THURSDAY, JANUARY 22, 1874

SCIENCE AND INDUSTRY

IS England rapidly losing that commercial and manufacturing supremacy which she has held before all the world for generations past? Is she going the way of Venice, of Florence, of Holland? If so, is it because she feels blindly secure that "what hath been, will be," neglecting the means on which success in commerce and manufactures in these days depends—means which are being so industriously used by rival nations, that they are rapidly shooting ahead of England on England's own ground?

Such would seem to be the drift of the utterances which have come from three different quarters during the past week. In Lord Derby's address at the inauguration of the Society for the Promotion of Scientific Industry; in the correspondence in the *Times* of the past few days; and in the statements of the Society of Arts' deputation last Saturday to the Lord Chancellor with respect to the Patent Museum, it is more or less distinctly hinted that the industries of England are perishing from lack of knowledge. Other countries, but especially Germany, we are told, are distancing us, and we fear the proofs of the statement are too convincing to be resisted. To all appearance, Germany is destined to step into the honourable position as an industrial nation, which all the world has hitherto acknowledged as belonging to England. In short, in Commerce as in Science we are losing ground.

One correspondent in Monday's *Times* tells us that in the East "the Germans are carrying everything before them;" "by their energy and enterprise they have gone ahead of their easy-going English neighbours . . . whatever be the causes, there can be no question that they are outstripping us in the race for commercial prosperity in the East." This is in confirmation of what a correspondent in a previous number of the *Times* had stated from observation as to the rapid ascendency of the Germans in commerce. Another correspondent, an "Ex-president of the Liverpool Chamber of Commerce," states in Monday's *Times*, without hesitation, that young Germans make the best business men. Dr. Lunge, in his recent address to the Newcastle-on-Tyne Chemical Society (see NATURE, vol. ix. p. 113), states that in the matter of the applications of chemistry, "foreign countries are taking the wind out of our sails very fast in that line, and that both their rate of progress and the means of attaining it are very much superior to ours," because a better career is open to chemists there than with us. Lord Derby says that if we don't take care we shall find ourselves in the position of a man who succeeds to a ready-made business, and who "does not get up as early nor work as hard as his father, who had to make it." Perhaps, had Lord Derby said all that he thought, he would have put the case much stronger against us.

What are the causes which have led to this state of things? How is it especially that Germany is getting so rapidly ahead of us? All who have inquired into the question, attribute it to the difference between the methods of education in England and in Germany, and the greater appreciation of Science in the former country. The mere fact of the establishment of the Society for the Promotion of Scientific Industry, shows that the eminent men who compose it feel that energetic measures should at once be taken to enlighten the multitudes on whom the success of our industries depend. Lord Derby, in his speech at Manchester, said:—

"If we mean to keep our old position as the industrial leaders of the world we must throw away no chance, and leave no stone unturned. No doubt, in applied science, whatever discoveries are made or inventions brought into use by one country will soon extend to all. Still there is an obvious advantage in getting the lead; and that advantage we ought, if possible, to secure. . . . We are shut up therefore to one or two conclusions—either we must acknowledge ourselves beaten, or we must contrive to make every day's labour of a man more productive than it has been hitherto by the more general, or by the more skilful use of mechanical and chemical science.

He then goes on to state that:—

"Now it is the belief of the promoters of this new society that a great deal may be done for technical training without interfering with that training of the workshop which is, in one sense, the best of all. They believe, moreover, that there are innumerable investigations of an experimental kind, having for their object the perfecting of industrial processes, which being everybody's business are nobody's business, which would in their results enormously benefit the trade or industry which they concern, but which individuals are slow to undertake, because they do not bring any certain return of profit to the person who spends time and labour upon them."

Hitherto the vast majority of those connected with our industries have done their work by mere rule-of-thumb, without anything like a scientific knowledge of the material or the machinery on which they are employed. This will no longer do; herein lies our weak point; in this direction it is that the Germans are rapidly excelling us. The secret of the growing success of the Germans in commercial and manufacturing industries lies not only in their thoroughly organised and scientific system of education, in their "Realschule" and their technical training-schools, but in the general interest taken in the advancement of knowledge, the development of new methods. In the Realschule the young German gets a thorough liberal and scientific education, not a mere rule-of-thumb technical training. The literary training is at least as good as that which can be obtained at our best public schools, with the advantage of a thorough instruction in the principles and facts of physical science, *without any narrow views as to their future practical application.* "The consequence is," says a German writing to Monday's *Times*,

"That the 'Realschule' trains thorough gentlemen who in future life are able to make themselves useful as bankers, merchants, and manufacturers. Many of my friends have acquired such positions; several of them are well-known inventors and chiefs of enormous trading and manufacturing concerns. This system of education produces a class of men who take a warm interest in all practical matters, and find as much pleasure and amusement in the invention and rivalry of machinery, or the production and quality of merchandise, as the young men in England find in horses and billiards. Go among a parcel of young Germans of that class, and though you find them ready for all amusements of youth, you will at the same time perceive that they can talk of a great many useful things in a spirit of enlightenment which has nothing mean in it, but displays a fitness for cosmopolitan life of which we see the practical results. Besides the 'Realschule,' there are throughout Germany a number of 'high schools of commerce,' where young men enter to learn office-work and technicalities."

This German hits the right nail on the head, when he says that—

"The English Government would do well to establish such schools upon some definite plan as to unity of teaching. Young Englishmen are quite as well disposed as Germans; in many matters their character is even more stable, but you must give them the opportunity of learning what the Germans do. Proprietary schools will never succeed in this; and no breach of the liberty of the subject would be committed if your Government were intelligent and far-seeing enough to recognise the need of such a system of schools, supernatant on the elementary education."

As another *Times* correspondent says, the maintenance of our commercial prosperity is pretty much a schoolmasters' question. No "association for the promotion of scientific industry" will ever be able to remedy our shortcomings in this respect unless there be a career for men of Science, in which case it will be studied, and unless Science be properly taught. Unless this country is to be entirely outstripped by other nations in the very direction in which we have hitherto prided ourselves as being supreme, Government must take the matter up and see that there is put within the reach of all who are in any way to carry on our industries the means of making themselves thoroughly acquainted with the sciences and scientific principles upon which these industries rest. Let us also, like the Germans, have well-organised Realschule and technical training-schools; and for this purpose let Government take the advice of the deputation which waited on the Lord Chancellor last Saturday, and make haste to appoint a responsible Minister of Education, whose duty it will be to see that our educational machinery in all departments, both in extent and in efficiency, is kept up to the wants of the age. The establishment of mere technical schools is not sufficient; these will be of but little avail unless those who wish to take advantage of them have had a previous thorough training in the scientific principles on which the arts are founded. Thanks to Mr. Cole's wise foresight, there are now tens of thousands of our artisans who have had such a training.

No better instance could be afforded of the evil consequences which arise from the want of a responsible Minister of Education, than the disgraceful condition of the Patent Museum. In a dark rusty iron shed at South Kensington are huddled together so as to be practically inaccessible for purposes of study, the paltry collection which represents the genius of that nation which has been foremost in mechanical invention. Let us hope that the object of the Society of Arts' deputation will be granted, and that no time will be lost in arranging in a suitable building everything necessary for the comprehension of Science applied to our various industries, in such a manner that anyone who wishes may study historically all the improvements that have been made in any department; and that, as in the French "Conservatoire des Arts et Métiers," lectureships will be established, thus furnishing a most efficient means for training the men who are to carry on our industries. If this were done, and if local museums were established in suitable centres throughout the country, and if Government take steps to put within the reach of all a thorough general scientific education, and do besides, what no "society for promoting scientific industry" can do, provide means for carrying on unremunerative scientific research, England will soon regain her industrial supremacy, or at least be placed beyond any danger of being outrivalled.

BELT'S "NATURALIST IN NICARAGUA"

The Naturalist in Nicaragua: a Narrative of a Residence at the Gold Mine of Chontales; Journeys in the Savannahs and Forests; with Observations on Animals and Plants in reference to the Theory of Evolution of Living Forms. By Thomas Belt, F.G.S., Author of "Mineral Veins," "The Glacial Period in North America," &c. With Maps and Illustrations. (London: Murray, 1874.)

MR. BELT is a close, an accurate, and an intelligent observer. He possesses the valuable faculty of wonder at whatever is new, or strange, or beautiful in nature; and the equally valuable habit of seeking a reason for all that he sees. Having found or imagined one, he goes on to make fresh observations and seeks out new facts, to see how they accord with his supposed cause of the phenomena. He is a man of wide experience; having travelled much in North and South America and in Australia, as well as in many parts of Europe—and always with his eyes open—before visiting Nicaragua. He is a geologist and an engineer, and knows how to overcome obstacles whether caused by the perversity of man or the forces of nature.

The book we are noticing has, therefore, a value and a charm quite independent of the particular district it describes. As a mere work of travel it is of little interest. The country and the people of Nicaragua are too much like other parts of Spanish tropical America, with their dull, lazy, sensual inhabitants, to possess any novelty. There is little that can be called adventure, and still less of geographical discovery; and the weakest and least interesting parts of the volume are the detailed descriptions of the daily route in the various journeys across the country. We have here and there good illustrations of Spanish American character, as when staying for the night at a ruinous farm-house, the proprietor, Don Filisberto, informed him that he was busy building a new residence. On asking to see it, "He took me outside and showed me four old posts used for tying the cows to, which had evidently been in the ground for many years. 'There,' he said, 'are the corner posts, and I shall roof it with tiles.' He was quite grave, but I could not help smiling at his faith. I have no doubt that, as long as he lives, he will lounge about all day, and in the evening, when his wife and children are milking the cows, will come out, smoke his cigarette, leaning against the door-post of his patched and propped up dwelling, and contemplate the four old posts with a proud feeling of satisfaction that he is building a new house. Such a picture is typical of Nicaragua."

Mr. Belt has done perhaps more than any other traveller to support the theory originated by Mr. Bates of the purpose and cause of what is termed "mimicry" in the animal world, since it was he who first directly observed insectivorous birds reject the Heliconii and allies as food. In Nicaragua he found that a tame monkey, which was extremely fond of insects, and would greedily munch up any beetle or butterfly given to him, would never eat the Heliconii. He would sometimes smell them, but invariably rolled them up in his hand and dropped them quietly after a few moments. One large spider used to drop them out of its web when put into it, but another spider seemed to like them, showing that the smell and taste is not universally, although very generally, displeasing to their enemies. The Lampyridæ, among beetles, which are almost as frequently mimicked as the Heliconidæ, were rejected by monkeys and fowls, as they are known to be rejected by insectivorous birds. Among the new cases of mimicry observed by our author was a longicorn beetle, which most deceptively resembled a hairy caterpillar—a kind which it is well known are never eaten by insectivorous birds. More remarkable is the account of the behaviour of a green leaf-like locust among insect-eating ants. "This insect stood immovably amongst a host of ants, many of which ran over its legs without ever discovering that there was food within their reach. So fixed was its instinctive knowledge that its safety depended on its immovability, that it allowed me to pick it up and replace it among the ants, without making a single effort to escape. This species closely resembles a green leaf, and the other senses, which in the Ecitons appear to be more acute than that of sight, must have been completely deceived. It might easily have escaped from the ants by using its wings, but it would only have fallen into as great a danger, for the numerous birds that accompany the army of ants are always on the look-out for any insect that may fly up, and the heavy locusts, grasshopers, and cockroaches have no chance of escape."

The view that conspicuously coloured creatures, and those that seem to court observation, have some special protection, and that the gay colouring is a warning signal to their enemies not to touch them, was first applied by myself to explain the brilliant colours of many caterpillars. It is now, however, found to have a very wide application, and Mr. Belt is so convinced of its truth that he is able successfully to predict the behaviour of other animals towards an unusually conspicuous species. Most frogs are of more or less protective tints—green or brown according as they live among foliage or on the ground. They feed only at night, and they are all preyed upon by snakes and birds. One species, however, found by Mr. Belt, was of a bright red and blue colour, and hopped about in the day-time without any attempt at concealment. He was at once convinced, theoretically, that this frog must be uneatable. He accordingly took it home, but neither fowls nor ducks would touch it. At length one young duck was induced to pick it up, but instead of swallowing it, instantly threw it out of its mouth, and went about jerking its head as if trying to throw off some unpleasant taste. The skunk, whose offensive secretion is universally dreaded, is a similar instance among mammalia. Its white tail laid back on its black body makes it very conspicuous in the dusk, when it roams about, so that carnivora may not mistake it for other night-roaming animals. When we consider that such cases as these are probably very numerous; that instances of clearly protective colouring are still more so; that both these kinds of colouring may vary almost infinitely, and that there is certainly some unknown influence which tends to produce certain colours in certain localities; and when we further consider that all these causes have been in a continual state of change with changing conditions of existence, organic and inorganic, and have acted and combined with each other in countless ways for untold generations, we have some ground for concluding that colour in nature may have been produced with less assistance from sexual selection than Mr. Darwin thinks is due to that undoubtedly powerful agent.

A very full and interesting account is given of the leaf-cutting ants (Œcodoma sp.), and though these have been so often described, our author has much that is new to tell about them. In his mining operations he cut through some of their subterranean galleries, and from his examination of these he arrives at the conclusion that the ants do not feed on the leaves which they gather in such enormous quantities, but that they use them to form beds for the growth of a minute fungus on which they and their young live. These ants are so destructive to certain plants by entirely destroying their foliage, that many species cannot be cultivated without constant care and protection. It becomes an interesting point, therefore, to determine by what means many of the less vigorous or less abundant species are preserved. It has long been known that there is a very close connection between certain trees and ants. Many Melastomas have a kind of pouch at the base of each leaf, which serves as a habitation for small ants. These have been described by Mr. Spruce, as well as others on the leaves of species of Chrysobalaneæ and Rubiaceæ, &c., in a paper read before the Linnæan Society but not yet published; and he arrived at the conclusion that these structures had become hereditary through the adaptation of the plant to the constant parasitism of the insect, although he did not consider that the ants were of any actual service to the plant. Mr. Belt figures the leaf of a Melastoma possessing these pouches as well as a curious thorny Acacia, the thorns of which are very large and hollow, and are tenanted by ants. In this case the constant attendance of the ants is secured by a provision of food in the shape of little stalked fruit-like glands on the leaves, which the ant feeds on. The hollow stems of the Cecropias are also infested by ants, and they always abound on Passion-flowers, feeding on the honey glands of the flower. Now Mr. Belt believes, and apparently with good reason, that in all these cases the ants are protectors of the plant against herbivorous insects, such as caterpillars, cockroaches, earwigs, &c., but especially against the leaf-cutting ants; and that on account of this service the plants have in many cases become specially modified so as to supply food or shelter to the ants which are so useful to them. It is a suggestive fact that introduced trees and shrubs are more subject to the attacks of the leaf-cutting ants than native species. They do not possess either the disagreeable juices or the insect protectors that the latter have in the course of ages acquired. We have here an altogether new view of the inter-relations of plants and insects, which may, in some cases, help botanists to account for the presence of the many curious and apparently useless glands and appendages plants often possess.

