THURSDAY, JANUARY 6, 1881

DR. GÜNTHER ON FISHES

An Introduction to the Study of Fishes. By Albert C. L. G. Günther, M.A., M.D., Ph.D, F.R.S., Keeper of the Zoological Department in the British Museum. (Edinburgh: A. and C. Black, 1880.)

A GENERAL work on Fishes could not have been undertaken by a more thoroughly qualified writer than Dr. Günther. Twenty years ago and more he commenced studying the collection of this ever-interesting and most important group in the vaults of the British Museum, with what success let not only the present fine collection of fish in the National Museum declare, but also that truly wonderful work, to be the product of one man's labours, "The Catalogue of Fishes," in eight volumes, published by order of the Trustees of the British Museum. Fishes have always been a subject of great interest to mankind; their commercial value interests some, others, as keen sportsmen, could not exist without their finny prey; from the earliest times, and among the earliest records, we find them of importance as articles of food. To the man of science, be he or be he not a specialist, fishes are of an ever-increasing interest, placed at the very beginning of vertebrate life, and by their study we seem to see more clearly into the evolution of that life which culminated in the production of ourselves.

A book to tell us in carefully selected generalities all about fishes: such the English reader had no access to, until the publication of this volume. If it come not up to a perfect standard how could it be otherwise, for had not the history of the structure of fish, their habits, their distribution, their classification to be condensed within the limit of a few hundred pages, and the wonder is that so much will be found here given, not that a few things have been left unnoticed or but partially touched upon. We have looked over each page of the handsomely got-up, well-printed, and well-illustrated volume, and we feel certain that it must find a place on the shelf of all biologists, and that it will find a place in the libraries also of that vastly larger class, the intelligent general reader.

The first and slightly smaller half of the volume treats of fishes in general; the second half of fishes from a systematic and descriptive point of view. The work opens with an account of the history and literature of the subject beginning with Aristotle; who had a perfect knowledge of the general structure of fish, and who wrote about them some three and a half centuries before the Christian era; which account is continued to the most recent times; the work done by Ray, Artedi, Linneus, Bloch, Lacépède, Cuvier, Agassiz, Müller, being passed in review. The next twelve chapters treat of the external morphology of fish and of their internal structure. We would have liked more details about the recent researches into the modifications to be met with in fishes' tails; the description of the electrical organs to be met with in some fish is far too brief; the myology of fishes is dismissed with a little over a page, as if it were not a favourite subject with the author, and yet it is one worth working at and by no means deficient in promise. In the chapter on Respiration the subject of the temperature in fishes is scarcely alluded to; the chapter on the Reproductive Instincts of Fish is sure to interest the readers, some of whom may learn for the first time of female fishes taking care of their progeny, and more curious, of male fishes doing the same. The chapter on the Growth and Variation of Fishes is well illustrated by woodcuts of some remarkable changes of form in fish. The fourteenth chapter treats of domesticated and acclimatised fishes, on the artificial impregnation of ova, tenacity of life and reproduction of lost parts, hybernation in fishes (a misuse of this term), useful and poisonous fishes. The uses of fishes to man our author disposes of in twelve lines, and it would almost seem as if he would rather not have referred to such a subject at all in the scientific part of this treatise. In these twelve lines we find the following:—"In the Polar regions *especially* whole tribes are *entirely* dependent on this class for subsistence." Without venturing on criticism we would ask, Is this so? Do the inhabitants of the Polar regions support their life wholly on fish, or are they not indebted for a large portion of their heat-producing food to the flesh or blubber of mammals? and do not the inhabitants of tropical countries, on the contrary, manage often to support their existence almost entirely on fish food?

While the chapters concerning the distribution of fishes in time leave a good deal to be desired, those on the distribution of fishes in space are most excellent; that on the fishes of the deep sea contains a complete list of deep-sea forms with the depths as ascertained by the dredgings of the *Challenger*, which list contains apparently over 100 species. Before the voyage of the *Challenger* scarcely thirty deep-sea fishes were known. Though this number has been now so very much increased yet no new types of families have been discovered. Perfectly novel and very interesting modifications of certain organs have been met with, but nothing more than what might have been expected from our previous knowledge of the group. The greatest depth reached hitherto by a dredge in which fishes were inclosed is 2900 fathoms; but the specimens then obtained belong to a species (*Gonostoma microdon*), which would seem to be extremely abundant in the upper strata of the Atlantic and Pacific Oceans, and were very probably caught by the dredge in its ascent. The next greatest depth, 2750 fathoms, must be accepted as one at which fishes undoubtedly do live. The fish obtained at this depth in the Atlantic, *Bathyophis ferox*, showing by its whole habit that it is a form living on the bottom of the ocean.

"The fish fauna of the deep sea," writes Dr. Günther, "is composed chiefly of forms or modifications of forms which we find represented at the surface in the cold or temperate zones, or which appear as nocturnal pelagic forms." The Chondropterygians are few in number, not descending to a depth of more than 600 fathoms. The Acanthopterygians, which form the majority of the coast and surface faunas, are also scantily represented; genera identical with surface types are confined to the same inconsiderable depths as the Chondropterygians, while those Acanthopterygians which are so much specialised for the life in the deep sea as to deserve generic separation, range from 200 to 2400 fathoms. Three distinct families belong to the deep sea fauna, viz. Trachypteridæ, Lophotidæ, and Notacanthidæ; they

respectively consist of three, one, and two genera. Gadidæ, Ophidiidæ, and Macruridæ are very numerous, ranging through all depths; they constitute about one-fourth of the whole deep-sea fauna. Of Physostomi, the families of Sternoptychidæ, Scopelidæ, Stomiatidæ, Salmonidæ, Bathythrissidæ, Alepocephalidæ, Halosauridæ, and Murænidæ are represented. Of these the Scopeloids are the most numerous, constituting nearly another fourth of the fauna. Salmonidæ are scarce, with three small genera only. Bathythrissidæ includes one species only, which is probably confined in its vertical as well as horizontal range: it (*Bathythrissa dorsalis*) occurs at a depth of about 350 fathoms in the sea of Japan. The Alepocephalidæ and Halosauridæ, known before the *Challenger* Expedition from isolated examples only, prove to be true, widely spread, deep-sea types. Eels are well represented, and seem to descend to the greatest depths; Myxine has been obtained from a depth of 345 fathoms.

In the systematic portion Dr. Günther divides the class of fishes into four sub-classes—the first Palæichthyes, the second Teleostei, the third Cyclostomata, and the fourth Leptocardii. The description of each order, sub-order, and family is given. In addition we have the diagnosis of all the more important genera, and under these are given the names of the species of economic value or special scientific interest. We select the following account of two interesting genera as examples taken from the eighth family of the sharks, Spinacedæ:—

"ACANTHIAS.—Each dorsal fin with a spine. Teeth equal in both jaws, rather small; their point is so much turned aside that the inner margin of the tooth forms the cutting edge. Spiracles rather wide, immediately behind the eye.

"The two species of 'Spiny Dog Fishes,' *A. vulgaris* and *A. Blainvillii*, have a very remarkable distribution, being found in the temperate seas of the Northern and Southern Hemispheres, but not in the intermediate tropical zone. They are of small size, but occur at times in incredible numbers, as many as 20,000 having been taken in one season on the Cornish coast. They do much injury to the fishermen by cutting their lines and carrying off their hooks.

"CENTROPHORUS.—Each dorsal fin with a spine, which however is sometimes so small as to be hidden below the skin; mouth wide; teeth of the lower jaw with the point more or less inclined backwards and outwards; upper teeth erect, triangular, or narrow, lanceolate with a single cusp; spiracles wide, behind the eye.

"Eight species are known from the southern parts of the European seas and one from the Moluccas; they do not appear to exceed a length of five feet. According to the observations of E. P. Wright some of the species at least live at a considerable depth, perhaps at a greater depth than any of the other known sharks. The Portuguese fishermen fish for them in 400 to 500 fathoms with a line of some 600 fathoms in length. The sharks caught were specimens of *Centrophorus cœlolepis*, from three to four feet long; the sharks as they were hauled into the boat fell down into it like so many dead pigs, there was not the smallest motion of their bodies. There can be no reasonable doubt that they were inhabitants of the same great depth as Hyalonema; and that in fact they were killed by being dragged to the surface from the pressure of water under which they lived. The dermal productions of some of the species have a very peculiar form, being leaf-shaped, pedunculate, or ribbed or fronded with an impression."

One other quotation must suffice; the Clupeidæ forms the twenty-second family of the Physostomii, which is the fourth order of the second sub-class; after enumerating several genera, among them Engraulis, to which the Anchovy belongs, the hint being given that "lucrative fisheries of Anchovies might be established in Tasmania, where the same species occurs, in Chili, China, Japan, California, at Buenos Ayres, each of which countries possesses Anchovies by no means inferior to the Mediterranean species;" the author proceeds to give the particulars of the genus Clapea. After the scientific description he adds:—

"This genus comprises more than sixty different species The majority are of greater or less utility to man, but a few tropical species (*C. thrissa*, *C. venenosa*, and others) acquire probably from their food highly poisonous properties so as to endanger the life of persons eating them. The most noteworthy species are:—

"1. *C. harengus* (the 'Herring'). It is readily recognised by having an ovate patch of very small teeth on the vomer. Gill cover smooth without radiating ridges. It inhabits in incredible numbers the German Ocean, the northern parts of the Atlantic, and the seas north of Asia. The herring of the Atlantic coasts of North America is identical with that of Europe. A second species has been supposed to exist on the British coast (*C. Leachii*), but it comprises only individuals of a smaller size, the produce of a late or early spawn. Also the so-called 'Whitebait' is not a distinct species, but consists chiefly of the fry or the young of herrings, and is obtained 'in perfection' at localities where these small fishes find an abundance of food, as in the estuary of the Thames.

"2. *C. mirabilis*. The herring of the North Pacific.

"3. *C. sprattus*. The 'sprat,' without vomerine teeth. Gill cover smooth, without radiating ridges. Abundant on the Atlantic coasts of Europe.

"4. *C. thrissa*. One of the most common West Indian fishes, distinguished by the last dorsal ray being prolonged into a filament. Hyrtl has discovered a small accessory branchial organ in this species.

"5. *C. alosa*. The 'shad' or 'Allice shad,' with very fine and long gill-rakers, from sixty to eighty on the horizontal part of the outer branchial arch, and with one or more black lateral blotches. Coasts of Europe, ascending rivers.

"6. *C. finta*. The 'shad' or 'Twaite shad,' with stout osseous gill-rakers from twenty-one to twenty-seven on the horizontal part of the outer branchial arch, and spotted like the preceding species. Coasts of Europe, ascending rivers and found in abundance in the Nile.

"7. *C. menhaden*. The 'mossbanker,' common on the Atlantic coasts of the United States. The economic value of this fish is surpassed in America only by that of the Gadoids, and is derived chiefly from its use as bait for other fishes and from the oil extracted from it, the annual yield of the latter exceeding that of the whale (from American fisheries). The refuse of the oil factories supplies a material of much value for artificial manures.

"8. *C. sapidissima*. The American shad, abundant and an important food-fish on the Atlantic coasts of North America. Spawns in fresh water.

"9. *C. mattowocca*. The 'Gaspereau' or 'Ale-wife,' common on the Atlantic coasts of North America, ascending into fresh water in early spring and spawning in ponds and lakes.

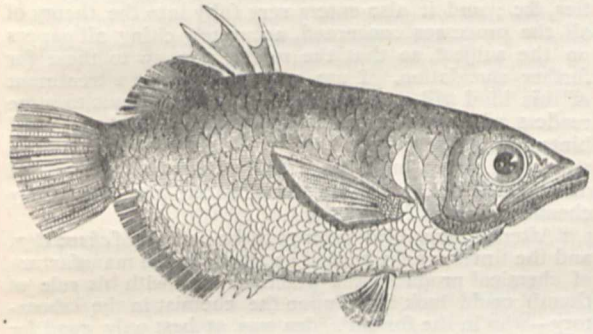
"10. *C. pilchardus*. The 'Pilchard' or the 'Sardine,' equally abundant in the British Channel, on the coast of Portugal, and in the Mediterranean, and readily recognised by radiating ridges on the operculum, descending towards the sub-operculum.

"11. *C. sagax*. Representing the Pilchard in the Pacific, and found in equally large shoals on the coasts of California, Chili, New Zealand, and Japan.

"12. *C. toli.* The subject of a very extensive fishery on the coast of Sumatra for the sake of its roes, which are salted and exported to China, the dried fish themselves being sent into the interior of the island. The fish is called 'Trubu' by the Malays, is about eighteen inches long, and it is said that between fourteen and fifteen millions are caught annually.

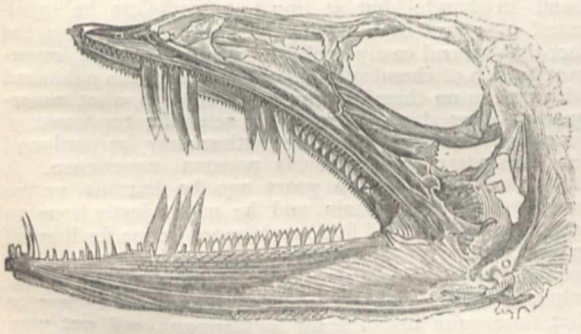
"13. *C. scombrina.* The 'oil sardine' of the eastern coast of the Indian Peninsula."[1]

These quotations will show the value and importance as well as the interest of the systematic and descriptive part of this volume, not a page of which is without some



Toxotes jaculator.

lines of most instructive reading, in many cases sufficiently so as to tempt one to turn "Ichthyologist" on the spot. We strongly recommend the reader to turn at once to the pages on the Salmonidæ. This portion too is illustrated with many excellent figures, two of which, through the courtesy of the publishers, we are permitted to reproduce —the first is of a fish belonging to the genus Toxotes. Two species of this genus are known from the East Indies, one of which (*T. jaculator*) is the more common, and it ranges to the north coast of Australia. It has received its name from its habit of squirting a drop of water at an insect which it perceives close to the surface in order to



Skull of *Plagyodus ferox.*

make it fall into it. The Malays, who call it "Ikan sumpit," keep it in a bowl in order to witness this singular habit, which it continues even in captivity.

The second woodcut represents the bones of the head of one of the largest and most formidable of the deep-sea fishes. Of the genus Plagyodus but one species is known (*P. ferox*). It has been found off Madeira and in the sea off Tasmania. Other species have been noticed from Cuba and from the North Pacific, but it is doubtful if they differ specifically from *P. ferox*. The fish grows to a length of six feet, and from the stomach of one specimen have been taken several eight-armed cuttle-fish, Crustacea, Ascidians, a young brama, twelve young boar fishes, a horse-mackerel, and one young of its own species. The stomach is coëcal, the commencement of the intestine has extremely thick walls, its inner surface being cellular, like the lung of a reptile, it has no pyloric appendage. All the bones are extremely thin, light, and flexible, containing very little earthy matter. Very singular is the development of a system of abdominal ribs symmetrically arranged on both sides and extending the whole length of the abdomen. Perfect specimens are rarely obtained on account of the want of coherence of the muscular and osseous parts, caused by the diminution of pressure when the fish reaches the surface of the water. The exact depth at which *Plagyodus ferox* lives is not known; probably it never rises above a depth of 300 fathoms; but woe betide any rash intruder that dares to descend into the realms of its abyss.

The volume closes with some directions for collecting and preserving fishes—when practicable fishes when dead should be set to swim in spirit. But we must not quote any more, so leave the curious reader to find out the details of how, having caught his fish, he can cook it so as to make it of value for some national museum.

[1] In this quotation the fin formulæ and references to works on the Herring, &c., are omitted.

SULPHURIC ACID AND ALKALI

A Theoretical and Practical Treatise on the Manufacture of Sulphuric Acid and Alkali, with the Collateral Branches. By George Lunge, Ph.D., F.R.S.E., Professor of Technical Chemistry at the Federal Polytechnic School, Zurich (formerly manager of the Tyne Alkali Works, South Shields). Vol. III. (J. Van Voorst, 1880.)

THE publication of the third and concluding volume of Prof. Lunge's excellent work follows wonderfully soon on that of the first and second. This volume, which fully equals the other two in accuracy of description and clearness of style, is devoted to the subsidiary processes lying alongside of the main channel of Leblanc's great discovery. We first find a chapter on the ammoniacal soda process now rising, through Solvay's exertions, into well-merited and formidable competition with its older rival. The ash made by this theoretically beautifully simple and practically most original process is very pure, containing from 98 to 99 per cent. of Na_2CO_3, and free of course from the impurities common to Leblanc's ash of caustic soda and sulphide of sodium.

But this Solvay's ash is less dense than that made by the old plan, and both German and English manufacturers are now making a Leblanc ash of 98 per cent. free from sulphur and of a dense quality. The struggle, says Lunge, is not now one of purity, but merely of price, and so far Leblanc soda is holding its own. Here however the beneficial action of competition is seen: if Messrs. Brunner, Mond, and Co., of Northwich and Sandbach, were not turning out from 35 to 40 tons of Solvay ash *per diem*, I cannot help thinking that the Leblanc soda-makers might have felt inclined to rest content with their previous performances. There is of course no chance of this new process turning out the old-fashioned plan until the chlorine of the common salt can by this new method

be made available as a marketable article. At present it runs away as calcium chloride ; but if Weldon's process for regenerating the chlorine were to prove as successful as his well-known plan (of world-wide application) for obtaining it from the ordinary chlorine-still liquor has proved (and this so far has not come to pass), it is pretty clear that all the old alkali works would have to be closed. Next come the chapters on Bleaching Powder and Chlorate of Potash. Here we find thirty-four pages of a practical treatise devoted to the theoretical consideration of the composition of bleaching powder, and even graphical formulæ may be detected on some of these pages, to say nothing of chemical equations of some complexity, involving the discussion of one of the most intricate of chemical problems. This is a pretty dish to set before our "typical practical man," who only knows the substance he makes under the names of "B.P." or "Chemic," and would be puzzled to say of what it consisted. It is however a species of nourishment which it will do him good inwardly to digest, for if he turns away from it in disgust and dismay, so much the worse for him and his manufacture. "The rule of thumb," as Mr. Mundella truly said at Leeds the other day, "is now over; we stand at its grave." Our manufacturers must all be thoroughly trained in the scientific principles which underlie their trades. Noble and great things have been done by Englishmen in the perfection and development of chemical industry, and still greater things remain for them to do; but whilst taking only proper credit for what England has done and is doing, let us not forget that the general scientific education of our manufacturers and managers is far below that of their Continental competitors. It is no doubt quite true that no German alkali work could exist were it not for their import duty on English soda ; for even with all their care and scientific knowledge, the Germans are unable to compete on equal terms with us, thanks rather to the circumstances of our environment than to any special merits of our own.

But this artificial and economically unsound condition of Continental manufacture ought rather to urge us so to complete our system that we not only shall have the advantages which geographical position and geological good fortune places at our disposal, but also that thorough scientific training and the knowledge of what is being done elsewhere, without which all natural advantages become comparatively valueless. In this way and in this way only can we, as it seems to me, fight against the incubus of protective tariffs. On this necessity for our typical "practical man" to re-consider his position and to arm himself for the technical war with every appliance which science places at his disposal, Dr. Lunge speaks so forcibly and so well in the preface to his third volume that I take the liberty of giving his remarks *in extenso*.

