Nature March 8th 1871.

Hermann L. F. Helmholtz

Engraved by C. H. Jeens, from a Photograph.

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NATURE

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

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NOVEMBER 1876 to APRIL 1877

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH

THURSDAY, NOVEMBER 2, 1876

THE ARCTIC EXPEDITION

IT is pleasing to be able to begin our fifteenth volume with congratulations to the officers and men of a British Arctic Expedition on their safe return. On another page we give a summary of the results obtained so far as these can yet be known. It will be seen that substantial additions have been made to our knowledge in many directions, and that the expedition must be pronounced a success. True, the Pole has not been reached, but this, in the consideration of all but the mere lovers of sensation, is a small matter; our explorers have done the next best thing to reaching it, they have proved that the Pole was impracticable this year from the quarter whence success was most to be expected. It is evident from the few hints which have already been published, that when all the tale is told, it will be quite as thrilling, and full of dangers and bravery, as any previous narrative of Arctic exploration. So far as the conduct of the expedition is concerned, it seems to have been all that could be wished; the original programme was, on the whole, closely stuck to, and the desperately hard and dangerous work was done in the most systematic and economical way at present possible. Everybody seems to have behaved admirably; there seems to have been no fault whatever to find with anyone; and so much has Capt. Nares endeared himself to officers and men, that he earned for himself the common title of "the father" of the expedition.

It was hardly to be expected that an expedition, on such an errand, and with such unprecedented dangers to face as this one has had, would return without casualties; they have left four of their comrades behind them. Of these one only died as the result of frost bite, the three others succumbing to that most dreaded of all Arctic foes, scurvy. No similar expedition ever left any country so well provided with everything that could be thought of conducive to sustenance and protection. There was an ample supply of fresh provisions of all kinds, sufficient medical staff, and all precautions were evidently taken throughout the long winter to keep everyone employed, and cheerful, and duly exercised. Yet, in all the sledge-parties, scurvy broke out with a virulence and to an extent not experienced, we believe, in any recent Arctic expedition. The cause of this outbreak will no doubt give much food for thought for some time to come, some thinking that the unusual length and intensity of the darkness may have had something to do with it. The darkness seems to have been much more intense, and certainly was longer-continued than ever before experienced, and such a condition, not to mention its effect on the spirits of the men, must necessarily, one would think, exercise some deleterious physical influence on the body. This is a point deserving of careful consideration; meantime we cannot but admire the way in which officers and men of these sledge-parties did their work in spite of physical weakness and terrible suffering; it would, however, have been surprising had the record been otherwise.

No men could have exerted themselves more to accomplish the popular, but really minor, object of their expedition, and none could have been more honourably baffled. The ice was met with off Cape Sabine in 78° 41′ N., and from that time till the *Alert* was compelled to take up her quarters in 82° 27′, it was a constant battle with ice of a thickness never before met with. The ice was from 100 to 150 and even 200 feet thick, resembling more a pell-mell assemblage of icebergs than the usual floes; to have been nipped between the masses of such ice would certainly have been fatal. Commander Markham in his daring attempt to carry out the instructions of the expedition by penetrating as far to the north as possible, found the ice piled in such rough and hilly hummocks that progress was only possible at the rate of a mile a day, and he wisely returned after reaching 83° 20′ N., the highest authentic latitude yet attained.

Capt. Parry's long and weary journey, which reminds one to a certain extent of that of Commander Markham, was only as far as 82° 45′; the Austro-Hungarian expedition of 1872-4 reached 82° 5′, though they saw as far as 83°; while Hall with the *Polaris* sailed without let or hindrance in 1872 over the same ground as the *Alert* and *Discovery* for 700 miles to 82° 16′ N. in the short space of one week.

Any such frightful ice-barrier as that reported, and, let us add, admirably photographed, by our expedition was not seen by Hall and his men; and indeed it has been stated that had it not been for the scruples of the second in command, Buddington, Hall would have pushed still further northwards, all on board, except Buddington, who had no heart in the work, agreeing that the undertaking was perfectly practicable. Meyer, in his evidence before the U.S. Commission, declared that if 82° 16′ could have been passed, there was nothing to hinder a ship reaching 85° or 86° "or even farther. Had poor Hall not met with an untimely death, the attempt would certainly have been made in the following summer. This terrible ice-barrier, then, before which our expedition has wisely returned, does not appear to be a constant phenomenon so far south, for Hall's observations have been generally accepted as perfectly trustworthy. May there not have been some cause at work in the high north to push the thick-ribbed ice south to the northern entrance of Robeson Channel? This seems to have been an unusually severe season in the north; icebergs were met with in abundance a week or two ago far south in the Atlantic, and last week we reported the wreck of a whole fleet of whalers in the Behring Straits region. If the latter casualty has been produced by ice, it would seem to show that some cause has been at work this season to render it unusually unfavourable for Arctic work. It is perhaps worth noting here, at least, that 1871 was a maximum, while 1876 is a minimum, sun-spot year. The temperature was undoubtedly the coldest on record, neither the *Polaris* nor the Austro-Hungarian expedition experiencing anything like it, namely, 104° of frost. There was no stint of animal life in the region in which the *Polaris* wintered, and as far north as the expedition penetrated, it was observed, while the Austro-Hungarian expedition found the cliffs swarming with life at their farthest north point. The dearth of animal life is a noticeable feature in the results of our expedition; it ceased altogether at a short distance to the north of the *Alert's* quarters. The prevailing wind during the sojourn of the *Polaris* was from the north-east; this year it is stated scarcely any easterly wind was noticed, but a strong current and drift set constantly in from the west along the north coast of America. We mention these points simply to suggest that the conditions met with by our gallant expedition can hardly without further observations be regarded as the normal ones. Round the Pole doubtless there must be a permanent barrier of impenetrable floe-bergs, for it would be ridiculous to suppose that 150 feet thick ice of thousands of square miles in extent is melted and re-formed every year. But is it possible that usually this barrier lies further north than our expedition found it?

As to positive discoveries, an unprecedentedly rich collection of observations in all departments have been obtained. It will be seen from our map that positive additions have been made to Arctic geography. With the exception of Hayes Inlet, all the coast from Cape Farewell to the northern end of Robeson Channel is now laid down, and considerable advances have been made west along the American, and east along the North Greenland coast, in the former case to 86° 30′ W., and in the latter to 48° 33′ W. President Land does not exist, no land having been seen north of Cape Columbia in 83° 7′ N. It was a pity that Petermann Fjord was blocked up with ice, otherwise it might have been ascertained whether or not it divides Greenland in two, as has been conjectured. There is little doubt, at any rate, that Greenland is an island, and that it does not extend right across to Wrangell Land as Petermann conjectured. For the more important scientific observations we must wait some little time, but we have reason to believe they are abundant and of the highest value. The drift of the current along the North American coast it will be seen, is from the west, and it is possible it may come right across from Behring Straits. A magnificen series of tidal observations has been obtained, entirely confirmatory of the conclusions that Bessels came to, viz., that the tides in the north of Smith's Sound come from the Pacific. It would be interesting now to know what lies between Parry Islands and the newly discovered coast, and whether currents have an unobstructed passage from Behring Straits across the Polar Sea. The magnetic observations entirely endorse the theory on which the charts have been constructed; and had it not been for a change of officers and an accident to the clock, the pendulum observations for determining the figure of the earth would have been completed and of the greatest interest. Capt. Feilden, the naturalist, whose exertions are beyond all praise, obtained admirable results in his department.

We may be permitted to say that we think Capt. Nares has acted gracefully and generously in his selection of names for the lands discovered; the most northern point discovered now bears the name of Cape Columbia. It was in keeping with this disposition to recognise America's claims to remembrance that Capt. Nares paid a deserved tribute to the brave Hall by affixing to his no longer lonely grave a brass tablet containing a suitable inscription.

Altogether we have every reason to be satisfied with the conduct and results of the expedition, and thankful that these results have been obtained with so little loss. It might have been otherwise, for the *Discovery* was within a minute of being crushed by an iceberg, and had it not been for an accident to the *Alert's* screw, she would certainly have pushed further north and got into a position from which it would have been impossible to extricate her. Many lessons with regard to future Arctic work are to be learned from the experiences of this latest expedition. We would also remind our readers of the plan advocated by Weyprecht, and recommended by a German Government Commission, to establish at suitable points all round the Polar region a series of permanent stations from which the Arctic citadel can be slowly but surely sapped. The recommendations of the German Government Commission we consider so important, that although we published them at the time, we think it appropriate to reproduce them here in the present connection, and the admirable scientific spirit in which the subject is approached is worthy of note.

"1. The exploration of the Arctic regions is of great importance for all branches of science. The Commission recommends for such exploration the establishment of fixed observing stations. From the principal station, and supported by it, are to be made exploring expeditions by sea and by land.

"2. The Commission is of opinion that the region which should be explored by organised German Arctic explorers, is the great inlet to the higher Arctic regions situated between the eastern shore of Greenland and the western shore of Spitzbergen.

"Considering the results of the second German Arctic expedition, a principal station should be established on the eastern shore of Greenland, and, at least, *two* secondary stations, fitted out for *permanent* investigation of different scientific questions, at Jan Mayen and on the western shore of Spitzbergen. For certain scientific researches the principal station should establish temporary stations.

"3. It appears very desirable, and, so far as scientific preparations are concerned, possible, to commence these Arctic explorations in the year 1877.

"4. The Commission is convinced that an exploration of the Arctic regions, based on such principles, will furnish valuable results, even if limited to the region between Greenland and Spitzbergen; but it is also of opinion than an exhaustive solution of the problems to be solved can only be expected when the exploration is extended over the whole Arctic zone, and when other countries take their share in the undertaking.

"The Commission recommends, therefore, that the principles adopted for the German undertaking should be communicated to the Governments of the States which take interest in Arctic inquiry, in order to establish, if possible, a complete circle of observing stations in the Arctic zones."

But to come to any final decision on the subject at present, as have some of the daily papers, is premature, more especially as we have only mere hints of the work of the latest expedition before us. It is evident, however, that three courses are open to us: we may rest on our oars and comfort ourselves with the belief that no more can be done; we may make another dash, blind to a certain extent it must be with our present knowledge; or, accepting the recommendation of the German Commission, a united and continuous sap may be commenced. But in order to come to a wise decision, men of science must long ponder over the enormous mass of new facts collected by the expedition, and not until this has been done can any opinion worth the stating be possibly arrived at.

Here we would have ended had it not been for the lamentable tone assumed by our leading newspaper in an article on the expedition in Tuesday's issue. It will be remembered that from the first, for some unaccountable reason, the *Times* set its face against the expedition, and prophesied that no good could come of it; now it utters a lonely shout of triumph at the supposed success of its prophecy. For the *Times* appears to be so ill-informed as to believe that the main, if not the sole, object of the expedition was to reach the Pole; if it failed in doing this, then, in the eyes of the *Times*, it was a complete failure. But this is sheer ignorance, real or assumed, on the part of the *Times;* for no informed person ever dreamt that the only object of the well-equipped expedition was to gratify unintelligent curiosity and craving after sensation. The printed instructions of the expedition were essentially: "Reach the Pole if you can, but at any rate, in the light of the latest scientific knowledge, make all possible observations on the multifarious phenomena which can be seen to advantage alone in the Arctic regions." These instructions have been faithfully carried out and with complete success. Every effort was made to reach the Pole, and when the results are published it will be seen that no expedition ever brought home a richer harvest. Whether these results are worth the suffering and the sacrifice of life which the expedition experienced, is a question which will be answered in accordance with one's idea of what is worth running the risk of life for. In spite of the scream of the *Times*, and although no new market has been opened, the people of this country will simply feel proud, and be ennobled by the thought, that the latest deed of heroism has been done by Englishmen—that "the ancient spirit is not dead."

The nation desired the expedition, scientific bodies and scientific men counselled it and worked for it, Government, only after long consideration, willing and liberally granted funds; and out of the volunteers, officers and men, who, well knowing all the risks that would be run, eagerly offered themselves for the service, a dozen similar expeditions could have been equipped. Under these circumstances the *Times'* article is simply an impertinence.

SCHIMPER'S "MOSSES OF EUROPE"

Synopsis Muscorum Europæorum. Auctore W. P. Schimper. Vol. I.—Introductio, pp. 130. Vol. II.—Specierum descriptio, pp. 886. Edit. 2. Stuttgartiæ, 1876. (London: Williams and Norgate.)

THIS long expected work has at last made its appearance, and all students of bryology will be grateful to possess such a vast storehouse of carefully arranged descriptive matter to help them in the determination of species; no easy task at any time, and sometimes one of difficulty and trouble even to an expert.

The first edition appeared in 1860, and we must frankly admit that we experienced some feelings of disappointment, on finding that almost the entire nomenclature and arrangement are identical with those of that edition; nay, in some respects we must look upon the classification as retrograde, for while in his classical work on the Sphagnaceæ, Prof. Schimper strongly insists on the elevation of this family to the rank of a class equivalent to those of Mosses and Hepaticæ, we here find him placing them along with *Andreæa* and *Archidium*, as an appendage to the mosses, under the title of BRYINÆ ANOMALÆ; surely a most unphilosophical mode of dealing with them, since the three genera have nothing else in common but the large saccate calyptra, which had already led Hampe to separate them as a section—*Saccomitria.*

The Cleistocarpous order heads the series, though the author half apologises for still retaining it "as being convenient for beginners, and because the position of some of them among the Stegocarpi is uncertain." Several of our best bryologists, however, have long felt that the solitary character of possessing a capsule without a separable lid, is not sufficient to outweigh all other points of structure and habit, especially when it also necessitates keeping up two parallel series of forms in widely separated families, *e.g.*, *Phascaceæ* and *Pottiaceæ.* We would venture to differ from our author, and consider that *Archidium* is a near ally of *Pleuridium*, and that the absence of a columella is not so momentous a character as to require the separation of these genera to the extreme ends of the system; while *Andreæa* as to its vegetative organs is essentially Grimmiaceous, but in its fruit standing apart and thus representing a most distinct natural family, imitating as it were the Hepaticæ by its quadrifid capsule, but not having any real affinity with that group.

About 200 new species are described in the present edition, many of them only known in a barren state, and in several instances misgivings are expressed by the author as to their stability. We may glance at some of these *en passant*. *Ephemerum* has one new species, *E. Rutheanum*, and we surmise our Sussex plant (*E. intermedium*, Wils., *E. tenuinerve*, Lindb.) is also distinct. The *Ephemeraceæ* really seem to merit the rank of a natural family rather allied to *Trichostomaceæ* than to *Funariaceæ*, for which the diminutive size, permanent protonema, and leaf structure would supply the chief characters.

