THURSDAY, SEPTEMBER 4, 1884

FUNGI AND BACTERIA

Vergleichende Morphologie und Biologie der Pilze, Mycetozoen, und Bacterien. By A. De Bary. (Leipzig: Engelmann, 1884.)

THOSE of us who have been awaiting the publication of a new edition of De Bary's "Morphologie und Physiologie der Pilze, Flechten, und Myxomyceten" of eighteen years ago, will be neither surprised nor disappointed to find that the author has felt compelled to change the title as well as to effect such important alterations in the text that the book is not only virtually but really a new one. This is, moreover, extremely satisfactory, since it shows that the province of mycology has been extended during the period named. How far this extension is due to the labours and influence of the writer of the book before us is well known to all botanists.

In some respects the general plan of the old book has been followed, and many of the woodcuts have been retained; but the large and at that time important section on the reproductive organs in the previous edition is no longer to be found as a separate part of the present book, the results of more recent investigations having completely altered the position of the question as to the sexual reproduction of the Fungi. This fact is of course also a motive in the very different views on classification held by the author now, as contrasted with those published in the earlier book. These and the addition of the Bacteria as an entirely independent group of organisms, are among the principal points of difference in the general plan of the book. That they are by no means the only changes in plan, however, is to be seen at a glance on comparing the two editions.

The present work is divided into three "Parts," devoted to the Fungi, the Mycetozoa (Myxomycetes), and the Bacteria respectively. Under the Fungi proper, there are three chapters devoted to "General Morphology," including Histology, the Segmentation of the Thallus, and the Morphology of the Spore; the latter being very fully treated of, and many new facts being added. The second part deals with the groups of Fungi themselves, and their evolution; the theoretical portions of Chapter IV. being extremely comprehensive and clear, and touching upon matters of the widest biological interest. Chapter V. deals with the various groups comparatively and in detail. Starting with the Peronosporeæ, the author follows the series through the main Ascomycetous series to the Uredineæ, in conformity with his now well-known views on the classification, dealing by the way with those groups which diverge from the main series or are still doubtfully situated.

The third part of the main subject (Chapters VI. and VII.) is devoted to the physiology of the Fungi, including the phenomena of parasitism and the commensalism of the Lichens, and bringing us through by far the larger part of the book.

The *Mycetozoa* (Chapters VIII. and IX.) occupy nearly 40 pages of most interesting matter, including a discussion as to the position of these remarkable organisms, and an account of what is known as to their physiology.

The *Bacteria* or Schizomycetes are dealt with separately and in detail at the conclusion of the book. Chapter X. is devoted to their morphology, and discussions as to their position in the system, and the meaning of "species." A sharp comparison of the extreme views on this subject is dealt with shortly, and in the author's characteristic style. Probably the most fascinating chapter in the book (unless Chapter IV. be excepted) is the last one, dealing with the physiology and life-history of the Bacteria, and of course touching the subjects of pathology and adaptation to different media and conditions with a master hand; and it will be an enormous boon, and should be a stimulus, to have the facts as to the resistance of germs, conditions of development, &c., of these important organisms sifted by an author of such wide experience.

Enough has been said to show that the present book is rather to be considered as a new work than as a second edition of the "Morphologie und Physiologie der Pilze, &c." But it is not only in that so much new matter has been added and a different arrangement been found necessary that this book differs from the former one; the theoretical portions have also undergone changes even more striking and important than the statements of fact. To put the subject in the shortest possible form:—While the then recent discoveries of Pleomorphism and the reproductive organs by Tulasne and De Bary were leading mycologists to suspect that a reproductive process exists in the case of all the higher Fungi, the prominent doctrine, so to speak, in the older work was in accordance with the expectations which had been aroused. Nevertheless, no better monument to the sagacity of the author could perhaps be suggested than his careful statement of the case of the sexuality of the Ascomycetes, even in 1866.

It is well known now that the investigations of the last eighteen years have gone to show that not only do the reproductive organs gradually become simpler and finally disappear in the higher Fungi, but that the physiological processes intrusted to them fade away even earlier—the former depending on the latter, in fact. This doctrine of Apogamy, established by De Bary, of course profoundly affects the work before us. The whole subject of Pleomorphy is also now in a far better position, and we strongly recommend all young botanists to read and mark well the introduction (Chapter IV.) to the second section of this book, which contains much just and trenchant criticism on all these matters, and on past mistakes and future dangers connected with them. The notes on terminology should also be well pondered by the more reckless.

It would take too long to enter further into details as to the classification adopted. It may suffice to point out that the *Peronosporeæ* (and *Ancylisteæ* and *Monoblepharis*), *Saprolegnia*, *Zygomycetes*, and *Entomophthoreæ* are treated as four groups, which, on account of their relations to the Algæ, may be comprehended as the *Phycomycetes*. The main line of the *Phycomycetes* leads us to the *Ascomycetes*, and, further, to the *Uredineæ*. The treatment of the enormous mass of *Ascomycetes* is masterly in the extreme, and testifies better than anything else to the progress made in the biology of these Fungi during the last twenty years. The groups mentioned are regarded as the "Ascomycetous series."

As diverging groups, or such the position of which is still doubtful, De Bary classifies the *Chytrideæ*, and *Protomyces*, and *Ustilagineæ*, all considered as allied phylogenetically with the *Phycomycetes*; and a series of doubtful *Ascomycetes* (*e.g.* Eidam's *Helicosporangium*; also *Exoascus*, *Saccharomycetes*, &c.), obviously to be placed next the *Ascomycetes* proper. Finally, the huge group of the *Basidiomycetes*, which De Bary regards as connected with the *Uredineæ*, though it is not an easy matter to satisfy one's self of the alliance.

The rigour with which the literature has been sifted is shown in the references given at the end of each section. There is no doubt that Prof. De Bary may be congratulated on once more having written a work which will be a monument to his skill and industry, and a boon to all biologists.

OUR BOOK SHELF

A Monographic Revision and Synopsis of the Trichoptera of the European Fauna. First Additional Supplement (with Seven Plates). By Robert McLachlan, F.R.S., F.L.S., &c. (London: Van Voorst, 1884.)

FOUR years ago, in the preface to his very important and elaborate "Monograph of European Trichoptera," Mr. McLachlan promised to continue from time to time the supplemental notices of which the necessity of the case had already caused two to be appended to the original work. The first of these has just (June) been published; it adds nearly fifty species to those described in the Monograph and its Supplements. Some new forms are noticed to which it has seemed right to assign the rank of varieties, and there is a great deal of additional information as to localities. While all the species in the original work have been passed under review, in one or two instances those belonging to some genera have been thoroughly revised. Very few new genera are indicated, and the author thinks the time has not yet arrived for a complete subdivision of some of the larger generic groups as now constituted. All but six of the additional species are from within the limits of Europe proper, proving how hazardous it would be to conjecture as yet as to the number forming part of the European fauna. While ready and liberal help has been afforded towards the work of this Supplement by many of the author's friends and correspondents, yet it is by one above all the others that the material for it has been accumulated; for to the labours of the Rev. A. E. Eaton in Italy, Portugal, Madeira, the Canary Islands, and elsewhere, the author stands indebted for more than three-fifths of the new species, and though Mr. Eaton is well known as an acute, indefatigable, and successful entomologist, does the remark press less home that "if a foreigner making short holiday tours through certain districts previously unexplored (so far as the Trichoptera are concerned) can produce such results, it is needless to call attention to what *might be done* by residents in the districts"?

Among the genera which have been revised we note Sericostoma, which it is now proposed to divide into two groups, *i.e.* (A) with the Maxillary palpi in the male very prominent and scarcely hairy; and (B) with the Maxillary palpi in the male slightly prominent and very hairy.

Additional and valuable information is given concerning the singular forms belonging to the genus Helicopsyche. The author now acknowledges three European species, while he seems to think that the number will yet be greatly increased. The three species at present stand as *H. sperata*, *H. lusitanica*, and *H. revelieri*. The last species equals *H. shuttleworthii*, and was bred in large numbers by M. Revelière, who found the larvæ in very great abundance in a stream near Porto Vecchio, Corsica. The imago is to be found all the year round, but it seems to require a certain degree of warmth for its emergence, which is always effected in the daytime. The larvæ and pupæ can exist in a very scanty supply of moisture; indeed some specimens which were left untended for many days were found quite active though all the water had evaporated from them, and the sand in which they were was only moist. The building material of the helix-like cases is fine sand-grains; each case forms fully two and a half whorls; the cement-like substance used to bind the sand-grains together is often applied so thickly that the individual grains are inconspicuous.

In the genus Setodes, Mr. McLachlan has discovered a character in the posterior wings which (with others) enables the species of the genus as it now stands to arrange themselves into two sharply defined groups (which will be hereafter considered genera). This character is the presence or absence in the posterior wings of a fold above the apical fork known as No. 5. *S. punctata* and its allies belong to the group in which the fold is absent, while *S. tineiformis*, Curt., &c., belong to the group with the fold.

This "First Additional Supplement" is illustrated by seven plates engraved from the author's drawings in a very creditable manner by Mr. G. Jarman. As the necessities of the case arise, we are promised a "Second Additional Supplement," which will be as gladly welcomed by those taking an interest in this group of insects as the present one is sure to be.

LETTERS TO THE EDITOR

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

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

Lœwy's New Telescope System

IN the June number of the *Bulletin Astronomique* there is an important article by M. Lœwy entitled "Description d'un nouveau Système de Télescope," on which, with your permission, I would offer some remarks.

M. Lœwy gives the two possible dispositions or arrangements that allow the principle of the *équatorial coudé* to be applied to the reflecting telescope. He assumes certain optical and mechanical conditions, and on these treats the question exhaustively, giving tables showing the different sizes of the mirrors required and other data obtained by the use of formulæ based on those conditions.

The practical difficulties are also dealt with and suggestions made for forms of mountings. There is also a suggestion of the MM. Henry to close the mirrors from the open air by means of a parallel plate of glass to protect them from the effects of dust, moisture, &c.

This subject has a particular interest for me (as I have no doubt it has also for many others), and I have considered for some time the mechanical difficulties from a different point of view from that of M. Lœwy, coming thereby to conclusions differing considerably from those given by him. There is, of course, much to be said on such a subject as this, involving as it does so many points that can be dealt with in so many different ways, and some of these I should much like to say more on by and by; but at this holiday time of year I will only offer the following observations:—

1. It is of the first importance to reduce as much as possible the distance (δ) between the middle mirror of either optical combination or disposition and the focal plane.

2. By placing the upper bearing of the polar axis below instead of above the cross tube of either disposition, all the mechanical conditions that M. Lœwy has used can be advantageously varied.

3. The use of the floating polar axis described by me in the May number of the *Monthly Notices* of the Royal Astronomical Society enables this to be done.

4. The shelter of the observer can then be quite detached from and independent of the telescope.

In the description of the floating polar axis referred to above, I mention its suitability for that disposition where one large and one small mirror is used.

My reason for not then mentioning the second disposition (that in which two large plane mirrors are used, one of these being perforated) to which this polar axis is most particularly adapted, was fear of stepping too far at once, as, apart from the additional difficulty of making a large plane perforated mirror, there seemed to me to be an element of risk and uncertainty in its use. After reading this article by M. Lœwy, I think there may not be much in my objections, but I cannot quite satisfy myself. In dealing with the support of the large plane mirror in the disposition that I allude to in the description of the polar axis, I contemplated such an arrangement for it as I have in use with my three-foot mirrors, this answering, as far as I have been able to see, perfectly, in eliminating flexure, and as the back of this large plane mirror would never wholly leave its supports, there would not be any fear of flexure here; the other mirrors offer no difficulty as they are practically as in an ordinary *Newtonian* telescope. The support of the large plane perforated mirror, when used for any latitude higher than 45°, is not easily obtained; it must rest on a rim touching the face all round, hence unless it could be hung up from the back in some way it might bend down and spoil the image.

It may be that the slight angle it would make would not bring in flexure of an injurious kind, and this could be determined by actual experiment beforehand, but at present it is an open question.

If it is not a difficulty, then I should agree with M. Lœwy that this is the best disposition for many reasons—it dispenses with the supports of the small mirror that cause diffraction rays, not objectionable to the observer except on bright objects, but very much so in a photograph, where they can impress themselves from an eighth or ninth magnitude star with any exposure that would be used for a nebula; it gives better support to the concave mirror: difficulties in connection with the reversal of the instrument do not come in with such force, and, most important of all, with such a polar axis as I have described, the focal plane might be kept very close behind the large perforated mirror, giving advantages of the greatest importance from many points of view.

The covering of the mirrors by a plate of glass has already been suggested and tried, but in a way that determined nothing. It is a capital thing to do; only experiment could really decide. Certainly flexure could be got over by air pressure, and it would be worth any trouble to get it, if not injurious to the image.

Ealing, August A. AINSLIE COMMON

Earthquakes in Japan

IN the one hundred and seventy-first volume of the "Konrui Shinko-Kushi," one of the oldest and finest works on Ancient Japan, there are tables giving the number, intensity, and remarkable characteristics of all the earthquakes which occurred in Japan between the years 416 and 886 A.D. Unfortunately, the few extant copies of this most important compilation are all more or less in a fragmentary condition. It is, however, evident from the context that the author intended to, or actually did, enumerate many more of these natural phenomena, and it is highly probable that many of his original notes have been lost with the rest; but even as it stands the work is of undoubted importance, now that the Seismological Society of Japan has been doing all in its power to bring forth the ancient records which refer to the great earthquakes of the past. As every one knows, Japan is the very hearth of earthquakes; in 1854 more than 60,000 people lost their lives in consequence of one of these great terrestrial catastrophes, and it has been calculated that from ten to twelve earthquakes, each lasting several seconds, occur every year, besides numerous others of too slight a nature to be worthy of remark.

The earthquakes mentioned in the work under consideration begin with that which took place in the fifth year after the coronation of Inkio Tenno (A.D. 416), and end with the one in the fifth year of Koko Tenno (A.D. 886). Earthquakes occurred during this period of 470 years on 640 days, but that by no means gives the probable total. It seems that those which are noted on the 640 days were all of sufficient importance to deserve particular mention. The great care taken by the compiler in his tables is evident from the fact that the exact date and time of each earthquake is given. Kiyoto was then the capital of Japan, and most of the earthquakes mentioned took place in the then Imperial City, 626 out of the total 640. Those not felt in Kiyoto are spoken of only when unusually intense, in which case the exact locality and amount of damage caused are given. Quite recently the vernacular Japanese press, in consequence of some lately published returns bearing on the subject, has devoted considerable attention to investigating the annals of the "Konrui-Shinko-Kushi," in hopes of being able to ascertain if earthquakes of certain intensity recur at certain periods, in fact, they have attempted to prove that earthquakes run in well-defined cycles. This is by no means a novel nor even very modern idea. Wernich, in his "Geographische-medicinische Studien," says that severe earthquakes occur in Japan every twenty years. In a footnote he adds:—"I am unable to adduce any natural or physical proofs in behalf of this hypothesis. And yet the Japanese earthquakes can be very readily explained by the theory of 'periodical phenomena.' They are commonest at the times of the highest tides, and in the months of January, April, and October."

Whatever may be the truth of the suppositions and theories, the Japanese journals, both the scientific and the dailies, have gone to work by accepting the periodicity of these phenomena. Taking ten years as the divisor, they divide the time between A.D. 628 (when the records begin to be more trustworthy) and A.D. 886 into twenty-six periods. The following table is the result:—

Periods	Earthquake days	Periods	Earthquake days	Periods	Earthquake days
1	0	10	6	19	3
2	3	11	5	20	56
3	0	12	29	21	39
4	1	13	3	22	18
5	2	14	0	23	104
6	15	15	11	24	87
7	1	16	22	25	95
8	0	17	10	26	100
9	3	18	9		

It is very evident from the foregoing that the records are far from being as exact as could be desired with regard to the earlier centuries, or else that the physical condition of the country in 886 was totally different from that of 628 A.D. But to return to the table, it will be seen that the intervals between the periods in which earthquakes were most frequent are as follows:—40 years between the 2nd and 6th periods, 60 years between the 6th and 12th, 40 years between the 12th and 16th, 40 years between the 16th and 20th, and 30 years between the 20th and 23rd. Acting on the supposition that one period of unusual frequency of earthquakes has been left unrecorded, the average length of the intervals is estimated at 35 years. Following the author's explanatory notes, a still more correct table can be deduced, by means of which the cycle of earthquake intensity is finally put at 33·3 years. A further deduction is made that earthquakes of a disastrous nature occur once every 59 years, so the next great catastrophe may be expected in 1913.

As the notes of the compiler give the date of each earthquake between the above-mentioned years, it appears that earthquakes used formerly to be most frequent in August, most severe in May and November, and followed or preceded by violent hurricanes, electric storms, and the like in January; 55 per cent. of all Japanese earthquakes occurring during the warm season.

Yokohama F. WARRINGTON EASTLAKE

"Udschimya sericaria," Rond., a Fly Parasitic on the Silkworm

I HAVE been engaged during the past year in tracing the life-history of *Udschimya sericaria*, Rond., and have succeeded in making it out completely. I send you a short account of it, hoping that it may not be entirely uninteresting to your readers. As you are no doubt aware, in Japan and China the maggot of this fly does great damage every year to the larvæ and pupæ of the silkworm, sometimes 80 per cent. of the caterpillars and pupæ being killed. The knowledge of its life-history would therefore be of great economic interest as furnishing the scientific basis for guarding against this parasite. Strange as it may seem, no one has, however, until recently, made any systematic observations on the matter.

In 1874 my father, Mr. N. Sasaki, who was the first to study this insect, found its larva in the main trunk of the trachea of the silkworm, just inside the stigma, and finally concluded that the maggot gained this place by entering through the stigma from outside.

My investigations extend from April 1883 to June of this year, and are briefly summed up as follows:—

Udschimya sericaria appears generally in the middle of April, and attains maturity in the beginning of May, at the time when mulberry-trees expand their spring leaves. The female flies, flying in bushes of mulberry-trees during the months of May and June, deposit their eggs on the under surface of the leaves in close contact with the mid-rib, or else with the fine ramified veins.

The eggs are nearly oval in shape, tapering at one end, and rounded at the other. They are very small in size, measuring 0·18 mm. in length, and 0·13 mm. in breadth, and generally convex on the upper and flat on the under surface. The upper convex surface, which is coloured blackish-brown, has a lustre, and is marked out into hexagonal areas; while the lower flat surface, which is coloured grayish-brown, lacks lustre, and is only faintly marked out into hexagonal areas. The whole egg is enveloped with a sticky substance, which fixes it firmly with its flat side on the under surface of the leaves.

When the leaves on which the eggs are thus deposited are given to the silkworms, they eat them whole along with the leaves, without crushing them at all. At one to six hours after the eggs are taken, they are hatched out near either end of the digestive canal, and a tiny white maggot comes into existence. After a while the maggot passes out of the alimentary canal through the mucous membrane, with the aid of its horny hooked tooth and of setæ provided on each segment, and enters directly into one of the nervous ganglia found just under the digestive canal. A thin transparent membrane which envelops the ganglion becomes a protecting sac, inside which the maggot lives, and takes nerve-cells as its food. As it grows in size, this sac gradually enlarges, and finally rupturing, the maggot passes out into the body-cavity. At this time it measures five to six millimetres in length.

The maggot now seeks the main stem of the trachea, which forms a kind of chamber just inside the stigma of the silkworm, and enters into it by making an opening with its hooked tooth. It now sticks its head out into the body-cavity of the silkworm through the opening by which it entered, and takes fat as its food. Its posterior end, which is provided with two large spiracles, is directed towards the stigma, and thus the maggot respires the air which passes in through the latter.

As the maggot grows, this newly-formed chamber in which it rests also becomes larger, and the opening through which the anterior end of the maggot is projected out into the body-cavity of the silkworm becomes wider and wider, until the chamber assumes the shape of a cup Around this cup a large amount of fat is fixed by the maggot, probably with a watery fluid it secretes of alkaline reaction, and thus the wall of the cup increases in thickness and becomes very tough. The wall is always coloured dark brown, owing probably to the fæces of the parasite and to the action of the secretion upon the fat in the wall of the cup. In this position the maggot attains maturity; it then crawls out through an opening it makes at any portion of the body of its host. If, however, the growth of the maggot has been slow, it may be found in the trachea of the silkworm after it has changed into a pupa.

In either case, whether the larvæ or the pupæ have the parasite in the trachea, the space around the stigma, inside which the maggot is lodged, is always marked with a large dark brown patch, so that the presence of the maggot is easily recognised by looking at the stigma.

If a larva or a pupa of the silkworm is once infested by this parasite, its fate is sealed, and the cocoons made by the infested caterpillars are usually thin, and of much less value.

Those maggots which become mature in the pupæ of the silkworm crawl out of the cocoon by making a round opening at one pole, and such perforated cocoons are entirely useless for reeling silk.

The mature free maggot, coloured light yellow, is very active, and searching for the corner of the case in which they are kept, or crawling deep into the ground, changes soon into a black, cylindrical pupa. There the pupa rests through the winter, and in the following spring a perfected fly hatches out by breaking open the pupa-case.

A detailed account with suggestions for the remedies will soon be published in a *Memoir* of the University of Tokio.

C. SASAKI

University of Tokio, July

Singular Instance of Instinct

AMONG the insects very common to Victoria is one popularly known as the mason-fly. In form it is very like a gigantic hornet; the wings and legs are of an orange colour, as is also the abdomen, which is decorated with broad black stripes. It has a strange habit of building its nest, composed of tempered mud, in keyholes. Mr. Ellery, F.R.S., the Government Astronomer, tells me that this same fly often commences to build within the tubes of their astronomical instruments. The nest is rather peculiar. A layer of mud is first laid down, and a certain number of eggs are laid. Then follows another layer of mud; on this are deposited a number of young spiders, paralysed but not killed. Another layer of mud, more eggs, then mud, then spiders again, and so on, until the nest is complete. The spiders are evidently stored up as food for the grubs, as soon as hatched, an arrangement already known to naturalists. This fly has a very fierce aspect, and its nature evidently does not belie its looks. It flies about with great liveliness, and when alighting, its long black antennæ are kept in a state of constant motion. Its favourite food seems to be spiders, which it is in the habit of seeking for under the bark and in holes in the trunk of the Eucalyptus. It order to catch them it burrows under the loose bark, and in a few seconds generally issues forth again with some larger or smaller prey between its mandibles. The enormous bulk of some of the victims does not appear to intimidate it in the least. Even the gigantic so-called tarantula (vulgarly triantelope) is fearlessly attacked. I was one day walking through a suburban park near Melbourne, and saw one of these flies suddenly pounce down on the back of a large tarantula some five inches in breadth, measuring from the ends of the legs. The huge arachnidian succumbed at once. Resistance with an adversary in such a position was altogether out of the question, the only resource being to die, like Cæsar, becomingly. I watched the fight, or rather the murder, for some minutes, and then touching the assailant with the point of my umbrella, drove it away. It only flew, however, to a short distance, and then returned, flying so viciously round that I fully expected I should be attacked. By flourishing the umbrella, however, I again drove it off, and it retired to a distance of about a hundred feet. I then left the spider, but afterwards went back, and found the mason-fly following up his victory as energetically as ever. I drove it away again, left the spot, and again returned to find the murderous work still going on. This was repeated some half a dozen times, and at last, taking out a book, I sat down on a seat resolving to see what would happen. The fly did not reappear for nearly a quarter of an hour, and I thought it had altogether departed. A small ditch ran beside the pathway, and, turning my eyes in that direction, I noticed the mason-fly peeping through some blades of grass growing on the edge. It was evidently waiting for me to leave the spot in order to secure the full advantages of its victory.

It may be mentioned that the tarantula is a great coward. Some of our large spiders, if placed on an ants' nest, will "run amuck" through the crowd, nipping with their immense mandibles scores of their assailants who may approach them. They will do this several times in succession, and generally get away. The tarantula, however, if placed in such a position, yields at once, and, gathering up its long legs, expires with all dignity. I have tried the experiment many times, when a run of six inches would have secured the freedom of the tarantula, but even in these cases no effort was ever made to escape. One species of spider, living under the bark of trees, the skin of the abdomen of which is very soft, often proves a match for the ants, not by fighting, but by stratagem. He plays his enemies a thoroughly Parthian trick, throwing out a number of webs, which completely entangle them. This same spider, if thrown into a pool of water, similarly throws out threads of web, and, these being wafted to the shore, and adhering to an overhanging branch, enable the spider to reach the land.

THOMAS HARRISON

244, Victoria Parade, East Melbourne, Victoria, July 9

Przevalsky's Horse

IT seems worth while to point out the close resemblance between the figure of this horse in NATURE for August 21 and those found incised on antlers in the cave of La Madelaine, copied in Dawkins' "Early Man." There is the same massive head, the same hog-mane, absence of forelock, pointed ears, short body, and powerful legs, while there seems even an indication that the long hairs of the tail spring first from the middle of that organ. In that from Cresswell Crags, as well as those from La Madelaine, the jaw is heavier than in the recent specimen.