Among other natural history information in this work, we find some excellent observations on reasoning power in insects, a good description of the habits of a monkey, and some judicious remarks on the mode of action of

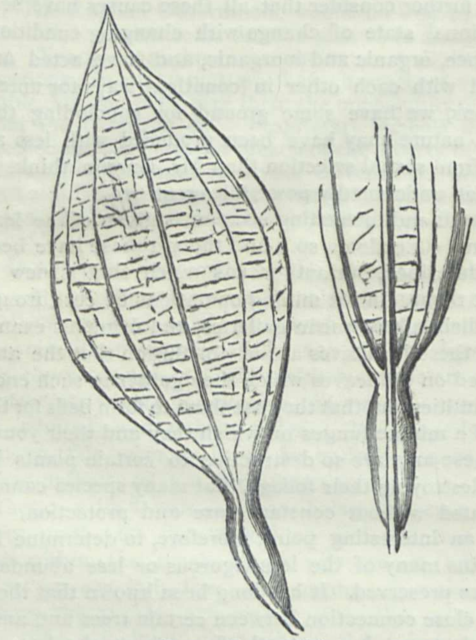


FIG. 1.—Leaf of Melastoma.

natural selection; although the idea that the hairless breed of dogs has been produced because hair favours the increase of *pediculi* and other parasites, is hardly one that will be accepted, seeing that hairless forms, of carnivora at all events, are quite unknown in a state of nature. On the subject of the fertilisation of flowers by insects Mr. Belt remarks, that besides the special adaptations for

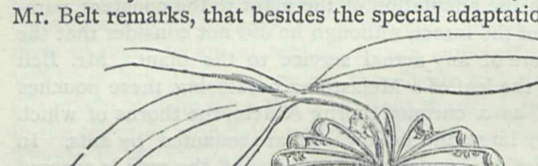


FIG. 2.—Flower of Marcgravia nepenthoides.

fertilisation by certain insects, there are often other adaptations for the express purpose of preventing useless insects from robbing the flowers of the attractive nectar, and he illustrates this by a description of our common foxglove. He also furnishes, what I believe are new and very curious cases of fertilisation by birds. In the *Marcgravia nepenthoides* (Fig. 2) there is a group of pitchers below the flowers, containing a sweet liquid which attracts insects; and numerous insectivorous birds come to feed upon these insects, and in doing so necessarily brush off the pollen and convey it to other flowers. In a species of Erythrina having a sword-shaped flower which will only admit very minute insects to the nectary, two species of long-billed humming birds probe the flowers in search after the insects, and in doing so get the pollen on their heads and carry it to other flowers. In this case the nectar is protected by a thick fleshy calyx, which effectually prevents bees and wasps from breaking in and stealing the attractive liquid.

As a geologist our author contributes some important facts on the great question of an intertropical glacial period. He found at from 2,000 to 3,000 feet above the sea, an extensive formation of boulder clay, full of great angular blocks, which he has not the slightest hesitation in pronouncing to be of glacial origin. He decides that this formation must be due to land glaciers and not to icebergs, because the latter would imply a depression of the country fully 3,000 feet, which would have produced a wide channel connecting the Atlantic and Pacific, and have caused more intermingling of the faunas of the two oceans than actually exists. It may, however, be argued, on the other hand, that if there has been no recent communication between the two oceans, then scarcely a single species of fish or mollusc should be common to the two. Yet no less than 48 species of fishes are absolutely identical; and as to the molluscs, Mr. P. P. Carpenter says that, besides those undoubtedly identical (about 40), more than 30 others may be identical, and that 40 more, although distinct, are very close representative species. We have, therefore, over 100 species of molluscs so nearly identical in the two oceans, that we cannot suppose their separation to date longer back than the Pliocene period. It may be fairly argued that this amount of community proves a connection between the oceans at a recent date, and that the number of species in common is quite as great as we can expect, when we consider—firstly, that migration into an already fully stocked area is by no means so easy and rapid a process as was once supposed; and secondly, that the presence of icebergs depositing their loads of clay and gravel in the straits themselves would, perhaps, destroy most forms of marine life, or drive them away to some distance. Mr. Belt further advocates, what seems a very untenable theory, that the glacial period of the northern and southern hemispheres was at its greatest severity at the same time, and that the glacial deposits of Central America and Brazil are synchronous. To get over the enormous difficulty as to what became of the exclusively tropical forms of insect and bird life that abound in such overpowering luxuriance in tropical America, he has recourse to the increased area of low land caused by the lowering of the ocean owing to the vast amount of water abstracted in the form of ice. But Mr. Andrew Murray's map of the 100 fathoms line of soundings shows that the tropical part of South America would not be materially increased in area by a depression of 600 ft., and another 600 ft. would add proportionately less. Besides, if astronomical causes have produced glacial epochs, it is certain that they would occur alternately in each hemisphere;

and this would enable us far better to understand how the tropical forms of life continued to flourish by migrating north or south away from the colder pole. The subject of glacial periods is rendered vastly more difficult by the discovery of signs of glaciation so far within the tropics, and all facts proving such glaciation are of the greatest importance. It seems most probable that the solution of the problem will be only possible by admitting a succession of glacial periods of unequal intensity; so that while in the tropics we have the traces of one of the more ancient and intense period of cold, in the more northern regions we see the results of successive glaciations and intervening denudations.

Much more satisfactory as well as more original, is Mr. Belt's theory of the cause of whirlwinds and cyclones. He well remarks that there is a complete gradation, from the little eddy which whirls up the dry leaves, through the moderate whirlwind, up to the most destructive hurricane; and that a great philosophical mistake has been committed in forming theories to explain the larger phenomena without ever having studied the smaller. The few pages devoted to this subject are well worth reading, and would alone stamp the author as an acute observer in physics as well as in natural history. He gives good reasons why all the received theories of the cause of cyclones are incorrect, and substitutes one founded on observation of the smaller and more easily observed phenomena which is very ingenious, and which appears to have received the provisional approval of the Astronomer Royal, but which would occupy too much space to give an account of here.

We have now sufficiently shown that most of the readers of NATURE will find matter of interest in this volume; and we sincerely trust that the author may soon find himself in a position to work more systematically at some of those branches of science which he has here touched upon. So clear-sighted and intelligent a student will probably make important discoveries.

ALFRED R. WALLACE

PETTIGREW'S ANIMAL LOCOMOTION

Animal Locomotion; or, Walking, Swimming, and Flying. By J. Bell Pettigrew, M.D., F.R.S. (London: Henry S. King and Co., 1873)

PROGRESSION on land, in water, and in air, are phenomena so intimately connected with everyday life, that all of a thoughtful and observant turn of mind cannot help becoming acquainted, unassisted, with most of the details and much of the principle of their production. Many will therefore open a new work on the subject with a wish to have explained to them some of the more difficult and obscure problems connected with it, which are too intricate or uncommon to be within the limits of ordinary powers of observation; and to have the fundamental principles on which the subject is based, fully expounded. With such a feeling we took up the book under consideration, especially as Dr. Pettigrew's name has been always held up as that of the British exponent of the phenomena of flight, and the combatant of the French school. Imagine our disappointment on finding that, instead of the work being by the hand of a master, its author is deficient in the knowledge of the first principles of physics, and of the undoubted meaning of some of the most simple terms employed in the science; his argument, if it may be so called, being but little more than a long series of vague and fanciful analogies, incorrectly stated physical facts, and untenable theories.

In the introduction, and more minutely in a special chapter, the subject of aëronautics is discussed, and the false hope perpetuated that it is quite within the range of human possibility to construct a flying machine, capable of sustained suspension; for we are told that "in order to construct a successful flying machine . . . all that is required is to distinguish the properties, form, extent, and manner of application of the several flying surfaces;" no mention being made of the true difficulty of the problem, which is, that it is at present impossible to obtain from any form of fuel, a sufficient percentage of the potentiality which it possesses for doing work, to work an engine sufficiently compact and light for the wings which it has to drive. In the chapter on progression through the air, one of the paragraphs commences with the astonishing title, "Weight, Momentum, and Power, to a certain extent synonymous in flight," which follows an equally extraordinary and oft-repeated statement that "weight, when acting upon wings, or what is the same thing, upon elastic twisted inclined planes, must be regarded as an independent moving power." After such indications of imperfect knowledge, nothing in the way of mechanical theories could cause surprise, and we are therefore not astonished to find it laid down as the fundamental principle of flight, that the up-stroke of the wing aids in propulsion, and that in the down-stroke the inferior surface of the wing is directed *downwards* and *forwards*. "I repeat downwards and forwards; for a careful examination of the relations of the wing in the dead bird, and a close observation of its action in the living one, supplemented by a large number of experiments with natural and artificial wings, have fully convinced me that the stroke is invariably delivered in this direction," the wings being said to act like a boy's kite during both the down and up stroke. Who can see any close relation between the flight of birds and that of a kite? Dr. Pettigrew seems to forget that a kite needs a string, and yet, backed by his false analogy, he has the presumption to quote the experimental verifications and opinions of such able and ingenious thinkers as Borelli and Marey, the authors of the true theory of flight, only to reject them; bringing forward in opposition such evidence as "from accurate examination, I am fully convinced," and the like, against the sound mathematical arguments and superbly conducted experiments of the two above-named physicists.

Another favourite notion which Dr. Pettigrew reiterates is that "the efficiency of the wings is greatly increased by the fact that when it ascends it draws a current of air up after it, which current, being met by the wing during its descent, greatly augments the power of the down-stroke. In like manner, when the wing descends, it draws a current of air down after it, which, being met by the wing during its ascent, greatly augments the power of the up-stroke. . . . The wing is endowed with this remarkable property, that it creates the currents on which it rises and progresses." This would be all very true, if the problem were as simple as here put; but it is evident that these induced currents are of no real service in flight, because in their production there is as much force lost as there may be gained from their subsequent employment on the reversal of the action of the wing, if the bird's body has not advanced sufficiently far to be in each stroke beyond the range of their action, which is probably the case.

Physiologists will also be considerably startled by a novel hypothesis of Dr. Pettigrew's, which we cannot give better than in his own words :—"Hitherto, and by common consent, it has been believed that whereas a flexor muscle is situated on one aspect of a limb, and its corresponding extensor on the other aspect, these two muscles must be opposed to and antagonise each other." We are not ashamed to say that such has always been, and still is, our idea, notwithstanding the author's remark that "This belief is founded on an erroneous assumption, viz., that muscles have only the power of shortening, and that when one muscle, say the flexor, shortens, it must drag out and forcibly elongate the corresponding extensor, and the converse. This would be a mere waste of power. Nature never works against herself. There are good grounds for believing . . . that there is no such thing as antagonism in muscular movements. . . . Muscles are, therefore, endowed with a centripetal and centrifugal action."

In conclusion, we must say that we expected better things of Dr. Pettigrew, and regret that he has not, before now, learned that there are errors in his methods and his results that cannot be tolerated by a thinking public, which prefers accurate reasoning rather than dogmatic statement, and well-grounded fact to fanciful analogy. A. H. GARROD

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

The Famine in India and Meteorology

OUT here in India our attention has been of late called to consider the best means of warding off the effects of one of Nature's laws, that threatens the lives of numbers of our fellow-creatures,

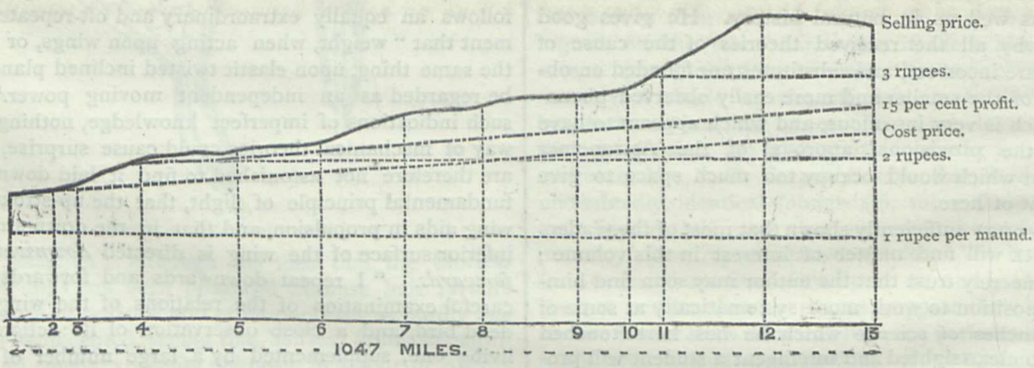


FIG. 1 shows the cost of Wheat per maund at the following Stations on the line of Railway in November 1873:—1, Umritsur; 2, Jullunder; 3, Loodianah; 4, Umballa; 5, Meerut; 6, Allyghur; 7, Etawah; 8, Cawnpore; 9, Allahabad; 10, Mirzapore; 11, Benares; 12, Dinapore; 13, Bhaugulpore.

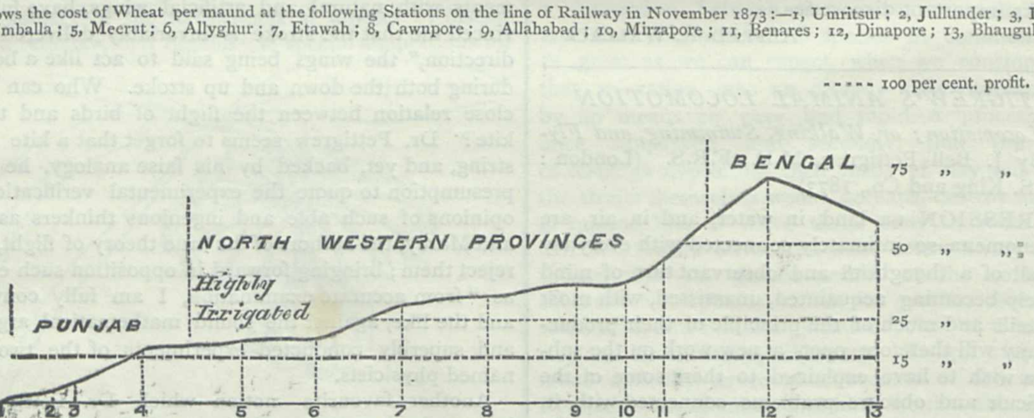


FIG. 2 shows the resen profits by the sale of Wheat at the following Stations:—1, Umritsur; 2, Jullunder; 3, Loodianah; 4, Umballa; 5, Meerut; 6, Allyghur: 7, Etawah; 8, Cawnpore; 9, Allahabad; 10, Mirzapore 11, Benares; 12, Dinapore; 13, Bhauguulpore.

for at this present moment the millions of Bengal are threatened with famine.

The study of the meteorological effects and changes of climate in India is very interesting, but I have not time to go into the question how one portion of the air laden with moisture moves up the Bay of Bengal, sweeps along the coast of Burmah and Asam; how it begins to part with the moisture in Burmah about the middle of May, continually advancing along the valley of the Ganges, till about a month later it reaches Simla, which is on the ridge which separates the drainage of the Ganges from that of the Indus.

Up the Indus valley another current of air from the Indian Ocean also moves northwards parting with large quantities of its moisture along the western coasts of Madras and Bombay, and then passes up the valley of the Indus, but without watering that large extent of desert lying between Scind and the Punjab, so it is not till within a short distance of the hills that the body of air begins to part with its moisture.

I say this is all a very interesting subject to study, but it is not my intention at present to go into it, but simply to state that this season Bengal has not had its average rainfall, while in the Punjab the rains were later than usual in setting in, yet the general fall has been on the whole seasonable, for though the cotton crop is a failure compared with other years, yet the cereals have been plentiful, and hence grain is cheap.

In Fig. 1 I have tried to show the price of grain along the line of the railway from Umritsur to Bhaugulpore, a distance of 1,047 miles. The full black line shows the actual prices at which grain is now selling in all the several districts through which the railway passes, it being least at Umritsur, which is in the centre of the Punjab, and greatest at Dinapore, in the Patna district of Bengal. At the right-hand side is a scale of rupees showing the cost per maund, which can be easily reduced to English values by considering a manud equal to ¾ cwt. and a rupee equal to 2*s.* This will approximately give the present English value of wheat during November last as published in the several gazettes. The lower dotted line shows how the price of this grain goes on increasing by the distance transported. The usual railway rate was ½ pice per maund per mile, which by a late order of Government has been reduced to half this rate, or approximately 3*s.* 6*d.* for 100 tons a mile.

If to this be added 15 per cent. profit to meet losses and deterioration, the thick dotted line indicates what grain could probably be sold at by Government without any loss, if it became a large dealer; and, as before said, the upper full line shows the actual prices with the large margin there is for profits.