In *Weissiaceæ* we find *Anæctangium*, a genus which has exercised the minds of most bryologists as to its systematic position, but which perhaps is as happily settled here as is possible. *Gyroweisia*, *Hymenostomum*, *Oreoweisia*, and *Rhabdoweisia*, standing as sections of *Weisia* in the previous edition, are now raised to the rank of genera. In *Dicranaceæ* we have also a new genus—*Metzleria*—which appears to be very close to *Dicranodontium*, and *Campylopus* now includes twelve species, while those of *Fissideus* number no less than nineteen. *Leptotrichum*, Hampe, is still retained as a genus, though its author has himself replaced it by the much older name, *Ditrichum*, Timm.

Didymodon and *Trichostomum* receive considerable additions, chiefly, however, only known in a barren state, as is also the genus *Geheebia*, established to receive *Tortula gigantea*.

We pass next to the great genus *Orthotrichum*, in which we find no less than forty-two species; so uniform are these in habit and foliage, that they have hitherto proved a most troublesome group to deal with, nor do we find that the nine sections into which it is divided help us readily to determine the species. In no genus of mosses do we require so full a series of specimens, for we must have the capsule with its calyptra, and with and without the lid, in order satisfactorily to determine them, and we fear that more species have been established than will eventually prove tenable.

Bryum is another genus receiving a large accession of species—no less than thirty-four new ones—and *Zieria* is still maintained, though used long ago by Sir J. E. Smith for a genus of *Rutaceæ*, and therefore altered by Prof. Lindberg to *Plagiobryum*, which must certainly be adopted. In the Addenda we also find a new genus, *Merceya*, founded on the *Eucalypta ligulata* of Spruce, but strictly we should say that this name must give place to *Scopelophila*, Mitten. Another new genus, *Anacolia*, is also established for *Glyphocarpus Webbii*.

Among Pleurocarpous mosses, *Myurella Careyana* does not find a place, although recorded as found in Europe. *Thuidium decipiens*, De Not., the author states he has not seen, yet it was distributed in Rabenhorst's Bryotheca under both No. 1,141 and 1,182. It has no relation to the genus *Thuyidium*, is erroneously described as monoicous, and indeed can only be regarded as one of the many forms of *Hypnum commutatum*. Of the great tribe *Hypneæ* thirty-six new species are described.

In the BRYINÆ ANOMALÆ we find *Sphagnum* now numbering twenty species, grouped in six sections according to Schliephacke's arrangement. These we fancy will have to be somewhat reduced, as it now appears to be certain that in this family at least, a dioicous and monoicous condition of the inflorescence may occur in the same species.

Neglect of the work of other writers and especially of papers in the various botanical journals of this and other countries is the principal shortcoming of the work before us, and probably the author has not had time properly to consult them; in every other respect the Synopsis maintains the high character it had already acquired, for no description of species could be more accurate and painstaking, while the paper and printing are superior to the ordinary run of foreign books.

It will thus be seen that Schimper's Synopsis must still continue to be the standard work on the mosses of Europe, and fitly comes to us from an author whose name has been identified with the study of these interesting plants for the past forty years.

OUR BOOK SHELF

Outlines of Practical Histology. By William Rutherford, M.D., F.R.S. Second Edition. (J. and A. Churchill, 1876.)

WHEN, a year ago, we reviewed this work upon its first appearance, it consisted of but seventy-two pages, and contained four illustrations; the second edition occupies very nearly two hundred pages, and is illustrated with sixty-three woodcuts. The enlargement gives the author an opportunity of entering with considerably greater detail into his subject, and he is able to introduce much new matter. Among the most important additions we may mention a chapter on the optical principles upon which the microscope is constructed, including immersion lenses, and an instrument manufactured by Mr. Swift of London, which is apparently as good as those of continental celebrity. The histological sections may be said, practically, to be re-written, for to almost every one is added matter of great value, essential to all but the merest commencer. Among these we notice paragraphs upon the effects of gases on the blood, the enumeration of the discs, the "prickle" cells of the epidermis, lymphatics of the diaphragm, coverings of hair, structure of the retina and of the cerebral convolutions. In the fourth part of the work, which is devoted to general considerations regarding histological methods, the application of vapours and gases to tissues is explained, as are the hot stage for the microscope, with its heating apparatus and the moist chamber of Dallinger and Drysdale. The author's microtome is figured, as is the apparatus necessary for injecting tissues by the pressure-bottle. All the figures are excellently drawn, and very lucid, and so greatly has the book increased in value, instructive as it was before, that we feel quite justified in recommending those who possess the first edition to purchase the second, and those who are studying the first principles of practical histology to obtain it without fail.

A Study of the Rhætic Strata of the Val di Ledro in the Southern Tyrol. By T. Nelson Dale, jun., Member of the Geological Society of France. Pp. 69, with Map and Sections. (Paterson, New Jersey, 1876.)

ON the western side of the Lago di Garda is situated a tract of Secondary rocks which has been comparatively little explored by geologists. Lying as it does exactly upon the Austro-Italian frontier, this area has neither been described by Stoppani and the Italian geologists, nor has it received full justice from the officers of the Vienna *geologische Reichsanstalt;* and under these circumstances Prof. Zittel of Munich has pointed it out to the author of the present paper as a promising field of study. Mr. Dale's work will certainly be of considerable use to future explorers of the district, though not carried out in sufficient detail to warrant, in his own case, any very important generalisations. Indeed, the memoir consists almost wholly of transcriptions of notes and rough drawings of sections relating to a number of different localities which are indicat d by reference to a key-map. The author's general c...clusions, so far as they go, are shown in a very clear and useful table, from which it appears that at this point of the Alps, the Jurassic and Rhætic strata (including in the former the Tithonian) have a united thickness of from 6,000 to 7,000 feet. Vast as is the estimate, no one acquainted with this or the surrounding districts will be inclined to regard it as excessive.

Mr. Dale has evidently made good use of his opportunities, so far as they have gone, and has given us in this memoir the results of a piece of well-directed observation. We hope to have further details from his pen concerning the same interesting region. The list of *errata*, which is rather long for a memoir of the proportions of the present, does not by any means exhaust the whole of the printer's errors. We are tempted to fear that Mr. Dale is not sufficiently careful in keeping so distinct from one another, as behoves a working geologist, his notes relating to various subjects; for, by some strange chance a stray page of a sermon seems to have fallen into the hands of the compositor and to have been set up by him at the end of the author's geological notes. J. W. J.

LETTERS TO THE EDITOR

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

"Geographical Distribution of Animals"

I FIND that Mr. Wallace in his new work on the "Geographical Distribution of Animals" when stating the limits of his Ceylon sub-region (vol. i. p. 327), gives among mammals the genus *Tupaia* and among birds "a species of *Myiophonus*, whose nearest ally is in Java" as characteristic of that sub-region. Further, in the tabular statement (vol. ii. p. 187), *Tupaia* is altogether omitted from the Indian sub-region.

It is not my intention to enter here into the general question of the divisions of the oriental region which Mr. Wallace has adopted. The subject has I know been undertaken by at least one well-known Indian naturalist. My object at present is simply to record the fact that I have found both *Tupaia Elliotti* and *Myiophonus Horsfieldi* ranging together far to the north of the limits given by Mr. Wallace for his Ceylon sub-region.

Tupaia I first met with at an elevation of about 1,500 feet in the Sutpuru Hills, near the *Pachmari* plateau in the Central Provinces (P.I.A.S.B., April, 1874), lat. 22° 20'. Subsequently I found it in Sambalpur, which is the most eastern district of the Central Provinces (lat. 21° 30'). But the former does not even give its extreme northern limit as it has been found in the Kurrucpur hills of the Monghyr district (lat. 25°).

Myiophonus Horsfieldi I first shot in Sirguja—a native state in Western Bengal (lat. 23°). Afterwards in the Sutpurus, where it occurred with *Tupaia* as above, and finally I obtained it also in Sambalpur, where it was found at elevations under 1,000 feet above the sea. Still further north it has been obtained at Mount Aboo ("Stray Feathers," vol. iii. p. 469), lat. 25°.

Myiophonus is, it is true, included in Mr. Wallace's list of Oriental genera in Central India, but its special employment as a characteristic form of the Ceylon sub-region seems scarcely compatible with a knowledge of its now ascertained wide range through-continental India.

During the ensuing field season I expect to be engaged in the geological examination of one of the wildest and least known parts of India—the area between the Godaveri and Mahanudi Rivers. I have great hopes of discovering there further facts regarding the range of species whose limits are now only imperfectly known. In the meantime I may state that during the present year I have shot *Harpactes fasciatus* in Sambalpur, thus confirming the late Col. Tukell's statement of its occurrence in the same general tract of country. The above allusion to *Tupaia* leads me on to record here that I have met with two other species of the genus.

During an ornithological tour which was made in 1873 by a party of which I was a member—through the islands of the Andaman and Nicobar groups—we obtained a species of *Tupaia* on the Island of Preparis. Our specimen appears to be identical with *T. Peguensis*, which occurs from Pegu to Sikkim. On the Great Nicobar we shot a specimen of the species described in the Novara account as *Nicobariensis*, and considered then to be worthy of generic distinction.

In Preparis, it may be added, we also shot a small grey squirrel which is allied to if not identical with *S. Assamensis*. These, with a monkey (*M. carbonarius?*), pigs, and probably rats and bats, constituted so far as we could ascertain the mammal fauna of the island.

Preparis I should perhaps explain is the most northern of the Andaman group lying between Cape Negrais and the Cocos.

Mr. Wallace has I observe included the Nicobar Islands in the Malayan sub-region and the Andamans in the Indo-Chinese. This separation of the two groups is, I believe, fully justified by the facts.

Some years ago when working at the avifauna of these islands (J.A.S.B., 1872, p. 274), while recognising the fact of a number of species being common to both groups, I could not resist a conviction as to the existence of a strong Malayan stamp upon the birds which are peculiar to the Nicobars.

In conclusion Mr. Wallace's magnificent work needs no praise from me; but as a field worker and observer I may perhaps venture here to offer my thanks for the valuable mine of information which it affords. V. BALL,

Calcutta, September 28 Geological Survey of India

European Polygalas

IN view of a monograph of the order Polygalaceæ which I have in preparation, may I make use of your columns to say that I should be greatly obliged to any correspondents who can send me specimens of any of the less common European *Polygalas*, especially *P. exilis*, *monspeliaca*, *microphylla*, *saxatilis*, *Preslii*, *nicæensis*, *flavescens*, *rosea*, *sibirica*, *supina*, *venulosa*, *anatolica*, or any well-marked varieties. I shall be glad to offer in exchange specimens of some of the rarer British plants.

6, Park Village, East, Regent's Park, London, October 28 ALFRED W. BENNETT

The Solidity of the Earth

IN his opening address to the Mathematical and Physical Section of the British Association, Sir William Thomson affirmed "with almost perfect certainty, that, whatever may be the relative densities of rock, solid and melted, or at about the temperature of liquefaction, it is, I think, quite certain that cold solid rock is denser than hot melted rock; and no possible degree of rigidity in the crust could prevent it from breaking in pieces and sinking wholly below the liquid lava," and that "this process must go on until the sunk portions of the crust build up from the bottom a sufficiently close-ribbed skeleton or frame, to allow fresh incrustations to remain bridging across the now small areas of lava, pools, or lakes" (NATURE, vol. xiv. p. 429).

This would doubtless be the case if the material of the earth were chemically homogeneous or of equal specific gravity throughout, and if it were chemically inert in reference to its superficial or atmospheric surroundings. But such is not the case. All we know of the earth shows that it is composed of materials of varying specific gravities, and that the range of this variation exceeds that which is due to the difference between the theoretical internal heat of the earth and its actual surface temperature.

We know by direct experiment that these materials, when fused together, arrange themselves according to their specific gravities, with the slight modification due to their mutual diffusibilities. If we take a mixture of the solid elements of which the earth, so far as we know it, is composed, fuse them, and leave them exposed to atmospheric action, what will occur?

The heavy metals will sink, the heaviest to the bottom, the lighter metals (*i.e.* those we call the metals of the earths, because they form the basis of the earth's crust) will rise along with the silicon, &c., to the surface; these and the silicon will oxidise and combine, forming silicates, and with a sufficient supply of carbonic acid, some of them, such as calcium, magnesium, &c., will form carbonates when the temperature sinks below that of the dissociation of such compounds. The scoria thus formed will float upon the heavy metals below and protect them from cooling by resisting their radiation; but if in the course of contraction of this crust, some fissures are formed reaching to the melted metals below, the pressure of the floating solid will inject the fluid metal upwards into these fissures to a height corresponding to the floatation depth of the solid, and thus form metallic veins permeating the lower strata of the crust. I need scarcely add that this would rudely but fairly represent what we know of the earth.

But it may be objected that I only describe an imaginary experiment. This is true as regards the whole of the materials united in a single fusion. Nobody has yet produced so complete a model with platinum and gold in the centre, and all the other metals arranged in theoretical order, and with the oxidised, silicated, and carbonated crust outside; but with a limited number of elements this has been done, is being done daily, on a scale of sufficient magnitude amply to refute Sir William Thomson's description of a fused earth solidifying from the centre outwards.

This refutation is to be seen in our blast furnaces, refining furnaces, puddling furnaces, Bessemer ladles, steel melting pots, cupels, foundry crucibles; in fact, in almost every metallurgical operation down to the simple fusion of lead or solder in a plumber's ladle, with its familiar floating crust of dross or oxide.

As an example I will—on account of its simplicity—take the open hearth finery, and the refining of pig iron. Here a metallic mixture of iron, silicon, carbon, sulphur, &c., is simply fused and exposed to the superficial action of atmospheric air. What is the result?

Oxidation of the more oxidisable constituents takes place, and these oxides at once arrange themselves according to their specific gravities. The oxidised carbon forms atmospheric matter and rises above all as carbonic acid, then the oxidised silicon being lighter than the iron floats above that, and combines with any aluminium or calcium that may have been in the pig, and with some of the iron; thus forming a siliceous crust closely resembling the predominating material of the earth's crust. The cinder of the blast furnace, which in like manner floats on the top of the melted pig iron, resembles still more closely the prevailing rock-matter of the earth, on account of the larger proportion, and the varied compounds of earth-metals it contains.

When the oxidation in the finery is carried far enough, the melted material is tapped out into a rectangular basin or mould, usually about 10 feet long and about 3 feet wide, where it settles and cools. During this cooling the silica and silicates—*i.e.*, the rock-matter—separate from the metallic matter and solidify on the surface as a thin crust, which behaves in a very interesting and instructive manner. At first a mere skin is formed. This gradually thickens, and as it thickens and cools becomes corrugated into mountain chains and valleys much higher and deeper, in proportion to the whole mass, than the mountain chains and valleys of our planet. After this crust has thickened to a certain extent volcanic action commences. Rifts, dykes, and faults are formed by the shrinkage of the metal below and streams of lava are ejected. Here and there these lava streams accumulate around their vent and form isolated conical volcanic mountains with decided craters, from which the eruption continues for some time. These volcanoes are relatively far higher than Chimborazo. The magnitude of these actions varies with the quality of the pig-iron.