Brosely, August 29 W. W. WATTS

"The Ores of Leadville"

MY attention has lately been drawn to a review in NATURE for April 17 of a work on "The Ores of Leadville and their Mode of Occurrence," by Mr. L. D. Ricketts, from which one would be led to suppose that all the facts mentioned were due to original investigation on the part of the author. Your reviewer does not state that which is acknowledged by the author himself, namely, that much of his information was obtained from the Report of the U.S. Geological Survey by Mr. S. F. Emmons, contained in the Second Annual Report, published a year previously.

A large atlas has lately been issued also by the U.S. Geological Survey completely illustrating the Leadville ore deposits, and an exhaustive monograph to accompany it is now in the printers' hands. I speak from an intimate knowledge of the subject, having taken part in the work, and should be much obliged by your inserting this correction without delay.

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AUSTRALIAN ORCHIDS

THE seventh and last part of vol. i. of Fitzgerald's "Australian Orchids," and the first part of vol. ii. have lately reached us. The testimony we bore to the value and merits of this work in our notice of part 5, vol. i. (NATURE, vol. xxii. p. 53) we can now repeat, and with emphasis, as we can base it on an examination of all the parts at present issued.

Mr. Fitzgerald is an ardent admirer and disciple of Darwin—indeed what true lover of orchids is not?—and his work is dedicated to his memory "as a token of the veneration in which he holds that great naturalist and fearless expounder of science." The synopsis shows that twenty-eight genera and 104 species are illustrated and described in vol. i., each part containing ten folio lithographic plates. The drawings and dissections leave nothing to be desired in point of fulness, completeness, and accuracy, the latter especially being far more numerous and varied than in any similar work we are acquainted with. There is one point on which those who are responsible for the nomenclature of Australian orchids are entitled to decided praise. All but one of the genera and 90 out of the 104 species in vol. i. bear really descriptive names, instead of being christened after "enterprising," or rather advertising, nurserymen or vanity-stricken cultivators, which is unfortunately the fate of most of the new orchids introduced into England. A large proportion of the orchids as yet described in this work are natives of New South Wales, but a few are contributed by Western Australia, Queensland, South Australia, and Tasmania. The enormous importance of insects to the maintenance of orchids is shown by the fact that, out of 104 species described in vol. i., ten only are self-fertilising. But the curious point is noted by the author that "self-fertilising species always produce a far greater proportion of seed." The difficulty with which some genera undergo fertilisation is illustrated by an instance given where a splendid plant of *Dendrobium Hillii* in the Sydney Botanic Gardens, freely open to insects, did not produce a single seed, though covered with about 40,000 flowers on 190 spikes! In another case mentioned by the author he found a small caterpillar on a flower of *Dendrobium speciosum*, which had partly eaten an adjoining flower. He marked the latter, and the flower so marked was the only one on the entire plant which produced seed. There is strong evidence that many species are dependent, not simply on insects, but on some particular, perhaps local, insect for fertilisation. *Sarcochilus parviflorus* often produces seed capsules in its native habitat, the Blue Mountains; if removed to Sydney, it flowers well, but does not produce seed unless artificially fertilised. One question discussed by the author is the fertility of hybrid orchids. We believe that this question has been settled in English plant-houses, where hybrids have been proved to be fertile in the case of one genus (Cypripedium) at all events. This result is what Mr. Fitzgerald anticipates, on account of the facility with which species of the same genus may be cross-fertilised, however far apparently they may be removed from one another. As he says, "a repugnance to intermixture does not exist in this family as it does in others."

While terrestrial orchids are very numerous in Australia, epiphytal orchids are comparatively rare. The latter are more ordinarily denizens of the hot and moist forests of tropical or sub-tropical regions. Thus not more than one-fifth of the species illustrated in Mr. Fitzgerald's work are epiphytal, and these belong almost entirely to the genera Sarcochilus and Dendrobium—the latter a genus of which there are probably two or three hundred species, mostly natives of Indo-Chinese regions, cultivated in this country. On the other hand, the author says:—"The centre of the terrestrial" (orchids) "may, I think, be placed in Sydney, where, within the radius of a mile, I have obtained 62 species of orchids, 57 of which were terrestrial—a number that could not, I believe, be equalled in any part of the world within a similar area."

The plates are accompanied by full descriptions giving curious and interesting details as to the methods of insect-fertilisation, and describing localities, surroundings, conditions of growth, &c. Notwithstanding the help derived from this source, Australian orchids have not, with some few exceptions, proved readily amenable to cultivation in this country. While it is comparatively easy to reproduce climates resembling those of the damp, shady, and hot valleys of the Amazon or of Burmah, or of the moist, cloud-covered, and cool slopes of the Andes or the Himalayas, it is very difficult to reproduce the dry, hot, and sunny conditions favourable to most of the terrestrial orchids of Australia. We shall therefore probably continue to know these for some time at least mainly from Mr. Fitzgerald's book. We doubt whether, excellent and obviously faithful as his drawings are, and carefully as they are coloured, the use of toned paper is judicious. It imparts a muddiness to the tints, as, for example, in the drawing of the beautiful Dendrobes, Phalænopsis, and Superbiens, part 7, vol. i., and part 1, vol. ii., where neither foliage nor flower have the clear bright colours natural to them.

Before concluding this notice of a work which devotes much attention to the curious and interesting study of orchid fertilisation, we might refer for a moment to the patience, care, and intelligence with which the raising of hybrid orchids is being prosecuted in this country, especially in the nursery of Messrs. James Veitch and Sons. In one genus, that of Cypripedium, the hybrids bids fair already to outnumber the known natural species, as well as to rival them in interest and beauty. The closely allied genera Cattleya and Lælia, which are distinguished only by the number of their pollen masses, have proved susceptible of cross-fertilisation, and have produced several intermediate hybrids of great beauty. It may well be said that patience is necessary for this work, for *Cattleya exoniensis*, the offspring of *Cattleya Mossiæ* and *Lælia purpurata*, did not flower until seventeen years after the seed had germinated. Even now it is only propagated by subdivision. The union of the genera Calanthe and Limatodes was more speedily fruitful; and the beautiful *Calanthe Veitchii*, especially valuable horticulturally, from its winter-flowering habit, is known in most gardens.

Few who have devoted themselves to the study or to the cultivation of orchids have failed to become greatly interested in this remarkable family. Their singular structure, their extraordinary variety and diversity, their beauty, form great attractions. To these may now be added the interest, indeed excitement, to be obtained by intelligent and judicious cross-fertilisation. Altogether we need not wonder that the cultivation of orchids is spreading rapidly among the garden-loving people of these isles. For they interest equally the man of science and the gardener. We trust that Mr. Fitzgerald may bring his labour of love to a successful termination, and that descriptions of the orchids of other parts of the world, equally complete, accurate, interesting, and intelligent, may be taken in hand by botanists equally competent and enthusiastic. T. L.

GRINNELL LAND

THE following is the *Times* report of the paper read by Lieut. Greely at the British Association on Tuesday on some of the results of his recent Arctic expedition :—

Lieut. Greely stated that the geographical work of the Lady Franklin Bay Expedition covers nearly 3° of latitude and over 40° of longitude. Starting from lat. 81° 44′ N., long. 84° 45′ W., Lieut. Lockwood reached, on May 18, 1882, on the north coast of Greenland, lat. 83° 24′ N., long. 40° 46′ W. From the same starting-point he reached to the south-west, in May 1883, in Greely Fjord, an inlet of the Western Polar Ocean, in lat. 80° 48′ N., long. 78° 26′ W. The journey to the northward resulted in an addition to our charts of a new coast-line nearly 100 miles beyond the furthest point seen by Lieut. Beaumont of the Royal Navy. It also carried Greenland over forty miles northward, giving that continent a much greater extension in that direction than it had generally been credited with. The furthest point seen on the Greenland coast was estimated at about lat. 83° 35′ N., long. 38° W. There were no indications that the furthest point seen was the northern termination of Greenland. The newly-discovered coast resembled in many respects that of Southern Greenland ; the mainland was intersected by many deep fjords, with numerous outlying islands. The interior of the country, as seen from an elevation of some 2000 feet, consisted of confused masses of mountains, eternally snow-clad or covered with ice-caps. The fjords presented to the eye nothing but broad, level expanses of snow and ice, being devoid of any marked ice-foot, floebergs, pressed-up hummocks, or any other indications tending to prove their direct connection with the Spitzbergen Sea. In general, the immediate coast was high, rugged, and precipitous ; the formation very like that around Discovery Harbour—schistose slate, with a sprinkling of quartz. The vegetation resembled closely that of Grinnell Land. Among the specimens brought back is the Arctic poppy. Several saxifrages were identified above the 83rd parallel. Traces of the Polar bear, lemming, and Arctic fox were seen. A hare and ptarmigan were killed at the furthest north, and the snow bunting was heard. A remarkable fact noted was the existence of a tidal crack—so called for lack of a better name—which extended from Cape Bryant along the entire coast, running across various fjords in a direct line from headland to headland, varying from one yard to several hundred yards in width. Inside the crack, rough hummocky ice was but rarely seen, while outside prevailed the palæocrystic ice, over which Commander Markham struggled so manfully and successfully in his wonderful journey of 1875, midway between Capes May and Britannia. A sounding was made, but no bottom was found at 800 feet. Apparently no current existed. It may be well to state that the latitude of the furthest northern point, Lockwood Island, was determined by a set of circum-meridian and sub-polar observations, which were reduced by the Gauss method. The latitude of Cape Britannia and several other points was determined by circum-meridian observations. It affords me pleasure to testify to the accuracy of Lieut. Beaumont's maps ; the only correction made places Cape Britannia a few miles south and Cape May a few miles west of their assigned positions. These points were located by Lieut. Beaumont from bearings. His comparative exactness was remarkable considering the disadvantages under which he laboured. The journeys made by Lieut. Lockwood and myself across Grinnell Land into its interior revealed striking and peculiar physical conditions which have been hitherto unsuspected. Between the heads of Archer and Greely Fjords, a distance of some seventy miles, stretches the perpendicular front of an immense ice-cap, which follows closely from east to west the 81st parallel. Its average height was not less than 150 feet. The undulations of the surface of the ice conformed closely to the configuration of the country, so that the variations in the thickness of the ice-cap were inconsiderable in about sixty miles. But two places were found where the slope and face were so modified as to render the ascent of the ice possible. This ice-cap, extending southward, covers Grinnell Land almost entirely from the 81st parallel to Hayes Sound, and from Kennedy Channel westward to Greely Fjord on the Polar Ocean. The glacier discharging into Dobbin Bay is but an offshoot of this ice-cap. Without doubt glaciers can be found at the head of every considerable valley debouching into Richardson, Scoresby, or other bays. Several valleys which were visited during the retreat southward displayed at their entrances evident signs of such occupancy in the past. In July I was fortunate enough to ascend Mount Arthur, the summit of which is 4500 feet above the sea. The day was very clear ; to the northward of Garfield Range a similar ice-cap appeared to view, from which extensive glaciers projected through every mountain gap. One of these, Henrietta Nesmith Glacier, had been visited by me in the preceding April, and was found to have a perpendicular face of about 200 feet. It discharged into a small bay, part of Lake Hazen. Gilmar, Abbé, and other glaciers feed the streams which empty into that lake. Similarly glaciers were found at the head of the rivers discharging into St. Patrick and Lincoln Basins, Norris Bay, and Discovery Harbour. From these indications I estimate the northern ice-cap of Grinnell Land as not far from 6000 miles in area. This southern limit closely coincides with the 82nd parallel. The country between the 81st and 82nd parallels, extending from Kennedy and Robeson Channels to the Western Polar Ocean, was found in July entirely free from snow, except on the very backbone. In over 150 miles travel into the interior my foot never touched snow. Vegetation abounded, being exceedingly luxuriant as compared with Cape Hawkes, Cape Sabine, or other points further south visited by me. Dead willow was found in such abundance as to serve for fuel in more than one instance. Willow, saxifrages, grasses, and other plants grew in such profusion as to completely cover large tracts of ground. These valleys afford excellent pasturage for musk cattle, which feed towards the sea coast during summer, but withdraw to the interior as winter advances. I frequently noted evidences of recent elevation above the sea of the region now free from ice-cap. Such indications consisted of raised beaches, marine shells, and driftwood. At one place the trunks of two large coniferous trees were found in such a state of preservation as to allow of their use for fuel. It seems probable that these ice-caps were originally united. It is certain that both the northern and southern ice-caps have recently retreated, even if such a process is not going on now. Along the frontier of the southern ice were found many small glacial lakes and moraines. To the north, Lake Hazen for some fifty miles borders the ice-cap. In front of Henrietta Nesmith Glacier there were three parallel moraines. Between the face of the glacier and the main lake at the junction of Lake Hazen and Ruggles River I discovered the remains of permanent Esquimaux huts. Many relics were obtained at that place and at various points along the southern shore of Lake Hazen, but no traces of any kind were found on the northern shore of the lake. It is perhaps worthy of remark that reindeer, which must have been plentiful in that country, have entirely disappeared, having either migrated or become extinct. In connection with the line of perpetual snow I may state that on Mount Arthur it was not far from 3500 feet above the sea. From barometrical measurements it appeared that the crest of Grinnell Land was above 2500 feet elevation in front of the southern ice-cap, 3000 feet near Mount Arthur.

THE BRITISH ASSOCIATION

SO far as reports have reached us, the Montreal meeting has been a brilliant success, at least from the social point of view. The enthusiasm of the reception by the Canadians could not have been greater, and that enthusiasm, we are glad to notice, has met with a cordial response from the 800 members of the Association who went to Montreal. From the ample reports in the *Times* it is evident that, notwithstanding the many outside attractions devised by the hosts of the Association, the work in the Sections has in quantity and quality been up to the average. The proceedings began on Tuesday week with an address from the Mayor and Corporation of Montreal, and on Wednesday the Governor-General, Lord Lansdowne, welcomed the Association in a warm speech, in which the right keynote was struck. "If," he said, "you selected within the British Colonial Empire a spot for your meeting, you could not have selected a colony which better deserved this distinction either in respect of warmth of affection for the mother country, or the desire of its inhabitants for the diffusion of knowledge and culture. In a young country such pursuits are conducted in the face of difficulties, competition with material activity necessarily absorbing the attention of a rapidly developing community. We may claim for Canada that she has done her best, and has spared no pains to provide for the interests of science in the future. She has scientific workers known and respected far beyond the bounds of their own nation." Lord Lansdowne spoke warmly of the honour conferred upon Principal Sir John Dawson, who is more responsible than any other single person for the Association's visit. "We regard," he said, "the knighthood Her Majesty has bestowed upon him as an appropriate recognition of his distinguished services, and an opportune compliment to Canadian science. But the significance of this meeting is far greater than if measured merely by the addition it will make to the Empire's scientific wealth. When we find a society which for fifty years has not met outside the British Islands transferring its operations to the Dominion; when we see several hundred of the best-known Englishmen arriving here, mingling with our citizens and dispersing over this continent; when we see in Montreal the bearers of such names as Rayleigh, Playfair, Frankland, Sanderson, Thomson, Roscoe, Blanford, Moseley, Lefroy, Temple, Bramwell, Tylor, Galton, Harcourt, and Bonney, we feel one more step has been taken towards the establishment of that closer intimacy between the mother country and her offspring which both here and at home all good citizens of the Empire are determined to promote."

In introducing Lord Rayleigh as President, Sir William Thomson said:—

"It would have been a well-earned pleasure for my friend Prof. Cayley had he been able to visit Montreal, to introduce Lord Rayleigh to-night as his successor in the office of President of the British Association. Prof. Cayley has devoted his life to the advancement of pure mathematics, and it is peculiarly appropriate that he should be followed in his honourable post by one who has made the brilliant applications of mathematical power to the discovery and illustration of natural phenomena with which Lord Rayleigh has enriched physical science. Lord Rayleigh's optical researches are of great value—notably his profound and searching mathematical investigation of the blue sky and the polarisation of light by reflection. His book on 'Sound' is the greatest and most important work which has yet appeared on the subject. His determination of the ohm, which constitutes the accurate foundation for the great modern science of electrical measurement, is of supreme importance not only in the scientific laboratory but in all practical applications of electricity, as in the telegraph cable factory and the signalling station, in electrical engineering works, in every practical application of electric light, electro-metallurgy, and the electrical transmission of power. With much pleasure I resign the chair for Prof. Cayley, and introduce Lord Rayleigh as President of the British Association."

The Royal Society of Canada presented an address of welcome to the Association, and the American Association sent a cordial invitation to the members to attend the meeting at Philadelphia. Over 200 were to go, leaving Montreal by special train this morning.

A brilliant reception was given on Thursday night by the Governors, Principal, and Professors of McGill University, and Saturday was devoted entirely to excursions. Prof. Lodge's lecture on "Dust" on Friday night was both scientific and practical, and appears to have been a great success. He did well to speak strongly to a practical people of the rewards of pure scientific research, though we trust that one result of the meeting will be to open the eyes of the Canadians to the utility of substantially encouraging such research.

One of the most notable incidents of the meeting seems to have been the reception given to Prof. Asa Gray in the Biological Section, where he read a paper on North American botany, one of the most remarkable papers, Prof. Moseley stated, ever read in that Section. When Prof. Gray rose to reply, he received a perfect ovation.

The Corporation of McGill University, in commemoration of the British Association meeting at Montreal, were to confer, at the closing meeting yesterday, the honorary degree of LL.D. upon the following prominent representatives of science:—The President, Lord Rayleigh; the following Vice-Presidents: the Governor-General, Lord Lansdowne; Sir John A. Macdonald, Sir Lyon Playfair, and Prof. Frankland; the General Secretaries, Capt. Douglas Galton and Mr. A. G. Vernon Harcourt; the Secretary, Prof. Bonney; the Sectional Presidents, Sir William Thomson, Sir Henry Roscoe, Mr. W. T. Blanford, Prof. Moseley, General Sir J. H. Lefroy, Sir Richard Temple, Sir Frederick Bramwell, and Dr. E. B. Tylor; also upon Prof. Daniel Wilson, President of Toronto University and the leading Canadian archæologist; Prof. Asa Gray of Harvard, the leading American botanist; and Prof. James Hall, the State Geologist of New York.

Lieut. Greely made his appearance in the Geographical Section on Tuesday, and gave a detailed account of the geographical and scientific results of his recent Arctic expedition. His paper, however, was no mere sensation; what he told the meeting of the condition of Grinnell Land is of real scientific value. On another page will be found the report of Lieut. Greely's paper.

One practical result of the Montreal meeting is that the Association will offer a gold medal in the Department of Applied Science in McGill University as a memento of the visit. Moreover, Mr. Blanford proposed in the Geological Section that as some return for the way in which they had been received the members should contribute for the formation of science scholarships in McGill College.

SECTION C

GEOLOGY

OPENING ADDRESS BY W. T. BLANFORD, F.R.S., SEC.G.S., F.R.G.S., PRESIDENT OF THE SECTION

IN commencing an address to the Geological Section of the British Association on the first occasion on which that body has met outside of the British Islands I feel much difficulty. Amongst the eminent geologists who have filled the post which you have done me the honour of calling upon me to occupy for the present year there are several who would have been able, from their knowledge of both European and American geology, to treat with authority of the many points of interest elicited by comparison of geological phenomena on opposite sides of the Atlantic Ocean. My own experience has been chiefly derived from the distant continent of Asia, and I have not that intimate acquaintance with the geology of Europe, nor that knowledge of the progress of geological research in America, which would justify my entering upon any comparison of the two continents. It has, however, occurred to me that, amongst the questions of wide importance connected with the correlation of strata in distant parts of the world, there is one to which some interesting contributions have been made by the work of the Geological Survey of India, and by the geologists of Australia and South Africa, and that a short time might be profitably devoted to a consideration of a few remarkable exceptions to the rule that similarity of faunas and floras in fossiliferous formations throughout the surface of the world implies identity of geological age.

It has probably occurred to other geologists here present, as it has to myself, to be engaged in examining a country the geology of which was absolutely unknown, and to feel the satisfaction that attends the first discovery of a characteristic fossil form. A clue is at once afforded to the geology of the region; one horizon at least is believed to be determined, and from this horizon it is possible to work upwards and downwards until others are found.

It is, therefore, of especial importance to those engaged in geological exploration to satisfy themselves whether the conclusion is correct that identity, or close specific similarity, amongst fossil forms, is a proof that the beds containing them are of the same geological age. It has been pointed out by some of the most careful thinkers, and especially by Forbes and Huxley, that a species requires time to spread from one area to another, that, in numerous cases, a migratory specific form must flourish in the region to which it has migrated, after it has died out in its original birthplace; and that the presence of the same species in two deposits at distant localities may rather tend to indicate that both were not formed simultaneously. Huxley, as is well known, invented the term "homotaxis" to express the relations between such beds, and to avoid the possibly misleading expressions "geological synchronism," and "contemporaneous origin."

Despite such cautions, however, it still appears to be generally assumed by palæontologists that similarity between faunas and floras is evidence of their belonging to the same geological period; that the geological age of any formation, whether marine, fresh-water, or subaërial, can be determined by a comparison of its organic remains with those of other deposits, no matter how distant, of which the position in the geological sequence is ascertained: in short, that homotaxis of marine, fresh-water, and terrestrial forms implies geological synchronism.

That, as a general rule, homotaxis affords evidence that beds exhibiting it belong approximately to the same geological period appears supported by a large amount of evidence. But there are some startling exceptions. I propose to notice a few typical instances, several of them Indian, in which the system of determining the age of various formations by the fauna or flora has led to contradictory results, before attempting to show wherein the source of the error appears to lie. Nothing would be gained and much time would be lost by entering upon the details of all the cases known, even if I were able to give authentic particulars, which is doubtful. It will be sufficient to cite some characteristic examples, concerning the details of which satisfactory evidence is forthcoming.

Pikermi Beds.—There are but few fossiliferous deposits on the face of the earth that have attracted more attention than the Pikermi beds of Greece. In one of the most classical and famous sites of the world, a few miles east of Athens, just where

> The mountains look on Marathon,
> And Marathon looks on the sea,

some red, silty beds occur, abounding in vertebrate remains. Some of the bones were described by Wagner and others, but for a complete account of the fauna we are indebted to Prof. Albert Gaudry, who has himself collected by far the greater portion of the remains hitherto procured. The following is a list of the genera determined; it is unnecessary to give the specific names:—

MAMMALIA.

PRIMATES.—*Mesopithecus*, 1 sp.
CARNIVORA.—*Simocyon*, 1; *Mustela*, 1; *Promephitis*, 1; *Ictitherium*, 3; *Hyæna*, 1; *Lepthyæna*, 1; *Hyænictis*, 1; *Felis*, 4; *Machærodus*, 1.
PROBOSCIDEA.—*Mastodon*, 2; *Dinotherium*, 1.
UNGULATA.—*Chalicotherium*, 1; *Rhinoceros*, 3; *Acerotherium*, 1; *Leptodon*, 1; *Hipparion*, 1; *Sus*, 1; *Camelopardalis*, 1; *Helladotherium*, 1; *Orasius*, 1; *Palæotragus*, 1; *Palæoryx*, 2; *Tragocerus*, 2; *Palæoreas*, 1; *Antidorcas* (?), 1; *Gazella*, 1; *Antilope*, 3; *Dremotherium*, 2.
RODENTIA.—*Hystrix*, 1.
EDENTATA.—*Ancylotherium*, 1.

AVES.

Phasianus, 1; *Gallus*, 1; *Gen. gallinac. indet.*, 1; *Grus*, 1; *Gen. ciconidar. indet.*, 1.

REPTILIA.

Testudo, 1; *Varanus*, 1.

Of Mammalia alone there are known from this deposit 31 genera, of which 22 are extinct, and 35 species.

Now, this fauna is almost invariably in European works quoted as Miocene. Of the species found no less than 14—*Simocyon diaphorus*, *Ictitherium robustum*, *I. hipparionum*, *Hyæna eximia*, *Hyænictis græca*, *Machærodus cultridens*, *Mastodon turicensis*, *Dinotherium giganteum*, *Rhinoceros schleiermacheri*, *Hipparion gracile*, *Sus erymanthius*, *Helladotherium duvernoyi*, *Tragocerus amaltheus*, and *Gazella brevicornis*—are met with in other European deposits assigned to the Miocene period. It is true that one of these deposits at least—that of Eppelsheim—has been shown on stratigraphical grounds to be much more probably Pliocene than Miocene, and the position of other deposits has been determined by the kind of argument which, as I shall show, has proved misleading in the case of Pikermi itself. Nevertheless so general is the consensus of opinion amongst palæontologists, that the beds with *Hipparion* at Pikermi and elsewhere are quoted as especially included in the Miocene system by the French Committee of the International Geological Congress. Amongst English writers the Miocene age of the Pikermi beds appears generally admitted, as by Mr. Wallace (*Geographical Distribution of Animals*, i. p. 115), Prof. Boyd Dawkins (*Q. J. G. S.* 1880, p. 389), Mr. E. T. Newton (*Q J. G. S.* 1884, pp. 284, 287, &c.), and many others. Prof. Gaudry himself is much more cautious; he classes the fauna as intermediate between Pliocene and Miocene, and only relegates it to Upper Miocene because that is the position assigned by other palæontologists to beds containing remains of *Hipparion*. However, in his subsequent works Prof. Gaudry has classed the Pikermi fauna as Miocene.