I may however express my own doubts whether the British alkali-maker has, as Dr. Lunge maintains, in reality been distanced by any foreign manufacturer of alkali or sulphuric acid, except so far as regards the import of British goods into countries where inland production is artificially stimulated by protection. As regards other chemical industries, especially those such as the manufacture of colours, in which great delicacy and care in manipulation and an intimate knowledge of the highest developments of organic chemistry are essential, one must in sorrow confess that Dr. Lunge is perfectly right when he says that the English trade is rapidly passing into the hands of French and German houses.

"Other books aim at nothing but giving an accurate description of the present style of making sulphuric acid and alkali in England; and they leave the chemistry of the subject almost totally aside. My treatise differs from this in several respects. First it gives a detailed chemical description of the raw materials, intermediate and final products, of the modes of testing, and so forth, supplemented by numerous tables of solubilities, densities, &c. ; and it also enters very fully into the theory of all the processes concerned, accurately citing all papers on the subject, so that the reader can go to these for further elucidation. I am quite aware that a treatment of this kind will appear lengthy and superfluous to some readers who look into this book merely for 'practical' hints. In this respect they will not, I trust, be disappointed either, but I make bold to say that they would do very well not to despise the scientific part, the purely chemical detail, of this work.

"After all, our subject belongs to the domain of *chemistry*, and the times are far behind us when, in the manufacture of chemical products, the practical man with his rule of thumb could look down upon the chemist in the laboratory—who in the former's idea was at best only good for testing the materials, but whose interference with the works would invariably cause mischief. That this was true to some extent, and still is so, where the chemist attempts to transfer his ideas into practice in a crude state without sufficient practical experience, nobody can possibly deny. But does the 'practical man' on his part make no mistakes?

"Have not untold sums been wasted in futile 'inventions' and 'improvements' merely because 'practical' inventors lacked a scientific knowledge of their subject? Probably very much larger sums have been lost in this way than by the deficiency in practical experience of 'theoretical' inventors, for the simple reason that the latter class of inventors generally have not so much means at command as the former. It is a mere truism that theory and practice should always go hand in hand; but it must nevertheless be inculcated over and over again, as would appear from the fact that several costly books on perhaps the most important branch of chemical industry have just been published with next to no chemistry in them. And to what consequences does this neglect of a scientific treatment of practical subjects lead? The author may be pardoned for illustrating this from his personal experience. A little more than sixteen years ago he left his native country for Great Britain, and he might justly hope to learn a great deal and find much more scope for himself in that country which he is proud to have made his second home. More particularly the manufacture of sulphuric acid, soda-ash, and bleaching-powder was at that time quite insignificant in Germany, and not very considerable in France as compared with Great Britain, nor could the technical appliances, the yields, or even the purity of the products in the two former countries vie with those of the latter. How different matters are now is a matter of notoriety. The manufacture of chemicals has made enormous strides forward, both in quantity and quality, in France, and even more so in Germany. Many of the chemicals of these countries outstrip those of English works in purity; and their plant and their processes are frequently superior to those used in the majority of English works. Everybody knows how this has come about. The foreign chemists and manufacturers have looked all round, not merely in their own countries, but wherever they could find improved methods and apparatus, and upon the practical knowledge thus gained

they have brought to bear the scientific training they had received at their universities and polytechnic schools. Thus they have already, in many fields formerly remunerative to British manufacturers, distanced the latter, immensely aided though these be by their long occupation of the ground and by permanent natural advantages, such as cheapness of coal and of freight, superior command of capital, &c., and this is likely to go on to an increasing extent if many British chemical manufacturers decline to profit from a scientific study of their respective branches. This is all the less excusable, as England from of old has been a stronghold of scientific chemistry, and can hold its own against the whole world in that respect."

To these words I will only add that one of the best possible signs of advancement in the study of science so necessary for the permanent well-being of our manufactures would be to find well-thumbed copies of Dr. Lunge's three volumes not only on the alkali-maker's shelves, but in the house of every manager, and on the table of every free library in the manufacturing districts.

H. E. ROSCOE

OUR BOOK SHELF

Aide-Mémoire du Voyageur. Par D. Kaltbrunner. (Zurich: Wurster et Cie., 1881.)

THIS is a sort of supplement to the "Manuel du Voyageur" by the same author, noticed in these pages at the time of its appearance. The present volume may be described as a collection of constants in all departments of science likely to be of service to the scientific traveller, and indeed to students of many kinds. It contains a series of sections in geography (mathematical, physical, and political), geology, biology, and anthropology. To each section is prefixed a list of works to be consulted on the particular subject, numerous plates and maps, an index, and a table of authors whose works are cited. The whole work seems to us well put together, the information really useful, and, so far as we have tested, trustworthy, though the lists of works are not always so complete as they might be; this can be easily amended in subsequent editions. To all interested in geography in its widest sense, the work must prove of real service.

LETTERS TO THE EDITOR

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

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

Geological Climates

I SHOULD not say more on this subject, but that the last paragraph of Mr. Starkie Gardner's letter seems to imply that I have adopted some of his views without acknowledgment. Now I certainly read his article in NATURE of December 12, 1878, with much interest and profit; but, as regards the special question of the cause of the mild climates of Eocene and Miocene times, I entirely disagreed with his views, as is sufficiently shown by my recent letter in NATURE. I quite admit that the closing up of the North Atlantic between Europe and North America *might* have considerably raised the temperature of Britain, but it would just as certainly have rendered the Arctic regions even colder than they are now, by shutting out the Gulf Stream, whereas all the evidence points to *continuous* mild Arctic climates through Cretaceous, Eocene, and Miocene times. Again, though I admit that there has probably, on more than one occasion during the Tertiary period, been a land connection between North-West Europe and North-East America, yet the peculiar distribution of the Tertiary mammalia of Europe and North America indicates that such connection was exceptional, and only endured for very short periods, the rule being a separation like that which now exists. I could therefore only have quoted Mr. Gardner's view to disagree with it; and I did not think it advisable to encumber the exposition of my own theory with more references of this kind than were absolutely necessary. I may add, that the extension of the Miocene Arctic flora to Grinnell Land since Mr. Gardner's article appeared, renders his views still more untenable. Of course I here refer to my chapter on "Mild Arctic Climates" in "Island Life." In my letter to NATURE I confined myself strictly to the point raised by Prof. Haughton, which I did not consider had been adequately met by Mr. Gardner's hypothesis.

ALFRED R. WALLACE

Is your correspondent, Mr. Ingram of Belvoir Castle, quite certain that he has not confused the *Araucaria Cunninghami* of Queensland with *Cunninghamia lanceolata* of China? The names are misleading.

H. KING

Chithurst, Petersfield

Temperature of the Breath

FROM time to time during the past few months letters on "the temperature of the breath" have appeared in NATURE, and some conjectures have been advanced regarding the cause of the high temperatures produced by breathing on thermometers enveloped in silk or other materials.

One of the correspondents supposes that the high temperature thus produced indicates a cooling action of the breath. The refrigerating agency of respiration by the heating of respired air and by evaporation from the lungs is sufficiently well known, and has been calculated by Helmholtz; but it is scarcely logical to ascribe to the breath a temperature so obviously produced by the intervention of another agent, and this hypothesis would involve the rejection of all observations hitherto made by physiologists on the temperature of the breath and of the blood.

A few lines which appeared in NATURE of October 7 indicated what appeared to me to be the simple and philosophical explanation (*i.e.* hygroscopic condensation) of the phenomenon under discussion. The higher temperatures produced in dry than in wet weather, and by some materials than by others, distinctly point to the hygroscopic state and nature of the material as the modifying influences.

The question is entirely physical, and not physiological. Wrapping the thermometer is a new factor in taking the temperature of the breath, and is, *primâ facie*, the cause of the high temperature. Some further experiments which I have just completed place the matter beyond all doubt. Not to occupy your space with unnecessary details, I give only an outline of them:—

1. A current of air directed upon the bulb of a naked thermometer caused no appreciable rise; neither did the mercury rise when the bulb was enveloped in silk; but when it was enveloped in *dried* silk it rose several degrees. (The silk was dried by heat, and allowed to cool in a stoppered bottle.)

2. Three thermometers—(1) bulb naked, (2) bulb wrapped in silk, (3) bulb wrapped in *dried* silk—placed in a current of *hot damp* air for some minutes, marked respectively 116°, 120°, and 123° F.

3. Two thermometers, one naked, the other wrapped in silk, were placed in a flask, with their stems passed through the cork. The flask was then immersed in hot water (about 150° F.). The naked thermometer rose rapidly, the covered one very slowly. After twenty minutes the temperature of the water was 120°, and the naked thermometer marked 112°, while the covered one registered only 108°.

4. Two thermometers, one naked, the second wrapped in dried silk, were fixed in a flask as for last experiment, but a little water was placed in the flask, which was then plunged into hot water as before. The naked thermometer rose rapidly at first, but it was soon outstripped by the covered one. The following was the result after some minutes:—Water, 128°; naked thermometer, 118°; covered thermometer, 136°.

5. Two thermometers, one naked, the second enveloped in dried silk, were passed through a cover fitting a glass vessel which was carefully dried and heated, and the cover was cemented on to prevent the passage of moisture from the air. After an hour the naked thermometer had cooled to 81° (temperature of air), and the covered one to 83°. They were then changed to a similar vessel containing a little water; the

covered thermometer rose rapidly till it nearly touched 94°, while the naked one remained stationary.

The conclusions to which these experiments point are too obvious to require demonstration. C. J. MCNALLY

Madras, December 9, 1880

Selenium

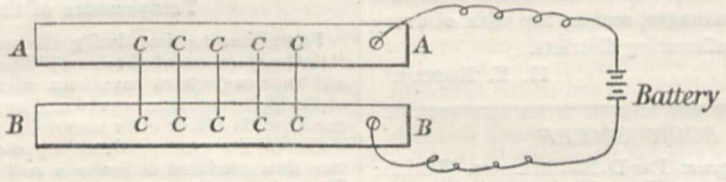
THE use of selenium in the photophone has suggested to me the possibility of using it in two ways, which I shall now describe, thinking you may perhaps consider them of sufficient general interest to publish in NATURE.

Firstly, it seems probable that selenium might be used to obtain the automatic registration in a chronograph of such phenomena as star transits. It possesses the property of being drawn into fine wire at a low temperature, but whether it can be drawn fine enough to represent transit wires in a telescope I do dot know.

The arrangement would be as shown in the diagram, where A A B B are parallel metal plates crossing the field of the telescope, and insulated from each other except by the selenium wires C C C C in one direction, and by a wire circuit passing through a battery, and a relay, R, in the other. The relay should be so adjusted that the increased force of the current passing through the circuit caused by the light of a star falling on each wire C C in succession, shall cause its armature to act, and pass on a signal to the chronograph.

The delicacy of the adjustment required for this purpose might be a greater difficulty than I am aware of; but it should be borne in mind that the length of selenium in the circuit may be very small, as the plates A A B B need not be farther apart than sufficient to insure the star's falling between them without excessive accuracy of setting, say one-twentieth to one-tenth of an inch in a telescope of moderate size. If necessary, it would be simple enough to give each wire C C its own distinct circuit. Should the brittleness of the wires prove a difficulty, they may be supported between the plates A A B B in any convenient way which does not interfere with the insulation of these plates.

The second purpose would perhaps be of more practical use than the above, viz. to secure an automatic daily time-signal.



Let a thin plate of selenium be placed between, and in firm contact with, two parallel plates of metal, which are connected with each other by a wire passing through a battery and a relay as above, so that the selenium alone interrupts the circuit. Then if this plate be placed with its length in the meridian, and a lens adjusted above it, so as to throw the image of a star, or the sun, as it crosses the meridian exactly on the selenium, a signal will be obtained from the relay as before, which in this case may be the stroke of a bell or any other convenient sound.

An ordinary lens would require constant changes of adjustment if used for the sun, moon, or any body of varying declination; but if the lens were the central slice cut out of a sphere by two small circles parallel to each other and equidistant from the centre, placed with its flat sides parallel to the meridian, while the selenium was placed in a curve concentric with that of the lens, at the proper distance from its surface, and of sufficient length—of course being accurately in the meridian—then any heavenly body of whatever declination—between certain wide limits—would throw its image on the selenium and afford a signal, if of sufficient brightness. The arrangement of a warning-signal would be easy.

If this method proved practicable the objection would remain of having to apply a correction to obtain mean time, which would probably prevent its being used for public purposes, such as dropping time-balls or firing time-guns. It seems to me however that it might nevertheless prove very useful to many private individuals who require an accurate knowledge of time.

Poona, December 3, 1880 W. M. C.

Experiments with Vacuum Tubes

AT a meeting of the Philosophical Society of Glasgow on December 22, 1880, I gave a very brief preliminary account of some experiments that I have been making, along with Sir William Thomson, with vacuum tubes. We have sealed up English and German glass tubes with very high vacuums, but without any electrodes; and have obtained very remarkable luminous effects both with the Ruhmkorf coil and also working by means of electrostatic induction. Using an ordinary frictional electric machine, and applying one end of a long vacuum tube to the prime conductor, while the other end of the tube is held in the hand, the tube becomes charged as a double Leyden jar in the following way:—one end of the tube, next to the prime conductor,—outside positive, inside negative; the other end—inside positive, outside negative. This can be shown by the gold leaf electroscope. The charges seem to be very high and the glass is very frequently perforated. Indeed it is difficult to work with the electric machine in tolerably good order without perforating the glass. While this double Leyden jar is slowly discharged, by removing, part by part, the charges from the outside of the tube, beautiful luminous effects are observed very different from those seen in the ordinary vacuum tubes. We have also obtained curious effects by heating the middle region of the tube so highly that it becomes a semi-conductor. J. T. BOTTOMLEY

Physical Laboratory, University, Glasgow, December 29

Modern Use of Ancient Stone Implements

PERHAPS the following statement will interest some of your readers:—In an old volume, "Thomae Bartolini Acta hafniensia," Ann. 1674, 1675, 1676, I find a paragraph signed by Olaus Borrichius, which clearly indicates that in the seventeenth century ancient stone implements, and probably many of them, were converted into flints for the use of the contemporaneous musquetry. The text runs thus:—"Silices Anholdini triangulares. Insula haec [Anholt in the Kattegat] porrigitur in sinu codano, minuta illa quidem et naufragiis multorum infamis, uno hîc laudanda quod si quis arenas littoris eiusdem scrutetur, infinitos reperiat silices nigros, albos, varios, in sabulo hinc inde sepultos, ad sex transversos digitos in longitudinem protensos, latos digitum unum, omnes triquetros ac si manu artificis fuissent acuminati, et lateribus plerumque in illam aciem excitatis, ut Iosuae servire potuerint cultris saxeis filiorum Israel circumcisionem imperanti. Nunc ferreo hic seculo in alios vocantur usus: malleo enim in frusta convenientia divisi sclopetorum rotulis ignem prompte ministrant et fomitis incendiarii loco fulmineis bellatorum tubis ancillantur." D. BUDDE

Rome, December 26, 1880

Pile Dwellings

IF the connection between pile dwellings in the Swiss lakes, the Swiss châlet, and the Malayan modern pile dwellings is demonstrated, a decided advance has been or will be made in prehistoric anthropology.

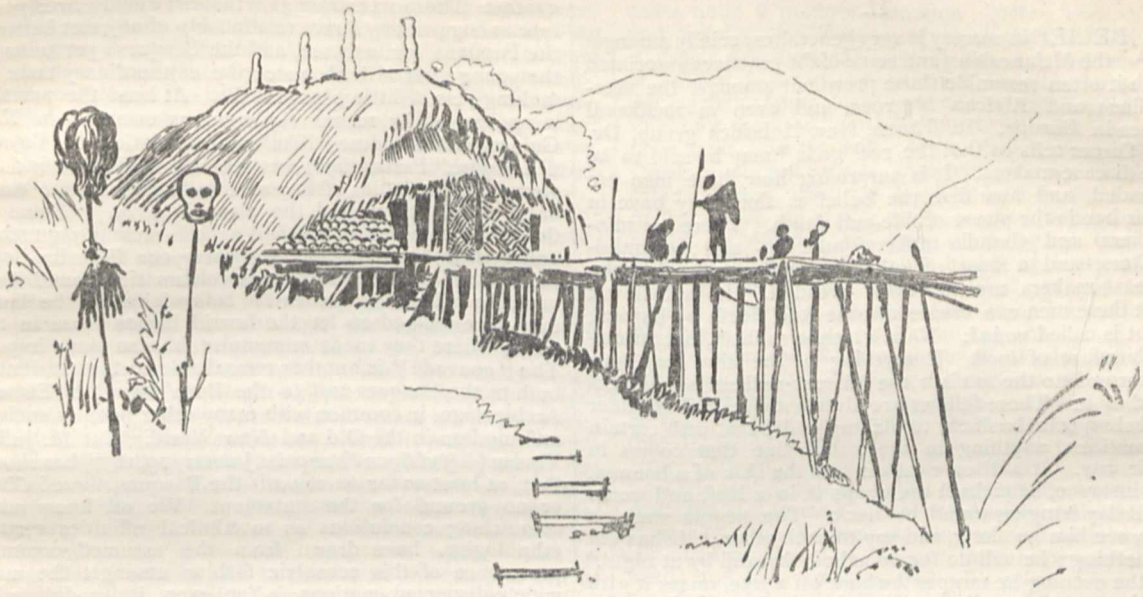
Pile dwellings are a very distinct characteristic of all the Hill races north-east of Bengal, except those on the Kasia Hill ranges, and so far as I can see is a conspicuous distinction between the Aryan and non-Aryan races here.

The persistence with which this custom is retained among tribes who have migrated to new sites, where the need is not obvious, seems to offer a safe means of tracing to some extent racial descent or relationships.

The "Miris" of Asam offer a case where part of the tribe is still in its hills, while the rest are more or less scattered along the Brahmaputra in the level land of Asam, and build houses alike. The Ahoms, a Shan race who invaded and settled in Asam in A.D. 1228, built pile dwellings, and the "Deodhaings," who are lineally descended from them, do so now. The Butias

Daflas, Akas, Abors, Mishmis, Singphus, and Nagas (all) build pile-dwellings, as do the Kamtis.

Several peculiarities are noteworthy, *i.e.* that the custom is confined to *hill races*, and not seen in plain races; that the invariable explanation offered to inquiry is that on the hill tops and spurs, where *alone* the villages are built, there is very little



level land; also that this form of house is a necessity among races that keep pigs and goats, which to any casual visitor is at once obvious.

As it is possible that this question may afford unexpected results when examined, I inclose sketch of a Naga "Morang," or skull house, which with its platform is the same as those they live in. Different tribes have variations of the pattern, and most have the platform balcony in some shape or other, and the posts go through the roof in some Nagas houses alone.