Fig. 2, however, shows this much clearer, and proves that the demand must be greater than the supply; or, in other words, that as much as over some 2,000 tons daily of grain, which was grown more than 700 miles away from the point where the famine is most severe, along the line of railway, is sent down from the Punjab, and the highly irrigated lands of the North-West Provinces, enough to sustain in life as many as there are inhabitants in London, or some four million souls; for 1¼ lbs. for each man, woman, and child, is considered enough to sustain the life of a native of India.

But what is this to the millions of Bengal that are now threatened with famine? It is hardly one-seventh, I am led to understand. So with all our canals and railways, and the great good they are doing in the present state of things, yet there is a larger demand than can be supplied, or the profits could never mount up to 70 per cent., as at Dinapore.

Though the subject of this letter may not be considered exactly a fit one for the pages of NATURE, yet I feel sure that those who study Nature in her works and effects, will be interested in the facts now given.

T. LOGIN
Sup. Engineer, Punjab

Umballa, Dec. 12, 1873

Dr. Tyndall and Sensitive Flames

IN the last number of NATURE a report is given of the first of Dr. Tyndall's Christmas "Lectures to Juveniles," on the Motion and Sensation of Sound. In that lecture Dr. Tyndall shows how the reflection of sound can be made manifest to an audience by means of a sensitive flame; and, according to the closing words of your report, Dr. Tyndall states,—"Never before have these phenomena been made visible. Hitherto these effects have been investigated by the sense of hearing; I have now been able to prove them by appealing to your eyes."

In the *Illustrated London News* a short notice is also given of the same lecture, and there Dr. Tyndall is reported to have said, that no philosopher had ever before witnessed the reflection of sound until that afternoon. I presume, therefore, that the report you have given accurately represents Dr. Tyndall's words. And this being so, will you permit me simply to place the following facts before your readers. In January 1870 I published an article in the *Quarterly Journal of Science* on the "Analogy of Light and Sound." In that article I stated how a sensitive flame can be used as a delicate *phonoscope*, to reveal perfectly well the decay, the absorption, and the reflection, and (less perfectly) the refraction of sound-bearing waves. A sketch is there given precisely the same as that which appears in Dr. Tyndall's lecture (Fig. 6), wherein a sensitive flame is placed in the conjugate focus of a pair of parabolic mirrors. This experiment was shown at a lecture I delivered on January 3, 1868, before the Dublin Royal Society. A copy ot my paper in the *Quarterly Journal of Science*, and of the printed ab stract of my lecture before the Dublin Society, I myself sent to Dr. Tyndall a few days after they appeared, and if I mistake not, drew his attention to these experiments.

Since 1868 I have so frequently shown to my own class and to large audiences the reflection of sound by a sensitive flame, that I have no doubt many of your readers will have been astonished when they heard or read Dr. Tyndall's assertion which I have quoted. Indeed, probably Dr. Tyndall himself will be able to recall the foregoing facts, and will gladly put his memory right on this matter.

W. F. BARRETT

Royal College of Science, Dublin, Jan. 19

The Potato Disease

SINCE October 1872 I have been growing potatoes, healthy and diseased, under test conditions, principally with a view to a further insight into the winter and subterranean life of the *Peronospora* and also in the hope of meeting with the (to me) apocryphal *Artotrogus*. The figures of the latter referred to by Mr. Berkeley, I am well acquainted with, as I have engraved them three times, once to illustrate Mr. Berkeley's own paper in the *Gardener's Chronicle*. I therefore well knew what to look for in the corroded cellular tissue of my diseased potatoes. I by no means wish to assert (or indeed asserted) that *Volutella ciliata* is positively the same with Montagne's *Artotrogus*, for I have never seen a specimen of the latter, (I know no one who has except Mr. Berkeley), and as far as I am aware no one has met with it since the time of its original publication between twenty and thirty years ago. As no one now (including Mr. Berkeley) ventures to suggest more than the "possible" or "probable" nature of *Artotrogus*, my note was meant to suggest another reasonable direction for future observation.

In my experiments, I have from the first been forcibly struck with the presence of *Volutella* with its mycelial threads, not only outside and just within spent potatoes, but also within the corroded cellular tissue. I have no doubt that the plasma of *Volutella* is equally disorganising with the plasma of *Peronospora* itself, and that the threads belonged to the former plant I have no manner of doubt, as I constantly traced young to mature specimens of *Volutella* from it, and that too from positions within *buried* potatoes. The strong external resemblance between some slates of *Volutella* and the figures referred to by Mr. Berkeley, suggested to me that this "will o' the wisp" *Artotrogus*, might perchance eventually turn out to be no other than some condition of *Volutella*.

So far from its being my desire to draw attention from *Artotrogus*, the paragraph in my first letter was written with a view to draw attention to it. Berkeley himself always speaks doubtfully of its nature, and Carruthers, in his recent paper on *Peronospora*, published by the Royal Agricultural Society, has not even referred to it.

Returning for a moment to the principal subject of my first note, viz. the failure of the essays submitted in answer to the offer of a prize on the part of the Royal Agricultural Society for the best essay on the potato disease and its extirpation. In NATURE, vol. ix. p. 212, I observe that the committee are now disposed to view the desired destruction of the potato disease from a different standpoint, and propose to offer three prizes of 100*l.* to dealers, who are to send in a ton each of "disease-proof" potatoes.

It appears to me as unreasonable to advertise for a "disease-proof" potato as for a "death-proof" man. Surely all organised bodies are liable to deviation from health, and though certain organisms may be made (by art) to more or less throw off or resist the attacks of disease, yet none can be said to be in themselves "disease-proof." As regards potatoes, I think I may say, without fear of contradiction, that at present no varieties whatever are either proof against the *Peronospora* or able to resist its attacks, neither is it at all likely that any such varieties will ever arise.

WORTHINGTON G. SMITH

ON DIFFRACTION SPECTRUM PHOTOGRAPHY, AND THE DETERMINATION OF THE WAVE-LENGTHS OF THE ULTRA-VIOLET RAYS*

ILLUSTRATED BY AN ALBERT-TYPE PLATE.

THERE are, as is well known, two methods by which spectra may be obtained: (1) by the action of a prism; (2) by a system of closely-ruled lines. In the latter case it is convenient to speak of the contrivance employed as a grating, and of the spectrum as an interference or diffraction spectrum. A casual inspection shows that there is a great difference between the spectra produced by these two methods, and close investigation proves that the diffraction spectrum is by far the more suitable for accurate scientific work. For this reason it has seemed desirable to make a trustworthy map of those parts of the solar diffraction spectrum which can be photographed on collodion, and to attach to it a scale for reading the wave-lengths of the rays.

The plate accompanying this memoir is from collodion photographs made by myself, transferred to a thick piece of glass, the latter process being known as the Albert-type. For the entire success of this transfer I am indebted to my friend Mr. E. Bierstadt, the owner of the patent in America. The glass is then used in a printing press in the same manner as a lithographic stone. The spectrum is absolutely unretouched. It represents therefore the work of the sun itself, and is not a drawing either made or corrected by hand.

The picture consists of two portions: first, the upper, which gives all the lines of the spectrum from near G to O, or from wave-length 4350 ten-millionths of a millimetre to 3440. Above that is placed a scale, which is a copy of Angström's from just below G to H_2, with the same-sized divisions carried out from H_2 to O. The second, or lower, is a magnified portion of the same negative, having H_1 and H_2 about its middle, and extending from wave-length 4205 to 3736.

It follows therefore that the lines in the solar spectrum are correctly represented in their relative positions. The only errors are those which may have arisen from maladjustment of the scale. The precautions that were taken to avoid such errors will be described. With a certain correction, to be mentioned hereafter, it may also be stated that the relative shadings and intensities are preserved.

The value of such a map depends on the fact that it not only represents parts of the spectrum which are with difficulty perceived by the eye (though they may be seen by the method of Stokes and Sekulic), but also that even in the visible regions there is obtained a far more correct delineation in those portions which can be photographed. In the finest maps drawn by hand, such as those in the celebrated "Spectre Normal du Soleil" of Angström, the relative intensity and shading of the lines can be but partially represented by the artist, and a most laborious and painstaking series of observations and calculations on the part of the physicist is necessary to secure approximately correct positions of the multitude of Fraunhofer lines. Between wave-lengths 3925 and 4205, Angström shows 118 lines, while my original negative has at least 293.

For such reasons many attempts have been made to procure good photographs of the diffraction spectrum. The earliest were by my father, J. W. Draper; his results were printed in 1843-44 in a work entitled "On the Forces which produce the Organisation of Plants." This memoir was accompanied by plates drawn from daguerreotypes, and the wave-lengths, which he first suggested as the proper indices for designating the Fraunhofer lines, were used as a scale.

Since that time the most important experiments in this direction have been by Mascart and Cornu. These eminent physicists have, however, resorted to the plan of taking portions of the spectrum on a small scale and subsequently making enlarged drawings therefrom. This course introduces the defects of handwork, and the artistic difficulties of copying intensity and shading, as well as the omission of fine lines.

In the photographs of the spectrum which I have taken I have tried to get as large a portion as I could at once, and on as large a scale as possible. I have usually obtained images from below G (wave-length 4307) to above O (wave-length 3440) of about 12 inches (·305 metre) long. I have succeeded, however, in photographing from near *b* (wave-length 5167) to T (wave-length 3032) by resorting to a ruled speculum plane and a concave speculum mirror, but the photographic and optical difficulties in securing an enlarged spectrum of that length are great.*

Of course, in such a research as this an essential is a finely and evenly ruled plane of glass or other material. Those which I have used were made by a machine devised and constructed by Mr. L. M. Rutherfurd, whose beautiful lunar and prismatic spectrum photographs are so well known to the scientific world. The plate generally employed is of glass ruled with 6481 lines to the inch; the ruled part is $1\frac{8}{100}$ inch (·027 metre) long, and $\frac{64}{100}$ inch (·016 metre) wide. It is unquestionably much more nearly perfect than similar gratings made by Nobert and others, for the character of the photographs and the uniformity of the orders on either side of the normal, together with its behaviour under a searching examination, show that it leaves little to be desired. As it is on glass, and gives a bright transmitted spectrum, I have constructed the remainder of the optical apparatus of glass achromatised, according to the plan used by J. W. Draper in 1843, except that I have not silvered the ruling, and therefore have used the refracted, and not the reflected beam. The slit is $\frac{8}{10}$ of an inch (0·2 metre) long, and $\frac{1}{110}$ of an inch (·00023 metre) wide; the jaws are of steel, and there is not only a micrometer screw for separating them, but also one for setting them at an angle. Occasionally I have taken photographs with the jaws $\frac{1}{90}$ of an inch (·00028 metre) apart at the top, and $\frac{1}{130}$ (·00019 metre) at the bottom, so as to obtain different intensity in the two edges of the spectrum.

Most of the photographs have been of the spectrum of the third order, which has certain conspicuous advantages. In the first place it is dilated to such an extent as to give a long image, and yet one not too faint to be copied by a reasonable exposure of the sensitive plate; and in the second place, the spectrum of the second order overlaps it in such a way that D falls nearly upon H, and *b* upon O. These coincidences are serviceable in determining the true wave-lengths of all the rays.

The only point of special interest in connection with the photographic part of the operation, is the device for avoiding the unequal action on the sensitive plate of different rays of the spectrum. It has been commonly supposed, until the recent memoirs of J. W. Draper, that there are in the spectrum three different types of force in three different but overlapping regions. Heat was supposed to be principally found at the less refrangible end, light in the middle, and actinism at the more refrangible. But he showed that this error has partly arisen from using prismatic spectra, which condense the red end and dilate the violet, and do not present the rays in the

* From the *American Journal of Science and Art*, Dec. 1873. Communicated by the author.

* Since writing the above I have succeeded in photographing the lines of the visible spectrum from *b* downward, and the picture comprises not only the regions including E, D, C, B, *a* and A, but also the ultra-red rays. The great groups, α, β, γ, below A, discovered by my father in 1843, are distinctly reproduced.

true order of their wave-lengths, and partly from the nature of our ordinary photographic substances. He proved that actinism, or the power of chemical decomposition, does not particularly belong to the violet end of the spectrum, but is found throughout its whole length. But bromide and iodide of silver, as used in collodion photography, are more readily decomposed by vibrations of certain lengths and periods than by others, and hence the excess of action seen at the violet end is a function of certain silver compounds, and not of the spectrum. Other substances, as carbonic acid, show maxima elsewhere, as in the yellow region. The solar beam is therefore not compounded of three forces, light, heat and actinism, but it is a series of ethereal vibrations, which give rise to one or other of these manifestations of force, depending on the surface upon which it falls.

In order to provide against this excess of action in certain parts of the spectrum, I introduced a system of diaphragms placed in the vicinity of the sensitive plate, and removed at suitable times during the exposure. The region from wave-length 4000 to 4350 only requires about one-tenth of the time demanded by that from 3440 in 3510. In the negative which produced the accompanying plate, the line O had 15 minutes and G $2\frac{1}{2}$ minutes, and the former is under-exposed. These exposures seem at first sight unusually long for a wet collodion surface, but it must be remembered that the slit used was only $\frac{1}{110}$ of an inch wide, and that the diffraction grating gives an almost complete circle of spectra round itself, amongst which this thin band of light is divided. A beam $\frac{1}{110}$ of an inch (·00023 metre) wide is spread out in this case into a streak about 78 ft. (23·77 metres) long.

After the production of spectra that were in focus from end to end, it was next necessary to attach a scale to them by which the wave-lengths might be read. At first I tried, by reducing Angström's maps to the proper dimensions, to accomplish this object, but the undertaking proved to be difficult, and was unsuccessful, because, though the original drawing on the stone was undoubtedly correct, the paper proof of it which I had, had stretched unequally in printing, and on applying a photographic reduction to my spectra, coincidence could not be obtained. As, however, the subject of dividing a scale for these diffraction spectra is of prime importance in giving value and precision to the wave-lengths presented in this memoir, I propose to describe fully the method eventually employed in fitting a scale to the photograph.

The wave-lengths of the ultra-violet rays have never as far as I know, been either determined or published except by J. W. Draper in 1844, Mascart in 1866, and Cornu in 1872. J. W. Draper's memoir has a steel engraving of some of the principal lines, from which the wave-lengths may be approximately read.

The large plate which accompanies Mascart's long and valuable memoir is of the prismatic spectrum, but he furnishes in addition the following table of wave-lengths :—

L	3819·0
M	3728·8
N	3580·2
O	3440·1
P	3360·2
Q	3285·6
R	3177·5

These numbers do not entirely coincide in all cases with my photograph, as I will show farther on.

The detailed results of M. Cornu have not appeared in any publication that has reached me.

I have used as a basis the numbers given by Angström for the rays D_2, b_4 and G, and if there should be any small error in his determination, my scale will require a proportionate correction, which can easily be effected. At first sight it seemed better to take G and H as fixed points, but the line H is so broad, and has so many component lines, that its position is uncertain, and moreover, being almost at the limit of visibility in Angström's apparatus, it was more open to errors of measurement. These reasons led me to take advantage of the fact that the second spectrum overlaps the third, the ray D of the second being near H of the third, and *b* of the second near O of the third. It is obvious that we have thus the means of ascertaining the wave-lengths of three points, one at each end, and one in the middle of my photograph. As the rays D and *b* cannot impress themselves on collodion by any length of exposure that it is convenient to give, and as in my method of working the ultra-violet rays could not be seen simultaneously with them, it was necessary to resort to the following device :—I placed in front of the sensitive plate and close to it two fine steel points, one of which was carefully adjusted to the position of D_2 of the second order, and the other to b_4 of the second order. When, therefore, after a suitable exposure to the ultra-violet spectrum of the third order, the collodion picture was developed, there were two sharply-defined images of the steel points superposed on the spectrum. The point which had been coincident with D_2 of the second order was then found to have cast its shadow on H_2 of the third order, and the point at b_4 of the second order had impressed itself near O of the third order.