Now, the lowest of the beds with the vertebrate fauna at Pikermi were by Prof. Gaudry himself found to be interstratified with a band of gray conglomerate containing four characteristic *marine* Pliocene Mollusca—*Pecten benedictus*, Lam.; *Spondylus gæderopus*, L.; *Ostrea lamellosa*, Brocchi; and *O. undata*, Lam. It should be remembered that the Pliocene fauna of the Mediterranean area is the richest and most typical in Europe, and is as well known as any geological fauna in the world. It should also be remembered that the Pliocene beds are well developed in Greece at other localities besides Pikermi. Prof. Gaudry especially points out that the vertebrate remains, supposed to be those of Miocene animals, are deposited in a stratum overlying a marine bed of undoubted Pliocene age, and he proposes the following hypothesis to account for the presence of Miocene fossils in a Pliocene stratum. The remains found at Pikermi are, he thinks, those of animals that inhabited the extensive plains which in Miocene times extended over a considerable proportion of the area now occupied by the Eastern Mediterranean, and which united Greece to Asia; the plains were broken up by the dislocations that took place at the close of the Miocene period, and the animals escaped to the mountains, where they died for want of space and of food. Their bones were subsequently washed down by the streams from the hills and buried in the Pliocene deposits of Pikermi.

Prof. Gaudry evidently has no very profound faith in this hypothesis, and it is unnecessary to refute it at length. One fact is sufficient to show that it is untenable. However sudden may have been the cataclysm that is supposed to have broken up the Miocene plains of Attica, a very long period, measured in years, must have elapsed before the Pliocene marine fauna could have established itself. Now, the bones of mammals exposed on the surface decay rapidly; the teeth break up, the bones become brittle. It is doubtful if bones that had been exposed for only five or six years would be washed down by a stream without being broken into fragments; the teeth especially would split to pieces. The condition of the Pikermi fossils proves, I think, that they must have been buried very soon after the animals died, that they were not exposed on the surface for any length of time, and that they could not have been washed out of an earlier formation, and it appears to me incredible that the Pikermi mammals were not contemporary with the Pliocene Mollusca that occur in the same beds. In short, I cannot but conclude that the Pikermi mammals were Pliocene and not Miocene.

This view is entirely in accordance with the opinions of Theodor Fuchs (*Denkschr. K. Acad. Wiss. Wien*, 1877, xxxvii. 2e Abth. p. 1). He has given a good account of the geology of various places in Greece, and amongst others of Pikermi. He found, again, the conglomerate with Pliocene marine Mollusca interstratified with the basal portion of the mammaliferous beds, and he concludes (*l.c.* p. 30), that not only is it clear that these mammaliferous beds are of Pliocene age, but that a comparison of their geological position with that of the marine strata of the Piræus proves that the Pikermi beds occupy a very high position in the Pliocene, and are probably the highest portion of the system as developed in the neighbourhood.

Fuchs also shows that the principal Pliocene mammaliferous beds are of later date than the typical Pliocene (sub-Apennine) beds of Italy, and that some Mammalia found associated with the latter comprise forms identical with those of the Pikermi beds. In subsequent papers on the age of the beds containing *Hipparion* the same writer shows reasons for classing these strata in Italy, France (Vaucluse), and Germany as intermediate between Miocene and Pliocene. This leaves the difficulty unsolved, for he had shown the Pikermi beds to be high in the Pliocene system. They rest unconformably upon certain fresh-water limestones, clays, &c., containing plants and Mollusca, and classed by Gaudry as Miocene, but by Fuchs as Pliocene. Thus by both writers mammaliferous beds of Pikermi are referred to a considerably later geological horizon than those containing identical species in other parts of Europe.

It would require too much time to enter into the still more difficult question of the various plant-bearing beds in different parts of Europe and in Greenland containing a flora classed by Heer and others as Miocene. Gardner has given reasons for considering the Greenland beds Eocene; Fuchs, as just stated, is of opinion that the Greek beds are Pliocene. One point should be noted, that the more nothern flora is considered older than the more southern, and it will be remarked that the same observation applies to the supposed Upper Miocene fauna of France and Germany and the Pikermi fauna of Greece.

Siwalik.—The next instance which I shall describe is another of the most important fossil mammalian faunas of the Old World, that found in the Upper Tertiary beds that fringe the Himalayas on the south. The name applied to this fauna is taken from one of the localities in which it was first found, the Siwalik (correctly, I believe, Shib-wala) hills, between the Deyra Dun and the plains north by east of Delhi. Bones of Siwalik Mammalia are found, however, throughout a considerable area of the Northern Punjab.

The Siwalik fauna has been worked out, chiefly by Falconer and Lydekker, the last-named being still engaged in describing the species. The following is a list of the genera found in the true Siwalik beds :—[1]

MAMMALIA.

PRIMATES.—*Palæopithecus*, 1 sp.; *Macacus*, 2; *Semnopithecus*, 1; *Cynopithecus*, 2.

CARNIVORA.—*Mustela*, 1; *Mellivora*, 2; *Mellivorodon*, 1; *Lutra*, 3; *Hyænodon*, 1; *Ursus*, 1; *Hyænarctus*, 3; *Canis*, 2; *Viverra*, 2; *Hyæna*, 5; *Lepthyæna*, 1; *Æluropsis*, 1; *Ælurogale*, 1; *Felis*, 5; *Machærodus*, 2.

PROBOSCIDEA.—*Elephas*, 6 (*Euelephas*, 1; *Loxodon*, 1; *Stegodon*, 4); *Mastodon*, 5.

[1] Lydekker, *J. A. S. B.* 1880, pt. 2, p. 34; *Palæontologia Indica*, ser. x. vols. i. ii. iii.; *Records Geol. Surv. India*, 1883, p. 81. I am indebted to Mr. Lydekker for some unpublished additions.

UNGULATA.—*Chalicotherium*, 1; *Rhinoceros*, 3; *Equus*, 1; *Hipparion*, 2; *Hippopotamus*, 1; *Tetraconodon*, 1; *Sus*, 5; *Hippohyus*, 1; *Sanitherium*, 1; *Merycopotamus*, 1; *Cervus*, 3; *Dorcatherium*, 2; *Tragulus*, 1; *Propalæomeryx*, 1; *Camelopardalis*, 1; *Helladotherium*, 1; *Hydaspitherium*, 2; *Sivatherium*, 1; *Alcephalus*, 1; *Gazella*, 1; *Antilope*, 2; *Oreas* (?), 1; *Palæoryx* (?), 1; *Portax*, 1; *Hemibos*, 3; *Leptobos*, 1; *Bubalus*, 2; *Bison*, 1; *Bos*, 3; *Bucapra*, 1; *Capra*, 2; *Ovis*, 1; *Camelus*, 1.

RODENTIA.—*Mus*, 1; *Rhyzomys*, 1; *Hystrix*, 1; *Lepus*, 1.

AVES.

Graculus, 1; *Pelecanus*, 2; *Megaloscelornis*, 1; *Argala*, 1; *Struthio*, 1; *Dromæus*, 1.

REPTILIA.

CROCODILIA.—*Crocodilus*, 1; *Gharialis*, 3.

LACERTILIA.—*Varanus*, 1.

CHELONIA.—*Colossochelys*, 1; *Testudo*, 1; *Bellia*, 2; *Damonia*, 1; *Emys*, 1; *Cautleya*, 1; *Pangshura*, 1; *Emyda*, 1; *Trionyx*, 1.

PISCES.

Bagarius, 1.

Now, until the last few years, this fauna was classed as Miocene by European palæontologists as unhesitatingly as the Pikermi fauna still is, and in the majority of European geological works, despite the unanimous opinion of all the geologists who are acquainted with the sub-Himalayan beds, the Siwalik fauna is still called Miocene. The geologists of the Indian Survey, however, class the fossiliferous Siwaliks as Pliocene, on both geological and biological grounds. With regard to the latter, not only does the fauna comprise a large number of existing genera of mammals, such as *Macacus*, *Semnopithecus*, *Ursus*, *Elephas* (*Euelephas*), *Equus*, *Hippopotamus*, *Camelopardalis*, *Bos*, *Hystrix*, *Mus*, and especially *Mellivora*, *Meles*, *Capra*, *Ovis*, *Camelus*, and *Rhizomys*, but three out of six or seven clearly-determined species of reptiles, viz.—*Crocodilus palustris*, *Gharialis gangeticus*, and *Pangshura tectum*—are living forms now inhabiting Northern India, whilst all the known land and fresh water Mollusca, with one possible exception, are recent species.

These data, however, although very important and very cogent, belong to a class of facts that have led, I believe, in other cases to erroneous conclusions. The geological evidence is far more satisfactory, and it is not liable to the same objection.

The whole Siwalik fauna, as given above, has been obtained from the upper beds of a great sequence or system. Beneath the fossiliferous strata at the base of the North-West Himalaya there is an immense thickness, amounting in places to many thousands of feet, of sandstones, clays, and other beds, from none of which recognisable fossils have been procured. The first beds of known age that are met with below the mammaliferous Siwaliks are marine rocks belonging to the Eocene system.

But as we pass from the Himalayas to the south-west, along the western frontier of India in the Punjab, and onwards to the south in Sind, the same Siwalik system can be traced almost without interruption, and in the last-named country the lower unfossiliferous strata become intercalated with fossiliferous beds. In Sind the upper Siwaliks no longer yield any vertebrate remains that can be identified, but far below the horizon of the Siwalik fauna a few bones have been found, and the following mammals have been identified (*Pal. Ind.* ser. x.; *Rec. Geol. Surv. Ind.* 1883, pp. 82, &c.)—

CARNIVORA.—*Amphicyon palæindicus*.

PROBOSCIDEA.—*Mastodon latidens*, *M. perimensis*, *M. falconeri*, *M. pandionis*, *M. angustidens*, *Dinotherium indicum*, *D. sindiense*, *D. pentepotamiæ*.

UNGULATA.—*Rhinoceros sivalensis*, var. *intermedius*, *Acerotherium perimense*, *A. blanfordi*, *Sus hysudricus*, *Hyotherium sindiense*, *Anthracotherium silistrense*, *A. hyopotamoides*, *Hyopotamus palæindicus*, *H. giganteus*, *Hemimeryx blanfordi* *Sivameryx sindiensis*, *Agriochærus sp.*, *Dorcatherium majus*, *D. minus*.

EDENTATA.—*Manis* (?) *sindiensis*.

Although about one-third of the species above named have been found also in the upper Siwalik beds of the Punjab, it is unnecessary to point out in detail why the lower Siwalik fauna is clearly by far the older of the two. The absence of such living genera as *Elephas*, *Bos*, *Equus*, &c., and the presence of so many typically Middle Tertiary forms, such as *Dinotherium*, *Anthracotherium*, and *Hyopotamus*, shows a great change. The Mollusca tell the same tale. All the forms known from the upper Siwaliks, with one exception, are recent species of land and fresh-water shells now living in the area. Of seven fresh-water Mollusca (*Mem. Geol. Surv. Ind.* vol. xx. pt. 2, p. 129) found associated with the lower Siwaliks none appears to be identical with any living species, and only two are allied, one closely, the other more remotely, to forms now met with in Burmah, 30° of longitude further east.

Before proceeding with the argument, it is as well to call attention to the very important fact just mentioned. It has been asserted over and over again that species of *Mammalia* are peculiarly short-lived, far more so than those of *Mollusca*. In this case, so far as the evidence extends at present, one-third of the species of *Mammalia* survived the changes that took place, whereas not a single mollusk is found both in the upper and lower Siwaliks. It should be remembered that the recent molluscan river fauna of this part of India is very poor in species, and that we probably know a considerable proportion of that existing in Siwalik times.

The geological age of the lower Siwalik beds of Sind is shown by their passing downwards into marine fossiliferous beds, known as the Gáj group, of Miocene age, the following being the section of Tertiary strata exposed in the hills west of the Indus:—

		Ft.	
Siwalik or Manchar	Upper	5000 unfossiliferous	Pliocene
	Lower	3000 to 5000 fossiliferous	Upper Miocene or Lower Pliocene
Gáj		1000 to 1500 fossiliferous	Miocene
Nari	Upper	4000 to 6000 unfossiliferous	Lower Miocene
	Lower	100 to 1500 fossiliferous	Oligocene
Khirthar	Upper	500 to 3000 fossiliferous	Eocene
	Lower	6000 fossiliferous	

Clearly the lower Siwaliks of Sind cannot be older than Upper Miocene; therefore the upper Siwaliks, which are shown by both biological and geological evidence to be of much later date, must be Pliocene.

Gondwána System of India.—In the peninsula of India there is a remarkable deficiency of marine formations. Except in the neighbourhood of the coast or of the Indus Valley there is, with one exception (some Cretaceous rocks in the Nerbudda Valley), not a single marine deposit known south of the great Gangetic plain. But in Bengal and Central India, over extensive tracts of country, a great sequence of fresh-water beds, probably of fluviatile origin, is found, to which the name of Gondwána System has been applied. The uppermost beds of this system, in Cutch to the westward, and near the mouth of the Godávari to the eastward, are interstratified with marine beds containing fossils of the highest Jurassic (Portlandian and Tithonian) types.

The Gondwána system is a true system in the sense that all the series comprised are closely connected with each other by both biological and physical characters, but it represents in all probability a much longer period of geological time than do any of the typical European systems. The highest members, as already stated, are interstratified with marine beds containing uppermost Jurassic fossils. The age of the lowest members is less definitely determined, and has been by different writers classed in various series from Middle Carboniferous to Middle Jurassic. The Gondwána beds from top to bottom are of unusual interest on account of the extraordinary conflict of palæontological evidence that they present.

The subdivisions of the Gondwána system are numerous, and in the upper portions especially the series and stages are different in almost every tract where the rocks are found. The following are the subdivisions of most importance on account of their fauna and flora, or of their geological relations:—

Upper Gondwána	Cutch and Jabalpur	
	Kota-Maleri	
	Rájmahál	
Lower Gondwána	Panchet	
	Damuda	Ráníganj and Kámthi
		Barákar
	Karharbári	
	Tálchir	

The upper Gondwánas, where best developed, attain a thickness of 11,000 feet, and the lower of 13,000 ft.

The Tálchir and Barákar subdivisions are far more generally present than any of the others.

Tálchir.—The Tálchir beds consist of fine silty shales and fine soft sandstone. Very few fossils have been found in them, and these few recur almost without exception in the Karharbári stage. The Tálchirs are principally remarkable for the frequent occurrence of large boulders, chiefly of metamorphic rocks. These boulders are sometimes of large size, 6 feet or more across, 3 to 4 feet being a common diameter; all are rounded, and they are generally embedded in fine silt.

Karharbári.—The Karharbári beds are found in but few localities. They contain some coal-seams, and the following plants have been met with (Feistmantel, *Palæontologia Indica*, ser. xii. vol. iii.):—

CONIFERÆ.—*Euryphyllum*, 1 sp.; *Voltzia*, 1; *Albertia*, 1; *Samaropsis*, 1.
CYCADEACEÆ.—*Glossozamites*, 1; *Noeggerathiopsis*, 1.
FILICES.—*Neuropteris*, 1; *Glossopteris*, 4; *Gangamopteris*, 4; *Sagenopteris*, 1.
EQUISETACEÆ.—*Schizoneura*, 2; *Vertebraria*, 1.

The most abundant form is a *Gangamopteris*. The *Voltzia* (*V. heterophylla*) is a characteristic Lower Triassic (Bunter) form in Europe. The *Neuropteris* and *Albertia* are also nearly related to Lower Triassic forms. The species of *Gangamopteris*, *Glossopteris*, *Vertebraria*, and *Noeggerathiopsis* are allied to forms found in Australian strata.

Damuda.—The Damuda series consists of sandstones and shales with coal-beds; the floras of the different subdivisions present but few differences, and the following is the list of plants found (*Pal. Ind.* ser. ii. xi. xii. vol. iii.):—

CONIFERÆ.—*Rhipidopsis*, 1 sp.; *Voltzia*, 1; *Samaropsis*, 1; *Cyclopitys*, 1.
CYCADEACEÆ.—*Pterophyllum*, 2; *Anomozamites*, 1; *Noeggerathiopsis*, 3.
FILICES.—*Sphenopteris*, 1; *Dicksonia*, 1; *Alethopteris*, 4; *Pecopteris*, 1; *Merianopteris*, 1; *Macrotæniopteris*, 2; *Palæovittaria*, 1; *Angiopteridium*, 2; *Glossopteris*, 19; *Gangamopteris*, 7; *Belemnopteris*, 1; *Anthrophyopsis*, 1; *Dictyopteridium*, 1; *Sagenopteris*, 4; *Actinopteris*, 1.
EQUISETACEÆ.—*Schizoneura*, 1; *Phyllotheca*, 3; *Trizygia*, 1; *Vertebraria*, 1.

The only remains of animals hitherto recorded are an *Estheria* and two Labyrinthodonts, *Brachyops laticeps* and an undescribed form formerly referred to *Archegosaurus*. The only European genus allied to *Brachyops* is of Oolitic age.

The most abundant of the above-named fossils are *Glossopteris* and *Vertebraria*. With the exception of *Noeggerathiopsis* all the cycads and conifers are of excessive rarity. More than one-half of the species known are ferns with simple undivided fronds and anastomosing venation.

For many years European palæontologists generally classed this flora as Jurassic.[1] This was the view accepted by De Zigno and Schimper, and, though with more hesitation, by Bunbury. The species of *Phyllotheca*, *Alethopteris* (or *Pecopteris*), and *Glossopteris* (allied to *Sagenopteris*) were considered to exhibit marked Jurassic affinities. It was generally admitted that the Damuda flora resembles that of the Australian Coal-Measures (to which I shall refer presently) more than it does that from any known European formation; but the Australian plants were also classed as Jurassic. There is no reason for supposing that the more recent discoveries of Damuda plants would have modified this view; the identification of such forms as true *Sagenopteris* and the cycads *Pterophyllum* and *Anomozamites* would assuredly have been held to confirm the Jurassic age of the beds. So far as European fossil plants are concerned, the Damuda flora resembles that of the Middle or Lower Jurassics more than any other.

One form, it is true, the *Schizoneura*, is closely allied to *S. paradoxa* from the Bunter or Lower Trias of Europe. Other plants have Rhætic affinities. But the connections with the Triassic flora do not seem nearly equal to those shown with Jurassic plants, and the reason that the Damuda flora has been classed as probably Triassic must be sought in the impossibility of considering it newer (Feistmantel, *Pal. Ind.* ser. xii. vol. iii. pp. 57, 129, &c.), if the next overlying stage is classed as Upper Trias or Rhætic, and in the close affinity with the underlying Karharbári beds, which contain several Lower Triassic types.

Panchet.—The uppermost series of the lower Gondwánas consists chiefly of sandstone, and fossils are rare. The most in-

[1] De Zigno, *Flora Fossilis Form. Ool.* pp. 50, 53; Schimper, *Traité de Paléontologie végétale*, i. p. 645; Bunbury, *Q. J. G. S.* 1861, xvii. p. 350.

teresting are remains of *Reptilia* and *Amphibia*. The following is a list of the fossil animals and plants corrected to the present time:—

ANIMALS.

REPTILIA.

DINOSAURIA.—*Ancistrodon*, 1 sp.
DICYNODONTIA.—*Dicynodon* (*Ptychognathus*), 2.

AMPHIBIA.

LABYRINTHODONTIA.—*Gonioglyptus*, 2; *Glyptognathus*, 1; *Pachygonia*, 1.

CRUSTACEA.

Estheria, 1.

PLANTS.

CONIFERÆ.—*Samaropsis*, 1.
FILICES.—*Pecopteris*, 1; *Cyclopteris*, 1; *Thinnfeldia*, 1; *Oleandridium*, 1; *Glossopteris*, 3.
EQUISETACEÆ.—*Schizoneura*, 1.

The *Schizoneura* and the three species of *Glossopteris* are considered the same as Damuda forms. But with them are found two European Rhætic species, *Pecopteris concinna* and *Cyclopteris pachyrachis*. The *Oleandridium* is also closely allied to a European Rhætic form, and may be identical. The flora may thus be classed as typically Rhætic.

All the genera of *Labyrinthodonts* named are peculiar; their nearest European allies are chiefly Triassic. *Dicynodontia* are only known with certainty from India and South Africa, but some forms believed to be nearly allied have been described from the Ural mountains (Huxley, *Q. J. G. S.* xxvi. p. 48.). These fossils were obtained from rocks now referred to the Permian (Twelvetrees, *Q. J. G. S.* xxxviii. p. 500).

Upper Gondwánas.—The different series of the lower Gondwánas are found in the same area, resting one upon the other, so that the sequence is determined geologically. This is not the case with the upper Gondwána groups; their most fossiliferous representatives are found in different parts of the country, and the relations to each other are mainly inferred from palæobotanical data. Although, therefore, it is probable that the Rájmahâls are older than the Cutch and Jabalpur beds, and that the Kota-Maleri strata are of intermediate age, it is quite possible that two or more of these series may have been contemporaneously formed in regions with a different flora.

Rájmahál.—The comparatively rich flora of the lowest upper Gondwána series is contained in beds interstratified with basaltic lava-flows of the fissure-eruption type. The following are the genera (*Pal. Ind.* ser. ii.; Feistmantel, *Rec. G. S. I.* ix. p. 39) of plants found:—

CONIFERÆ.—*Palissya*, 2 sp.; *Cunninghamites*, 1; *Chirolepis*, 2; *Araucarites*, 1; *Echinostrobus*, 1.
CYCADEACEÆ.—*Pterophyllum*, 9; *Ptilophyllum*, 1; *Otozamites*, 3; *Zamites*, 1; *Dictyozamites*, 1; *Cycadites*, 2; *Williamsonia*, 2; *Cycadinocarpus*, 1.
FILICES.—*Eremopteris*, 2; *Davallioides*, 1; *Dicksonia*, 1; *Hymenophyllites*, 1; *Cyclopteris*, 1; *Thinnfeldia*, 1; *Gleichenia*, 1; *Alethopteris*, 1; *Asplenites*, 1; *Pecopteris*, 1; *Macrotæniopteris*, 4; *Angiopteridium*, 3; *Danæopsis*, 1; *Rhizomopteris*, 1.
EQUISETACEÆ.—*Equisetum*, 1.

The marked change from the lower Gondwána floras is visible at a glance; not a single species is common to both, most of the genera are distinct, and the difference is even greater when the commonest plants are compared. In the lower Gondwánas the prevalent forms are *Equisetaceæ* and ferns of the *Glossopteris* type, whilst in the Rájmahál flora cycads are by far more abundant than any other plants. The whole assemblage, moreover, is more nearly allied than are any of those in the lower Gondwána beds to European Mesozoic floras.

Of the Rájmahál plants (Feistmantel, *Pal. Ind.* ser. ii. pp. 143, 187; *Manual Geol. Ind.* p. 145) about fifteen are allied to Rhætic European forms, three to Liassic or Lower Jurassic (two of these having also Rhætic affinities), and six to Middle Jurassic (two having Rhætic relations as well. The flora must therefore as a whole on purely palæontological grounds be classed as Rhætic.

Kota-Maleri.—The deposits belonging to this series are found in the Godávari valley at a considerable distance from the Rájmahál hills in Bengal, the locality for the Rájmahál flora. Both Rájmahál and Kota-Maleri beds overlie rocks of the Damuda series. It is not quite clear whether the Kota beds, which contain fish, insects, and crustaceans, and the Maleri beds, in which remains of fish, reptiles, and plants are found, are interstratified, or whether the Kota beds overlie those of Maleri. That the two are closely connected is generally admitted.

From the Maleri beds the following remains have been collected:—

ANIMALS.

REPTILIA.—*Hyperodapedon*, 1 sp.; *Parasuchus*, 1.
PISCES.—*Ceratodus*, 3.

PLANTS.

CONIFERÆ.—*Palissya*, 2; *Chirolepis*, 1; *Araucarites*, 1.
CYCADEACEÆ.—*Ptilophyllum*, 1; *Cycadites*, 1.
FILICES.—*Angiopteridium*, 1.

From the Kota fresh-water limestone nine species of ganoid fish—viz. five of *Lepidotus*, three of *Tetragonolepis*, and one of *Dapedius*—have been described. An *Estheria*, a *Candona*, and some insects have also been found. The fish (*Pal. Ind.* ser. iv. pt. 2) are Liassic forms.

The Reptilia of the Maleri beds are, on the other hand, Triassic[1] and closely allied to Keuper forms. *Ceratodus* is chiefly Triassic (Keuper and Rhætic). The plants show relations with both the Rájmahál and Jabalpur floras, and, as the palæontological relations to beds in the same country are considered far higher in importance than those to deposits in distant regions, the Kota-Maleri beds are classed as intermediate between the Rájmahál and Jabalpur epochs.

Cutch and Jabalpur.—Jabalpur beds are found in Central India to the south of the Nerbudda Valley, and form the highest true Gondwána beds. The Cutch beds, as already mentioned, are found interstratified with marine deposits of uppermost Jurassic age far to the westward, a little east of the mouths of the River Indus. The similarity of the plant-remains in the two series has caused them to be classed together, but it is not certain that they are really of contemporaneous origin.