Asam S. E. PEAL

Landslips.—The Cheshire Subsidences

UNDER the guidance of Mr. Thos. Higgin, F.L.S., and your correspondent Mr. Ward, I have just been examining the subsidences that have been lately taking place in the neighbourhood of Northwich. To understand how they occur, it is necessary to know that there are two beds of rock salt in the Triassic marl. The upper bed, 25 yards thick, is from 40 to 60 yards below the surface; the lower, 35 yards thick, is separated from the upper by about 10 yards of hard marl. The greater bulk of the salt is obtained in the form of brine pumped up from the upper bed. The lower bed is to a smaller extent worked as a salt-mine. From these operations two classes of subsidences result: the one general and gradual, due to the removal in solution of the rock salt of the upper bed by percolation of water and pumping, by which the surface of the ground sinks in undulations; the other, sudden fallings in of the ground into the mines, forming crater-like pits. It is to these I wish to call attention. I was fortunate enough to see one before it had become, as they all do, partially filled with water. I should judge it to be about 70 feet deep, 150 feet diameter at the top, and 20 or 30 feet at the bottom, where a little water was lodging. The problem to account for is how such an inverted cone of marl capped with boulder-clay and drift-sand could apparently have disappeared through so small a hole? The explanation appears to be this: By percolation of water the roof of the mine begins locally to give way and fall into the mine, gradually working its way to the surface, where it first appears in the form of a hole about the size of a well. The vacuity will no doubt take a conical form, the base being at the roof of the mine; once the hole is formed, the surface-ground begins to slip and fall in around, gradually enlarging the orifice, the material disappearing into the mine below. This continues until the bottom is filled up and the sides of the "crater" attain the angle of repose. The whole thing will occur in a night. The subsidences certainly present a very remarkable appearance from the regularity of their circular or elliptical form and funnel crater-like shape. It is evident such subsidences could not happen except under special conditions, such as are provided by salt-mining and pumping in these Keuper marls. T. MELLARD READE

Park Corner, Blundellsands, Liverpool, December 22, 1880

Animal Reasoning

I SEND an account of a singular act of animal intelligence which may not be uninteresting to the readers of NATURE. A lady, a friend of mine, was at one time matron of a hospital for poor women and children which was maintained by subscription. One of the inmates was a blind girl who was there not as a patient, but temporally till a home could be found for her. She had learned to feed herself, and at meal times a tray containing her dinner was placed on her knees as she sat in a comfortable chair for her special convenience in feeding herself. One day while she was eating, the pet cat of the establishment placed herself before the girl and looked long and earnestly at her, so earnestly that the matron, fearing the animal meditated some mischief to the girl, took her out of the room. Again the next next day, at the same hour, the cat entered the room, but this time walked quietly to the girl's side, reared herself on her hind legs, and noiselessly, stealthily reached out her paw to the plate, selected and seized a morsel that pleased her, and, silently as she came, departed to enjoy her stolen meal. The girl never noticed her loss, and when told of it by her companions laughed very heartily.

It is evident that the cat from observation had entirely satisfied herself that the girl could not see, and by a process of reasoning decided she could steal a good dinner by this practical use of her knowledge. K. P.

Cambridge, Massachusetts

Ozone

THE letter of J. P. on this subject hardly gives enough data to enable one to found an opinion upon; but is it not possible the paper is coloured by ozone from the air? It is well known that a flame is the most potent method of collecting atmospheric electricity, and a properly-insulated spirit flame ignited in dry air seldom fails to show some traces. I would suggest the experiment being repeated on the exposed plate of a gold leaf electrometer, the surrounding conditions of place, air, &c., being noted: also under a bell glass, where such conditions would be varied. Ozone is very strong just now, my paper this morning reaching 10, the limit of Negretti and Zambra's scale. J. RAND CAPRON

Guildown, December 28, 1880

THE INDO-CHINESE AND OCEANIC RACES—TYPES AND AFFINITIES[1]

II.

A BELIEF in sorcery is very general, especially amongst the Melanesians, and some of the practices associated with it often resemble those prevalent amongst the Australians and African Negroes, and even in mediæval times in Europe. In Tanna, New Hebrides group, Dr. G. Turner tells us that the real gods "may be said to be the disease-makers. It is surprising how these men are dreaded, and how firm the belief is that they have in their hands the power of life and death. There are rain-makers and thunder-makers, and fly- and mosquito-makers, and a host of other 'sacred men'; but the disease-makers are the most dreaded. It is believed that these men can create disease and death by burning what is called *nahak*. Nahak means rubbish, but principally refuse of food. Everything of the kind they burn or throw into the sea lest the disease-makers should get hold of it. These fellows are always about, and consider it their special business to pick up and burn, with certain formalities, anything in the nahak line that comes in their way. If a disease-maker sees the skin of a banana, for instance, he picks it up, wraps it in a leaf, and wears it all day hanging round his neck. The people stare as they see him go along, and say to each other, 'He has got something; he will do for somebody by and by at night.' In the evening he scrapes the bark off a tree, mixes it with the banana skin, rolls up tightly in a leaf in the form of a cigar, and then puts the one end close enough to the fire to cause it to singe, and smoulder and burn away gradually. Presently he hears a shell blowing. 'There,' he says to his friends, 'there is the man whose rubbish I am now burning; he is ill. Let us stop burning and see what they bring in the morning.'

"When a person is taken ill he believes it is occasioned by some one burning his rubbish. Instead of thinking about medicine he calls some one to blow a shell, which, when perforated and blown, can be heard two or three miles off. The meaning of this is to implore the person who is supposed to be burning the sick man's rubbish and causing all the pain to stop burning; and it is a promise as well that a present will be sent in the morning. The greater the pain, the more they blow the shell, and when the pain abates they cease, supposing that the disease-maker has been kind enough to stop burning. Then the friends of the sick man arrange about a present to be taken in the morning. Pigs, mats, knives, hatchets, beads, whales' teeth, &c., are the sort of thing taken. Some of the disease-making craft are always ready to receive the presents and to assure the party that they will do their best to prevent the rubbish from being again burnt. If the poor man has another attack at night he thinks nahak is again burning. The shell is again blown, and so they go on; and if he dies his friends lay it all down to the disease-makers, as not being pleased with the presents taken and as having burned the rubbish to the end. The idea is that whenever it is all burned the person dies." ("Nineteen Years in Polynesia.") Substitute for the nahak a waxen image of the absent victim, and you have in this account a perfect parallel to the belief in the power of witchcraft to injure at a distance universal at all times in Europe:—

"Devovet absentes, simulacraque cerea fingit,
Et miserum tenues in jecur urget acus."
(Ovid, *Epist.* 6.)

But this merely shows how little reliance can be placed on similarity of manners and customs in tracing the affinities of races. The mind of man having sprung, as seems most probable, from one original centre, is everywhere very much the same in the infantile or undeveloped stage. Hence, like practices under like conditions may very well arise independently in diverse places without implying any ethnical relationship or even any necessary social contact. The most extravagant theorist would scarcely venture to suggest any direct relationship of any sort between the Papûans, for instance, and the Basques; yet amongst the young girls of both races the extraordinary taste for making pets of little pigs prevails. At least the practice is spoken of by recent explorers as common in New Guinea, while Mdme. d'Aulnoy ("Relation du Voyage d'Espagne," Paris, 1691) was greatly surprised to find the young Basque ladies of Bayonne indulging in the same habit when she visited the place in 1679. "Some of those who came to see me had a little sucking-pig tucked under their arms, just as we carry our little lap-dogs. Several had ribbons of different colours tied round their necks as collars. But when the ladies joined in the dance they were obliged to let the horrid beasts loose in the room, where they made more noise than so many imps." The "couvade" is another remarkable custom attributed both to the Basques and to the Buru Islanders, Eastern Archipelago, in common with many other peoples ancient and modern in the Old and New World. But M. Julien Vinson (*République Française*, January 19, 1877) has shown that, at least as far as regards the Basques, there is little or no ground for the statement. We all know what astonishing conclusions as to ethnical affinities certain ethnologists have drawn from the assumed common prevalence of this eccentric fashion amongst the most widely-dispersed nations. Yet even if it did exist amongst them such conclusions would be otherwise inadmissible.

It may be mentioned that the missionaries have been for some years at work amongst the Mafôr people and their kinsmen of Dorey, into whose language they have translated several tracts and portions of Scripture. Here is a specimen from Genesis i. 1 ("In the beginning," &c.): "Beponeia kaku manseren allah ibejadi nanggi ma dûnya. Dûnya ibeürba ma ibro beri, ma ifnurep kôn ro bo i, ma rûr manseren allah biëda iriob ro bo wâreya." The Malay, or rather Arabic words, *allah*, God, *dûnya*, earth, *rûr* for *rûh*, spirit, are of course borrowed by the translator; but the structure of the language is entirely different, being highly agglutinating and employing both pre- and post-fixes, like other Papûan dialects. In other respects the Papûan and Melanesian tongues differ so profoundly from each other that it is impossible to group them in one linguistic family. As a rule they possess absolutely nothing in common beyond a certain uniformity of structure and such verbal resemblance as is due to Malay and Sawaiori influences. These influences are very wide-spread, as shown especially in the numerals, which the dark races have almost everywhere borrowed from their brown and olive neighbours. But they often still retain the old quint system at one time common to Indo-China and Malaysia, but in the Oceanic area now mostly replaced by the decimal. Thus in the Duke of York Islands, between New Britain and New Ireland, the five first numerals only are taken from the Sawaiori or Eastern Polynesians, the numbers beyond five being expressed by addition, as in Cambojan and several Malayan and Western Papûan dialects. Hence for the Samoan *e ono* = six, *e sefulu* = ten, we have *limadi ma ra* = 5 + 1, *limadi ma limadi* = 5 + 5, where *limadi* is from the Samoan or Eastern Polynesian *lima* = 5. By an analogous process the numerous Sawaiori words that have found their way especially into the Eastern Papûan idioms are always compelled to conform to the agglutinating character of Papûan grammar. Thus the Fijian and Duke of York *tama* = brother, apparently answering to the Samoan *tama* = boy, assume the pronominal post-fixes *zu*, *g*, *na*, &c., peculiar to those groups, the Fijian *tamazu* and Duke of York *tamag* being equivalent to the Samoan *o loʻu tama* = my brother or my boy. Here we

[1] Continued from p. 203.

clearly see how entirely the structure of the Papûan differs from that of the Sawaiori tongues, and how constant is the law that languages of different systems may borrow any number of words from each other, while each invariably retains its own grammatical genius. Hence, when we hear of mixed Papûan, Malayan, and Sawaiori tongues in these regions the expression is always to be understood as referring to the vocabularies only, never to the grammar or structure of those languages. In philology there is no rarer phenomenon than mixed grammatical systems, though perhaps it might be premature to deny the absolute possibility of such mixture.

III. The Austral Races: *Australians; Tasmanians* (?)

The area occupied by this division of the dark races is limited to the Australian continent and neighbouring island of Tasmania. Here we enter an entirely new ethnical world, for, although the extinct Tasmanians betray certain doubtful affinities to the Melanesians, the Australians stand quite apart. They are usually represented as black, straight-haired, dolichocephalous, and prognathous. But this general description can pretend to no scientific accuracy, and in any case it is extremely doubtful whether they can be regarded as all belonging to one original stock. Topinard, who has devoted great attention to the subject, recognises at least two distinct aboriginal types, the fusion of which results in the average Australian as above described, and whose essential peculiarity may be said to consist in the combination of more or less negroid features with straight hair. The more primitive race, found mainly on the low-lying coast tracts about King George's Sound, in the north-west and extreme east, is described as of short stature, very black and prognathous, with woolly or at least frizzly hair; the second and finer race, occupying the interior, and especially the north-eastern highlands, are much taller, of lighter colour, with straight or wavy hair, and slight prognathism.

But, notwithstanding these discrepancies, Brough Smith well observes that "throughout Australia the natives exhibit a general conformity to one pattern as regards features, colour, and mental character. A man from Southern Gippsland [Victoria] would be recognised as an Australian by the inhabitants of Port Essington, and a native of King George's Sound would be surely known if taken to York Peninsula." This common racial instinct or fellow-feeling is perhaps our best justification for treating as an independent ethnical group a people for whom affinities have been sought far and wide, by Huxley with Logan in India, by others in Polynesia, Egypt, Europe, or America. One of the arguments adduced in support of an Egyptian or Indian relationship is based on the assumed resemblance of the throwing-sticks of those peoples with the Australian womguine or boomerang; but Brough Smith ("The Aborigines of Victoria," i. p. 323), who has gone thoroughly into this question, concludes that "it is safe to deny the affinity of the Dravidian or Egyptian boomerang with that of the Australian native, because the first, under no circumstances whatever, could be made to behave as the womguine does. The flat leaf-like weapon of the Australian differs essentially from the Egyptian crooked stick." Much reliance is also placed on a certain resemblance between the Dravidian and Australian systems of kinship. But when we find that L. H. Morgan discovered a somewhat similar system prevailing throughout the North American tribes, and that the Rev. Lorimer Fison was able to extend its domain to the South Sea Islanders, we begin to attach less importance to a character of this sort. *Quod nimis probat nihil probat* was a sound maxim amongst the schoolmen.

The Australian languages, which, with great differences, present a remarkable uniformity of structure and phonetics throughout the continent, have also been compared with the Semitic, Aryan, and other systems, but with no results, except where the unscientific method has been adopted. Thus *murry*, great, is compared with the Keltic *mor*, or the English *more; cobbera*, head, with the Spanish *cobra*, quite a modern formation; *gibber*, rock, with the first syllable of *Gibraltar*, of which the true Arabic form is *Jebel; hieleman*, shield, with the Anglo-Saxon *helian* or *heligan*, to cover, or with the English *helmet*, which the ingenious etymologists are careful to tell us is "a little shield for the head"; *cabohn*, good, with the French *bon; tiora*, land, with the Latin *terra; kirajî*, wizard, with the Greek χειρουργός; *ruwi*, country, with the Latin *rus; takkin*, eating, with the English *take in* (why not *tuck in?*); *marti*, limestone, with *mortar*, beyond which it would be difficult to carry etymological eccentricity. Many of these languages are highly agglutinating, some even verging on true inflection; but scarcely any have distinct names for the numerals beyond 1 and 2, after which $3 = 2 + 1$; $4 = 2 + 2$, and so on.

This common feature alone should be sufficient to reject any Semitic, Aryan, or Dravidian affinities, for if the Australians came of any of those stocks, it is not to be believed that all the tribes would have agreed to forget their inherited arithmetical system, and stop short precisely at the inconveniently low numeral 2. At the same time it is conceivable that at an extremely remote age, while Australia still formed part of the Asiatic mainland, tribes resembling the Korumbas, Maravans, Todas, and other low-caste peoples of the Deccan, may have spread southwards and here amalgamated with others of a Papûan type from Melanesia. The result of such an intermingling might be a race not unlike the present average Australian—dark, prognathous, more or less dolichocephalous and with wavy or shaggy hair intermediate between the frizzly and straight. But these migrations cannot have taken place since the subsidence of the land, because none of the races in question are navigators, although some of the New Guinea tribes have recently learnt the art from the Malays. On the other hand the remoteness of the period to which such movements must be referred is no objection, for Australia has been peopled for many ages, as is evident from the vast kitchen-middens found on the coast, and some of which have already been used as manure by the white settlers.

The extremely low estimate of the Australian intellect formed by Mr. Wake and other ethnologists seems at least somewhat premature, and no one can turn over the pages of Brough Smith's great work on the Aborigines of Victoria without coming to the conclusion that the race has been much vilified and unduly depreciated by careless or superficial observers. Many instances are given of their skill even in drawing, a capacity for which was wholly denied them. They often show great quickness in adapting themselves to the ways of the white man, and the children constantly show themselves "quite as capable of receiving and profiting by instruction as the children of untaught parents among the white race" (*op. cit.* ii. p. 256). It was recently stated that the native school at Coranderrk, on the Yarra, had gained relatively more passes than any other school in Victoria.

At the same time most of the tribes are addicted to extremely revolting practices, those by which the "coming of age" is celebrated being especially barbarous and disgusting. Some also, under unfavourable conditions, have either sunk to, or never risen from, the most debased condition compatible with existence. Mr. Taplin was acquainted with a Narrinyeri family, "residing on Lake Alexandrina, the members of which were as nearly brutes as they could be. . . . They subsisted on roots and native fruits, and such fish and game as came into their hands by means of the simplest contrivances, the thrown waddy, or the simple noose, and they were regarded by their own people as very low. They would not even make a shelter, but cowered under bushes and in holes; and yet it could not but be evident how far they were

above the brute. The man could make twine, the woman a rush basket" (*op. cit.*, p. 10).

Cannibalism has also been prevalent, assuming amongst some tribes a very revolting form.

Unfortunately not many of the Aborigines are left to benefit by the enlightened and humane system of treatment tardily introduced by the local administrations. There are probably not 30,000 left in all Australia; even those of Victoria, who are best cared for, are dying out except in a few favoured stations, and "Lalla Rookh," the last of the pure blood Tasmanian women, died in June, 1876. The Tasmanians differed in many important respects from the Australians. They were of darker colour and considerably less dolichocephalous, with decidedly frizzly hair, this latter feature bringing them into close connection with the Melanesians. In point of culture they stood almost on the lowest level, possessing no fixed abodes, wearing no clothes, never cultivating the land, unacquainted with the rudest arts, possessing neither domestic animals, pottery, nor the boomerang or bows and arrows of the Australians. They were divided into a great number of tribes, speaking as many as nine quite distinct languages, but so little developed that the sense was largely eked out with the aid of gesture and signs. Yet their cranial capacity seems to have been slightly greater than that of their neighbours (index 80 as compared with 78), while they were nearly as orthognathous as Europeans. These contradictions constitute the Tasmanian a type *sui generis*, allied partly to the Australian, partly to the Melanesian and Polynesian, with some special features which may perhaps be due to their long isolation from other races.

B—CAUCASIAN TYPE

IV. Continental Branch: *Khmêr or Cambojan Group*

In Further India, with one exception, all the settled peoples forming recognised nationalities, that is, the Burmese, Thai or Siamese and Annamese, are physically of Mongolian stock, and all speak languages of the monosyllabic or isolating class. The same is largely true of the Mishmis, Khasias, Kukis, Nagas, Khyengs, Karens, and other wild tribes in the west and north-west, as well as of the Shans, Mou-tz', and many Miau-tz' tribes in the north. Hence the universal assumption that, excluding Malacca, all the inhabitants of the peninsula constitute one ethnical and linguistic group allied to the Chinese in the north and to the Tibeto-Himalayan races of the north-west, and with them forming collectively the great South-Eastern division of the Mongolian family. This comfortable theory was first shaken by the revelations of the famous French expedition of 1866-8 up the Me-Khong River, since when the writings of Dr. Thorel, Francis Garnier, E. Aymonnier, C. E. Bouillevaux, Dr. Harmand, and other French naturalists have made it abundantly evident that there is in this region an important non-Mongolian element, which must henceforth be taken into account. Yet so slowly does scientific truth make its way against long-established error, that the fact has scarcely yet been recognised in any comprehensive treatise on ethnology or linguistics. In a paper prepared for the meeting of the British Association in Sheffield in 1879, and since published in separate form,[1] I endeavoured to determine the true nature of this non-Mongolian element, and to point out its essential importance in connection with the classification of all the Indo-Chinese and Oceanic races. It was there shown that the Khmêr or Cambojan nation, the exception above referred to, together with a large number of kindred peoples inhabiting the Lower Mekhong basin and the region between that river and the Coast range running from Cape St. James northwards to the Chinese frontier, form a distinct racial and linguistic group, of the same physical type as the Mediterranean or Caucasian races of the west, and closely akin to the brown Oceanic races of Malaysia and the Pacific.

