The Fungus which is here responsible has been shown by Prof. Ward to afford an excellent example of a saprophyte which can become a parasite on occasion.

The next three chapters describe the ergot of rye, the mildew of hop (Podosphæra), and the rust of wheat. In the case of the hop-disease, a figure of the conidia might have been added with advantage. The now familiar but always interesting story of the heterœcism of rust is well told.

With a caution which in the case of a popular work cannot be too highly commended, the author avoids expressing any opinion on the subjects of fertilization in Podosphæra, and of the function of the spermogonia in Æcidium.

In the concluding chapter, Prof. Ward endeavours to interest his readers in the wider questions of mycology, so fascinating to the botanist, such as the phylogenetic origin and relationships of the Fungi.

The book should have a wide circulation among the numerous classes interested in the important group of diseases of plants with which it deals.

D. H. S.

OUR BOOK SHELF.

The Physician as Naturalist. Addresses and Memoirs bearing on the History of and Progress of Medicine chiefly during the last hundred years. By W. T. Gairdner, M.D. (Glasgow: Maclehose and Sons, 1889.)

A SUCCESSFUL physician, during a long and busy life, is frequently called upon to preside and deliver addresses at meetings at which he is expected to treat his subjects in a more or less popular manner.

Dr. Gairdner has brought together a most interesting series of such addresses, which fall into two main groups. First, those in which he has contrasted the treatment of the present day with that in vogue among our predecessors of more or less remote times; and in which he has attempted to present the answer to that ever-interesting question, "Is the treatment of disease adopted at the present day superior to that in vogue formerly? And if so, in what does its superiority consist?" Second, those in which he lays down the lines on which he considers the medical education of the future should be conducted, in order to lead to still greater advances.

The dependence of modern treatment upon the discussion of accumulations of facts, and not solely upon theory, and the necessity of making experience and not authority the arbiter in cases of doubt, are the conclusions which the author inculcates throughout.

A century ago it was considered a fundamental principle that venesection was essential in most, if not all, serious illnesses; and, to such an extent was this carried, that 200 ounces of blood were sometimes drawn off during a week, and even half that amount in 24 hours. Next came a reaction, and the theory that fever patients required stimulation, rather than venesection, led to the administration of enormous quantities of alcohol, especially at the hands of Dr. Todd, who at times administered more than four gallons of brandy to young girls during an illness. Finally, to Dr. Gairdner himself is due much of the credit of the modern treatment; for in 1864 he showed that in fevers, especially typhus, the mortality is far less when the patients are supported with milk and not with alcohol. Quackery and humbug meet with but little mercy at the author's hands, and the hollowness of the pretensions of homœopathy is well brought out in an essay contributed thirty years ago, which is reprinted in this collection.

The volume should meet with a large circle of readers outside the medical profession, as it is eminently readable and touches upon many points in the past history of medicine as well as in modern practice, which are of interest to all.

Materials for a Flora of the Malayan Peninsula. Part I. By Dr. George King, F.R.S., Calcutta. Pp. 50. (Reprinted from the *Journal of the Asiatic Society of Bengal*, 1889, No. 4.)

SIR J. D. HOOKER'S "Flora of British India," of which five volumes out of seven are now printed, marks an era in tropical botany, inasmuch as it will probably contain descriptions, with their synonymy, of half the tropical plants of the Old World. It furnishes, therefore, a broad platform for his successors to build upon. It is not likely that within the bounds of India proper many new plants still remain to be described; but it is not so in the wonderfully rich flora of the Malay peninsula. During the last ten years large collections have been accumulated at Calcutta from this region, gathered mainly by Scortechini and other collectors who have been sent out by the authorities of the Calcutta Botanic Garden. In the present pamphlet, which is reprinted from the Journal of the Asiatic Society of Bengal, Dr. King, the Director of the Calcutta Garden, begins a synopsis of the plants which are indigenous to the British provinces of the Malay peninsula, including the islands of Singapore, Penang, and the Nicobar and Andaman groups.

In this present paper he deals with the orders Ranunculaceæ, Dilleniaceæ, Magnoliaceæ, Menispermaceæ, Nymphæaceæ, Capparideæ, and Violaceæ, leaving over the intricate and largely represented order Anonaceæ for another time. In these seven orders there are 35 Malayan genera and 90 species, of which 32 are here described for the first time. Amongst the novelties are included a Magnolia, a Manglietia, 3 Talaumas, an Illicium, 4 species of Capparis, and no less then 11 new Alsodeias. Besides the species here described for the first time, there are several others, known previously in Java and China, which are new to British India. It will be seen that the work will add materially to our knowledge of Indian plants, and it is to be hoped that Dr. King, in the midst of his multifarious official duties, may be able to go on with it quickly and steadily. It is hardly worth while, we think, in a series of papers of this kind, to take up space and time by recapitulating in detail the characters of the orders and genera, as, from the nature of the case, it is essentially a supplement to Hooker's "Flora of British India," in which they are already fully worked out.

J. G. B.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Panmixia.

SEEING that the whole structure of Prof. Weismann's theory is founded—both logically and historically—upon the doctrine of "panmixia," and seeing that in some important respects his statement of the doctrine appears to me demonstrably erroneous, I propose to supply a paper on the subject.

It will be remembered that the principal evidence on which Mr. Darwin relied to prove the inheritance of acquired characters was that which he derived from the apparently inherited effects of use and disuse—especially as regards the bones of our domesticated animals when compared with the corresponding bones of ancestral stocks in a state of nature. Now, in all his investigations regarding this matter, the increase or decrease of a part was estimated, not by directly comparing, say, the wing bones of a domesticated duck with the wing-bones of a wild duck, but by comparing the *ratio* between the wing and leg bones of a tame duck with the *ratio* between the wing and leg bones of a wild duck. Consequently, if there be any reason to doubt the supposition that a really inherited diminution of a part thus estimated is due to the inherited effects of diminished use, such a doubt will also require to extend to the evidence of a really inherited augmentation of a part being due to the inherited effects of augmented use. Now, there is the gravest possible doubt lying against the supposition that any really inherited decrease is due to the inherited effects of disuse. For it may be—and, at any rate to a large extent, must be—due to another principle which it is remarkably strange that Mr. Darwin should have overlooked. This is the principle of what Prof. Weismann has called panmixia. If any structure which was originally built up by natural selection on account of its use, ceases any longer to be of so much use, in whatever degree it so ceases to be of use, in that degree will the premium before set upon it by natural selection be withdrawn. And the consequence of this withdrawal of selection as regards that particular part will be to allow the part in a corresponding measure to degenerate through successive generations. Weismann calls this principle panmixia, because, by such withdrawal of natural selection from any particular part, promiscuous breeding ensues with regard to that part. And it is easy to see that this principle must be one of great importance in nature, inasmuch as it must necessarily come into operation in all cases where a structure or an instinct has ceased to be useful. It is likewise easy to see that its effects —viz. of inducing degeneration—must be precisely the same as those which were attributed by Mr. Darwin to the inherited effects of disuse; and, therefore, that most of the evidence on which he relied to prove the inherited effects both of use and of disuse is vitiated by the fact that the idea of panmixia never happened to occur to him. In this connection, however, it requires to be stated that the idea first of all occurred to myself, unfortunately just after the appearance of his last edition of the "Origin of Species." I then published in these columns a somewhat detailed exposition of the subject (see NATURE, vol. ix. pp. 361, 440, vol. x. p. 164). I called the principle the cessation of selection—which still seems to me a better, because a more descriptive, term than panmixia—and at first it appeared to me, as it now appears to Weismann, entirely to supersede the necessity of supposing that the effects of use and of disuse are ever inherited in any degree at all. Thus it obviously raised the whole question touching the admissibility of the Lamarckian principles in any case, or the question which is now being so much discussed concerning the possible inheritance of acquired as distinguished from congenital characters. But Mr. Darwin satisfied me that this larger question could not be raised. That is to say, although he fully accepted the principle of panmixia, and as fully acknowledged its obvious importance, he left no doubt in my mind that there was independent evidence for the transmission of acquired characters sufficient in amount to leave the general structure of his previous theory unaffected by what he nevertheless recognized as a necessarily additional factor in it. And forasmuch as no further facts bearing upon the subject have been forthcoming since that time, I see no reason to change the judgment that was then formed.

There is, however, one respect in which Prof. Weismann's statement of the principle of panmixia differs from that which was considered by Mr. Darwin ; and it is this difference of statement—which amounts to an important difference of theory—that I now wish to discuss.

The difference in question is, that while Prof. Weismann believes the cessation of selection to be capable of inducing degeneration down to the almost complete disappearance of a rudimentary organ, I have argued that, *unless assisted by some other principle*, it can at most only reduce the degenerating organ to considerably above one-half its original size—or probably not through so much as one-quarter. The ground of this argument (which is given in detail in the NATURE articles before alluded to) is, that panmixia depends for its action upon fortuitous variations round an ever-diminishing average—the average thus diminishing because it is no longer *sustained* by natural selection. But although no longer sustained by *natural selection*, it does continue to be sustained by *heredity* ; and therefore, as long as the force of heredity persists unimpaired, fortuitous variations alone—or variation which is no longer controlled by natural selection—cannot reduce the dwindling organ to so much as one-half of its original size ; indeed, as above foreshadowed, the balance between the positive force of heredity and the negative effects of promiscuous variability will probably be arrived at considerably above the middle line thus indicated. Only if for any reason the force of heredity begins to fail, can the average round which the cessation of selection works become a progressively diminishing average. In other words, so long as the original force of heredity as regards the useless organ remains unimpaired, the mere withdrawal of selection cannot reduce the organ much below the level of efficiency above which it was previously *maintained* by the *presence* of selection. If we take this level to be 70 per cent. of the original size, cessation of selection will reduce the organ through the 30 per cent , and there leave it fluctuating about this average, unless for any reason the force of heredity begins to fail—in which case, of course, the average will progressively fall in proportion to the progressive weakening of this force.

Now, according to my views, the force of heredity under such circumstances is always bound to fail, and this for two reasons. In the first place, it must usually happen that when an organ becomes useless, natural selection as regards that organ will not only *cease*, but become *reversed*. For the organ is now absorbing nutriment, causing weight, occupying space, and so on, *uselessly*. Hence, even if it be not also a source of actual danger, "economy of growth" will determine a reversal of selection against an organ which is now not merely useless, but deleterious. And this degenerating influence of the reversal of selection will throughout be assisted by the cessation of selection, which will now be always acting round a continuously sinking average. Nevertheless, a point of balance will eventually be reached in this case, just as it was in the previous case where the cessation of selection was supposed to be working alone. For, where the reversal of selection has reduced the diminishing organ to so minute a size that its presence is no longer a source of detriment to the organism, the cessation of selection will carry the reduction a small degree further ; and then the organ will remain as a "rudiment." And so it will remain permanently, unless there be some further reason why the still remaining force of heredity should be abolished. This further reason I found in the consideration that, however enduring we may suppose the force of heredity to be, it would be unreasonable to suppose that it is actually everlasting ; and, therefore, that we may reasonably attribute the eventual disappearance of rudimentary organs to the eventual failure of heredity itself. In support of this view there is the fact that rudimentary organs, although very persistent, are not everlasting. That they should be very persistent is what we should expect, if the hold which heredity has upon them is great in proportion to the time during which they were originally useful, and so firmly stamped upon the organization by natural selection causing them to be strongly inherited in the first instance. Thus, for example, we might expect that it would be more difficult finally to eradicate the rudiment of a wing than the rudiment of a feather ; and accordingly we find it a general rule that long-enduring rudiments are rudiments of organs distinctive of the higher taxonomic divisions—*i.e.* of organs which were longest in building up in the first place, and longest sustained in a state of working efficiency in the second place. Again, that rudimentary organs, although in such cases very persistent, should not be everlasting, is also what we should expect, unless (like Weismann) we have some argumentative reason to sustain the doctrine that the force of heredity is inexhaustible, so that never in any case can it become enfeebled by a mere lapse of time—a doctrine the validity of which in the present connection I will consider later on.

Thus, upon the whole, my view of the facts of degeneration remains the same as it was when first published in these columns sixteen years ago, and may be summarized as follows.

The cessation of selection when working alone (as it probably does work in our domesticated animals, and during the first centuries of its working upon structures or colours which do not entail any danger to, or perceptible drain upon the nutritive resources of, the organism) cannot cause degeneration below, probably, some 20 to 30 per cent. But if from the first the cessation of selection has been assisted by the *reversal* of selection (on account of the degenerating structure having originally been of a size sufficient to entail a perceptible drain on the nutritive resources of the organism, having now become a source of danger, and so forth), the two principles acting together will continue to reduce the ever-diminishing structure down to the point at which its presence is no longer a perceptible disadvantage to the species. When that point is reached, the reversal of selection will terminate, and the cessation of selection will not then be able of itself to reduce the organ through more than at most a very few further percentages of its original size. But, after this point has been reached, the now total absence of selection, either for or against the organ, will sooner or later entail this further and most important consequence—viz. a failure of heredity as regards the organ. So long as the organ was of use, its efficiency was constantly *maintained* by the *presence* of selection—which is merely another way of saying that selection was constantly maintaining the force of heredity as regards that organ. But as soon as the organ ceased to be of use, selection ceased to maintain the force of heredity ; and thus, sooner or later, that force began to waver or fade. Now it is this wavering or fading of the force of heredity, thus originally due to the cessation of selection, that in turn *co-operates* with the still continued cessation of selection (panmixia) in reducing the structure below the level where its reduction was left by the actual reversal of selection. So that from that level downwards the cessation of selection and the consequent failing of heredity act and react in their common work of causing obsolescence. In the case of newly acquired characters the force of heredity will be less than in that of more anciently acquired characters ; and thus we can understand the long endurance of "vestiges" characteristic of the higher taxonomic divisions, as compared with those characteristic of the lower. But in all cases, if time enough be allowed, under the cessation of selection the force of heredity will eventually fall to zero, when the hitherto obsolescent structure will finally become obsolete.[1]

Let us now turn to Weismann's view of degeneration. First of all, he has omitted to perceive that "panmixia" alone (if unassisted either by reversed selection or an inherent diminishing of the force of heredity) cannot reduce a functionless organ to the condition of a *rudiment*. Therefore he everywhere represents panmixia (or the mere *cessation* of selection) as of itself sufficient to cause degeneration, say from 100 to 5, instead of from 100 to 80 or 70, which, for the reasons above given, appeared (and still appears) to me about the most that this principle alone can accomplish, so long as the original force of heredity continues unimpaired. No doubt we have here what must be regarded as a mere oversight on the part of Prof. Weismann ; but the oversight is rendered remarkable by the fact that he *does* invoke the aid of reversed selection *in order to explain the final disappearance of a rudiment*. Yet it is self-evident that the reversal of selection must be much more active during the initial than during the final stages of degeneration, seeing that, *ex hypothesi*, the greater the degree of reduction which has been attained the less must be the detriment arising from any useless expenditure of nutrition, &c.

And this leads me to a second oversight in Prof. Weismann's statement, which is of more importance than the first. For the

[1] It may not be needless to add that in the case of newly acquired and comparatively trivial characters, with regard to which reversal of selection is not likely to take place (*e.g.* slight differences of colour between allied species), cessation of selection is likely to be very soon assisted by a failure in the force of heredity ; seeing that such newly acquired characters will not be so strongly inherited as are the more ancient characters distinctive of higher taxonomic groups.

place at which he does invoke the assistance of reversed selection is exactly the place at which reversed selection must necessarily have ceased to act. This place, as already explained, is where an obsolescent organ has become rudimentary, or, as above supposed, reduced to 5 per cent. of its original size; and the reason why he invokes the aid of reversed selection at this place is in order to save his doctrine of "the stability of germ-plasm." That the force of heredity should finally become exhausted if no longer *maintained* by the *presence* of selection, is what Darwin's theory of perishable gemmules would expect to be the case, while such a fact would be fatal to Weismann's theory of an imperishable germ-plasm. Therefore he seeks to explain the eventual failure of heredity (which is certainly a fact) by supposing that after the point at which the cessation of selection alone can no longer act (and which his first oversight has placed some 70 per cent. too low), the reversal of selection will begin to act directly against the force of heredity as regards the diminishing organ, until such direct action of reversed selection will have removed the organ altogether. Or, in his own words, "The complete disappearance of a rudimentary organ can only take place by the operation of natural selection; this principle will lead to its diminution, inasmuch as the disappearing structure takes the place and the nutriment of other useful and important organs." That is to say, the rudimentary organ finally disappears, not because the force of heredity is finally exhausted, but because natural selection has begun to utilize this force against the continuance of the organ—always picking out those congenital variations of the organ which are of smallest size, and thus, by its now *reversed* action, *reversing* the force of heredity as regards the organ.