The following is a list of the Jabalpur plants (*Pal. Ind.* ser. xi. pt. 2):—

CONIFERÆ.—*Palissya*, 2 sp.; *Araucarites*, 1; *Echinostrobus*, 2; *Brachyphyllum*, 1; *Taxites*, 1; *Gingko*, 1; *Phœnicopsis*, 1; *Czekanowskia*, 1.
CYCADEACEÆ.—*Pterophyllum*, 1; *Ptilophyllum*, 2; *Podozamites*, 3; *Otozamites*, 4; *Williamsonia*, 1; *Cycadites*, 1.
FILICES.—*Sphenopteris*, 1; *Dicksonia*, 1; *Alethopteris*, 3; *Macrotæniopteris*, 1; *Glossopteris*, 1; *Sagenopteris*, 1.

Of these thirty species nine are regarded either as identical with forms found in the Middle Jurassic (Lower Oolitic) of England, or as closely allied.

The Cutch plants belong to the following genera (*Pal. Ind.* ser. xi. pt. 1):—

CONIFERÆ.—*Palissya*, 3 sp.; *Pachyphyllum*, 1; *Echinostrobus*, 1; *Araucarites*, 1.
CYCADEACEÆ.—*Ptilophyllum*, 3; *Otozamites*, 3; *Cycadites*, 1; *Williamsonia*, 1; *Cycadolepis*, 1.
FILICES.—*Oleandridium*, 1; *Tæniopteris*, 1; *Alethopteris*, 1; *Pecopteris*, 1; *Pachypteris*, 2; *Actinopteris*, 1.

Of the twenty-two species enumerated, four are identified with specific forms found in the Middle Jurassic of Yorkshire, and seven others are closely allied. The Cutch and Jabalpur beds, in short, are intimately related with European fossil floras, whilst the associations of Indian fossil plants found in the Rájmahál, Damuda, and Karharbári beds have no such close connection with Western types.

One interesting fact should be mentioned. The Cutch flora occurs in the upper part of the Umia beds, the lower beds of which contain *Cephalopoda* of Portlandian and Tithonian forms. In a lower subdivision of the Cutch Jurassic rocks, the Katrol group, shown by numerous Ammonites to be allied to Kimmeridge and upper Oxford beds of Western Europe, four species of plants have been found, of which three are met with in the Umia beds, and the fourth, an English Oolitic form, in the Jabalpur series. This evidence seems in favour of the view that the flora underwent change more slowly than the marine fauna.

It will be as well, before leaving the subject of the Gondwána groups, to show in a tabular form the geological age assigned to the flora and fauna of each separately, on the evidence afforded

[1] *Q. J. G. S.* 1869, pp. 138, 152, &c.; 1875. p. 427; *Pal. Ind.* ser. iv. pt. 2; *Man. Geol. Ind.* p. 151.

by comparison with the plants and animals known from European formations.

		Plants	Animals
Upper Gondwána	Cutch	Middle Jurassic .	Uppermost Jurassic ? Neocomian (marine)
	Jabalpur	Middle Jurassic .	—
	Kota	—	Lower Jurassic (Liassic)
	Maleri	Middle or Lower Jurassic . .	Triassic
	Rájmahál	Rhætic . . .	—
Lower Gondwána	Panchet	Rhætic . . .	Triassic or Permian
	Damuda	Middle Jurassic .	Middle Jurassic
	Karharbári, Talchir	Lower Triassic .	—

Flora of Tonquin.—Quite recently M. Zeiller has described a series of plants from some coal-bearing beds in Tonquin (*Bull. Soc. Géol.* ser. iii. vol. xi. p. 456). This flora is very extraordinary in every respect. It consists of twenty-two species, and contains only two peculiar forms; ten, or nearly one-half, are European species found in the Lower Lias or Rhætic; whilst of the remaining ten, five are Damuda forms *Noeggerathiopsis hislopi, Macrotæniopteris feddeni, Palæovittaria kurzi, Glossopteris browniana*, and *Phyllotheca indica*, one species being common to the Newcastle beds and Carboniferous flora of Australia, and two others closely allied to the forms there occurring. The other five are said to be Rájmahál forms, four *Tæniopteris* or *Angiopteridium* and an *Otozamites*. M. Zeiller unhesitatingly classes the Tonquin beds as Rhætic. It is most singular that these coal-beds, although more distant from Europe by 18° of longitude than either the Damuda or Rájmahál beds of India, contain a larger proportion of European fossil species than any known Indian plant-beds; whilst the association in the same strata of upper and lower Gondwána forms, if well ascertained, shows how hopeless is the attempt to classify these deposits by plant evidence alone.

Australian Coal-Measures and Associated Beds.—In the notice of the lower Gondwána floras of India it was observed that there was a great resemblance between some of them and those found in certain beds of Australia. These latter present even a more remarkable instance of homotaxial perversity than do the Indian rocks. The Australian plant-bearing beds are found in Eastern and Southern Australia, Queensland, and Tasmania. For a knowledge of the geology of the country we are chiefly indebted to the writings of the late Mr. Clarke,[1] whilst the flora has been worked out by McCoy, Dana, Carruthers, and Feistmantel, the latter having recently published a much more complete account than was previously available (*Palæontographica.—Pal. u. mes. Flora des östl. Australien*, 1878-79).

The following are the fresh-water or subaërial beds of Australia, according to the latest classification:—

6. Clarence River beds, New South Wales (Mesozoic carbonaceous of Queensland, Victoria, and Tasmania).
5. Wianamatta beds, N.S. Wales.
4. Hawkesbury beds, N. S. Wales (Bacchus Marsh sandstones, Victoria).
3. Newcastle beds, N.S. Wales.
2. Lower Coal-Measures with marine layers interstratified, N.S. Wales.
1. Lower Carboniferous beds, N.S. Wales.

To a still lower horizon probably belong some beds in Queensland, containing *Lepidodendron nothum* and *Cyclostigma*. They are considered Devonian by Carruthers, and there are some ancient plant-beds in Victoria that may be of the same period.

1. *Lower Carboniferous Beds.*—These underlie the beds with a Carboniferous marine fauna. The localities given are Smith's Creek, near Stroud, Port Stephens, and Arowa. The following plants are enumerated:—

LYCOPODIACEÆ.—*Cyclostigma*, 1 sp.; *Lepidodendron*, 2 or 3; *Knorria*, 1.
FILICES.—*Rhacopteris*, 4; *Archæopteris*, 2 (?); *Glossopteris*, 1.
EQUISETACEÆ.—*Calamites*, 2; *Sphenophyllum*, 1.

This flora contains several species identical with those in the Lower Carboniferous (Bernician) of Europe, corresponding to the mountain limestone. The agreement both in homotaxis and position is the more remarkable because of the startling contrast in the next stage. The only peculiarity is the presence of a *Glossopteris*. This comes from a different locality—Arowa—from most of the fossils, and the species is identical with one found in a much higher series. Under these circumstances it is impossible to feel satisfied that the specimen was really from this horizon. The evidence is not so clear as is desirable.

2. *Lower Coal Measures with Marine Beds.*—The following plants are recorded:—

CYCADEACEÆ.—*Noeggerathiopsis*, 1 sp.
FILICES.—*Glossopteris*, 4.
EQUISETACEÆ.—*Annularia*, 1; *Phyllotheca*, 1.

In the marine beds, which are interstratified, are found Lower Carboniferous (mountain limestone) marine fossils in abundance, such as *Orthoceras, Spirifer, Fenestella, Conularia*, &c. The plants belong to forms declared to be typically Jurassic by palæontologists. As the interstratification of the marine and plant-bearing beds has been repeatedly questioned by palæontologists, it is necessary to point out that the geological evidence brought forward by Mr. Clarke is of the clearest and most convincing character, that this evidence has been confirmed by all the geologists who are acquainted with the country, and has only been doubted by those who have never been near the place.

3. *Newcastle Beds.*—By all previous observers in the field these had been united to the preceding and the flora declared to be the same. Dr. Feistmantel has, however, pointed out important differences. Unfortunately, as he has been unable to examine the beds, it still remains uncertain whether the distinction, which has been overlooked by all the field geologists, is quite so great as it appears from the list of fossils given. The following is the flora:—

CONIFERÆ.—*Brachyphyllum*, 1 sp.
CYCADEACEÆ.—*Zeugophyllites*, 1; *Noeggerathiopsis*, 3.
FILICES.—*Sphenopteris*, 4; *Glossopteris*, 8; *Gangamopteris*, 2; *Caulopteris* (?), 1.
EQUISETACEÆ.—*Phyllotheca*, 1; *Vertebraria*, 1.

The only animal known from the beds is a heterocercal ganoid fish, *Urosthenes australis*, a form with Upper Palæozoic affinities.

It will be noticed that the difference from the flora of the underlying beds associated with marine strata is chiefly specific, and by no means indicative of great difference of age, though the only species considered as common to the two by Dr. Feistmantel is *Glossopteris browniana*, found also in the Damuda series of India, in Tonquin, and in South Africa.

The plant fossils of the Newcastle beds and of the underlying series with marine fossils are those which exhibit so remarkable a similarity to the flora of the Indian lower Gondwánas, and especially to the Damudas. The same genera of plants, especially *Noeggerathiopsis, Glossopteris, Phyllotheca, Vertebraria*, prevail in both. But the lower beds of Australia, to judge by the marine fauna, are of Lower Carboniferous age, and it is impossible to suppose that the Newcastle beds are of very much later date. They are said to be comformable to the lower beds with marine fossils, and even to pass into them, and they should probably, if the lower beds are Lower Carboniferous, be classed as Middle or Upper Carboniferous. Thus if the evidence of marine faunas be accepted as decisive, the Damuda beds of India are homotaxially related to Jurassic strata in Europe and to Carboniferous in Australia.

But the Australian Newcastle flora has been quite as positively classed as Jurassic by European palæobotanists as that of the Damudas. It would be easy to quote a long list of authorities—McCoy, De Zigno, Saporta, Schimper, Carruthers, and others—in support of the Jurassic age of the Australian beds. For years the testimony of Australian geologists was rejected, and doubts thrown upon their observations. There is, so far as I know, no case in the whole history of palæontology in which the conflict of palæontological evidence has been so remarkably displayed.

4. *Hawkesbury Beds.*—The fauna and flora are poor. Only two fish, *Clithrolepis granulatus* and *Myriolepis clarkei*, and one plant, *Thinnfeldia odontopteroides*, are known, and of the three forms two recur in the Wianamatta beds.

An important character of the Hawkesbury beds, to which further reference will be made presently, is the occurrence of transported boulders (Wilkinson, quoted by Feistmantel, *Rec. Geol. Surv. Ind.* 1880, p. 257), apparently brought thither by the action of ice.

Similar boulders have been observed in certain sandstones in

[1] *Q. J. G. S.* 1861, p. 354, and *Remarks on the Sedimentary Formations of New South Wales*, 1878, besides numerous other works.

Victoria known as the Bacchus Marsh beds. From these beds two species of *Gangamopteris* have been described by McCoy. *Gangamopteris*, it should be recollected, is a genus of ferns closely allied to *Glossopteris*, and abundant in the Damuda and still more so in the Karharbári beds of the lower Gondwánas in India.

5. *Wianamatta Beds.*—These are the highest portion of the whole system in New South Wales. They contain the following organic remains:—

ANIMALS.

PISCES.—*Palæoniscus antipodeus, Clithrolepis granulatus.*

PLANTS.

FILICES.—*Thinnfeldia (Pecopteris) odontopteroides, Odontopteris microphylla, Pecopteris tenuifolia, Tæniopteris wianamattæ.*

EQUISETACEÆ.—*Phyllotheca hookeri.*

The fish from the Wianamatta, Hawkesbury, and Newcastle beds, four in number, were considered as a whole by Sir P. Egerton to be most nearly allied to the Permian fauna of Europe.

The Wianamatta plants, like those in the lower beds, are classed as Jurassic.

6. *Higher Mesozoic Beds.*—These, which do not appear to have been traced into connection with the Wianamatta and Hawkesbury beds, occur in widely separated localities, from Queensland to Tasmania. The correlation of these widely scattered deposits, and the assignment of them collectively to a position above that of the Wianamatta beds, appear solely founded upon the fossil flora, and it would be satisfactory to have in addition some geological evidence or some palæontological data derived from marine fossils. The Queensland flora is said to occur in beds overlying marine strata of Middle Jurassic age.

The following plants are recorded from these higher beds:—

CYCADEACEÆ.—*Zamites (Podozamites)*, 3 sp.; *Otozamites*, 1.
FILICES.—*Sphenopteris*, 1; *Thinnfeldia*, 1; *Cyclopteris*, 1; *Alethopteris*, 1; *Tæniopteris*, 1; *Sagenopteris*, 1.
EQUISETACEÆ.—*Phyllotheca*, 1.

Tabulating, as in the case of the Indian Gondwána system, the age of the different Australian subdivisions as determined by their fossil plants and animals on purely palæontological grounds, we have the following result:—

	Plants	Animals
6. Higher Mesozoic beds	Jurassic	Jurassic (marine)
5. Wianamatta beds	Jurassic	Permian
4. Hawkesbury beds	Jurassic	Permian
3. Newcastle beds	Jurassic	Permian
2. Lower Coal-Measures	Jurassic	Lower Carboniferous (marine)
1. Lower Carboniferous beds	Lower Carboniferous	—

South Africa.—In connection with the later Palæozoic and older Mesozoic rocks of Australia and India, it is of importance to mention briefly the corresponding fresh-water or subaërial formations of Southern Africa, although in that country there are not such marked discrepancies in the palæontological evidence, perhaps because the relations of the beds with remains of animals to the plant-bearing strata are less clearly known. It will be sufficient to notice some of the most prominent peculiarities of these formations here, as I hope that a fuller account will be given to the section by Prof. Rupert Jones, who has made an especial study of South African geology.

In the interior of South Africa, occupying an immense tract in the northern parts of Cape Colony, the Orange Free State, Transvaal, and the deserts to the westward of the last two, there is a great system of sandstone and shales with some coal-beds generally known as the Karoo formation. The sequence of subdivisions is the following (*Q. J. G. S.* xxiii. 1867, p. 142):—

Stormberg beds, about 1800 feet thick
Beaufort ,, ,, 1700 ,, ,,
Koonap ,, ,, 1500 ,, ,,

The beds are but little disturbed in general, and form great plateaux. They rest partly on Palæozoic rocks (Carboniferous or Devonian), partly on gneissic formations. As in Australia, the underlying Palæozoic rocks contain a flora allied to the Carboniferous flora of Europe.

At the base of the Karoo formation are certain shales with coal, known as the Ecca beds, and remarkable for containing a great boulder-bed, the Ecca or Dwyka conglomerate (Sutherland, *Q. J. G. S.* xxvi. p. 514), like that in the Tálchir beds in India and the Hawkesbury sandstone in Australia, the boulders, precisely as in the Tálchir beds, being embedded in fine compact silt or sandstone, which in both countries has been mistaken for a volcanic rock. The Ecca beds are said to contain *Glossopteris* and some other plants, but the accounts are as yet somewhat imperfect. The whole Karoo system, according to the latest accounts, rests unconformably on the Ecca beds, whilst the Ecca beds are conformable to the underlying Palæozoic strata.

Unfortunately, although a considerable number of animals and a few plants have been described from the "Karoo formation," it is but rarely that the precise subdivision from which the remains were brought has been clearly known.

The known species of plants are very few in number: *Glossopteris browniana*, and two other species of *Glossopteris* (one classed by Tate as *Dictyopteris*, *Q. J. G. S.* xxiii. p. 141) *Rubidgea*, a fern nearly akin to *Gangamopteris* and *Glossopteris*, and a *Phyllotheca*-like stem are recorded, without any certain horizon, but probably from the Beaufort beds. There is no doubt as to the close similarity of these plants to those of the Damudas of India and the Newcastle beds of Australia.

From the Stormberg beds there are reported *Pecopteris* or *Thinnfeldia odontopteroides*, *Cyclopteris cuneata*, and *Tæniopteris daintreei* (Dunn, "Report on Stormberg Coal-Field," *Geol. Mag.* 1879, p. 552), three of the most characteristic fossils of the uppermost plant-beds in Australia, and all found in the upper Jurassic Queensland beds.

The animals found in the Karoo beds (Owen, "Cat. Foss. Rept. S. Africa, Brit. Mus. 1876," &c.) are more numerous by far than the plants. The greater portion have been secured from the Beaufort beds. They comprise numerous genera of dicynodont, theriodont, and dinosaurian reptiles, two or three genera of labyrinthodont amphibians, some fish allied to *Palæoniscus* and *Amblypterus*, and one mammal, *Tritylodon*. Of the above the *Tritylodon* and some reptilian and fish remains are said to be from the Stormberg beds.

Tritylodon is most nearly related to a Rhætic European mammal. The relations of the reptiles called *Theriodontia* by Sir R. Owen are not clearly defined, but representatives of them and of the *Dicynodontia* as already noticed are said to be found in the Permian of Russia. The *Glossopteris* and its associates may of course be classed as Carboniferous or Jurassic, according to taste. Neither the fauna nor flora show sufficiently close relations to those of any European beds for any safe conclusions as to age, even if homotaxis and synchronism be considered identical. On the other hand, there are remarkable points of agreement with the faunas and floras of the Indian and Australian rocks.

Away from the typical Karoo area on the coast south of Natal there is found a series of beds, partly marine, sometimes called the Uitenhage (*Q. J. G. S.* xxvii. p. 144) series. A few cycads (*Otozamites*, *Podozamites*, *Pterophyllum*), a conifer, and ferns (*Pecopteris* or *Alethopteris*, *Sphenopteris*, *Cyclopteris*) are quoted from them, and three or four of the forms are closely allied or identical with species found in the Rájmahál beds of India.

It was at first supposed that the plant-bearing beds were lower in position than those containing marine fossils, and the whole of the Uitenhage series was considered as of later age than the Karoo beds. The marine beds were considered Middle Jurassic. Subsequently, however, Stow (*Q. J. G. S.* xxvii. p. 479) showed conclusively that a portion of the marine beds, judging by their fossils, are of uppermost Jurassic or even Neocomian age, and also that the relation of the plant-bearing beds to the marine strata are far less simple than was supposed (*l.c.* p. 505, 511, 513, &c.). Indeed, to judge from Stow's account, it is by no means clear that a portion of the wood-bed series or saliferous series, to which the plant-beds belong, is not higher in position than the marine Jurassic strata.

There is a very extraordinary similarity between the geology of the southern part of Africa and that of the peninsula of India. In both countries a thick fresh-water formation, without any marine beds intercalated, occupies a large area of the interior of the country, whilst on the coast some marine Jurassic and Cretaceous rocks are found, the former in association with beds containing plants. The coincidence is not even confined to sedimentary beds. As in India so in South Africa, the uppermost inland Mesozoic fresh-water beds are capped by volcanic rocks.

It has been assumed, but not apparently on any clear evidence, that the marine coast-beds and the associated plant-beds are in Africa much newer than the inland sandstone formation, but it is not impossible that the relations may really be the same as in India, and that the Stormberg beds of the inland formation may be the equivalents of the Upper Jurassic or even the Cretaceous marine beds on the coast. The discovery of plants identical with those of the Jurassic (probably Upper Jurassic) beds of Queensland in the Stormberg series may of course be taken for what it is worth; it is of quite as much importance in indicating the age of the rocks as the occurrence of dicynodont reptiles in the Permian of Russia and in the lower Godwánas of India.

Altogether there is quite sufficient probability that the upper Karoo or Stormberg beds are of later age than Triassic to justify the protest which I made last year against a skull being described from these beds as that of a "Triassic" mammal (*Q. J. G. S.* xl. p. 146). The practice, so common amongst palæontologists, of positively asserting as a known fact the geological age of organisms from beds of which the geological position is not clearly determined is very much to be deprecated.

I have called attention to the occurrence of boulders in the Tálchir beds in India, the Ecca beds of South Africa, and the Bacchus Marsh sandstones and Hawkesbury beds of Australia. The idea has occurred quite independently to several different observers that each of these remarkable formations affords evidence of glacial action; and although, in the case of India especially, the geographical position of the boulder-bed within the tropics seemed for a long time to render the notion of ice action too improbable to be accepted, further evidence has so far confirmed the view as to cause it to be generally received. Even before the Australian boulder-deposits had been observed, it was suggested that the Tálchir beds and Ecca conglomerate might be contemporaneous (*Q. J. G. S.* xxxi. p. 528), and that the evidence in favour of a Glacial epoch having left its traces in the Permian beds of England (*Q. J. G. S.* xi. p. 185) might possibly indicate that the Indian and South African boulder-beds are of the same geological epoch. The discovery of two similar deposits in Australia adds to the probability that all may have resulted from the same cause and may record contemporaneous phenomena. It would be very unwise to insist too much on the coincidence.

It would be easy to call attention to further examples of discrepancies in palæontological evidence, but I should weary you and nothing would be attained by going through instance after instance of deposits in distant parts of the world, the age of which has been solely determined by the examination of a few fossil forms of land and fresh-water animals and plants. I have, therefore, only taken a few with the details of which I have had occasion to become acquainted. In some of the most important cases I have mentioned, such as those of the Pikermi and Siwalik faunas, the Cutch (Umia beds) flora, and that in the lower Coal-Measures of Australia, the conflict is between the evidence of the marine and terrestrial organisms. Manifestly one or the other of these leads to erroneous conclusions.

The general opinion of geologists is in favour of accepting the evidence of marine organisms. The reason is not far to seek. So far as I am aware no case is known where such an anomaly as that displayed in the Gondwánas of India has been detected amongst marine formations of which the sequence was unquestioned. In the Gondwánas we have a Rhætic flora overlying a Jurassic flora, and a Triassic fauna above both. In Australia we find a Jurassic flora associated with a Carboniferous marine fauna, and overlaid by a Permian fresh-water fauna. The only similar case amongst marine strata is that of the well-known colonies of the late M. Barrande in Bohemia, and in this instance the intercalation of strata containing later forms amongst beds with older types is disputed, whilst the difference in age between the faunas represented is not to be compared to that between Triassic and Jurassic.

There is, however, another and an even stronger reason for accepting the evidence of marine instead of that afforded by terrestrial and fresh-water animals and plants. If we compare the distribution of the two at the present day, we shall find a very striking difference, and it is possible that this difference may afford a clue to the conditions that prevailed in past times.

Wanderers into what they fancy unexplored tracts in palæontology are very likely to find Prof. Huxley's footprints on the path they are following. I have had occasion to turn to a paper of his on *Hyperodopedon* (*Q. J. G. S.* xxv. p. 150), that very curious reptile already mentioned, of which the remains occur both in Great Britain and in India, and I find the following remarks, which appear so exactly to express a portion of the view to which I wish to call your attention, that I trust I may be excused for quoting them. Prof. Huxley writes:—

"It does not appear to me that there is any necessary relation between the fauna of a given land and that of the seas of its shores. The land-faunæ of Britain and Japan are wonderfully similar; their marine faunæ are in several ways different. Identical marine shells are collected on the Mozambique coast and in the easternmost islands of the Pacific; whilst the faunæ of the lands which lie within the same range of longitude are extraordinarily different. What now happens geographically to provinces in space is good evidence as to what, in former times, may have happened to provinces in time; and an essentially identical land-fauna may have been contemporary with several successive marine faunæ.

"At present our knowledge of the terrestrial faunæ of past epochs is so slight that no practical difficulty arises from using, as we do, sea-reckoning for land-time. But I think it highly probable that sooner or later the inhabitants of the land will be found to have a history of their own."

When these words were written more than twenty-four years ago, scarcely one of the geological details to which I have called your attention was known. I need not point out how wonderful a commentary such details have afforded to Prof. Huxley's views.

I have no desire to quote authority. I fear that in the facts I have been laying before you my quotations of the most authoritative writers have been made less for the purpose of showing reverence than of expressing scepticism. My reason for calling attention to Prof. Huxley's views is different. I entirely agree with them; but there is, I think, something to be added to them. There is, I believe, an additional distinction between land and marine faunas that requires notice, and this distinction is one of very great importance and interest. It appears to me that at the present day the difference between the land-faunas of different parts of the world is so vastly greater than that between the marine faunas that, if both were found fossilised, whilst there would be but little difficulty in recognising different marine deposits as of like age from their organic remains, terrestrial and fresh-water beds would in all probability be referred to widely differing epochs, and that some would be more probably classed with those of a past period than with others of the present time.

I had proposed to enter at some length into this subject, and to attempt a sketch of the present state of our knowledge concerning the distribution of terrestrial and marine faunas and floras. But I found that it was impossible to do justice to the question without making this address far longer than is desirable, and I have already taken up more time than I ought to have done. I can therefore only treat the subjects very briefly.

As you are doubtless aware, the most important work upon the distribution of terrestrial animals yet published is that of Mr. Wallace. He divides the earth's surface into six regions—Palæarctic, Ethiopian, Oriental, Australian, Neotropical, and Nearctic. Some naturalists, with whom I am disposed to agree, consider Madagascar and the adjacent islands a seventh region, and it is possible that one or two other additions might be made.