The open hearth finery is now but little used, but probably some are to be seen at work occasionally in the neighbourhood of Glasgow, and I am sure that Sir William Thomson will find a visit to one of them very interesting. Failing this he may easily make an experiment by tapping into a good-sized "cinder bogie," some melted pig-iron from a puddling furnace (taking it just before the iron "comes to nature"), and leaving the melted mixture to cool slowly and undisturbed.

For the volcanic phenomena alone he need simply watch what occurs when in the ordinary course of puddling the cinder is run into a large bogie and the bogie is left to cool standing upright. I need scarcely add that these phenomena strikingly illustrate and confirm Mr. Mallett's theory of earthquakes, volcanoes, and mountain formation.

In merely passing through an iron-making district one may see the results of what I have called the volcanic action, by simply observing the form of those oyster-shaped or cubical blocks of cinder that are heaped in the vicinity of every blast furnace that has been at work for any time. Radial ridges or consolidated miniature lava streams are visible on the exposed face of nearly, if not quite all, of these. They were ejected or squeezed up from below while the mass was cooling, when the outer crust had consolidated but the inner portion still remained liquid. Many of these are large enough and sufficiently well marked, to be visible from a railway carriage passing a cinder heap near the road.

I intended to have made a few remarks upon another of Sir William Thomson's arguments for the earth's solidity, but the pressure of necessary business compels me to postpone them.

W. MATTIEU WILLIAMS

Belmont, Twickenham, October 17

Are We Drying Up?

IN NATURE, vol. xiv. p. 527, there is an article condensed from one by Prof. Whitney, with the alarming title "Are We Drying Up?" with a number of facts to prove that we are—that in the temperate zone at least, the supply of water in the rivers and lakes is failing at a more rapid rate than the destruction of forests will account for.

Supposing this to be true, it can have only one of two causes: a decrease in the area of the ocean, from which the rivers are supplied through evaporation and rainfall; or a diminution in the supply of heat from the sun, which would of course diminish evaporation.

It is scarcely necessary to say that any perceptible decrease in the area of the ocean during historical time is theoretically most improbable, and that practically there is no evidence of it.

A diminution in the radiation of heat from the sun is not impossible: and it is also shown in the concluding paragraph of your article, that a diminution in the obliquity of the ecliptic, which I believe is now going on, must tend to diminish the supply of solar heat to the higher latitudes, and, consequently, to diminish evaporation and rainfall there.

But were it true the supply of heat to the temperate zone were sensibly diminishing from either of these two causes, the fall of temperature would be quite as noticeable as the diminution of rainfall; and we should have proof of this from historical evidence as to the distribution of cultivated and wild plants. But there is no general evidence of the kind. In Iceland and Siberia, it is true, there appears to be some evidence of the summers having become colder, but in the more temperate regions the range of cultivated plants seems to have remained unchanged, or at least not to have receded, from the earliest periods of which we have any record.

It appears, therefore, most likely that the diminution of rainfall, where it really exists, is a merely local phenomenon.

It seems to be forgotten, that while any local diminution of rainfall is certain to give proof of itself in unfilled water-courses, any corresponding increase of rainfall in another locality will not prove itself in any equally visible way.

There appears to be little doubt of the recent desiccation of the region round the Caspian and Aral Seas, but it admits of being explained by a local cause. The Caspian has, within the last few thousand years, been cut off by a geological change from the Black Sea or the Arctic Ocean, or from both; since then it has shrunk in consequence of the excess of evaporation over rainfall, and the more its area has diminished, the less is the rainfall of the surrounding regions.

Some of the facts quoted, showing that rivers are ceasing to be navigable, do not necessarily prove that the rainfall is less than formerly, but only that the flow of the rivers is less regular. It appears certain that the destruction of forests, and the introduction of agricultural drainage tend to this result, by throwing the water more rapidly off the land. But there is also a good deal of evidence to show that the destruction of forests, and of vegetation generally, tends to diminish rainfall. The most satisfactory instances, in every sense, are those of the converse kind, which show that rainfall may be increased by the judicious fostering of vegetation. I will mention a few of these which occur to me, without being able to remember my authorities.

In Lower Egypt, rain has become much commoner since the formation of extensive date-tree plantations; and the flow of water in the Kedron, in the neighbourhood of Jerusalem, has become more abundant and regular since the planting of groves of mulberry and other trees about its sources. In the arid volcanic Island of Ascension, where trees would not have lived, showers of rain have been attracted, by planting such herbaceous plants as are best able to endure the almost permanent drought. The introduction of cultivation in the neighbourhood of the Great Salt Lake of North America has increased the rainfall, and caused the level of the lake to rise. JOSEPH JOHN MURPHY

Antedon rosaceus (Comatula rosacea)

THE communication from Major Fred. H. Lang in NATURE, vol. xiv. p. 527, as to the abundant capture of *Comatula rosacea* in Torbay by himself and Mr. Hunt with the dredge during last month, is a valuable contribution to the study of the question of the appearance and disappearance o certain marine animals in certain localities respecting which we know so little. It is specially interesting to the Birmingham Natural History and Microscopical Society, and as president of the Society and reporter during the marine excursion to Teignmouth in 1873, alluded to by Major Lang, I must say that I read it with very great surprise and pleasure. My knowledge of the locality has extended over a period of about thirteen years, and during that time I have on several occasions dredged the ground which he mentions, and never once succeeded in taking an adult specimen of the rosy feather star, much less the more interesting pedunculate form of it. I have not, however, dredged there since our marine excursion. Mr. Gosse, whose experience is very large, and who resides in the neighbourhood, to whom I showed our mounted specimens, had never before seen the animal in that form, and there is no mention made of the adult animal in any of his descriptive works except in "A Year at the Shore," where at p. 182 he states, "We sometimes but very rarely find on this coast a very lovely form of this class of animals. . . . . *Comatula rosacea*, a fine specimen of which, taken by myself in a little cove near Torquay, I have delineated." This was written in 1864. In the year previously, I believe, Prof. Allman dredged the same locality, and communicated to the Royal Society of Edinburgh a paper "On a pre-brachial stage in the development of *Comatula*," founded on a single specimen which he took on the occasion. It is a most remarkable circumstance, therefore, that in the space of about three years the species should have become numerous to the extent alluded to by Major Lang, more than a hundred being taken in one haul of the dredge! The marine naturalist who year by year finds his favourite specimens disappearing on many parts of the coast, will derive some consolation from Major Lang's communication as a set-off to disappointments elsewhere. I notice that Major Lang uses—as I did in 1873—the nomenclature, *Comatula rosacea* of Lamarck. Will he forgive me informing him of what I was then ignorant—that Dr. Carpenter, reverting to the previous designation of Fréminville, has adopted *Antedon rosaceus*—and at the same time directing his attention to the two wonderful and exhaustive monographs on the animal in the *Philosophical Transactions*:—(1) "On the Embryogeny of *Antedon rosaceus*," by Sir Wyville Thomson, at page 513, for the year 1865, and (2) "Researches on the Structure, Physiology, and Development of *Antedon rosaceus*," by Dr. Carpenter, at page 671, for the year 1866?

Birmingham, October 20 W. R. HUGHES

Caterpillars

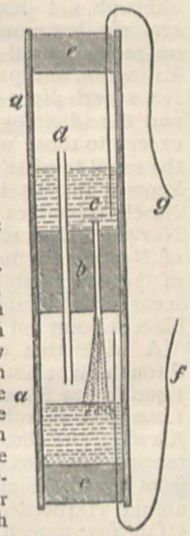
IF the experiment related below has never been made before, it appears to me deserving of notice in reference to instinct and evolution. The successful result of the experiment in a single case last year led me to repeat it on a somewhat larger scale this autumn. On September 25 I placed a number of the caterpillars of *Pieris brassicæ* in boxes, and fed them with cabbage till they began to spin up. As soon as they had attached themselves by the tail and spun the suspensory girdle, and therefore *before* the exclusion of the chrysalis, I cut the girdle and caused them to hang vertically by the tail in the manner of the *Suspensi*. More than half of the caterpillars had been ichneumonized, and some accidents to the others finally reduced the number in which the experiment was fairly tried to eight. Of these, *three* came out successfully, the chrysalids maintaining their hold of the caterpillar-skin until they had succeeded in fastening themselves by their anal hooks to the silk to which the caterpillars were attached The other five, as might have been expected of all, fell to the ground for want of the suspensory girdle. Counting the case last year, here then are no less than four out of nine caterpillars of the *Succincti*, when artificially placed in the conditions of the *Suspensi*, adapting themselves to circumstances so greatly changed, and whether by plasticity of instinct or reversion to ancestral habit accomplishing a very difficult operation no less successfully. J. A. OSBORNE

Milford, Letterkenny, October 14

Electro-Capillary Phenomena

THE electro-capillary machine of Lippmann and his capillary electrometer, besides the capillary electroscope of Werner Siemens and the electro-chemical relay of Wheatstone are all illustrations of a phenomenon resulting from *application* of an electric current. I am not aware that the converse phenomenon is so generally known, namely, that the motion of the mercury in the tube *produces* an electric current. If we substitute a galvanometer for the battery in a Lippmann capillary machine and move the lever by hand, the galvanometer needle is deflected. Similarly, if in any of the electro-capillary electrometers a galvanometer is substituted for the battery and the bubble caused to move by mechanical action, electrical currents are produced which deflect the galvanometer needle.

The following small instrument may serve to show this action for lecture purposes:—*a a* is a glass tube of any convenient bore, say 15 to 20 millimetres, by 300 mm. length; *b* is a cork fitting tightly into the middle of the tube, and perforated in two places where are inserted—at *c* a tube of $\frac{1}{3}$ mm. bore, slightly longer than the cork is thick, and at *d* a longer tube, extending half way into both compartments. The ends of the tube *a a* are stopped by the corks *e e*, through which pass the platinum wires *f g*. Sufficient mercury to quarter fill each compartment is introduced into the tube *a a*, with a small quantity of diluted sulphuric acid. The apparatus being now sealed up, the wires *f* and *g* are connected to the terminals of a somewhat delicate galvanometer.



By inverting the tube, as is done with an hour or egg-glass, a current flows through the galvanometer so long as any mercury runs through the tube *c* (the tube *d* is an air-tube simply). Reinverting the tube gives a current in an opposite direction, the platinum wire from that compartment from which the mercury flows always being the zincode of the electrical system. The current decreases with the mercury in the upper chamber as it falls, being a maximum with greatest head of mercury, and falling to nothing when all the mercury has dropped through. By any arrangement maintaining a constant head of mercury a constant current may be maintained.

Such an apparatus is especially useful in an electrical laboratory where weak currents are required for the adjustment of delicate galvanometers, or where the heating effect of currents of greater intensity and quantity are required to be avoided. The apparatus can be made in glass and hermetically sealed. A tube like the above placed on a stand which will allow it to revolve in a vertical plane, and fitted with a commutator, can be made to give a constant current in one direction, and is always ready to hand.

With a filter funnel the tube of which is drawn out to a fine point placed above a vessel containing mercury and acidulated water (wires being led from the funnel and lower vessel to the galvanometer) some interesting results are to be noticed which serve to throw considerable light on the action in electro-capillary apparatus. It will be found that when the mercury breaks away from the funnel at too great height the mercurial column becomes discontinuous, the circuit is interrupted, and of course no current passes through the galvanometer; and when the funnel is brought so close to the lower vessel as to give only a continuous column, the current is on short circuit and the galvanometer needle undeflected. There is a point, consequently, between these two positions giving a maximum current in the outer circuit, and this is easily found experimentally.

P. HIGGS

THE CAPERCAILZIE IN NORTHUMBERLAND

A SHORT time back an account appeared in a Newcastle paper of the occurrence of the Capercailzie at Lilburn, in the north of Northumberland. Of course it was also stated that the bird had been shot. The account was "descriptive," and the writer evidently thought he was noting a fact worth telling, for he had "reason to believe that this is the first specimen of a wild Capercailzie which has been shot in Northumberland in the memory of man."

Probably the writer's glee was somewhat chilled by the appearance in the same paper of an indignant letter from the Earl of Ravensworth, stating that the bird was reared in his park at Eslington from eggs sent from the Highlands, in the hope of naturalising the species in our country; the bird had strayed from its home.

All naturalists—and especially such as know this noble bird in its northern home—must hope that Lord Ravensworth will not be discouraged by this mishap, nor by others like it, but that he will persevere in his experiment. Eslington Park is situated in the valley of the Aln, near the foot of the Cheviots. Perhaps this is not the best part of the country in which to rear the birds, as, although not devoid of timber, the woodland there is scarcely that most suited to the Capercailzie. Pine woods on rocky ground are probably the best. Not far from Eslington, and partly on the Ravensworth estates, there is a superb piece of woodland and crag. Thrunton Crags, and the adjoining crags of Callaly, are very little known except to those who live near them, for they are out of the usual tourists' routes. But in all the county we do not know a district better worth a visit, nor one which so closely resembles the fir-clad mountain sides of southern Norway. The rocks are craggy sandstones, whilst those of Norway are mostly bosses of schists, and there is none of the water which gives such a charm to Norwegian scenery, but, in spite of these differences, the other resemblances point out this as the Capercailzie's fitting home.

A wide area of high sandstone moorland stretches through Northumberland, attaining a height of over 1,400 feet at Simonside, near Rothbury, and approaching 1,000 feet in other places. This runs to the west of Alnwick, and thence north-west to Chillingham and away towards the Tweed. Another similar district branches from that of Simonside and spreads over a wide area around Harbottle, and between the Coquet and the Reed. Of the first-named range the crags of Thrunton and Callaly form conspicuous features. Only a small part of this range is wooded. It is much to be wished, for the sake of the springs and streams, that plantations were more numerous; and for many reasons, artistic and others, we could wish the same. In such parts of these wild hills as fir plantations occur, the Capercailzie should do well; and, as plantations increase, we might hope that the birds would here find a permanent home. Besides the crags of Thrunton and Callaly we may note, as districts especially well suited to them, the fir woods of Harbottle; parts of the Duke of Northumberland's extensive park at Alnwick; and the wild forest-like park at Chillingham, the home of the far-famed "wild cattle." In years to come, when the plantations increase, Sir W. Armstrong's grounds at Cragside, near Rothbury, will afford the birds a shelter. Here, amidst a profusion of sub-Alpine plants, the Capercailzie should be quite at home. W. TOPLEY

NEWTON ON FORCE

MANY English mathematicians are in the habit not only of using the word "force" in a certain technical sense—briefly, as cause of change of motion—but of regarding all other senses as loose and inaccurate. Of late years there has been an increasing tendency, largely due to Sir W. Thomson and Prof. Tait, to return to the methods of expressing dynamical principles used by Newton; so that at the present time his statement of the laws of motion is adopted to the exclusion of others which had usurped its place. This return to Newton has led to a very prevalent notion that for all the statements of fundamental dynamical principles current in modern English mathematical literature, we have his authority, and in particular for the above-mentioned restriction of the use of the word "force." As the authority of Newton seems to me to be here claimed without warrant, and as Newton's conception of force cannot be without interest, I propose to examine as briefly as possible what this conception was. In doing so I shall assume that the English word "force" is the equivalent of Newton's Latin word *vis*.