By a simple calculation it was thus rendered evident that a given ray in the compound line H_2 was of the wave-length 3930·1 ten millionths of a millimetre, and that another line near O had the wave-length 3444·6. By looking at the photograph, the reader will see that 3930 falls upon a fine division in H_2, which is beautifully shown in both the spectrum with the scale and the enlarged proof below. Of course, the ray G of the third order, the wave-length of which is known, had impressed itself photographically on the collodion.

Having thus ascertained the wave-lengths of three fixed points in the photograph, the next step was to apply a scale reading to a single ten-millionth of a millimetre, and, if possible, fractions thereof. After many abortive attempts to use that part of Angström's map which lies between G and H, and to attach thereto an additional length of scale sufficient to extend to the end of the ultra-violet region, I was compelled to resort to a linear dividing engine, and rule a scale which was about twice the length of the photographic reduction shown in the accompanying plate. Of course this necessitated drawing in by hand the same systems of lines and lettering as are shown on Angström's chart, and this I did as carefully and faithfully as I could.

It only remained to reduce this divided scale to the proper size to fit the spectrum photograph; after many trials it was accomplished.

It is proper in this place to make a criticism on my scale, and to point out a small error, which may be due, however, to an incorrect determination of the wave-lengths that I have used as fixed points. Taking the distance from G (wave-length 4307) in the photograph to the fixed line 3930 in H_2, and dividing it into 377 parts, and then prolonging these divisions toward O, it was found that the third fixed point was not attained, but that there was an error of about two divisions. But if the position of D_2 in Angström's determinations should be incorrect to the extent of one ten-millionth of a millimetre, or if this small error should be partly attributed to D_2, and partly to G, my scale would be correct. Future measures of the wave-lengths of these rays, and of b_4, can alone settle this delicate point, for the determinations of Mascart and Angström and Thalen differ nearly to the extent mentioned above. The same remark is true of Angström compared with Ditscheiner, while the difference between Angström and van der Willigen is more than three times the amount necessary to remove my discrepancy. In any case the photograph is correct, as it is the work of the sun, and is only open to errors arising from imperfect flatness in the field of a fine lens, and that field only subtending an angle of about 4°. The angular aperture of the lens, viewed from the sensitive plate, is 20 minutes. I trust, therefore, that the photograph may be of permanent value to physicists, for any one can affix another scale if this be slightly erroneous.

An examination of the photographed spectrum shows many points of interest, some of which are best seen in the spectrum with the scale above, and some in the portion enlarged below. The latter is magnified about twice, and comprises the region from wave-length 3736 to 4205. I have also made photographs on the same scale as Angström's map, but have not as yet printed them. The capital letters which are attached to the region above H are according to the nomenclature of Mascart, although the wave-lengths assigned by him to those letters do not coincide exactly in all cases with the lines in my photograph; for instance, the line L, which he regards as single, is in reality triple, and does not correspond to 3819, but to 3821; M is correctly designated by 3728, but it is double; N is really at 3583, and not 3580. It has been suggested that it would be proper to return to the old nomenclature of Becquerel and J. W. Draper, who simultaneously discovered these lines in 1842-43, but the designation of position by wave-length in reality renders the letters unnecessary.

The spectrum above H, when compared with the region from G to H, is marked by the presence of bolder groups of lines, and most conspicuous are those between 3820-3860, 3705-3760, 3620-3650, 3568-3590, 3490-3530. The first of these groups is strikingly shown in the enlarged photograph. I am not as yet able to offer an opinion as to the chemical elements producing these groups, for almost all the photographs of the ultra-violet spectra of metalline vapours that I have thus far made were produced by a quartz train, and have not yet been reduced to wave-lengths. Indeed, that is a separate field of inquiry, and could not be comprised in a memoir of this length. I have also tried to utilise the photographic spectra of the late Prof. W. A. Miller, published in the "Transactions" of the Royal Society for 1862, but for some reason, probably insufficient intensity of the condensed induction spark, his pictures do not bring out the peculiarities of the various metals in the striking manner that is both necessary and attainable. The diffraction spectra of metalline vapours that I have made are not yet ready for use.

The probabilities are that each of these groups will be found to be due to several elements, as is plainly seen in the group H. This compound line, which is commonly spoken of as being caused by calcium, iron, and aluminum, is in reality much more complex, for there can readily be counted in it more than fifty lines in the original negative, and a careful inspection of the accompanying paper picture shows a large proportion of them. This observation leads us to a more general statement. *The exact composition of even a part of the spectrum of a metal will not be known until we have obtained photographs of it on a large scale.* The coincidences which were so thoroughly examined by Mr. Huggins (Trans. Royal Society, Dec. 1863) will only disappear when we can, in addition to the position of a line, have a clear idea of its size, strength, and degree of sharpness or nebulosity. The eye is not able to see all the fine lines, or even if it does, the observer cannot map them with precision, nor in their relative strength and breadth. For example, in Angström's justly celebrated chart, of which the G-H portion is copied in this plate, and in the construction of which the greatest pains were taken by him, many regions are defective to a certain extent. The region from 4101 to 4118 is without lines, yet the photograph shows in the enlarged copy seventeen that can easily be counted, a the original negative shows more yet. The reader course understands that a paper print of a collodion pi ture is never as good as the original; the coarseness c grain in the paper, want of contact in transferring, &c. effect such a result. Moreover, the Albert-type process depends on a certain fine granulation which is given to the bichromated gelatine, and this forbids the use of a magnifier upon these paper proofs. It is only just, however, to Mr. Bierstadt to state, that without his personal supervision, such sharp and fine-grained proofs could not have been obtained, and that no other printing-press process that I know of could have accomplished this work at all.* As an illustration of the difficulty of depicting the relative intensity of lines, we may examine 3998, which in Angström's chart is shown of equal intensity with 4004; while in reality it is much fainter, and instead of being single, is triple, as is well seen in the enlarged spectrum.

When, however, we compare Angström's chart with the photograph, it requires, as the above remarks show, a critical examination to detect defects, and we have a striking confirmation of the surprising accuracy of the Swedish philosopher.

So also in comparing Mascart's excellent map of the prismatic spectrum with the photograph, the difficulty of depicting all the fine lines is seen. In the group L he shows twelve lines, while even in the Albert-type copy of my photograph twenty-five can be counted, and in the original negative many more. From H to L he exhibits seventy lines; in my plate 138 can be observed, besides many unresolved bands.

In the earlier part of this memoir it was stated that the relative intensities of the lines in the spectrum were correctly represented if a certain allowance was made. If an unshielded collodion plate were presented to the ima, of the spectrum, there would be produced a stain ve dense from G to H, fainter above H, and still faint below G. But this stain would not represent the actin force of the sun; it would merely be the index of th decomposability of a mixture of iodide and bromide c silver. I have for this reason adopted the idea of J. W. Draper, that force is equally distributed through the spectrum, and have tried to produce a photograph of equal intensity throughout. This has been accomplished, as I have before stated, by suitable diaphragms. But whether this view be correct or not, lines which are not far distant from one another are presented virtually without any interference by diaphragms, and must therefore be correct both as to shading and intensity.

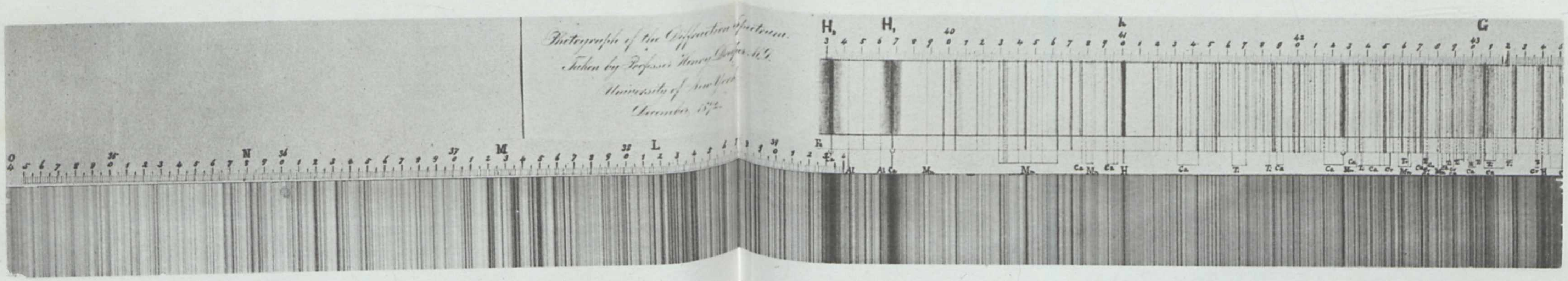
Besides the points above mentioned, there are many theoretical considerations suggested by the photograph which it does not seem expedient to enter upon fully at present. Among such is the possibility of arriving at an estimate of the sun's temperature, by interpreting the apparent bands, such as those near G and H, by the aid of Lockyer's researches on the temperature of dissociation of compounds. No one has yet ascertained whether there are or are not unresolvable bands in the solar spectrum. If they do exist, the compounds to which they belong, and the necessary temperature for dissociation, remain to be determined.

It would seem also to be possible to find out whether, as asserted by Zöllner, there is a liquid envelope around the sun, by a search for more diffused bands in its photographed spectrum.

In the hope that this photograph may prove to be of value to scientific men for further investigations upon the sun and the elements, I have caused a number of extra copies to be printed, and shall be glad to present them to anyone who can make use of them.

HENRY DRAPER

* From the original negative of the spectrum 12,000 copies have up to the present been printed, and it is not in the slightest degree injured as yet.


Photograph of the Diffraction Spectrum.
Taken by Professor Henry Draper M.D.
University of New York
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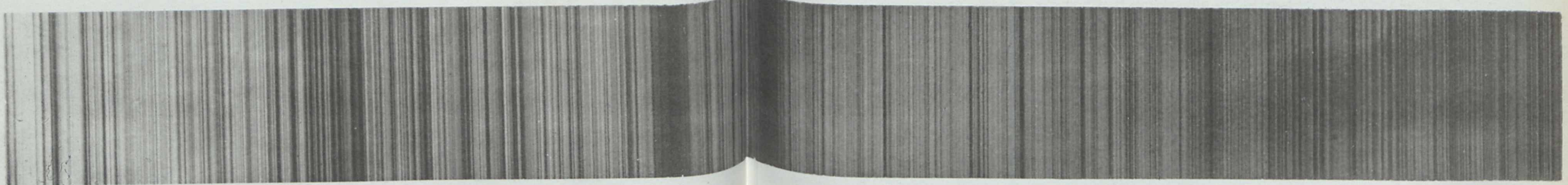

THE "BRONTOTHERIDÆ," A NEW FAMILY OF FOSSIL MAMMALS

VERY nearly a year ago Prof. O. C. Marsh, of Yale College, announced the discovery of a new order of Mammalia, the Dinocerata, huge elephantine forms, with three pairs of horns and large canine teeth, from the Eocene deposits of the country to the east of the Rocky Mountains, including the states of Dakota, Nebraska, Wyoming and the "Bad Lands" of Colorado, which was described and one of its species figured in this journal at the time (NATURE, vol. vii. p. 366). This same able zoologist has the opportunity of adding still another unexpected group of animals, this time from the Miocene beds of the same district, which, though Ungulate and almost certainly Perissodactylate, are very different from any known form.

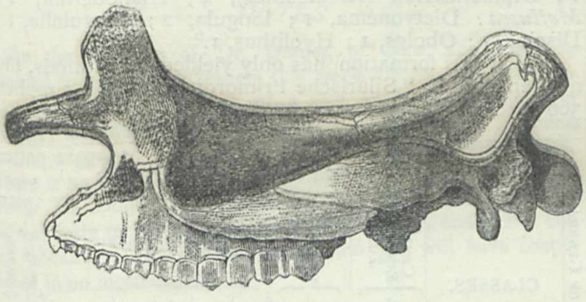

FIG. 1.—*Brontotherium ingens*, Marsh.

Brontotherium ingens is the name given by Prof. Marsh to the animal, the upper and side view of whose skull are shown in the accompanying drawings, copied from his paper in the *American Journal of Science and Art* for this month. The specimen here figured is 36 in. long, and 20 in. between the tips of the two horn-cores. The proportions of the skull are peculiar, the whole being elongate and very slight in depth. The high zygomatic arches, without any well-marked postorbital processes on them, or on the frontal bones, to divide off the temporal from the orbital fossæ, also add to the uncomplicated general appearance of the skull, whose aspect is rendered more abnormal by the development of a huge pair of horn-cores, which spring almost entirely from the firmly "coössified" nasal bones, which make the anterior region of the face exceptionally broad and heavy. The upper part of each horn-core is rugose and the base contains large air cells.

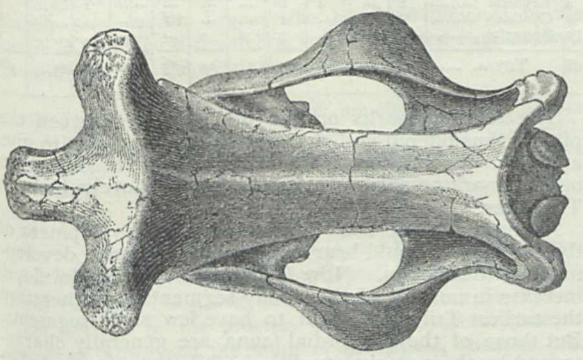

FIG. 2.—*Brontotherium ingens*, Marsh.

The teeth present many points of interest. The dental formula is *i.* $\frac{2}{2}$ *c.* $\frac{1}{1}$ *p.m.* $\frac{4}{3}$ *m.* $\frac{3}{3}$ = 38. The upper incisors are quite small, and so are the lower. The canines are short, stout, and not removed from the premolars by any interval. The premolars are much smaller than the molars, those of the lower jaw being very Palæotherium-like. The lachrymal foramina are small, and the infraorbital foramina are peculiarly large, as are the occipital condyles. The cervical and most of the dorsal vertebræ are distinctly opisthocœlous. The atlas is much expanded transversely; the odontoid process of the axis is stout and conical. The epiphyses of the vertebræ are, in most specimens, loosely united to the centra. The caudal vertebræ give indications of the tail having been long and slender.

The limbs are shorter than in the Elephant, having the toes arranged as in the Tapir, four in front and three behind. The whole of the distal end of the humerus is occupied by the articulation; the radius and ulna are distinct. The phalanges are all short, and the terminal ones are short and tubercular, as in the elephant. The femur has a small third trochanter; the tibia and fibula are separate, and each complete. The distal facets on the tarsal naviculare are subequal.

Prof. Marsh remarks that "the wide narial opening, the rugose extremity of the nasals, and the very large infra-orbital foramen, naturally suggest that there must have been an elongated, flexible nose, possibly as extensive as in the tapir. That there was no long proboscis, as in the elephant, is indicated with equal certainty by the length of the head and neck, which renders such an organ unnecessary."

That *Titanotherium proutii* of Leidy is closely allied to *Brontotherium*, Prof. Marsh considers very probable; but the former genus was determined from a specimen which wanted the skull, and it differs in some respects. *Megacerops* of Leidy, as well as *Symborodon* and *Miobasileus* of Cope, belong to the same group, but their identification has been established on data too imperfect for complete and correct description.

We have adopted Prof. Marsh's term horn-cores for the large conical bony processes on the nasal bones; but it is not at all certain that such is the nature of these protuberances; for it seems improbable that any large horns could be efficiently employed by its owner at the free end of so elongate and flat a skull; at the same time that if they were directed forward, they would seriously interfere with the animal's power of grazing. It must also be remembered that in *Rhinoceros* the horn is not supported on any osseous core, whilst in the wart-hog (*Phacochœrus*) the wart has a conical osseous support.