These regions are essentially founded on the distribution of *Vertebrata*, especially mammals and birds, and the following table, taken from Wallace's lists, shows the percentage of peculiar families of Vertebrata and peculiar genera of Mammalia in each region, Mammalia being selected as being more characteristic than birds, and better known than reptiles, amphibians, or fishes:—

Regions	Total Families of Vertebrates	Peculiar Families	Percentage of Peculiar Families	Total Genera of Mammals	Peculiar Genera of Mammals	Percentage of Peculiar Genera
Palæarctic . . .	137	3	2·2	100	37	37
Ethiopian . . .	175	23	13·1	142	90	63
Oriental . . .	163	12	7·4	118	54	46
Australian . . .	142	30	21·1	70	45	65
Neotropical . . .	168	45	26 8	131	103	79
Nearctic . . .	121	12	9·9	74	24	32

The marine mammals and reptiles are too few in number to be compared with the land-fauna, but whales, porpoises, seals, sirenians, turtles, and sea-snakes are for the most part widely diffused. The best class of the Vertebrata for comparison is that of the fishes, and some details taken by Wallace from Günther's "British Museum Catalogue" are very important. The whole class is divided into 116 families, of which 29 are exclusively confined to fresh water, whilst 80 are typically marine. Of these 80 no less than 50 are universally, or almost universally, distributed, whilst many others have a very wide range. Four families are confined to the Atlantic and 13 to the Pacific Ocean, whilst a few more are exclusively southern or northern. About 63 are found in both the Atlantic and Pacific.

Now, of the 29 fresh-water families, 15, or more than one-half, are confined each to a single region, 9 are found each in two regions, 2 in three regions, and the same number in four; one only (*Cyprinidæ*) is found in five regions, whilst not one is met with in all six. It is impossible to conceive a greater contrast: 50 marine families, or 62·5 per cent., have a world-wide distribution, whilst not a single fresh-water family has an equally extended range, and more than one-half are confined each to a single region.

The regions adopted by Wallace, as already stated, are founded on the *Vertebrata;* he considers, however, that the distribution of the invertebrates is similar. So far as the terrestrial Mollusca are concerned, I am inclined to dissent from this view. But for one circumstance, the Mollusca would afford an admirable test of the theory that marine types—species, genera, and families—are much more widely spread than terrestrial. I am assured that this is the case, but the difficulty of proving it arises from the fact that the classification of pulmonate terrestrial Mollusca, as adopted by naturalists generally, is so artificial as to be worthless. Genera like *Helix*, *Bulimus*, *Achatina*, *Pupa*, *Vitrina*, as usually adopted, are not real genera, but associations of species united by characters of no systematic importance, and the attempts that have hitherto been made at a natural classification have chiefly been founded on the shells, the animals not being sufficiently known for their affinities, in a very large number of cases, to be accurately determined. Of late years, however, more attention has been devoted to the soft parts of land mollusks, and in Dr. Paul Fischer's "Manuel de Conchyliologie" now being published, a classification of the Pulmonate Gasteropoda is given, which, although still imperfect for want of additional information, is a great improvement upon any previously available. In this work the first 13 families of the *Pulmonata Geophila* comprise all the non-operculate land Mollusca, or snails and slugs, and these 13 families contain 82 genera thus distributed:—

Peculiar to one of Wallace's land regions . . .	54
Found in more than one, but not in both America and the Eastern Hemisphere	12
Common to both hemispheres	16

The last 16, however, include *Limax*, *Vitrina*, *Helix*, *Pupa*, *Vertigo*, and some other genera which certainly need further repartition. The operculated land-shells belonging to a distinct sub-order, or order, and closely allied to the ordinary Prosobranchiate Gasteropoda, are better classified, the shells in their case affording good characters. They comprise four well-marked families (*Helicinidæ*, *Cyclostomidæ*, *Cyclophoridæ*, and *Diplommatinidæ*), besides others less well marked or but doubtfully terrestrial. Not one of the families named is generally distributed, and the genera are for the most part restricted to one or two regions. The portion of Dr. Fischer's manual relating to these Mollusca is unpublished, and the latest general account available is that of Pfeiffer, published in 1876 (*Monographia Pnemonopomorum Viventium*, *Supp.* iii.). From this monograph I take the following details of distribution. The number of genera enumerated is 64 (including *Proserpinidæ*).

Peculiar to one of Wallace's land regions . . .	48
Found in more than one, but not in both America and the Eastern Hemisphere	8
Common to both hemispheres	8

It is the distribution of the terrestrial operculate Mollusca which induces me to suspect that the distribution of land Mollusca differs from that of land vertebrates. One instance I may give. There is nowhere a better-marked limit to two vertebrate faunas than that known as Wallace's line separating the Australian and Oriental regions, and running through the Malay peninsula between Java, Sumatra, and Borneo on the one hand, and Papua with the neighbouring groups on the other. There is in the two regions a very great difference in the vertebrate genera, and a considerable replacement of families. The Oriental *Vertebrata* contain far more genera and families common to Africa than to Australia. Now, the operculate land-shells known from New Guinea and Northern Australia belong to such genera as *Cyclophorus*, *Cyclotus*, *Leptopoma*, *Pupinella*, *Pupina*, *Diplommatina*, and *Helicina*, all found in the Oriental region, and mostly characteristic of it, whilst the only peculiar types known are *Leucoptychia*, closely allied to *Leptopoma*, from New Guinea, and *Heterocyclus*, apparently related to the Indian *Cyathopoma*, from New Caledonia. Farther east, in Polynesia, there are some very remarkable and peculiar types of land-shells, such as *Achatinella*, but these do not extend to Australia or Papua. On the other hand, scarcely a single Oriental genus extends to Africa, the terrestrial molluscan fauna of which continent differs far more from that of the Oriental region than the latter does from that of tropical Australia.

The same is the case with plants. In an important work lately published by Dr. O. Drude of Dresden, the tropics of the Old World are divided into three distinct regions—(1) tropical Africa; (2) the East African islands, Madagascar, &c.; (3) India, South-Eastern Asia, the Malay Archipelago, Northern Australia, and Polynesia.

A very large proportion of the families and even of the genera of marine Mollusca are almost of world-wide distribution, and even of the tropical and sub-tropical genera the majority are found in all the warmer seas. I have no recent details for the whole of the marine Mollusca, but a very fair comparison with the data already given for land-shells may be obtained from the first twenty-five families of Prosobranchiate Gasteropoda, all that are hitherto published in Fischer's manual. These twenty-five families include *Conidæ*, *Olividæ*, *Volutidæ*, *Buccinidæ*, *Muricidæ*, *Cypreidæ*, *Strombidæ*, *Cerithiidæ*, *Planaxidæ*, and their allies, and contain 116 living marine genera, the known range of which is the following:—

Found only in the Atlantic Ocean	15	
Found only in the Pacific or Indian Ocean, or both	28	
Found only in Arctic or Antarctic Seas, or in both	12	
		—55
Found in the warmer parts of all oceans . . .	34	
Widely, and for the most part universally, distributed	27	
		—61

That is, 52·6 per cent. are found in both hemispheres, whilst only 19·5 per cent. of the inoperculate, and 12·5 per cent. of the operculate land Mollusca, have a similar distribution. This is, however, only an imperfect test of the difference, which is really much greater than these numbers named imply by themselves.

Some genera of fresh-water Mollusca, as *Unio*, *Anodon*, *Cyclas*, *Lymnea*, *Planorbis*, *Paludina*, and *Bythinia*, are very widely spread, but a much larger number are restricted. Thus, if *Unio* and *Anodon* are extensively distributed, all allied fresh-water genera, like *Monocondylæa*, *Mycetopus*, *Iridina*, *Spatha*, *Castalia*, *Ætheria*, and *Mülleria*, inhabit one or two regions at the most. The same result is not found from taking an equally important group of marine Mollusca, such as *Veneridæ* or *Cardiadæ*.

Throughout the marine Invertebrata, so far as I know, the same rule holds good: a few generic types are restricted to particular seas; the majority are found in suitable habitats throughout a large portion of the globe. The marine provinces that have been hitherto distinguished, as may be seen by referring to those in Woodward's "Manual of the Mollusca," or Forbes and Godwin-Austen's "Natural History of the European Seas," or Fischer's "Manuel de Conchyliologie," or Agassiz' "Revision of the Echini," are founded on specific distinctions, whilst the terrestrial regions are based on generic differences, and often on the presence or absence of even larger groups than genera.

Botany offers a still more remarkable example. I have just referred to Dr. Oscar Drude's work (*Petermann's Mittheilungen*, Ergänzungsheft, No. 74, "Die Florenreiche der Erde"), published within the last few months, on the distribution of plants. Dr. Drude divides the surface of the globe into four groups of floral regions (*Florenreichsgruppe*), and these again into floral regions (*Florenreiche*), fifteen in number, which are again divided into sub-regions (*Gebiete*). The first group of floral regions is the oceanic, comprising all the marine vegetation of the world;

and so uniform is this throughout that no separate regions can be established, so that there is but one oceanic to contrast with fourteen terrestrial regions.

It is impossible to enter further into this subject now, and I can only allude to the evidence in favour of the existence of land-regions in past times. It is scarcely necessary to remind you of the proofs already accumulated of differences between the fauna of distant countries in Tertiary times. The Eocene, Miocene, and Pliocene Vertebrata of North America differ quite as much from those of Europe in the same periods as do the genera of the present day; and there was as much distinction between the Mammalia of the Himalayas and of Greece when the Siwalik and Pikermi faunas were living as there is now. In Mesozoic times we have similar evidence. The reptiles of the American Jurassic deposits present wide differences from those of the European beds of that age, and the South African reptilian types of the Karoo beds are barely represented elsewhere. But there is no reason for supposing that the limits or relations of the zoological and botanical regions in past times were the same as they now are. It is quite certain indeed that the distribution of land-areas, whether the great oceanic tract has remained unchanged in its general outlines or not, has undergone enormous variations, and the migration of the terrestrial fauna and flora must have been dependent upon the presence or absence of land communication between different continental tracts; in other words, the terrestrial regions of past epochs, although just as clearly marked as those of the present day, were very differently distributed. The remarkable resemblance of the floras in the Karoo beds of South Africa, the Damuda of India, and the Coal-Measures of Australia, and the wide difference of all from any European fossil flora, is a good example of the former distribution of life; whilst it is scarcely necessary to observe that the present Neotropical and Australian mammals resemble those of the same countries in the later Tertiary times much more than they do the living Mammalia of other regions, and that the Australian mammal fauna is in all probability more nearly allied to the forms of life inhabiting Europe in the Mesozoic era than to any European types of later date. If the existing mammals of Australia had all become extinct, a deposit containing their bones would probably have been classed as Mesozoic.

The belief in the former universality of faunas and floras is very much connected with the idea once generally prevalent, and still far from obsolete, that the temperature of the earth's surface was formerly uniform, and that at all events until early or even Middle Tertiary times the Poles were as warm as the Equator, and both enjoyed a constant tropical climate. The want of glacial evidence from past times in Spitzbergen and Greenland, where a temperature capable of supporting arboreal vegetation has certainly prevailed during several geological periods, is counterbalanced by the gradually accumulating proofs of Lower Mesozoic or Upper Palæozoic Glacial epochs in South Africa, Australia, and, strangest of all, in India. Even during those periods of the earth's history where there is reason to believe that the temperature in high latitudes was higher than it now is, evidence of distinct zones of climate has been observed, and quite recently Dr. Neumayr,[1] of Vienna, has shown that the distribution of Cretaceous and Jurassic *Cephalopoda* throughout the earth's surface proves that during those periods the warmer and cooler zones of the world existed in the same manner as at present, and that they affected the distribution of marine life as they do now.

The idea that marine and terrestrial faunas and floras were similar throughout the world's surface in past times is so ingrained in palæontological science that it will require many years yet before the fallacy of the assumption is generally admitted. No circumstance has contributed more widely to the belief than the supposed universal diffusion of the Carboniferous flora. The evidence that the plants which prevailed in the Coal-Measures of Europe were replaced by totally different forms in Australia, despite the closest similarity in the marine inhabitants of the two areas at the period, will probably go far to give the death-blow to an hypothesis that rests upon no solid ground of observation. In a vast number of instances it has been assumed that similarity between fossil terrestrial faunas and floras proves identity of geological age, and, by arguing in a vicious circle, the occurrence of similar types assumed without sufficient proof to belong to the same geological period has been alleged as evidence of the existence of similar forms in distant countries at the same time.

[1] "Ueber klimatische Zonen während der Juras und Kreidezeit," *Denkschr. Math. Nat. Cl. Akad. Wiss. Wien*, vol. xlvii. 1883.

In the preceding remarks it may perhaps have surprised some of my auditory that I have scarcely alluded to any American formations, and especially that I have not mentioned so well-known and interesting a case of conflicting palæontological evidence as that of the Laramie group. My reason is simply that there are probably many here who are personally acquainted with the geology of the American Cretaceous and Tertiary beds, and who are far better able to judge than I am of the evidence as a whole. To all who are studying such questions in America I think it will be more useful to give the details of similar geological puzzles from the Eastern Hemisphere than to attempt an imperfect analysis of difficult problems in the great Western continent.

Perhaps it may be useful, considering the length to which this address has extended, to recapitulate the principal facts I have endeavoured to bring before you. These are—

1. That the geological age assigned on homotaxial grounds to the Pikermi and Siwalik mammalian faunas is inconsistent with the evidence afforded by the associated marine deposits.

2. The age similarly assigned on the same data to the different series of the Gondwána system of India is a mass of contradictions: beds with a Triassic fauna overlying others with Rhætic or Jurassic floras.

3. The geological position assigned on similar evidence to certain Australian beds is equally contradictory, a Jurassic flora being of the same age as a Carboniferous marine fauna.

4. The same is probably the case with the terrestrial and fresh-water faunas and floras of South Africa.

5. In instances of conflicting evidence between terrestrial or fresh-water faunas and floras on one side, and marine faunas on the other, the geological age indicated by the latter is probably correct, because the contradictions which prevail between the evidence afforded by successive terrestrial and fresh-water beds are unknown in marine deposits, because the succession of terrestrial animals and plants in time has been different from the succession of marine life, and because in all past times the differences between the faunas and floras of distant lands have probably been, as they now are, vastly greater than the differences between the animals and plants inhabiting the different seas and oceans.

6. The geological age attributed to fossil terrestrial faunas and floras in distant countries on account of the relations of such faunas and floras to those found in European beds has proved erroneous in so large a number of cases that no similar determinations should be accepted unless accompanied by evidence from marine beds. It is probable in many cases—perhaps in the majority—where the age of beds has been determined solely by the comparison of land or fresh-water animals or plants with those found in distant parts of the globe, that such determinations are incorrect.

SECTION H

ANTHROPOLOGY

OPENING ADDRESS BY EDWARD B. TYLOR, D.C.L., F.R.S., PRESIDENT OF THE SECTION

OUR newly-constituted Section of Anthropology, now promoted from the lower rank of a Department of Biology, holds its first meeting under remarkable circumstances. Here in America one of the great problems of race and civilisation comes into closer view than in Europe. In England anthropologists infer from stone arrow-heads and hatchet-blades, laid up in burial-mounds or scattered over the sites of vanished villages, that Stone Age tribes once dwelt in the land; but what they were like in feature and complexion, what languages they spoke, what social laws and religion they lived under, are questions where speculation has but little guidance from fact. It is very different when under our feet in Montreal are found relics of a people who formerly dwelt here, Stone Age people, as their implements show, though not unskilled in barbaric arts, as is seen by the ornamentation of their earthen pots and tobacco-pipes, made familiar by the publications of Principal Dawson. As we all know, the record of Jacques Cartier, published in the sixteenth century collection of Ramusio, proves by text and drawing that here stood the famous palisaded town of Hochelaga. Its inhabitants, as his vocabulary shows, belonged to the group of tribes whose word for 5 is *wisk*—that is to say, they were of the Iroquois stock. Much as Canada has changed since then, we can still study among the settled Iroquois the type of a race lately in the Stone Age, still trace remnants and records of their peculiar social institutions, and still hear spoken their language of strange vocabulary and unfamiliar structure. Peculiar importance is given to Canadian anthropology by the presence of such local American types of man, representatives of a stage of culture long passed away in Europe. Nor does this by any means oust from the Canadian mind the interest of the ordinary problems of European anthropology. The complex succession of races which make up the pedigree of the modern Englishman and Frenchman, where the descendants perhaps of palæolithic, and certainly of neolithic, man have blended with invading Keltic, Roman, Teutonic-Scandinavian peoples—all this is the inheritance of settlers in America as much as of their kinsfolk who have stayed in Europe. In the present scientific visit of the Old to the New World, I propose to touch on some prominent questions of anthropology with special reference to their American aspects. Inasmuch as in an introductory address the practice of the Association tends to make arguments unanswerable, it will be desirable for me to suggest rather than dogmatise, leaving the detailed treatment of the topics raised to come in the more specialised papers and discussions which form the current business of the Section.

The term *prehistoric*, invaluable to anthropologists since Prof. Daniel Wilson introduced it more than thirty years ago, stretches back from times just outside the range of written history into the remotest ages where human remains or relics, or other more indirect evidence, justifies the opinion that man existed. Far back in these prehistoric periods, the problem of Quaternary man turns on the presence of his rude stone implements in the drift gravels and in caves, associated with the remains of what may be called for shortness the mammoth-fauna. Not to recapitulate details which have been set down in a hundred books, the point to be insisted on is how, in the experience of those who, like myself, have followed them since the time of Boucher de Perthes, the effect of a quarter of a century's research and criticism has been to give Quaternary man a more and more real position. The clumsy flint pick and its contemporary mammoth-tooth have become stock articles in museums, and every year adds new localities where palæolithic implements are found of the types catalogued years ago by Evans, and in beds agreeing with the sections drawn years ago by Prestwich. It is generally admitted that about the close of the Glacial period savage man killed the huge maned elephants, or fled from the great lions and tigers, on what was then forest-clad valley-bottom, in ages before the later waterflow had cut out the present wide valleys 50 or 100 feet or more lower, leaving the remains of the ancient drift-beds exposed high on what are now the slopes. To fix our ideas on the picture of an actual locality, we may fancy ourselves standing with Mr. Spurrell on the old sandy beach of the Thames near Crayford, 35 feet above where the river now flows two miles away in the valley. Here we are on the very workshop-floor where palæolithic man sat chipping at the blocks of flint which had fallen out of the chalk cliff above his head. There lie the broken remains of his blocks, the flint chips he knocked off, and which can be fitted back into their places, the striking-stones with which the flaking was done; and with these the splintered bones of mammoth and tichorhine rhinoceros, possibly remains of meals. Moreover, as if to point the contrast between the rude palæolithic man who worked these coarse blocks, and apparently never troubled himself to seek for better material, the modern visitor sees within fifty yards of the spot the bottle-shaped pits dug out in later ages by neolithic man through the soil to a depth in the chalk where a layer of good workable flint supplied him with the material for his neat flakes and trimly-chipped arrow-heads. The evidence of caverns such as those of Devonshire and Perigord, with their revelations of early European life and art, has been supplemented by many new explorations, without shaking the conclusion arrived at as to the age known as the reindeer period of the northern half of Europe, when the mammoth and cave-bear and their contemporary mammals had not yet disappeared, but the close of the Glacial period was merging into the times when in England and France savages hunted the reindeer for food as the Arctic tribes of America do still. Human remains of these early periods are still scarce and unsatisfactory for determining race-types. Among the latest finds is part of a skull from the loess, at Podbaba, near Prague, with prominent brow-ridges, though less remarkable in this way than the celebrated Neanderthal skull. It remains the prevailing opinion of anatomists that these very ancient skulls are not apt to show extreme lowness of type, but to be higher in the scale than, for instance, the Tasmanian. The evidence increases as to the wide range of palæolithic man. He extended far into Asia, where his characteristic rude stone implements are plentifully found in the caves of Syria and the foot-hills of Madras. The question which this Section may have especial means of dealing with is whether man likewise inhabited America with the great extinct animals of the Quaternary period, if not even earlier.

Among the statements brought forward as to this subject, a few are mere fictions, while others, though entirely genuine, are surrounded with doubts, making it difficult to use them for anthropological purposes. We shall not discuss the sandalled human giants, whose footprints, 20 inches long, are declared to have been found with the footprints of mammoths, among whom they walked, at Carson, Nevada. There is something picturesque in the idea of a man in a past geological period finding on the Pampas the body of a glyptodon, scooping out its flesh, setting up its carapace on the ground like a monstrous dish-cover, and digging himself a burrow to live in underneath this animal roof; but geologists have not accepted the account. Even in the case of so well-known an explorer as the late Dr. Lund, opinions are still divided as to whether his human skulls from the caves of Brazil are really contemporary with the bones of megatherium and the fossil horse. One of the latest judgments has been favourable: Quatrefages not only looks upon the cave-skulls as of high antiquity, but regards their owners as representing the ancestors of the living Indians. The high and narrow dimensions of the ancient and modern skulls are given in the "Crania Ethnica," and whatever a similarity of proportions between them may prove, it certainly exists. Dr. Koch's celebrated flint arrow-head, recorded to have been found under the leg-bones of a mastodon in Missouri, is still to be seen, and has all the appearance of a modern Indian weapon, which raises doubt of its being really of the mastodon period. This antecedent improbability of remote geological age is felt still more strongly to attach to the stone pestles and mortars, &c., brought forward by Mr. J. D. Whitney, of the California Geological Survey, as found by miners in the gold-bearing gravels. On the one hand, these elaborate articles of stone-work are the very characteristic objects of the Indian graves of the district, and on the other the theory that the auriferous gravels capped by lava-flows are of Tertiary age is absolutely denied by geologists such as M. Jules Marcou in his article on "The Geology of California" (*Bull. Soc. Géol. de France*, 1883). It is to be hoped that the Section may have the opportunity of discussing Dr. C. C. Abbott's implements from Trenton, New Jersey. The turtle-back celts, as they are called from their flat and convex sides, are rudely chipped from pebbles of the hard argillite out of the boulder-bed, but the question is as to the position of the sand and gravel in which they are found in the bluffs high above the present Delaware River. The first opinion come to, that the makers of the implements inhabited America not merely after but during the great Ice Age, has been modified by further examination, especially by the report of Mr. H. Carvill Lewis, who considers the implement-bearing bed not to have been deposited by a river which flowed over the top of the boulder-bed, but that, at a later period than this would involve, the Delaware had cut a channel through the boulder-bed, and that a subsequent glacier-flood threw down sand and gravel in this cutting at a considerable height above the existing river, burying therein the rude stone implements of an Esquimaux race then inhabiting the country. Belt, Wilson, and Putnam have written on this question, which I will not pursue further, except by pointing out that the evidence from the bluffs of the Delaware must not be taken by itself, but in connection with that from the terraces high above the James River, near Richmond, where Mr. C. M. Wallace has likewise reported the finding of rude stone instruments, to which must be added other finds from Guanajuato, Rio Juchipila, and other Mexican localities.

This leads at once into the interesting argument how far any existing people are the descendants and representatives of man of the Post-Glacial period. The problem whether the present Esquimaux are such a remnant of an early race is one which Prof. Boyd Dawkins has long worked at, and will, I trust, bring forward with full detail in this appropriate place. Since he stated this view in his work on "Cave-Hunting," it has continually been cited, whether by way of affirmation or denial, but always with that gain to the subject which arises from a theory based on distinct facts. May I take occasion here to mention as preliminary the question, Were the natives met with by the Scandinavian seafarers of the eleventh century Esquimaux, and whereabouts on the coast were they actually found? It may be to Canadians a curious subject of contemplation how about that time of history Scandinavia stretched out its hands at once to their old and their new home. When the race of bold sea-rovers who ruled Normandy and invaded England turned their prows into the northern and western sea, they passed from Iceland to yet more inclement Greenland, and thence, according to Icelandic records, which are too consistent to be refused belief as to main facts, they sailed some way down the American coast. But where are we to look for the most southerly points which the Sagas mention as reached in Vineland? Where was Keelness, where Thorvald's ship ran aground, and Cross-ness, where he was buried, when he died by the *skräling's* arrow? Rafn, in the "Antiquitates Americanæ," confidently maps out these places about the promontory of Cape Cod, in Massachusetts, and this has been repeated since from book to book. I must plead guilty to having cited Rafn's map before now, but when with reference to the present meeting I consulted our learned editor of Scandinavian records at Oxford, Mr. Gudbrand Vigfusson, and afterwards went through the original passages in the Sagas with Mr. York Powell, I am bound to say that the voyages of the Northmen ought to be reduced to more moderate limits. It appears that they crossed from Greenland to Labrador (Helluland), and thence sailing more or less south and west, in two stretches of two days each they came to a place near where wild grapes grew, whence they called the country Vineland. This would, therefore, seem to have been somewhere about the Gulf of St. Lawrence, and it would be an interesting object for a yachting cruise to try down from the east coast of Labrador a fair four days' sail of a Viking ship, and identify, if possible, the sound between the island and the ness, the river running out of the lake into the sea, the long stretches of sand, and the other local features mentioned in the Sagas. While this is in the printers' hands, I hear that a paper somewhat to this same effect may come before the Geographical Section, but the matter concerns us here as bearing on the southern limit of the Esquimaux. The *skrälings* who came on the sea in skin canoes (*huđhkeipr*), and hurled their spears with slings (*valslöngva*), seem by these very facts to have been probably Esquimaux, and the mention of their being swarthy, with great eyes and broad cheeks, agrees tolerably with this. The statement usually made that the word *skräling* meant "dwarf" would, if correct, have settled the question; but, unfortunately, there is no real warrant for this etymology. If we may take it that Esquimaux 800 years ago, before they had ever found their way to Greenland, were hunting seals on the coast of Newfoundland, and cariboo in the forest, their life need not have been very unlike what it is now in their Arctic home. Some day, perhaps, the St. Lawrence and Newfoundland shores will be searched for relics of Esquimaux life, as has been done with such success in the Aleutian Islands by Mr. W. H. Dall, though on this side of the continent we can hardly expect to find, as he does, traces of long residence, and rise from a still lower condition.