Now, the oversight here is that the smaller the disappearing structure becomes, the less hold must "this principle" of reversed selection retain upon it. As above observed, during the earlier stages of reduction (or while co-operating with the cessation of selection) the reversal of selection will be at its *maximum* of efficiency; but, as the process of diminution continues, a point must eventually be reached at which the reversal of selection can no longer act. Take the original mass of a now obsolescent organ in relation to that of the entire organism of which it then formed a part to be represented by the ratio 1 : 100. For the sake of argument we may assume that the mass of the organism has throughout remained constant, and that by "mass" in both cases is meant capacity for absorbing nutriment, causing weight, occupying space, and so forth. Now, we may further assume that when the mass of the organ stood to that of its organism in the ratio of 1 : 100, natural selection was strongly reversed with respect to the organ. But when this ratio fell to 1 : 1000, the activity of such reversal must have become enormously diminished, even if it still continued to exercise any influence at all. For we must remember, on the one hand, that the reversal of selection can only act so long as the presence of a diminishing organ continues to be so injurious that variations in its size are matters of life and death in the struggle for existence; and, on the other hand, that natural selection in the case of the diminishing organ does not have reference to the presence and the absence of the organ, but only to such variations in its mass as any given generation may supply. Now, the process of reduction does not end even at 1 : 1000. It goes on to 1 : 10,000, and eventually $1 : \infty$. Consequently, however great our faith in natural selection may be, a point must eventually come for all of us at which we can no longer believe that the reduction of an obsolescent organ is due to this cause. And I cannot doubt that if Prof. Weismann had sufficiently considered the matter, he would not have committed himself to the statement that "the complete disappearance of a rudimentary organ can only take place by the operation of natural selection."

According to my view of the matter, the complete disappearance of a rudimentary organ can only take place by the *cessation* of natural selection, which permits the eventual exhaustion of heredity, when heredity is thus simply left to itself. During all the earlier stages of reduction, the cessation of positive selection was assisted in its work by the activity of negative or reversed selection; but when the rudiment became too small for such assistance any longer to be supplied, the rudiment persisted in that greatly reduced condition until the force of heredity with regard to it was eventually worn out. This appears to me, as it appeared to me in 1874, the only reasonable conclusion that can be drawn from the facts. And it is because this conclusion is fatal to Prof. Weismann's doctrine of the permanent "stability" of germ-plasm, while quite in accordance with all theories which belong to the family of pangenesis, that I deem the facts of degeneration of great importance as tests between these rival interpretations of the facts of heredity. It is on this account that I have occupied so much space with the foregoing discussion; and I shall be glad to ascertain whether any of the followers of Prof. Weismann are able to controvert the views which I have thus re-published.

London, February 4. GEORGE J. ROMANES.

P.S.—Since the above article was sent in, Prof. Weismann has published in these columns (February 6) his reply to a criticism by Prof. Vines (October 24, 1889). In this reply he appears to have considerably modified his views on the theory of degeneration; for while in his essays he says (as in the passage above quoted) that "the complete disappearance of a rudimentary organ can only take place by the operation of natural selection"—*i.e.* only by the *reversal* of selection,—in his reply to Prof. Vines he says, "I believe that I have proved that organs no longer in use become rudimentary, and must finally disappear, solely by 'panmixia'; not through the direct action of disuse, but because natural selection no longer sustains their standard structure"—*i.e.* solely by the *cessation* of selection. Obviously, there is here a flat contradiction. If Prof. Weismann now believes that a rudimentary organ "must finally disappear *solely*" through the *withdrawal* of selection, he has abandoned his previous belief that "the complete disappearance of a rudimentary organ can *only* take place by the *operation* of selection." And this change of belief on his part is a matter of the highest importance to his system of theories as a whole, since it betokens a surrender of his doctrine of the "stability" of germ-plasm—or of the virtually everlasting persistence of the force of heredity, and the consequent necessity for a reversal of this force itself (by natural selection placing its premium on *minus* instead of on *plus* variations) in order that a rudimentary organ should finally disappear. In other words, it now seems he no longer believes that the force of heredity in one direction (that of sustaining a rudimentary organ) can only be abolished by the active influence of natural selection determining this force in the opposite direction (that of removing a rudimentary organ). It seems he now believes that the force of heredity, if merely left to itself by the withdrawal of natural selection altogether, will sooner or later become exhausted through the mere lapse of time. This, of course, is in all respects my own theory of the matter as originally published in these columns; but I do not see how it is to be reconciled with Prof. Weismann's doctrine of so high a degree of stability on the part of germ-plasm, that we must look to the Protozoa and the Protophyta for the original source of congenital variations as now exhibited by the Metazoa and Metaphyta. Nevertheless, and so far as the philosophy of degeneration is concerned, I shall be very glad if (as it now appears) Prof. Weismann's more recent contemplation has brought his principle of panmixia into exact coincidence with that of my cessation of selection.—G. J. R.

Newton in Perspective.

THE interesting modern science termed by the Germans *Geometrie der Lage*, and by the French and other Latin peoples *géométrie de position*, may be traced in germ to that part of Newton's "Principia" which deals with the construction of curves of the second order, and to what has survived in tradition of Pascal's lost manuscript entitled "Traité complet des Coniques." The more recent developments of this important subject cast much new light upon Newton's propositions, many of which we are now enabled to solve by easier and more direct methods. A noteworthy example is here fully worked out, in order to show how problems which Newton solved by indirect and circuitous processes may be solved more simply by the aid of modern graphics.

PROBLEM.—*Given the four tangents EA, AB, BC′, C′D (Fig. 1), as well as a point of contact; to construct the conic.*—First it will be necessary to give some faint idea of Newton's solution of this problem, without entering upon details which can be found in the Latin edition of the "Principia" edited by Sir William Thomson and Prof. H. Blackburn. Having expounded at great length a general theorem for the transformation of curves, Newton transforms the quadrilateral figure formed by the four tangents into a parallelogram. Then he joins the given point of contact *y*, transformed according to the same principle as the given four tangents, to the centre O of the parallelogram

—which is also the centre of the conic—and producing the line yO to y', so that Oy' may be equal to Oy, he determines a second point of contact y' on the conic, by which means the problem is reduced to the case dealt with in the preceding proposition, showing how to construct the curve when three tangents and two points are given. Having in this way found five points on the transformed conic, Newton next proceeds to retransform the whole of the figure to its original shape, in order to apply his well-known method of constructing a conic of which five points are known.

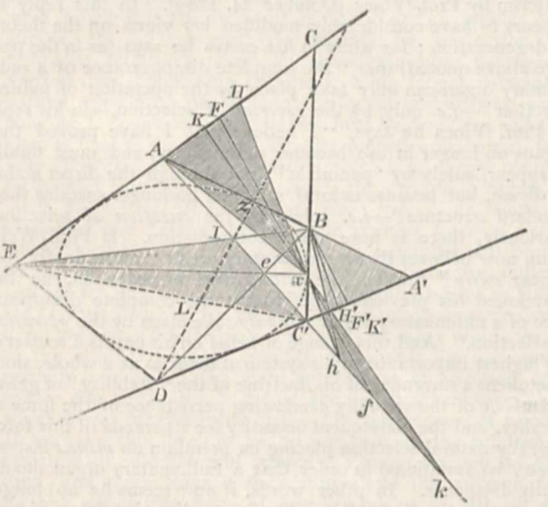


FIG. 1.

Now all these transformations and retransformations of lines and quadrangles involve very tedious and laborious operations, which can be avoided by borrowing a few simple principles of modern geometry. The following two original solutions of the above problem will serve to illustrate this statement.

SOLUTION.—*Case* I. *When the given point of contact x lies on one of the given four tangents.*—Assume the given point of contact x and the neighbouring apex B of the quadrangle as centres of projection, and the given tangent lines EA and C'D as punctuated lines. The meaning of the term "punctuated line," familiar to students of modern geometry, will appear in the sequel.

It will be seen that the fourth tangent AB cuts the first punctuated line EA in A and the second punctuated line C'D in A'. Now, according to a proposition of modern geometry, if the points A and A', in which the tangent AB intersects the two punctuated tangents EA and C'D, be projected by rays xA and BA' issuing from their respective centres of projection x and B, those rays will meet in a point A, situate on what is termed the perspective line of the pencils x and B.

Next imagine the tangent AB to revolve upon the curve so as gradually to approach the limiting position BC. In that case A will approach C, B will fall upon C', and the intersection of the projecting rays xC and BC' will coincide with C', which is therefore a second point on AC', the required perspective line of the pencils x and B. Wherefore, in order to find a fifth or any number of tangents to the curve, choose any point E on the punctuated line EA, and project this point from x, the corresponding centre of projection, upon the perspective line AC' in e; and then project e from the second centre of projection B upon the corresponding punctuated line C'D in D. The line ED is a fifth tangent to the conic, and any number of tangents can be drawn in precisely the same way. Then, let F be any other point on EA. Join and produce Fx, intersecting the perspective line AC' in f; and from the centre B project f upon the punctuated tangent C'D in F'. Then the line FF' will be a sixth tangent to the conic.

COR. I.—Since the lines AC', BD, and xE all meet in the same point e, it follows that, in any pentagon ABC'DE circumscribed to a conic, the opposite diagonals AC' and BD and the line joining the fifth point E to the opposite point of contact x all meet in the same point.

Case II. *When the given point of contact z lies outside of the four tangents AEDC'B.*—By the corollary, Case I., if AB be the fifth tangent, it must pass through the given point of contact z in such a direction that the diagonals C'A and EB may intersect in a point I situate on a given line Dz.

Now let AB revolve about the fixed point of contact z as a fulcrum, whilst A and B describe the lines EC and CC' (Figs. 1 and 2). Then, necessarily, z will be the centre of perspectivity of the punctuated lines EC and CC', whose centres of projection are respectively C' and E. But, by a well-known proposition of geometry of position, when the points of two converging punctuated lines, such as EC and CC', are projected from opposite centres in this fashion, the locus of the successive intersections of the rays C'A and EB, or in other words the variable position of the point I, will describe a conic, which in the present instance is a hyperbola. But the problem is how to find the point I on the transversal Lz without constructing the hyperbola, four points on which are already known. For it will be observed that, when A coincides with E, the point B will lie on the prolongation of Ez, and the corresponding projecting rays Ez and C'E will meet in E, a point on the hyperbola. Similarly C' is a second point on the hyperbola. Again, as AB continues to revolve about the fixed centre of perspectivity z, its intersections A and B with the punctuated lines EC and CC' will ultimately coalesce in the point C, common to both those lines. Hence, since in that case the rays projecting the double point C from the centres E and C' meet in C, this point must lie on the hyperbola.

Fourthly, if the line Cz be produced to intersect the line EC' in N, it can be easily shown that i, the third point in the harmonic ratio GziN, is a fourth point on the hyperbola. A fifth point can be found by simply drawing AB in any direction traversing z and intersecting EC in A' and CC' in B', and then projecting A' and B' from the centres C' and E respectively by rays C'A' and EB' which will meet in a fifth point upon the hyperbola.

Thus, given these or in fact any five points EDiTH (Fig. 2)

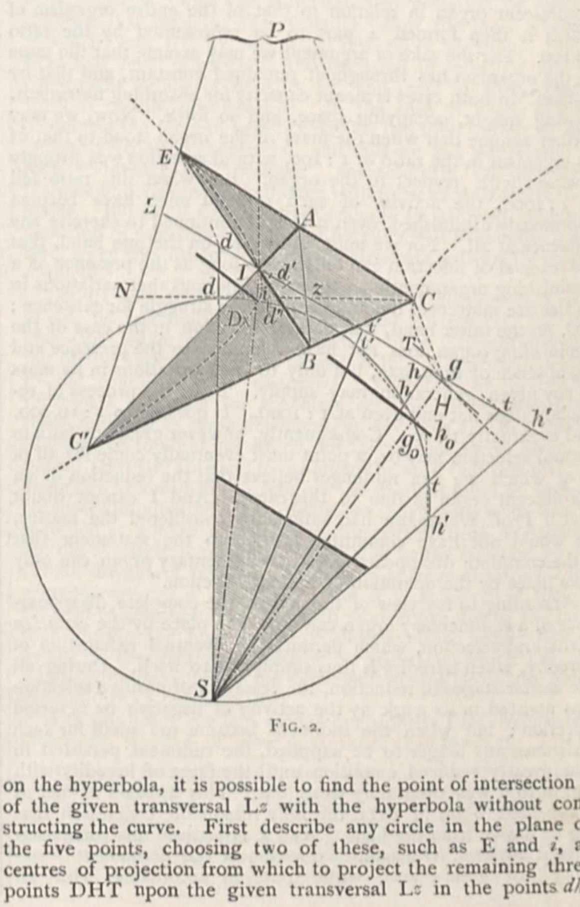


FIG. 2.

on the hyperbola, it is possible to find the point of intersection I of the given transversal Lz with the hyperbola without constructing the curve. First describe any circle in the plane of the five points, choosing two of these, such as E and i, as centres of projection from which to project the remaining three points DHT upon the given transversal Lz in the points *dht* and $d'h't'$ respectively. Then, from any point S on the circumference of the circle, reproject the six points *dht*, $d'h't'$, upon the same circumference in the points similarly lettered.

By means of this double projection from the centres E and *i* the points DHT have been transferred in duplicate from the hyperbola to the circle, or from one conic to another of a different species; and it is proved in treatises on modern geometry that points so transferred lose none of their projective properties. Hence the points *dht* and $d'h't'$ on the circumference of the circle are allied projective systems. Therefore, in order to find the perspective line common to both systems, choose one point *t* of the first set as the centre of projection of the second system; and make t', the correlative point of the second set, the centre of projection of the system *dht*.

From *t* project the points d' and h' by rays td' and th', and from t' project the correlative points *d* and *h* by rays $t'd$ and $t'h$. Then the correlative rays td' and $t'd$ will intersect in a point d_0 on the required perspective line; and the correlative rays th' and $t'h$ will meet in h_0, a second point on the same line. This perspective line d_0h_0 will intersect the circumference in two points i_0 and g_0 which, being joined to S and produced, will determine the double points I and *g* common to the hyperbola and transversal L*z*. The complete quadrangle EC'IC shows that the harmonic ratios C*zi*N and *gz*IL are segments of the same harmonic pencil P.

The lines E*z* and C'*z* are tangents to the curve at E and C' respectively; and *z* is the pole of the polar EC' with respect to the hyperbola. The proofs of these last two deductions may be found in any good text-book on geometry of position.

ROBERT H. GRAHAM.

Thought and Breathing.

PROF. MAX MÜLLER's article on thought and breathing, in your issue of February 6 (p. 317) has just come into my hands. In it he states that the power of retaining the breath is practised largely by Hindus as a means towards a higher object, viz. the abstraction of the organs of the human body from their natural functions. The same custom prevails amongst a certain sect of Mahometans also—the so-called Softas.

In 1878, when in the Central Provinces of India, I came across a native Christian—Softa Ali, as he was called—who had a history. His father had been a Cazi—or religious judge—and a wealthy man, who through scruples of conscience fell into disgrace with a certain native ruler, lost his all, and was banished. His son was, or became, a Softa, and after some years embraced Christianity from conviction, and at great cost to himself—for his wife and children would no longer consort with him. When describing to me the practices formerly enjoined upon him by his religion, this man stated that a Softa is required to draw in and retain his breath and respire it again in various manners. He did not give full details as to how this should be effected, but said that the object of this procedure was to worship with every organ of one's body—heart, lungs, &c., in turn. He added that this practice was a fruitful source of heart-disease.

The following year, when staying at Futtehpore Sikri, near Agra, I saw and heard a Mahometan, unknown to himself, make his evening devotions near the tomb of Suleem Chisti in the way above described; his movements, and the sounds he uttered, were most peculiar.

It has been often related, from well-attested evidence, that in the case of those who have been recovered from drowning, or of those who have been hung and cut down before life was extinct, a kind of automatic consciousness seems to be extraordinarily active in them at the time of their peril. It would appear that, as regards Hindu and Mahometan devotees, and the drowning or partially hung man, a kind of asphyxia is the result, and that, when sensation is almost gone, the intelligence acquires increased activity. In our ordinary life, if our minds are intently fixed upon a subject, we instinctively and involuntarily retain the breath.

When in Rajputana, and again when on the frontier of Chinese Tibet, I saw in each place a man who, to all appearance, seemed to have attained the power of perfect abstraction. In the former case, the villagers asserted that the devotee rose only once a week from his most uncomfortable and constrained position; in the second instance, the man—a most singular-looking person—remained absolutely immovable the whole day. Both seemed to be in a kind of cataleptic trance.

HARRIET G. M. MURRAY-AYNSLEY.

Former Glacial Periods.

I HAVE long felt convinced that geologists are being misled in reference to former glacial epochs by failing to give due thought to a consideration referred to on former occasions,[1] viz. that when the present surface of the globe has been disintegrated, washed into the sea, and transformed into rock, there will undoubtedly then be about as little evidence that there had been a glacial epoch during post-Tertiary times as there is at present that there was one during Miocene, Eocene, Permian, and other periods.

JAMES CROLL.

Perth, March 6.

AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE formation of this Association, mainly by the efforts of Prof. Liversidge, of Sydney University, and its first meeting in Sydney in August 1888, were noticed at the time in NATURE (vol. xxxviii. pp. 437, 623). One of the chief rules of the Association is that it shall meet in turn in the capital cities of the various colonies; and Melbourne was agreed upon as the second meeting-place. It was found inconvenient, however, to hold the Melbourne meeting during 1889, as should have happened in due course, for it is only after Christmas that all the Universities are simultaneously in vacation; and accordingly it was commenced on the 7th of January in the present year, and was continued through the following week. Some anxiety was felt as to the result of this choice of date, for there is always a risk in January of such continuous heat as would hinder the work and destroy the pleasure of the meeting; but the Association proved to be specially favoured in the matter of weather.