The discovery of these entirely new and unexpected types of previously existing animals in the comparatively unexplored region of the Rocky Mountains must give a great stimulus to evolutionary thought; for, more than anything, it helps to illustrate to what extent the geological record is incomplete; and further, how great stress ought to be laid on the imperfection, not of the geological record—but of what seems to vary very nearly inversely as it—human palæontological information. The recent exhumation of these several fully differentiated mammals from American Eocene and Miocene beds, when considered in connection with the occurrence of equally specialised and somewhat parallel lines of development in Europe, tends to substantiate the considerable antiquity and the wide distribution of the higher members of the vertebrate subkingdom, and ought to lead to a more thorough search for prototypal forms in the higher secondary strata, other than the few at present known, so that the vast gap which at present exists in our knowledge of the pedigree of the mammalia, may be filled, partly at least, from the record of Mesozoic formations.

*ON THE STUDY OF NATURAL HISTORY**

THE value of Natural History would be more fully appreciated if its higher aims were more perfectly understood. Too many fancied that the study of natural history consisted in mere collecting and naming, and looking at pretty objects. This was, however, mere scientific play; whereas the more thorough study was real work, of use not only as an intellectual training, but also as applied to the practical life of every day. They often heard the remark that the proper study of mankind was man, but to confine their study to him would be to take the first term of a great series, and neglect all the other terms—a proceeding which could lead only to an inaccurate and one-sided view of the order of the universe.

As an illustration of the connection of one class of facts with another he would briefly describe some of the results to which he had been recently led by applying physical methods to the study of the evolution of plants. He had studied the changes that had occurred in the colouring matters in the leaves and flowers during their development from a rudimentary to a perfect state, and the connection between them and the action of light, and had found that there was apparently a most remarkable correlation. When more and more developed under the influence of light, coloured compounds were formed which are more and more easily decomposed by the action of light and air when they were no longer parts of living plants, but dissolved out from them. There was thus apparently some condition in living plants which actually reversed these reactions.

He had also found that in the more rudimentary state of the leaves of the highest classes the colouring matters corresponded with those found in lower classes, and in the case of the petals of flowers their more rudimentary condition often corresponded with some other variety, which thus appeared as if due to a naturally arrested development of a particular kind. This principle would perhaps serve to explain the greater prevalence of flowers of particular colours in tropical or colder regions and at different elevations. Now, since the effect of the various rays of light was different, it became a question of much interest to decide whether an alteration in the character of the light of the sun would produce a somewhat different effect in the case of other classes of plants in which the fundamental colouring matter differed; for example, whether light, with a relatively greater amount of the blue rays, might not be relatively more favourable to the cryptogamia than to the flowering plants. So far this was a mere theoretical deduction; but, if proved to be true by experiment, it might, at all events, assist in explaining the difference in the character of the vegetation of our globe at an earlier epoch, when perhaps our sun was in a somewhat different physical state, and the light more similar to that of Sirius and other stars of the highest and bluer type.

The practical applications of natural history were of course most varied, but he would now merely refer to such as depended upon the equilibrium between different plants and animals. The successful cultivation of useful plants in a foreign country might depend upon very complicated conditions to be learned only by accurate study. The accidental introduction of some plants or animals might prove most injurious if there were no native check to their inordinate multiplication. This was perhaps why in some cases such importations were far more injurious than in their native country, and it became of great importance to learn what means could be taken to provide some adequate check.

* From an address by Mr. H. C. Sorby at the annual *conversazione* of the Sheffield Field Naturalists' Club, January 5.

TRILOBITES

JOACHIM BARRAUDE has published a preliminary epitome (Prague and Paris, 1871, 8vo) of an intended supplement to his "Système Silurien du Centre de la Bohême."

He therein gives a list of the fossils as yet found in the Cambrian formation:—"PLANTÆ: Palæophycus, 1 species; Fucoides, 2; Archæorrhiza, 1; Halopoa, 2; Cordaites, 1; Eophyton, 2; Frœna, 1; Buthotrephis, 1; Scotolithus, 1; Oldhamia, 3; PETRIFICATA INCERTÆ SEDIS: Cruziana, 2; Lithodictyon, 1; ANIMALIA: *Vestigia*, vel Vermium, vel Crustaceorum, vel Molluscorum: Psammichnites, 4; *Spongia:* Astylospongia, 1; *Cœlenterata:* Protolyellia, 1; *Echinodermata:* Spatangopsis, 1; (doubtful Echinoderm?), Agelacrinus, 1; *Vermes:* Micropium, 1; Spirocolex, 2; Scolithus, 4; Monocraterion, 1; Diplocraterion (Arenicolites), 4; Histioderma, 1; *Mollusca:* Dictyonema, 1; Lingula, 2; Lingulella, 1; Discina, 1; Obolus, 1; Hyolithus, 1."

Whilst this formation has only yielded 28 animals, his next epoch, his "Silurische Primordial Fauna" supplies 366 species as follows:—

Number of Genera.	Classes.	Number of Species.												Different Species.
		Central European Zone.		European.		North America.								
		Bohemia.	Spain.	Scandinavia.	England.	Newfoundland.	Canada—Vermont.	New Brunswick.	New York.	Massachusetts.	Upper Mississippi.	Texas.	Georgia.	
28	Trilobita	27	9	77	61	9	9	18	6	1	37	8	1	252
2	Ostracoda	...	1	5	4	...	...	...	...	...	...	...	...	10
2	Other Crustacea	...	...	...	1	...	...	...	...	...	1	...	...	2
5	Vermes	...	...	...	4	...	...	...	...	...	1	...	...	5
2	Pteropoda	5	...	2	7	...	3	...	...	...	1	...	...	18
1	Heteropoda......	...	...	...	1	...	...	...	...	...	...	...	...	1
2	Gasteropoda ...	...	2	...	...	...	...	...	...	...	2	...	...	4
12	Brachiopoda ...	2	6	8	12	...	5	6	2	...	9	5	...	55
4	Bryozoa	1	...	4	1	...	...	...	...	...	1	...	...	7
6	Cystidea	5	1	...	1	...	...	1	...	...	...	...	...	8
2	Spongia	...	...	...	3	2	2	...	...	...	...	...	...	7
66	TOTAL	40	19	96	95	11	19	25	8	1	52	13	1	366

The author remarks on the discordance between the picture thus offered and that which should appear to give any positive confirmation to Darwinism. He then goes on to remark on some phenomena in the development of Trilobites.

According to the Darwinian theory, the development of the individual should bear relation to the past development of the species. Now Trilobites, as they develope, increase in number of their body segments, and therefore the earliest Trilobites ought to have few such segments. But those of the primordial fauna are generally characterised by the opposite condition, while the number is left in those of the succeeding fauna.

Again, on the Darwinian theory, there ought at first to be but few types, the number increasing later. But, in fact, out of seventy-five genera of Trilobites, no less than seventy-two appear in the first two Silurian faunas, and the three others at the beginning of the third fauna. Moreover, the perfection of organisation by no means gradually increases but is quite irregular.

Once more as regards orders, there is no approximation as we recede in time. The Trilobites, Phyllopoda, and Ostracoda, are as sharply differentiated at their very first appearance as they are later, and the Trilobites of the lowest beds are not less easy to divide into genera than those of a later period. *Bohemilla* might, perhaps, be considered as an intermediate form between *Agnostus* and *Paradoxides* (resembling the former in its segments, the latter in its head), but then its geological position is above, not below, those genera.

In the Primordial fauna no single Trilobite has been discovered which can be regarded as an intermediate connecting link between and two other genera.

Finally, no trace of a Tribolite has been found in the antecedent Cambrian formation, and yet from the number of these fossils found it is eminently likely that had they existed they would have left traces of their existence amongst the Cambrian fossils.

The author concludes that we have here a very important discord between Darwinism and facts.

NOTES

BY the kindness of Dr. Draper, of New York, we are enabled to issue to our readers this week a copy, absolutely untouched, of a photograph of a part of the solar spectrum recently obtained by that gentleman by means of the reflection grating suggested by himself, and made by Mr. Rutherfurd. There is no doubt that in all such physical inquiries as those in which Dr. Draper is interested all observations will in time be permanently recorded by means of photography, and to this end the labours of Drs. Draper, father and son, will have contributed in no mean degree.

WE learn from the *Athenæum* that the Gold Medal of the Royal Astronomical Society has been awarded by the Council of the Society to Prof. Simon Newcomb, of the United States, for his tables of Neptune and Uranus, and other mathematical works.

THE French Academy of Sciences, at their meeting on Monday last, elected Dr. Huggins, F.R.S., and Prof. Simon Newcomb, to fill two vacancies among the correspondents in the Astronomical Section.

WE regret to announce the premature death of two eminent French *savants*, Dr. Legros, who has been poisoned in the course of histological researches, and M. Fernand Papillon, well known for his physiological investigations.

SIR SAMUEL BAKER has been appointed Rede Lecturer in the University of Cambridge for the ensuing year. Sir Samuel, upon whom the University conferred the honorary degree of Master of Arts in 1866, will deliver the lecture in the Easter Term.

SIR SAMUEL BAKER was entertained on Monday at a banquet given by the Mayor and Town Council of Brighton, at the Royal Pavilion. In a long and interesting speech Sir Samuel Baker referred to the progress of African discovery, the resources of Africa and the future of the natives, which he does not think hopeful, and of what he did for the suppression of the slave-trade.

THERE has been a good deal said recently as to the fate of the Memorial to Government in favour of an Arctic Expedition; but we believe the matter stands exactly as it did when our article appeared on Dec. 11 last (NATURE, vol. ix. p. 97). The uncalled-for and aggravating delay of Mr. Gladstone in answering the Memorial is only what might be expected.

FROM the 1st inst. there will be published daily at Copenhagen a "Bulletin Météorologique du Nord," containing the daily reports from the Danish, Norwegian, and Swedish stations. This makes the fourth such publication in Europe, the others being published in France, Russia, and in this country. In almost all other countries the reports appear at least in the newspapers.

ORNITHOLOGISTS will be glad to hear of the safe arrival lately in the Gardens of the Zoological Society, of a pair of very interesting new species of White Stork (*Ciconia boyciana*) from Japan, described by Mr. R. Swinhoe nearly a year ago. This new form presents points of particular interest, as in general appearance it resembles both the common European Stork (*C. alba*) as well as the Maguari Stork (*C. maguari*) of South America, and so tends to favour the impression derived from other facts—such as the geographical distribution of the *Tapiridæ*, of the *Cinclidæ*, and perhaps of the *Cervulidæ*, if, as shown by Sir Victor Brooke, *Cervus pudu* is related to them in important osteological peculiarities—that it is in that direction, and not across the Atlantic Ocean that the European continent was last in communication with the New World.

WE direct the attention of our readers to the account, given in another page, of an extraordinary gigantic new form of Miocene mammals, the *Brontotheridæ*, from Colorado, discovered by Prof. Marsh of Yale College.

WE are glad to observe that Mr. Dresser's excellent work on "The Birds of Europe" continues to appear with marvellous regularity, considering the amount of work involved. A double number, comprising Parts 23 and 24, is just issued, completing the second volume in fourteen months; and the author states that he has such a large amount of manuscript ready in advance, that he can with confidence promise equal punctuality with the next volume. The work continues to maintain its high character both in letter-press and illustrations. The plates representing the Spoonbill and the Snowy Owl, in the parts just issued, are charming pictures as well as accurate ornithological portraits.

A TELEGRAM from Philadelphia announces that the Siamese Twins died on Saturday at their home in North Carolina, aged 63. Eng lived two hours longer than Chang.

WE learn that M. J. C. Houzeau has been investigating the directions of the major axes of cometary orbits. He has examined 233 orbits from Mädler's catalogue, but for the purposes of his investigation he has eliminated those comets of short period, having their aphelia inside the orbit of Neptune, numbering 15, and also the seven probable appearances of Halley's comet and three others whose elements are uncertain, and so reduces the number 233 to 208; he, however, adds Comet I., 1819, making 209 comets whose orbits he discusses. He finds that there is a decided tendency in the major axes of those orbits to place themselves parallel to the double heliocentric meridian 102° 20′ and 282° 20′, being only 28° from long. 254° 5′, in which the point that the solar system is approaching is situate. The major axes do not, however, show a tendency to aggregate near lat. + 57° 26′, in which the before-mentioned point lies; but he observes that it is probable that a large number of southern comets have passed unseen, and that there may be inaccuracies in the elements of the orbits.

WE have received several documents relating to the School of Mines, Ballaarat, which was established in 1870, its primary object being to impart instruction in the various branches of science relating to mining, the theory and practice of mining, mine management, mining surveying, and mining engineering. It grants certificates to all classes of men connected with mining, from mining-engineers and assayers to engine-drivers, all candidates being subjected to a good testing examination. The attendance at the School has increased every quarter since it was started, the number of students in the third term of 1873 having been 59. The benefit likely to accrue to a mining country such as Victoria from an efficient school of this kind is incalculable, and those interested in the welfare of the colony are bound to do all in their power to bring it into thorough working order, and enable it to become a national institution. The school is possessed of a good metallurgical laboratory, but its efficiency is sadly hampered for want of funds, the fees payable by the comparatively small number of students being quite insufficient to maintain the requisite staff ot teachers. Government grants only 500*l*. a year, private subscription and fees amounting to about another 200*l*., but to keep up a full staff of lectures, the Council require an income of at least double what is now at their com. mand. This is surely a case in which the industrial welfare of the whole colony is involved, and we therefore think it is certainly the duty of the Government to see that the Ballaarat School of Mines does not fall short of complete efficiency for want of funds.

AMONG Mr. Murray's announcements of new works we notice the following, which may be of interest to our readers :—" A Memoir of Sir Roderick Impey Murchison," based upon his journals and letters, with notices of his scientific contemporaries, and a sketch of the rise and progress, for half a century, of palæozoic geology in Britain, by Professor Archibald Geikie, LL.D., F.R.S. This book will be published, we understand, early in the spring. "The Moon, considered as a Planet, a World, and a Satellite," by James Nasmyth, C.E., and James Carpenter, F.R.A.S. This work will be accompanied by numerous illustrations produced from drawings made with the aid of powerful telescopes, woodcuts, &c. " The Impending Famine in Bengal : how it will be met, and how to prevent future famines in India," by Sir Bartle Frere, D.C.L., with maps, &c. "England and Russia in the East," a series of papers on the political and geographical condition of Central Asia, by Major-General Sir Henry Rawlinson, F.R.S., with a map. A new edition of "Metallurgy," by Dr. John Percy, F.R.S., Lecturer on Metallurgy at the Government School of Mines, vol. i. containing Fuel, Wood, Coal, Copper, Zinc, &c. A new edition, re-constructed and re-written, of the first volume of Prof. Phillips' " Geology of Yorkshire," comprising the coast of the county. It will contain a large number of additional illustrations and be issued in quarto size.

ANOTHER work on the threatened famine in Bengal is announced by Messrs. Trübner & Co. It is by Dr. W. W. Hunter, Director-General of Statistics to the Government of India, and will be entitled "Famine Aspects of Bengal Districts."

DR. SCHWEINFURTH's account of his travels and discoveries in Central Africa during the years 1868 to 1871 will be published by Messrs. Sampson Low & Co. in the course of a few days. This work will be translated by Ellen E. Newer, and will contain an introduction by Winwood Reade, whose work on Africa was reviewed in NATURE a few months back. It will be copiously illustrated by woodcuts from drawings made by the author, and will be issued in two octavo volumes.

IT is known that the Russian Government have made considerable preparations in view of the great astronomical event of this year. A General Assembly of the Commission charged to study the question has finally adopted twenty-seven stations, the list of which (with latitude and longitude, the instruments available at each, and the chances of good weather) may be found in the *Revue Scientifique* for 10th inst. The probable temperatures of the different stations, at the time of observation, are also estimated; they range from —20° C. at Kiakhta, and — 10° at Omsk. to + 10° at Naktritchevan and Erivan. At Nertschinsk and some other stations in Eastern Siberia, for which calculations are not had, the cold is expected to be still greater. The observers for the different stations have all been appointed, and have been engaged in practising with their instruments at the observatory of Pulkowa. All the telescopes are mounted equatorially; and the equatorials are fitted with a clock-work movement and a micrometric apparatus. The personal equations of the different observers will be determined by means of an apparatus like that of M. Wolf (Paris Observatory), in which an artificial star is observed in its passage across a net-work of wire. The telegraphic determination of the longitudes of the various towns of Siberia is likely to be completed in 1875. Several of the stations chosen for this determination are also stations for the transit observations. The other transit stations will be easily connected with these by chronometric observations, and as for the stations bordering on the Caspian Sea and the Black Sea, these longitudes are already known with sufficient exactness.