[1] "On the Relations of the Indo-Chinese and Inter-Oceanic Races and Languages." (Trübner, 1880.)

The arguments brought forward in support of this view need not here be formally repeated, and it will be sufficient to vindicate the use of the term "Caucasian" as thus extended to the remotest Polynesian islands. It has been objected that there are no Aryan languages in the far east, and that the Eastern Polynesians are a brown race, consequently that the word Caucasian cannot here apply. But those who so argue seem scarcely to realise the nature of the problem. Caucasian is not a linguistic, but an ethnical expression; hence although the Aryan, Basque, Semitic, and many languages of the Caucasus have no conceivable relationship with each other, we do not hesitate to regard those who speak these languages as of one stock because their physical type is substantially the same. This type we conventionally call Caucasian or Mediterranean, which terms must be held to apply wherever the physical features implied by them are found, irrespective altogether of the language question. Why speech and type should not correspond is another problem, which admits of an obvious solution, but which cannot here detain us.

The objection based on colour, though more to the point, is scarcely more forcible. The brown Polynesians are not supposed to spring directly from the fair Europeans, but to have gradually spread from Indo-China through Malaysia to their present homes; and it will be presently seen that there are peoples in Indo-China brown enough to suit the Polynesian taste, and fair enough to claim kinship with the western nations. Besides, the question of colour must anthropologically be regarded as altogether of secondary importance. There are black Caucasians in Abyssinia, deep brown Caucasians in the Ganges Valley, dusky or swarthy Hamites and Semites, also Caucasians, in North Africa and Arabia; and why may there not be brown Caucasians in Polynesia? Surely the evolutionist, who does not hesitate to accept the development of the *genus homo* from some anthropoid ape, need not scruple about the relationship of the human species because of such a secondary matter as colour. Schweinfurth tells us that albinism is common amongst the negroes of the Nile basin, and there is at the present moment a clear case of melanosis in London. If these be regarded as morbid symptoms, they are often hereditary, and it has not yet been shown that they may not be cases of atavism, such as the reappearance of the bars on the pigeon's wing, however far removed from the original blue-rock type. *Nimium ne crede colori*, wisely said Linnæus, speaking of plants, and the remark is equally applicable to the animal kingdom. Observing that the black pigment does not make its appearance on the Negroes of Loango, West Coast of Africa, until after birth, the Berlin anthropologist Falkenstein suggests that it may be due to the action of the solar rays. If so, what becomes of colour as a fundamental characteristic at all?

Besides the civilised Khmêrs, forming the bulk of the present kingdom of Camboja and neighbouring Siamese provinces of Ongkar and Battambang, the chief Caucasian peoples of Indo-China are the Chams, Charays, Bolovens, Stiêngs, Suê, Xong, Cedangs, Rhoedehs, Banhars, Samrê, Lemets, and Kûys, the last of whom are looked on by the Cambojans as the primitive Khmêr stock; hence are called by them *Khmêr-dom*, or "original Khmêrs." In the paper above referred to the physical characteristics of these tribes are thus summed up mainly from Thorel:—"A fine, vigorous race, with symmetrical and well-set frames; stature rather above the middle size, straight profile, oval face, dolichocephalous head, high forehead, retreating very slightly, black hair, often inclining to brown, straight or wavy and elliptical in section,

beard and whiskers well furnished and always frizzled, or at least wavy, eyes perfectly straight and horizontal, nose not particularly prominent, but nearly always straight and never flattened at the root, cheek-bones scarcely if at all prominent, mouth of medium size and even small size, with moderately thick lips but no trace of prognathism, complexion mainly of a bister or brown colour, but varying from fair and even white to light brown and dark, though never so dark as that of the Aryans of India."

This description, given by a scientific observer, is the very antithesis of the Mongolian, and corresponds in all essentials to the ordinary Caucasian of Western Asia and Europe. Hence it is not surprising to find recent French writers freely applying to these peoples such epithets as "Caucasique," "Indo-Européen," "blanc," and so on. Bouillevaux calls the Chareys "white savages of Caucasian type." Thorel connects the northern tribes with "the Caucasian race, or more correctly with the Indo-European peoples." Dr. Harmand gives us a description of a beautiful Khang woman, dwelling particularly on her "aquiline nose, large eyes, thin lips, round shoulders," and other points of a European character. The Bolovens of Bassac he describes as of lighter complexion and taller than the surrounding Laos (Mongoloid) peoples, with sub-dolichocephalous head,

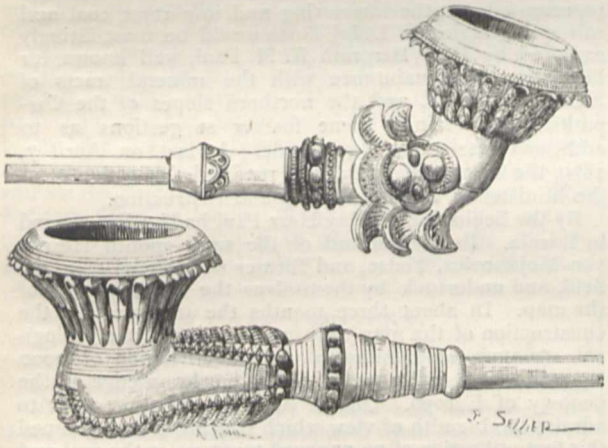


FIG. 11.—Stieng Pipes.

whereas that of the Laos is decidedly brachycephalic. Many Boloven women are remarkably beautiful in the European sense, with large straight eyes, regular features, and ruddy rather than yellow complexion. The colour of these wild tribes is often described as darker than that of their Siamese and Laos neighbours; but Dr. Harmand points out that this is due to the deep-rooted prejudice of the Laos, who habitually speak of them as even "black," though often fairer than the Laos themselves. The essential difference between the two races in this respect is precisely what we should expect, the Thai being more yellow, the Khâs, or Caucasian wild tribes, more red. This red or ruddy tinge was also noticed by Dr. A. Maurice amongst the Banhars, and the Piâks are even said to have wavy black hair with a russet hue, a trait never occurring in any pure branch of the Mongolian family.

These Caucasian tribes seem to be the true Aborigines of Indo-China, where they have been mostly supplanted, or driven to the impenetrable forests and highlands of the south-east by the intruding Mongol races, descending by the valleys of the great rivers from the Tibetan plateau. Still one branch, the Khmêrs, or Cambojans, were powerful and numerous enough to hold their ground in the lower Mekhong Valley, where, under Buddhistic influences, they established a flourishing empire and erected monuments 2000 years ago, whose stupendous ruins rival those of Java and India itself in archæological and artistic interest. Indeed it may be doubted whether there is anything in the whole world

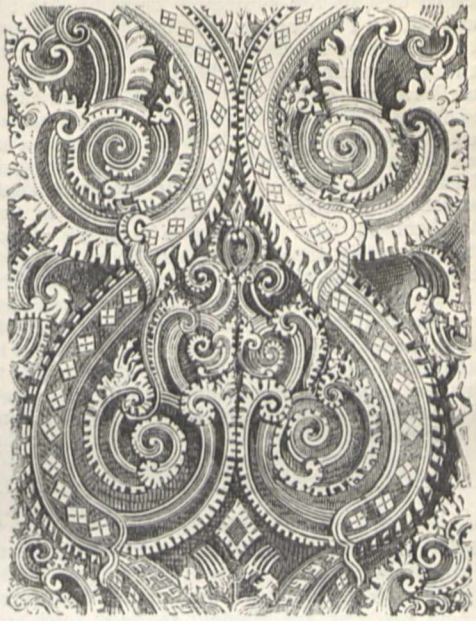


FIG. 12.—Ornamental Work on Stieng Quiver.

more wonderful in its way than the magnificent temple of Ongkor Vâht, on the northern shores of Lake Toulé-sap. It is noteworthy that the bas-reliefs and other figures on these monuments are of the same type as the present Cambojan race, with the same regular features, full beard,

FIG. 13.—Ornamental Work on Stieng Quiver.

and even their very dress, arms, and musical instruments. Traditions of this early civilisation still linger amongst the surrounding Khmêr tribes, many of whom, such as the Stiengs, Kings, and Chams, possess natural endow-

ments of a high order, cultivate their lands with great intelligence, are skilful workers in metals, and betray extreme taste in their decorative art. In the *Tour du Monde* for May 15, 1880, Dr. Harmand figures two native pipes and a quiver of a Stieng tribe, whose forms and arabesque designs are supremely beautiful (see Figs. 11, 12, and 13). "Their artistic instincts," this observer remarks, "are more developed and especially more original [than those of their Laos neighbours]. From them I have procured various objects betraying a refined taste, and woven fabrics with simple designs and well-harmonised colours." Amongst them there is prevalent a curious system of writing, at first sight somewhat suggestive of the Irish Ogham, but of a far more primitive character. It consists of a series of notches, varying in size and number, cut on both edges of a bamboo planchette, which is generally set up as a sort of public notice at the entrance to the villages. Thus a row made up of eight large, eleven medium-sized, and nine small notches was explained to mean: "Our village contains eight men, eleven women, and nine children." It is evident that in a system of this sort as wide a scope must be left to the imagination as in the hypothetical primitive speech, in which broken utterances are largely supplemented by signs and gesture. A. H. KEANE

(*To be continued.*)

GEOLOGY OF BOSNIA AND HERZEGOVINA[1]

AMID the conflict of political parties, the jealousies of rival powers, the rumours of renewed dispeace among the nations, and the smouldering embers of war that seem ready at any moment to burst forth into renewed conflagration, it is a relief to turn to a volume in which the Austrian Government has just shown to the world one of the first uses to which she has put her new acquisitions in the East. Nothing could have been more quietly and unostentatiously done, and nothing could show a more enlightened and humanising policy than the action which is modestly described in the volume before us. The story is briefly told by the Ritter von Hauer in an introductory note. It appears that immediately after the pacification of the occupied provinces of Bosnia and Herzegovina the Director of the Geological Institute at Vienna addressed to the Minister of Public Worship and Instruction (under whom the Geological Institute is placed) a letter in which he pointed out the desirability of expanding the pacific mission on which the country had entered in these provinces by organising a geological survey of them under the guidance of the Geological Institute. His representations were acceded to, and on March 9, 1879, he received instructions to commence a geological reconnaissance of the provinces with detailed investigation of such localities as might be found of sufficient importance. The task was to be undertaken conjointly by the Geological Institutes in Vienna and Buda-pest. The Director was requested as soon as possible to submit a plan of survey with proposals as to the number of geologists to be detailed and the individuals most competent for the exhaustive discharge of the duties required; and he was further instructed to put himself in direct relations with the Hungarian Geological Institute with a view to a proper sub-division of the work. Ritter von Hauer had no difficulty with one part of his instructions. Two of his staff, Dr. E. von Mojsisovics and Dr. E. Tietze, had already signified their wish to undertake the work, and Dr. Bittner expressed his desire to share in it. After some delay the Hungarian Institute made known its inability, from want of a sufficient staff, to take part in the intended survey. At last, on March 23, Director Von Hauer was able to announce to the Ministry that he was ready to begin operations. He proposed that as the work would naturally fall into two sections, (1) the preparation of a geological sketch-map of the whole occupied Provinces, and (2) a special detailed investigation of localities affording indications of salt, coal, or ores, it would be desirable to arrange the officers employed into two divisions. For the preparation of the map he suggested that four geologists should be employed, which, estimating the area to be surveyed at 1000 square German miles, would give 250 square miles to each surveyor. He recommended for this duty the three gentlemen above-named, and added the name of Prof. Hörnes of Graz as the fourth, should the Hungarian Geological Institute have no other to propose. It was of course impossible that these officers, intrusted with the task of rapidly traversing the country and seizing on the salient features of its geological structure, should have time to halt anywhere long enough to make detailed investigations for useful minerals. This part of the duties however was one in which the services of the Hungarian Geological Institute might be especially useful, seeing that the distribution of ores in the Hungarian territory bore the closest analogy to that in Bosnia. The name of Herr F. Herlich of Klausenberg was accordingly suggested as one of the most competent persons to be intrusted with this part of the survey. It was further represented that the interesting and important coal and salt-spring region of Dolnj-Tuzla would be most fittingly explored by Herr Bergrath K. M. Paul, well known for his intimate acquaintance with the mineral tracts of Slavonia, Croatia, and the northern slopes of the Carpathian Mountains. Some further suggestions as to additional assistants were made. At last on April 7, 1879, the scheme of operations received the sanction of the Minister of Public Worship and Instruction.

By the beginning of May Herr Paul had broken ground in Bosnia. Before the end of the same month Herren von Mojsisovics, Tietze, and Bittner were likewise in the field, and undertook by themselves the whole burden of the map. In about three months the traverses for the construction of the map were completed, and the geological structure of a hitherto unexplored region of 1000 square German miles was added to our knowledge of the geology of Europe. One is at a loss whether most to admire the breadth of view which conceived and planned this first utilisation of an annexed territory, or the zeal and capacity which so rapidly carried out and completed the conception.

The *Jahrbuch der k. k. Geologischen Reichsanstalt* is one of the best-known and most useful geological journals in existence. The present number considerably exceeds the usual size of the periodical, since it is expanded by containing the reports of the geologists upon the recent survey of Bosnia-Herzegovina. Dr. von Mojsisovics takes West Bosnia and Turkish Croatia. In his report, after acknowledging assistance received in the country and enumerating the literature of the subject, in which the work of the veteran Ami Boué stands in the foremost place, the author proceeds to give a general outline of the topography and geology of the region examined by him. Most of his survey was done on horseback. He chose various traverses of the country, noting down by the way his observations upon the general map of Europe on a scale of $\frac{1}{300000}$, published by the Military Geographical Institute of Vienna. The first section of his report is devoted to geological topography, and includes some interesting information regarding what has been termed the "oriental fixed land"—an ancient island or nucleus round which, in the Balkan Peninsula, the Lias and more recent formations have been ranged. The second section treats of the geological formations in stratigraphical order, the more important being Triassic, Jurassic, Cretaceous, and Flysch, the last-named belonging partly to the Cretaceous

[1] *Jahrbuch der k. k. Geologischen Reichsanstalt*, Band xxx. Heft ii., containing "Grundlinien der Geologie von Bosnien-Hercegovina," von Dr. E. v. Mojsisovics, Dr. E. Tietze, und Dr. A. Bittner, mit Beiträgen von Dr. M. Neumayr und C. v. John. Vienna, 1880. The work is also published separately by Holder of Vienna, with a preface by Fr. v. Hauer.

and partly to the Eocene system. Among the younger formations the author devotes a couple of pages to sub-aërial deposits, including the results of the superficial weathering of rocks and the formation of "eluvial" accumulations. The third section describes the geological structure of different traverses of the country, and localities of geological interest, while a supplement contains observations on the mineral resources of the ground reported upon.

Dr. Tietze describes in a similar methodical way the geology of East Bosnia, while Dr. Bittner takes the Herzegovina and the south-east part of Bosnia. These reports are full of interest, especially in relation to the Cretaceous and Tertiary geology of the east of Europe. To some of the questions discussed in them we may return on another occasion. Though the geologists in their rapid marches had little time to collect specimens they nevertheless found opportunity to carry off some rocks and fossils which were found of sufficient importance to deserve special description. Herr C. v. John gives a report on some crystalline rocks of the Provinces, including granite, older plagioclase rocks, younger diabases, diorites, and similar rocks from the Flysch, gabbros, serpentines, eclogites, with trachytic and andesitic lavas. Dr. Neumayr describes a series of brackish-water shells from the Tertiary formations of the Provinces.

The Geological Institute of Vienna may be congratulated on the signal success of its well-planned and admirably-conducted enterprise. Rarely has so compendious a body of detailed information in geology been so rapidly accumulated and so promptly published. Ritter von Hauer's preface is dated March 1, 1880—that is within a year from the time when his proposal for the Survey was laid before the Austrian Government. These few months sufficed for the field-work, for the elaboration of the reports, and for the preparation of the map and engravings. The Reports form a volume of 333 closely-printed octavo pages. The map is issued in one sheet on the scale of $\frac{1}{576000}$, with twenty-one colours. ARCH. GEIKIE

MICHEL CHASLES

Born November 15, 1793, *Died December* 18, 1880.

"KNOW ye not that there is a prince and a great man fallen this day?" might well have been the thought of the President Becquerel when he announced to the Academy on the 20th ult. that Chasles was dead. To many the man who had surpassed in age Leibnitz by seventeen, Euler by eleven, Lagrange by ten, Laplace and Gauss by nine, and Newton by two years, was a "venerabile nomen," but yet a "nomen" only.

As far back as the present generation can remember Chasles has been a prince of geometers, and it has come upon many of us as a surprise to hear that he was still walking and working in our midst. A few years back a telegram was sent him from Boston conveying congratulations, and expressing the hope that the illustrious mathematician might see the close of the present century, in which event he would have surpassed the years of Pythagoras. Length of days is not always a boon, but Chasles's was a pleasant old age, and he died in harness: in such a case he might say with one of old, "nihil habeo quod incusem senectutem." "La vie de M. Chasles a été heureuse et simple; il a trouvé dans la Science, avec les plus grandes joies, une gloire qui sera immortelle, et dans la vive affection de ses amis, dans leur assiduité empressée aux réunions où il les conviait avec une grâce si aimable, dans leur respectueuse déférence en toute circonstance, la consolation de sa vieillesse."