The following are the names of the officers of the Association and of the Sections. With regard to the latter, the rule obtains that Presidents are chosen from other colonies, while Vice-Presidents and Secretaries are chosen from the colony in which the meeting is held.

President, Baron von Mueller, K.C.M.G., F.R S.

Local Treasurer, R. L. J. Ellery, C.M.G., F.R.S.

General Secretaries: Prof. Archd. Liversidge, F.R.S., Permanent Hon. Secretary; Prof. W. Baldwin Spencer, Hon. Sec. for Victoria.

Assistant Secretary for Victoria, J. Steele Robertson.

Sectional Officers:—Section A (Astronomy, Mathematics, Physics, and Mechanics)—President, Prof. Threlfall, Sydney University. Vice-President, Prof. Lyle, Melbourne University. Secretaries: W. Sutherland, E. F. J. Love.

Section B (Chemistry and Mineralogy)—President, Prof. Rennie, Adelaide University. Vice-President, C. R. Blackett, Government Analyst, Melbourne. Secretary, Prof. Orme Masson, Melbourne University.

Section C (Geology and Palæontology—President, Prof. Hutton, Canterbury College, New Zealand. Vice-President, Prof. McCoy, C.M.G., F.R.S., Melbourne University. Secretary, James Sterling,

Section D (Biology)—President, Prof. A. P. Thomas, Auckland. Vice-Presidents: J. Bracebridge Wilson; P. H. MacGillivray. Secretaries: C. A. Topp, Arthur Dendy.

Section E (Geography)—President, W. H. Miskin, President of the Queensland Branch of the Royal Geographical Society of Australasia. Vice-Presidents: Commander Crawford Pasco, R.N.; A. C. Macdonald. Secretary, G. S. Griffiths.

Section F (Economic and Social Science and Statistics—President, R. M. Johnson, Registrar-General, Hobart. Vice-President, Prof. Elkington, Melbourne University. Secretaries: A. Sutherland, H. K. Rusden.

Section G (Anthropology)—President, Hon. J. Forrest, C.M.G., Commissioner for Crown Lands, Western

[1] Quart. Journ. Geol. Soc. for May 1889; "Climate and Time," p. 266.

Australia. Vice-President, A. W. Howitt, Secretary for Mines, Melbourne. Secretary, Rev. Lorimer Fison.

Section H (Sanitary Science and Hygiene)—President, Dr. J. Ashburton Thompson, Sydney. Vice-Presidents: A. P. Akehurst, President of the Central Board of Health, Melbourne; G. Gordon. Secretary, G. A. Syme.

Section I (Literature and Fine Arts)—President, Hon. J. W. Agnew, Hobart. Vice-Presidents: Prof. Tucker, Melbourne University (Literature Sub-Section); J. Hamilton Clarke (Music Sub-Section). Secretaries: Dr. Louis Henry (Music Sub-Section); Tennyson Smith (Literature Sub-Section).

Section J (Architecture and Engineering)—President, Prof. Warren, Sydney University. Vice-Presidents: A. Purchas, H. C. Mais. Secretary, A. O. Sachse.

All arrangements for the meeting were made by the Local Committee, of which Mr. R. L. J. Ellery, the Government Astronomer, was chairman, and Prof. W. Baldwin Spencer secretary. The greater share of the work devolved on Prof. Spencer, and to his indefatigable energy is mainly due the undoubted success of the meeting. The buildings and grounds of the University were placed at the service of the Association, and nothing could have been better than the accommodation thus afforded. A lecture theatre was set apart for each of the ten Sections; and, as these theatres are situated in different parts of the grounds, and some distance apart, they were all connected by telephone, so that the advent of each paper in any Section could be signalled in every other. The large Wilson Hall was used as a reception-room; and a luncheon-hall, smoking-rooms, reading- and writing-rooms, a press-room, &c., were also provided, as also a special post- and telegraph-office. An official journal of the proceedings was published each morning, and every member was supplied with a copy of a special hand-book compiled for the occasion, and containing the following chapters:—

(1) "History of Victoria," by Alexander Sutherland.
(2) "Geology of Melbourne," by G. S. Griffiths.
(3) "Aborigines of Victoria," by Lorimer Fison.
(4) "Zoology, Vertebrata," by A. H. S. Lucas.
(5) "Zoology, Invertebrata," by A. Dendy.
(6) "Entomology," by C. French, Government Entomologist.
(7) "Botany," by C. A. Topp.
(8) "Commerce and Manufactures," by W. H. Thodey.
(9) "Climate," by R. L. J. Ellery, C.M.G., F.R.S., Government Astronomer.

Over six hundred members, representing all parts of Australasia, were in actual attendance, the total membership roll numbering more than a thousand. Some hundred and fifty papers in all were set down for reading in the various Sections. All these figures show a large increase since the first meeting, and give gratifying evidence of the growing interest taken in science throughout the colonies; further proofs of which are to be found in the facts that the Government of Victoria voted the liberal sum of £1000 towards defraying the expenses of the meeting, and that the entertainments provided by the hospitality of prominent citizens were numerous and on a most sumptuous scale. Many visits to places of scientific interest were also arranged for—short afternoon excursions for those who might not care for continuous Sectional work, and longer excursions at the conclusion of the meeting, under special leaders, to the Australian Alps, the Black Spur and Marysville, Gippsland Lakes, Ferntree Gully, Ballarat, and Sandhurst, all of which proved highly successful.

At the opening meeting in the Town Hall—presided over by His Excellency the Governor, the Earl of Hopetoun—the President, Baron Sir Ferdinand von Mueller, delivered his address, after being introduced by his predecessor in office, Mr. Russell, the Government Astronomer of New South Wales. Baron von Mueller undoubtedly stands at the head of the scientific workers in Australia. He has been a colonist since 1848, and since 1852 has held the position of Government Botanist in Victoria. His fame, which is based not only on the immense amount of work he has done in his special subject, the botany of Australia, but on his early achievements as an explorer, may be indicated in the words used by Mr. Russell:—"In 1861 he was made a Fellow of the Royal Society; he received from Her Majesty the Queen the Knight Companionship of St. Michael and St. George; was made a Commander of the Orders of St. Iago of Portugal, of Isabella of Spain, and of Philip of Hesse; was created hereditary Baron by the King of Würtemberg in 1871; and is honorary or corresponding member of a hundred and fifty learned societies." To this enumeration may be added what is, perhaps, the most honourable award of all—that of a Royal Medal by the Royal Society at the end of 1888. Throughout the colonies "the Baron" is known: a unique personality, not always wholly understood, but always recognized as a proud possession. His address, therefore, was listened to with peculiar interest, and perhaps all the more so that he did not confine himself to any special branch, but dealt generally with the past and future of Australasian science.

The Presidents of Sections also, in many cases, chose for their addresses subjects of particular interest in Australia. Prof. Rennie spoke of the work that has been done in the investigation of the chemistry of native plants and minerals, and made suggestions as to how this work may in future be encouraged and facilitated. Prof. Thomas discussed the problems here awaiting the biologist, and the local desiderata in scientific education. Mr. Miskin spoke principally of exploration in Australia and New Guinea, and of the importance to the colonies of Antarctic exploration; but he also discussed the chief geographical work now being done in other parts of the world. Mr. Forrest's address dealt with the present condition of the Australian aboriginal races. Dr. Ashburton Thompson discussed the sanitary organizations of Victoria and New South Wales, and the modes of obtaining and interpreting health statistics. Prof. Warren spoke of the education of engineers, with special reference to the local conditions and requirements. Dr. Agnew reviewed the literature and art of Australia. In the other Sections the Presidents chose subjects that do not owe their interest to local colour. Prof. Threlfall gave an account of the present state of electrical knowledge; Prof. Hutton's address was on the oscillations of the earth's surface; and Mr. Johnston spoke generally of current social and economic problems. A large proportion of the papers read by members in the various Sections were also Australian in their character. This was specially the case in the Sections of Geology and Anthropology; where, perhaps, the most valuable original work was communicated. As the Transactions will soon be published, the individual papers need not now be noticed; but reference may be made to the work done in the form of reports from Committees appointed at the previous meeting. The most bulky and perhaps the most valuable of these reports is that by a Committee which undertook, with Prof. Liversidge as its secretary, to prepare a census of the known minerals of the Australasian colonies. It disposes of New South Wales (only such information being given as was required to supplement Prof. Liversidge's published work), Queensland, and New Zealand. The portions dealing with Victoria and Tasmania are in process of completion; and, the Committee having been re-appointed, it is hoped that by next year the whole census will be complete. The publication will probably be delayed till then, and it will if possible take the form of a separate volume. A very important recommendation was made by another Committee (Prof. Haswell, of Sydney, secretary), which when it is carried out will do much for biological research, viz. that steps be taken to establish and endow a central biological station at Port Jackson. Among the other reports may be mentioned one on the Polynesian races and Polynesian bibliography.

At the final meeting of the General Committee of the Association new special Committees were appointed to investigate and report on the following subjects: wheat rust, the manner of laying out towns, the preparation of geological maps, the arrangement of museums, the fertilization of the fig, Australian tides, and the present state of knowledge with regard to Australasian palæontology. A Committee was also appointed to formulate a scheme for obtaining practical assistance from the various Colonial Governments in the collection of material for research—chemical, geological, or biological. Other special Committees were appointed for the publication of the Transactions and for the revision of the laws of the Association.

The next meeting is to be held in Christchurch, New Zealand, probably in January 1891; and Sir James Hector has been elected President, and Prof. Hutton, Secretary. It has also been decided to hold the fourth meeting in Hobart, Tasmania, so that the Association will not again meet on the mainland for three years. To adventure so far as Christchurch is somewhat bold in so young an Association; but the success of the Melbourne meeting has demonstrated its usefulness and popularity, and warrants the belief that many will cross the water next year. There is even a strong hope felt by some that the occasion and the place may tempt a few of the members of the parent British Association to make the longer voyage from home, and see for themselves what is being done and what waits to be done for science at the antipodes.

ORME MASSON.

METEOROLOGICAL REPORT OF THE "CHALLENGER" EXPEDITION.[1]

PREVIOUS to 1872, discussions of the fundamental problems of meteorology relating to diurnal changes in atmospheric pressure, temperature, humidity, wind, and other phenomena, may be regarded as restricted to observations made on land. It had then, however, become evident that data from observations made on land only, which occupies about a fourth part of the earth's surface, were quite inadequate to a right conception and explanation of meteorologieal phenomena; and hence, when the *Challenger* Expedition was fitted out, arrangements were made for taking, during the cruise, hourly or two-hourly observations. These observations were published in detail in the "Narrative of the Cruise," Vol. II. pp. 305–74, and are still by far the most complete yet made on the meteorology of the ocean.

Elaborate observations were likewise made on deep-sea temperatures, which were at once recognized as leading to results of the first importance in terrestrial physics, and opening for discussion the broad question of oceanic circulation, on a sound basis of authentic facts. Preliminary, however, to any such inquiry, a full discussion of atmospheric phenomena was essential, requiring for its proper handling maps showing the mean temperature, mean pressure, and prevailing winds of the globe for each month of the year, with tables giving the data from which the maps are constructed. In other words, what was required was an exhaustive revision and ratification of Dove's isothermals, 1852; Buchan's isobars and prevailing winds, 1869; and Coffin's winds of the globe, 1875.

[1] "Report of the Scientific Results of the Voyage of H.M.S. *Challenger* during the Years 1873–76." Prepared under the superintendence of John Murray, LL.D. "Physics and Chemistry," Vol. II., Part V. "Report on Atmospheric Circulation." By Alexander Buchan, M.A., LL.D.

The work was entrusted to Mr. Buchan, of the Scottish Meteorological Society, in 1883, and was published in the beginning of this year. In addition to the tables of the appendices, giving the results of the *Challenger* observations, the more important are those giving the mean diurnal variation of atmospheric pressure at 147 stations in all parts of the world; the mean monthly and annual pressure at 1366 stations; a similar table of temperatures at 1620 stations; and the mean monthly and annual direction of the wind at 746 stations. It is believed that these tables include all the information at present existing that is required in the discussion of the broad questions raised in the Report, which includes, with the exception of the rainfall, all the important elements of the climates of the globe.

The Report itself is divided into two parts, the first dealing with diurnal, and the second with monthly, annual, and recurring phenomena. This is the first attempt yet made to deal with the diurnal phenomena of meteorology over the ocean—the temperature, pressure, and movements of the atmosphere, together with such phenomena as squalls, precipitation, lightning, and thunderstorms.

In equatorial and subtropical regions, the mean temperature of the surface of the sea falls to the daily minimum from 4 to 6 a.m., and rises to the maximum from 2 to 4 p.m., the amount of the diurnal variation being only 0°·9 F. In the higher latitudes of the Antarctic Ocean, the diurnal variation was only 0°·2. Of the four great oceans, the greatest variation was 1°·0 in the North Pacific, and the least 0°·8 in the Atlantic. This small daily variation of the temperature of the surface of the sea, shown by the *Challenger* observations, is an important contribution to physical science, being in fact one of the prime factors in meteorology, particularly in its bearings on the daily variations of atmospheric pressure and winds. The diurnal phases of the temperature of the air over the open sea occur at the same times as those of the temperature of the surface, but the amount of the variation is about 3°·0, and when near land the amount rises to 4°·4. The greater variation of the temperature of the air, as compared with that of the surface of the sea on which it rests, is a point of much interest from the important bearings of the subject on the relations of the air, and its aqueous vapour in its gaseous, liquid, and solid states, and the particles of dust everywhere present, to solar and terrestrial radiation. Thus the air rises daily to a higher and falls to a lower temperature than does the surface of the sea on which it rests.

The diurnal variation in the elastic force of vapour in the air is seen in its amplest form over the open sea, the results giving a curve closely coincident with the diurnal curve of temperature. But near land, the elastic force instead of rising towards, and to, the daily maximum at noon and 2 p.m., shows a well-marked depression at these hours, and indicates no longer merely a single, but a double maxima and minima. In other words, the curve now assumes the characteristics of this vapour curve as observed at all land stations, or where during the warmest hours of the day ascending currents rise from the earth's surface, and down-currents of drier air take their place. An important point specially to be noted here is that over the open sea, hygrometric observations disprove the existence of any ascending current from the surface of the sea during the hours when temperature is highest. On the other hand, the curve of relative humidity is simply inverse to that of the temperature, falling to the minimum at 2 p.m. and rising to the maximum early in the morning.

As regards the diurnal variation of the barometer, it is shown that the special forms of the monthly curves are, in their relations to the sun, direct and not cumulative as is the case with most of the monthly mean results of meteorology. The movement of the daily barometric oscillations from east to west is only quasi-tidal, being quite different from the manner in which the tides of the ocean are propagated from place to place over the earth's surface; these oscillations being, undoubtedly, directly generated by solar and terrestrial radiation in the regions where they occur, and it is thus only that the striking variations in the curves of restricted districts comparatively near each other are to be explained. These peculiarities do not occur over the open sea.

As illustrating these variations, reference is made to the retardation of the time of occurrence of the morning maximum, which is delayed as the year advances, the latest retardation being in June; and the curves of 14 stations are given, these stations being situated in the middle and higher latitudes, and in localities which, while strongly insular in character, are at the same time not far from extensive tracts of land to eastward or south-eastward. These barometric curves for June present a graduated series, the two extremes being Culloden, where the morning maximum occurs at 7 a.m., and Sitka, where the same phase of pressure is delayed till 3 p.m., there being thus eight hours between them. Another set of curves is given from lower latitudes, showing the diurnal variation in mid-ocean from the *Challenger* observations, together with a series of land stations representing the influence of a land surface in increasing the amount of the variation, which reaches the maximum in the driest climates. Latitude for latitude, the maximum daily variation occurs in such arid climates as Jacobabad on the Indus, and the minimum over the anticyclonic regions of the great oceans. At Jacobabad the variation from the morning maximum to the afternoon minimum reaches 0·187 inch, whereas in the South Pacific it is 0·036 inch, and in the North Atlantic only 0·014 inch.

The following are some of the other types of barometric curves discussed—the curves at high-level stations on true peaks, and down the sides of the mountain; the curves in deep contracted valleys; those in high latitudes in the interior of continents where the morning minimum disappears; and those in high latitudes over the ocean where the afternoon minimum disappears. In the two last cases, the curve is reduced to a single maximum and minimum, which as regards the times of occurrence are the reverse of each other.