PROFESSOR WHITTLESLEY has given a paper on the fluctuation of the level of Lake Superior—a subject specially studied by him many years ago, and which has as yet received but slight elucidation. In his present communication he has confined himself to the consideration of those fluctuations which are not only transient, but also occurring with the regularity of a wave—those low pendulum-like pulsations which are probably common to all the lakes, but are most noticeable in Lake Superior. Until a better theory can be found, he adopts the explanation that these undulations are caused by atmospheric movements.

THE Tower Hill Microscopical Club holds its first *Conversazione* at 3, Great Tower Street, on Tuesday, the 27th inst.

IN a letter to the *American Journal of Science and Arts*, dated Cordoba, September 18, 1873, Dr. Gould gives an account of a remarkable swarm of large grasshoppers, or locusts, recently witnessed there. Myriads filled the air, invaded the houses, and covered the ground, from which they rose like thick clouds of dust, on approach of man or beast. These, however, seem to have been merely the stragglers of the main body. Going out to observe the phenomenon more closely, Dr. Gould saw, to the eastward, what looked like a long trail of dense black smoke, extending over 160° of the horizon, and to an altitude of about 5°. A strong field-glass showed that it was no smoke, but a swarm of locusts. Its width there was no means of determining, but from the position of the focus needed for resolving the cloud at its point of nearest approach, Dr. Gould estimated that none of the swarm passed within less than three or four miles. The insects were evidently transported with the wind, which blew from the north with a velocity of ten miles an hour. This was at 10 A.M. (on August 13). The head of the column had passed far out of sight, and certainly twenty miles of its length were visible over the far-stretching pampa. They continued to pass in apparently undiminished numbers till daylight failed. On September 1 the phenomena were repeated, the insects being borne back by a south wind; and they were coming directly on the town when the wind hauled to S.E. and carried them past about six miles off. From measurements made, Dr. Gould stated that the height of the dense nucleus must have been at least 2,000 ft., its width here not more than six or seven miles; the whole environed by a penumbra of stragglers. At the time of writing, the wind had brought them on in full force "literally darkening the sun," and "there is probably not a square inch of our grounds unoccupied by them."

"CRONACO DEL VESUVIO," by Prof. Palmieri (Naples: Detken and Rochall, 1874), contains a brief summary of the principal eruptions from 1840 to 1872, by far the greater part of the work, however, being occupied with details of the outbreak on April 26, 1872, Palmieri's account of which has been already noticed in these pages. The present work contains several appendices on subjects of chemical and mineralogical interest in connection with eruptions of Vesuvius.

WE learn from the *Medical Record* that the Geographical

Society of Italy has received from Alexandria, with the news of the death of the explorer Miani, and various ethnological objects, two living individuals whom he had forwarded of the tribes of the Akka or Tikku-Tikki, and whom the learned traveller had bought of the King Munza. These individuals—of whom one is eighteen years old, and forty inches in height, and the other sixteen and thirty-one inches high—are stated by Miani to belong to the race of dwarfs described by Herodotus, and recently re-discovered by the German explorer Schweinfurth, who described them carefully. They are pot-bellied, very thin-limbed, and knock-kneed, spherical and prognathous crania, very long limbs, copper skins, and crisp, tow-like hair.

"EXTRA No. 14" (Scientific Series) of the *New York Tribune* is devoted to accounts of three scientific expeditions. The first the Hayden Expedition of 1873, an account of which is given in a letter from Prof. W. D. Whitney, and in a review by Dr. F. V. Hayden; of the progress of this expedition we have at various times given news. A "New Route to Yellowstone Park" is described in the account of Captain Jones's Expedition of 1873. The third expedition is that of the late Professor Agassiz to Brazil, the *Tribune* reproducing the six lectures delivered by Agassiz after his return in February 1867.

WE have received in a separate form two papers communicated to the French Academy by M. A. Poëy—one on the "Connection between Solar Spots and the Hurricanes of the Antilles, of the North Atlantic and the Southern Indian Ocean," and the other on the "Connection between the Solar Spots, the Storms at Paris and Fécamp, the Tempests and Sudden Storms in the North Atlantic."

WE have received from Quebec the "Transactions of the Literary and Historical Society" of that city, for session 1872-3, the longest paper in which is an interesting diary of "A Whaling Voyage to Spitzbergen in 1818," kept by Dr. James Douglas. Another paper, by Dr. H. H. Mills, contains some observations on Canadian Chorography and Topography, and on the meritorious services of Jean Baptiste Duberger, sen., who died in 1821, and who seems to have been an excellent surveyor and map-maker. The Society appears to have been in existence for many years, is in a flourishing condition as to members and income, and possesses a good Natural History Museum. We are glad to see that the Society's programme includes scientific as well as literary and historical subjects.

THE *Bulletin* of the French Geographical Society, for December, contains an account of a voyage made last autumn by M. A. Pinart along the south coast of the Aleutian Isles and the Peninsula of Alaska, illustrated by a good map; the continuation of M. J. Halévy's Journey to Nedjràn; and a very long paper by M. Dournaux-Dupéré, on the part which France ought to play in Northern Africa, advocating the complete subjection of the Sahara by France.

"ON the Geology of Western Wyoming," is a paper by Mr. T. B. Comstock, reprinted from the *American Journal of Science and Arts*.

THE additions to the Zoological Society's Gardens during the past week include two Cinereous Sea Eagles (*Haliaëtus albicilla*), European, presented by Sir Victor Brooke, Bart.; a pair of Pink-headed Ducks (*Anas caryophyllacea*) from India, new to the collection; a Nicobar Pigeon (*Calœnas nicobarica*), from the Indian Archipelago; a Cheetah (*Felis jubata*) from Africa; a White-lipped Peccary (*Dicotyles labiatus*), from South America; a Sooty Mangabey (*Cercocebus fuliginosus*), from West Africa; a Verreux's Guinea fowl (*Numida cristata*), from East Africa; a Masked Weaver Bird (*Hyphantornis personata*), from West Africa; and four Grenadier Weaver Birds (*Euplectes oryx*), from Abyssinia, purchased, or received in exchange.

NEW REMARKS ON THE NATURE OF THE CHEMICAL ELEMENTS, BY M. BERTHELOT*

THERE will be no necessity for me to remind the Academy of the great importance of the question raised at the last meeting. Between our illustrious master, M. Dumas, and the author of these lines, there should not be any difference of opinion neither on the principles of a science which he himself has taught us, nor as to the originality of his ideas with regard to the chemical elements, their relation to each other or to the organic radicles.

It is therefore more for the purpose of avoiding the reproach of an incomplete knowledge of the science than for further insisting on what I have before advanced, that I ask his permission to quote in this place, p. 280 of his "Leçons de Philosophie Chimique" a passage in which he has approached my own remarks:—

"Before commencing with any confidence to build a system upon this foundation," says M. Dumas, "it is necessary that a great number of exact experiments should increase our knowledge of it. It will therefore be of the greatest importance to study compounds in relation to their capacities for heat, for it cannot be supposed that the relation of the specific heat to the weight of the atom holds only for elementary bodies; it is also found in compounds of the same order. It would therefore be wrong to seek in this direction for a proof of the truth of the ideas which we have imagined of the bodies which appear to us to be elements, and we ought to say that the capacity of their chemical atoms tends towards equality because they are bodies of the same order, without their elementary nature necessarily following from it."

In support of these opinions M. Dumas cites the then recent experiments of Naumann on the specific heats of the carbonates of barium, strontium, calcium, iron, zinc, and magnesium, which, multiplied by their corresponding atomic weights, give a constant product of 131; while the sulphates of barium, strontium, calcium, and lead give the product 155. M. Dumas adds with reason—"For the other compounds we are in want of data sufficiently precise to enable us to make similar comparisons."

It will be seen then that in 1836 the point in question is no longer the relation between the specific heats of compounds and that of their elements, but entirely between compounds of the same order, *à fortiori* the possibility of distinguishing elements from compound bodies in general by means of specific heats was expressly discarded.

Although the specific heats of compound bodies were formerly but little known, the gap was being filled for many series by the researches of M. Regnault. But Regnault, like Naumann, confined himself to the determination of the specific heats of compounds the constitution of which was similar, without seeking to establish any more remote relation.

Wœstyn in 1848 was, I believe, the first to announce the approximate relation between the specific atomic heat of a compound and those of its elements, and the partial relations discovered by Naumann and Regnault then became a consequence of this more general law.

In applying it in my turn to the organic radicles and especially to the carbides of hydrogen, I have been led to put in evidence the difference which distinguishes their specific heats from those of the elements, whether taken individually or together, as members of a group of bodies of the same order. The carbides of the ethylene series are bodies of the same order, and present quite as many analogies amongst themselves as simple radicles such as calcium, barium, strontium, iron, zinc, and magnesium do, and the same may be said of the combination formed by these radicles. I repeat, therefore, that as the specific atomic heats of the simple radicles have the same value, and this value being known and considered in connection with their atomic weights, the simplicity of their composition results of necessity therefrom almost always, as I have already established in my preceding note. At the same time the specific atomic heats of the com-

* Translated from the *Comptes Rendus* of December 15, 1873. At the preceding meeting M. Berthelot read a note on the same subject, in which he gave a more detailed description of the observed differences between the specific atomic heats of elements and compounds. The principal points were, that whilst the specific atomic heats of elements whose atomic weights are multiples of the same number, such as the S, Se, Te group, are identical, the specific atomic heats of compounds whose atomic weights are multiples of some common number, as in the group of polymerised hydrocarbons, ethylene, amylene, caprylene, &c., are multiples of each other, being proportional to their atomic weights. He concludes: "This difference is important, inasmuch as the notion of specific heat is a representation of the general molecular work by which bodies are maintained in an equilibrium of temperature with each other, and it would also indicate that the decomposition of our elements, if possible, ought to be accompanied by phenomena of another kind than those which determine the decomposition of our compounds."

pound radicles are nearly always multiples of one another, and their magnitude is sufficient to establish the complexity of the radicles themselves.

The combinations of the same order formed by the simple radicles have all of them nearly the same atomic heat, as the observations of Naumann and Regnault have shown. On the contrary, combinations of the same order formed by a series of analogous compound radicles exhibit specific heats which tend to increase proportionally with the variation of their atomic weights. This, which is precisely the opposite of the relations which would have been supposed to exist between compounds of the same order at the time of Naumann's researches on the identity of the specific atomic weights of the carbonates and sulphates, is another proof of the complexity of these radicles.

To sum up, the study of the specific heats established by the most recent researches, tends to prove that there is a positive characteristic which, it seems to me, distinguishes the elements of modern chemistry from its compounds, and shows that no known compound body ought to be considered as of the same order as an actually simple one. The importance of such a characteristic cannot be doubted, and it becomes greater on account of the mechanical meaning which modern theories ascribe to specific heat. This I feel bound to put in evidence.

Nevertheless, and I ask permission to return once more to this point, exaggerated conclusions must not be drawn from such an opposition between the mechanical and physical characteristics of our simple and compound bodies.

If our elements have not as yet been decomposed and appear not to be decomposable by the forces which are at present at the command of the chemist, and which, as M. Dumas at the time of his discussion with Despretz justly remarked, have been so often tried in vain, nothing compels us to assert that they are not decomposable in another way than our compounds are; as, for instance, as Mr. Lockyer asserts, by means of the forces acting in cosmical space. Nor does anything prevent the supposition that such a discovery as that of voltaic electricity would enable the chemists of the future to overpass the limits which are imposed upon us.

The possible fundamental identity of the matter constituting our elements, and the possibility of transmuting into one another the so-called elements, can moreover be admitted into the category of more or less plausible hypotheses without it necessarily resulting that there is a single really existing matter of which our actual elements represent unequal states of condensation. In fact nothing compels us to conceive the existence of a final decomposition which shall tend necessarily to reduce our elements either to more simple bodies, from the addition of which they arise, or to multiples of a single elementary ponderable unit. The various states of equilibrium under which the fundamental matter manifests itself would exhibit certain general relations to each other analogous to those which exist between the multiple values of the same function. According to this hypothesis, an elementary body could be broken up without being destroyed in the ordinary meaning of that word. At the moment of its destruction it would suddenly change into one or more simple bodies identical with, or analogous to, our elements. But the atomic weights of the new elements would not show any simple relation to the atomic weight of the element which had by its metamorphosis produced them, the absolute weight alone would remain unaltered throughout the catena of changes.

But I do not wish to insist further on this hypothesis of a matter fundamentally identical, although multiform in its appearances, and characterised in each one of them by a peculiar mode of motion, such, in fact, that no single one of them can be definitely considered as the starting-point of all the others. Nevertheless, we shall only be too glad if Mr. Lockyer, guided by stellar spectral analysis, succeeds in shedding a new light upon these hypotheses, and continues to investigate questions which M. Dumas raised forty years ago in a book which has contributed so much to our scientific education.

R. J. F.

SCIENCE IN LIEGE

WE have received a somewhat bulky volume of Memoirs of the Royal Society of Science in Liege (1873), in which a considerable variety of subjects comes under notice; zoology and mathematics being, perhaps, the most largely represented.

An *éloge*, by Prof. Morren, on Jean Théodore Lacordaire (who died in 1870), is accompanied with a good portrait of that eminent naturalist. Lacordaire was originally destined for the law, which, however, he left for commerce. Going out to South America in a business capacity, his bias for natural research was quickly developed; and he commenced those labours to which his after life was devoted. In 1835 he became professor of zoology at Liege, where he continued till his death. Lacordaire was a voluminous writer; but his *summum opus* is the *Genera des Coléoptères*, which is remarkable for the minuteness of its details and its rigorous truthfulness.

For some years past we have heard a great deal about the services which birds render to agriculture by destroying injurious insects. The sentiment is widespread; and vigorous measures of bird protection have been taken in various countries of Europe. M. Edouard Perris here brings forward a somewhat opposite view, which he supports by many curious facts from a long experience of country life. His position is, briefly, the following:—1. Birds are congregated in considerable numbers only in the migration time in autumn and spring, when insects are very much less numerous than in the fine season. The rest of the time they live in pairs, sparsely distributed; and rare in cultivated parts, while the insects come forth *en masse* to do their mischievous work. 2. Birds destroy insects largely, but these insects are, in great part, indifferent, others are eminently useful; and the really hurtful species destroyed are in very small proportion to the whole. Thus the birds do us little service; and they often do injury in destroying our carnivorous and parasitic insects, as well as attacking fruits and seeds. 3. The insects we have most to complain of are, some of them, big enough to brave the birds, others are too small to attract them; others prove disagreeable as food; many are nocturnal in habits, or, by their immobility, escape notice; some live underground, or in houses; and all have an astonishing fecundity which is quite baffling to human resources. 4. Larvæ and caterpillars, which do the most damage, live nearly all concealed under ground, under bark, in the deep parts of wood, in the roots of plants, in fruits, in inhabited places, &c., and furnish little tribute to the birds. Those which develop in open air are generally provided with hairs which protect them; some are nocturnal, some are extremely small. All these facts, in the author's opinion, should greatly modify the ordinary view as to the utility of birds in agriculture. He points out that certain natural influences tend to preserve an equilibrium in the insect world; such are, famine occasioned by the too great multiplication of individuals, meteorological phenomena adverse to their growth or metamorphosis, and the abundant production of parasites. M. Perris does not find fault with measures of bird protection, but objects to the undue merit which is assigned to birds. He urges upon farmers the importance of exercising more discernment in their destructive measures, and of respecting many animals they often regard as nuisances, such as hedgehogs, snakes, lizards, toads, &c.