Newton commences the Principia with eight definitions, among which are definitions of the intrinsic force of matter (*vis insita* or *vis inertiæ*), impressed force, and centripetal force; he then proceeds to state and explain the laws of motion. From the chapters on the definitions and the laws of motion, we are able to infer with much probability the sense in which the word "force" is used. To show this it will only be necessary to translate a few extracts.

"Def. III.—*The intrinsic force of matter* is its power of resistance, by which every body, as far as depends on itself, persists in its state either of rest or of uniform rectilinear motion."

"Def. IV.—*An impressed force* is an action exerted on a body towards changing its state either of rest or of uniform rectilinear motion."

"Def. V.—*A centripetal force* is one by which bodies are pulled, pushed, or in any way tend from all parts towards any point as a centre."

"Just as in cases of impact and rebound bodies are equipollent whose velocities are reciprocally as their intrinsic forces; so in moving mechanical instruments agents are equipollent, and mutually support each other by their contrary efforts, whose velocities, estimated in the direction of the forces, are reciprocally as the forces." (Scholium to the Laws of Motion.) In the latter part of this quotation the word "forces" is used in the sense of impressed forces as defined by Def. IV.

One more quotation must be made; it is from Newton's comment on Def. III.: "—but a body exerts this force [*vis inertiæ*] only while a change is being made in its state by another force impressed on it."

In the quotation from the Scholium, Newton is considering two cases in which bodies are to be moved; in one the power of resisting the motion arises from the intrinsic force of the body (or its *vis inertiæ*), in the other from the impressed force; in each case he seeks a measure of the effort required to move the bodies. Newton argues that, in the first case, this is to be measured by the intrinsic force and velocity conjointly, and in the second by the impressed force and [virtual] velocity conjointly; implying that, in the first case, to give a body a certain velocity is equivalent to giving a body of twice its intrinsic force half that velocity; and in the second case—to take an example—that to lift a body vertically at a certain rate is equivalent to lifting a body of twice its weight at half the rate.

In this Scholium, in the case both of intrinsic force and of impressed force, the word "force" indicates some power of resistance to change of state; a general power due to the intrinsic force, and a special power due to the impressed force. And throughout it will be found that Newton's use of the word *in its most general sense* indicates a power of resistance, which professed metaphysicians are not alone in attributing to matter as essential to the conception of it. This most general sense of the word does not prevent Newton using it in any one of its special senses, and in particular very frequently for *impressed* force, where no confusion is likely to arise; but his language is very far from sanctioning the dictum that this is the sense and the *only* sense in which the word "force" may be used.

It is painful to reflect that Newton, great as he undoubtedly was, does not seem to have been sufficiently advanced to doubt whether there is such a *thing* as force, nor to have had a proper sense of the heinousness of his conduct in writing of accelerative force, motive force, and —worst of all—centrifugal force. P. T. MAIN

PRINCIPLES OF TIME-MEASURING APPARATUS[1]

IV.

Balance Springs.

THE earliest watches were constructed, so far as the escapement and balance were concerned, upon exactly the same plan as the clock from Dover Castle, and in this condition they must have perpetually remained (useless as time-measurers), but for the invention of the balance-spring (sometimes called the pendulum-spring, on account of the uniformity it imparts) by Dr. Hooke.

This spring bears the same relation to the balance which gravity does to the pendulum. Everybody, I presume, knows the form it usually takes in watches; and in chronometers it is coiled up around an imaginary cylinder. This spring (as in the case of the pendulum) absorbs the energy of the impulse, and when the balance has reached the limit of its swing, redelivers to it all it has received. A watch is regulated by shortening or lengthening the balance-spring, which makes it more or less rigid.

Watches and chronometers vary their time to a much greater extent upon any change of temperature than clocks do. For instance, if we regulate a chronometer without any compensating arrangement, with

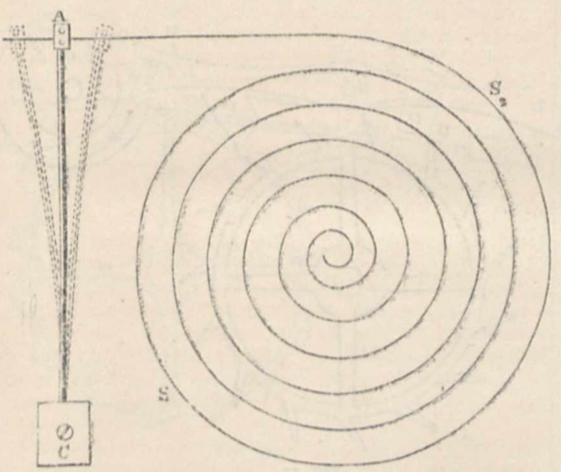


FIG. 19.

a balance-spring of steel, to go right at a temperature of 32 deg., when we raise the temperature to 100 deg. it will lose 6 minutes 25 seconds a day, whereas a clock with an ordinary steel rod pendulum would barely lose 20 seconds for the same change. This great difference is owing to the alteration in elasticity of the balance-spring (the effect really being the same as if, with reference to the pendulum, we could reduce the force of gravity).

Different materials are in this respect differently affected. Whereas a chronometer with a spring of steel will lose 6 minutes 25 seconds a day for 68 deg. rise in temperature, one with a gold spring would lose 8 minutes 4 seconds; a palladium spring would lose 2 minutes 31 seconds; a glass[2] spring would lose 40 seconds. On account of the large amount of compensation required, quite a different plan has to be employed to that made use of in clocks.

Suppose I take two thin strips of brass and steel, and fasten them rigidly together (the best plan is to pour the melted brass upon the steel), what will happen when there is any change of temperature? Imagine the temperature to rise, both expand, but the brass more than the steel, and how it manages this, being rigidly fastened to it, is by bending round the steel into a curve, of which *it* (the brass) is upon the *outside*.

Fig. 19 represents the first form of compensation applied to watches. C A is our compound bar (the steel, shaded black, being nearest the spiral), the extremity of which carries two pins applied to the balance-spring as the ordinary regulator.

When the temperature rises the brass expands and bends round the steel, shortening the balance-spring, and thus compensating for its loss of elasticity due to the rise in temperature. The reverse action takes place when the temperature falls.

The plan adopted now-a-days is the compensation-balance (see Fig. 20). The rims, R_1R_2, are formed of two strips of brass and steel, the brass being upon the outside. When the temperature rises, the brass expands more, and bends in the rims, carrying the weights W towards the axis of motion a sufficient distance to compensate for the loss of time due to the loss of the spring's elasticity.

As you see, the action of the compensation may be readily increased by shifting the weights nearer to the ends of the rims.

Where a chronometer is exposed to very wide ranges of temperature, there is another error (called the secondary

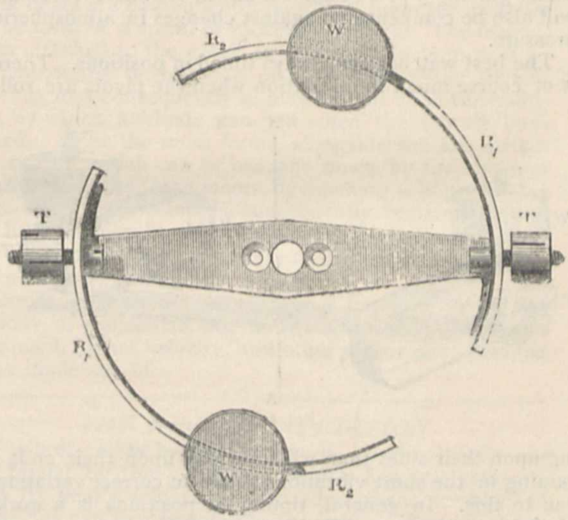


FIG. 20.

error) introduced. If, for example, we take a chronometer with such a balance as just described, and so adjust the compensation-weights that it shall go right at a temperature of 66 deg. and 32 deg., we shall find that when we expose the chronometer to a temperature of 100 deg. it will lose about four seconds a day; and we cannot correct it, for if we advance the compensation-weights along the rims to increase their action in the heat, we shall also increase it in the cold, and then the chronometer will lose in that direction. The best we could do would be so to adjust the weights as to make the chronometer lose two seconds a day in the heat, and two seconds a day in the cold.

The cause of this error is that the time of the swing of a balance depends not directly upon the distance of its weights from the axis of motion, but upon the square of that distance; and it therefore requires a greater amount of motion inwards to produce the same effect as any given motion outwards.

The following is one of the plans adopted for the correction of this error (see Fig. 21):—

F B is a flat bar composed of brass and steel fastened together, the brass being beneath. L L are two loops also formed of brass and steel, the brass being inside. The compensation weights, W W, are mounted upon

[1] Lectures by Mr. H. Dent Gardner, at the Loan Collection, South Kensington. Concluded from vol. xiv. p. 575.

[2] The glass spring was the invention of the late Fredk. Dent.

two rods, R R, fastened upright upon the extremities of the loops.

When the temperature rises, the flat bar bends upwards, and tilts in the loops and the weights at their extremities. But at the same time the loops open a little, and as they are pointed towards the axis of motion, A A, advance the compensation weights a little further in upon their own account. Thus the action of the main bar is increased in the heat. In the cold, the main bar bends downwards, and tilts out the weights, but in this case the loops close, and as they are now pointed away from the axis of motion, by doing so, *bring back* the weights a little. Thus the action of the balance is reduced in the cold. The secondary error is in this manner corrected.

Balance-springs have this very important property, that you are able to isochronise them, that is, so adjust them that the balance shall perform long and short arcs of vibration in the same time. The rule for doing this is simple, though exceedingly difficult of execution upon account of the minuteness of the operation; if the chronometer gains in the short vibrations, you shorten the spring, and if it gains in the long vibrations, you lengthen it. The best plan is to leave it gaining a trifle in the short vibrations, for the reason I pointed out to you when discussing the circular error in pendulums. A chronometer gaining 3 or 4 seconds a day in the short vibrations will also be compensated against changes in atmospheric pressure.

The best watches are always timed in positions. There is of course much more friction when the pivots are roll-

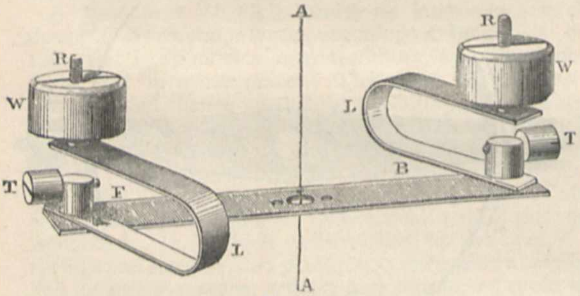


FIG. 21.

ing upon their sides than when turning upon their ends; gaining in the short vibrations tends to correct variation due to this. In general, timing in positions is a work of the very greatest difficulty, and perfect accuracy can only be obtained when the balance-spring weight of the balance and mainspring are in exact adjustment.

A very curious property sometimes exhibited by chronometers is to gain upon their rates, that is to say, if the average daily rate of the chronometer were during the first month 1 second a day fast, during the second it would be 1½ seconds, and during the third month 2 seconds.

This arises from the balance-spring having been left at too high a temper after hardening. On the other hand, if the temper were left too low the chronometer would lose upon its rate. Glass springs exhibit the tendency to gain upon their rates to a remarkable degree.

Watch Escapements.

It would never do to have watch balances vibrating so small an arc as clock pendulums; the least we can do with is 200°, that is, 100 times as much. If you will remember the various clock escapements described, you will see that not one of them is suitable to fulfil such conditions, and something quite different had to be devised.

The form most generally employed is Mudge's detached lever, which is more in favour to-day than it ever was. P P are the pallets (see Fig. 22) mounted along with a lever, L L, upon a spindle, S. During the greater part of the swing of the balance, the lever and pallets are lying against either of the banking pins, B B. There is a notch, N, in the lever and a pin, I, to correspond upon the disc, R, which moves around along with the balance in the direction shown by the arrow. By-and-by the pin upon the disc will catch the notch in the lever and unlock the escape-wheel, a tooth of which is now being held against the dead face, D, of the pallet; the tooth will immediately slide along the slant, and deliver its impulse, which will be transmitted to the balance through the connection of the pin and disc R. The lever whilst resting against either of the banking pins is held in position by a little "draw" upon the dead faces of the pallets, that is, they are slanted back so that the pressure of the wheel teeth thrusts them away from it. There is also a safety disc, O, underneath the unlocking one, and a safety tongue in the lever, which, in the event of the watch getting a shake prevents its falling over to the opposite side of the balance-spindle to that where the unlocking pin is then situated.

People are continually "improving" this escapement, generally by making some slight alteration in the pins, but the broad principle and details always remain the same, as I have described them to you.

Another form of escapement very much used in foreign watches is the horizontal, invented by the same Graham

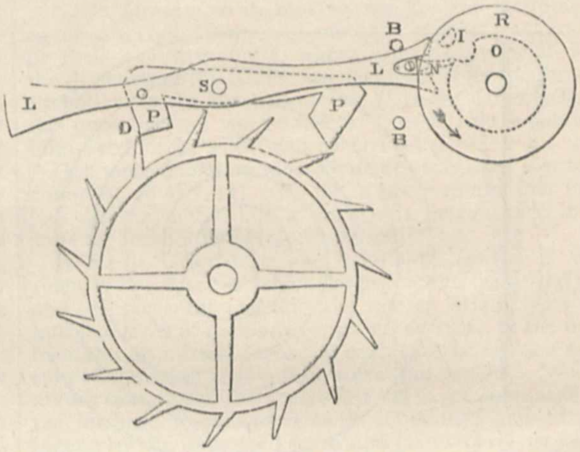


FIG. 22.

already referred to; but as it does not possess qualifications for accurate time measurement, I shall not describe it.