The atmosphere over the open sea rests on a floor or surface, subject to a diurnal range of temperature so small as to render that temperature practically constant both night and day; but notwithstanding this, the diurnal oscillations of the barometer occur over the open sea, equally as over the land surfaces of the globe. Hence the vitally important conclusion is drawn that the diurnal oscillations of the barometer are not caused by the heating and cooling of the earth's surface by solar and terrestrial radiation and by the effects following these diurnal changes in the temperature of the surface, but that they are primarily caused by the direct heating by solar radiation and cooling by terrestrial radiation of the molecules of the air and of its aqueous vapour, and the changes consequent on that cooling. It follows that these changes of temperature are instantly communicated through the whole atmosphere, from its lowermost stratum resting on the surface to the extreme limit of the atmosphere. There are important modifications of the barometric curves affecting the amplitude and times of occurrence of the principal phases of the phenomena, over land surfaces, for example, which are superheated during the day and cooled during the night according to the amount of aqueous vapour present in the atmosphere. But it is particularly insisted on that the barometric oscillations themselves are independent of any change in the temperature of the floor of the earth's surface on which the atmosphere rests. It scarcely requires to be added that these results of observation will necessitate the revision of all theories of the diurnal oscillations of the barometer that have assumed a diurnal change of the temperature of the surface on which the atmosphere rests as a necessary cause of these oscillations. The theory of the diurnal oscillations of the barometer submitted by Mr. Buchan may be thus stated: Assuming that aqueous vapour, in its purely gaseous state, is as diathermanous as the dry air of the atmosphere, it is considered that the *morning minimum* of pressure is due to a reduction of tension brought about by a comparatively sudden lowering of the temperature of the air itself by terrestrial radiation through all its height, and by a change of state of a portion of the aqueous vapour from the gaseous to the liquid state by its deposition on the dust particles of the air. The morning minimum is thus due, not to any removal of the mass of air overhead, but to a reduction of the tension by a lowering of the temperature and change of state of a portion of the aqueous vapour.

As the heating of the air proceeds with the ascent of the sun, evaporation takes place from the moist surfaces of the dust particles, and tension is increased by the simple change from the fluid to the gaseous state; and as the dust particles in the sun's rays rise in temperature above that of the air-films in contact with them, the temperature of the air is thereby increased, and with it the tension. Under these conditions the barometer steadily rises with the increasing tension to the *morning maximum;* and it is to be noted that the rise of the barometer is not occasioned by any accessions to the mass of air overhead, but only to increasing temperature of the air itself and change of state of a portion of its aqueous vapour.

By and by an ascending current of the warm air sets in, and pressure gradually falls as the mass of air overhead is reduced by the ascending current flowing back as an upper current to eastward—in other words, over the section of the atmosphere to eastward whose temperature has now fallen considerably lower than that of the region from which the ascending current is rising; and this continues till pressure falls to the *afternoon minimum.*

The back flow to eastward of the current, which has ascended from the longitudes where pressure at the time is at the minimum, increases pressure over the longitudes where temperature is now rapidly falling, and this atmospheric quasi-tidal movement brings about the *evening maximum* of pressure, which occurs from 9 p.m. to midnight according to latitude and geographical position. As the early hours of morning advance these contributions through the upper currents become less and less, and finally cease, and the effects of terrestrial radiation now going forward again introduce the morning minimum as already described. It is during the evening maximum that the diurnal maximum of periods of lightning without thunder and of the aurora take place, it being during this phase of the pressure that the atmospheric conditions result in an abundant increase of ice spicules in the upper regions of the atmosphere, which thus serve as a screen for the better presentation of any magneto-electric discharges that may occur.

It is interesting to note, in this connection, that the amount of the diurnal barometric tide falls conspicuously to the minimum, latitude for latitude, within the anticyclonic regions of the great oceans, where, owing to the descending currents which there prevail, deposition from the aqueous vapour is less abundant on the dust particles.

From a discussion of the whole of the two-hourly observations of the wind made during the cruise, sorted into those made over the open sea and those made near land, it is shown that the velocity of the wind is greater over the open sea than at or near land, the difference being from 4 to 5 miles per hour. The most important result is that there is practically no diurnal variation in the wind's velocity over the open sea. But as respects the winds observed near land, the velocity at the different hours of the day gives a curve as clearly and decidedly marked as that of the temperature, the minimum occurring from 2 to 4 a.m., and the maximum from noon to 4 p.m., the absolute maximum being at 2 p.m. The difference between the hour of least and that of greatest velocity is for the Southern Ocean $6\frac{1}{2}$ miles; South Pacific, $4\frac{1}{2}$ miles; South Atlantic, $3\frac{1}{4}$ miles; and North and South Atlantic, each 3 miles. It is also to be noted that even the maximum of the day near land in the case of none of the oceans attains to the velocity observed over the open sea. The curve near land is substantially the same as the curves characteristic of stations on land. Thus, over the sea, where surface temperature is practically a constant day and night, the velocity of the wind shows no diurnal variation; whereas over land, and also near it, where the temperature of the surface is subject to a diurnal variation, the wind's velocity is also subject to an equally well-marked diurnal variation. On the other hand, at high-level observatories situated on true peaks, the maximum velocity occurs during the night, and the minimum during the day. In deep valleys in mountainous regions, an abnormally high barometer obtains during the night, which is the result of cold currents from the adjoining slopes that the cooling effects of terrestrial radiation set in motion. Now since these down-flowing winds must be fed from higher levels than those of the mountain itself, the winds prevailing on their tops are really the winds of a higher level, and blow therefore with the increased velocity due to that greater height. On the other hand, during the warmer hours of the day, the barometric pressure in deep valleys is abnormally low, owing to the superheating of these valleys as contrasted with the temperature of the surrounding region, thus giving rise to a warm wind blowing up the valleys, and an ascending current close to the sides of the mountain up to the summit. Now, since no inconsiderable portion of this ascending current, whose horizontal velocity is necessarily much retarded, mingles with the air-current proper to the level of the peak, the wind on the peak is retarded, and falls to the minimum of the day when the temperature is highest.

The results of the averaging of the squalls over the open sea entered in the *Challenger's* log show a strongly marked diurnal maximum early in the morning, when the effects of terrestrial radiation are at the maximum. But over land the diurnal curves for whirlwinds, tornadoes, and allied phenomena, show the minimum at these hours, and the maximum at the hours when insolation is strongest. It is probable that the daily maximum occurs in each case at those hours when temperature decreases with height at a greatly more rapid rate than the normal.

The distribution during the day of thunderstorms, and of lightning without thunder, is very remarkable. During the cruise 26 thunderstorms occurred over the open sea, of which 22 occurred during the 10 hours from 10 p.m. to 8 a.m., and only 4 during the other 14 hours of the day. Hence, over the open sea, the diurnal curve of thunderstorms is precisely the reverse of what obtains on land. Of the 209 reported cases of lightning without thunder, 188 occurred during the 10 hours from 6 p.m. to 4 a.m., and only 21 during the other 14 hours of the day. The following are the hours of the maxima of these phenomena in the warmer months over land and the open sea respectively. Thunderstorms over land, 2 to 6 p.m.; lightning over land, 8 p.m. to midnight; lightning over the open sea, 8 p.m. to 4 a.m.; and thunderstorms over the open sea, 10 p.m. to 8 a.m. These facts are a valuable contribution to the science, from their intimate connection with the ascending and descending currents of the atmosphere.

The second part of the Report, dealing with the monthly and annual phenomena, aims at giving a comparative view of the climatologies of the globe to a degree of completeness not previously attempted. The distribution of the temperature and pressure of the atmosphere and prevailing winds is illustrated by 52 newly constructed maps, of which 26 show by isothermals the mean monthly and annual temperature on hypsobathymetric maps, first on Gall's projection, and second on north circumpolar maps on equal surface projection; and 26 show, by isobars, for each month and for the year, the mean pressure of the atmosphere, with the gravity correction to lat. 45° applied, and by arrows the prevailing winds of the globe. Two other maps are given in the text, one showing for July the geographical distribution of the amount of the barometric oscillation from the morning maximum to the afternoon minimum; and the other, the annual range of the mean monthly pressure, which, in a sense, may be regarded as indicating the relative stability of the atmospheric pressure in different regions of the earth.

For the details of this discussion, we must refer to the Report itself, the broad results of which Mr. Buchan thus summarizes:—

"The isobaric maps show, in the clearest and most conclusive manner, that the distribution of the pressure of the earth's atmosphere is determined by the geographical distribution of land and water in their relations to the varying heat of the sun through the months of the year; and since the relative pressure determines the direction and force of the prevailing winds, and these in their turn the temperature, moisture, rainfall, and in a very great degree the surface currents of the ocean, it is evident that there is here a principle applicable not merely to the present state of the earth, but also to different distributions of land and water in past times. In truth, it is only by the aid of this principle that any rational attempt, based on causes having a purely terrestrial origin, can be made in explanation of those glacial and warm geological epochs through which the climates of Great Britain and other countries have passed. Hence the geologist must familiarize himself with the nature of those climatic changes which necessarily result from different distributions of land and water, especially those changes which influence most powerfully the life of the globe."

It is evident from what has been said that many of the results of the diurnal and seasonal phenomena of ocean meteorology are equally novel and important, and, when combined with the analogous results obtained from land observations, enable us to take a more intelligent and comprehensive grasp of atmospheric phenomena in their relations to the terraqueous globe taken as a whole than has hitherto been possible.

THE BOTANICAL LABORATORY IN THE ROYAL GARDENS, PERADENIYA, CEYLON.

THE attention of the readers of NATURE has been drawn more than once (vol. xxxi. p. 460, vol. xxxiv. p. 127) to the opportunities which are before botanists for the study of plants other than those of our own flora. But since the latter of these articles appeared, a step has been taken which will justify a return once more to this important subject.

It is certainly one of the most healthy signs of the present time that our younger botanists desire not merely to pore over minute details of microscopical structure in the laboratory at home, but to become personally acquainted with plants in the open. When the somewhat sudden reversion occurred some fifteen years ago, from taxonomy as an academic study, to the more detailed examination of the tissues of plants in the laboratory, and the study of their functions, those who took a large view of the progress of the science must have seen with regret that the change, however valuable in itself, brought with it a new danger. Those who as students were first introduced to plants as subjects of microscopic study ran the risk of failing to appreciate the importance of external form: they acquired a knowledge of the minute structural details of certain plants, but did not acquire a strong grasp of the external characters of plants as a whole. But the pendulum which thus swung rapidly over to an extreme position is now returning to the mean. While duly appreciating the value of microscopic examination, the younger botanists are awake to the advantage, or even the necessity, of a wide knowledge of plants. The whole area of facts upon which those who are now engaged in teaching draw in the course of their lectures is much wider than it was ten years ago, and the extension has, perhaps, been most marked in the province of external morphology.

This being so, there will be no need to press upon the men who are starting upon a career as botanists the importance of a visit to the tropics: they will look upon the collections in our Botanic Gardens, which they are hardly allowed to touch, as only a temporary substitute for a tropical jungle, where they may cut down plants as they please, in order to obtain specimens illustrating mature or developmental characters. Moreover, those characters of a tropical flora which are the most striking and characteristic are often those which must remain entirely unrepresented in our glass houses at home. An expedition to the tropics should, in fact, become a recognized item in the programme of preparation for a career as a teacher of botany.

The advantages offered by the Royal Gardens at Peradeniya have already been pointed out in NATURE (vol. xxxiv. p. 127); but since that article was written steps have been taken by a Committee of the British Association to add to them. Backed by a grant of money, they have undertaken the establishment of a permanent laboratory in which visitors may carry on their work. A room has been set apart for this purpose in the official bungalow by the directorate of the Royal Garden. It has every advantage of position, being placed centrally in the garden, and within easy reach of the herbarium, &c.; while, since it is under the same roof as the Director's office, visitors would have the great advantage of the presence of Dr. Trimen himself as a referee in recognition of the plants of the rich native flora. In this room are to be found such apparatus and reagents as are ordinarily required for laboratory work, and steps are being taken to add other facilities.

The mere mention of these facts will probably suffice to attract those who were not previously aware of them. The chief deterrent will be the cost of the journey. It has already been stated that £200 to £250 will suffice for all expenses of an expedition of six months' duration, while if two club together the individual cost would be considerably smaller. Though the Committee of the British Association have no power to use the money entrusted to them as a personal grant, still it is well known that there are sources from which such grants may be obtained in order to assist those who are engaged on a definite line of research. Bearing all these facts in mind, the value of such an expedition as that to Peradeniya cannot be too strongly urged on those who are about to enter definitely on a career as professed botanists. The widening of view, and opportunity for research, which any man of originality would obtain by it would amply repay him for his expenditure of time and money. Applications for the use of the laboratory, which is at present vacant, should be made to Prof. Bower (University, Glasgow), who is the secretary to the Committee.

THE ASTRONOMICAL OBSERVATORY OF HARVARD COLLEGE.

PROF. EDWARD C. PICKERING has presented to the Visiting Committee the forty-fourth Annual Report of the Director of the Astronomical Observatory of Harvard College. The following are the more important passages:—

Henry Draper Memorial.—The first research on the spectrum of over ten thousand of the brighter stars is now nearly completed and is partially in print. The photographs required for the second research on the spectrum of the fainter stars are also nearly complete. The eleven-inch telescope has been in constant use throughout nearly every clear night in photographing the spectrum of the brighter stars. This work is approaching completion for all stars bright enough to be photographed by means of our present appliances, with the large dispersion now employed. Good progress has also been made with the classification of the spectra, and the study of the slight differences in different stars. By the use of an improved process for staining plates with erythrosin, the yellow and green portions of the spectrum, even of the fainter stars, can be advantageously studied. Numerous experiments have been made with a device for measuring the approach and recession of stars, by means of an achromatic prism in front of the object-glass. Several peculiar spectra have been studied, especially that of ζ Ursæ Majoris. The periodic doubling of its lines seems to be due to the rotation of two components too close to be distinguished by direct observation. The detection of bright lines in one of the stars in the Pleiades suggests a possible explanation of the legend that seven stars were formerly visible in this group.

During last spring an expedition was sent to Peru in charge of Mr. S. I. Bailey, assisted by Mr. M. H. Bailey. A station was selected on a mountain about six thousand feet high and about eight miles from Chosica. All supplies for the station, including water, must be carried by mules for this distance. Two frame buildings covered with paper have been erected, one for an observatory, the other for a dwelling-house. Since May 9 the Bache telescope has been kept at work during the whole of every clear night. 1236 photographs have been obtained. The plan proposed will cover the sky south of -15° four times, once with photographs of spectra having an exposure of an hour, which will include stars to about the eighth magnitude; secondly, with an exposure of ten minutes, giving the brighter stars; thirdly, with charts having an exposure of one hour, permitting a map of the southern stars to the fourteenth magnitude inclusive; and fourthly, with charts having an exposure of ten minutes, including stars to about the tenth magnitude. The weather for the first four or five months was excellent, being clear nearly every evening. Fogs and cloud which often covered the adjacent valleys and the city of Lima did not reach to the top of the mountain. The cloudy season is now beginning and the work will be more interrupted. But nearly one-half of the entire programme has already been carried out. A large number of interesting objects have been detected, among others several stars having bright lines in their spectra. Including the photometric work described below, the amount of material so far collected is unexpectedly large.

Boyden Fund.—The climate of Southern California seems especially favourable to the undertaking desired by Mr. Boyden. An expedition under the direction of Prof. William H. Pickering was accordingly sent in November 1888 to the summit of Wilson's Peak, in the vicinity of Los Angeles. In order that as much useful work as possible might be accomplished, the thirteen-inch telescope and the eight-inch telescope now in Peru were sent to Willows, California, where the total solar eclipse of January 1, 1889, was successfully observed. Forty-seven photographs were obtained by the party during the three minutes of totality, and the instrumental equipment was much superior to any previously used for such a purpose. It was not until May 11, that the large telescope was successfully mounted on Wilson's Peak, by Messrs. E. S. King and Robert Black, but since then it has been kept at work throughout every clear night. The number of photographs obtained is 1155. The objects photographed are selected from a list of 625 double stars, 143 clusters and other celestial bodies, such as the moon and planets. As these same objects have been repeatedly photographed at Cambridge with the same instrument, an accurate comparison of the atmospheric conditions of the two places may be made. It will of course be impossible to derive a final conclusion until the observations have extended over at least a year, but the evidence already secured shows that in summer results can be obtained at Wilson's Peak which cannot be obtained here. The difference is very pronounced for such objects as the markings on Jupiter. Clusters like that in Hercules are well resolved, so that the individual stars are easily measured, which cannot be done with the best Cambridge photographs. As a test-object the sixth star in the trapezium of the Orion nebula is clearly photographed for the first time. A new variable star has been discovered in the midst of the cluster G. C. 3636. A beginning has been made of the measurements of the position and brightness of the double stars, and it is hoped to extend this work to the clusters, and thus furnish an extensive addition to this department of micrometic astronomy.

Much experimental work has also been done at Cambridge, as is shown by the fact that nearly a thousand photographs have also been taken there. Moreover, the expedition to Peru is largely supported by the Boyden Fund. The meridian photometer will be used to extend two large series of observations to the south pole. These are the "Harvard Photometry," and the zones used in the revision of the *Durchmusterung*. This work will furnish photometric magnitudes of stars as bright as the ninth magnitude in all parts of the sky. The Messrs. Bailey have observed 67 series, one of them including 293 stars. In all, during less than six months, about 6700 stars have been observed, which have required 26,800 settings.