Medical men will doubtless be interested in two teratological observations communicated by Dr. Eugene Charlier. One is that of a child inferiorly double, or a double ileadelphous monster. It is a kind of monstrosity of which Is. Geoffrey Saint-Hilaire supposed the existence, but of which he did not know any authentic case. The other monstrosity is a new variety of pygomelian chicken; the animal has two accessory limbs joined to the normal wing and leg on one side. The forms are represented in plates annexed to the notes in question.

An important mathematical paper by M. Brasseur, furnishes a "new exposition of the principles of the differential and integral calculus." The following sentences from a commendatory preface by M. Folie, will give some idea of the point of view which the author adopts. "Of all the modes of considering the differential calculus, we do not know of any more philosophical than that of Newton; but it requires, to be properly understood, a mind well trained to metaphysical speculations. We have, indeed, known good analysts who never grasped it, though they had studied at the best sources. The great difficulty of the differential calculus is that it attempts to analyse the idea of continuity; it seeks to express how a function passes in a continuous manner from one state to another; and it is this passage which has given rise to the contradictory idea of the infinitely little, to the indirect idea of limits, and to the philosophic idea of Newton. Brasseur has avoided this great difficulty; he has succeeded in rendering the method of La Grange, who only employs finite analysis, as convenient in its applications, and as rigorous, as that of limits or of fluxions. We will even say that his method has, from the educational point of view, the advantage, over that of fluxions, of not requiring any metaphysical notion; and, over that of limits, of being much more direct, and not exposed to any attack, even specious. Instead of analysing the idea of continuity he studies two successive states of a continuous function; and continuity only comes in so far as that the difference between these two states may become as small as we choose without ever becoming *nil*, as seems to be the case in limits; or infinitely little, in the old signification of the word, a signification simply absurd."

We simply name, in conclusion, the following zoological lists, which make up the greater part of the volume:—Monography of the Malabrides, by M. de Marseul; Synopsis of the Scolytides, by M. Chapuis; and new or little known Araneides from the South of Europe, by M. Simon.

SCIENTIFIC SERIALS

Zeitschrift für Ethnologie (1873). The fifth number of the journal for last year is of less than average importance to English readers, since the principal article—a most valuable and comprehensive one on the descriptive ethnology of Bengal—is a translation of Colonel Dalton's digest of the official reports drawn up by the different Commissioners of the province, and published at the cost of the Indian Government. This work, which supplies information that can nowhere else be found in regard to the tribes occupying the Brahmaputra and Gangetic valleys, must henceforth be considered as indispensable to every student of Indian ethnology, and the editors of the *Zeitschrift* have done good service in making it known to their readers. In an article on a proposed improvement in the methods of craniometry now in use, Dr. Jhering passes in review the difference in the values of the indices, proposed by Blumenbach, Retzius, Broca, and others, for the definition of Dolichocephalic and Brachycephalic types. His three main propositions are briefly these:—1. All cranial measurements must be projected in a line that is parallel or vertical to the horizontal base of the cranium. 2. The most important maximum and minimum dimensions should be obtained *per se*, and without reference to distances from definite anatomical points. 3. For all parts not in the medial plane, the percentage of lengths and heights must be given at the points where such parts intersect these diameters. Dr. Jhering thinks that it is time finally to set aside the theory transmitted from Blumenbach, and through Retzius to the present day, that every race possesses at once a special language, and a special type of cranium. According to his view it is never possible to determine with certainty from the form of the skull the precise race from which an individual has sprung, and in his opinion the problems which ought to engage the attention of future students of craniology are the determination of the *mean* cranial type of each race; and the definition of the limits within which each special type varies among different races. Finally the author wishes to show that craniology is not competent to determine questions of race, but is merely to be accepted as an auxiliary science to anthropology. The learned missionary, Th. Jellinghaus, to whom we are already indebted for many valuable contributions to our knowledge of the languages spoken by the outlying tribes of our vast empire in India, gives in this number a short account of the language of the Munda Kohls of Chota Nagpore. The peculiarities of their tongue seem to be a distinct dual for all three persons: the formation of the plural and dual by the addition of an abbreviated form of the third personal pronoun; the insertion of the letter *p* with the vocal accent for the formation of the plural and dual of certain nouns and adjectives; the interpellation of the letter *n* in the root-syllable of the verb to form the abstract noun. The units of the Munda Kohls' numeral system are 10 and 20. The author describes these people as kind and simple in their social relations with one another. Herr Virchow draws attention to a specimen of a synostolic cranium as the form has been figured and described by J. B. Davis in his work on "Synostolic Crania among Aboriginal Races of Man" (Haarlem, 1865). As this skull belonged to a rachitic child, and similar skulls, in which the calvaria was entirely obliterated, and the cranial bones were thickened outwardly, are preserved in the Berlin and other Pathologico-Anatomical collections, and were taken from rachitic subjects, Herr Virchow considers that such forms must be held to be quite independent of ethnological peculiarities, and that their occurrence amongst savage or aboriginal races must be ascribed to the frequent presence amonst them of rachitism—a fact to which Pruner-Bey has already drawn attention. We canno close our notice of the contents of this number without mentioning an interesting communication by Dr. Brehm in regard to his experience—based on an eight years' acquaintance—of the habits of the Chimpanzee under confinement. The last individual which fell under his notice, and which died at the age of four from pulmonary disease, showed, in many respects, an aptitude of comprehension, a docility and a capability of practising the ordinary usages of daily life which made the animal an interesting and wholly unobjectionable inmate of Dr. Virchow's house, where he ran about with little more surveillance than would have been awarded to a human child of the same age. The result of the learned author's experience of this, and other individuals of the race is, that although not human, there is *very much* of the element of humanity in the Chimpanzee.

Poggendorff's Annalen der Physik und Chemie, No. 9, 1873.—This number commences with a theoretical examination, by the editor, of the action of Holtz's electrical machines of the "second" kind, those being meant which have two discs rotating in opposite directions, whereas in the "first," and more common kind, one disc rotates while the other is stationary. The author's view is, not that there is suction, by the conductors, of the electricities expanded in the insulators, as commonly supposed, but conversely, that electricities separated in the conductors, through induction, stream over to the insulators. In this way, both modes of excitation, by induction and by inflow (*Einströmung*), are explained on one principle. The same holds good for machines of the first kind.—M. Julius Thomsen continues his "Thermo-chemical Researches," investigating here the action of four agents of reduction, and seven of oxidation. —Dr. Müller describes a new tangent galvanometer and rheostat, free from the disadvantages of not being equally available for currents of all degrees of intensity, and of waste of time in use. The galvanometer differs from ordinary ones in the arrangements for reading and deadening; and, in the rheocord, to neutralise heating effects with strong currents, the wires are surrounded by distilled water.—There are four papers referring to the "horizontal pendulum;" in two of which M. Zöllner describes the instrument as he constructs and uses it, giving several observations made with it, which indicate its great sensitiveness. In a third paper he represents that the idea was first conceived by Lorenz Hengler, a writer in "Dingler's Polytechnisches Journal" in 1832; while in a fourth note on the subject, Prof. Safarik produces evidence of the same fact, and also shows that the bold idea of demonstrating the variations of gravity and of cosmic attractions by terrestrial observations in one place, had already been expressed and experimented on by Gruithuisen, some fifty-two years before Zöllner, viz., in 1817.—M. von Bezold communicates the first part of a valuable paper on the law of colour mixtures, and the physiological primary colours; and Prof. Clausius discusses a new mechanical proposition with reference to stationary motions.—In a note translated from the Italian, the question is considered by Prof. Roiti, Is the electric current an ether current? He argued that if this were the case, then the velocity of propagation of light in a body traversed by a galvanic current must be altered by the direction of this current. In his experiments he caused rays from two parallel slits to pass through two cell-divisions, respectively, of a rectangular glass vessel containing sulphate of zinc solution (the thickness of the dividing wall being equal to the interval between the slits). Interference fringes were obtained at the exit of the rays. Four electrodes being inserted, so that a current passed in opposite directions in the two cells, this had no effect in displacement of the fringes. M. Roiti concludes that if the galvanic current were an ether current, it must have a very small velocity, less than 200 metres per second, which does not agree with the phenomena of galvanic electricity.—Prof. Mach's paper on the stroboscopic determination of the pitch of tones, deserves the attention of musicians and others.

Der Naturforscher, Nov. 1873.—Among the botanical notes in this number is one on the age and mode of growth of woody plants in Greenland. M. Kraus finds that these plants often attain great age (150 years, *e.g.* in the case of some willows), but that the annual increase of thickness is extremely small, 1·5 mm. at the maximum.—Some experiments described by M. Godlewski prove that formation of starch in chlorophyll granules is not possible without access of CO_2; that the liberation of starch from these granules may occur in bright light; that we cannot, from absence of starch, infer there is no process of assimilation; and that the cause of change of form in etiolated plants does not lie in the suppression of the assimilative process. Mr. Sorby's observations on the colour of plants are also given.—In physics and chemistry, we have an account of experiments by M. Meyer as to the influence of access of air on alcoholic fermentation, MM. Favre and Valson's researches on work done in saline solutions, those of M. Edlund on the electromotive and thermoelectric forces of metallic alloys with copper, those of MM. Mach and Fischer on reflection and refraction of sound, Prof. Maxwell's lecture on molecules, and other papers.—In a physiological paper, entitled "The internal mechanics of nerves," some additional light is thrown by M. Bernstein on the electrotonic state investigated by Pflüger, and a hypothesis is offered, to account for the phenomena. There are also biological papers on the apparatuses for production of sound in insects, and on the deep-sea fauna of the Swiss lakes.—We further note an interesting lecture by M. Sandberger, on a portion of the geological history of the *Oberrheinthal*; and a quantity of valuable information in the *Kleinere Mittheilungen*.

Journal of the Franklin Institute, Dec. 1873.—In this number are given two reports of the Committee on the mode of determining the horse-power of steam boilers. A division of opinion is indicated, a minority in the Committee holding, that the horse-power of boilers for stationary engines is properly defined as the capability to evaporate a cubic foot of water per hour from and at the temperature of 212° F. and there is no reason for modifying its normal value; while the majority (4 against 3), consider, that, in view of variations of capacity of the same boiler under varied conditions, the discontinuance of the term horse-power, as descriptive of the size and capacity of the boiler, is advisable; purchasers and makers should, instead, describe fully and in accurate terms, the evaporative capacity of boilers poposed, and the conditions under which they are worked and tested. Considerations are urged in support of each of these views.—Mr. Richards continues his "Principles of shop manipulation, for engineering apprentices;" this part treating chiefly of the various kinds of motive machinery.—A paper read by Mr. Ransome before the Franklin Institute gives an account of the improvements which he has introduced into the manufacture of artificial stone.—We also find notes on a new hydraulic railway car-brake, by Mr. Henderson, and on the stability of towers and chimneys, by Mr. Evans.—Among the "Items and Novelties" reference is made to some important results obtained by Prof. Thurston, from experiments at the Stevens Institute of Technology, as to the behaviour of metals under stress. The following deduction was repeatedly confirmed:—Metal strained so far as to take a permanent set, and left under the stress producing it, gains in power of resistance up to a limit of time, which in these experiments was about seventy-two hours, and to a limit of increase which has a value, in the best iron, of about 20 per cent., where the applied force is 80 per cent. of the ultimate breaking force.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, Jan. 8.—Dr. Hirst, F.R.S., president, in the chair.—Mr. J. W. L. Glaisher read a paper on the transformation of continued products into continued fractions. The paper had its origin in a remarkable continued fraction for π given by Prof. Sylvester in the Philosophical Transactions for 1869, viz.:—

$$\frac{\pi}{2} = 1 + \cfrac{1}{1 + \cfrac{1 \cdot 2}{1 + \cfrac{2 \cdot 3}{1 + \cfrac{3 \cdot 4}{1 + \cfrac{4 \cdot 5}{1 + \text{\&c.}}}}}}$$

which is there shown to be equivalent to Wallis's formulæ—

$$\frac{\pi}{2} = \frac{2 . 2 . 4 . 4 . 6 . 6 . 8 . 8 \ldots}{1 . 3 . 3 . 5 . 5 . 7 . 7 . 9 \ldots}$$

Prof. Sylvester arrived at his result by means of a complete solution he had previously found of the equation of finite differences

$$U_{x+1} = \frac{U_x}{x} + U_{x-1}$$

(a "shaving" as the discoverer remarked from his method of "reducible cyclodes") whereas the present paper arrives at the result by a direct transformation.—Prof. Clifford spoke upon the foundations of the differential calculus and of dynamics. The points dwelt upon were—all continuous quantity is expressed by lines, therefore every fluxion is really velocity or the method of fluxions and the beginning of kinematic is the same; he then dwelt upon Newton's definition of tangents and Hankel's remark, and pointed out the necessity of a modification of the definition, traced out certain analogies to the methods of Euclid and Archimedes (definition of fourth proportional and of area), and closed his remarks with a proof of the composition of velocities.—The secretary read a note from Prof. Crofton on a method of treating the kinematical question of the most general displacement of a solid in space.—Mr. Perigal made a few remarks on the subject of link trammels (in connection with Prof. Sylvester's recent paper), in the course of which he stated that Peaucillier's lozenge-trammel is a modified reproduction of Jopling's "double cranks" trammel, invented about 1822. The statement was impugned by Prof. Sylvester and Mr. S. Roberts.—The following papers were taken as read:—On Hamilton's characteristic function for a narrow beam of light, by Prof. J. Clerk-Maxwell.—Preliminary account of investigations on the free motion of a solid in elliptic space, by Prof. Clifford.

Geological Society, Jan. 7.—Prof. Ramsay, V.P.R.S., Vice-President, in the chair. The following communications were read:—1. "The Origin of some of the Lake-basins of Cumberland."—First Paper. By J. Clifton Ward, F.G.S. After referring to the fact that the question of the origin of lake-basins cannot be satisfactorily discussed unless the depth of the lakes and the heights of the mountains are brought before the mind's eye in their natural proportions, the author sketched out the physical geography of the lakes under discussion (Derwentwater, Bassenthwaite, Buttermere, Crummock, and Loweswater), and pointed out what must have been their original size and shape before they were filled up to the extent they now are. These lakes were not moraine-dammed, but true rock-basins. The belief that the present Lake-district scenery was the result of the sculpturing of atmospheric powers, such as we see now in operation, varied by climatal changes and changes in the height of the district above the sea, was enforced, and the opinion given that the work of elaboration of the lake-country scenery has been going on ever since Carboniferous or pre-Carboniferous times. When all the evidence was considered—the fact of the lake-hollows under examination being but long shallow troughs, the thickness of the ice which moved along the valleys in which the lakes now lie, the agreement of the deepest parts of the lakes with the points at which, from the confluence of several ice-streams and the narrowing of the valley, the onward pressure of the ice must have been greatest,—the conclusion was arrived at that Prof. Ramsay's theory was fully supported by these cases, and that the immediate cause of the present lake-basins was the onward movement of the old glaciers, ploughing up their beds to this slight depth.—2. "On the Traces of a Great Ice-sheet in the Southern part of the Lake-district and in North Wales." By D. Mackintosh, F.G.S. In this paper the author brought forward the evidence which seems to him to establish the existence in the southern part of the Lake-district of a "valley-ignoring and ridge-concealing ice-sheet." He gave a table of the direction of ice-marks observed by him in the Lake-district, and stated that about Windermere and Ambleside the general direction is nearly N.N.W., round Grasmere between N.W. and N.N.W., north-west and west of Grasmere in upland valleys and on high ridges about N. 30° W., south of Grasmere and in Great Langdale N. 35° W., and in the Coniston district a little W. of N. In many places he recognised an uphill march of the ice. The author also referred to the glaciation of North Wales, some of the marks of which, observed by him in a district south of Snowdon, seemed to him to indicate the southerly movement of a great ice-sheet capable of ignoring or crossing deep valleys.—3. Notes on some Lamellibranchs from the Budleigh-Salterton Pebbles. By Arthur Wyatt Edgell, F.G.S.