Born at Epernon (Eure-et-Loir), he entered the École Polytechnique in 1812. At this early date he would communicate to students in the rival colleges the problems and exercises of the week, asking in return the questions proposed by their masters: "Dans cet échange organisé par le jeune lycéen, on peut croire aisément que le futur géomètre avait souvent la meilleure part." After taking his place in the defence of Paris in 1814 he passed out in engineering, but he re-entered the school in 1815. And this is the reason: Chasles was on the point of leaving for Chartres to show his uniform and to bid farewell to his mother before going to Metz, when he was waited on by the father of one of his comrades. "Mon fils," said the father, "est le premier des élèves qui n'ont pas obtenu de place; vous avez hésité, je le sais, à accepter l'épaulette; votre refus aurait assuré à votre camarade une carrière qui lui plaît et pour laquelle j'ai fait les derniers sacrifices; il m'est impossible de les continuer pour lui en préparer une autre." Chasles made no reply: he went to Chartres; on his arrival his choice was made, and he told his mother he would stay with her. The army lost him as an officer, the world gained him as a geometer. On finally leaving the establishment, in spite of the high position he held amongst his companions, he voluntarily renounced public employment (Larousse states however: "Fut agent de change et plus tard aux affaires pour les sciènces") and went to Chartres, where he spent some ten years. He was working quietly however: "Toujours passionné pour la géométrie, il résolvait de beaux problèmes, comme au collège, trouvait chaque jour d'élégants théorèmes, inventait des méthodes générales et fécondes, sans attirer l'attention des maîtres de la science et sans y prétendre. 'Que de talent perdu!' disaient les plus bien-veillants, sans songer même à traiter d'égal ce jeune homme obstiné à approfondir les théories élémentaires et qui bientôt peut-être devait, par elles, s'élever bien au-dessus d'eux." Elected a Corresponding Member of the Academy in 1839 ("decorated" the same year), he was made "Professeur de Machines et de Géodésie" at the École Polytechnique, in succession to Savary in 1841. This chair he occupied for ten years, when, in consequence of some alterations ("profondes et très regrettables" [1]), he sent in his resignation, and ever afterwards did all in his power to combat these, as he thought, dangerous reforms. His affection however continued unabated: "C'est ainsi qu'il acceptait avec tout d'empressement la présidence du Comité de la Société amicale des Anciens Élèves; c'est ainsi qu'il entrait au conseil de perfectionnement, et que, tout récemment encore, malgré son grand âge, il acceptait le renouvellement de son mandat, avec le désir, disait-il, de continuer jusqu'à son dernier souffle á entretenir ce foyer de travail, d'honneur et de dévouement au pays." With the ardour which so distinguished him, M. Chasles had undertaken to write a history of the school; an extract from this history he recently published: "Exposé historique concernant le Cours de Machines, dans l'Enseignement de l'École Polytechnique" (see notice in NATURE, vol. xxiii. p. 75). M. Laussedat informs us that the veteran's wish is in great part attained, and that it was with great pleasure Chasles learned before his death that the *Journal de l'École Polytechnique* is to be revived, and that the revision of the "programmes de l'enseignement" was decided upon. In France the professorial chairs are *special*.[2] Poinsot was, for some years, desirous that a chair should be appointed for the Modern Geometry, and in 1846 this chair was created by the Faculté des Sciences, and Chasles was elected to be the first occupant. In 1851 he was elected a Member of the Academy, and in the same year, as above stated, gave up his appointment at the Polytechnic. In 1854 he became Foreign Member of our Royal Society, in 1865 he was awarded the Copley medal, and in April, 1867, he was elected the first (and for some time the only) Foreign Member of the London

[1] Note, p. 583, to the admirable "Discours d'Inauguration de Cours de Géométrie Supérieure de la Faculté des Sciences de Paris" (December 22, 1846), which follows the second edition of the "Traité de Géométrie Supérieure" (1880).

[2] "Toutes les chaires ont un titre special." "Rapport sur les Progrès de la Géométrie," Paris, 1870, pp. 219, 376.

Mathematical Society. His honours of membership were numerous, and are printed on the title-pages of his works. The Pascal-Newton controversy has already been alluded to in these pages, and we willingly leave it here untouched.

"M. Chasles a poursuivi son œuvre sans interruption depuis sa sortie du Lycée jusqu'à l'âge de quatre-vingt-sept ans. Soixante-huit années séparent la première note de l'élève Chasles, insérée dans la *Correspondance sur l'École Polytechnique*, du dernier mémoire présenté à l'Académie des Sciences. Tous les géomètres, sans distinction de nationalité ni d'école, se sont inclinés devant ce vénérable vieillard; tous ont admiré sa puissance d'invention, sa fécundité, que l'âge semblait rajeunir, son ardeur, et son zèle, continués jusqu'aux derniers jours."

A mere recital of the titles of M. Chasles' numerous papers would fill several columns. In the "Catalogue of Scientific Papers" will be found the titles of 177, and from the slight examination we have been able to make we have little doubt that the number published since 1873 would bring the total to nearly 240. The subjects range over curves and surfaces of the second and of any degree, geometry, mechanics (and attractions), history, and astronomy. Amongst his earliest papers are those which were translated by the present Bishop of Limerick in 1841, under the title "Two Geometrical Memoirs on the General Properties of Cones of the Second Degree, and on the Spherical Conics." "These possess strong claims on the attention of mathematicians, whether they are considered merely as exercises of pure geometry, exhibiting its elegance and power in a remarkable degree, or as a rich and early contribution to the theory of spherical curves."

Chasles himself remarks in his *Rapport*[1] (which perhaps furnishes the best key to his writings), "On peut s'étonner que, jusque vers la fin du premier tiers de ce siècle, on n'ait eu l'idée d'étudier ni les propriétés des cônes du second ordre qui servent à engendrer les coniques, ni celles des courbes qui tiennent sur la sphère le rang des coniques sur le plan" (p. 75).

In reply to the question, "On demande un examen philosophique des différentes méthodes employées dans la géométrie récente et particulièrement de la méthode des polaires reciproques," was written, "Mémoire de Géométrie sur deux Principes généraux de la Science, la Dualité, et l'Homographie" (January, 1830, to the Académie Royale of Brussels), preceded by some historical researches. This work subsequently took the form of the famous "Aperçu historique sur l'Origine et le Developpement des Méthodes en Géométrie . . . . suivi d'un Mémoire . . . sur deux Principes généraux . . . et l'Homographie." This work appeared in 1837, and having become exceedingly scarce, was reprinted verbatim in 1875, with the addition of a short preface giving a brief historical account of the book. In the *Rapport* (p. 80) we are told "c'est cette troisième partie" (the memoir on Duality and Homography) "qui à donné lieu à la composition de l'ouvrage. La théorie des figures homologiques et celle des polaires reciproques qui sont la base des beaux travaux de l'illustre Général Poncelet donnèrent une heureuse impulsion aux recherches de pure géométrie." These two methods were susceptible, he says, of generalisation, and the progress of the science demanded it. The *Aperçu*, which has been translated into German (except the third part) by Sohncke, is a perfect mine of geometrical facts, and is to the present day a high authority on the subject of which it treats. In some places too great reliance on Montucla (see Dr. Allman on "Greek Geometry from Thales to Euclid," p. 171, cf. also p. 202), and in others non-acquaintance with German ("nous éprouvons un vif regret de ne pouvoir citer ici leurs ouvrages, qui nous sont inconnues, par suite de notre ignorance de la langue dans laquelle ils sont écrits," p. 215) may slightly detract from its merits, but after all deductions it exhibits a vast amount of research and originality, and well merits the title of *ouvrage classique*.[1]

The appointment to the Chair of Modern Geometry necessitated a course (or courses) of lectures, and in 1852 these were embodied in the "Traité de Géométrie supérieure," "an elaborate and masterly treatise," which of late years has been rarely attainable, and only at a very high price. M. Chasles, hardly two months before his death, had the satisfaction of seeing a second edition, accompanying which is (pp. 547-585) the excellent "Discours d'Inauguration" (referred to above). The three fundamental principles of this work are "Anharmonic Ratio of Four Points," "Homographic Divisions," and "Involution" (*Rapport*, p. 220).

In 1865 appeared the first volume of the "Traité des Sections coniques, faisant suite au Traité de Géométrie supérieure." As its title indicates, constant application is made in it of the principles of pure geometry unfolded in the earlier work. It thus differs considerably not only from analytical treatises, but from geometrical treatises also: "Ces trois théories primordiales s'appliquent avec une extrême facilité à toutes les recherches concernant les sections coniques" (*Rapport*, pp. 266-9).

Mathematicians have long looked for a second volume, materials for which have appeared in the *Comptes rendus*. In the *Rapport* (pp. 257-266) will be found an account of the method of *geometrical substitution* and a definition of the *elements* (or *characteristics*) of a system of conics (*Comptes rendus*, 1864-7). Numerous applications are made of this remarkable theory (for further accounts the English student may refer to Dr. Salmon's "Higher Plane Curves," pp. 360, &c., and "Conics," p. 368; see also later papers in the *Comptes rendus*, vol. lxxviii.[2] p. 577, &c., vol. lxxxv. p. 362, pp. 460-6).

We must now go back to the year 1863, when Chasles published his "Les trois Livres de Porismes d'Euclide, rétablis pour la première Fois, d'après la Notice et les Lemmes de Pappus, et conformément au Sentiment de R. Simson, sur la Forme des Enoncés de ces Propositions." In 1838 he had contributed a paper, "Sur la Doctrine des Porismes d'Euclide," to Quetelet's *Corresp. Math.* x. (pp. 1-23). We must content ourselves with referring to the *Rapport*, pp. 155, 233-42; the *Aperçu*, pp. 39, &c. (He cites Montucla as to the profoundness of the Porisms, gives high praise to Simson, and shows that there is in Pappus's Lemmas what is in effect the projective property of the anharmonic ratio of four points). The publication of this work led to a short controversy with M. P. Bréton ("Question des Porismes—notices sur les débats de priorité auxquels a donné lieu l'ouvrage de M. Chasles sur les porismes d'Euclide," Paris, 1865; and a second part, Paris, 1866). M. Chasles comments on these in the *Rapport* (cf. reff. above).

We turn now for a moment to the subject of attraction. "La question de l'attraction presenta-t-elle à l'auteur sous plusieurs points de vue, qui donnèrent lieu à divers mémoires et s'étendirent même au problème général de l'attraction d'un corps de forme quelconque" (*Rapport*, p. 101); on p. 103 he gives a history of Maclaurin's theorem (of which Todhunter—"History of the Theories of Attraction," &c., vol. i. 260, writes: "Chasles is correct"); on p. 105 we read: "Mais il restait toujours à désirer une démonstration directe et rigoureuse du théorème de Maclaurin;" and he cites an extract from Poinsot's report on his paper (*Mémoires* par divers Savants, t. ix. 1846): "Ce mémoire remarquable nous offre un nouvel exemple de l'élégance et de la clarté que la géométrie peut répandre sur les questions les plus

[1] Pp. 72–126, 220-280, contain an account of the author's own contributions to geometry.

[1] De Morgan says, "A work of great importance in the historical point of view."

[2] "Considérations sur le caractère propre du principe de correspondance," "S'applique avec une très grande facilité, à une infinité de questions."

obscures et les plus difficiles" (*Comptes rendus*, t. vi. 1838, pp. 808–812).

This, the first *synthetic* solution (of General Sabine's address on presenting the Copley Medal) was published, if we mistake not, in 1837. M. Bertrand, in his *éloge* of Lamé (January 28, 1878, *Mémoires* de l'Académie des Sciences), says "M. Chasles obtenait, en la transportant à la théorie si souvent étudiée de l'attraction des ellipsoïdes, des démonstrations et des résultats admirés comme un modèle d'élégance et de généralité."

We have no space left, having perhaps already dwelt too much in detail upon the complete works, to give an account of the numerous papers we referred to above. This is the less necessary as the results of many are already incorporated in the larger works. We must however just mention the important mechanical principle founded upon the proposition "quand deux polygones égaux sont placés d'une manière quelconque dans un plan, il existe toujours un point du plane qui est également distant de deux sommets homologues quelconques des deux polygones, le point est semblablement placé par rapport aux deux polygones."

The applications of this, under Poncelet's form of enunciation, are fully treated of by Richard in his "Note sur un nouveau principe de cinématique sur son emploi et sur la Théorème de M. Chasles" (Paris, 1856).

In the closing lines of the *Rapport* M. Chasles indignantly condemns the modern system which has for its supreme and immediate object *des applications pratiques;* and which is "caractérisée suffisamment par l'idée fatale de *bifurcation.*" These remarks we pass over, but gladly draw attention to a wish which he strongly expresses, viz. that a defect should be remedied by the creation of two chairs, one for "Géométrie infinitésimale et analytique," and the other for "Analyse transcendante." If these chairs do not now exist, it would be a fitting compliment to his memory to establish one or both. One other wish we have which we repeat, and that is, following the fashion of the time, that a collected edition of his papers be issued, for at present they are scattered over a very wide area.

In this notice we are indebted to the funeral speeches pronounced over M. Chasles's grave (*Comptes rendus*, xci. No. xxv., December 20, 1880) which, and M. Chasles's own remarks, we have freely cited in their original language, thereby securing conciseness of expression.

We must however linger no longer by the grave, but turn to the "living present," after repeating M. Dumas's last words, "Adieu, Chasles, adieu!" R. TUCKER

PROF. HUXLEY ON EVOLUTION[1]

II.

IF all the Mammalia are the results of a process of evolution analogous to that which has taken place in the case of the Equidæ, and if they exhibit different degrees of that process, then a natural classification will arrange them, in the first instance, according to the place which they occupy in the scale of evolution of the mammalian type, or the particular rung of the "scala mammalium" on which they stand. The determination of the position thus occupied by any group may, I think, be effected by the deductive application of the laws of evolution. That is to say, those groups which approach the non-mammalian Vertebrata most closely, present least inequality of development, least suppression, and least coalescence of the fundamental parts of the type, must belong to earlier stages of evolution; while those which exhibit the contrary characters must appertain to later stages.

Judged from this point of view, there can be no doubt that the Monotremes embody that type of structure which constitutes the earliest stage of mammalian organisation:—

1. The mammary glands are devoid of teats; and thus the essential feature of the mammal could hardly be presented under a simpler form.

2. There is a complete and deep cloaca, as in Vertebrata lower in the scale.

3. The openings of the ureters are *hypocystic*—that is to say, they open, not into the bladder of these animals, but behind it, into the dorsal wall of the genito-urinary passage. As this answers to the neck of the allantois, the ureters of the Monotremes retain their primitive embryonic position.

4. There is no vagina apart from the genito-urinary passage, and the oviducts are not differentiated into distinct uterine and Fallopian regions.

5. The penis and the clitoris are attached to the ventral wall of the cloaca.

6. The epiphyses of the vertebræ are but slightly, or not at all developed.[1]

7. The malleus is relatively very large, and the "processus gracilis," which is singularly long and strong, passes between the tympanic and the periotic bones to the pterygoid, with which it is firmly united. Thus the palato-pterygoid apparatus is directly connected by a "suspensorium" with the periotic, as in the Amphibia and Sauropsida. As in these, the representative of the incus is extremely small and that of the stapes columelliform.

8. The coracoid is complete, distinct, and articulates with the sternum.

9. The hip-girdle is provided with large epipubes, and the iliac axis is inclined at a large angle to the sacral axis.

10. The corpus callosum is very small.

11. There appears to be no allantoic placenta, though, from the obvious remains of the ductus arteriosus and of the hypogastric arteries, there can be little doubt that the fœtus has a large respiratory allantois. It is quite possible that, with a large umbilical sac, there may be an imperfect "umbilical" placentation.

But, while the *Ornithorhynchus* and the *Echidna* are thus the representatives of the lowest stage of the evolution of the Mammalia, I conceive it to be equally unquestionable that, as Haeckel has already suggested, they are greatly modified forms of that stage—*Echidna*, on the whole, representing a greater, and *Ornithorhynchus* a less, departure from the general type. The absence of true teeth in both genera is an obvious sign of extreme modification. The long tongue, extraordinary external auditory passages, and relatively large convoluted brain of *Echidna*, and the cheek-pouches and horny mouth-plates of *Ornithorhynchus*, are other indications of the same kind.

Hence, the primary mammals which were less modified, and the existence of which is necessarily postulated in the conception of the evolution of the group, cannot, without risk of confusion, be called Monotremata or Ornithodelphia, since in all probability they were as widely different from *Ornithorhynchus* and *Echidna* as the Insectivora are from the Edentata, or the Ungulata from *Rhytina*. It will therefore be convenient to have a distinct name—*Prototheria*—for the group which includes these, at present, hypothetical embodiments of that lowest stage of the mammalian type, of which the existing Monotremes are the only known representatives.

A similar reasoning applies to the Marsupialia. In their essential and fundamental characters they occupy an

[1] Continued from p. 204. By the courtesy of the Secretary of the Zoological Society we are able to give the remainder of the paper "On the Application of the Laws of Evolution to the Arrangement of the Vertebrata, and more particularly of the Mammalia," by Prof. T. H. Huxley, F.R.S.

[1] Dr. Albrecht ("Die Epiphysen und die Amphiomphalie der Säugethierwirbel-körper:" *Zoologischer Anzeiger*, 1879, No. 18), while admitting that *Echidna* has no epiphyses, describes epiphyses of an incomplete character between the posterior twelve caudal vertebræ of *Ornithorhynchus*. So far as I am aware, the memoir of which Dr. Albrecht has given a preliminary notice, has not yet been published. I content myself therefore with remarking that my own recent observations are in harmony with Dr. Albrecht's statement.

intermediate position between the Prototheria and the higher mammals.

1. The mammary glands are provided with teats.

2. The cloaca is so greatly reduced that it is often said to have disappeared.

3. The openings of the ureters are *entocystic*—that is to say, the ureters open into what is called the "base" of the bladder in front of the narrowed "neck" by which it passes into the tubular "urethra." This means, I conceive, that, morphologically, the bladder of the Marsupial represents the bladder of the Monotreme + the anterior part of the genito-urinary passage; the so-called "trigonum," if not more, of the bladder of the Marsupial, being the homologue of that anterior segment of the genito-urinary passage of the Monotreme.

4. There is a distinct and long vagina, quite separated from the cystic urethra, in the female; and the oviducts are differentiated into uterine and Fallopian portions.

5. The penis is large, and the corpora cavernosa are connected by fibrous tissue and muscles with the pelvis. The spongy body has a large bifurcated bulb, and Cowper's glands are very largely developed.

6. The vertebræ have distinct epiphyses.

7. The malleus is small, and its connections are similar to those which it possesses in the higher mammals. The incus is relatively larger, and the stapes more or less stirrup-shaped.

8. The coracoid is short, does not articulate with the sternum, and becomes ankylosed with the scapula.

9. The hip-girdle is provided with epipubes, usually of large size and well ossified; and the iliac axis is inclined at a small angle to the sacral axis.

10. The corpus callosum is small.

11. In the few forms of which the fœtus is known there is no allantoic placenta; while the umbilical sac is so large that the possibility of the existence of a transitory umbilical placentation must be taken into account.

It will be observed that in the characters 1, 2, 3, 4, 5, 6, 7, 8, and the latter part of the 9th, the Marsupials agree with the higher mammals; while in the former part of the 9th, the 10th, and the 11th, they present Prototherian characters. So far, therefore, they constitute an intermediate type between that of the Prototheria and that of the higher mammals, which may be termed that of the *Metatheria*. And if there were any known animals which combined these characters, with a complete double dentition, unmodified pentadactyle manus and pes, and normal uterogestation, they would furnish us the exact transition between the Prototheria and the higher mammals, which must have existed if the law of evolution is trustworthy.

No known Marsupial, however, possesses these additional characters. None has more than a single successional tooth on each side of each jaw; and, as Prof. Flower (to whom we owe the highly important demonstration of this fact) has pointed out, the question arises whether we have here a primary dentition with only one secondary tooth, or a secondary dentition with only one tooth of the primary set left. I have no doubt that the answer given to this question by Prof. Flower is correct, and that it is the milk-dentition of which only a vestige is left in the Marsupialia. Among existing Rodents, in fact, all conditions of the milk-dentition exist, from a number equal to that of the permanent incisors and premolars (as in the Rabbit [1]) to none at all.