Our last escapement is that universally employed in chronometers (see Fig. 23); its original conception is apparently due to Arnold, though it was modified and greatly improved by Earnshaw. S S is the escape-wheel, which is now being held by the detent, D. R_1 R_2 are two discs, the smaller being situated in the plane of the detent, and the larger in the plane of the escape-wheel; both of them move upon the same spindle with the balance. The balance is now turning in the direction of the arrow; by-and-by the finger, P_2, upon the smaller roller will come round and lift away the detent, and the wheel will be free. The tooth, T, will then drop upon the impulse pallet, P_1, and deliver impulse to the balance. Meanwhile, the finger, P_2, gets clear of the detent, which it allows to fall just in time to receive the succeeding tooth of the escape-wheel.

The balance now passes on to the limit of its excursion, and returns; but in returning the finger does not interfere with the detent for the detent, D, is actually too short to reach it. Just now the finger really unlocked the detent by means of the little spring, Y Y, which is fastened some distance down the detent, the little spring being supported by the horn or extremity of the detent; but when the finger returns, it merely lifts out the spring, as there is upon this side no horn or extremity to support it.

Distribution of Time by Electricity—Chronographs.

To those acquainted with the difficulties in the way of communicating a uniform impulse to the pendulum through the medium of a train of wheel-work, it has, always been a favourite idea directly to maintain the swing of the pendulum by means of an electric current, but, unfortunately, the thing has not hitherto proved feasible; apparently it must be taken for granted that the action of an electric current cannot be *constantly* maintained.

But although electricity is of little service for keeping clocks going, it has been very successfully employed in controlling them. It is, of course, very much more economical to have inferior clocks than good ones, and what is done in this case is to use one good clock for the purpose of controlling a quantity of bad ones. The nature of the apparatus is in general this: our first good clock and all the others are placed in the circuit of a galvanic battery, and what our first good clock does is to close the circuit and transmit a current at every beat of its pendulum. The passage of an electric current around a coil of copper wire (as you no doubt know) converts it for so long as it passes into a magnet, and this current so transmitted by the clock is employed for such a purpose, and the magnets so formed are constructed to operate upon the pendulums of the controlled clocks and accelerate them if they are

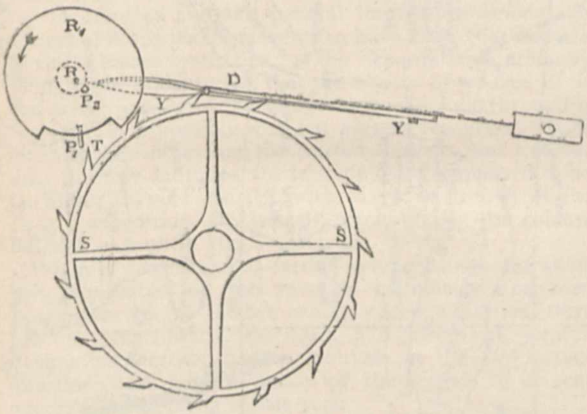


Fig 21

lagging, or resist them if they should be moving too quickly.

Electricity is also employed for the purpose of correcting the time of a clock, say once a day. In this case the clock which is to be corrected is kept at a slight gaining rate. Upon the axis of its escape-wheel is a little finger which revolves with it. At a few seconds before, say 1 o'clock, the controlling clock, by the transmission of a current, brings down an arm in front of the finger and stops the controlled clock for just so many seconds as it is in advance of the controlling clock; at 1 o'clock the arm is raised again, and the controlled and controlling clock start off approximately together.

Such a controlling clock as is used to transmit a current, say once a day, is also employed for the purpose of dropping time-balls and discharging guns. The time-ball itself is generally composed of wicker-work covered with canvas, and is wound up by hand to its position a few minutes before the transmission of the current, and held by a hook or detent. Upon the arrival of the current the detent (by what arrangement it is unnecessary to describe) is withdrawn, and the time-ball falls.

To discharge a time-gun, the current usually passes through a very fine platinum wire, which it makes red-hot. Both with time-balls and guns, and wherever it has heavy work to perform, the current from the clock is employed to close another and much more powerful circuit, the latter being that which operates upon the mechanism.

Instruments employed for the purpose of registering the passage of short intervals of time are called chronographs. These in the main consist of a cylinder covered around with paper revolving at a uniform rate. The rotation of those employed in observatories is generally controlled by what is called a conical pendulum, that is, a pendulum swinging round in the surface of a cone. Such pendulums are much more sensitive to any slight change in the pressure of the clock-train than ordinary oscillating pendulums, and require to be controlled by special apparatus. The pendulum used at Greenwich is so contrived, that when it endeavours to move faster (in doing so, of course swinging out further) it dips little spades into an annular trough of glycerine, and its velocity by this means is checked.

The operation of the apparatus is the following:—A pin upon the pendulum of the normal sidereal clock presses two weak springs together at every vibration, and so transmits a current. This current, by making an electro-magnet, brings down a striker upon the paper of the revolving cylinder. By an arrangement similar to a screw-cutting lathe, the frame carrying this striker just as the cylinder rotates, travels alongside of it, and the clock-beats are consequently indicated upon the cylinder in the form of a spiral of successive pricks. The mechanism attached to the clock is arranged so as to pass no current at the termination of each minute (the sixtieth second), and consequently a blank is left upon the cylinder, by which anybody can tell when the minute happened. Upon the same frame alongside the first striker is a second, which can be brought down by the observer at any one of the instruments, by touching a button at his side. His observation is consequently registered upon the barrel alongside the clock-beat, and you have no difficulty in determining its precise time of occurrence to the tenth or one-hundredth of a second.

Similar instruments are employed for determining the velocity of projectiles, but in these the cylinder travels at a much higher velocity, and other means of controlling it are made use of.

THE ARCTIC EXPEDITION

IT will of course be some time ere all the results obtained by the Expedition which has just returned from its year's sojourn on the edge of the ice-blocked Polar Sea can be presented to the public. Enough, however, is known to lead us to believe that abundant additions of the highest importance to our knowledge of the physics and natural history of the Arctic Regions have been made; and meantime we are able to exhibit in a map the main additions which have been made to Arctic geography.

The *Alert* and *Discovery*, under Captains Nares and Stephenson, left England in May, 1875. Godhavn was left on July 15, and all seems to have gone well till July 30, when, after leaving Port Foulke, the ice was met off Cape Sabine, 78° 41′ N., from which point the ships had a constant struggle with the pack to the north end of Robeson Channel. So close was the ice that on every occasion the water channel by which the ships advanced very soon closed behind them, rendering it as difficult to return as to proceed north. On August 25, after many hairbreadth escapes, a well-sheltered harbour was reached on the west side of Hall's Basin, north of Lady Franklin Sound, in lat. 81° 44′ N. Here the *Discovery* was secured for the winter, a few miles north of Polaris Bay, which was in sight on the opposite side of the channel.

The *Alert*, pushing onward, rounded the north-east point of "Grant Land," but instead of finding a continuous coast-line leading 100 miles further towards the north, as everyone had expected, found herself on the border of what was evidently a very extensive sea, with

Map showing Discoveries of Arctic Expedition.

impenetrable ice on every side. No harbour being obtainable, the ship was secured as far north as possible, inside a sheltering barrier of grounded ice, close to the land, and there she passed the winter; during her stay of eleven months no navigable channel of water permitting further advance to the northward ever presented itself. We believe that had an accident not happened to the screw of the *Alert* she would have endeavoured to push still further north; but the current round the corner of the land was so great she could not make headway. It was fortunate that the accident happened, for had she gone much further she would probably have got so jammed in the frightful ice-masses that it would have been impossible to get her out again. In lieu of finding an "open Polar sea," the ice was of most unusual age and thickness, resembling in a marked degree, both in appearance and formation, low floating icebergs rather than ordinary salt-water ice. It has now been termed the "Sea of Ancient Ice"—the Palæocrystic Sea; and a stranded mass of ice broken away from an ice-floe has been named a floe-berg. Whereas ordinary ice is usually from 2 feet to 10 feet in thickness, that in the Polar Sea, in consequence of having so few outlets by which to escape to the southward in any appreciable quantity, gradually increases in age and thickness until it measures from 80 feet to 120 feet, floating with its surface at the lowest part 15 feet above the water-line. In some places the ice is spoken of as reaching a thickness of from 150 to 200 feet, and the general impression among the officers of the expedition seems to have been that the ice of this "Palæocrystic Sea" is the accumulation of many years, if not of centuries, that the sea is never free of it and never open, and that progress to the Pole through it or over it is impossible with our present resources. It is interesting to note that the Aurora Borealis was not distinct in these latitudes, the latitude being supposed to be too high; this is consistent with the observations of the *Polaris* expedition, Dr. Bessels rarely finding the colours brilliant enough to give a spectrum.

When it was seen that further advance with the ships was impossible, all the energies of officers and men were directed to sledge-work. Sledge-parties were sent out northward, eastward, and westward, depôts having been established at intervals in the two former directions last autumn ready for the parties to be sent out during the spring of this year.

Although the two ships were only seventy miles from each other, it was impossible for any communication to pass between them till last March, when a party from the *Alert* succeeded in reaching the *Discovery* and relieving those on board the latter of any doubt as to the fate of their fellows. Owing to the high latitude of both ships the winter was unusually long and dark, the sun having been absent 142 days, and the cold was more intense than had ever been experienced by any previous expedition. All the old and a few new expedients were resorted to to relieve the unimaginable monotony of such a position, and apparently with great success. The lowest temperature observed was 104° below freezing, Fahr., at least 20° below the minimum observed by the *Polaris* expedition, and the mean temperature for thirteen consecutive days was 91° of frost; the mercury was frozen forty-seven days during the winter.

As soon as the sun appeared in the spring of this year active preparations were made for sledge-exploration, and by the beginning of April each ship was left with only half-a-dozen officers and men whose duties kept them on board. After that date sledges were continually arriving and departing, carrying forward provisions to be placed in depôt, ready for the return of the advanced parties.

Capt. Stephenson, besides looking after his own division, visited the *Alert*, and also made two trips across Hall's Basin to Greenland, and Capt. Nares started off like the rest, with Capt. Feilden, naturalist to the Expedition, immediately all the provision depôts were complete along the line of route, and the safety of the travellers insured. When at Polaris Bay Capt. Stephenson hoisted the American ensign and fired a salute as a brass tablet, which he and Capt. Nares had prepared in England, was fixed on Hall's grave. The plate bore the following inscription:—"Sacred to the memory of Captain C. F. Hall, of the U.S. ship *Polaris*, who sacrificed his life in the advancement of science on November 8, 1871. This tablet has been erected by the British Polar Expedition of 1875, who, following in his footsteps, have profited by his experience."

A party, headed by Commander Markham and Lieut. Parr, made a most gallant and determined attempt to push northwards by means of sledges. They were absent 72 days from the ship; and on May 12 succeeded in planting the British flag in lat. 83° 20′ 26″ N., within about 400 miles of the Pole. From this position there was no appearance of land to the northward, but, curiously enough, the depth of water was found to be only 70 fathoms. Owing to the extraordinary nature of the pressed-up ice, a roadway had to be formed by pickaxes for nearly half the distance travelled before any advance could be safely made, even with light loads; this rendered it always necessary to drag the sledge loads forward by instalments, and therefore to journey over the same road several times. The advance was consequently very slow, and only averaged about 1¼ mile daily—in fact, much the same rate attained by Sir Edward Parry in his somewhat similar attempt during the summer of 1827. Although the distance made good was only seventy-three miles from the ship, 276 miles were travelled over to accomplish it. It is quite impossible for any body of men ever to excel the praiseworthy perseverance displayed by this gallant party in their arduous struggle over the roughest and most monotonous road imaginable. Their journey, considering the ever-recurring difficulties, has eclipsed all former ones.

The result of their severe labour is held to prove the impracticability of travelling over the Polar Sea to any great distance from land, and also that Baron von Wrangell was perfectly correct in his expressed opinion that before the North Pole can be reached it is first necessary to discover a continuous coast line leading towards it.

In addition to the despatch of the northern travellers, the coast line to the westward of the *Alert's* position was traced for a distance of 220 miles by a party under the command of Lieut. Aldrich; the extreme position reached was in lat. 82° 10′ N., long. 86° 30′ W., the coast line being continuous from the *Alert's* winter quarters. The most northern land, Cape Columbia, is in lat. 83° 7′ N., long. 70° 30′ W. The coast of Greenland was explored by travelling parties from the *Discovery*, under the command of Lieutenants Beaumont and Rawson; they succeeded in reaching a position in lat. 82° 18′ N., long. 50° 40′ W., seventy miles north-east of Repulse Harbour. The land extended as far as lat. 82° 54′ N., long. 48° 33′ W., but very misty weather prevented its character being determined with exactness. The coast is much cut up into fjords and land was seen to the north-east, probably reaching to 83°. Lieut. Archer, with a party from the *Discovery*, explored Lady Franklin Sound, proving that it terminates at a distance of sixty-five miles from the mouth, with lofty mountains and glacier-filled valleys to the westward. Lieut. Fulford and Dr. Coppinger explored Petermann Fjord, finding it blocked up with a low glacier, which extends across from shore to shore. With the exception of Hayes Sound the coast line of Smith Sound has now been explored from north to south. President Land, marked in recent maps in about 84° N., is proved to have no existence, though Lieut. Aldrich, when engaged in pioneering the way for the main party, which was led by Commander Markham, advanced three miles beyond Sir Edward Parry's most northern position, and, from a mountain 2,000 feet high, sighted land towards the west-north-west, extending to lat. 83° 7′.

Ancient Eskimo remains were traced on the west side of Smith Sound up to lat. 81° 52′ N. From that position the wanderers had evidently crossed the channel at its narrowest part to Greenland. The most diligent search was made further north, but no trace of them discovered.

Six musk oxen were shot at the *Alert's* winter quarters, and three half way between her position and that of the *Discovery*, while fifty-four were shot near Discovery Bay. The ermine was seen, and owls were found on the Greenland shore opposite the *Discovery's* quarters, the young ones on their appearance being mostly devoured by wolves. The remaining items in the *Alert's* game list at her northern station show seven hares and ninety birds of different kinds, the latter shot only in July. The birds certainly do not migrate beyond Cape Joseph Henry, lat. 82° 50′ N. Very few besides those accounted for by the sportsmen passed the *Alert*. Very few seals were seen north of Cape Union, and no bears, dovekies, or looms, it is stated, ever reach the Polar Sea. Water animals were notably absent, and it is surmised that those that do visit the Arctic Sea come from the south. Among other birds visiting the country, but not advancing beyond the point mentioned, are the knots. Although no nests or eggs were found, the young in all stages of growth were obtained. Amongst the flora described by the parties from the *Alert*, were the saxifrage, sorrel, and dwarf oak, and late in the summer a few poppies were met with.