Linnean Society, Jan. 15.—Mr. George Bentham, F.R.S., in the chair.—Dr. Hooker, Pres. R.S., exhibited a very beautiful series of specimens of Fossil Copal, the product of *Trachylobium Hornemannianum*, some specimens of Recent Copal from the same plant, and some fruits of a *Momordica*, all fowarded from Zanzibar, by Dr. Kirk, F.L.S., for the Kew Museum.—Before proceeding to the regular business of the Society, the president again read, and explained the purport of, the alterations in the Bye-laws agreed to by the Council. The proposed alterations were adopted by the Society. The following papers were then read, viz. :—On some Species of Japanese Marine Shells and Fishes which inhabit also the North Atlantic, by J. Gwyn Jeffreys, F.R.S. The mollusca noticed by the author were procured by Captain St. John in H.M.S. *Sylvia*, during the years 1871 and 1872, on the coasts of North Japan. His dredgings varied betweeen 3 and 100 fathoms. After passing in review the works of naturalists who had described the marine shells of Japan, and especially the "Mollusca Japonica" by Dr. Lischke, with reference to those species which are common to Japan and Europe, Mr. Jeffreys proposed to record from Captain St. John's dredgings thirty-nine species, and to give the range of depth for such of them as he had obtained in the *Porcupine* expeditions of 1869 and 1870. He then offered an explanation of the occurrence of the same species in the Atlantic and Pacific Oceans, by suggesting that it was probably owing to involuntary transport by tides and currents, and not to voluntary migration. Very little is known about the direction and force of deep sea currents; but high northern species might be transported on the one side to Japan, and on the other to Europe, by a bifurcation of the great Arctic current, which has been traced as far south as the Straits of Gibraltar in the course of the *Porcupine* expeditions. The entry of northern species into the Mediterranean may be accounted for by the former existence of a wide channel, or rather an open sea between the lower part of the Bay of Biscay and the Gulf of Lyons, which has been satisfactorily proved, on geological grounds, to have been formed since the Tertiary epoch. A list of the mollusca referred to in the paper was given, with critical remarks, as well as a list of twenty-two species of fish which Dr. Günther communicated as common to the Japanese Seas and the North Atlantic or Mediterranean.—Dr. Carpenter, F.R.S., made some general remarks on Ocean-currents, especially with reference to the zones of temperature in the North and South Atlantic. He stated that it has been ascertained that water of 40° F. comes nearer to the surface in the equatorial regions than in the north and south temperate zones. There are, he believes, zones of all temperatures in all deep seas, such as that of 33° F. observed by Capt. St. John between Socotra and the Seychelles. He hoped that Capt. St. John would, in his future expeditions, be able to obtain a very valuable series of observations of deep-sea temperatures. Dr. G. J. Allman, F.R.S., said the specimens all belonged to types hitherto considered extinct; and he entered into some description of one of the most remarkable forms.—Note on Japanese Brachiopoda, by Thomas Davidson, F.R.S., communicated by J. Gwyn Jeffreys, F.R.S.

Chemical Society, Jan. 15.—Prof. Odling, F.R.S., president, in the chair. Mr. W. C. Roberts handed in a table supplementary to his paper read at the last meeting, and containing complete analyses of all the standard trial plates still extant, dating from A.D. 1477, namely, 17 gold plates and 14 silver ones.—The first paper was "On the action of trichloracetyl chloride on Amines: I. Action on aniline," by Dr. D. Tommasi and Mr. R. Meldola. This reaction gives rise to a substance callen *phenyl-triacetamide*, which crystallises in lustrous plates. It is acted on by nitric acid with production of *dinitrophenyl-triacetamide* crystallising in yellow needles.—Dr. H. E. Armstrong read a note "On the action of sodic ethylate on ethylic oxalate and other ethereal salts."—"On the products of decomposition of castor oil: I. Sebacid acid," by Mr. E. Neison. An account of the preparation and properties of pure sebacic acid, and of many of its salts.

Geologists' Association, Jan. 2.—Henry Woodward, F.R.S., president, in the chair.—On the nature and formation of Flint and allied bodies, by Mr. M Hawkins Johnson. The object of the paper was to show the nature of several members of a large group of bodies occurring in sedimentary deposits of different ages, and which are generally known as nodules, and described as concretionary. Those specially alluded to were the septaria from the London and Kimmeridge clays, the flints from the chalk, the iron pyrites from the chalk, the phosphatic nodules from the gault, the clay ironstone nodules from the carboniferous series, and the ironstone from the Woolwich beds. By the gentle action of solvents the structure of these bodies is revealed so as to be easily examined by the microscope. They are thus found all to agree in possessing a silicified organic structure, which may be described as a net-work of fibres or a mass permeated in every direction by anastomosing canals. This structure was subsequently filled in with other material, such as carbonate of lime, silica, bisulphide of iron, phosphate of lime, carbonate of iron, &c., the particular substance thus filled in depending upon the relative abundance of the substance dissolved in the interstitial water of the surrounding matrix. The singular group of concentric siliceous circular bands seen upon many fossils, and known as orbicular silica, or Beekite markings, were also explained. The fossils on which they occur are imbedded in a matrix more porous than themselves and of irregular constitution, so that the evaporation, to which the consolidation of the dissolved silica in their pores was mainly due, occurred at a number of points on the surface of the fossil, at which points a deposit of silica took place forming the central tubercles. The cessation of evaporation was followed by a fresh saturation, with the solution to be again evaporated. But as the evaporating points were now plugged up by the previous deposits, the silica last consolidated was deposited around their margin and upon them internally appearing outwardly as a ring round the tubercles. Alternations of these conditions account for the numerous bands seen in some of the groups.

Anthropological Institute, January 13.—Prof. Busk, F.R.S., president, in the chair.—A paper, by Mr. S. E Peal, was read, on the "Nagas and neighbouring tribes." The tract of country occupied by the Nagas lies mainly between lat. 25° N. to 27° 30′ N., and long. 93° 30′ E. to 96° E. It is bounded on the east by the country of the Singphus or Tsingpos, a distinct race showing strongly-marked differences in language, physique, and customs; on the north by Assam; and on the west are various other tribes, while to the south the boundary is undefined. The inhabitants of the tract, although all termed Nagas, are divided and sub-divided to so great an extent that few parts of the world can present such a minute segregation of innumerable and independent tribes. A common and conspicuous feature of the Nagas, Garos, Kukis, Lushais, and other hill-races of that district, is their custom of taking human heads either by regular warfare, raids, or casual surprises. Not only is the custom general among them, but it has obviously existed for a long period of time, and, in its present phase, is the true cause of the strongly-marked variations both in language and physique that exist among the Naga tribes, no two of whom are really alike. An almost necessary consequence of this mode of life is that they are a fine, hardy, active race, excelling in all that relates to forest lore and labour, while, on the other hand, they are conspicuously deficient in the arts of pottery, working in metals, and writing. The most singular feature is, perhaps, the almost total absence of agricultural implements; everything is done with the Daú, or P-shaped axe. The mental capacity of the Nagas is low, although they exhibit smartness or cunning in matters relating to ordinary life; no individual known to the author was able to count beyond ten.—Mr. C. B. Clarke contributed a paper on the "Stone Monuments of the Khasi Hills." The Khasi Hills form a plateau, at a mean elevation of 4,500 feet above the sea, between the plains of Assam on the north, and Sylhet on the south, and are inhabited by a people quite distinct from the neighbouring Hindus. The stones, which are profusely scattered over the range of hills are of three kinds: the funeral pyres, the kists containing the jars of ashes, and the monumental groups. One great feature of the Khasi sepulture is, that the ashes of the family are collected from time to time. At first the ashes of a man are kept in a small kist, then, after a few years, a great funeral ceremony is held, and the ashes of the various individuals of the family are collected from the smaller kists. The ashes of all the men are collected into one earthen jar, those of the women into another, and these two jars are placed in one large kist; the jar of the women's ashes is placed next the last stone closed, for the reason that among the Khasi the woman is always mistress of the house.

RIGA

Society of Naturalists, Aug. 27—Dr. Buhse presented some growing specimens of *Elodea Canadensis*, the American aquatic weed which, since 1836, has appeared and spread over Middle and Northern Europe; and gave some account of it. Two different analyses of the weed, by Fischer and Liebig, show a large proportion of salts in its ashes, and also how widely the proportion of its constituents varies with the nature of the water in which the plant grows.

Sept. 17—M. Schweder directed attention to a fossil egg now in the St. Petersburg Museum. It was found in the Chersonese Government a few years ago, and has been secured for 1,000 roubles (say 166*l*.). It is 18 cm. length, and 15 cm. short diameter; its capacity is reckoned equal to that of 40 to 44 hen's eggs. It is thus larger than an ostrich egg, but much smaller than the egg of the Epiornis, which is equal to 148 hen's eggs.—Various plants and other specimens were presented.

VIENNA

Imperial Academy of Sciences, Nov. 6.—Prof. Mach presented a paper on physical experiments as to the sense of equilibrium in man. From experiments on himself, he is led to think that Flourens' turning phenomena, the orientation of equilibrium and of motion, the phenomena of giddiness, certain optical movements, &c., may be explained by supposing that the nerves of the ampullæ of the semicircular canals respond to every stimulus (which commonly involves a turning of the contents of the canal), with a sensation of turning.—Dr. Boué gave results of 33 years' observations on the circumstances attracting lightning strokes. He points out that the lightning often strikes low objects, though higher may be nearer; and he considers that constancy of course, in thunder clouds (from presence of mountain chains, &c.) and repeated discharges at particular points, may afford an explanation, in the superior attraction, viz. of subterranean masses of metal in certain regions.—Prof. Niemtschik made a communication on the construction of an ellipse inscribed in a circle, centre and tangent being given.

Nov. 13.—Prof. Pfaundler described three forms of apparatus he had devised for showing the composition of vibrations occurring at right angles to each other.—M. Stefan gave a paper on evaporation, examining theoretically the experiments lately described. From the formulæ of his dynamical theory of gases, he calculates the mean courses of the vapour-molecules of ether and sulphuretted hydrogen from one collision to the next; these are 23 and 32 respectively, the millionth part of a millimetre being taken as unit; also, from these, the diameter of the molecules; which are 0·9 and 0·7.

Nov. 20.—M. Puschl presented a paper on the co-motion (*Mitbewegung*) of light in moved media. He states the following conclusions: (1) Through participation of the ponderable atoms in propagation of light, the latter may, in various bodies, be more or less retarded, but in no case is it considerably accelerated. (2) The specific refractive power of a body is connected with the substance of its atoms, and independent of its density, so long as the internal nature of the atom substance remains the same. (3) The internal nature of atoms is modifiable through external pressure, crystallisation, solution, mixture, and especially chemical action. (4) The ether waves sent out from substances themselves are not produced immediately through the motions of the atoms as a whole, but mediately, through corresponding disturbances and concussions of the atom substance, which vibrates in the periods natural to it, according to the specific elasticity and the dimensions of the atoms.—Prof. Luess read a paper on the earthquakes of Southern Italy. He specified some points, in Sicily, and neighbouring islands, from which shocks spread radially in various directions (Etna, however, not being one of these centres); in other cases the earthquakes seemed to take a quite irregular course.—Dr. Weiss made some observations tending to identify the comet lately discovered by Coggia and Winnecke with Comet 1818 I.—M. Payer presented some fossils brought by the Weyprecht expedition from Spitzbergen.

BOSTON, U.S.

Natural History Society, Nov. 19, 1873.—Mr. F. W. Putman gave an account of the anatomy of *Bdellostoma*, and compared it with that of *Myxine* (known as hag-fish), illustrating his remarks with series of dissections, showing the brain, skeleton, intestine, ovary, liver, heart, branchial sacs, &c. These two genera of fishes form the family of *Myxinidæ*, and have similar habits and a very close external resemblance, although they can be readily distinguished by the number and position of the brandial outlets, and by the position of the œsophageal duct. Mr. Putnam said that his dissections, though in great part repetitions of those of Müller, made over thirty years ago, showed conclusively the natural separation of the genera by their internal structure.—Mr. L. S. Burbank read a paper on the "Surface Geology of North Carolina," with especial reference to some phenomena of Northern drift. From the facts noted the following inferences may be drawn:—(1) The time which has elapsed since the close of the drift period must be very short compared with the previous ages, during which the solid ledges were disintegrated by chemical and atmospheric agencies. 2) Boulders of the drift do not, in general, owe their rounded fo ms to attrition by glacial action, but, while still in place, assumed these forms by disintegration and exfoliation. (3) Whatever the force or agency of the drift may have been, it did not produce the great mass of the drift material by mechanical action in wearing and grinding down the solid rocks, but has merely carried forward and commingled the materials already disintegrated.—The secretary read an extract from a letter dated St. John's, Newfoundland, Nov. 10, 1873, from Mr. Alexander Murray, the geologist of Newfoundland, to Professor Jules Marcou, giving an account of a remarkable marine monster, which recently made its appearance off the shores of that island, and of a severed arm or tentacle of the same in his possession. The tentacle measured on October 31, having then been several days in strong brine and shrunk in consequence, seventeen feet, but was said to have measured nineteen feet previously.

PARIS

Academy of Sciences, Jan. 12—M. Bertrand in the chair.—The following papers were read:—Tables of Jupiter, by M. U. J. Leverrier. The author finds that the influence of all the small planets on Jupiter is inappreciable.—Third memoir on chemical dynamics, by M. Becquerel. This paper dealt with the action of water in chemical combinations and with the effects of water and other liquids acting as electrodes.—On the distribution of magnetism in soft iron, by M. Jamin.—On the heat set free by the combination of nitrogen with oxygen, by M. Berthelot.—On the osteology of the anterior limbs of the *Ornithorhyncus*, &c., as compared with that of the corresponding members of reptiles, birds, and mammalia, by M. Ch. Martins.—On the problem of three bodies, by M. F. Siacci.—Studies on diffraction, by M. A. Cornu. The author gave a method for the geometrical discussion of diffraction problems.—On the physiology of the flight of birds in relation to the action of the wing on the air, by M. Marey.—Organogenesis compared with androgenesis (*l'androcée*) in its relation with natural affinities (class of *Cruciferæ*), by M. Ad. Chatin.—On the transformation of the vibroscope into a tonometer, and on its use for determining the absolute number of vibrations, by M. A. Terquem.—On chloral and its combinations with albuminous substances, by M. J. Personne.—On an acoustic pyrometer, by M. J. Chautard. This instrument depends on the variation of wave-length of a sonorous wave when the vibrating air is heated.—On a re-agent paper for detecting urea, by M. Musculus.—On the formation of gum in fruit trees, by M. Ed. Prillieux.—Researches on the glands of *Rosa rubiginosa* and on their contents, by M. R. Guérin.—On the geometrical properties of rational fractions, by M. F. Lucas.—On theorems of indeterminate analysis, by Father Pepin.—On the action of definite ternary systems compounded of mannite, borax, and water on polarised light, by M. L. Vignon.—On the artificial production of crystals of calcic oxalate resembling those produced by plants, by M. Vesque. The method consisted in causing solutions of potassic oxalate and calcic chloride to mingle very slowly in a third neutral liquid by causing them to flow through strips of blotting paper, or one solution and the neutral liquid were mixed and the other introduced in the same way, or the solutions were diffused into each other through a dialyser.—Notes on the storms of the year 1869, by M. Fron.

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ERRATUM.—Vol. ix. p. 128, 1st col. line 35, for "18 degrees" read "180 degrees."