The same thing is observed in the Insectivora, where the Hedgehog, and probably *Centetes*, have a full set of milk-teeth, while none have yet been found in the Shrews. In these cases, it is obvious that the milk-dentition has gradually been suppressed in the more modified forms; and I think that there can be no reasonable doubt that the existing Marsupials have undergone a like suppression of the deciduous teeth, in the course of their derivation from ancestors which possessed a full set.

Again, no existing Marsupial possesses an unmodified pentadactyle pes. If the hallux is present, it presents an extensive movement in adduction and abduction; in fact, the pes is prehensile. This is the case in the *Phascolomyidæ*, *Phalangistidæ*, *Phascolarctidæ*, and *Didelphidæ*. The *Dasyuridæ* present the same type of pes, with the hallux reduced or suppressed. Hence, considering the relations of the *Macropodidæ* and the *Peramelidæ* with the Phalangers, it seems likely that the hind foot in these groups is also a reduced prehensile pes; in which case this special modification of the foot would characterise the whole of the existing *Marsupialia*.

Thirdly, the most marked peculiarities of the reproductive organs and processes in the Marsupial are in no wise transitional, but are singularly specialised characters. The suspension of the scrotum in front of the root of the penis is unlike any arrangement in the higher mammals, and the development of the bulb and of Cowper's glands is in excess of anything observable in them. In the female, the cystic urethra is as completely separated from the vagina as it is in the higher mammals; while the doubling of the vagina must, in my opinion, also be considered as a special peculiarity which leads from, rather than towards, the higher mammals. In a Monotreme, in fact, the anterior end of the genito-urinary passage exhibits two very short dilatations or cornua, one on each side. In the middle line, a little distance behind these, the ureters open on a prominent ridge-like papilla. The opening of the bladder lies in front of and below the genital cornua. Now, if we compare this arrangement with that which obtains in the lower forms of the higher Mammalia, we find that the ureteric papillæ have separated laterally and moved forwards, in such a manner as to occupy the base of the bladder, and the genital cornua come to lie behind and somewhat dorsad of them. At the same time a longitudinal separation has taken place between what may be called the "ureteric" region of the genito-urinary passage and the "genital" region. The first is taken into the bladder and becomes connected by a longer or shorter "cystic urethra" with the latter, which is converted into the longer or shorter vagina. In the Marsupial the same general modification has taken place; but the "genital cornua" become immensely elongated, and give rise to the so-called "double" vagina.

Lastly, the marsupium, where it exists, is a no less special feature of the Marsupialia, and, like the peculiarities of the female genital organs, appears to be related with the abnormally early birth of the fœtus. Among the higher Mammalia, it is well known that the fœtus is born in a relatively much earlier state in some cases than in others, even among closely allied species. Thus Rabbits are born hairless and blind, while Hares are born hairy and with their eyes open. I think it probable, from the character of the pes, that the primitive forms, whence the existing Marsupialia have been derived, were arboreal animals; and it is not difficult, I conceive, to see that with such habits it may have been highly advantageous to an animal to get rid of its young from the interior of its body at as early a period of development as possible, and to supply it with nourishment during the later periods through the lacteal glands, rather than through an imperfect form of placenta.

However this may be, the characters of the existing Marsupialia leave no doubt on my mind that they are greatly modified members of the metatherial type; and I suspect that most, if not all, of the Australian forms are of comparatively late origin. I think it probable that the

[1] The deciduous molars and the posterior deciduous upper incisors of the Rabbit have been long known. But I have recently found that unborn Rabbits possess, in addition, two anterior upper and two lower deciduous incisors. Both are simple conical teeth, the sacs of which are merely embedded in the gum. The upper is not more than one-hundreth of an inch long, the lower rather larger. It would be interesting to examine fœtal Guinea-pigs in relation to this point; at present they are known to possess only the hindmost deciduous molars, so far agreeing with the Marsupials.

great majority of the Metatheria, of which I doubt not a great multitude will shortly be discovered in Mesozoic formations, differed widely from our existing Marsupials; not only lacking the pouch, as do some existing "Marsupialia," but possessing undivided vaginæ, and probably bringing forth their young, not earlier than existing Carnivores and Rodents do, the nutrition of the fœtus during prolonged gestation being provided for, in all probability, by an umbilical placental apparatus, and its respiration by a non-placental allantois.

In the remaining group of the Mammalia, hitherto spoken of as the "higher Mammalia:"—

1. The mammary glands are provided with teats.[1]

2. The cloaca has usually disappeared. Sometimes, however (Beavers, Sloths), a shallow cloaca is present, especially in the female.

3. The openings of the ureters are always entocystic; but their position varies greatly, from close to the neck (e.g. *Sorex*) to the anterior end of the bladder (e.g. *Hyrax*).

4. There is a distinct vagina, which is almost always undivided. The oviducts are differentiated into uterine and Fallopian portions.

5. The penis is usually large, the bulb single or partially divided, and the corpora cavernosa almost always directly attached to the ischia.

6. The vertebræ have epiphyses.

7. The malleus is usually small, the incus relatively large, the stapes stirrup-shaped.

8. The coracoid is almost always much reduced, and it is ankylosed with the scapula.

9. The iliac axis makes a small angle with the sacral axis; and there is no epipubis, or only a fibrous vestige of it.

10. The corpus callosum and the anterior commissure vary widely. In such forms as *Erinaceus* and *Dasypus* they are almost Monotreme-like.

11. The fœtus is connected with the uterus of the mother by an allantoic placenta. The umbilical sac varies in size, and in some lower forms (e.g. *Lepus*) it is, at first, highly vascular, and perhaps plays a quasi-placental part during the early stages of development.

It is obvious that, in all these respects, we have the mammalian type in a higher stage of evolution than that presented by the Prototheria and the Metatheria. Hence we may term forms which have reached this stage the *Eutheria*.

It is a fact, curiously in accordance with what might be expected on evolutionary principles, that while the existing members of the Prototheria and the Metatheria are all extremely modified, there are certain forms of living Eutheria which depart but little from the general type. For example, if *Gymnura* possessed a diffuse placentation, it would be an excellent representative of an undifferentiated Eutherian. Many years ago, in my lectures at the Royal College of Surgeons, I particularly insisted on the central position of the Insectivora among the higher Mammalia; and further study of this order and of the Rodentia has only strengthened my conviction, that any one who is acquainted with the range of variation of structure in these groups, possesses the key to every peculiarity which is met with in the Primates, the Carnivora, and the Ungulata. Given the common plan of the Insectivora and of the Rodentia, and granting that the modifications of the structure of the limbs, of the brain, and of the alimentary and reproductive viscera, which occur among them, may exist and accumulate elsewhere, and the derivation of all the *Eutheria* from animals which, except for their simpler placentation, would be Insectivores, is a simple deduction from the law of evolution.

There is no known Monotreme which is not vastly more different from the Prototherian type, and no Marsupial which has not far more widely departed from the Metatherian type, than *Gymnura*, or, indeed, *Erinaceus*, have from the Eutherian type.

The broadest physiological distinction between the Prototheria, the Metatheria, and the Eutheria respectively lies in the differences which the arrangements for prolonging the period of intra-uterine and extra-uterine nutrition by the parent present in each. The possibility of a higher differentiation of the species is apparently closely connected with the length of this period. Similarly, the broadest morphological distinction which can be drawn among the *Eutheria* lies in their placentation. All forms of deciduate placentation commence by being non-deciduate, and the intimate connection of the fœtal with the maternal structures is subsequent to their loose union. Hence *Eutheria*, with deciduate placentæ, are in a higher stage of evolution than those with non-deciduate placentæ.

In discussing the relations of the various existing groups of the higher Mammalia with one another, it would be a mistake to attempt to trace any direct genetic connection between them. Each, as the case of the Equidæ suggests, has probably had a peculiar line of ancestry; and, in these lines, Eutherian forms with deciduate placentation constitute the latest term, Eutherian forms with non-deciduate placentation the next latest, Metatherian forms the next, Prototherian forms the earliest among those animals which, according to existing definition, would be regarded as Mammals.

The accompanying Table (p. 230) presents, at a glance, the arrangement of the Mammalia in accordance with the views which I have endeavoured to express. The sign O marks the places on the scheme which are occupied by known Mammals; while × indicates the groups of which nothing is known, but the former existence of which is deducible from the law of evolution.

I venture to express a confident expectation that investigation into the Mammalian fauna of the Mesozoic epoch will sooner or later fill up these blanks. But if deduction from the law of evolution is to be justified thus far, it may be trusted much farther. If we may confidently expect that *Eohippus* had a pentadactyle claviculate ancestor, then we may expect, with no less confidence, that the *Prototheria* proceeded from ancestors which were not mammals; in so far as they had no mammary glands, and in so far as the mandible was articulated with a quadrate bone or cartilage, of which the malleus of the true mammal is the reduced representative. Probably also the corpus callosum had not appeared as a distinct structure.

Our existing classifications have no place for this "submammalian" stage of evolution (already indicated by Haeckel under the name of *Promammale*). It would be separated from the Sauropsida by its two condyles, and by the retention of the left as the principal aortic arch; while it would probably be no less differentiated from the Amphibia by the presence of an amnion and the absence of branchiæ at any period of life. I propose to term the representatives of this stage *Hypotheria;* and I do not doubt that, when we have a fuller knowledge of the terrestrial Vertebrata of the later palæozoic epochs, forms belonging to this stage will be found among them. Now, if we take away from the Hypotheria the amnion and the corpus callosum, and add the functional branchiæ—the existence of which in the ancestors of the Mammalia is as clearly indicated by their visceral arches and clefts, as the existence of complete clavicles in the ancestral Canidæ is indicated by their vestiges in the dog—the Hypotheria, thus reduced, at once take their place among the Amphibia. For the presence of branchiæ implies that of an incompletely divided ventricle and of numerous aortic arches, such as exist in the mammalian embryo, but are more or less completely suppressed in the course of its development.

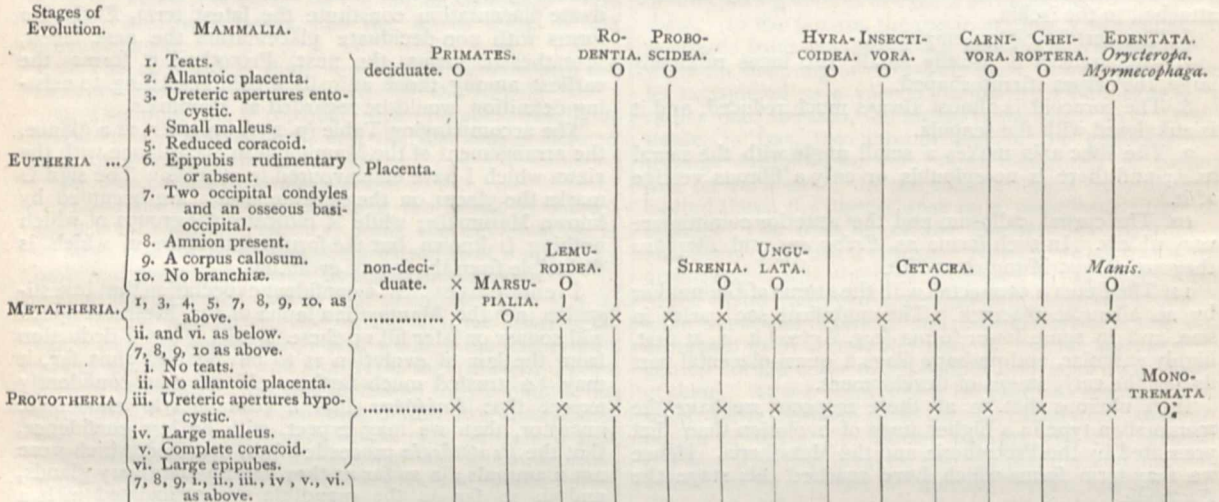
[1] The only exception known to me is the Cape Mole (*Chrysochloris*), which, according to Peters, has none.

Thus I regard the Amphibian type as the representative of the next lower stage of vertebrate evolution; and it is extremely interesting to observe that even the existing Amphibia present us with almost every degree of modification of the type, from such forms as the oviparous, branchiate, small-lunged *Siredon* and *Menobranchus*, which stand in the same relation to it as *Gymnura* to the Eutheria, to the exclusively air-breathing Salamanders and Frogs, in which the period of intraovular development, either within the uterus itself or in special receptacles, may be as much prolonged as it is in the Mammalia.

A careful study, on full materials, of the development of the young of such forms as *Hylodes* will probably throw great light on the nature of the changes which ended in the suppression of the branchiæ, and the development of the amnion and of the extra-abdominal part of the allantois in the fœtus of the higher Vertebrata.

The recent researches of Boas[1] on the structure of the heart and the origin of the pulmonary arteries of *Ceratodus* fell into my hands when I happened to be working afresh at the subject, and had arrived, so far as the heart is concerned, at results which are entirely confirmatory of his. This wonderful creature seems contrived for the illustration of the doctrine of evolution. Equally good arguments might be adduced for the assertion that it is an amphibian or a fish, or both, or neither—the reason of this being that, as it appears to me, *Ceratodus* is an extraordinarily little modified representative of that particular stage of vertebrate evolution of which both the typical Fishes and the typical Amphibia are special modifications. I think it will be convenient to have a name for the representatives of this stage, and I propose that of *Herpetichthyes*.

If we were to take away from *Ceratodus* the membrane-bones of the heart and the pneumatocœle, and slightly simplify the structure of the heart, the result would be an animal which would undoubtedly be classed among the *Chimeroidei*; and if, in such a Chimæroid, the lamellar septa of the branchiæ were not reduced, as they are in the *Chimæroidei*, while the opercular fold remained undeveloped, the product would be a little modified representative of the Selachian group, to which, among actually known forms, *Heptanchus* and *Cestracion* present the nearest approximations. Vertebrated animals in this stage of evolution may be termed *Chondrichthyes*.



Suppose the limbs and the genital ducts of the *Chondrichthyes*-stage to be undeveloped, and let the two nasal sacs be represented by a partially divided sac with a single external aperture, the result will be a still lower grade of vertebrate life, which may be termed *Myzichthyes*, represented only by the greatly modified Lampreys and Hags of the existing fauna.

Finally, let the head retain its primitive segmentation, and the heart its primitive character of a contractile tube, and we reach, in the *Hypichthyes*, a stage of simplification of the vertebrate type, from which it would be difficult to remove any essential feature without reaching a point at which it is questionable whether an animal should be called "vertebrate." This stage is at present represented only by a singularly modified form, the living *Amphioxus*.

Thus, in the order of evolution all the Vertebrata hitherto considered may be arranged in nine stages:—1, that of the *Hypichthyes*; 2, that of the *Myzichthyes*; 3, that of the *Chondrichthyes*; 4, that of the *Herpetichthyes*; 5, that of the *Amphibia*; 6, that of the *Hypotheria*; 7, that of the *Prototheria*; 8, that of the *Metatheria*; and, 9, that of the *Eutheria*. All these stages, except that of the *Hypotheria*, are represented by existing groups of vertebrated animals, which, in most cases, are composed of greatly modified forms of the type to which they belong, only the Amphibia and the Eutheria exhibiting near approximations to the unmodified type in some of their existing members.

It will be observed that I have omitted to mention the Ganoid and the Teleostean Fishes and the Sauropsida. I have done so because they appear to me to lie off the main line of evolution—to represent, as it were, side tracks starting from certain points of that line. The Ganoidei and the Teleostei I conceive to stand in this relation to the stage of the Herpetichthyes, and the Sauropsida to the stage of the Amphibia.

There is nothing, so far as I can see, in the organization of the Ganoid and Teleostean fishes which is not readily explicable by the application of the law of evolution to the Herpetichthyes. They may be interpreted as effects of the excessive development, reduction, or coalescence of the parts of a Herpetichthyan.[1]

[1] "Ueber Herz und Arterienbogen bei *Ceratodus* und *Protopterus*," *Morph. Jahrbuch*, 1880.

[1] That the heart of *Butirinus* affords a complete transition between the characteristically Ganoid and characreristically Teleostean heart, has recently been proved by Boas (*Morphol. Jahrbuch*, 1880). Thus the last remnant of the supposed hiatus between the Ganoids and the Teleostean vanishes.

Similarly, the suppression of the branchiæ, the development of an amnion, and of a respiratory extra-abdominal allantois, and that enlargment of the basioccipital relatively to the exoccipitals which gives rise to a single skull-condyle, is all the change required to convert an Urodele amphibian into a Lizard. It is needless to recapitulate the evidence of the transition from the Reptilian to the Bird type, which the study of extinct animal-remains has brought to light.

The scheme of arrangement of the Vertebrata which naturally flows from the considerations now brought forward will stand thus :—

Stages of Evolution.	Representative Groups.			
9. *Eutheria*	*Monodelphia.*			
	O			
8. *Metatheria*	*Marsupiala.*			
	O			
7. *Prototheria*.....	*Monotremata.*			
	O			
6. *Hypotheria*	×	*Sauropsida*		{*Aves.* *Reptilia.*
		O		
5. *Amphibia*	*Amphibia*	×		
	O			
4. *Herpetichthyes*.	*Dipnoi*	×	... *Osteichthyes*	{*Ganoidei.* *Teleostei.*
	O		O	
3. *Chondrichthyes.*	*Chimæroidei*	×	...	×
	O			
	Selachii.	×	...	×
	O			
2. *Myzichthyes* ...	*Marsipobranchii*...	×	...	×
	O			
1. *Hypichthyes* ...	*Pharyngobranchii.*	×	...	×
	O			

It appears to me that everything which is at present known respecting the Vertebrata of past epochs agrees with the assumption that the law which expresses the process of ancestral evolution of the higher Mammalia is of general application to all the Vertebrata. If this is admitted, I think it necessarily follows that the Vertebrata must have passed successively through the stages here indicated, and that the progress of discovery, while it will obliterate the lines of demarcation between these stages, and convert them into a continuous series of small differentiations, will yield no vertebrate form for which a place does not exist in the general scheme.

NOTES

DR. JOHN STENHOUSE, F.R.S., died on December 31, in the seventy-second year of his age. He was a native of Glasgow, where he was educated and long resided. A pupil of Graham and of Liebig, he devoted all his time to research work in the domain of organic chemistry. He was a Royal Medallist of the Royal Society, LL.D. of Aberdeen, and one of the founders of the Chemical Society. On removing to London he was appointed Lecturer on Chemistry in St. Bartholomew's Hospital, London, but was obliged to resign in 1857, owing to a severe attack of paralysis. This however did not deter him from continuing his scientific studies, which were a labour of love to him. He was the inventor of the charcoal respirator, of the charcoal ventilator for sewers, and of a process for rendering fabrics waterproof by means of paraffin. In 1865 he succeeded Dr. Hofmann as non-resident assayer to the Royal Mint, but was deprived of the appointment when the office was abolished by Mr. Lowe in 1870.