In the neighbourhood of the *Discovery's* winter quarters a seam of coal of good quality and readily worked, was discovered by Mr. Hart, naturalist; but, unfortunately, not before the present summer, otherwise it might have been of service during the winter, when the allowance of that article on board was necessarily kept as low as possible. Capt. Feilden obtained some fine fossil corals at the extreme northern hills. Very large collections of natural history subjects have been made by the naturalists, assisted by one and all of the officers and crew. The dredge and trawl were used on several occasions with great success. The observations on the physics and meteorology of the Arctic Regions aie likely to prove of the greatest value when published. It will be remembered that during the stay of the *Polaris* in the north, the prevailing wind was from the north-east; during the present expedition scarcely any easterly wind was noticed at all, the prevailing wind, like the prevailing current, coming from the west.

All the *Polaris's* cairns were visited. At the boat depôt in Newman's Bay a box chronometer by Negus, New York, was found to be in perfect order after an exposure of four winters; it has since been keeping excellent time on board of the *Discovery*. Some wheat sent out in the *Polaris* in order to ascertain whether it would deteriorate when exposed to extreme cold, has been grown successfully under a glass shade by Dr. Belgrave Ninnis.

A magnificent series of photographs has been brought home, a selection of which will no doubt be published, and afford some idea of the strange scenery to be seen in these inhospitable regions.

Such is a brief summary of the results obtained by this latest Arctic expedition, but at what expense of hard work and suffering it is difficult for those who read the narrative to realise. The labour which had to be undergone would have been trying enough to perfectly healthy men, but unfortunately the dreaded scourge of Arctic explorers, scurvy, broke out among them. No expedition could have been better provisioned, but in spite of every precaution all the sledge parties suffered most severely. Notwithstanding this, every one worked determinedly and cheerfully. Only three seamen, however, died of scurvy, and only one death was the result of frostbite, that of Niels Christian Petersen, the interpreter of the expedition.

The ice in the Polar Sea remained firm until July 20, when there was a movement, increasing with each tide. On the 31st the *Alert* succeeded in leaving her winter quarters, and, after many struggles with the ice, joined company with the *Discovery* on August 12. Lady Franklin Bay remained closed until the 20th, when, a chance occurring, both ships were pushed into the ice, and succeeded in crossing. After this date the same kind of battle and slow progress took place daily between the ships and the ice, as during the passage north every inch gained being of importance as the ice closed in the rear. As the season advanced, or rather slipped away, many were the fluctuations in the social barometers as hopes and fears rose and fell, for it was not until September 9, the very last of the season, that the mouth of Hayes Sound was crossed, and the expedition again rejoiced in "open water."

The *Alert* reached Valentia on the 27th ult., and both ships arrived at Queenstown on the 29th. On Monday they left for Portsmouth, where they arrived on Wednesday morning. "It goes without saying" that everywhere officers and men have had the heartiest welcome, though no heartier than they deserve.

OUR ASTRONOMICAL COLUMN

μ DORADÛS.—This star, which was called a fifth magnitude by Lacaille at the end of 1751, and a sixth by Brisbane, was observed by Moesta from February, 1860, to January, 1861, of 8·9m. or 9m. only. Perhaps one of our southern readers will put upon record the actual magnitude of this star, the period of which, as Moesta remarked, would appear to be one of considerable length. Position for 1877·0 in R.A. 5h. 5m. 52s., N.P.D., 151° 58′.

SOUTHERN DOUBLE-STARS.—(1) α Centauri.—Measures of the angle of position and distance of this star, taken in the course of the ensuing year or two, will materially contribute towards defining within narrow limits the elements of the orbit. Even in Powell's last orbit, which was founded upon measures to January, 1870, the peri-astron passage (1874·2) is certainly too early, though each successive calculation of elements from Jacob's first has assigned a later date; it probably occurred in 1875.

(2) p Eridani also deserves close attention from the astrometer in the other hemisphere. There must be a great change in angle since the epoch of the last-published measures. The position (1877·0) is in R.A. 1h. 35m. 7s., N.P.D. 146° 49′.

THE INTRA-MERCURIAL PLANET QUESTION.—If in the general formula obtained by M. Leverrier, and given in last week's NATURE, we put $k = -1$, the solution, which gives for the sidereal period as referred to the node 27·964 days semi-axis major 0·180, and synodical period 30·282 days, accords with Stark's observation on October 9, 1819, one of the most definite upon record, besides representing, as well as the solution with $k = 0$, the five data upon which M. Leverrier has relied in deducing the formula. In this case we have—

$$v = 285°·76 + 12°·873724j - 10°·8 \cos v.$$

Stark's observation was published in his "Meteorologisches Jahrbuch," 1820. Under date, October 9, 1819, he says:—"At the same time there appeared, at a distance of 12′ 28″ from the southern limb of the sun, and 4′ 58″ from the eastern limb, a black, well-defined nuclear spot, which was perfectly round and of the size of Mercury. At 4h. 37m. this nuclear spot was no longer present, and I found also later on the 9th, as well as on the 12th, when the sun next came out, no trace of this spot." The observation was probably made about noon at Augsburg, which was one of Stark's usual hours for examining the sun's disk—corresponding to October 8, at 23h. 16m. Greenwich time. For this time the above formula gives $v = 16°·9$, and the earth's heliocentric longitude being 15°·3, the inferior conjunction of the assumed intra-Mercurial body with the sun would have occurred on the morning of Stark's observation.

THE FOURTH COMET OF 1857.—The best determined period of revolution of a comet, exceeding in length the period of the comet which appears to be associated with the August stream of meteors, is that of the fourth comet of 1857, discovered by Prof. C. H. F. Peters at Albany, U.S., on July 18, by Dien, at Paris, on the 27th, and by Habicht at Gotha, and Donati at Florence on the 30th of the same month. It was observed with the great refractor at the observatory of Harvard College till October 21. These dates include an interval of from about one month before to two months after the perihelion passage, or an arc on the orbit of 145°. A very complete discussion of the observations was made by Dr. Axel Möller, whose masterly investigations relating to the motion of Faye's comet have led to such accurate prediction of its apparent track in the heavens at recent returns; the period he assigns is 234·7 years. A similarly rigorous calculation led Dr. Hans Lind to a revolution of 243·05 years, and there are ellipses of nearly the same length of period by other computers.

If we examine the path of this comet through the planetary system we soon discover that it passes near to the orbit of Venus. Employing the elements of Axel Möller, a strict calculation shows that in heliocentric ecliptical longitude 24° 54′, the distance between the two orbits is less than 0·023 of the earth's mean distance from the sun. It may therefore be reasonably concluded that it is to an actual near approach of the comet to Venus about this point that the present form of orbit is due. The comet's perihelion distance is 0·747, the aphelion distance 75·35.

BIOLOGICAL NOTES

POCK-LYMPH.—The efficacy of pock-lymph has been attributed by several observers to the presence of small organisms of the nature of Micococcus. M. Hiller has recently studied this subject (*Centralblatt für d. Med. Wiss.*), and from 6,840 separate inoculations, he finds that the degree of activity of the lymph and the proportion of micrococci present do not correspond; on the one hand, the development of the organisms was often at its greatest when the action of the lymph was falling off, and on the other, lymph was often active, though no bacteria were perceptible in it. Fresh diluted lymph having been put in vertical tubes in a freezing mixture, and slowly thawed after freezing, the upper half gave on inoculation, 41·4 per cent. positive results, the lower half, 63·8 per cent. It appears from this that the poison is associated with the solid constituents more than with the liquid. Boiled lymph was, without exception, inoperative. The addition of 1 to 4½ per cent. carbolic acid merely weakened the contagiousness of pock-lymph, while addition of glycerine left it unaltered. Strong dilutions weakened the action, while condensations exalted it; with evaporation, the percentage of favourable cases was increased about a half. In coagulated parts produced in the lymph, the active element was present in great quantity. Perfectly dried lymph is also active in high degree; hence we may infer that the communication of pox may occur by means of the crust and scurf of pustules which are rubbed off and float in the air. Inoculation with the blood of persons that were successfully inoculated proved inoperative; so also were the fresh contents of the bladders, seven days after inoculation. It is inferred that the cow-pox ferment is not contained in the blood, or not in the active state; and that very probably, also, the blood is not itself the seat of fermentation and reproduction of the poison.

ALGOID SWARM-SPORES.—If vessels of water containing algæ are placed in a room where they are lighted only on one side, swarm-spores are generally found to collect at the side turned towards the window, more rarely on the opposite side. If they are present in considerable number, they often become arranged in peculiar cloudy forms; network, rays, tree-like branched figures, &c. The phenomenon has been frequently studied, and has been always regarded as an action of light, causing the living swarm-spores to move towards it or withdraw from it. After a long investigation of the phenomena, M. Sachs has come to a different conclusion. He considers that these groupings of zoospores are not phenomena of life, inasmuch as quite a similar process is found to occur with emulsions of oil in alcohol diluted with water; also that the light either does not at all participate in the action, or does so only indirectly, for all the phenomena may be reproduced in darkness. The accumulation of spores and the cloud-like figures are rather due to currents produced by differences of temperature in the water. M. Sachs's experiments are described in *Flora*, 1876, No. 16.

DISEASES GERMINATED IN HOSPITALS.—Several observers have remarked on the presence of globules of pus and microscopic algæ in the air and on the walls of hospitals. Some interesting facts of this order have recently been communicated to the French Société de Biologie, by M. Nepveu of the laboratory of La Pitié. A square metre of the wall of a surgery-ward, having been washed, after two years without washing, the liquid pressed from the sponge (about 30 gr.) was examined immediately after. It was somewhat dark throughout and contained micrococcus in very great quantity (fifty to sixty in the field of the microscope), some micro-bacteria, a small number of epithelial cells, a few globules of pus, some red globules, and lastly a few irregular dark masses and ovoid bodies of unknown nature. The experiment was made with all necessary precautions; the sponge employed was new, and carefully washed in water that was newly distilled. Facts like those referred to make it easy to comprehend how the germs of a large number of diseases occur in the air of hospitals, and how the latter may readily become centres of infection. The same conditions, though in less degree, may sometimes be met with in private life.

MARINE MOSSES.—M. Gisard lately showed to an audience at the Congress of learned societies at the Sorbonne, specimens of marine mosses growing on a madrepore placed in an aquarium, since January, 1872. They produce every year, in spring, phenomena of fructification, consisting of urns of a superb nacreous colour, growing at the ends of beautiful green filaments, then becoming detached and rising to the surface of the water. He cited the following fact as showing the vitality of certain marine plants. On May 13, 1875, a parcel of algæ which had been taken from an aquarium and dried several months in the sun, was placed in sea-water, and developed a magnificent green plant of ribbon form. In February and March, 1876, there were formed on the border of the ribbon sparse filaments carrying rounded urns of variegated colour, which became detached, and rose to the surface, giving rise to green plants.

NOTES FROM ST. PETERSBURG.—At the last meeting, October 18, of the Zoological Section of the St. Petersburg Society of Naturalists, Prof. Wagner gave some information as to his recent researches made in the Solovetsky Bay of the White Sea. The special aim of them was to throw some light on the causes which determine the use in certain organisms, as for instance the hydroids, of two different modes of reproduction, sometimes by gemmation, and sometimes with the help of special organs. Without coming to any decided conclusions (the researches having to be continued) M. Wagner pointed out, as one possible cause of this difference, the influence of different nutrition which generally so greatly influences the reproductive functions. M.

Cherniaffsky, who has been many years engaged in the study of the fauna of the Black Sea, and now studies especially the influence of the media on organic forms, reported upon his numerous collections of animals from various depths, and traced in them the slow variations which animals of the same species undergo at different depths, and the appearance of new species with the increase of depth; the labours of M. Cherniaffsky promise to be of great interest when published in full.

COLOURS OF ANIMALS.—At the last meeting of the St. Petersburg Entomologists' Society, October 16, M. Porchinsky reported upon some results on the exploration of a scientific party engaged last summer upon the exploration of the Caucasus. The southern limit of the region explored was the Steppe of Erivan, a plain covered with sand, with some patches of variously coloured clays appearing in the low hills. A remarkable feature of the animal inhabitants of the Steppe, insects and reptiles, and especially of the lizards, is the most perfect coincidence of their colouring with the colouring of the Steppe. The same thing was observed also in the Steppe of Elizabethpol. Interesting collections of the fauna made by the party were produced at the meeting.

NOTES

DR. CARL JELINEK, the eminent and accomplished meteorologist, died at Vienna on October 19, after a protracted illness.

THE death is announced, on the 16th ult., of Dr. von Waltershausen, Professsor of Mineralogy and Geology at Göttingen, where he was born in 1809. While young he travelled much, especially in Sicily and Iceland, making large mineralogical collections, which he presented to the university. He is specially known for his researches in connection with volcanic phenomena. During his later years he was engaged in a large work on the topography and orography of Etna.

PROF. H. J. S. SMITH's valedictory address to the London Mathematical Society, on the 9th inst., will touch upon various points affecting the present state and prospects of pure mathematics.

THE popular German poet and mineralogist, Prof. von Kobell, has just celebrated, in Munich, the fiftieth anniversary of the day on which he was appointed extraordinary professor of mineralogy in that city.

DR. RÖNTGEN has been appointed extraordinary Professor of Physics in Strasburg University.

DR. CARPENTER, F.R.S., Secretary to the Gilchrist trust, has, for the special benefit of the Primary Teachers of the Metropolis, arranged for a course of lectures to be given by Dr. Richardson, F.R.S., at St. Thomas Charterhouse Schools, on Human Physiology, and its application to daily life. The course will be opened on Friday, November 3, by Dr. Carpenter, delivering an address on a Sound Mind in a Sound Body.

WILLIAM CLARKE MILLER, B.A. Lond., vice-principal of Huddersfield College, has been elected Registrar of the General Medical Council of Education in the place of Dr. Erasmus Hawkins, resigned. The new Registrar has been long known as an able mathematician.

IT is stated by the *Medical Press and Circular* that the Goldsmith's Company has voted a sum of 1,000*l.* to the Chemical Society to aid in the formation of the fund to be devoted to the promotion of original research in the science of chemistry.

M. WADDINGTON, the intelligent Minister of Public Instruction in France, has come to a most liberal decision on behalf of the Paris Observatory. According to the standing financial rules used in France, no adjudicator of works executed in the public interest is entitled to be paid except when his task has been completed and received. As an exception, M. Leverrier is authorised to pay in advance to the opticians and philosophical instrument makers a sum amounting to one-third of the total value.

THE Bischofsheim transit instrument, which has been so long delayed by the red-tapeism of the Finance Department, is almost finished, and observations will very shortly be inaugurated in the new pavillion which has been built on an improved scheme for its reception.