The Bruce Photographic Telescope.—For the last six years experiments have been in progress here on the use of a photographic doublet in the preparation of maps of the stars. The eight-inch telescope now in Peru is of this form and was mounted here in 1885. Since then 4500 photographs have been taken with it. With an exposure of an hour twice as many stars can be photographed as are visible with a telescope having an aperture of fifteen inches, and as many stars as can be photographed in the same time with a telescope of the usual form having an aperture of thirteen inches. Moreover with a doublet a portion of the sky covering twenty-five square degrees can be photographed with good definition, while only three or four degrees can be covered equally well with telescopes of the usual form. The time required to photograph the entire sky will be reduced in the same proportion. With a doublet each hemisphere could be covered in one year with eight hundred plates. In 1885 it was proposed to photograph the entire sky with the eight-inch telescope, enlarging the plates three times. The results would resemble in scale and size the charts of Peters and Chacornac. The generous aid of Miss Bruce mentioned above will permit this result to be attained in the original photographs, without enlargement. A contract has been made with Messrs. Alvan Clark and Sons for a telescope having an aperture of twenty-four inches and a focal length of eleven feet. Meanwhile nineteen foreign Observatories have united in an Astrophotographic Congress to prepare a map of the stars to the fourteenth magnitude with telescopes of the usual form having apertures of thirteen inches. The plans have been matured with great care and skill. The courteous reference to the Bruce telescope and its proposed work by Admiral Mouchez shows that both plans can be carried out without disadvantageous duplication. Doubtless each plan will possess certain advantages over the other. The Bruce telescope will be especially adapted to studying the very faint stars. It is hoped that those of the sixteenth magnitude and fainter can be photographed. Its principal use will probably be for the study of the distribution of the stars, for complete catalogues of clusters, nebulæ, and double stars, and for the spectra of faint stars. The amount of material accumulated will be enormous, and the best method of discussion will form a very difficult and important problem.

NOTES.

THE bulletins relating to the health of Sir Richard Owen, who is suffering from a paralytic stroke, have called forth many expressions of sympathy from the general public, as well as from men of science. Hopes of his recovery are entertained, but at his advanced age the process must necessarily be slow.

A CIRCULAR letter from the Conseil Général des Facultés de Montpellier, issued March 1, 1890, and addressed to the chief learned bodies, sets forth that on October 26, 1289, a Bull of Pope Nicolas IV. "érigeait en *Studium generale* les Facultés de Droit, de Médecine et des Arts, qui existaient déjà depuis longtemps dans notre ville." It is proposed, therefore, as we have already noted, that during the present year the University shall commemorate its entry upon its seventh century. The *fête* will probably be held towards the end of May.

AFTER the reading of the papers at the ordinary meeting of the Royal Meteorological Society on Wednesday, March 19, the Fellows and their friends will have an opportunity of inspecting the Exhibition of Instruments illustrating the application of photography to meteorology, and of such new instruments as have been invented and first constructed since the last Exhibition. The Exhibition will, at the request of the Secretary of the Institution of Civil Engineers, be open in readiness for their meeting on Tuesday evening the 18th instant, and will remain open till Friday the 21st instant.

AN International Exhibition of Mining and Metallurgy will be held this year at the Crystal Palace from July 2 to September 30. The Lord Mayor is the patron, the Duke of Fife the Hon. President, and the list of Hon. Vice-Presidents contains the names of Lord Wharncliffe, Lord Brassey, Lord Thurlow, Sir Frederick Abel, Sir Alexander Armstrong, Sir F. Dillon Bell, Sir Graham Berry, Sir Charles Clifford, Sir James Kitson, Sir Roper Lethbridge, M.P., Sir John Lubbock, M.P., Sir John Pender, Sir E. J. Reed, M.P., Sir Saul Samuel, Sir Warington W. Smyth, Sir Charles Tennant, M.P., Sir Edward Thornton, Sir Charles Tupper, Sir H. Hussey Vivian, and Prof. Roberts-Austen. Mr. Pritchard Morgan, M.P., is chairman, and Mr. Henry Cribb deputy-chairman of the Executive Council, which consists of 20 gentlemen well known in engineering and mining matters. The following are the subjects likely to be included within the scope of the Exhibition:—Machinery, mining in gold and silver, diamonds and precious stones, ironstone and iron-ore mining, the manufacture of iron and steel, lead, tin, copper, and coal mining, petroleum and salt industries, and a number of other kindred subjects. Ambulance practice and the condition of miners will also be illustrated.

A GENERAL meeting of the Society for the Preservation of Ancient Monuments in Egypt will be held at the rooms of the Royal Archæological Institute to-morrow (Friday), at 5 p.m. Attention will be specially called to the wanton excision of portions of the well-known fresco paintings in the tomb of the Colossus on a sledge, dating from the Twelfth Dynasty, or between 2000 and 3000 years B.C., at Der-el-Barsha, the chipping out of cartouches of different Sovereigns from the Sixth

Dynasty tombs at the same place, the mutilations of tombs at Beni Hassan, the malicious removal of curious bas-reliefs at Tel-el-Armana, and other recent acts of vandalism. Such outrages as these ought surely to be made practically impossible. All that is needed is that the matter shall be seriously taken in hand by the Foreign Office.

AN attempt is being made by the Society of Antiquaries of London to raise a fund, the interest of which shall be used from time to time to defray the expense of excavations, or to advance archæological knowledge in such other ways as may seem suitable to the President and Council of the Society. The object is one which ought to commend itself to all who interest themselves in archæology. The Society wants a capital sum of only £3000. Subscriptions should be sent to the treasurer, Dr. E. Freshfield, 5 Bank Buildings, E.C.

MR. GLADSTONE has consented to open the new Residential Medical College at Guy's Hospital on Wednesday, March 26, at 2 p.m.

THE treasures of the Ruskin Museum at Sheffield are being transferred from the small building at Walkley, in which they have hitherto been kept, to more convenient premises. The Museum will be reopened by Lord Carlisle on July 15.

THE March number of the *Kew Bulletin* opens with an account of Indian Yellow, or Purree, about the origin of which there used to be much uncertainty. Some time ago, in consequence of inquiries made in India at the request of the authorities at Kew, the mystery was cleared up; and full information on the subject will be found in the present paper. Another paper deals with Bombay aloe fibre, and there are sections on the commercial value of loxa bark, and on barilla.

AN industrial and artistic Exhibition will shortly be opened in Oueno, the most beautiful park in Tokio. M. de Lezey, writing to *La Nature* on the subject from Tokio, says that the Exhibition will be particularly rich in collections of Japanese antiquities.

ON February 22 the Johns Hopkins University celebrated the twelfth anniversary of its opening. It was announced that, of the various pressing needs of the University for expansion, that of the chemical laboratory was to be met by turning over to it for reconstruction the ill-ventilated Hopkins Hall.

THE collections belonging to the Academy of Natural Sciences of Philadelphia grow so rapidly that the accommodation provided for them is wholly inadequate. A new building is to be erected, and the State Legislature has voted $50,000 as a contribution towards the expenditure. It is hoped that another "appropriation" of the same amount will be made, and that the rest of the money required will be privately subscribed.

GERMAN papers announce the death of Dr. Karl Emil von Schafhäutl, Professor of Geology, Mining, and Metallurgy at Munich University, keeper of the geognostic collection of the Bavarian State, and member of the Academy of Sciences. He was not only an eminent physicist and geologist, but also a theoretical musician of some note. He was born at Ingolstadt on February 26, 1803, and died at Munich on February 25 last.

THE death of Victor, Ritter von Zepharovich, is also announced. He was Professor of Mineralogy at the German University of Prague, a member of the Academy of Sciences at Vienna, and author of the "Mineralogical Dictionary of the Austrian Empire," and many valuable mineralogical and crystallographical works. He was born at Vienna on April 13, 1830, and died at Prague on February 24 last.

ON Tuesday evening, Dr. Dallinger delivered an interesting lecture at the Royal Victoria Hall, on "The Infinitely Great and the Infinitely Small," to an audience numbering about 400, composed principally of working men. The lecture was illustrated by numerous lantern-views, and was evidently much appreciated.

IN the *Engineer* of the 7th inst., there is an excellent article on the latest express compound locomotive on the North-Eastern Railway. This engine is for the east coast Scotch traffic on the section between Newcastle and Edinburgh—about 125 miles. A trial was made with a train of thirty-two coaches (total weight of train 270 tons) between Newcastle and Berwick, a distance of sixty-seven miles; and the time was seventy-eight minutes, or three minutes less than the Scotch express. With the heaviest loads an assistant engine will not be necessary. In another trial with a special train of eighteen six-wheeled coaches, a speed of about ninety miles per hour was obtained. This is the highest recorded speed by several miles. Diagrams were taken at various speeds, one set at a speed of eighty-six miles per hour on the level. This speed was carefully measured by stop-watch and mile-posts; the highest speed observed was just over ten seconds per quarter mile run. It is evident from these facts that passengers to the north will not waste much time on the journey when the summer traffic begins on the east coast route.

SOME time ago we referred to a paper in which Dr. Daniel G. Brinton developed the theory that the ancient Etruscans were an offshoot or colony of the Libyans or Numidians of Northern Africa—the stock now represented by the Kabyles of Algeria, the Rifians of Morocco, the Touaregs of the Great Desert, and the other so-called Berber tribes. This paper Dr. Brinton has followed up by another, in which he compares the proper names preserved in the oldest Libyan monuments with a series of similar names believed to be genuine Etruscan. The resemblances in many cases are certainly striking, and Dr. Brinton's ideas on the subject deserve to attract the attention of scholars.

AT a meeting of the Royal Botanic Society on Saturday, reference was made to a very interesting collection of seeds of economic and food plants, timber trees, &c., of Uruguay, presented by Consul Alex. K. Mackinnon. On the table were plants in flower of *Narcissus poeticus*, lately received from China, and several varieties of the same flower from the Scilly Isles, illustrating the cosmopolitan nature of this family of plants. In the Scilly Isles narcissi are grown by the acre, and over ten tons of the flowers are sent off weekly to market.

IN the current number of the *Revue des Sciences naturelles appliquées*, M. Mégnin has a valuable paper on the existence of tuberculosis in hares. About two years ago he described a peculiar disease brought on by the presence of some species of *Strongylus* in the lungs of hares. The disease dealt with in the present paper is wholly different.

M. H. BEAUREGARD, *aide-naturaliste* in the Paris Museum of Natural History, has published an elaborate monograph on the Vesicant tribe of insects. It is illustrated by many fine plates.

THE skeleton of a mammoth has been discovered in the Russian province of Tula, and the Moscow Society of Naturalists have sent a commission to excavate it.

MESSRS. MACMILLAN AND CO. are issuing a thoroughly revised edition of "A Treatise on Chemistry," by Sir H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S., and have just published Part II. of Vol. III., dealing with the chemistry of the hydrocarbons and their derivatives. Since this part of the work was published in 1884, many additions have been made to our knowledge of this department of organic chemistry; and the authors, as they themselves explain, have sought to represent the present position of the science by introducing the results of the latest and more important researches, with the effect that the greater part of the volume has been re-written.

Mr. John Murray has published the nineteenth edition of "The Reign of Law," by the Duke of Argyll.

The *Amateur Photographer* has issued its fourth "home portraiture number." It reproduces one photograph each from the work contributed by sixty competitors for prizes.

In the Report of the U.S. Commissioner of Education for the year 1887–88 it is stated that 48 educational institutions in the United States receive the benefit of the national land grant of 1862. Among these institutions are the Arkansas Industrial University, the State Agricultural College at Colorado, the Maine State College of Agriculture and the Mechanic Arts, the Massachusetts Institute of Technology, the Missouri School of Mines and Metallurgy, and the Scientific School of Rutgers College. In 38 of the Colleges an officer of the Army or Navy is detailed to act as professor of military science and tactics. If a State has more than one school endowed by the national land grant of 1862, the school which is reported by the Governor of the State as most nearly meeting the requirements of existing law is held to have the first claim to the officer allotted to the State.

M. A. Angot, of the French Meteorological Office, has published in the *Annales* of that office a very careful discussion of the diurnal range of the barometer, based upon the best available data for all parts of the globe. After having given the mean range for each month and for the year, he has calculated the amplitudes and phases of the first four simple harmonic oscillations into which the complex oscillation of the barometric diurnal range may be resolved, and which may be considered as the resultant of the superposition of two waves of different origin and character. One of these, which the author terms the thermic wave, is of a more or less complicated form in appearance, and is easily explained as being produced by the diurnal variation of temperature and by the differences that this variation presents between neighbouring stations. The other, the principal semi-diurnal wave, for which he has given the numerical law, presents a much more simple form, and is not at all affected by local conditions. It is possibly produced by the calorific action of the sun upon the upper strata of the atmosphere; but, as the author states, this is still only an hypothesis, and the theory of this part of the phenomenon remains to be established. His conclusions upon the effect of the thermic wave are very interesting, and the whole discussion will well repay a careful study.

Mr. T. W. Baker writes to us that, in his note regarding the meteor of March 3, he omitted to state the time of its appearance, which was 7.28 p.m.

An important paper upon the crystalline allotropic forms of sulphur and selenium is contributed by Dr. Muthmann, of Munich, to the latest number of the *Zeitschrift für Krystallographie*. Besides the well-known rhombic pyramids and monoclinic prisms, sulphur may, under certain conditions, be obtained in a third crystalline modification, which has been termed by Gernez "*soufre nacré*." This third modification has been fully investigated by Dr. Muthmann, and, in addition, a new fourth totally distinct variety has been discovered. The third form is best obtained by boiling about five grams of powdered sulphur with 750 c.c. of absolute alcohol in a flask provided with an inverted condenser for one hour, filtering through a warmed funnel into a large flask heated to 70° C. in a water-bath, and allowing the alcohol to slowly evaporate. After about twelve hours a large deposit of brilliant tabular crystals is formed. Similar crystals of the third variety may be obtained by agitating a saturated alcoholic solution of ammonium sulphide with excess of powdered sulphur, filtering, diluting with a little alcohol and allowing to stand in a loosely covered cylinder. In a few hours crystals are found deposited, often measuring a couple of centimetres in length and 1–2 mm. thick. Another method which yielded very beautiful crystals of this modification consisted in allowing a solution of acid potassium sulphate to slowly diffuse into a solution of sodium thiosulphate. In about four weeks' time, perfect crystals, almost white in appearance, and exhibiting strongly the mother-of-pearl lustre, were obtained. This third variety of sulphur also crystallizes in the monoclinic system. The ratio of its axes is $a : b : c = 1·0609 : 1 : 0·7094$. The axial angle $\beta = 88° 13'$. The symmetry plane, $b = (010) \infty ᑭ \infty$, is so largely developed as to give the crystals the appearance of plates. At the edges of the plates the two primary pyramids (111) − P and ($\bar{1}$11) + P, a prism (210) ∞ P 2, and a clinodome (012) $\frac{1}{2}$ ᑭ ∞ are well developed. These crystals are totally distinct from those of the second modification; the axial ratios of the latter are $a : b : c = 0·9957 : 1 : 0·9998$ and $\beta = 84° 14'$. Upon the sides of the vessel containing the alcoholic ammonium sulphide solution prepared as above, Dr. Muthmann noticed curious tabular crystals of hexagonal section, which immediately became altered upon contact with a disturbing body, such as a platinum wire or glass rod. They were likewise found to consist of pure sulphur, and, on optical and goniometrical examination, were found to consist of a distinct fourth modification, also monoclinic. They greatly resemble a rhombohedron with predominating basal plane. They are best obtained by allowing to slowly evaporate in a tall cylinder a saturated solution of sulphur in alcoholic ammonium sulphide diluted with four times its volume of alcohol. The temperature during this crystallization must not exceed 14° C. Occasionally in this experiment all four forms of sulphur are obtained; the surface is covered with crystals of the third variety, tables of the fourth modification are deposited upon the sides, and the base of the cylinder is spangled with rhombic pyramids interspersed with monoclinic needles of the second form. If crystals of the third variety are suspended in their mother liquors and left for some days, they are converted into a voluminous mass of minute rhombic pyramids. The conversion into the more stable rhombic form is almost instantaneous if a rhombic crystal be dropped into the liquid containing suspended third variety crystals. The immediate alteration of crystals of the fourth kind is even more remarkable, the mere movement of the cover-glass, when examining them under the microscope, being sufficient to instantly change the optical properties to those of the rhombic form. It is interesting that this fourth form of sulphur is isomorphous with the form of selenium obtained by evaporation of a hot saturated solution in carbon bisulphide.

The additions to the Zoological Society's Gardens during the past week include two Badgers (*Meles taxus*) from Ireland, presented by Mr. P. Bicknell; a Grey Hypocolius (*Hypocolius ampelinus* ♂) from Scinde, presented by Mr. W. D. Cumming; a Rhesus Monkey (*Macacus rhesus* ♂) from India, a Spotted Ichneumon (*Herpestes nepalensis*) from Nepal, deposited; an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Objects for the Spectroscope.

Sidereal Time at Greenwich at 10 p.m. on March 13 = 9h. 25m. 55s.