ON the 3rd inst. Mr. John Thomas Towson died at his residence in Liverpool, in his seventy-seventh year. Mr. Towson was connected with the early history of photography, but in 1846 he devoted his thoughts to navigation, especially to determining the quickest routes across the ocean to distant countries. With this object he constructed a set of tables for facilitating the practice of great circle sailing, and at the British Association in 1854 Mr. Towson aided Dr. Scoresby in directing the attention of the scientific section to the importance of investigating more fully the subject of the deviation of the compasses on board iron ships. The result of this discussion was the formation of the Liverpool Compass Committee. The observations and the deductions resulting from them were embodied in three reports, "presented to both Houses of Parliament by command of Her Majesty." In 1863 Mr. Towson was instructed by the Board of Trade to prepare a manual on the deviation of the compass, which was subsequently published at the expense of the Board, under the title of "Practical Information on the Deviation of the Compass; for the use of Masters and Mates of Iron Ships."

WE are glad to learn that Prof. MacOwan, late of Gill College, Somerset East, has accepted the post of Director of the Botanic Garden, Cape Town. He will also lecture at the South African College. The appointment of a man whose long and enthusiastic devotion to South African botany has earned him a wide reputation is to the credit of the Cape Government, and is of good omen for the scientific future of the Cape Botanic Garden. This has never yet attained the position which it would naturally derive from the resources of one of the most interesting floras in the world.

DR. W. FEDDERSEN of Leipzig is preparing a supplement to Poggendorff's well-known biographical dictionary. Many of our readers will receive during the next few days circulars asking them to answer a few questions as to their scientific life and labours. As the great utility of such a work lies in the completeness of the information it supplies, we trust that every one will fill up the answers to the questions as completely as is in his power, and that neither false modesty nor carelessness will create a gap in the work.

PROF. CORFIELD'S lectures on Health to ladies will commence to-day, January 6, by an Introductory Lecture at 3 p.m., and will be continued on Tuesdays and Thursdays at the same hour. Ladies are admitted free to the Introductory Lecture.

HERR ROBERT OPPENHEIM of Berlin announces the forthcoming publication of a "Grundriss der Anatomie des Menschen," by Prof. Ad. Pansch of Kiel.

THE Reale Istituto Lombardo has awarded two sums of 1500 lire, on the Brambilla foundation, (1) to the Milanese Committee of Animal Vaccination for founding a vaccinogenic establishment in Milan; and (2) to S. Bassolini for establishing in Milan a manufactory of white-lead colours and varnishes. On the Fossati foundation a sum of 2000 lire has been awarded to Dr. Golgi for studies on the fine anatomy of central organs of the nervous system; and 1000 lire to Drs. Tenchini and Staurenghi for researches in the anatomy of the cerebellum, the Pons Tarini, &c. A list of prizes now open to competition will be found in the *Rendiconti* of the Institute, vol. xiii. fasc. xviii. The subjects have nearly all been previously published. (We note that one is "Studies on the Telephone.") The prizes vary in value from 500 to 4000 lire. Foreigners may compete, and memoirs must be written in Italian, French, or Latin.

THE Transit of Venus Commission has already met at the French Academy of Sciences, as usual under the presidency of M. Dumas, but no resolution was come to. A number of scientific men have already offered themselves as observers.

BARON NORDENSKJÖLD arrived at St. Petersburg on Saturday, and was received at the station by the Swedish Ambassador and delegates from the Russian societies. In the course of the day he was received at the Foreign Office, and is to be *fêted* by the Municipality and the learned societies.

THE dates for some of the papers which will be read at the Society of Arts before Easter next have been announced. The following are set down for the ordinary meetings (Wednesday evenings):—January 12: A Sanitary Protection Association for London, by W. Fleeming Jenkin, F.R.S. (On this evening Prof. Huxley will preside.) January 19: Causes of Success and Failure in Modern Gold-Mining, by A. G. Lock. February 23: Recent Advances in Electric Lighting, by W. H. Preece. March 2: Flashing Signals for Lighthouses, by Sir William Thomson, F.R.S. March 9: Improvements in the Treatment of Esparto for the Manufacture of Paper, by William Arnot, F.C.S. March 16: The Manufacture of Aërated Waters, by T. P. Bruce Warren. In the Indian Section (Friday evenings), the following will be read:—January 21: Forest Conservancy in India, by Sir Richard Temple, Bart., G.C.S.I. February 11: The Gold-Fields of India, by Hyde Clarke. March 4: The Results of British Rule in India, by J. M. Maclean. March 25: The Tenure and Cultivation of Land in India, by Sir George Campbell, K.C.S.I., M.P. The dates and Papers for the Foreign and Colonial Section (Tuesday evenings) will be:—February 1: The Industrial Products of South Africa, by the Right Hon. Sir Henry Bartle Edward Frere, Bart., G.C.B., &c. February 22: The Languages of South Africa, by Robert Cust. March 15: The Loo Choo Islands, by Consul John A. Gubbins. April 5: Trade Relations between Great Britain and her Dependencies, by William Westgarth. For the Applied Chemistry and Physics Section (Thursday evenings) the arrangements are as follows:—January 27: A New Mechanical Furnace, and a Continuous System of Manufacturing Sulphate of Soda, by James Mactear. February 24; Deep-Sea Investigation, and the Apparatus used in it, by J. G. Buchanan, F.R.S.E., F.C.S. March 24: The Future Development of Electrical Appliances, by Prof. John Perry.

VARIOUS earthquake shocks in Roumania, Transylvania, Hungary, &c., in the latter days of December, are reported; in Bucharest, on the 23rd of that month at 11.20 a.m., and on the 25th at 5.45 p.m.; in Tultscha also, on the 25th, at 5.25 p.m. (direction north-west to south-east); in Fokschau, at 5.5 p.m., pretty strong, duration 8 sec.; in Tecuciu at 4.51 p m., two strong shocks, the first lasting 2 sec.; the second 4 sec.; in Washui (near Tassy), a very violent undulatory shock; in Silistria (Bulgaria), at 3.22 p.m., 20 shocks lasting 1m. 20s.; in Homorod (Hungary), at 4.18 p.m., duration 5s., direction west to east; in Földvar (Hungary), at 4.20 p.m., direction north-west to south-east. At the same time shocks were felt at various places in the south-east of Transylvania.

IT may be useful to some of our readers to know that the Library of the Society of Telegraph Engineers and of Electricians is open to members of all scientific bodies, and (on application to the librarian) to the public generally. The library is open daily between the hours of 11.0 a m. and 8.0 p.m., except on Thursdays and on Saturdays, when it closes at 2.0 p.m.

"WHITAKER'S ALMANAC" is undoubtedly a most useful publication; but in the larger edition there is a supplement of miscellaneous information which seems to us to require looking after. Among other things there is a variety of items more or less connected with science. There is a "Scientific Summary" consisting of nine lines of introduction (in which the only geological fact mentioned is the discovery of some fossil remains in Essex), followed by selected subjects of general interest, including such items as "Steam Power in Germany," "Forests in Russia," "The World's Gold and Silver," "American Railroad Progress," all looking like so many random newspaper cuttings; but no mention of perhaps the most brilliant scientific event of the year—Mr. Graham Bell's "Photophone." In another part of the supplement we have two pages on the "Progress of Astronomical Science"; why this is not included in the "Scientific Summary" the editor perhaps knows. A page is devoted to "Radiant Points of Shooting Stars," two to the "Year's Weather," three to "Earthquakes and Volcanic Eruptions," and three to "Geographical Discovery." The writer of the last-mentioned actually places Mr. Leigh Smith's yacht voyage to Franz Josef Land as "the most remarkable geographical event" of a year which witnessed the successful conclusion of Mr. Joseph Thomson's remarkable African Expedition, because he thinks it opens up "a new and apparently feasible route for future Polar research:" does he not mean *search*? Evidently the supplement to this "Almanac" stands in need of editing, and as the whole work is to be reset for next year, perhaps this part will be brought up to the level of the rest of the work.

THE *Annuaire* of the Bureau des Longitudes for 1881 has been issued by Gauthier-Villars. As usual, it is full of information on a great variety of subjects more or less connected with science.

Land and Water states that the late Mr. Frank Buckland has bequeathed his valuable Museum of Economic Fish Culture to the nation; and on the de cease of Mrs. Buckland a sum of 5000*l.* will revert to the nation, to be applied for the purpose of founding a professorship of economic pisciculture in connection with the Buckland Museum and the Science and Art Department at South Kensington.

A SCOTCH Fisheries Improvement Association has been formed for the purpose of making an effort to improve by various means the fisheries of the Scotch rivers, which have in recent years considerably deteriorated. The president is the Duke of Sutherland, and the chairman of the provisional committee Mr. David Milne Home.

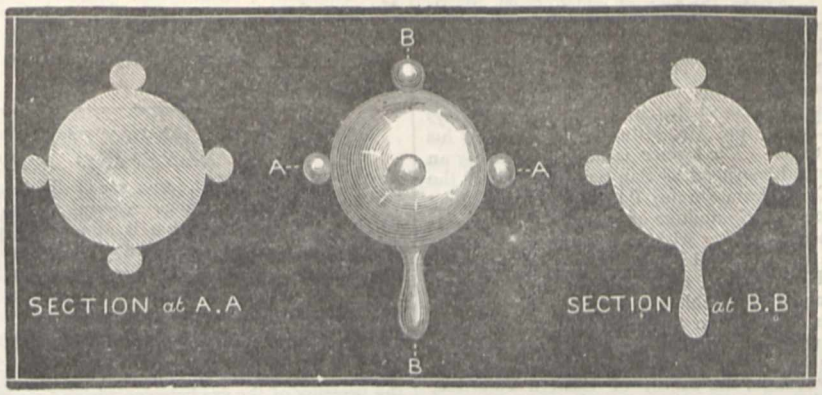
WE have received a copy of the regulations issued by the French Minister of Posts and Telegraphs for the International Congress and Exhibition of Electricity, to be opened at Paris next September. Those interested in the Congress should apply to M. le Commissaire Général de l'Exposition Internationale d'Electricité, at the Palace of the Champs Élysées, porte No. IV., Paris.

MR. INNES ROGERS, in a letter to us, calls attention to a list of bamboos published in vol. i. of the *Garden*, which are found to be hardy under cultivation, and to the fact that several kinds, chiefly from China and Japan, grow in Battersea Park, Kew Gardens, &c. He further instances as hardy plants a Cactus from the Rocky Mountains, Begonia from the Andes, the well-known *Chamærops excelsa*, *Ficus repens*, and a Mesembryanthemum acclimatised at Scilly, and believes that the fixity of continents through long geological periods would cause tropical species in spreading to adapt themselves to temperate conditions. He thinks that the Gulf Stream may have brought tropical seeds to Bournemouth, and that a most trifling change of climate would have made them thrive there.

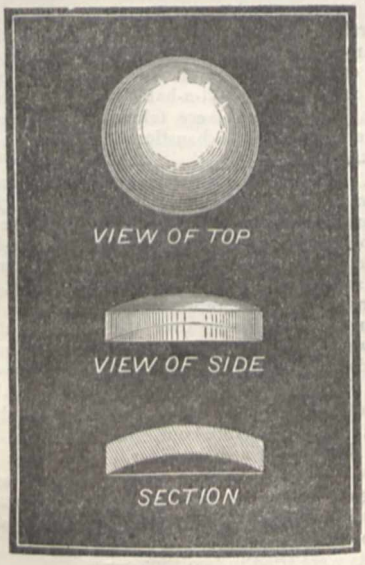
A NEW illustrated archæological review will soon be published at Naples by MM. Augusto Mele and Enrico Abeniacco. It will be in French, and its title will be "Pompeii." The object of the new publication is to excite in wider circles a vivid interest for the excavations at Pompeii, Herculaneum, &c., as well as for archæology generally.

IN the Austrian "Engineers and Architects Union" at Vienna, a new aëronautical department has been created, with the object of discussing and solving aëronautical problems and questions both theoretically and in practice, as well as making the necessary experiments. The application of aëronautics to meteorological science forms a special study of the department.

To the October number of *Symons's Monthly Meteorological Magazine* Col. Foster Ward writes describing some remarkable hailstones that fell during a slight thunderstorm at Partenkirchen, Bavaria, at 6 p.m. on August 21. He was on a mountain about 3000 feet above the village, and saw the cloud (a small one) pass over the valley below. There were several peals of thunder, but there was no visible lightning, owing, he concludes, to the sun's brightness. "On arriving near home, I met a friend who told me it had been hailing 'tadpoles' and 'acidulated drops. There had been little or no rain and no visible lightning, and



the hailstones fell at intervals and about six feet apart. There were very few of them, my family only picking up twenty in a space occupied by a full-sized lawn tennis court. My son made a sketch of their shape and size, which I inclose. The greater part were of the 'tadpole' shape and were clear as glass, perfectly round, the five knobs being at equal distance from one another. The flat stones had more or less a slight nucleus of snow in the convex portion of the stone. My wife and three daughters, and two ladies staying with us, say that the stones looked just like a lady's hand looking-glass, with a knob at the top and on either



side for ornament. More than twenty, perhaps thirty, were picked up of this shape. Of these about two-thirds were studded, the rest plain, with only the tail or handle, the thinnest part of it being near the body of the stone, as in sketch. The studs were all symmetrically placed. There were from three to five in each stone besides the handle. When there were less than five they occupied the same positions as if the five had been complete. In some cases the handle appeared to have been knocked off. The drops were more numerous, were *all* of same shape, convex at the top, the bottom being concave (like a small china painting palette)."

THE total completion of the St. Gothard tunnel will very likely take place in July of this year; the railway is to be opened on July 1, 1882. The mail-bags are even now carried through the tunnel by messengers when rough weather prevails upon the mountain. On December 21 the first mail-bag was so carried through the tunnel, and it took four hours to convey it from Œrschenen to Airolo.

GEOGRAPHICAL NOTES

AT the Second International Polar Conference at Berne all the leading nations of Europe were represented except England. The leading stations have been definitely decided on. Austria undertakes to establish a station in northern Novaya Zemlya, at the expense of Count Wilczek; Denmark has selected Upernivik; Germany New Georgia for the Antarctic, and Jan Mayen or East Greenland for the Arctic regions; Norway, Bossekop in Finmark; Holland the south-east coast of Novaya Zemlya, or the coast of Siberia, between the mouth of the Yenissei and Cape Taimyr; Russia has selected two stations, the mouth of the Lena and the New Siberian Islands. Even Switzerland, which has not even a sea-board, hopes to take part in the international movement, by establishing a station at Mossel Bay, in Spitzbergen. The expedition to be sent out by Italy to the Antarctic region under Lieut. Bove is to some extent connected with this scheme, and no doubt France will ultimately be compelled to take her part. As to England, there has hitherto been no sign that as a nation she is even interested in a scheme so full of important issues for science and navigation.

IN a recent paper to the R. Accademia dei Lincei, Signor Guido Cora, a member of the International Polar Commi tee, urges the importance of the enterprise under consideration, and of Italy sharing in it. He considers the Antarctic zone as the more suitable one for Italy, as being nearer regions where Italians form a large portion of the population and conduct an extensive commerce; moreover the south has a brilliant record of geographical exploration by Italians in the sixteenth century, and the recent project of an Antarctic exploring expedition has drawn enthusiastic attention. For the temporary scientific observatory which the Italian Government is recommended to plant in 1882 (in harmony with the large scheme), S. Cora suggests one or other of three places:—1. Port Spence, on the east coast of Coronation Island in the Southern Orkneys, at about 60° 50′ S. lat., and 45° 45′ W. long. 2. Cape Look-out, on the south coast of Elephant Island, in the north-east part of the Southern Shetland group, at about 61° 17′ S. lat. and 55° 15′ W. long. (a station at either place would serve well as a base of operations for the Italian Exploring Expedition). 3. In the case of means being inadequate for a station at either of the two places named, S. Guido recommends some one of the islands close to Cape Horn. Supposing that the transport would be by a Government vessel destined to the naval station

in South America, it is calculated that the cost of the observatory would amount to 70,000 or 80,000 lire, of which 10,000 would be for instruments, and the remainder would provide three dwelling-houses, salaries of four scientists, two assistants, and two servants, food, &c. This is calculated for an absence of sixteen months, twelve of which would be occupied in observations.

THE Geographical Society's *Proceedings* this month contains three papers relating to Africa, the first of which is Sir Bartle Frere's, on Temperate South Africa. This, as now printed, embodies some useful statistical information and is illustrated by a general map of South Africa. The other two papers bring some additions to our knowledge of the geography of West Africa, Mr. Comber giving a short sketch of his recent journeys in the interior of Congo, and Mr. Milum an account of his travels in the Niger region. The former is accompanied by an excellent map of the neighbourhood of San Salvador and of the course of the River Congo from Stanley Pool to the sea. The final report of the Executive Committee of the African Exploration Fund is published, together with a statement of receipts and expenditure. In the Geographical Notes extracts are given from a letter by Mr. Hore of Ujiji, on the long-continued rise of the waters of Lake Tanganyika, which he seems to connect with earthquake-movements. Mr. Hore is shortly about to return to England, so that we shall probably hear more on this subject before long. Among the other notes we may call attention to those on the River Okavango, the survey of Eastern Palestine, and the United States' Survey operations in the neighbourhood of Behring Strait. Increased attention, we note, is being paid to the proceedings of foreign geographical Societies, those of the French Society being very fully reported.

M. VOSSION, who, it will be remembered, spent some time in Burmah, and not long since read papers on that country before the French Geographical Societies, has lately gone to Egypt to take up the Vice-Consulship of Khartum. During his stay there he is to pay special attention to the slave trade, and to the best means of opening up commercial relations with the Sudan.

CAPT. SERRA-CARRACIOLI left Naples on November 23, 1880, for the Bay of Assab, having undertaken a mission, under the auspices of the Club Africano, to inquire into the possibility of developing commerce there and with the natives of the interior. The Club Africano is desirous of establishing pearl, mother-of-pearl, and sponge fisheries in the Bay of Assab. While funds are being raised for more extensive operations, this expedition is sent out to make a careful survey of the region, to form a depôt for further expeditions, whether commercial or scientific, and to make other preparations. The expense is expected not to exceed 600*l*. It is also stated that the Italian Geographical Society have made arrangements for the establishment of a meteorological station at the Bay of Assab. The October part of the *Bolletino* of the Italian Geographical Society contains a long and valuable memoir by Signor C. de Amezaga on Assab.

AT the last meeting of the Lyons Geographical Society M. Coillard gave an interesting account of his twenty years' experiences in South Africa. He was engaged for some time on a missionary expedition in the Upper Zambesi region, and was probably the means of saving Major Serpa Pinto's life, afterwards accompanying him in some of his explorations. As no particulars have yet been published of M. Coillard's geographical work in this region, it is to be hoped that his paper will be given in full in the Lyons Society's *Bulletin*.

IN last week's *Missions Catholiques* we have the concluding instalment of some interesting and useful papers by the Bishop of Vancouver, entitled "Une Visite Pastorale dans le Territoire d'Alaska." Père Montiton's notes on the traditions and customs of the Sandwich Islands are also continued.