M. FEIL, the glass-worker of Paris, has just finished the casting of the crown-glass lens for the great Vienna refractor. The diameter is 28 inches and the weight 112 pounds. It will be sent immediately to Mr. Howard Grubb, of Dublin, who already possesses the flint lens.

THE course of lectures at the Sorbonne for candidates for the *licence* and pupils of the Normal Schools was opened a few days since. In former years the lecturers were confined to merely elementary subjects relating to mechanics, classics, astronomy, differential and integral calculus. But this year M. Bonnet lectures on the recent discoveries in high geometry, and M. Puiseux on a subject which has been largely discussed by men of science in England, the figure that the earth must have taken owing to its fluidity.

WITH exception of the schools of Paris, which rank among the first in the world, most of the faculties of sciences and *lettres* in France (says M. Grad in *La Nature*) have only five professors. Now there were a hundred and thirty-five at the University of Berlin, seventy at the University of Königsberg, against three hundred and forty-eight in all the faculties of the fifteen academical divisions of France in 1870. The faculty of sciences and that of *lettres* of Strasburg, more favoured than others, had then thirteen professors, against thirty-six in the faculty of philosophy and sciences of the present University. The University at present has a total of eighty professors distributed among the five faculties of theology, law, medicine, philosophy, and natural and mathematical sciences. This year Prussia devotes to the maintenance of its nine universities 6,577,397 marks, of which 4,820,841 marks are furnished from the State Treasury. With regard to population, the expenditure per head of inhabitants is 0·70 fr. in Alsace-Lorraine, 0·12 fr. in France, 0·33 fr. in Prussia.

A COMMITTEE appointed by the Russian Government at the St. Petersburg Medical Academy to investigate various proposed antiseptics and disinfectants, have arrived at the following conclusions:—1. Carbolic acid is the most efficient means against the development of ammoniacal gas, putrescence, and development of lower organisms in organic matter under decomposition, and it is therefore the best antiseptic. 2. Vitriol, salts of zinc, and charcoal, are the best means for deodorising matter under putrefaction. 3. The powders of Prof. Kittary, besides the properties they share in common with other carbolic disinfectants, deserve attention because of the isolated state of phenol in them and their contents of quick-lime, which absorbs moisture—the principal condition of each kind of putrefaction—as also some part of the gases. 6. Chloride of lime and permanganate of potash quickly destroys the lower organisms in putrid liquids. 7. The disinfectants certainly retard the putrid processes in organic bodies, but their influence is only temporary, as a means of purifying air in dwellings their influence is very small if not totally *nil*, because of the very small degree of concentration of their ingredients that can be used without injuring the health of inhabitants. 9. For uninhabited buildings the best disinfectants are nitrous acid and chlorine.

REFERRING to our recent correspondence on "Antedated Books," a correspondent calls attention to another evil practice that has of late years crept into the publishing trade, namely, that of publishing books without any date at all. Our correspondent mentions two firms that sin extensively in this respect; but there are several others, especially in what is known as the "number trade," who of *malice prepense* publish undated books. Such books are generally of small literary or scientific value, but circulate among a class who are generally unable to test their value. Of course the purpose of issuing undated books is evident; works half a century old may be palmed off on the unknowing as the genuine product of the current year.

WE understand that Dr. A. Wojeikoff, of St. Petersburg, has arrived at Singapore from Batavia on his way to Japan, on what may be truly characterised as a meteorological tour, at his own expense, over the whole civilised world. The tour was begun upwards of seven years ago, when the greater part of Europe was visited, and after a return to and brief residence in Russia, was again resumed through the United States, extending as far as Manitoba, and thence southwards through South America, and onwards to the East India Islands. Those who have had the pleasure of meeting him know that this tour means a large amount of meteorological work, in the prosecution of which he has made prolonged sojourns in different regions with the view of familiarising himself practically with their meteorology and with the steps which have been taken towards its investigation. The training which this able meteorologist is giving himself well deserves our warmest commendation.

AS being somewhat analogous to the above, it may be notified that Dr. Hamberg, meteorological assistant to Prof. H. Hildebrandsson, of Upsal University, is at present engaged on a year's tour through Europe for the purpose of familiarising himself with the systems of meteorological research pursued in different countries, funds for the purpose having been provided by the Upsal University. This is real professional education, and deserves to be carried out more extensively and in a more Catholic spirit than has yet been done by our British Universities.

WE have received from Prof. Dove the *Monatliche Mittel für Druck, Temperatur, Feuchtigkeit, und Niederschläge und fünftägige Wärmemittel* for 1875. In addition to the usual meteorological results, this admirable annual serial gives the five-day means of temperature for the year and their departure from the means of the twenty years ending 1867, and the same for ten Austrian, thirteen Swiss, and twenty-four Italian stations, thus presenting in a clear manner the temperature conditions of Germany, and their relations to those of immediately surrounding regions during 1875. The results of the observations made at the Forest-stations of Bavaria and additional rain returns are also given, together with a most valuable *résumé* of the monthly amounts of rainfall observed at all stations in Germany during the past five years, and monthly and annual averages of rainfall calculated from all the past observations at each place as are available. The latitude, longitude, and height of the Austrian, Swiss, and Italian stations are stated, and we very earnestly hope that, with next issue, Prof. Dove will be able to give the data for his stations in Germany, the want of which is felt to be a serious omission in nearly all discussions of German meteorology.

IN a paper in this month's Petermann's *Mittheilungen* Prof. H. Fritz treats of the Geographical Distribution of Hail. He refers to our comparative ignorance of the origin and peculiarities of the appearance of hail, of the want of long series of observations on the subject, and in those that do exist of the frequent confounding of hail and graupel—the balls of true hail having an icy structure, whereas the balls of graupel are only small pellets of snow. The latter he shows falls in all latitudes and at all heights; while hail is mainly confined to middle latitudes. In high latitudes and in tropical valleys, hail is a rare phenomenon. Prof. Fritz brings together for comparison observations on the subject made in various quarters of the globe, the statistics being, as might be expected, fullest in the case of Europe. The following are some of his conclusions from these data:—He infers that hail occurs whenever the moisture of the atmosphere is precipitated in very great quantity as rain or snow, and that hail phenomena correspond to the amount of this excess of precipitation. With increase in latitude and in height the fall of graupel increases and that of hail decreases, while hailstones of large size are most frequent towards the equator. But since in the low lands of the tropics hail is little known, the regions of the most frequent and especially most destructive hailstorms belong to the middle latitudes, while in high and low latitudes hail-falls of large stones are exceptional. It appears then that no region in which an excessive rainfall occurs is secure against hailstorms, if only the height of fall is sufficient to allow of the formation of hail. In high latitudes and in high table-lands the vertical distances to the atmospheric strata with temperature below zero are small, and therefore more snow and graupel will fall than hail, while in middle and low latitudes this distance, especially in summer, is great enough to allow of the formation of large hailstones. North and south of the zone of calms the hail-fall becomes more frequent and reaches its maximum between 40° and 60° of latitude. The currents of the atmosphere and the formation of the land-masses have also an influence on the distribution of hail. A satisfactory solution of the hail question can, however, only be obtained by complete series of observations, the details for each station being given separately, and the distinction between true hail and graupel being attended to.

THE German Society for Arctic Exploration (Bremen) has just heard from Drs. Finsch and Brehm. They speak of the most difficult part of their journey from the Ob to the Kara Sea through a hitherto quite unknown region, which they performed partly in boat, partly by reindeer, and partly on foot, over the Tundras. The knowledge obtained by the expedition in this region is an important contribution to the geography of West Siberia. The collections with reference to the ethnology of the Samoyeds and Ostiaks are especially valuable, as also the specimens of birds and fishes. The travellers expected to be home by the beginning of this month.

PROF. JAMES ORTON, of Vassar College, U.S., has nearly completed his preparations for the exploration of the river Beni, a little known tributary of the Madeira River, the largest affluent of the Amazon. Prof. Orton sums up the special objects of the survey as follows: 1. To solve some of the most interesting and important geographical problems of the day. 2. To search for the traces of the ancient military roads, probably built by the Inca Yupanqui when he invaded that region. 3. To open up the trade of the eastern slope of the Andes with the United States. In Prof. Orton's opinion, the search for the source of the Nile, while of not greater interest than that of the Beni, is of very much less commercial value.

IN a paper on "The Climate Controversy," published in the two last numbers of the *Geological Magazine*, Mr. Searles V. Wood, jun., discusses the possible cause of the latest changes of climate experienced by the earth. The aim of Mr. Wood is less to advocate some special solution of the question than to insist on the difficulties which beset all the theories hitherto offered as a solution, and which are (1) a decrease in the original heat of our planet; (2) changes in the obliquity of the ecliptic; (3) the combined effect of the precession of the equinoxes and of the excentricity of the earth's orbit; (4) changes in distribution of land and water; (5) changes in the position of the earth's axis; (6) a variation in the amount of heat radiated by the sun; and (7) various temperatures of those regions of space through which the solar system has moved. Discussing each of them, Mr. Wood deals at greater length with the theory advocated by Mr. Croll, arriving at the conclusion that, although the influence of geographical conditions and currents is a powerful agent in modifying climate, nevertheless the cause of the Glacial period must have been a cosmical one; that the cold of this period seems to have fallen upon the earth while its axis was in its present position; and that nothing has yet been found to raise a doubt as to the glaciation of the northern and southern hemispheres having been synchronous. Mr. Wood inclines to admit that it is to the sixth suggested cause, a diminution in the heat emitted by the sun, that the probabilities incline. The discussion of the geological facts connected with the latest changes of climate is the main attraction of the paper of Mr. Wood.

CAPT. ALLEN YOUNG's Arctic ship *Pandora* is back again, all well. It will be remembered Capt. Young went out to endeavour to communicate with the Arctic expedition, which he met on its road home.

TWO shocks of earthquake were felt at Irkutsk and its neighbourhood, on August 31 at 10 P.M., and on September 4 at 1.30 A.M. Both extended over a large region, and the last was rather strong at Irkutsk.

TWO earthquakes are reported as having occurred in Germany on October 14, the one near Kehl at 11 A.M., and the other at Schopfheim between 8.30 and 9 P.M. The former extended over Strasburg, Kehl, Kork, Auerheim, Zierolshofen, Leutesheim, Linz, Diersheim, Rhein-Bischofsheim; the direction was apparently in a south-west-north-east direction. There were three or four shocks lasting about four seconds. The other earthquake was to the north of Schopfheim, at Neuenweg and Gresgen, and was of shorter duration than the former; the direction was apparently north-south.

THE African explorer, Eduard Mohr, writes to Dr. Nachtigal, under date August 28, of his arrival at St. Paul de Loanda. Within eight days he was to proceed to Malange, on the eastern limit of Angola, which he was to make his base of operations for an exploring journey to the northern interior.

IN the Geological Section of the Helvetic Society of Sciences, besides many interesting smaller communications, the following larger contributions to geological science were made:—The results of a thorough exploration of the earlier geological history of the Black Forest and of the Vosges, by Prof. Sandberger; the results of explorations in the Argovian Jura, by Prof. Muhlberg; the results of explorations by M. Mœsch in the Bernese Alps, accompanied by a map of the mass of the Faulhorn and of its neighbourhood; a map on the scale of 1:250,000 of the glacial deposits of Switzerland, with full particulars as to the former extension of glaciers, their depths, slopes, &c., made by Prof. Favre; and a very detailed map, on a scale of 1:5,000, of the glacier of the Rhone, with all its moraines, moulins, crevices, &c., constructed by M. Gosset, at the charge of the Swiss Alpine Club.

AT the same meeting Prof. Sandberger presented his work "Land- und Süsswasser-Conchylien der Vorwelt." The terrestrial and fresh-water molluscs are described here in these geological succession, beginning from the oldest formations. Being very abundant in the Tertiary deposits, they have, as is known, much contributed to settle the classification of these deposits.

AT the *conversazione* of the Chester Society of Natural Science held last month, Mr. Cross exhibited some specimens of *Drosera rotundifolia* which had been grown in Mr. Siddall's fern case, and which presented characters differing greatly from those of the typical plant. The axis had elongated considerably and bore a number of alternate leaves, quite green, with aborted tentacles, and several of them showing buds produced on the mid-rib. Some of the old leaves of the original plants placed in the case for preservation also exhibited the phenomenon last named.

WE have received from Dr. C. A. MacMunn an account of the method he proposes for measuring and comparing different spectra with the spectrum microscope. In order to overcome the difficulties due to the difference in the dispersion of different prisms, he proposes to look upon the distance between the Fraunhofer lines B and E as equal to 100, and to express the position of all bands in relation to this scale. We, however, think that it is very desirable not to multiply the already too numerous arbitrary scales of this kind, and would strongly advise him and all others who are studying this subject, to express their results in terms of wave lengths, since, as Mr. Sorby has argued, that system alone has a true physical basis.

THE Bethnal Green Museum is becoming just now a great centre of attraction to the multitudes from the numerous interesting collections illustrative of art and science now deposited together. The former speak to the eye for themselves, although the Secretary of the Department has taken care to provide admirable historical and descriptive cheap catalogues. But the scientific and industrial collections require more carefully prepared aids for study, and these are now being furnished by the Department in illustrated manuals, published at a cheap price, written by eminent authors, and on these no expense has been spared to make them thoroughly practical and useful treatises upon the subjects on which they treat. Messrs. Chapman and Hall, we are informed will publish immediately for the Council of Education and Department of Science, three of these works—"Food, its Chemical Constituents and Uses," by Mr. A. W. Chunt, F.C.S., Professor at the Royal Agricultural College, Cirencester; "Economic Entomology," by Mr. Andrew Murray, F.L.S., and "Animal Products, their Preparation, Commerce, and Uses," by Mr. P. L. Simmonds.

THE additions to the Zoological Society's Gardens during the past week include a Cape Hyrax (*Hyrax capensis*) from South Africa, presented by Mr. J. M. Thornton; an Ocelot (*Felis pardalis*) from Honduras, presented by Mr. H. Fielding; two Norwegian Lemmings (*Lemmus norvegicus*) from Norway, presented by Mr. W. Duppa Crotch; a Common Hangnest (*Icterus vulgaris*) from South America, presented by Mr. J. T. Levett; an African Cobra (*Naia haje*) from South Africa, presented by the Rev. G. H. R. Fisk; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, deposited; two Indian Cobras (*Naia tripudians*) from India, received in exchange; a Merlin (*Hypotriorchis æsalon*), European, purchased.