Name.	Mag.	Colour.	R.A. 1890.	Decl. 1890.
			h. m. s.	° ′
(1) { G.C. 1861	—	White.	9 25 47	+21 58
{ G.C. 1863	—	White.	9 25 58	+22 0
(2) 8 Leo Minoris ...	5·7	Reddish-yellow.	9 24 51	+35 35
(3) ι Hydræ	4	Whitish-yellow.	9 34 12	− 0 39
(4) o Leonis...	4	Yellowish-white.	9 35 18	+10 24
(5) 132 Schj.	Var.	Red.	10 32 7	−12 25

Remarks.

(1) Described by Herschel as a bright extended nebula with two nuclei, the north following one being very faint. In 1848, Lord Rosse observed that the nebula was distinctly spiral, and his drawing represents it as elliptical in shape. The nebula is about 3′ long and is situated about 2° south of the star λ Leonis. I am not aware that any record of the spectrum has been published.

(2) A star of Group II. Dunér states that the bands 2, 3, 7, 8 are visible, but are rather weak and not very wide. The bands 4 and 5 are very delicate. The star belongs to species 5 of the subdivision of the group, which means that the meteor-swarm of which the "star" is probably composed is somewhat sparse. The bright carbon flutings should therefore be well developed. Bright lines may possibly also be present, if the swarm is not too far condensed.

(3) Konkoly and Vogel both describe the spectrum of this star as a well-developed one of the solar type. The usual differential observations are required.

(4) A star of Group IV. (Vogel). The usual observations of the relative thicknesses of the hydrogen and other lines are required.

(5) A star of Group VI., with a spectrum of extraordinary beauty (Dunér). The spectrum consists of four zones, and all the bands 1–10 are strongly developed. Band 6 is not very dark. The specific differences in stars of this group have not yet been fully investigated. The principal variations so far observed are: (1) the length of continuous spectrum, as indicated by the number of zones visible; (2) the number and intensities of the secondary bands; (3) the intensity of band 6 as compared with bands 9 and 10.

Gould believes this star to be variable, his estimates of the magnitude varying between 4·3 and 6·1. Birmingham's values vary from 4·5 to 6·3. The star appears to be U Hydræ, and, if so, a maximum will be reached about March 18 (*Observatory Companion*, 1890). Espin believes the period to be about 195 days.

As yet, we have no information as to changes of spectrum accompanying changes of magnitude in stars of this group.

A. FOWLER.

THE SOLAR AND THE LUNAR SPECTRUM.—Prof. Langley's second memoir on this subject, which was read before the National Academy of Science in November 1886, has been received. In a previous memoir it was demonstrated that evidence of heat had been found in the invisible spectrum of the sunlit side of the moon, and the experiments indicated that this heat was chiefly not reflected but radiated from a surface at a low temperature. The amount of heat, however, was excessively minute, even when compared with the feeblest part of the solar spectrum known in 1882, yet it was easily recognizable because of the fact that, whereas in the typical solar spectrum heat is greatest in the short wave-lengths, in the typical lunar spectrum heat is greatest in the long wave-lengths.

In this second memoir the results of further observation of the infra-red solar spectrum are given, the newly investigated region being close to that which contains a large part of the lunar heat. The researches considerably extend those previously made. In passing from the visible part of the spectrum into the infra-red region, wider regions of absorption occur. To an eye which could see the whole spectrum, visible and invisible, the luminous part would be, as is well known, interrupted by dark lines, the lower part to 5 μ would appear to consist of alternate dark and bright bands, and the part below 5 μ be nearly dark, but with feeble "bright" bands at intervals. This appearance is shown in a plate accompanying the memoir. It is noted as a curious fact that the centres of several of the bands or lines are under some conditions found to be shifted to a recognizable extent, and hence their wave-lengths are, within certain limits, variable. This apparent shift is found to be because the absorption does not increase symmetrically with the centre of the band, but more on one side than another, so as to considerably modify the position of greatest absorption.

THE CORONA OF 1889 DECEMBER 22.—The March number of the *Observatory* contains a Woodburytype reproduction of this corona taken by the late Father Perry with a short focus reflector of Mr. Common's, and a note by Mr. W. H. Wesley, assistant secretary of the Royal Astronomical Society, upon its prominent features. Mr. Wesley finds that, as in the eclipse of January 1, 1889, the extension is greatest towards the equatorial regions, and on the longest exposed plate it can be traced to nearly a diameter from the limb. A wide rift at the north pole, extending 60° or 70° along the limb, contains several fine straight rays similar to the polar rays in 1878 and 1889 January 1, but not so numerous, regular, or distinct. The usual polar rays are scarcely distinguishable at the south pole. A remarkable fact is that the general mass of the corona on the eastern side is considerably broader from north to south than on the western side. This was also the case in 1878. Numerous prominences are seen on the eastern limb, and plates taken near the end of totality show a range of low prominences on the western limb. An interesting feature in the plates taken with the reflector is the photographic reversal of the prominences and the brighter parts of the corona. In the larger exposed negatives the prominences and the corona near the limb are bright instead of dark, whilst the limb itself is bounded by a very definite dark line indicating a double reversal.

THE NEBULAR HYPOTHESIS.—Mr. Herbert Spencer contributed an essay on Laplace's famous theory to the *Westminster Review* for July 1858. With the assistance of Mr. Thynne Lynn, a new edition of this essay has been prepared and distributed amongst leading astronomers at home and abroad.

The revised calculations bring out more strongly than ever Mr. Spencer's views of the nebular hypothesis, and in particular the portion referring to Mars. When the essay first appeared the density of this planet was taken as 0·95, but recent and more exact determinations show the value to be much too high, and taking this into account the fact comes out that to agree with Mr. Spencer's views Mars should have from one to four satellites as it has since 1877 been known to have.

Olbers's theory that the asteroids are fragments of an exploded planet is favoured, and the genesis of the thirteen short-period comets is found in the same catastrophe. It is needless to say that the theory is defended in a most masterly manner, although the arguments against its acceptation are overwhelming.

NEBULA, GENERAL CATALOGUE NO. 4795.—The Journal of the Liverpool Astronomical Society for December 1889, which has just been issued, contains a note by Mr. W. E. Jackson on this nebula, R.A. 22h. 24m., N.P.D. 111° 24′. It is described in the General Catalogue as "Remarkable, pretty faint, very large, extended or binuclear." Mr. Jackson has carefully observed the nebula several times, and finds that there are several stars involved, although no mention of them is made in the Catalogue, and that there is a strong suspicion of others beyond the reach of his 6 inch Grubb telescope. A sketch of the appearance accompanies the note.

A NEW ASTEROID.—Minor planet (288) was discovered by Prof. Luther (Hamburg) on February 24.

CAMBRIDGE ANTHROPOMETRY.

ABOUT two years ago the results were published, in the Journal of the Anthropological Society, of the first batch of measurements taken at Cambridge. These comprised rather more than 1100 cases. During the last two years a nearly equal number have been obtained, and it therefore becomes important to compare the results yielded by these distinct batches.

The measurements proposed by Mr. Galton, and adopted by the Cambridge Committee, were the following:—(1) A test for the eyesight. The extreme distance at which a man could read "diamond type" (viz. the print employed in the little pocket Common Prayer-books) was noted with each eye separately; the figures given in our tables indicate the mean of the two. It may be remarked that, as this instrument would only record up to 35 inches, and as about ten per cent. of the men could read at this distance, it is certain that many could have seen further. The arithmetical mean, therefore, though good enough for our present purposes, is here less scientifically appropriate than the "median." (2) A test of the muscular strength of the arms when employed in an action similar to that of pulling a bow. Two handles, connected at a convenient distance apart, are pulled away from each other against the pressure of a spring. (3) A test of the power of "squeeze" of each hand separately. In this case two handles stand a short distance apart, and are then pressed towards each other against the action of a spring. The figures here given denote the mean of the two results. (4) Measurement of the size of the head. This is taken in three different directions, viz. from front to back, between the two sides, and upwards from a line between the eye and the ear. The product of these three measurements is what is given in the annexed tables as "head-volumes." It need hardly be said that these numbers do not assign the actual magnitudes of the heads; but they do all that is wanted for our purpose, viz. they are *proportional to* these magnitudes, on the assumption, of course, that the average shape of the head is the same throughout. (5) A test of the breathing capacity. The volume of air, at ordinary pressure, that can be expired is measured by the amount of water displaced from a vessel. The result is given in cubic inches. (6) The height; deducting, of course, the thickness of the shoes. (7) The weight, in ordinary indoor clothing. This is assigned, in our tables, in pounds.

As regards the persons measured, they are exclusively students —that is, undergraduates, with a small sprinkling of bachelors and masters of arts. Nine-tenths of them were between the ages of 19 and 24 inclusive. Statisticians will understand the importance of this fact in its bearing upon the homogeneity of our results; since a comparatively small number of measurements, in such cases, will outbalance in their trustworthiness a very much larger number which deal with miscellaneous crowds.

But it is not so much to the above characteristics that I wish to direct attention here as to one in respect of which our University offers an almost unique opportunity. No previous attempt, it is believed, has ever been made to determine by actual statistics the correlation between intellectual and physical capacities. What, however, with the multiplicity of modern examinations, and the intimate knowledge possessed by many tutors about the character and attainments of their pupils, this could here be effected to a degree which could not easily be attempted anywhere else. By appeal to these sources of information, the students were divided into three classes (here marked as A, B, and C), embracing respectively (1) scholars of their College, and those who have taken, or doubtless will take, a first class in any tripos; (2) those who go in for honours, but fall short of a first class; and (3) those who go in for in for an ordinary degree, to which class also are assigned those who fail to pass. It is not for a moment pretended that such a classification is perfect, even within the modest limits which it hopes to attain. Very able men may fail from indolence or ill-health, and very inferior ones may succeed through luck or drudgery. But it must be remembered that we only profess to deal with averages, and not with individuals, and on average results such influences have little power. There are probably few cricket or football clubs in which one or more men in the second eleven or fifteen are not really better than some in the first, but no one supposes that the second team would have much chance of beating the first. All that is maintained here is that our A, B, C classes, *as classes*, stand out indisputably distanced from each other in their intellectual capacities. The average superiority of one over the next is patent to all who know them, and would be disputed by very few even of the men themselves.

The plan adopted has been to classify the A, B, C men separately, arranging each of these in sub-classes according to their age. On the last occasion about 1100 were thus treated, and it is very important to observe that the new batch (of about 1000) independently confirms the conclusions based on the previous set. Space can scarcely be afforded for these tables separately, so I only give here the results of grouping the entire two sets together. But as a matter of evidence, it must be insisted upon that the two separate tables tell the same tale.

The following, then, are the results of thus tabulating the measurements of 2134 of our students :—

TABLE I.

Class A (487).

No.	Age.	Eyes.	Pull.	Squeeze.	Head.	Breath.	Height.	Weight.
10	18	21·3	75·8	75·3	235·8	244·0	68·13	142·6
42	19	22·6	75·3	80·9	242·9	255·5	69·04	148·0
99	20	23·7	81·2	83·5	242·8	252 7	69·00	152·1
104	21	23·6	81·6	82·8	242·1	255·2	68·82	152·3
94	22	24·6	83·9	87·1	244·3	257·2	68·71	154·0
48	23	21·9	82·0	84·2	242·9	262·8	69·11	149·7
33	24	23·6	84·9	84·0	245·9	261·5	68·90	154·8
57	25	23·0	80·9	82·7	247·2	251·0	68·59	154·6
Average..		23·4	81·5	83·5	243·6	255·6	68 85	152·5

Class B (913).

38	18	24·4	77·4	82·1	236·7	235·0	68·92	148·5
136	19	25·4	78·7	80·3	238·0	249·8	68·78	149·7
280	20	24·0	82·5	84·2	237·3	255·1	69·08	153·5
212	21	23·5	83·7	83·7	235·5	257·2	68·84	153·0
136	22	24·6	84·7	85·3	239·2	257·2	69·17	153·3
54	23	22·7	81·5	83·5	234·4	259·0	69·31	154·0
21	24	26·1	90·6	87·4	245·5	261·5	68·93	157·7
36	25	22·6	85·8	86·1	237·1	264·5	68·83	157·2
Average..		24·1	83·2	84·4	237·3	254·9	69·00	152·8

Class C (734).

32	18	24·4	82·4	83·7	234·2	238·0	68·68	156·0
98	19	24·8	81·8	83·6	231·4	250·0	69·10	152·9
185	20	24·8	83·5	82·8	235·0	252·7	69·03	153·6
163	21	23·7	86·1	84·5	239·6	258·1	69·23	156·0
123	22	24·4	89·5	86·6	236·8	255·5	68·79	155·4
57	23	23·8	88·1	87·2	238·5	256·4	68·97	156·2
26	24	25·4	87·4	36·1	239·3	244·0	68·35	156·0
50	25	24·0	82·5	84·2	243·2	247·5	68·24	154·2
Average..		24·4	85·2	84·5	236·8	252·9	68·93	154·8

These tables may be looked at from two points of view, which would commonly be called the practical and the theoretical. By the former, to speak in the more accurate language of statistics, I understand any conclusions to be involved which do not recognize distinctions of less than about 4 or 5 per cent. of the totals in question. Looked at with this degree of nicety, the main fact that the tables yield is, that there is no difference whatever (with a single exception, to be presently noticed) between the physical characteristics of the different intellectual grades. Whether in respect of height, weight, power of squeeze, eyesight, breathing capacity, or head-dimensions, there is no perceptible distinction. There *are* differences, of course, but to say whether or not these are of any significance requires an appeal to the theory of statistics and to tests beyond the reach of the "practical" standard.

The one exception is in the power of "pull." I called attention to this two years ago; but, with the bulk of statistics at that time at our command, I felt somewhat doubtful as to its real significance. But there can scarcely be any doubt as to the non-casual nature of a difference of power between the A and C classes amounting to 4·6 per cent., when this difference displays itself between the averages of such large numbers as 487 and 734 respectively. At least, if there were any doubt, it would be removed by another mode of displaying the results, to explain which a brief digression must be made. In the preceding tables the primary division into three classes was based on intellectual differences. Let us make, instead, one based on physical differences. Let the first class, in respect of each kind of measurement, embrace "the best in ten"; in other words, select the top 200, or thereabouts, in each separate list. Such a table will show, for one thing, the extent to which one kind of physical superiority is correlated with another; and also, by reference to the triposes and tutors' information, it will show how these classes are composed in respect of their A, B, C con stituents. The following is such a table, arranged to show how such "first classes" in one physical department stand in relation to the principal other such departments.

TABLE II.

Comparative Excellence in Different Physical Capacities.

	Eyes.	Pull.	Squeeze.	Breath.	Height.	Weight.
1st Class, Eyes	34·6	86·6	83·5	263·2	69·40	157·1
,, Pull	25·4	113·0	93·9	280·2	69·82	167·3
,, Squeeze	24·2	96·5	103·7	278·7	70·45	170·1
,, Breath	24·9	94·3	92·4	320·5	71·19	167·3
,, Height	25·3	88·0	90·4	286·7	73·25	171·5
Average student..	24·1	83·5	84·2	254·5	68·94	153·4

I shall call attention hereafter to certain conclusions furnished by this table as to the correlation of these various physical characteristics. At present they are only appealed to in confirmation of the fact alluded to above. It is rather curious that, when we sort out these first classes into their A, B, C constituents, we find that, with the same single exception, the distribution is about what it would be on a chance arrangement. That is, the men of exceptional height or breathing capacity are just as likely to be found amongst the A's as amongst the B's or C's. This is the case even with the eyesight. The first class here was confined to men who could read distinctly the small print (diamond) employed, at a distance of at least 35 inches; with the additional restriction that the weaker eye of the two could read the same at 33 inches. Of such men there were 196 out of 2134. Now had these been taken indiscriminately from the three classes A, B, C, the most likely proportions would have been respectively 44, 84, and 68. The actual numbers were 46, 88, and 62. But when we select in the same way a first class (consisting of 182) of the strongest "pullers," we find that whereas A, B, C, should contribute respectively 41, 78, and 63, they actually contribute 28, 78, and 83. Taken in connection with our previous results, the conclusion seems inevitable that this particular kind of physical superiority is, to a certain extent, for some reason or other, hostile to intellectual superiority.

The question *why* this is so is one which it is not easy to answer with confidence, but the following suggestion may be offered. The action of "pulling" is the only one in the above list of physical tests which is much practised in any popular games: it obviously is so in rowing, whilst in cricket a similar set of muscles appear to be exerted. But no known game appears much to practise our "squeezing" power; and, as regards the height, weight, breathing, and seeing powers, probably any form of exercise which keeps a man in good health offers sufficient scope for development. It would therefore seem to meet all the observed facts if we suppose that our hard-reading men take amply sufficient exercise to develop their *general* physical powers fully up to the same relatively high standard found amongst the others; but that the non-reading men, or a certain proportion of them, are rather apt to devote themselves to certain kinds of exercise which develop a proportional superiority in one special muscular development.

I should not have directed so much attention to this second table if it were not that such considerations have a very direct bearing upon a question of importance at the present day. As some readers of this journal probably know, it has been seriously discussed, in influential quarters, whether it is not advisable to take some account of physical qualifications in our Civil Service or other State examinations.[1] By this, we may presume, is not to be understood any mere *pass* examination. The necessity of some test of that kind may be taken for granted, and would naturally be secured by a medical certificate. Something much more serious than this may plausibly be defended, and on the following grounds.