THE January number of *Good Words* contains the first of a series of papers by Mr. Joseph Thomson on his experiences during his recent journey in East Central Africa. The present instalment deals with the preparatory journey which he made with Mr Keith Johnston to Usambara, and furnishes interesting notes on the country traversed.

THE Alexandria Correspondent of the *Daily News* tells us that M. Chower, formerly a newspaper correspondent in Turkey, Kurdistan, Armenia, and Albania, started on December 31, "to explore Africa from north to south, from Alexandria to the Cape of Good Hope." *Bon voyage.*

THE death is announced of Dr. Fr. Mook, the well-known African traveller, who accompanied Dr. E. Riebeck on his expedition, which started in August last for the East. Dr. Mook died at Jaffa shortly before Christmas.

WE have received parts 17 to 22 of the new edition of Stieler's Hand-Atlas, with three supplementary parts containing in eight sheets a very fine map of the Basin of the Mediterranean Sea.

THE Dutch Committee, which arranged the North Polar Expeditions of the last few years, held a general meeting at the Hague a short time ago, when the resolution was passed to collect funds for the organisation of a fourth Arctic expedition. In the meantime the Committee will endeavour to have a steamer built for this purpose.

ON HEAT CONDUCTION IN HIGHLY RAREFIED AIR[1]

THE transfer of heat across air of different densities has been examined by various experimentalists, the general result being that heat conduction is almost independent of pressure. Winkelmann (*Pogg. Ann.* 1875, 76) measured the velocity of cooling of a thermometer in a vessel filled with the gas to be examined. The difficulty of these experiments lies in the circumstance that the cooling is caused not only by the conduction of the gas which surrounds the cooling body, but that also the currents of the gas and, above all, radiation play an important part. Winkelmann eliminated the action of currents by altering the pressure of the gas between 760 and 1 millim. (with decreasing pressure the action of gas currents becomes less); and he obtained data for eliminating the action of radiation by varying the dimensions of the outer vessel. He found that, whereas a lowering of the pressure from 760 to 91·4 millims. there was a change of only 1·4 per cent. in the value for the velocity of cooling, on further diminution of the pressure to 4·7 millims. there was a further decrease of 11 per cent., and this decrease continued when the pressure was further lowered to 1·92 millim.

About the same time Kundt and Warburg (*Pogg. Ann.* 1874, 5) carried out similar experiments, increasing the exhaustion to much higher points, but without giving measurements of the pressure below 1 millim. They inclosed a thermometer in a glass bulb connected with a mercury pump, and heated it to a higher temperature than the highest point at which observations were to be taken; then left it to itself, and noted the time it took to fall through a certain number of degrees. They found that between 10 millims. and 1 millim. the time of cooling from 60° to 20° was independent of the pressure; on the contrary, at 150 millims. pressure the rate was one-and-a-half times as great as at 750 millims. Many precautions were taken to secure accuracy, but no measurements of higher exhaustions being given the results lack quantitative value.

It appears, therefore, that a thermometer cools slower in a so-called vacuum than in air of atmospheric pressure. In dense air convection currents have a considerable share in the action, but the law of cooling in vacua so high that we may neglect convection has not to my knowledge been determined. Some years ago Prof. Stokes suggested to me to examine this point, but finding that Kundt and Warburg were working in the same direction it was not thought worth going over the same ground, and the experiments were only tried up to a certain point, and then set aside. The data which these experiments would have given are now required for the discussion of some results on the viscosity of gases, which I hope to lay before the Society in the course of a few weeks; I have therefore completed them so as to embody the results in the form of a short paper.

An accurate thermometer with pretty open scale was inclosed in a 1½ inch glass globe, the bulb of the thermometer being in the centre, and the stem being inclosed in the tube leading from the glass globe to the pump.

Experiments were tried in two ways:—

I. The glass globe (at the various exhaustions) was immersed in nearly boiling water, and when the temperature was stationary it was taken out, wiped dry, and allowed to cool in the air, the number of seconds occupied for each sink of 5° being noted.

II. The globe was first brought to a uniform temperature in a vessel of water at 25°, and was then suddenly plunged into a large vessel of water at 65°. The bulk of hot water was such that the temperature remained sensibly the same during the continuance of each experiment. The number of seconds required for the thermometer to rise from 25° to 50° was registered as in the first case.

[1] Abstract of a Paper read before the Royal Society by William Crookes, F.R.S., December 16, 1880.

It was found that the second form of experiment gave the most uniform results; the method by cooling being less accurate, owing to currents of air in the room, &c.

The results are embodied in the following Table:—

(Rate of Heating from 25° to 50°)

TABLE I.

Pressure.	Temperature.	Seconds occupied in rising each 5°.	Total number of seconds occupied.
760 millims.	25°	0	0
	25 to 30	15	15
	30 to 35	18	33
	35 to 40	22	55
	40 to 45	27	82
	45 to 50	39	121
1 millim.	25°	0	0
	25 to 30	20	20
	30 to 35	23	43
	35 to 40	25	68
	40 to 45	34	102
	45 to 50	48	150
620 M.[1]	25°	0	0
	25 to 30	20	20
	30 to 35	23	43
	35 to 40	29	72
	40 to 45	37	109
	45 to 50	53	162
117 M.	25°	0	0
	25 to 30	23	23
	30 to 35	23	46
	35 to 40	32	78
	40 to 45	44	122
	45 to 50	61	183
59 M.	25°	0	0
	25 to 30	25	25
	30 to 35	30	55
	35 to 40	36	91
	40 to 45	45	136
	45 to 50	67	203
23 M.	25°	0	0
	25 to 30	28	28
	30 to 35	33	61
	35 to 40	41	102
	40 to 45	55	157
	45 to 50	70	227
12 M.	25°	0	0
	25 to 30	30	30
	30 to 35	37	67
	35 to 40	41	108
	40 to 45	58	166
	45 to 50	86	252
5 M.	25°	0	0
	25 to 30	38	38
	30 to 35	43	81
	35 to 40	54	135
	40 to 45	71	206
	45 to 50	116	322
2 M.	25°	0	0
	25 to 30	41	41
	30 to 35	51	92
	35 to 40	65	157
	40 to 45	90	247
	45 to 50	165	412

There are two ways in which heat can get from the glass globe to the thermometer—(1) By radiation across the intervening space; (2) by communicating an increase of motion to the molecules of the gas, which carry it to the thermometer. It is quite conceivable that a considerable part, especially in the case of heat of low refrangibility, may be transferred by "carriage," as I will call it to distinguish it from convection which is different, and yet that we should not perceive much diminution of transference, and consequently much diminution of rate of rise with increased exhaustion, so long as we work with ordinary exhaustions up to 1 millim. or so. For if, on the one hand, there are fewer molecules impinging on the warm body (which is adverse to the carriage of heat), yet on the other the mean length of path between collisions is increased, so that the augmented motion is carried further. The number of steps by which the temperature passes from the warmer to the cooler body is diminished, and accordingly the value of each step is increased. Hence the increase in the difference of velocity before and after impact may make up for the diminution in the number of molecules impinging. It is therefore conceivable that it may not be till such high exhaustions are reached that the mean length of path between collisions becomes comparable with the diameter of the case, that further exhaustion produces a notable fall in the rate at which heat is conveyed from the case to the thermometer.

The above experiments show that there *is* a notable fall, a reduction of pressure from 5 M. to 2 M. producing twice as much fall in the rate as is obtained by the whole exhaustion from 760 millims. to 1 millim. We may legitimately infer that each additional diminution of a millionth would produce a still greater retardation of cooling, so that in such vacua as exist in planetary space the loss of heat—which in that case would only take place by radiation—would be exceedingly slow.

[1] M = millionth of an atmosphere.

SCIENTIFIC SERIALS

Journal de Physique, December, 1880.—Note on magic mirrors, by M. Bertin.—On some applications of articulated systems, by M. Robin.—Experiments on the discharge in rarefied gases, by M. Righi.—Notice on the life and works of M. Almeida.

Archives des Sciences Physiques et Naturelles, November 15.—Meteorological *résumé* of the year 1879 for Geneva and the Great St. Bernard, by M. Plantamour.—Disinfection of vehicles, plants, collections of natural history, and various objects with anhydrous sulphurous acid, by Dr. Fatio.—Observations on a memoir of M. Schönn, by M. Soret.—On the phenomenon of hydration in peptonisation of albuminoid substances, by Dr. Danilewsky.—Notes on the winds of mountains, by M. Pittier.—Case of diplopia, by Prof. Wartmann, &c.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti. vol. xiii. fasc. xviii., November, 1880.—This number contains lists of prizes awarded and offered.

Atti della R. Accademia dei Lincei, vol. v. fasc. 1 (December 5, 1880).—New studies on the nature of malaria, by SS. Cuboni and Marchiafava.—Graphic determination of the elastic force relative to plane elements passing through a point, by S. Modigliano.—On the geological nature of strata met with in the tubular foundations of the new iron bridge built on the Tiber at Ripatta, and on the *Unio sinuatus*, Lamk., there found, by S. Meli.—On the structure of the envelope of the ova of some fishes, by S. Lepori.—On the preservation of man in countries of malaria, by S. Tommasi-Crudeli.—On bilinear ternary forms, by S. Battaglini.—On the projected stations for systematic physical observations in polar regions, by S. Cora.—On a cebocephalic caprine monster, by S. de Sanctis.—On the recent restoration of the scholastic and tomistic philosophy, by S. Ferri.

SOCIETIES AND ACADEMIES

LONDON

Photographic Society, December 14, 1880.—J. Glaisher, F.R.S., president, in the chair.—Papers were read by Prof. T. E. Thorpe, F.R.S., on a simple and expeditious method of preparing pyrogallol for dry plate development. The method proposed is to put dry gallic acid and glycerine into a flask, which is then heated to 200° on a sand tray, as long as bubbles of carbon dioxide are seen to be formed in the liquid. The gallic acid soon dissolves and is entirely converted into the theoretical quantity of pyrogallol, viz., 80 per cent.—By Capt. Abney, R.E., F.R.S., iodide and ammonia in gelatine emulsions. It was stated that iodides in gelatine bromide emulsion kept the silver salts from being deposited upon the shadows, as also that there is freedom from decomposition of the film, and tendency to red fog, and more light can be used in preparing and developing the plates.—And also by Capt. Abney on a photographic sunshine recorder. This consisted of a semi-cylindrical box with a flat lid, in the centre of which is a small hole; round the inside of the cylinder strips of sensitive paper are

fixed; the instrument is then so placed that the sun, the hole, and the centre line of the paper are in the same plane, so that as the sun moves, its track will be recorded on the paper.

Victoria (Philosophical) Institute, January 3.—A paper on the early destinies of man was read by Mr. J. E. Howard, F.R.S., F.L.S., &c., in which he considered them in relation to science, to philosophy, and also to religion, and gave an analysis of the various known traditions in regard to the early history of man in all ages and in all countries.

MANCHESTER

Literary and Philosophical Society, December 14, 1880.—E. W. Binney, F.R.S., F.G.S., president, in the chair.—Boulder stones as grave stones. The president, when visiting Ashton-under-Lyne the other day, observed in the churchyard on the Manchester Road a greenstone boulder used as a tombstone over the grave of a son of an alderman of that borough. This is the first instance where he had seen a boulder stone used for such a purpose, and it is one where they may not only be preserved, but exhibited to the public.—The land subsidence at Northwich, by Thomas Ward.—Some endeavours to ascertain the nature of the insoluble form of soda existing in the residue left on causticising sodium carbonate solutions with lime (Part ii.), by Watson Smith, F.C.S., Assistant Lecturer on Chemistry in the Owens College, and W. T. Liddle. Communicated by Prof. C. Schorlemmer, F.R.S.

PARIS

Academy of Sciences, December 27, 1880.—M. Edm. Becquerel in the chair.—M. Faye presented the *Annuaire du Bureau des Longitudes* for 1881, and noted the improvements. —On the series of Fourier and other analytical representations of functions of a real variable, by M. Hermite.—On the velocity of propagation of light, by M. Cornu. He controverts M. Gouy's ideas.—On the chlorhydrates of metallic chlorides, and on the reduction of chlorides by hydrogen, by M. Berthelot. These chlorhydrates play an important part in chemical mechanics, by reason of their considerable heat of formation and their state of dissociation.—On an oxygenated base derived from aldol, by M. Wurtz.—Effects of tearing out the intracranial part of the glossopharyngeal nerve, by M. Vulpian. This action does not (in the cat) appreciably affect the influence of nerves which act as direct vaso-dilators on the mucous membrane of the buccal cavity, except as regards the effects of excitation of the nerve itself on the posterior region of the dorsal face of the tongue.—Observations on some animals of Madagascar, by M. Milne-Edwards. This relates to an important collection of mammalia and birds by M. Humblot, sent to the Museum of Natural History They show the modifications of species well. M. Humblot has sent to the menagerie two living Aye-Ayes, two Makis, &c. (offering many points of interest).—Order of production of the first vessels in the ear of *Lolium* (first part), by M. Trécul. —M. Sella was elected Correspondent in Mineralogy in room of the late Prof. Miller, and Mr. Warren De La Rue in Astronomy in room of the late Mr. MacLear.—Observations on phylloxera, by M. Lichtenstein. He indicates ten or eleven animal parasites of phylloxera, but does not regard any of these hopefully as a means of stopping the disease. He is studying the effect of inoculation with cryptogams; the results are not yet decisive. —Determination of the time of rotation of Jupiter, by M. Cruls. From observations of the spot at Rio Observatory during 1083 rotations he obtains the number 9h. 55m. 36s. in mean solar time. Mr. Pratt, at Brighton, got the number 9h. 55s. 33·91, from 321 rotations. Thus the time of Jupiter's rotation seems to be known to within a second.—On Hartwig's comet (*d* 1880), by MM. Schulhof and Bossert. They consider the period 62⅔ years must be rigorously excluded.—Solar observations at the Royal Observatory of the Roman College during the third quarter of 1880, by P. Tacchini. There was increased activity. The number of spots was double that in the preceding quarter, and there was hardly a day without them. The number of faculæ in September was extraordinary. In the case of the protuberances (also more frequent) there was a maximum in each hemisphere between 50° and 60° and another between 20° and 40°.—Observations on Swift's comet (*e* 1880) at the Royal Observatory of the Roman College, by P. Tacchini.—On the contact of conics and surfaces, by M. Moutard.—On a new method of producing intermittent luminous signals, by M. Crova. M. Leverrier and he used in 1870-71 a very similar arrangement to M. Mercadier's. They found that they must use oxygen under weak pressure and give the pipe a wide orifice; also that the key must be pressed and released very suddenly.—On a new electrodynamic theorem, by M. Cabanellas.—Regulator of pressure for vapours, by M. D'Arsonval. The triple problem here solved is (1) keeping constant, in a boiler, the pressure of a given vapour whatever the discharge; (2) using the combustible gas only in proportion to the vapour expended; (3) making the instrument quite automatic without danger of explosion. There is a membrane of caoutchouc between two metallic rings; its lower surface is in contact with the vapour, and on its upper rests a metallic disk with rod and lever like that of a safety valve. At the upper surface of the disk debouches a tube which brings the gas; there is another tube above through which the gas goes to the boiler.—On a new derivative of sulphide of nitrogen, by M. Demarcay.—On a platinous hypophosphite, by M. Engel. This is got by action of phosphuretted hydrogen on tetrachloride of platinum.—On borotungstates of sodium, by M. Klein.—On some facts relative to the transformation of chloral into meta-chloral, by M. Bryasson.—On the products of oxidation of cholalic acid.—On the excretion by urine of sulphur incompletely oxidised, in various pathological states of the liver, by MM. Lépine and Flavard.—On visual sensibility and its relations with luminous and chromatic sensibility, by M. Charpentier. What he calls visual sensibility corresponds to visual acuteness, but while the latter is expressed by the smallest angle under which one can recognise as distinct two luminous points; the former is expressed by the smallest quantity of light which renders those two points distinct. The order of increasing complexity is, luminous sensibility, chromatic sensibility, visual sensibility.—On the distribution of light in the solar spectrum (spectrum of Daltonians), by MM. Macé and Nicati. These observations appear to give certain proof of the existence of two distinct kinds of Daltonians; also to support the Young-Helmholtz theory of colours, and to contradict Hering's.—Reactions of the motor-zone of the brain in animals paralysed by curare, by MM. Couty and De Lacerda.—On passage of red corpuscles into the lymphatic circulation, by M. Laulaine. This is effected by obliteration of veins. The effect appears in about twelve hours, and the number of corpuscles increases to about the fortieth hour.—On the internal and external sheaths of hairs, by M. Renaut.—New researches on the organs of touch, by M. Ranvier. By observing the tactile corpuscles in infants and children he has come to a better appreciation of their structure.—On the sensitive nerve-termination in the skin of some insects, by M. Viallanes. Examining larvæ of *Musca* and *Eristalis*, he finds under the hypodermis an extremely rich plexus of ganglionic cells, connected on one hand with the chief nerve-centres, and on the other with sensitive terminal nerve-branches.—On the sensorial cylinders of the internal antenna of crustaceans, by M. Jourdain. While these have undoubtedly the characters of an organ of sense, they cannot (anatomically, and independently of all physiological experiment) be said to be affected with olfaction.—Marine mollusca living on the coasts of Campbell's Island, by M. Filhol.—Examination of the marine fauna of the upper sands of Pierrefitte near Etampes, by M. Meunier.—On the age of upheaval of the district of Bray, by M. Dollfus.—On the crystalline schists of Brazil and the red earths which cover them, by M. Gorceix.

CONTENTS

	PAGE
DR. GÜNTHER ON FISHES (*With Illustrations*)	213
SULPHURIC ACID AND ALKALI. By Prof. H. E. ROSCOE, F.R.S.	215
OUR BOOK SHELF:—	
Kaltbrunner's "Aide-Mémoire du Voyageur"	217
LETTERS TO THE EDITOR:—	
Geological Climates.—ALFRED R. WALLACE; H. KING	217
Temperature of the Breath.—C. J. MCNALLY	217
Selenium.—W. M. C. (*With Diagram*)	218
Experiments with Vacuum Tubes.—J. T. BOTTOMLEY	218
Modern Use of Ancient Stone Implements.—D. BUDDE	218
Pile Dwellings.—S. E. PEAL (*With Illustration*)	218
Landslips.—The Cheshire Subsidences.—T. MELLARD READE	219
Animal Reasoning.—K. P.	219
Ozone.—J. RAND CAPRON	219
THE INDO-CHINESE AND OCEANIC RACES—TYPES AND AFFINITIES. II. By A. H. KEANE (*With Illustrations*)	220
GEOLOGY OF BOSNIA AND HERZEGOVINA. By Prof. ARCH. GEIKIE, F.R.S.	224
MICHEL CHASLES By R. TUCKER	225
PROF. HUXLEY ON EVOLUTION, II.	227
NOTES	231
GEOGRAPHICAL NOTES	233
ON HEAT CONDUCTION IN HIGHLY RAREFIED AIR. By WILLIAM CROOKES, F.R.S.	234
SCIENTIFIC SERIALS	235
SOCIETIES AND ACADEMIES	235