SEXUAL SELECTION IN RELATION TO MONKEYS

IN the discussion on Sexual Selection in my "Descent of Man," no case interested and perplexed me so much as the brightly-coloured hinder ends and adjoining parts of certain monkeys. As these parts are more brightly coloured in one sex than the other, and as they become more brilliant during the season of love, I concluded that the colours had been gained as a sexual attraction. I was well aware that I thus laid myself open to ridicule; though in fact it is not more surprising that a monkey should display his bright-red hinder end than that a peacock should display his magnificent tail. I had, however, at that time no evidence of monkeys exhibiting this part of their bodies during their courtship; and such display in the case of birds affords the best evidence that the ornaments of the males are of service to them by attracting or exciting the females. I have lately read an article by Joh. von Fischer, of Gotha, published in *Der Zoologische Garten*, April, 1876, on the expression of monkeys under various emotions, which is well worthy of study by any one interested in the subject, and which shows that the author is a careful and acute observer. In this article there is an account of the behaviour of a young male mandrill when he first beheld himself in a looking-glass, and it is added, that after a time he turned round and presented his red hinder end to the glass. Accordingly I wrote to Herr J. von Fischer to ask what he supposed was the meaning of this strange action, and he has sent me two long letters full of new and curious details, which will, I hope, be hereafter published. He says that he was himself at first perplexed by the above action, and was thus led carefully to observe several individuals of various other species of monkeys, which he has long kept in his house. He finds that not only the mandrill (*Cynocephalus mormon*) but the drill (*C. leucophæus*) and three other kinds of baboons (*C. hamadryas*, *sphinx*, and *babouin*), also *Cynopithecus niger*, and *Macacus rhesus* and *nemestrinus*, turn this part of their bodies, which in all these species is more or less brightly coloured, to him when they are pleased, and to other persons as a sort of greeting. He took pains to cure a *Macacus rhesus*, which he had kept for five years, of this indecorous habit, and at last succeeded. These monkeys are particularly apt to act in this manner, grinning at the same time, when first introduced to a new monkey, but often also to their old monkey friends; and after this mutual display they begin to play together. The young mandrill ceased spontaneously after a time to act in this manner towards his master, von Fischer, but continued to do so towards persons who were strangers and to new monkeys. A young *Cynopithecus niger* never acted, excepting on one occasion, in this way towards his master, but frequently towards strangers, and continues to do so up to the present time. From these facts von Fischer concludes that the monkeys which behaved in this manner before a looking-glass (viz., the mandrill, drill, *Cynopithecus niger*, *Macacus rhesus*, and *nemestrinus*) acted as if their reflection were a new acquaintance. The mandrill and drill, which have their hinder ends especially ornamented, display it even whilst quite young, more frequently and more ostentatiously than do the other kinds. Next in order comes *Cynocephalus hamadryas*, whilst the other species act in this manner seldomer. The individuals, however, of the same species, vary in this respect, and some which were very shy never displayed their hinder ends. It deserves especial attention that von Fischer has never seen any species purposely exhibit the hinder part of its body, if not at all coloured. This remark applies to many individuals of *Macacus cynomolgus* and *Cercocebus radiatus* (which is closely allied to *M. rhesus*), to three species of Cercopithecus and several American monkeys. The habit of turning the hinder ends as a greeting to an old friend or new acquaintance, which seems to us so odd, is not really more so than the habits of many savages, for instance that of rubbing their bellies with their hands, or rubbing noses together. The habit with the mandrill and drill seems to be instinctive or inherited, as it was followed by very young animals; but it is modified or guided, like so many other instincts, by observation, for von Fischer says that they take pains to make their display fully, and if made before two observers, they turn to him who seems to pay the most attention.

With respect to the origin of the habit, von Fischer remarks that his monkeys like to have their naked hinder ends patted or stroked, and that they then grunt with pleasure. They often also turn this part of their bodies to other monkeys to have bits of dirt picked off, and so no doubt it would be with respect to thorns. But the habit with adult animals is connected to a certain extent with sexual feelings, for von Fischer watched through a glass door a female *Cynopithecus niger*, and she during several days, "umdrehte und dem Männchen mit gurgelnden Tönen die stark geröthete Sitzfläche zeigte, was ich früher nie an diesem Thier bemerkt hatte. Beim Anblick dieses Gegenstandes erregte sich das Männchen sichtlich, denn es polterte heftig an den Stäben, ebenfalls gurgelnde Laute ausstossend." As all the monkeys which have the hinder parts of their bodies more or less bright coloured live, according to von Fischer, in open rocky places, he thinks that these colours serve to render one sex conspicuous at a distance to the other; but as monkeys are such gregarious animals, I should have thought that there was no need for the sexes to recognise each other at a distance. It seems to me more probable that the bright colours, whether on the face or hinder end, or, as in the mandrill, on both, serve as a sexual ornament and attraction. Anyhow, as we now know that monkeys have the habit of turning their hinder ends towards other monkeys, it ceases to be at all surprising that it should have been this part of their bodies which has been more or less decorated. The fact that it is only the monkeys thus characterised which, as far as at present known, act in this manner as a greeting towards other monkeys, renders it doubtful whether the habit was first acquired from some independent cause, and that afterwards the parts in question were coloured as a sexual ornament; or whether the colouring and the habit of turning round were first acquired through variation and sexual selection, and that afterwards the habit was retained as a sign of pleasure or as a greeting, through the principle of inherited association. This principle apparently comes into play on many occasions: thus it is generally admitted that the songs of birds serve mainly as an attraction during the season of love, and that the *leks*, or great congregations of the black grouse, are connected with their courtship; but the habit of singing has been retained by some birds when they feel happy, for instance by the common robin, and the habit of congregating has been retained by the black grouse, during other seasons of the year.

I beg leave to refer to one other point in relation to sexual selection. It has been objected that this form of selection, as far as the ornaments of the males are concerned, implies that all the females within the same district must possess and exercise exactly the same taste. It should, however, be observed in the first place, that although the range of variation of a species may be very large, it is by no means indefinite. I have elsewhere given a good instance of this fact in the pigeon, of which there are at least a hundred varieties differing widely in their colours, and at least a score of varieties of the fowl differing in the same manner; but the range of colour in these two species is extremely distinct. Therefore the females of natural species cannot have an unlimited scope for their taste. In the second place, I presume that no supporter of the principle of sexual selection believes that the females select particular points of beauty in the males; they are merely excited or attracted in a greater degree by one male than by another, and this seems often to depend, especially with birds, on brilliant colouring. Even man, excepting perhaps an artist, does not analyse the slight differences in the features of the woman whom he may admire, on which her beauty depends. The male mandrill has not only the hinder end of his body, but his face gorgeously coloured and marked with oblique ridges, a yellow beard, and other ornaments. We may infer from what we see of the variation of animals under domestication, that the above several ornaments of the mandrill were gradually acquired by one individual varying a little in one way, and another individual in another way. The males which were the handsomest or the most attractive in any manner to the females would pair oftenest, and would leave rather more offspring than other males. The offspring of the former, although variously intercrossed, would either inherit the peculiarities of their fathers, or transmit an increased tendency to vary in the same manner. Consequently the whole body of males inhabiting the same country, would tend from the effects of constant intercrossing to become modified almost uniformly, but sometimes a little more in one character and sometimes in another, though at an extremely slow rate; all ultimately being thus rendered more attractive to the females. The process is like that which I have called unconscious selection by man, and of which I have given several instances. In one country the inhabitants value a fleet or light dog or horse, and in another country a heavier and more powerful one; in neither country is there any selection of the individual animals with lighter or stronger bodies and limbs; nevertheless after a considerable lapse of time the individuals are found to have been modified in the desired manner almost uniformly, though differently in each country. In two absolutely distinct countries inhabited by the same species, the individuals of which can never during long ages have intermigrated and intercrossed, and where, moreover, the variations will probably not have been identically the same, sexual selection might cause the males to differ. Nor does the belief appear to me altogether fanciful that two sets of females, surrounded by a very different environment, would be apt to acquire somewhat different tastes with respect to form, sound, or colour. However this may be, I have given in my "Descent of Man" instances of closely-allied birds inhabiting distinct countries, of which the young and the females cannot be distinguished, whilst the adult males differ considerably, and this may be attributed with much probability to the action of sexual selection.

CHARLES DARWIN

SCIENTIFIC SERIALS

THE *Bulletin de l'Academie Impériale des Sciences de St. Pétersbourg*, t. xxii., No. 1, contains the following papers of scientific interest:—On the absorption of carbonic acid by sulphuric acid and its mixtures with water, by J. Setschenow.—On tartronamic acid, by N. Menschutkin.—On ethyl- and methylsuccinimid, by the same.—On the geological age of the North-Caucasian Jura coal sandstones, and on natural saltpetre occurring in the same in the valley of Kuban, by H. Abich.—On diethyl-methyl-acetic acid, a new isomeric variety of œnanthylic acid, by M. E. Idanow.—On the formation of buds in *Equisetum*, by Prof. A. Famintzin.—Observations made at the astronomical observatory of the Academie des Sciences de St. Petersbourg, by A. Sawitch.

Journal de Physique, September.—M. André here investigates the subject of diffraction in optical instruments and its influence on astronomical observations. He shows that the diameter of Venus and Mercury during transit must always be less than in ordinary conditions of observation, and less by day than by night, with an instrument of the same aperture; also that it is less, the smaller the aperture of the instrument, the variation being equal to the difference of constants of instrumental diffraction of the instruments employed.—It is known that sulphur affects two incompatible crystalline forms, the right octahedron with rectangular base, and the symmetrical oblique prism. M. Gernez specifies the circumstances in which they are produced without intervention of any solvent.—M. Egoroff gives a description, with figure, of his differential electro-actinometer, an instrument for determining the co-efficients of absorption of ultra-violet rays by different substances.—M. Lecoq de Boisbaudran describes the physical properties of gallium. *Inter alia*, even a few degrees under its point of fusion + 29°·5, it is hard and remarkably tenacious for a metal so fusible; it can be cut, however, with a knife. It crystallises with great facility. The spectrum got by passing the spark in a saline solution, has two violet lines, the brighter with wave length 417·0, the other 403·1. In gas flame the former is hardly observable. The density is 4·7; the equivalent, not yet quite fixed, seems to be near the number deduced from the position of gallium between iodium and aluminium.

Sitzungsberichte der naturwissensch. Gesellsch. Isis in Dresden, July to December, 1875.—In this number will be found an interesting account of the Auckland Islands, by M. Hermann Krone, of the German Transit Expedition. The copper-bearing strata of Lake Superior, a potato exhibition at Altenburg, in October, Dr. Dohrn's zoological station at Naples, and an instance of lightning with a clear sky, are among other subjects treated; there are also a few archæological papers.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 23.—Vice-Admiral Paris in the chair.—The following papers were read:—Theorems relating to systems of three segments forming a constant length, by M. Chasles.—Remarks on a critique of Dr. Boué on the theory of *trombes*, by M. Faye. The gyration of the base of a trombe is generally too rapid to be perceived; but on reaching the ground or the sea, a quantity of dust or of water-droplets is raised by the escaping air, and passes obliquely before the trombe, with a perceptible slow movement. The spectator may by mistake attribute this motion to the trombe itself, and conclude that the trombe pumps the water (*e.g.*) up to the clouds. The trombe's motion is really a descending gyratory one.—On the order of appearance of the first vessels in the aërial organs of *Anagallis arvensis*, by M. Trécul.—Report to the Academy on the works of M. Francis Garnier, naval lieutenant. M. Garnier died about three years ago. His travels in China have had important results. The Minister of Public Instruction, on the recommendation of the Academy, has appointed an annual pension of 1,200 francs to be given to his widow.—Note on electric effluves, by M. Boillot. To obtain the dark effluves the conducting tubes for the electricity should be sufficiently apart to prevent any phosphorescent glow in the darkness. M. Boillot describes some modifications of his apparatus.—On determination of the depth of the sea by means of the bathometer, and without use of a sounding line, by Dr. C. W. Siemens.—On the industrial applications of phosphuret of copper and phosphorised bronze, by MM. de Ruolz, Montchal, and De Fontenay. Of two bells presented to the Academy, one made with phosphuret of copper in proportion of $\frac{9}{100}$ gave sounds much superior in acuteness, intensity, and timbre, to those of the other bell, which was of an ordinary bronze (78 copper, 22 tin). Its composition was also more homogeneous. By reducing the proportion of phosphorus to a few thousandths, red copper may be cast in sand without its physical properties being sensibly altered as regards industrial use. A bronze alloy with the proportion of $\frac{3}{1000}$ of phosphorus, sustains friction well, and can be indefinitely recast without appreciable loss industrially.—On the cure of hypertrophic elongation of the neck of the uterus by igneous utero-vaginal myotomy, by M. Abeille.—On the industrial preparation of nitro-glycerine, by MM. Boutmy and Faucher. (This note was in a sealed packet, deposited in August, 1872.) In the ordinary manufacture the reaction liberates much heat, which tends to decompose the nitro-glycerine formed. The authors first make sulpho-glyceric acid treating glycerine at 30° with three times its weight of sulphuric acid at 66°; and sulpho-nitric acid by mixing equal weights of sulphuric acid at 66° and nitric acid at 48°. Then these two acids are united, giving a mixture like this: glycerine, 100; nitric acid, 280; sulphuric acid, 600. The rise of temperature is then limited to 10° or 15°. The reaction is finished in about twenty-four hours. The nitro-glycerine forms in a distinct layer above the acids, from which it can be separated by decantation.—Report on experiments made, in several communes of Charente, with a view to destruction of phylloxera, by M. Boutin. To succeed well with sulpho-carbonate of potassium, alone or with water, or with coal-tarred sulphur carbonate, the operations should be done in October, November, or even December (if not too cold), then again from March till the end of May.—On a general proposition of the theory of conics, by M. Halphen.—On the effects of eddies observed in water-courses, by M. Bouquet de la Grye. If there be poured into a glass vessel first a dense liquid like aniline, then water, then oil, and the upper liquids be put in rotation with paddles, a central depression forms at the surface of the oil; a cone of the liquid descends in the centre, while a protuberance of niline rises from the bottom. A similar action of the eddies in rivers accounts for the raising and removal of sand, and the form assumed by the river's bed. And the movement of liquid threads in a river-bend may be compared to that in the vessel, taking as centre the successive points of the convex bank, and as border the concave part. There are vortices with horizontal axes also. The author thinks that by suitable dams, &c., the *vis viva* of the water might be utilised for deepening the channel.—On the laws of vibratory motion of tuning-forks, by M. Mercadier. The duration of the period of vibratory motion increases or diminishes with the amplitude. This variation, even for considerable amplitudes of 1 cm., is very small, and extends only to the fourth figure. If a certain limit, which may be fixed at 4 mm., be not exceeded, the duration of the period may be regarded as constant.—On the electrical apparatus of the torpedo, by M. Rouget. A histological description

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