In most of the examinations of any magnitude with which the State is concerned, it may be taken as a fact of experience that the number of selected candidates bears some moderate ratio to that of those who compete. If two hundred men are found to go in and try, it will seldom be the case that there were very many more or less than fifty vacancies. Supply and demand, in a country in the present social and economic condition of England at any rate, will generally obviate any extreme disproportion between the two quantities. Now it is well known that where many aims of any kind are made at an object the so-called "law of large numbers," or "law of error," comes into play. At the two ends of our list of competitors the discrepancies in their performances will be very great. But, for a wide range on both sides of the middle, the differences will be comparatively small. A glance at any one of the lists, which are published in the papers from time to time, of the selected candidates for the army, with the number of marks gained by each, will illustrate this. Near the top the difference between one candidate and the next may be measured by hundreds of marks, whilst towards the bottom of the selected candidates (*i.e. towards the middle of the competitors*) the difference will be given in tens only, or even in units. So marked is this tendency that any well-informed statistician could often give a very shrewd guess, from the mere inspection of such a list, as to the number of candidates who had failed to pass, and whose names therefore were not mentioned.

Now, this being so, it follows that the differences between, say, the last 20 per cent. who succeeded, and the first 20 per cent. who failed, are extremely slight, *in respect of the qualities thus tested*. Might it not then be wise to take account of some other quality, and what better could be found than the physical? If by sacrificing little or nothing of mental superiority we can gain a good deal of physical superiority, there is much to be said in favour of such a final appeal. If, for instance, we accepted, in the first instance, 20 per cent. more than we wanted to retain, and then subjected the whole number to some physical test, for which a moderate amount of marks were assigned, the men finally excluded would at worst necessarily be those who were only just admitted on the customary plan, and those finally admitted would at worst necessarily be those who otherwise would only just have been rejected.

There is not space here to discuss fully any such proposal, but if any scheme of this kind is ever introduced its justification must rest on considerations such as those displayed in our second table. One or two results may be pointed out. In the first place, it must be insisted that the whole merit of any such scheme rests upon the assumption that mental superiority may be considered as perfectly "independent" (in the mathematical sense) of physical. This we find is *not* quite the case as regards the "pulling" power, but is the case as regards every one of the other qualities here displayed. If we set much store upon tall men, or upon men with good eyes, we may rest assured that little or nothing will be sacrificed in the way of mental results by giving reasonably good marks for such excellence. Again, it may be remarked to what extent these different kinds of physical superiority are correlated. It appears that great superiority in any one kind of physical power is accompanied by considerable superiority in every other. It is a striking fact that in only one of the thirty subdivisions there indicated, do we fail to find the "first class" man, in any one department, standing above the average man in every department.

This being so, it is rather for the physiologist, or for the man of affairs, to select the particular physical test which is likely best to serve the public interest. So far as mere statistics are concerned, I should give the preference to the *breathing power*. For one thing, this appears, in my judgment, to be correlated, on the whole, with a higher general physical superiority than is the case with the other qualities. I apprehend also that good breathing power could not readily be "crammed," so to say, by attendance at a gymnasium, and by aid of professional advice and direction, as can be done to some considerable extent in the case of muscular power.

It has been already remarked that high excellence in one physical capacity seems correlated with decided superiority in all the others. This is evident from a glance at the tables. But it deserves notice that *equally* high excellence is not by any means implied. The chance of a man who is in one of these physical first classes being also in another such class is not very much more than what it would be if the two capacities were distributed at random. As a matter of fact, four men only out of the entire number are in every one of these first classes. As between the exertions of muscular strength apparently so closely similar as those of pulling and squeezing, it is found that only 44, out of the total of 195 in the latter, also secured a place in the former; whereas a purely chance distribution might have been expected to secure as many as about 20. As between the corresponding selections, of about equal numbers, from the best in respect of eyesight and breathing, it appears that not more than 30 obtain a place in both classes.

Turn now to some of the less obviously certain conclusions. Comparing the "head-volumes" of the students, two facts claim notice, viz. first, that the heads of the high-honour men are distinctly larger than those of the pass men; and, second, that the heads of all alike continue to grow for some years after the age of 19.

The actual amount of difference as between the A and C students is, of course, small. On our scale it is just about 7 inches—that is 3 per cent. on the real size of the head. Is this small difference to be regarded as significant? The answer can only be given by an appeal to the theory of statistics, which yields the following conclusions.

I must premise that the figures given here as average head-volumes were thus obtained. The average was taken of each of the three separate head-measurements (in the three directions

[1] See Mr. Galton's paper on this subject at the last meeting of the British Association.

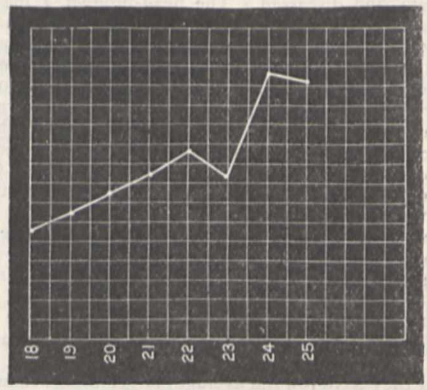
already explained) of each sub-class of students—*e.g.* of those of the A class who were 19 years of age; these three were then multiplied together, and the product resulting (in the case in question, 242·9) was entered in the table. What we have, therefore, is not strictly the mean of the products, but the product of the means. Theoretically, I apprehend, the former should have been preferred; but as the extra labour entailed would have been very great, and as the difference, when dealing with large numbers of cases and small amounts of divergence, is extremely small, I have been content with the latter. It may be added that the actual computation was made in both of these ways for a sample number of cases, and the insignificance of the difference for our purposes of comparison was statistically verified.

What theory directs us to do is of course to begin with determining the probable error of the individual head-volumes of the men generally. This is found to be, on the scale in question, about 17 inches. The usual formula for the difference between the means of 734 and of 487 would then assign to this difference a probable error of $17 \times \sqrt{\frac{1}{734} + \frac{1}{487}}$, viz. nearly one inch. The actual observed difference, of nearly 7 inches, thus lies enormously outside the bounds of probability of production from mere statistical chance arrangement. But in this calculation there is a source of error omitted to which attention was directed not long ago by a correspondent in NATURE, viz. the actual errors (in the literal sense of that rather unfortunate technical term) committed by the observer, or involved in the mechanism of the instrument. Two years ago I had taken it for granted that these were insignificant; and, had it been otherwise, the materials at our disposal would hardly have enabled us to make the due allowance. But, as the correspondent pointed out, the error is by no means to be neglected, and we have now the means of fairly estimating it. A considerable number of men have been measured five or six times, and some even oftener, whilst one man, who seems to have had a morbid love of this physical inspection, has actually had his various dimensions and capacities tested no less than eighteen times during the course of some three years. These cases have furnished a fair basis of determination. They show that these personal errors are certainly greater than they should be (they seem to arise in part from a certain looseness in the machine, which will be remedied in future), amounting in certain extreme cases to as much as even half an inch on the single measurement, and therefore to much more in what appears here as a "head-volume." The resultant "probable error" from this fresh source of disturbance amounts to about five (cubic) inches. Those unfamiliar with probability may perhaps be staggered by such an admission, but they may be assured that the healing tendency of the averages of large numbers is very great, and that the results remain substantially unaffected. The problem appears to be simply one of the superposition of two independent sources of error, and may be stated thus: Given a large number (over 2000) of magnitudes, with a mean of 239, and a "probable error," about this mean, of 17; and assume that these magnitudes are inaccurately measured with a further probable error of 5 inches (as seems to be the fact), what is the probable error of the divergence between the two averages obtained respectively from 734 and 487 of these results? The answer is still a little less than one inch. It is, that is to say, an even chance that the two averages will not differ by more than this; and it is, consequently, thousands to one that they will not differ by so much as seven inches. The conclusions, therefore, previously drawn, lose little of their force.

It seems to me almost as certain that the size of the head continues to increase up to at any rate the age of 24. This will be made clear by looking at the following diagram, which is drawn to show the sum of the figures of the head-measurements as contained in Table III.

As regards the comparative physical endowments, in the other respects, of the different classes of students, there does not seem to be much to say. The differences—sometimes one way and sometimes the other—between them in respect of height, weight, breathing, and squeezing power, are so small as to be statistically insignificant, averaging only about 1 per cent. That the first-class honour men, however, have slightly inferior eyesight seems established, especially when we bear in mind that each batch of about 1000 cases tells the same tale; the only evidence telling the other way is the fact, already adverted to, that when a class comprising "the best in ten," as regards eyesight, is selected from the whole number, we do not find any appreciable intellectual selection to be thereby entailed.

An equally trustworthy basis of comparison is found by observing the distribution of the short-sighted men. Let us take as the limit of what shall be termed "short sight" the inability to read the diamond print with both eyes at a distance greater than ten inches. Adopting this test, we find that the A, B, C classes furnish respectively 14, 11, and 11 per cent., indicating a very small difference between them.



The general conclusion to be drawn here seems, then, to be this. With the single exception of eyesight—and this to a very slight extent—it does not appear that intellectual superiority is in the slightest significant degree either correlated with any kind of natural physical superiority or inferiority, or that it tends incidentally to produce any *general* superiority or inferiority. I emphasize the word "general" in the last clause in order to allow for the difference shown in respect of pulling power. It seems probable, as has been already suggested, that the superiority of the non-honour men does not point to the slightest superiority of their general bodily development—as would be indicated perhaps if it displayed itself in respect of their height, weight, or breathing capacity—but is solely brought about by greater muscular exercise in the pursuit of certain athletic games.

So much as regards the first and second tables. As regards the third—which is arranged in order to show the development

TABLE III.

Physical Development of Students from 18 *to* 25.
A, B, C *combined* (2134).

No.	Age.	Eyes.	Pull.	Squeeze.	Head.	Breath.	Height.	Weight.
80	18	24·0	79·2	81·9	235·6	237·3	68·72	150·8
276	19	24·8	79·3	81·6	236·4	250·8	68·93	150·5
564	20	24·2	82·6	83·6	237·5	253·9	69·05	153·3
479	21	23·6	84·0	83·8	238·3	257·0	68·96	154·1
353	22	24·6	86·2	86·2	239·7	256·6	68·91	154·2
159	23	22·8	84·0	85·0	238·4	259·4	69·12	153·5
80	24	24·8	88·4	85·6	243·6	255·8	68·73	156·0
143	25	23·3	82·7	84·1	243·3	253·2	68·53	155·1

of the physical powers between 18 and 25—there is very little to be said, as statistics of this character offer no particular novelty. Such merit, therefore, as this may possess must depend mainly on the homogeneity of the class of men concerned. As indicated at the commencement of this paper, this homogeneity is equivalent to a considerable increase in the total numbers where more heterogeneous materials are dealt with. They appear to indicate that the physical powers, as a whole, culminate at the age of 22 or 23, and thence begin to steadily decline. Too much stress, however, must not be laid upon the rate of decline here, since the last subdivision is of a somewhat less homogeneous character than the others. For one thing, the men of twenty-five really include those also who are *over* that age, though these are relatively but few. Again, whilst the men up to 24 remain (for all statistical purposes) identically the same individuals, with a year or two more added on to their age, it would probably be found that a not insignificant proportion of those marked as 25 were men who were already older when they came into residence. J. VENN.

ABOUT eighteen months ago a brief memoir of mine—"Head Growth in Students at the University of Cambridge"—read before the Anthropological Institute, was published in NATURE (vol. xxxviii. p. 15). The *means* obtained by Dr. Venn, of the "head-products" of Cambridge students between the ages of nineteen and twenty-five were there thrown into the form of a diagram, and discussed. The head-product, I may again mention, is the maximum length of the head, × its maximum breadth, × its height above the plane that passes through the following three points: 1 and 2, the apertures of the ears; 3, the average of the heights of the lower edges of the two orbits. I drew curves that appeared to me to approximately represent the true average rate of growth, and deduced from them the following conclusions, in which I have now interpolated a few words in brackets, not because any criticism has been founded on their omission, but merely as a safeguard against the possibility of future misapprehension.

(1) Although it is pretty well ascertained that in the masses of the population the brain ceases to grow after the age of nineteen, or even earlier, it is by no means so with University students.

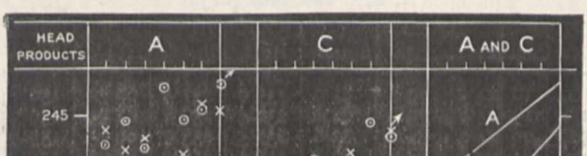
(2) That men who have obtained high honours have had [on the average] considerably larger brains than others at the age of nineteen.

(3) That they have [on the average] larger brains than others, but not to the same extent, at the age of twenty-five; in fact, their predominance is by that time diminished to [about] one-half of what it was.

(4) Consequently, "high honour" men are presumably, as a class, both more precocious and more gifted throughout than others. We must therefore look upon eminent University success as [largely due to] a fortunate combination of these two helpful conditions.

These conclusions have been latterly questioned by two of your correspondents, partly on the ground of discordance among the data, and partly on that of insufficient accuracy of the individual observations. To this I replied, that materials had since been accumulating, and that a second batch of observations, about equally numerous with those in the first, were nearly ripe for discussion, and that I thought it better to defer discussion until these had been dealt with; then, their agreement or disagreement with the first batch would go a long way towards settling the doubt.

This second batch of observations has now been discussed by Dr. Venn on exactly the same lines as the first one, and I give the results of both in the annexed diagram. The data from the



first batch, which formed the basis of the above-mentioned memoir, are here shown by dots with little circles round them; those from the second batch by crosses.