Surveying now the vast series of so-called native, or indigenous, tribes of North and South America, we may admit that the fundamental notion on which American anthropology has to be treated is its relation to Asiatic. This kind of research is, as we know, quite old, but the recent advances of zoology and geology have given it new breadth as well as facility. The theories which account for the wide-lying American tribes, disconnected by language as they are, as all descended from ancestors who came by sea in boats, or across Behring's Straits on the ice, may be felt somewhat to strain the probabilities of migration, and are likely to be remodelled under the information now supplied by geology as to the distribution of animals. It has become a familiar fact that the Equidæ, or horse-like animals, belong even more remarkably to the New than to the Old World. There was plainly land-connection between America and Asia for the horses whose remains are fossil in America to have been genetically connected with the horses re-introduced from Europe. The deer may have passed from the Old World into North America in the Pliocene period; and the opinion is strongly held that the camels came the other way, originating in America and spreading thence into Asia and Africa. The mammoth and the reindeer did not cross over a few thousand years ago by Behring's Straits, for they had been since Pleistocene times spread over the north of what was then one continent. To realise this ancient land-junction of Asia and America, this "Tertiary-bridge," to use Prof. Marsh's expression, it is instructive to look at Mr. Wallace's chart of the present soundings, observing that an elevation of under 200 feet would make Behring's Straits land, while moderately shallow sea extends southward to about the line of the Aleutian Islands, below which comes the plunge into the ocean depths. If, then, we are to consider America as having received its human population by ordinary migration of successive tribes along this highway, the importance is obvious of deciding how old man is in America, and how long the continent remained united with Asia, as well as how these two difficult questions are bound up together in their bearing on anthropology. Leaving them to be settled by more competent judges, I will only point out that the theory of northern migration on dry land is after all only a revival of an old opinion which came naturally to Acosta in the sixteenth century, because Behring's Straits were not yet known of, and was held by Buffon in the eighteenth, because the zoological conditions compelled him to suppose that Behring's Straits had not always been there. Such a theory, whatever the exact shape it may take, seems wanted for the explanation of that most obvious fact of anthropology, the analogy of the indigenes of America with Asiatics, and more especially with East and North Asiatics or Mongoloids. This broad race-generalisation has thrust itself on every observer, and each has an instance to mention. My own particular instance is derived from inspection of a party of Botocudo Indians lately exhibited in London, who in proper clothing could have passed without question as Thibetans or Siamese. Now when ethnologists like Dr. Pickering remark on the South Asiatic appearance of Californian tribes, it is open to them to argue that Japanese sailors of junks wrecked on the coast may have founded families there. But the Botocudos are far south and on the other side of the Andes, rude dwellers in the forests of Brazil, and yet they exhibit in an extreme form the Mongoloid character which makes America to the anthropologist part and parcel of Asia. Looked at in this light, there is something suggestive in our still giving to the natives of America the name of Indians; the idea of Columbus that the Caribs were Asiatics was not so absurd after all.

It is perhaps hardly needful now to protest against stretching the generalisation of American uniformity too far, and taking literally Humboldt's saying that he who has seen one American has seen all. The common character of American tribes, from Hudson's Bay to Tierra del Fuego, though more homogeneous than on any other tract of the world of similar extent, admits of wide subvariation. How to distinguish and measure this subvariation is a problem in which anthropology has only reached unsatisfactory results. The broad distinctions which are plainly seen are also those which are readily defined, such as the shape of the nose, curve of the lips, or the projection of the cheekbones. But all who have compared such American races as Aztecs and Ojibwas must be sensible of extreme difficulty in measuring the proportions of an average facial type. The attempt to give in a single pair of portraits a generalised national type has been tried—for instance, in the St. Petersburg set of models of races at the Exhibition of 1862. But done merely by eye, as they were, they were not so good as well-chosen individual portraits. It would be most desirable that Mr. Francis Galton's method of photographs superposed so as to combine a group of individuals into one generalised portrait, should have a thorough trial on groups of Iroquois, Aztecs, Caribs, and other tribes who are so far homogeneous in feature as to lend themselves to form an abstract portrait. A set of American races thus "Galtonised" (if I may coin the term) would very likely be so distinctive as to be accepted in anthropology. Craniological measurement has been largely applied in America, but unfortunately it was set wrong for years by the same misleading tendency to find a uniformity not really existent. Those who wish to judge Morton's dictum applied to the Scioto Mound skull, "the perfect type of Indian conformation, to which the skulls of all the tribes from Cape Horn to Canada more or less approximate," will find facts to the contrary set forth in Chap. XX. of Wilson's "Prehistoric Man," and in Quatrefages and Hamy, "Crania Ethnica." American crania really differ so much that the hypothesis of successive migrations has been brought in to account for the brachycephalic skulls of the mound-builders as compared with living Indians of the district. Among minor race-divisions, as one of the best established may be mentioned that which in this district brings the Algonquin and Iroquois together into the dolichocephalic division;

yet even here some divide the Algonquins into two groups by their varying breadth of skull. What may be the interpretation of the cranial evidence as bearing on the American problem it would be premature to say; at present all that can be done is to systematise facts. It is undisputed that the Esquimaux in their complexion, hair, and features approximate to the Mongoloid type of North Asia; but when it comes to cranial measurement the Esquimaux, with their narrower skulls, whose proportion of breadth to length is only 75 to 80, are far from conforming to the broad-skulled type of North Asiatic Mongoloids, whose average index is toward 85. Of this divergence I have no explanation to offer; it illustrates the difficulties which have to be met by a young and imperfect science.

To clear the obscurity of race-problems, as viewed from the anatomical standing point, we naturally seek the help of language. Of late years the anthropology of the Old World has had ever-increasing help from comparative philology. In such investigations, when the philologist seeks a connection between the languages of distant regions, he endeavours to establish both a common stock of words and a common grammatical structure. For instance, this most perfect proof of connection has been lately adduced by Mr. R. H. Codrington in support of the view that the Melanesians and Polynesians, much as they differ in skin and hair, speak languages which belong to a common stock. A more adventurous theory is that of Lenormant and Sayce, that the old Chaldean language is connected with the Tatar group; yet even here there is an *a priori* case based at once on analogies of dictionary and grammar. The comparative method becomes much weaker when few or no words can be claimed as similar, and the whole burden of proof has to be borne by similar modes of word-formation and syntax, as, for example, in the researches of Aymonier and Keane tending to trace the Malay group of languages into connection with the Khmer or Cambodian. Within America the philologist uses with success the strong method of combined dictionary and grammar in order to define his great language-groups, such as the Algonquin, extending from Hudson's Bay to Virginia, the Athabascan, from Hudson's Bay to New Mexico, both crossing Canada in their vast range. But attempts to trace analogies between lists of words in Asiatic and American languages, though they may have shown some similarities deserving further inquiry, have hardly proved an amount of correspondence beyond what chance coincidence would be capable of producing. Thus when it comes to judging of affinities between the great American language-families, or of any of them, with the Asiatic, there is only the weaker method of structure to fall back on. Here the Esquimaux analogy seems to be with North Asiatic languages. It would be defined as agglutinative-suffixing, or, to put the definition practically, an Esquimaux word of however portentous length, is treated by looking out in the dictionary the first syllable or two, which will be the root, the rest being a string of modifying suffixes. The Esquimaux thus presents in an exaggerated form the characteristic structure of the vast Ural-Altaic or Turanian group of Asiatic languages. In studying American languages as a whole, the first step is to discard the generalisation of Duponceau as to the American languages from Greenland to Cape Horn being united together, and distinguished from those of other parts of the world by a common character of polysynthetism, or combining whole sentences into words. The real divergences of structure in American language-families are brought clearly into view in the two dissertations of M. Lucien Adam, which are the most valuable papers of the Congrès International des Americanistes. Making special examination of sixteen languages of North and South America, Adam considers these to belong to a number of independent or irreducible families, as they would have been, he says, "had there been primitively several human couples." It may be worth suggesting, however, that the task of the philologer is to exhaust every possibility of discovering connections between languages before falling back on the extreme hypothesis of independent origins. These American language-families have grammatical tendencies in common, which suggest original relationship, and in some of these even correspond with languages of other regions in a way which may indicate connection rather than chance. For instance, the distinction of gender, not by sex as male and female, but by life as animate and inanimate, is familiar in the Algonquin group; in Cree *muskesin* = shoe (mocassin) makes its plural *muskesinǎ*, while *eskwayū* = woman (squaw) makes its plural *eskwaywuk*. Now, this kind of gender is not peculiar to America, but appears in South-East Asia, as for instance in the Kol languages of Bengal. In that Asiatic district also appears the habit of infixing, that is, of modifying roots or words by the insertion of a letter or syllable, somewhat as the Dakota language inserts a pronoun within the verb-root itself, or as that remarkable language, the Chocta, alters its verbs by insertions of a still more violent character. Again, the distinction between the inclusive and exclusive pronoun *we*, according as it means "You and I" or "they and I," &c. (the want of which is perhaps a defect in English), is as familiar to the Maori as to the Ojibwa. Whether the languages of the American tribes be regarded as derived from Asia or as separate developments, their long existence on the American continent seems unquestionable. Had they been the tongues of tribes come within a short time by Behring's Straits, we should have expected them to show clear connection with the tongues of their kindred left behind in Asia, just as the Lapp in Europe, whose ancestors have been separated for thousands of years from the ancestors of the Ostyak or the Turk, still shows in his speech the traces of their remote kinship. The problem how tribes so similar in physical type and culture as the Algonquins, Iroquois, Sioux, and Athabascans, should adjoin one another, yet speaking languages so separate, is only soluble by influences which have had a long period of time to work in.

The comparison of peoples according to their social framework of family and tribe has been assuming more and more importance since it was brought forward by Bachofen, McLennan, and Morgan. One of its broadest distinctions comes into view within the Dominion of Canada. The Esquimaux are patriarchal, the father being head of the family, and descent and inheritance following the male line. But the Indian tribes further south are largely matriarchal, reckoning descent not on the father's but the mother's side. In fact, it was through becoming an adopted Iroquois that Morgan became aware of this system, so foreign to European ideas, and which he supposed at first to be an isolated peculiarity. No less a person than Herodotus had fallen into the same mistake over 2000 years ago, when he thought the Lykians, in taking their names from their mothers, were unlike all other men. It is now, however, an accepted matter of anthropology that in Herodotus's time nations of the civilised world had passed through this matriarchal stage, as appears from the survivals of it retained in the midst of their newer patriarchal institutions. For instance, among the Arabs to this day, strongly patriarchal as their society is in most respects, there survives that most matriarchal idea that one's nearest relative is not one's father but one's maternal uncle; he is bound to his sister's children by a "closer and holier tie" than paternity, as Tacitus says of the same conception among the ancient Germans. Obviously great interest attaches to any accounts of existing tribes which preserve for us the explanation of such social phenomena. Some of the most instructive of these are too new to have yet found their way into our treatises on early institutions; they are accounts lately published by Dutch officials among the non-Islamised clans of Sumatra and Java. G. A. Wilken, "Over de Verwantschap en het Huwelijks en Erfrecht bij de Volken van den Indischen Archipel," summarises the account put on record by Van Hasselt as to the life of the Malays of the Padang Highlands of Mid-Sumatra, who are known to represent an early Malay population. Among these people not only kinship but habitation follows absolutely the female line, so that the numerous dwellers in one great house are all connected by descent from one mother, one generation above another, children, then mothers and maternal uncles and aunts, then grandmothers and maternal great-uncles and great-aunts, &c. There are in each district several *suku* or mother-clans, between persons born in which marriage is forbidden. Here then appear the two well-known rules of female descent and exogamy, but now we come into view of the remarkable state of society that, though marriage exists, it does not form the household. The woman remains in the maternal house she was born in, and the man remains in his; his position is that of an authorised visitor; if he will, he may come over and help her in the rice-field, but he need not; over the children he has no control whatever, and were he to presume to order or chastise them, their natural guardian, the mother's brother (*mamak*), would resent it as an affront. The law of female descent and its connected rules have as yet been mostly studied among the native Americans and Australians, where they have evidently undergone much modification. Thus 150 years ago Father Lafitau mentions that the husband and wife, while in fact moving into one another's hut, or setting up a new one, still kept up the matriarchal idea by the fiction that neither he nor she quitted their own maternal house. But in the Sumatra district just referred to, the matriarchal system may still be seen in actual existence, in a most extreme and probably early form. If, led by such new evidence, we look at the map of the world from this point of view, there discloses itself a remarkable fact of social geography. It is seen that matriarchal exogamous society, that is, society with female descent and prohibition of marriage within the clan, does not crop up here and there, as if it were an isolated invention, but characterises a whole vast region of the world. If the Malay district be taken as a centre, the system of intermarrying mother-clans may be followed westward into Asia, among the Garos and other hill-tribes of India. Eastward from the Indian Archipelago it pervades the Melanesian islands, with remains in Polynesia; it prevails widely in Australia, and stretches north and south in the Americas. This immense district represents an area of lower culture, where matriarchalism has only in places yielded to the patriarchal system, which develops with the idea of property, and which, in the other and more civilised half of the globe, has carried all before it, only showing in isolated spots and by relics of custom the former existence of matriarchal society. Such a geographical view of the matriarchal region makes intelligible facts which while not thus seen together were most puzzling. When years ago Sir George Grey studied the customs of the Australians, it seemed to him a singular coincidence that a man whose maternal family name was Kangaroo might not marry a woman of the same name, just as if he had been a Huron of the Bear or Turtle totem, prohibited accordingly from taking a wife of the same. But when we have the facts more completely before us, Australia and Canada are seen to be only the far ends of a world-district pervaded by these ideas, and the problem becomes such a one as naturalists are quite accustomed to. Though Montreal and Melbourne are far apart, it may be that in prehistoric times they were both connected with Asia by lines of social institution as real as those which in modern times connect them through Europe. Though it is only of late that this problem of ancient society has received the attention it deserves, it is but fair to mention how long ago its scientific study began in the part of the world where we are assembled. Father Lafitau, whose "Mœurs des Sauvages Amériquains" was published in 1724, carefully describes among the Iroquois and Hurons the system of kinship to which Morgan has since given the name of "classificatory," where the mother's sisters are reckoned as mothers, and so on. It is remarkable to find this acute Jesuit missionary already pointing out how the idea of the husband being an intruder in his wife's house bears on the pretence of surreptitiousness in marriage among the Spartans. He even rationally interprets in this way a custom which to us seems fantastic, but which is a most serious observance among rude tribes widely spread over the world. A usual form of this custom is that the husband and his parents-in-law, especially his mother-in-law, consider it shameful to speak to or look at one another, hiding themselves or getting out of the way, at least in pretence, if they meet. The comic absurdity of these scenes, such as Tanner describes among the Assiniboins, disappears if they are to be understood as a legal ceremony, implying that the husband has nothing to do with his wife's family. To this part of the world also belongs a word which has been more effective than any treatise in bringing the matriarchal system of society into notice. This is the term *totem*, introduced by Schoolcraft to describe the mother-clans of the Algonquins, named "Wolf," "Bear," &c. Unluckily the word is wrongly made. Prof. Max Müller has lately called attention to the remark of the Canadian philologist Father Cuoq (N. O. Ancien Missionnaire), that the word is properly *ote*, meaning "family mark," possessive *otem*, and with the personal pronoun *nind otem*, "my family mark," *kit otem*, "thy family mark." It may be seen in Schoolcraft's own sketch of Algonquin grammar how he erroneously made from these a word *totem*, and the question ought perhaps to be gone into in this Section, whether the term had best be kept up or amended, or a new term substituted. It is quite worth while to discuss the name, considering what an important question of anthropology is involved in the institution it expresses. In this region there were found Iroquois, Algonquins, Dakotas, separate in language, and yet whose social life was regulated by the matriarchal totem structure. May it not be inferred from such a state of things that social institutions form a deeper-lying element in man than language or even physical race-type? This is a problem which presents itself for serious discussion when the evidence can be brought more completely together.

It is obvious that in this speculation, as in other problems now presenting themselves in anthropology, the question of the antiquity of man lies at the basis. Of late no great progress has been made toward fixing a scale of calculation of the human period, but the arguments as to time required for alterations in valley-levels, changes of fauna, evolution of races, languages, and culture, seem to converge more conclusively than ever toward a human period short indeed as a fraction of geological time, but long as compared with historical or chronological time. While, however, it is felt that length of time need not debar the anthropologist from hypotheses of development and migration, there is more caution as to assumptions of millions of years where no arithmetical basis exists, and less tendency to treat everything prehistoric as necessarily of extreme antiquity, such as, for instance, the Swiss lake-dwellings and the Central American temples. There are certain problems of American anthropology which are not the less interesting for involving no considerations of high antiquity; indeed they have the advantage of being within the check of history, though not themselves belonging to it.

Humboldt's argument as to traces of Asiatic influence in Mexico is one of these. The four ages in the Aztec picture-writings, ending with catastrophes of the four elements, earth, fire, air, water, compared by him with the same scheme among the Banyans of Surat, is a strong piece of evidence which would become yet stronger if the Hindoo book could be found from which the account is declared to have been taken. Not less cogent is his comparison of the zodiacs or calendar-cycles of Mexico and Central America with those of Eastern Asia, such as that by which the Japanese reckon the Sixty-year cycle by combining the elements seriatim with the twelve animals, Mouse, Bull, Tiger, Hare, &c.; the present year is, I suppose, the second water-ape year, and the time of day is the goat-hour. Humboldt's case may be reinforced by the consideration of the magical employment of these zodiacs in the Old and New World. The description of a Mexican astrologer, sent for to make the arrangements for a marriage by comparing the zodiac animals of the birthdays of bride and bridegroom, might have been written almost exactly of the modern Kalmuks; and in fact it seems connected in origin with similar rules in our own books of astrology. Magic is of great value in thus tracing communication, direct or indirect, between distant nations. The power of lasting and travelling which it possesses may be instanced by the rock-pictures from the sacred Roches Percées of Manitoba, sketched by Dr. Dawson, and published in his father's volume on "Fossil Man," with the proper caution that the pictures, or some of them, may be modern. Besides the rude pictures of deer and Indians and their huts, one sees with surprise a pentagram more neatly drawn than that defective one which let Mephistopheles pass Faust's threshold, though it kept the demon in when he had got there. Whether the Indians of Manitoba learnt the magic figure from the white man, or whether the white man did it himself in jest, it proves a line of intercourse stretching back 2500 years to the time when it was first drawn as a geometrical diagram of the school of Pythagoras. To return to Humboldt's argument, if there was communication from Asia to Mexico before the Spanish Conquest, it ought to have brought other things, and no things travel more easily than games. I noticed some years ago that the Aztecs are described by the old Spanish writers as playing a game called *patolli*, where they moved stones on the squares of a cross-shaped mat, according to the throws of beans marked on one side. The description minutely corresponds with the Hindoo game of *pachisi*, played in like manner with cowries instead of beans; this game, which is an early variety of backgammon, is well known in Asia, whence it seems to have found its way into America. From Mexico it passed into Sonora and Zacatecas, much broken down, but retaining its name, and it may be traced still further into the game of plum-stones among the Iroquois and other tribes. Now, if the probability be granted that these various American notions came from Asia, their importation would not have to do with any remotely ancient connection between the two continents. The Hindoo element-catastrophes, the East Asiatic zodiac-calendars, the game of backgammon, seem none of them extremely old, and it may not be a thousand years since they reached America. These are cases in which we may reasonably suppose communication by seafarers, perhaps even in some of those junks which are brought across so often by the ocean-current and wrecked on the Californian coast. In connection with ideas borrowed from Asia there arises the question, How did the Mexicans and

Peruvians become possessed of bronze? Seeing how imperfectly it had established itself, not even dispossessing the stone implements, I have long believed it to be an Asiatic importation of no great antiquity, and it is with great satisfaction that I find such an authority on prehistoric archæology as Prof. Worsaae comparing the bronze implements in China and Japan with those of Mexico and Peru, and declaring emphatically his opinion that bronze was a modern novelty introduced into America. While these items of Asiatic culture in America are so localised as to agree best with the hypothesis of communication far south across the Pacific, there are others which agree best with the routes far north. A remarkable piece of evidence pointed out by General Pitt-Rivers is the geographical distribution of the Tatar or composite bow, which in construction is unlike the long-bow, being made of several pieces spliced together, and which is bent backwards to string it. This distinctly Asiatic form may be followed across the region of Behring's Straits into America among the Esquimaux and northern Indians, so that it can hardly be doubted that its coming into America was by a northern line of migration. This important movement in culture may have taken place in remotely ancient times.

A brief account may now be given of the present state of information as to movements of civilisation within the double continent of America. Conspicuous among these is what may be called the northward drift of civilisation which comes well into view in the evidence of botanists as to cultivated plants. Maize, though allied to, and probably genetically connected with, an Old World graminaceous family, is distinctly American, and is believed by De Candolle to have been brought into cultivation in Peru, whence it was carried from tribe to tribe up into the north. To see how closely the two continents are connected in civilisation, one need only look at the distribution on both of maize, tobacco, and cacao. It is admitted as probable that from the Mexican and Central American region agriculture travelled northward, and became established among the native tribes. This direction may be clearly traced in a sketch of their agriculture, such as is given in Mr. Lucien Carr's paper on the "Mounds of the Mississippi Valley." The same staple cultivation passed on from place to place, maize, haricots, pumpkins, for food, and tobacco for luxury. Agriculture among the Indians of the great lakes is plainly seen to have been an imported craft by the way in which it had spread to some tribes but not to others. The distribution of the potter's art is similarly partial, some tribes making good earthen vessels, while others still boiled meat in its own skin with hot stones, so that it may well be supposed that the arts of growing corn and making the earthen pot to boil the hominy came together from the more civilised nations of the south. With this northward drift of civilisation other facts harmonise. The researches of Buschmann, published by the Berlin Academy, show how Aztec words have become embedded in the languages of Sonora, New Mexico, and up the western side of the continent, which could not have spread there without Mexican intercourse extending far north-west. This indeed has left many traces still discernible in the industrial and decorative arts of the Pueblo Indians. Along the courses of this northward drift of culture remain two remarkable series of structures probably connected with it. The Casas Grandes, the fortified communal barracks (if I may so call them) which provided house-room for hundreds of families, excited the astonishment of the early Spanish explorers, but are only beginning to be thoroughly described now that such districts as the Taos Valley have come within reach by the railroads across to the Pacific. The accounts of these village-forts and their inhabitants, drawn up by Major J. W. Powell, of the Bureau of Ethnology, and Mr. Putnam of the Peabody Museum, disclose the old communistic society surviving in modern times, in instructive comment on the philosophers who are seeking to return to it. It would be premature in the present state of information to decide whether Mr. J. L. Morgan, in his work on the "Houses and House-life of the American Aborigines," has realised the conditions of the problem. It is plausible to suppose with him a connection between the communal dwellings of the American Indians, such as the Iroquois long-house with its many family hearths, with the more solid buildings inhabited on a similar social principle by tribes such as the Zuñis of New Mexico. Morgan was so much a man of genius, that his speculations, even when at variance with the general view of the facts, are always suggestive. This is the case with his attempt to account for the organisation of the Aztec State as a highly-developed Indian tribal community, and even to explain the many-roomed stone palaces, as they are called, of Central America, as being huge communal dwellings like those of the Pueblo Indians. I will not go further into the subject here, hoping that it may be debated in the Section by those far better acquainted with the evidence. I need not, for the same reason, do much more than mention the mound-builders, nor enter largely on the literature which has grown up about them since the publication of the works of Squier and Davis. Now that the idea of their being a separate race of high antiquity has died out, and their earthworks with the implements and ornaments found among them are brought into comparison with those of other tribes of the country, they have settled into representatives of one of the most notable stages of the northward drift of culture among the indigenes of America.