To the best of my judgment, the conclusions that were reached before are now confirmed. No person can, I think, doubt that the swarm of the A dots, and that of the C dots, are totally distinct in character. I have avoided drawing curves through either of them, lest by doing so the effect of the marks, when standing alone, should be overpowered, and it might be prejudiced. In their place, small arrow-heads are placed outside each diagram, to indicate the direction of the stretched thread that seemed most justly to represent the general trends of the two swarms of dots. Then, for the sake of convenient comparison, lines corresponding to these threads have been placed on the third diagram. It must, however, be understood that I have supposed the lines to be drawn straight, merely for convenience. In making my own final conclusions, I should take into account not only what the swarms of dots appear by themselves to show, but also the strong probability that the rate of head-growth diminishes in each successive year, and I should interpret the true meaning of the dots with that bias in my mind. FRANCIS GALTON.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, February 6.—Dr. W. J. Russell, F.R.S., in the chair.—The following papers were read:—Observations on nitrous anhydride and nitric peroxide, by Prof. Ramsay, F.R.S. The author recommends as the best method of preparing pure nitrogen peroxide that the deep blue-green liquid, supposed to be a mixture of this oxide with nitrous anhydride, which is obtained by condensing the products of the interaction of arsenious oxide and nitric acid, be added to a solution of nitric anhydride in nitric and phosphoric acids, prepared by adding phosphoric anhydride to well-cooled nitric acid; after agitating the mixture, the upper layer is decanted and distilled. He assumes that the two oxides interact according to the equation: $N_2O_3 + N_2O_5 = 2N_2O_4$. The melting-point of the peroxide was found to be 10°·14, in agreement with Deville and Troost's statement. The depression of the freezing-point caused by one part of chloroform in 100 parts of the peroxide was 0°·35, and by one part of chlorobenzene 0°·37; the molecular depression is therefore 41°. The heat of fusion, W, of the peroxide, calculated from this number and the observed fusing-point, by Van't Hoff's formula $W = \frac{0{\cdot}02T^2}{t}$, where T is the freezing-point of the solvent in absolute degrees and t the molecular depression, is 33·7 cals.; a direct determination gave 32·3 cals. To determine the molecular weight of nitrous anhydride, a known quantity of nitric oxide was passed into the peroxide, and the depression of the freezing-point determined. Assuming that an amount of nitrous anhydride equivalent to the nitric oxide was formed, the results gave the values of 80·9, 92·7, and 81·0 against 74, the value corresponding with the formula N_2O_3. The author was unsuccessful in freezing nitrous anhydride even at −90° by means of liquefied nitrous oxide. It was found to be soluble in this liquid, and it was further observed that as evaporation took place nitric oxide gas was given off together with the nitrous oxide; it would therefore appear that N_2O_3 is unstable even at the very low temperature at which nitrous oxide is liquid. In the discussion which followed the reading of the paper, Mr. Pickering pointed out, with reference to Prof. Ramsay's determination of the heat of fusion of nitric peroxide, that observations on substances which exercise an appreciable influence on each other cannot safely be used in deducing the heat of fusion. Thus in the case of mixtures of water and sulphuric acid, solutions containing 29·5, 18·5, 8·6, 1·0, and 0·07 per cent. of acid, gave respectively the values 37·4, 58·3, 79·9, 74·9, and 56·3 as the heat of fusion of water, instead of 79·6. In reply to Mr. Wynne, who remarked that nitric oxide alone should interact with nitric anhydride in the way attributed to N_2O_3, Prof. Ramsay stated that he had not examined the action of nitric oxide on nitric anhydride.—Note on the law of the freezing-points of solutions, by Mr. S. U. Pickering.—The action of chromium oxychloride on nitrobenzene, by Messrs. G. G. Henderson and Mr. J. M. Campbell.—Studies on the constitution of the tri-derivatives of naphthalene; No. 1, The constitution of β-naphthol- and β-naphthylaminedisulphonic acids R. and G.; naphthalenemetadisulphonic acid, by Prof. H. E. Armstrong, F.R.S., and Mr. W. P. Wynne. After alluding to the great theoretical importance of a study of the tri-derivatives of naphthalene, the authors draw attention to the necessity of determining the constitution of those tri-derivatives which are employed technically in the manufacture of azo-dyes in order that the dependence of colour and tinctorial properties on structure may be determined; and especially is this the case, since all are not equally valuable—β-naphtholdisulphonic acid G. (Gelb), like Bayer's β-naphtholmonosulphonic acid, interacting but slowly with diazo-salts, whilst the corresponding β-naphthylamine-disulphonic acid G, like the Badische modification of β-naphthyl-aminemonosulphonic acid, is incapable of forming azo-dyes with the majority of diazo-salts. The method adopted in this and the following papers consists firstly in displacing the NH_2 radicle by hydrogen by v. Baeyer's hydrazine method and determining the constitution of the resulting naphthalenedisulphonic acid, and secondly in substituting chlorine for the NH_2 radicle by Sandmeyer's method, and characterizing the resulting chloronaphthalene-disulphonic acid and the trichloronaphthalene derived from it by treatment with phosphorus pentachloride. β-naphthylamine-disulphonic acid R is in this way found to have the constitution [$NH_2 : SO_3H : SO_3H = 2 : 3 : 3'$ (for nomenclature, see NATURE, vol. xxxix. p. 598)], and β-naphthylaminedisulphonic acid G, the constitution [$NH_2 : SO_3H : SO_3H = 2 : 1' : 3'$]. From the latter acid by the hydrazine method naphthalenemeta-disulphonic acid, the fifth known naphthalenedisulphonic acid, has been prepared; this yields a disulphochloride melting at 137°, and 1 : 3-dichloronaphthalene melting at 61°·5. The further investigation of derivatives of this acid is expressly reserved by the authors. The results obtained in the case of the G acid make it evident that, as in the case of the Bayer β-naphthol-sulphonic acid [$OH : SO_3H = 2 : 1'$] and Badische β-naphthyl-aminesulphonic acid [$NH_2 : SO_3H = 2 : 1'$], the action of diazo-salts is either retarded or prevented by the "protecting influence" exercised by an α-1'-sulphonic group.—Studies on the constitution of the tri-derivatives of naphthalene; No. 2, α-amido-1 : 3'-naphthalenedisulphonic acid, by the same. The constitution of the acid known technically as α-naphthylamine-ε-disulphonic acid is found to be [$NH_2 : SO_3H : SO_3H = 1' : 1 : 3'$], a result agreeing with that arrived at by Bernthsen (*Ber. der. deut. chem. Gesellsch* .22, 3327).—Studies on the constitution of the tri-derivatives of naphthalene; No. 3, α-naphthylaminedisulphonic acid, Dahl, No. iii., The constitution of naphthol-yellow S., by the same. α-naphthylaminedisulphonic acid No. iii. of Dahl's patent (Germ. pat. No. 41,957), which when diazotised and warmed with nitric acid yields naphthol-yellow S., is found to have the constitution [$NH_2 : SO_3H : SO_3H = 1 : 4 : 2'$], whence it follows that naphthol-yellow S. has the constitution [$OH : NO_2 : NO_2 : SO_3H = 1 : 2 : 4 : 2'$]. The trichloro-naphthalene prepared from the α-naphthylaminedisulphonic acid affords a remarkable case of dimorphism: it is sparingly soluble in hot alcohol from which it crystallizes in slender needles melting at 66°; if the melting-point be redetermined as soon as solidification has taken place, it is found to be 56°, but if determined after a longer interval, 66°, as in the first instance. The tri-chloronaphthalenes prepared by Cleve from nitro-1 : 3'-dichloro-naphthalene (m.p. given as 65°), and by Widman from 1 : 4-dichloronaphthalene-β-sulphochloride (m.p. given as 56°) are found to be identical with this compound, and to behave in the same way on fusion.

Geological Society, February 21.—Annual General Meeting.—Dr. W. T. Blanford, F.R.S., President, in the chair.—After the reading of the reports of the Council and of the Library and Museum Committee for the year 1889, the President handed the Wollaston Medal to Prof. J. W. Judd, F.R.S., for transmission to Prof. W. Crawford Williamson, F.R.S.; the Murchison Medal to Prof. E. Hull, F.R.S.; the Lyell Medal to Prof. T. Rupert Jones, F.R.S.; the balance of the Wollaston Fund to Mr. W. A. E. Ussher; the balance of the Murchison Geological Fund to Mr. E. Wethered; the balance of the Lyell Geological Fund to Mr. C. Davies Sherborn; and a grant from the proceeds of the Barlow-Jameson Fund to Mr. W. Jerome Harrison.—The President then read his anniversary address, in which, after giving obituary notices of several Fellows, Foreign Members, and Foreign Correspondents deceased since the last annual meeting, including the Venerable Archdeacon Philpot (who was the senior Fellow of the Society, having joined it in 1821), Dr. H. von Dechen (the oldest Foreign Member, elected in 1827), Mr. Robert Damon, Mr. J. F. La Trobe Bateman, Mr. W. H. Bristow, Dr. John Percy, the Rev. J. E. Tenison Woods, Mr. Thomas Hawkins, Prof. F. A. von Quenstedt, Prof. Bellardi, Dr. Leo Lesquereux, and Dr. M. Neumayr, he referred briefly to the condition of the Society during the past twelve months, and to a few works on palæontological subjects published in the same period. He also mentioned the finding of coal *in situ* in a boring at Shakespear Cliff, and then proceeded with the main subject of his address—namely, the question of the permanence of continents and ocean-basins. After reviewing the evidence derived from the rocks of oceanic islands, and the absence of deep-sea deposits in continental strata of various ages, he proceeded to the points connected with the geographical distribution of animals and plants, and gave reasons for believing that Sclater's zoological regions, founded on passerine birds, were inapplicable to other groups of animals or plants, and that any evidence of continental permanence based on such regions was worthless. He also showed that both elevations and depressions exceeding 1000 fathoms had taken place in Tertiary times, and gave an account of the biological and geological facts in support of a former union between several lands now isolated, and especially between Africa and India *viâ* Madagascar, and between Africa and South America. From these and other considerations it was concluded that the theory of the permanence of ocean-basins, though probable, was not proved, and was certainly untenable to the extent to which it was accepted by some authors.—The ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—President: A. Geikie, F.R.S. Vice-Presidents: Prof. T. G. Bonney, F.R.S., L. Fletcher, F.R.S., W. H. Hudleston, F.R.S., J. W. Hulke, F.R.S. Secretaries: H. Hicks, F.R.S., J. E. Marr. Foreign Secretary: Sir Warington W. Smyth, F.R.S. Treasurer: Prof. T. Wiltshire. Council: Prof. J. F. Blake, W. T. Blanford, F.R.S., Prof. T. G. Bonney, F.R.S., James Carter, John Evans, F.R.S., L. Fletcher, F.R.S., A. Geikie, F.R.S., Prof. A. H. Green, F.R.S., A. Harker, H. Hicks, F.R.S., Rev. Edwin Hill, W. H. Hudleston, F.R.S., J. W. Hulke, F.R.S., Major-General C. A. McMahon, J. E. Marr, H. W. Monckton, E. T. Newton, F. W. Rudler, Sir Warington W. Smyth, F.R.S., W. Topley, F.R.S., Rev. G. F. Whidborne, Prof. T. Wiltshire, H. Woodward, F.R.S.

PARIS.

Academy of Sciences, March 3.—M. Hermite in the chair.—On the absorption of atmospheric ammonia by soils, by M. Th. Schlœsing. Experiments were made on the quantities of ammonia absorbed in a given time by various soils—viz. non-calcareous earths, similar to those previously used in the fixation of free nitrogen, earths containing 40 per cent. of calcareous matter, and entirely calcareous earths. The analytical results are given for each case.—Contribution to the chemistry of the truffle, by M. Ad. Chatin.—Upon the method of using, and the theory of, seismographic apparatus; note by M. G. Lippmann. The theory of the deduction of the true movement of the soil from the apparent movement, as indicated by the instruments, is mathematically discussed. A general solution of the problem is given, and applied to some special cases.—An historical note on batteries with molten electrolytes, by M. Henri Becquerel. It is shown that M. Lucien Poincaré was not justified in claiming the invention of such batteries, as M. Jablochkoff, so long ago as 1877, proposed the combustion of carbon in the nitrates as a source of electricity; and still earlier, thirty-five years ago, M. A. C. Becquerel studied similar methods.—A facsimile atlas to illustrate the history of the earliest period of cartography, by M. A. E. Nordenskiöld.—Observations of the new minor planet, Luther (288) (Hamburg, February 24, 1890), made at the Paris Observatory (equatorial of eastern tower), by Mdlle. D. Klumpke.—On the transversal magnetization of magnetic conductors, by M. Paul Janet.—On the localization of interference fringes produced by Fresnel mirrors; note by M. Charles Fabry.—Researches upon the dispersion of aqueous solutions, by MM. Ph. Barbier and L. Roux. The authors find, for concentrated solutions, that, if B be the dispersive power and p the weight of anhydrous substance dissolved in unit of volume of the solution, the relation $B = Kp + b$ holds, b being always sensibly equal to the dispersive power of water. The specific dispersive power is practically a constant quantity for each substance.—On the vapour-density of the chlorides of selenium, by M. C. Chabrié.—Upon some derivatives of erythrite, by MM. E. Grimaux and Ch. Cloez. The writers, by investigating the transformations of hydrofurfural, have attempted to establish its constitution and the method whereby it is formed from erythrite. They conclude that hydrofurfurane may be represented by the formula $\left.\begin{array}{l} CH \,.\, CH_2 \\ \| \\ CH \,.\, CH_6 \end{array}\right\rangle O$.—Derivatives of heptamethylene; note by M. Markownikoff.—Researches on the preparation and properties of aricine, by MM. H. Moissan and Ed. Landrin.—Influence of light and of the leaves upon the development of the tubers of the potato, by M. Pagnoul.—The comparative physiology of the sensations of taste and touch; note by M. Raphael Dubois.—A method of studying the nuclei of white corpuscles, by M. Mayet.—On the localization, in plants, of the principles which yield hydrocyanic acid, by M. Léon Guignard.—On the intensification of sexuality in a hybrid (*Ophrys tenthredinifero-scolopax*), note by M. L. Trabut.—On the relations which appear to exist between the Cretaceous Mammalia of America and the Mammalia of the Cernaysienne fauna in the neighbourhood of Rheims.—Remarks by M. Albert Gaudry on the communication of M. Lemoine; appearances of inequality in the development of the beings of the Old and New Worlds.—New anthropological discoveries at Champigny (Seine), by M. Émile Rivière.—Note on the formation of the delta of the Neva, according to the latest researches, by M. Venukoff.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, March 13.

ROYAL SOCIETY, at 4.30.—On the Organization of the Fossil Plants of the Coal-Measures, Part 17: Prof. W. C. Williamson, F.R.S.—The Nitrifying Process and its Specific Ferment, Part 1: Prof. P. F. Frankland and Grace C. Frankland.

MATHEMATICAL SOCIETY, at 8.—Some Groups of Circles connected with Three given Circles: R. Lachlan.—Perfect Numbers: Major P. A. MacMahon, R.A.

SOCIETY OF ARTS, at 5.—Agriculture and the State in India: W. R. Robertson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Theory of Armature Reactions in Dynamos and Motors: James Swinburne.—Some Points in Dynamo and Motor Design: W. B. Esson. (Discussion.)

ROYAL INSTITUTION, at 3.—The Early Development of the Forms of Instrumental Music (with Musical Illustrations): Frederick Niecks.

FRIDAY, March 14.

ROYAL ASTRONOMICAL SOCIETY, at 8.

ROYAL INSTITUTION, at 9.—The Glow of Phosphorus: Prof. T. E. Thorpe, F.R.S.

SATURDAY, March 15.

SOCIETY OF ARTS, at 3.—The Atmosphere: Prof. Vivian Lewes.

ROYAL INSTITUTION, at 3.—Electricity and Magnetism: Right Hon. Lord Rayleigh, F.R.S.

SUNDAY, March 16.

SUNDAY LECTURE SOCIETY, at 4.—A Trip to British Columbia—the Life of an Emigrant in North-West Canada (with Oxyhydrogen Lantern Illustrations): Dr. James Edmunds.

MONDAY, March 17.

SOCIETY OF ARTS, at 8.—Some Considerations concerning Colour and Colouring: Prof. A. H. Church, F.R.S.

ARISTOTELIAN SOCIETY, at 8.—Symposium—The Relation of the Fine Arts to one another: B. Bosanquet, E. W. Cook, and D. G. Ritchie.

TUESDAY, March 18.

ZOOLOGICAL SOCIETY, at 8.30.—On the South American Canidæ: Dr. Mivart, F.R.S.—A Revision of the Genera of Scorpions of the Family Buthidæ, with Descriptions of some New South African Species: R. I. Pocock.—On some Points in the Anatomy of the Condor: F. E. Beddard.

SOCIETY OF ARTS, at 5.—Brazil: James Wells.

MINERALOGICAL SOCIETY, at 8.—An Account of a Visit to the Calcite Quarry in Iceland: J. L. Hoskyns Abrahall.—Mineralogical Notes: H. A. Miers.—The History of the Meteoric Iron of Tucson: L. Fletcher, F.R.S.

ROYAL STATISTICAL SOCIETY, at 7.45.—On Marriage-Rates and Marriage-Ages, with Special Reference to the Growth of Population: Dr. William Ogle.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Lough Erne Drainage: James Price, Jun.

ROYAL INSTITUTION, at 3.—The Post-Darwinian Period: Prof. G. J. Romanes, F.R.S.

WEDNESDAY, March 19.

SOCIETY OF ARTS, at 8.—Commercial Geography: J. S. Keltie.

ROYAL METEOROLOGICAL SOCIETY, at 7.—A Brief Notice respecting Photography in Relation to Meteorological Work: G. M. Whipple.—Application of Photography to Meteorological Phenomena: William Marriott.

ROYAL MICROSCOPICAL SOCIETY, at 8.—On the Variations of the Female Reproductive Organs, especially the Vestibule, in different Species of Uropoda: A. D. Michael.

UNIVERSITY COLLEGE CHEMICAL AND PHYSICAL SOCIETY, at 5.—The Manufacture of Aluminium by the Deville-Castner Process: F. A. Anderson.

THURSDAY, March 20.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—The External Morphology of the Lepidopterous Pupæ; Part 2, the Antennæ and Wings: E. B. Poulton, F.R.S.—On the Intestinal Canal of the Ichthyopside with especial Reference to its Arterial Supply: Prof. G. B. Howes.

CHEMICAL SOCIETY, at 8.—The Evidence afforded by Petrographical Research of the Occurrence of Chemical Change under Great Pressures: Prof. Judd, F.R.S.

ZOOLOGICAL SOCIETY, at 4.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

ROYAL INSTITUTION, at 3.—The Early Developments of the Forms of Instrumental Music (with Musical Illustrations): Frederick Niecks.

FRIDAY, March 21.

PHYSICAL SOCIETY, at 5.—On the Villari Critical Point of Nickel: Herbert Tomlinson.—On Bertrand's Idiocyclophanous Prism: Prof. Silvanus Thompson.

INSTITUTION OF CIVIL ENGINEERS, at 7.30.—Economy Trials of a Compound Mill-Engine and Lancashire Boilers: L. A. Legros.

ROYAL INSTITUTION, at 9.—Electro-magnetic Radiation: Prof. G. F. Fitzgerald, F.R.S.

SATURDAY, March 22.

SOCIETY OF ARTS, at 3.—The Atmosphere: Prof. Vivian Lewes.

ROYAL BOTANIC SOCIETY, at 3.45.

ROYAL INSTITUTION, at 3.—Electricity and Magnetism: Right Hon. Lord Rayleigh, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

The Reign of Law, 19th Edition: Duke of Argyll (Murray).—Recherches sur les Tremblements de Terre: J. Girard (Paris, Leroux).—The English Sparrow in North America: Dr. C. H. Merriam and W. B. Barrows (Washington).—Facsimile-Atlas to the Early History of Cartography: A. E. Nordenskiöld; translated by J. A. Ekelöf and C. R. Markham (Stockholm).—Birds' Nests, Eggs, and Egg-Collecting: R. Kearton (Cassell).—Force as an Entity with Stream, Pool, and Wave Forms: Lieut.-Colonel W. Sedgwick (Low).—Notes on Indian Economic Entomology (Calcutta).—National Academy of Sciences, vol. 4; Second Memoir, the Solar and the Lunar Spectrum: S. P. Langley.—Erläuterungen zu der Geologischen Uebersichtskarte der Alpen: Dr. F. Noë (Wien, Hölzel).—Journal of Morphology, vol. 3, No. 3 (Collins).—North American Fauna, No. 3: C. H. Merriam (Washington).—Himmel und Erde, Heft 6 (Berlin).

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