Concluding this long survey, we come to the practical question how the stimulus of the present meeting may be used to promote anthropology in Canada. It is not as if the work were new here; indeed some of its best evidence has been gathered on this ground from the days of the French missionaries of the seventeenth century. Naturally, in this part of the country, the rudimentary stages of thought then to be found among the Indians have mostly disappeared. For instance, in the native conceptions of souls and spirits the crudest animistic ideas were in full force. Dreams were looked on as real events, and the phantom of a living or a dead man seen in a dream was considered to be that man's personality and life, that is, his soul. Beyond this, by logical extension of the same train of thought, every animal or plant or object, inasmuch as its phantom could be seen away from its material body in dreams or visions, was held to have a soul. No one ever found this primitive conception in more perfect form than Father Lallemant, who describes, in the "Rélations des Jesuites" (1626), how, when the Indians burried kettles and furs with the dead, the bodies of these things remained, but the souls of them went to the dead men who used them. So Father Le Jeune describes the souls, not only of men and animals, but of hatchets and kettles, crossing the water to the Great Village out in the sunset. The genuineness of this idea of object-souls is proved by other independent explorers finding them elsewhere in the world. Two of the accounts most closely tallying with the American come from the Rev. Dr. Mason, in Burmah, and the Rev. J. Williams, in Fiji. That is to say, the most characteristic development of early animism belongs to the same region as the most characteristic development of matriarchal society, extending from South-East Asia into Melanesia and Polynesia, and North and South America. Every one who studies the history of human thought must see the value of such facts as these, and the importance of gathering them up among the rude tribes who preserve them, before they pass into a new stage of culture. All who have read Mr. Hale's studies on the Hiawatha legend and other Indian folk-lore, must admit that the native traditions, with their fragments of real history, and their incidental touches of native religion, ought never to be left to die out unrecorded. In the Dominion, especially in its outlying districts toward the Arctic region and over the Rocky Mountains, there is an enormous mass of anthropological material of high value to be collected, but this collection must be done within the next generation, or there will be little left to collect. The small group of Canadian anthropologists, able and energetic as they are, can manage and control this work, but cannot do it all themselves. What is wanted is a Canadian Anthropological Society with a stronger organisation than yet exists, able to arrange explorations in promising districts, to circulate questions and requirements among the proper people in the proper places, and to lay a new burden on the shoulders of the already hard-worked professional men and other educated settlers through the newly-opened country, by making them investigators of local anthropology. The Canadian Government, which has well deserved the high reputation it holds throughout the world for wisdom and liberality in dealing with the native tribes, may reasonably be asked to support more thorough exploration, and collection and publication of the results, in friendly rivalry with the United States Government, which has in this way fully acknowledged the obligation of making the colonisation of new lands not only promotive of national wealth but serviceable to science. It is not for me to do more here, and now, than to suggest practical steps towards this end. My laying before the Section so diffusive a sketch of the problems of anthropology as they present themselves in the Dominion has been with the underlying intention of calling public notice to the important scientific work now standing ready to Canadian hands; the undertaking of which it is to be hoped will be one outcome of this visit of the British Association to Montreal.

COMETS[1]

FOR several months past I have anxiously considered how I could best discharge the honourable duty which has been intrusted to me this evening. I have to deliver an astronomical discourse, and to do my very utmost to make that discourse adequate to the subject, adequate to this large and cultivated audience, and adequate to the memorable occasion on which the British Association has first crossed the Atlantic Ocean.

I propose to address you this evening on the subject of comets, but it will be readily understood that, of a subject so vast and so elaborate, only a slender proportion can be comprised within a single lecture. The first question to be decided was how to select from the vast mass of materials those which would be most suitable for our discussion this evening. To describe the natural history of comets with any approach to completeness would be a very tedious, indeed almost an endless, task. We must rather select those episodes in the history which have especially added to our knowledge, and enabled us to obtain a rational view of the whole subject. Does not Longfellow tell us how impossible it would have been for him to portray the fortunes of Evangeline throughout every detail? He has only disclosed to us the picturesque and eventful phases of that history. May I be permitted to say that I desire to treat my subject in a similar manner, and while concentrating my attention on the really important matters I shall yet follow the wanderers' footsteps, "not through each devious path, each changeful year of existence."

In pursuance of this scheme I shall at a single blow lop off all the earlier parts of the history. The great primitive discoveries of the character of comets and of their movements must be entirely omitted. The splendid researches of Sir Isaac Newton, and the classical achievement of Halley, are among this class. They are no doubt familiar to every cultivated mind, for they belong to that wondrous alliance between mathematics and astronomy which imparts a thrill of pleasure to the generous intellect. They are not for our discussion to-night.

I shall only address you upon the more recent acquisitions to our knowledge of comets, and in order to give definiteness to our programme, I shall select a certain epoch not yet twenty years old, which is to bound our retrospect into time past. There is a special appropriateness in the choice of the year 1866 as a starting point for the modern history of comets. A very memorable occurrence in that year attracted universal attention, and threw much and quite unexpected light on the nature of comets. The review of the subject given in this lecture will extend from the year 1866 to the present time. But even in this restricted interval it will not be practicable for me to give anything like an exhaustive account of the different researches that have been made. Every astronomical journal teems with observations of comets. Every year brings us one, or two, or three, or more comets; organised efforts are made to observe these comets to the utmost, and each season has its own harvest of discoveries. Amid this host of claimants for our attention we must wend our way this evening, glancing at some discoveries, according to others such notice as their importance may merit, but reserving special attention for the three monumental achievements in the modern history of comets. These are, firstly, the determination of the connection between comets and shooting stars; secondly, the spectroscopic researches on comets; and thirdly, the investigations of the tails of comets. The first of these subjects must be for ever associated with the name of Professor Schiaparelli, the second with the name of Dr. Huggins, the third with the name of Professor Bredichin.

It was long ago remarked by Kepler, in language of splendid exaggeration, that there were as many comets in the heavens as there were fishes in the ocean. There are comets large and comets small, comets with one tail, comets with two tails, and comets without any tail at all. Comets appear at uncertain and irregular intervals, they are not confined to any special part of the heavens. A comet may be first discovered in one constellation, and after a journey across the heavens it may sink to invisibility in any other constellation. A comet is sometimes only seen for days or for weeks, but sometimes it remains visible for months or even for years. The features of the comet itself are also in a course of incessant transformation during its visit. Its size and its shape are not constant. The interval of a few days, or sometimes of even a few hours, suffices to work wondrous changes in a body almost spiritual in its texture.

Amid all these elements of confusion where are we to seek for the law and the order which really underlie the phenomena? There is law and there is order. Each one of the myriad comets pursues a definite high-road through space. It is in the province of the mathematician and the astronomer to ascertain by their joint labours what the path is for each comet. The astronomer directs his telescope to the comet, and he reads from the graduated circles attached to his telescope the precise point in the heavens where the comet is located. He repeats this observation a few nights later, he does it a third time, and his work is done. All the mathematician absolutely requires is to know the place of the comet accurately on three nights. He will no doubt be glad to accept further observations; they will help to eliminate the errors inseparable from such labours; they will enable him to obtain three places of the comet purged from all sources of uncertainty. The comet is then within his toils. He can determine the route which the comet is pursuing. He can by his calculations follow the comet in its movements through the profundity of space far beyond the penetration of the telescope. The telescope only watches the comet during a brief portion of its career, but the subtle eye of the mathematician seldom loses sight of a comet once detected. He watches it recede to its greatest distance; he knows when the comet begins to return; he sees how it gradually approaches the sun. He assigns the spot on the heavens where the comet is first to appear, and he tells the day and sometimes even the hour when the telescope will welcome the wanderer's return.

It has long been known that the highway of each comet is one of those graceful curves known to geometers as conic sections. The comets which appear only once sweep through our system in a curve which cannot be distinguished from a perfect parabola. The small but exceedingly interesting class of comets which return periodically revolve in the most beautiful of all curves—the ellipse. The supreme law of gravitation has ordained that the comets must follow a conic section whereof the sun lies at one of the foci. But subject to this imperative restriction the orbit of a comet may have every degree of variety. A comet may revolve in a path so small that it only requires three years to complete a revolution. Another comet moving in a much longer ellipse will require seventy-five years. There may be every intermediate gradation, and there are some cometary orbits so vast that the mighty journey cannot be accomplished in less than thousands of years, while there are others whose orbits stretch out to a distance so stupendous that we fail to follow them in their wanderings. The ellipses seem to be utterly interminable, and in the language of mathematics we say that the orbit is parabolic.

In order to enunciate the first of the great modern discoveries which we are to consider to-night, it is necessary to associate with each comet a certain particular elliptic path lying in a particular plane with a particular position in that plane, and with a particular magnitude. The comet is, in fact, to be identified by its path as its only permanent characteristic, for, though the comets may exist in myriads, yet no two comets follow the same course through space: such a contingency is too remote to be worthy of serious contemplation; it is, in fact, infinitely improbable.

There is not, I believe, a greater surprise in the whole of modern astronomy than the discovery of a myriad of small bodies stealthily accompanying a comet in its mighty journey, and the surprise is all the greater when we consider that in another aspect we have been long familiar with these small bodies, and we have called them shooting stars or luminous meteors. It was Schiaparelli who first demonstrated, in 1866, the wholly unlooked-for connection between the showers of shooting stars and the movements of comets.

Every one is familiar with the very beautiful spectacle of a shooting star, which is seen to flash into the air and vanish in a streak of splendour. These little bodies were long an enigma in astronomy, but they have gradually been subordinated to law and order. It has been found that the sun which controls the mighty Jupiter does not disdain to guide with equal care the tiny shooting stars, and their movements are now tolerably well known. The received doctrine about the shooting stars has stood the severest test known to science—that is, the test of fulfilled prediction. The first great prediction in this refined branch of astronomy was made about twenty years ago. It was foretold that a splendid shower of shooting stars would occur on the night of November 12th, 1866. All the world knows how triumphantly this prediction was fulfilled.

If I may be permitted, I would wish to narrate in a few words my own experience of that ever-memorable night. The details of that majestic spectacle have been engraved on my memory.

[1] Lecture by Prof. R. S. Ball, Astronomer-Royal for Ireland, at the Montreal meeting of the British Association.

I have had the good fortune to see other striking astronomical phenomena. The first was the glorious comet of 1858, the last was the transit of Venus in 1882; but I have no hesitation in saying that no phenomenon I have ever seen in the heavens, and no spectacle that I have ever witnessed on the earth, has impressed me so deeply and so profoundly as the great shower of shooting stars in 1866.

I was at that time astronomer to the late Earl of Rosse, at Parsonstown, and in the autumn of the year I attended my first meeting of the British Association at Nottingham. From the lips of my esteemed friend, Mr. James Glaisher, I learned that a great shooting star shower was to be anticipated on the 12th of November. The prediction could not be put forward with all the confidence that we have when the almanac foretells an eclipse. It was rather a venture, by which an important theory was to be put to a severe test.

On the ever-memorable night I was occupied as usual in observing nebulæ with the present Earl of Rosse at the great reflecting telescope. In the early part of the evening the sky was clear, and the night was dark; but no unusual phenomenon occurred until about ten o'clock. I was at that moment watching a nebula at the eye-piece, when I was startled by an exclamation from the assistant by my side. I looked up just in time to see a superb shooting star stream across the heavens. Soon came another star, and then another, and then in twos and in threes. We saw at once that the prediction was about to be verified. We ceased the observations with the telescope and ascended to the top of the wall, which forms one of the supports of the great telescope. This position commanded an extensive view of the heavens, and from it Lord Rosse and myself, on a beautiful starlight night, witnessed that gorgeous display of celestial fireworks which has given fresh impetus to astronomy.

It was not merely the incredible number of the shooting stars that was remarkable. They came no doubt in thousands which no man could number, but what was especially to be noticed was the intrinsic brilliancy of each individual star. There were innumerable meteors that night any one of which would have elicited a note of admiration on any ordinary occasion. As the night wore on and the constellation of Leo climbed up from the east, then the display exhibited a very interesting and characteristic feature, for, as each shooting star was projected across the sky, the track which it followed was invariably directed from the constellation of Leo, nay, even from a particular point in that constellation. So marked a property of the shower suggests an appropriate name, and accordingly this particular group of shooting stars bears the not unpleasing name of the "Leonids."

It is easy to demonstrate that the apparent radiation of the meteors from a point is only the effect of perspective. They are really moving in parallel lines. Those parallel lines have a vanishing point, and that point is the radiant in the constellation of Leo. As we stood on the walls of the great telescope we saw the true character of the radiant most beautifully demonstrated. Those meteors which appeared close to the radiant pursued a track which was greatly foreshortened. A few that were actually at the radiant, or very close to it, had no visible track at all, they merely shone like a very rapidly variable star, which rose from invisibility to brilliancy, and then again declined to evanescence, all within the space of a very few seconds. In these exceptional cases we viewed the track of the stars "end on." They were, in fact, coming straight at us, but fortunately there was a kindly screen which shielded the earth that night from the awful meteoric tempest. Each one of those meteors hurries along with a velocity truly appalling; it is more than a hundred times swifter than the swiftest bullet that was ever fired from a rifle. It is really the demoniacal impetuosity of this velocity which is the source of the earth's safety. The meteor moving freely through space suddenly plunges into our atmosphere. Instantly a gigantic resisting force is aroused. The velocity of the meteor is checked, and the energy stored in that velocity is transformed into heat. That heat is enough to raise the body red hot, to raise it white hot, nay, even to drive the solid mass into a streak of harmless vapour. Of all the countless myriads of shooting stars which went to their destruction on that night, not one single particle has ever been recovered. These facts, when placed in the crucible of the mathematician, conduct him to a solution of the problem as to the nature of the great shooting star shower. It is to be remembered that the law of gravitation determines the movements of these bodies. The meteor, ere its disastrous collision with our atmosphere, must have been traversing the solitudes of space in an elliptic path with the sun in one of the foci. This is as true of a meteor the size of a grain of sand as it is of the earth or the planet Jupiter. The astronomer then approaches the question with the knowledge that the orbit of the meteors is an ellipse (or at all events one of the conic sections), but what the particular ellipse is must be decided by an appeal to the actual observations. The facts are simple enough: we note in the first place that the shower took place on the 12th of November, but on the 12th of November in each year, or on any other fixed date, the earth is always at a particular point of its annual journey round the sun. The stream of meteors must therefore pass through that particular point of space, and hence the search for the orbit is narrowed, for only ellipses which pass through this particular point can fulfil the conditions of the question. Another clue is afforded by the position of that point in Leo from which all the meteors seemed to radiate. The mathematician sees how to fit the ellipse so that it shall give the proper radiant. And now the question has been narrowed almost to the last point. One more appeal to observation and the ellipse will be absolutely known. All we must now learn is how long the swarm of meteors takes to complete the circuit of its mighty path. To answer this question profound historical research has been made by Prof. Newton, and a mathematical research has been made which has given additional lustre even to the name of Adams. The great showers of meteors have been shown to have occurred at intervals for the last 1,000 years. The earliest record was in the year 902, on the occasion of the death of the Moorish king Ibrahim-bin-Ahmad. An old chronicler describes how the event was solemnised in the heavens no less than on the earth; he tells us how "that night there were seen as it were lances, an infinite number of stars which scattered themselves like rain to right and left, and that year was called the year of the stars." We now know that this exhibition was not, as the old chronicler thought, a miraculous compliment to the memory of the deceased prince, it was really only a shower of the Leonids, such a shower as appears every thirty-three years, such a shower as appeared in 1866, such a shower as may be anticipated in the year 1899.

By these researches the path followed by the Leonids has been completely determined. The plane of the ellipse, and every circumstance of its position, and its proportions have been reduced to numerical accuracy. The shoal of meteors pursue their path unseen by any astronomer, but the mathematician knows precisely where they are at this moment, and at every moment.

This point being gained a great discovery was made by Schiaparelli in 1866. About that time a comet was seen, this comet was duly observed, and the path which it followed was computed. There was nothing very remarkable about the comet, and it would not now be much remembered save for one most extraordinary circumstance which Schiaparelli was the first to proclaim. Like the shoal of meteors this comet also revolves in an elliptic path around the sun. This is a mere consequence of the law of gravitation and calls for no remark, but the fact that the two ellipses lie in the same plane is a very remarkable coincidence which could not be overlooked. When we further come to see that the two ellipses are of the same size and shape, when we see that they are placed in the same position, when we see, in fact, that the ellipse which is the orbit of the shooting stars is identical with the orbit of the comet, then we have obtained a result which ranks as one of the most striking astronomical discoveries that this century has witnessed.

The Leonids therefore travel through space precisely in the track of the comet of 1866. The question at once arises of the relation of the shoal of meteors to the comet. Is the shoal of meteors one thing and the comet another thing, and do both these things happen to be travelling in the same orbit without any necessary connection, or are we to suppose that the two objects, if not actually identical, are at all events very intimately connected? These are problems which, in the present state of our knowledge, it seems difficult to solve. I shall only lay down one or two principles which may help us to form a conclusion.

Whatever be the nature of comets, or the materials of which they are composed; whether they be faint or bright, large or small, periodic or parabolic; one fact is certain, their masses are all extremely small in comparison with their great dimensions. I shall indeed, at a later part of this lecture, show that comets seem to be almost imponderable when compared with the great masses of the sun and of the planets. The great bulk of a comet necessarily implies that many parts of it are at a considerable distance from its centre of mass. Hence for a double reason the coherence of the parts of a comet arising from their mutual gravitation is an extremely feeble force. Each particle of the comet is directly solicited by the sun to pursue a path of its own, and if the forces of coherence be not adequate to overcome this tendency the comet must undergo a gradual degradation into separate parts. As the periodic time of the orbit of each part will vary, it will follow that the comet will be spread out in fragments along its path. It would seem that these small fragments constitute the meteors.

It is often supposed that meteorites, or solid bodies which actually tumble down on the earth, are connected with shooting stars, and hence it has been asserted, and even by very good authority, that meteorites are connected with comets, if not actually parts of comets. I merely mention this view for the purpose of saying that to me it seems quite unsupported by the facts. There is no reliable evidence, or indeed no evidence at all, that meteorites are connected with the periodic showers of shooting stars which alone are connected with the comets. This would not be the occasion to discuss the interesting question as to the origin of meteorites, but all the available facts seem to me to point to an origin on some body far more closely resembling a planet than a comet.

It is now about sixteen years since Dr. Huggins first turned his spectroscope upon these bodies, and showed that certain lines in the spectra of the comet of 1868 were identical with certain of the lines of carbon. Since then many comets have been observed and much valuable spectroscopic work has been done. This has been so often and so fully discussed that I do not now propose to dwell on the subject at length. It is, however, quite impossible to avoid a brief reference to one of the latest efforts of Dr. Huggins' marvellous skill. He has succeeded in inducing a comet to depict with absolute fidelity its spectrum on the photographic plate. That photograph has not only shown the lines which could be *seen* with the spectroscope, but it has also exhibited many other lines in the invisible part of the spectrum. The discussion of this photograph and of the bright lines and the dark lines it contains is full of interest, though here I shall only remark that it contains convincing evidence of the presence of carbon in this comet.

That a comet's tail should be directed away from the sun is a very remarkable and characteristic feature of this group of bodies. At the first glance it seems at variance with every received doctrine of astronomy. The great law of Nature which regulates the movements of the heavenly bodies is the law of attraction. The very movement of a comet in an elliptic path around the sun is in itself a demonstration that the comet is attracted by the sun.

While the comet as a whole is amenable to the law of gravitation, it is obvious that the materials, whatever they may be, which constitute the tail of the comet must be repelled by some force of an exceptional character. This force must sometimes be of very great intensity. Cases are not wanting where a comet, after darting in close to the sun, has actually whirled round the sun with the stupendous velocity of 300 miles a second, and in a few hours has commenced its outward journey. During this appalling swoop what has been the conduct of the tail of the comet? It seems necessary to believe that at the commencement the tail was streaming away for millions of miles on one side of the sun, while in a few hours the tail has gone completely round, so as to be extending for millions of miles in the opposite direction. No known laws of mechanics allow us to believe that the *same* tail is seen under circumstances so diverse. We are compelled to believe that the tail is constantly dissipated and constantly renewed. It would, in fact, seem that the tail of a comet was in some respects like the column of smoke ascending from a chimney—the column remains, but the particles of which that column consists are in perpetual transition.

In the study of this subject we have to make use of the interesting labours of Prof. Bredichin of Moscow. This accomplished astronomer has devoted himself for many years to the collection and to the discussion of all the known phenomena of comets' tails, and he has succeeded, I believe, in taking a considerable step in the solution of the problems involved. In the first place he has shown that there are different types of comets, and he has proceeded to classify them. There are, first of all, the comets with very long and very straight tails, such, for instance, as the comet of 1874, and many others. The next class included the tails of a scimitar shape. These are often of very great splendour, though not so long or so straight as those of the first type. The great comet of 1858 may be cited as an illustration of this class. The third and last class of comets' tails are very short and curved. It is to be observed that these tails sometimes exist in combination, so that a comet is often decorated with two tails of different types.

Once the form of the tail has been laid down, and the perihelion distance of the comet given, then the investigation of the forces adequate to the production of that tail is a problem admitting of numerical solution. It can be demonstrated that the straightest tail that ever streamed from a comet could be produced by a repulsive force not more than twelve times as great as the intensity of gravitation at the same distance. This number twelve will be the characteristic of tails of the first type. The tails of the second type vary within certain limits, but speaking generally, the repulsive force adequate to their production need not be more than about equal to the force of gravitation itself. The tails of the third type would be explained if the repulsive force were only the fifth part of gravity.

The next question that arises is as to the physical explanation of the repulsive force which produces these tails. We have to find this force of three different intensities, one about twelve times as great as gravity, one about equal to gravity, and one about a fifth of gravity. Before we postulate the existence of a new force of some unknown character, it is surely our duty to inquire whether there may not be some force already known which is competent to produce the phenomena. The best known repulsive force is of course that with which every one is familiar in connection with electricity. Electricity attracts electricity of an opposite type, while it repels that of the same type. We are also aware that in some mysterious manner the sun is connected with electricity. We know that the phenomena of terrestrial magnetism are connected with solar phenomena, and hence we are tempted to inquire whether the electricity of the sun may not offer an adequate explanation of the phenomenon of the comet's tail.

Let us suppose that the sun is attracting a distant body by virtue of gravitation, and at the same time repelling that body in virtue of the fact that the sun and the body are both charged with electricity of the same name. When the attracted body is one of large dimensions, the attraction will vastly exceed the repulsion, and indeed the latter may be entirely neglected in most cases. There is, however, a radical difference between the nature of the electrical forces and the nature of the gravitational forces. The latter are proportional to the masses of the attracting bodies, while the electrical forces are proportional to their surfaces. The mass varies as the cube of the linear measurements, while the surface only varies as the square. The relative efficiency of the electric repulsion in comparison with the gravitational attraction increases as the radius of the particle decreases. It must thus necessarily follow that no matter how great may be the preponderance of the power of gravitation on masses of finite dimensions, yet it must always be possible, other things being equal, to have a particle so small that the electrical repulsion shall exceed in any required ratio the intensity of the attraction of gravitation.

As the comet draws near the sun, the heat it experiences increases, so that the materials of the comet begin to dilate, and to be driven off into a vaporous condition. The matter is thus resolved into a state of extreme subdivision. These separate particles are charged with an electricity similar to that of the sun, and in virtue of their minuteness the intensity of that repulsion has become sufficient to sweep off the particles in a stream, and thus generate the tail.

Such is the modern view of the formation of comets' tails. Professor Bredichin has given good reasons for thinking that we can even discover the special ingredients which enter into the formation of each of the three types of tail. It seems, from the molecular nature of hydrogen, that this element is especially suitable for the tails of the first type. The tails of the second type seem to arise from some substances possessing the properties of hydrocarbons, while the tails of the third type contain some elements which seem to have a high atomic weight. The theory of Professor Bredichin is well illustrated by the comet of 1858. This comet, besides the majestic curved tail, the object of so much admiration, had a pair of long, faint, slender tails, streaming straight from the head. These two objects were doubtless the edges of a conical tail of the first type, too faint to be visible throughout its entire extent. The great tail was one of the second type.

We have many reasons for believing that the masses of comets are very much less than the masses of the planets. We might indeed almost conclude that the masses of the comets are inappreciable. Let us briefly indicate the grounds for this important conclusion.

The sun and the planets form a system characterised by perfect order and symmetry. We have the sun in the centre. We have all the great planets moving round the sun in the same direction. They all move nearly in circles, and all these circles lie nearly in the same plane. This organisation is a necessary *modus vivendi* among the bodies of our system. Each planet acts and reacts upon all the other planets, but, owing to the circumstances of their movements, their irregularities are but small, and the permanence of the system is insured. Alter that system to any extent, merely reverse for example the direction in which one of the planets is moving, and the whole compromise is destroyed. The actions and reactions, instead of being quickly balanced, will go on accumulating, and the seeds of confusion and ultimate dissolution have been sown. But we have in our system thousands of comets which repudiate all the regulations by which the planetary convention is restrained. Comets come in what direction they please, they move in every plane but the right one, and their orbits are not in the least like circles. The very fact that our earth continues to revolve around the sun so as to be a fit abode for life, is a proof that comets cannot have any considerable mass. If comets had mass then organic disease would be introduced into the solar system which must ultimately prove fatal.

Science has gradually dissipated the fears which once invested comets: they are interesting and beautiful visitors which come to please and to instruct, never to threaten or to destroy.

NOTES

THE autumn Congress of the Sanitary Institute of Great Britain will be held this year at Dublin, and the programme of the proceedings has been issued. The President of the Congress is Sir Robert Rawlinson, C.B., who will open the Congress with an inaugural address on Tuesday the 30th inst., and the proceedings will last until October 4. The Congress is divided into three sections—the first, "Sanitary Science and Preventive Medicine"; the second, "Engineering and Architecture"; and the third, "Chemistry, Meteorology, and Geology." Of the first section, the president is the Registrar-General for Ireland, Mr. Thomas W. Grimshaw, M.A., M.D. In the section of "Engineering and Architecture," the president is the Engineering Inspector of the Local Government Board for Ireland, Mr. C. D. Cotton, C.E.; and the president of the section of "Chemistry, Meteorology, and Geology" is Mr. C. A. Cameron, M.D., the City Analyst and Superintendent Medical Officer of Health for Dublin. The sectional meetings and the general meetings will be held at Trinity College, where the opening address will be delivered on Tuesday evening by Sir Robert Rawlinson. On Wednesday morning the actual work of the Congress will commence with the address of the president of the first section, and the remainder of the day will be taken up with the reading of papers and their discussion, while a *conversazione* will be held in the evening. The business of the second section will be taken on Thursday, October 2, and in the evening a lecture will be delivered to the Congress by Dr. Alfred Carpenter on "Education by Proverb in Sanitary Work." On Friday, after the third section, the closing general meeting of the Congress will be held. Arrangements for excursions will be made for the Saturday.

THE fifth International Congress of Hygiene, which has concluded its session at the Hague, is reported to have been highly successful; it was decided to accept the invitation from Vienna for 1886.

IT is reported that Mr. Melville, chief engineer of the *Jeannette* Expedition, will command a Polar expedition which it is said will start next autumn to attempt to reach the Pole *viâ* Franz Josef Land. It is stated that Mr. Cyrus Field and the New York Yacht Club will each furnish one-half the cost of the expedition.

IN the course of the present month a geographical professorship will be established at each of the Russian universities. In Germany, fourteen out of twenty-one universities have a chair of this sort.

A VERY favourable Report has been issued of the second year of the College Hall of Residence for Women Students. That such an institution was wanted is shown by the fact that last autumn another house had to be added in order to meet the number of applications from students. The Hall is already almost self-supporting, and in another year will probably be entirely so; and it is hoped that this will encourage friends to assist the Committee in paying off the 1000*l*. they had to borrow in order to extend the premises. Subscriptions and donations may be sent to Mrs. Edward H. Busk, 44, Gordon Square, W.C.

THE Geographical Society have received a letter from Mr. H. H. Johnston, who has been sent out to explore and collect plants on Mount Kilimanjaro. It is dated June 18, from "Uvura, in Chagga, altitude 5000 feet." "For nearly a week now," Mr. Johnston says, "I have been settled on Kilimanjaro, camped on one of the loveliest sites in the world. Above me towers into the deep blue heaven the snowy head of Kibó, around me are green hills and forest-clad ravines in whose profound depths great cascades of water leap from rock to rock and splash the fronds of luxuriant ferns; before me lies spread out a vast blue plain—'all the world,' as my host, the chief Mandara, proudly says, and my view southward is only bounded by the distant horizon. Perched as I am up here on the shoulder of a great buttress of the mountain, I seem to be on a level with the uppermost flight of the vultures, who hardly ever soar higher, and who poise themselves and wheel in circles over the awful depths at my feet. When the first cares of my installation are over, I am going to set to work on a picture such as I see before me, and call the view 'à vol de vautour.'"

THE difference between the temperatures of places in America and those of places in similar latitudes in Europe is already well known, but it would hardly be expected to be so great as it actually was in January of this year. That month was a mild one all over Europe, but in the United States, especially in the eastern part, it was extremely cold. Thus, in Nashville and Knoxville, in the same latitude as Malta, the thermometer marked 26°·7 C. and 23°·3 C. of cold, while in Malta it was only 5°·9 below zero. At Indianapolis and Columbus it was 31°·7 C. and 28°·9 C. respectively below zero, while at Madrid, in the same latitude, the maximum was 9° below zero. The average temperature of the month in the States was 3° C. to 5° C. beyond the normal average.

THE experiment of MM. Renard and Krebs in balloon steering at Meudon, of which so much has recently been heard, formed the subject of a paper read before the Academy of Sciences on the 18th ultimo. The solution of the problem of aërial navigation was first attempted in 1855 by M. Giffard, who employed steam, then in 1872 by M. de Lôme, and finally by M. Tissandier, who was the first to apply electricity. The conditions which MM. Renard and Krebs studied to fulfil were steadiness of the path obtained by the shape of the balloon, and the arrangement of the rudder; the diminution of resistance while travelling by the proportion of the dimensions—bringing together the centres of traction and resistance; and finally, to attain a speed capable of resisting the winds prevailing in France during the greater part of the year. The paper then enters into details of the construction, and of the journey, during which the writers claim they were able to manœuvre the balloon as easily and effectively as a ship is put through its evolutions.

WE have recently received from various scientific societies in the United States their late publications. The contents of these are too numerous and too varied to be noticed now in any but the most general way. The New York Academy of Sciences appears to lead them all in the number and importance of the papers read before it, in every conceivable department of science. The Philosophical Society of Washington sends us vol. vi. of its *Bulletin*, containing the President's address (on "The Three Methods of Evolution"), as well as the abstracts of a large number of papers. This Society appears to work in conjunction with the Smithsonian Institution. The last number of the *Bulletin* of the Buffalo Society of Natural Sciences is almost wholly occupied with an elaborate paper on the plants of Buffalo and its vicinity, by Mr. Day, the present instalment being occupied by the Cryptogams. The toilers in the vineyard of science in the United States are evidently numerous and enthusiastic, and they have provided themselves with ample means of giving their results to the world.

THE last numbers of the "Encyklopædie der Naturwissenschaften" (Breslau, Eduard Trewendt) are Part 1, No. 37, and Part 2, Nos. 21 and 22. The first forms the continuation of the "Handwörterbuch der Zoologie, Anthropologie, und Ethnologie," and numbers among its writers Shellwald, Reichenow, Pfeffer, Martens, Jäger, Röckl, and others. Among the articles in the present instalment are the pacing of horses, by Prof. Röckl; the brain, by Mojisisowics; and on the geographical distribution of animals, by Dr. Reichenow. No. 21 of Part 2 continues the section on mineralogy, geology, and palæontology, and contains articles on islands, by Von Lasaulx; the Jura system, the formation of coal in the different geological epochs, and cryptogams, by Dr. Rolle. No. 22 belongs to the chemical section.

DURING the last fifty years several attempts have been made to form oyster banks in the Baltic. The first attempt was made about forty years ago, when a quantity of European oysters were laid down, but it proved a failure, and the oysters soon died. In recent years, however, experiments have been made with the American oyster (*Ostrea virginiana*), which, according to the researches of Prof. Möbius is a different variety of the European. The idea of laying down American oysters in the Little Belt was due to Mr. Meyer, an engineer of Hadersleben, who formed a company for the purpose of carrying it out, to which the Prussian Government granted a concession for forty years to form oyster banks up to lat. 55° N. In the autumn of 1879 Mr. Meyer went to the United States, whence he brought back to Hadersleben a million and a half small and half a million large oysters, which were laid down in ten different places from the Danish frontier to the southern part of the Als Sound. Recent examinations of these spots have shown varying results. In some there are only a few oysters left, and in others considerable quantities. Where seaweed is very plentiful the oysters have died. The best result was found on the south-east coast of Als. During the present summer fresh attempts at oyster-hatching are to be made in these parts, and the German Fishery Association has granted Prof. Möbius a sum of about fifty pounds towards expenses. On the west coast of Norway, too, strenuous efforts have been made in recent years to improve the oyster fisheries there, which were formerly very important. Several companies have been formed for acquiring old banks and restocking them. In some places the results have been very satisfactory.

THE Tung Wen, or Foreign Language College at Pekin, is about to issue a large work on Anatomy by Dr. Dudgeon of that place. It is said to contain prefaces, in the usual Oriental manner, from several of the highest officials at the capital. The work has over 500 cuts made at the Government expense. A large work on Physiology is also ready for the press; while Dr. Dudgeon has ready for the English press a little work on the diet, dress, and dwellings of the Chinese in relation to health.

IT is known that the Boyle-Marriott law is true only within certain limits, and that a gas submitted to great pressures, as well as to very low ones, ceases to obey it; the product received by multiplying its volume by its elasticity ceases to be a constant, and decreases under very low pressures: the elasticity decreases at a higher rate than the density of the gas, and to express the relations between the two, a more complicated formula must be resorted to. Another source of complication is due again to the condensation of the gases on the solid surfaces of the recipients, and if this cause be taken into account, the measured elasticities must be lower than the true ones, and in the rarefied gases the ratio between elasticity and density must increase with the increase of elasticity at a higher rate than would result from Prof. Mendeléeff's observations. Such was the idea that guided M. Kraevitch in a series of experiments he undertook a few years ago, with M. Petersen, in order to eliminate the influence of the condensation. These experiments being not sufficiently accurate, M. Kraevitch has now undertaken a new series of researches based on the rate of sound in different gases. They were carried on in tubes of very different lengths and diameters, and it appears from a preliminary communication, now published in the *Journal* of the Russian Chemical Society (vol. xvi. fasc. 6), that the air, when rarefied, does not obey at all the Boyle-Marriott law. The researches carried on on this principle promise to be, on the whole, very interesting, and may lead to conclusions of some value.

A SHOCK of earthquake occurred at Réunion on August 7 at midnight. The oscillation was from east to west, and was preceded by a loud report, like an explosion. No damage was done.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii* ♀) from South Africa, presented by Major Newson D. Garrick; a Moustache Monkey (*Cercopithecus cephus* ♂) from West Africa, presented by Mr. G. A. Broderick; a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mr. H. Johnson; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by the Rev. Walter Hudson; a Squirrel Monkey (*Chrysothrix sciurea*) from Brazil, presented by Mrs. J. M. A. King; a Himalayan Bear (*Ursus tibetanus*) from North India, presented by Mr. Percy H. Cooper; a Red and Yellow Macaw (*Ara chloroptera*) from South America, presented by Mr. P. J. Prior; a Common Cuckoo (*Cuculus canorus*), British, presented by Mrs. William Smith; a Sharp-nosed Crocodile (*Crocodilus acutus*) from Central America, a Hawk's-billed Turtle (*Chelone imbricata*) from the West Indies, presented by the Rev. W. T. Lax; two Spotted Slow-worms (*Acontias meleagris*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Common Slow-worm (*Anguis fragilis*), British, presented by Mr. H. Scherren; a Ludio Monkey (*Cercopithecus ludio*) from West Africa, a Kit Fox (*Canis velox*) from North America, a Banded Aracari (*Pteroglossus torquatus*) from Central America, an Æthiopian Wart Hog (*Phacochœrus æthiopicus*) from South-East Africa, a Tiger Bittern (*Tigrisoma brasiliensis*) from Brazil, a Common Boa (*Boa constrictor*) from South America, an Indian Eryx (*Eryx johni*) from India, purchased.

OUR ASTRONOMICAL COLUMN

COMET 1884 *b*.—M. Trépied further writes with respect to his observations of the comet discovered by Mr. Barnard:—"I hope you will favourably receive some remarks on the subject of your last article on the Barnard Comet. You say that it would not be prudent to pronounce upon the nature of the orbit on account of the uncertainty which seems to attach to the observations at Algiers. There was in fact an error committed on the first day, in the identification of the star of comparison, but that error was rectified almost immediately, and I am able to state that the verification to which I subsequently submitted that star (B.A.C. 5457) leaves no doubt as to the legitimacy of the identification. But I wish especially to remark that amongst the published orbits is one in which the observations at Algiers have had no part; it is that calculated by Chandler on the observations of July 16, 21, and 28." M. Trépied suggests that the conjecture of Prof. Weiss as to the nature of the orbit rested not only on the differences in the mean place, but on the agreement of his own elements with those of Chandler. We are now aware, however, as was mentioned last week, that the apparent deviation from parabolic motion was caused by error in the position published for the night of discovery, and that M. Trépied's observations (the comparison star having been identified) prove very exact. The doubt we expressed was occasioned by the large corrections given in the circular of the *Astronomische Nachrichten*.

Brorsen's Comet of Short Period.—The following positions of this comet are deduced upon the same assumption with respect to the epoch of perihelion passage as those lately given for the period of absence of moonlight in August:—

12h. G.M.T.	R.A. h. m.	Decl. ° ′	Distance from Earth	Distance from Sun
Sept. 15	10 26·6	+13 37	1·416	0·590
17	10 40·0	13 28	1·436	0·593
19	10 53·3	13 15	1·455	0·598
21	11 6·3	12 58	1·475	0·606
23	11 19·1	12 37	1·496	0·617
25	11 31·7	+12 12	1·518	0·630

An acceleration of four days in the time of arrival at perihelion would cause the following differences in the comet's geocentric position:—

		m.		′
On Sept. 15	In R.A.	+16·9	In Decl.	+31
,, 23	,,	+15·3	,,	+ 1

The intensity of light on September 15 is 1·43, and the comet would rise about 2h. 8m. before the sun. It should be sought for as soon as the moon is off the morning sky.

M. Trépied writes on August 26 that he had commenced a search for the comet according to the places given in Nature. "Malheureusement," he says, "à Algers le temps qui peut être consacré à la recherche est très-court, car le crépuscule arrive presque immédiatement. Néanmoins je n'ai pas encore perdu tout espoir."

The Cape Heliometer.—The Treasury have granted Dr. Gill's application for a heliometer of large size for the Royal Observatory at the Cape of Good Hope, and a contract has been entered into with the Messrs. Repsold of Hamburg. The instrument will be of seven inches aperture, and is to be completed by the end of 1886, at an expense of 2700*l*.

SCIENTIFIC SERIALS

The American Journal of Science, August 1884.—Contributions to meteorology: reduction of barometric observations to sea-level (continued), by Prof. Elias Loomis. The author considers that it is quite useless to seek for a formula exactly representing the barometric reduction to sea-level at all pressures and temperatures, unless the irregular movements in the upper and lower strata of the atmosphere be taken into account. But these movements are greatly modified by the obstruction of the mountains upon which the observations are made, and therefore vary with the locality; hence he concludes that such an attempt seems a hopeless undertaking.—Notes on the rock and ore-deposits in the vicinity of Notre Dame Bay in Newfoundland, by M. E. Wadsworth. The districts examined were chiefly various points between Exploits Burnt Island and Betts Cove, which yielded basalt, diorite, porodite, andesite (?), porphyrite, and argillite, variously impregnated with chalcopyrite, malachite, and copper. But none of the ores were found associated with serpentine, which was nowhere seen except in small quantity at Betts Cove.—On the origin of bitumens, by S. F. Peckham. The author deals with the views of those who regard bitumens (asphalt, naphtha, petroleum, &c.) either as indigenous to the rocks in which they are found, as the product of chemical action, or as a distillate produced by natural causes. He is on the whole inclined to regard these substances as distillations from animal and vegetable organic remains, and argues that if they were the result of a purely chemical process we should not expect to find Palæozoic petroleums of a composition corresponding with the simple animal and vegetable organisms that flourished at that period, and Tertiary petroleums containing nitrogen unstable, and corresponding with the decomposition-products of more highly organised beings; but we should expect to find a general uniformity in the character of the substance wherever found all over the earth. On the other hand, if petroleum is the product of metamorphism, its formation is coexistent only with that of metamorphic action, which does not seem to have prevailed on a large scale during recent geological periods. Hence on this hypothesis its production must be considered as practically ended.—On the measurement of rapidly alternating electric currents with the galvanometer, by L. M. Cheesman.—Note on some specimens of nickel ore from Churchill County, Nevada, by Spencer B. Newberry. The analysis of these samples gave:—

NiO	33·71 per cent.
As_2O_5	36·44 ,,
H_2O	24·77 ,,

From the extraordinary purity and richness of these ores, the author considers it probable that the Nevada mines, which run 6000 feet north-east and south-west to the Carson Desert, will eventually become a chief source of the world's supply of this valuable metal.—On the formation of gorges and waterfalls, by W. Morris Davis. The author considers that, although the Colorado Cañon, the greatest gorge in the world, was formed by rapid downward erosion following the rapid elevation of the plateau, most falls and ravines result from the local displacement of streams by blockades of glacial drift, or by temporary obstruction from the glacial sheet itself.—On the influence of light on the electrical resistances of metals, by Arthur E. Bostwick. From a series of experiments with various metals, the author concludes that, if light causes any diminution in the electrical resistance of metals, it probably does not exceed a few thousandths of one per cent.—Note on the rare mineral vanadinite occurring in the Black Prince Mine, Pinal County, Arizona, by Francis Hayes Blake.—Remarks on the united metatarsal bones of the Ceratosaurus, an already described new Dinosaurian, by Prof. O. C. Marsh. The author points out that all known adult birds, living and extinct, with perhaps the single exception of Archæopteryx, have the tarsal bones firmly united, whereas all the Dinosauria, except Ceratosaurus, have these bones separate. The exception in each case brings the two classes near together at this point, and their close affinity has now been clearly demonstrated.

Bulletin de l'Académie Royale de Belgique, May 1884.—Observations on the shooting-stars made at the Royal Observatory of Brussels on August 9–11, 1883, by L. Niesten.—Description of the effects of a stroke of lightning on the new Palace of Justice, Brussels.—Memoir on the process of segmentation in the Ascidians, and its relations with the organisation of the larvæ (two plates), by Edouard van Beneden and Charles Julin.—Some arithmetical theorems, by E. Catalan.—Researches on the absolute power of the muscles in the invertebrates, second part: absolute power of the flexor muscles of the pinchers in the decapod crustaceans (one plate), by Felix Plateau.—Exact dates of the birth and death of Wenceslas Coebergher, by Auguste Castan.—Essay on freedom of conscience in Athens, by M. A. Wagener.—Theories of Plato and Aristotle on the social question, by Ch. Loomans.—Memoir on the best means of improving the moral, intellectual, and physical state of the working classes, by Joseph Danby.

SOCIETIES AND ACADEMIES

Sydney

Royal Society of New South Wales, July 2.—H. C. Russell, B.A., F.R.A.S., President, in the chair.—Six new members were elected, fifty-four donations received, and the following papers read:—Notes on gold, viz. (1) a remarkable occurrence of nearly pure gold in Queensland, being 99·7 of gold, the rest copper, with a trace of iron, found in quartz and stalactites of brown hæmatite; (2) preparation of pure gold; (3) volatilisation of gold, by A. Leibius, Ph.D., M.A.—Notes on minerals new to New South Wales, by Prof. Liversidge, F.R.S., accompanied by specimens. Remarkable concretions of friable iron pyrites containing septa of quartz, resembling in appearance the well-known "septaria" of the London Clay, large crystals of axinite, idocrase in association with grossularite from Nundle, tourmaline in large prisms resembling the celebrated Bovey Tracey forms, Scheelite, molybdenum ochre, antimonite containing native gold from near Armidale, and allophane, serving as a matrix for native copper, Blayney.—On the oven-mounds of the aborigines in Victoria, by the Rev. Peter MacPherson, M.A. The situations, sizes, and structure (internal and external) of these aboriginal relics were considered, and measurements given. The cooking oven, or smaller portion of the mound, was specially investigated. Besides the more common contents, namely, ashes, charcoal, and stones, human remains were sometimes found. Where no timber existed, a kind of turf and coarse grass were used as fuel. Circles of stones girdling the mound were described. So far as appeared, no very high antiquity was required to account for the mounds.—Mr. W. Neill exhibited some very rich specimens of gold in quartz and mispickel from the new mine Wahaup, East Ballarat.

Paris

Academy of Sciences, August 25.—M. Rolland, President, in the chair.—Remarks on aërial navigation, in connection with the experimental trip made on August 9 by Capts. Renard and Krebs with their new balloon, by M. Dupuy de Lome. The author regards the experiment as so far highly satisfactory, and announces that it will be soon renewed with a screw machine possessing double the motive power of the first, and calculated to travel in any direction with an average speed of fifteen miles an hour. It is further pointed out that the balloon is constructed on the principles expounded in a memoir addressed by the author to the Academy of Sciences and dated February 2, 1872.—Contributions to the study of algebraic equations: (1) general considerations, binomial and trinomial equations, by M. de Jonquières.—On the process of cold-hammering, and the variation in the limit of elasticity in metals and other solid substances, by M. Tresca.—Researches in organic botany; studies on the formation and presence of nitrates in plants; methods of analysis, by MM. Berthelot and G. André. An account is here given of the authors' attempt at a complete analysis of a vegetable organism with a view to determining the chemical equation during its development from the fertilised germ to its fructification and reproduction. Experiments were also made for the purpose of varying the physiological conditions of vegetable growth, and for these various objects ten botanical species, including six varieties of the Amaranthus were subjected to a methodical and comparative study during the season of 1883.—Note on astronomical measurements and especially on the choice of a common meridian, by M. A. d'Abbadie. The author pronounces in favour of the west coast of Flores, one of the Azores, for the chief meridian, or else for its anti-meridian, should the latter be preferred. He also proposes the adoption of a unit of 10,000 kilometres for the measurement of celestial spaces, this unit to be called a *mégiste* (μέγιστον).—A study of the sphincters of the cardiac and other veins, with remarks on their hermetic occlusion during the presystole state, by M. P. Duroziez.—Note on the inequality in the distribution of the solar temperature according to latitude and the activity of the photosphere, by P. Lamey.—Observations of the new planet Palisa 239 made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—Observations of the Barnard comet and of the new planet Palisa 238, by M. Perrotin.—Remarks on the universal hour, and on the formula—

Universal time = local time − (12h. + longitude),

where the longitude is reckoned eastwards from 0h. to 24h., by M. Caspari.—Description of a thermo-regulator of simple construction intended also to serve as a registering thermometer (two illustrations), by M. E. H. von Baumhauer.—Researches on the infra-red spectra of emission of metallic vapours, by M. Henri Becquerel. The paper is accompanied by a table of the wave-lengths of the most intense rays, bands, or groups of rays characterising the spectra of the vapours of potassium, sodium, strontium, calcium, zinc, aluminium, cadmium, lead, silver, tin, and some other metals.—Determination of the indices of refraction by linear measurements, by M. Ch. V. Zenger.—On the quality of the various farinas obtained by different processes of grinding, by M. Aimé Girard.—Note on the poisonous properties of urea, determined by a series of experiments made on frogs, guinea-pigs, rabbits, and pigeons, by MM. Gréhant and Quinquaud. The experiments consisted in subcutaneous injections of aqueous solutions of pure urea, the doses being gradually increased, and invariably terminating in tetanic convulsions and death. The convulsions resembled those produced by strychnine, and were followed by death in the course of from one to ten hours.—Remarks on the action of high pressure on the phenomena of putrefaction and on the vitality of minute organisms in fresh and salt water, by M. A. Certes. The object of M. Certes' studies was to determine the processes and the conditions under which organic matter is reduced to the inorganic state at the bottom of the sea. Experiments were also incidentally made with the bacteria of charbon, which preserved their vitality and virulence under a pressure of 600 atmospheres, maintained for a period of twenty-four hours.—Remarks on the action of lesions of the rachidian bulb on the digestive functions, by MM. Couty, Guimaraes, and Niobey.—Experiments made to determine the loss of nitrogen during the fermentation of farmyard manure, by M. Ch. Brame.—On the dehiscence of the anthers in phanerogamous plants, by M. Leclerc du Sablon.—Report on the present state of the Krakatoa volcano, by MM. Bréon and Korthals. The report embodies an account not only of Krakatoa, but also of all the surrounding districts, which were wasted by the eruption of August 26, 1883. Some successful photographs were taken, including the only exact profiles hitherto obtained of Krakatoa.

Vienna

Imperial Academy of Sciences, June 19.—R. Herth, researches on hemialbumose or propeptone.—R. Scharitzer, on the minerals and rocks of Jan Mayen.—F. Bayer, on the extremities of a young Hætteria.—K. Natterer, on the opposition of hydric chloride to dichlorocrotonaldehyde.—L. Tausch, on some Conchylia from the fauna of Lake Tanganyika (Central Africa), and their allied fossils.

July 3.—E. Marenzeller, on Southern Japanese Annelids; description of species of the genera Ampharetea, Terebellacea, Subellacea, and Serpulacea.—F. Bertolasi, on the applicability of Wittstein's and Kinkelin's formulæ to volumetric calculations.—S. Bernheimer, contribution to a knowledge of the nerve-fibre layer of the human retina.—A. Nalepa, preliminary communication on the anatomy of Tyroglypha.—T. Habermann, on acetonhydroquinone.—T. Zehenter, on the action of phenol and sulphuric acid on hippuric acid.—E. von Oppolzer, determination of the length of the pendulum at the Vienna Observatory.—M. Pernter, contribuions to a knowledge of the winds in the upper strata of the air.

July 10.—T. Lerch, researches on chelidonic acid.—A. Lieben and A. Haitinger, on chelidonic acid.—F. Spitzer and T. Kachler, on camphoronic acid.—H. Molisch, on aërotropism of roots.—E. von Oppolzer, determination of the force of gravity while using two Repsold's pendulums of different weights.

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