THURSDAY, AUGUST 23, 1883

DECENTRALISATION IN SCIENCE

THE increasing recognition of the importance of the natural sciences in education, the daily augmenting numbers of those who devote themselves to the practical cultivation of these sciences, and the still more rapid growth of a widespread general interest in and sympathy with such pursuits have been noticed with no small satisfaction by all to whom the progress of natural knowledge is dear. It is impossible even plausibly to conjecture what changes this awakening may eventually involve. At the conclusion of the disastrous Prusso-Austrian war one of the members of the Austrian Reichsrath began his speech by insisting that the first question to be decided in the reconstruction of his country was whether the doctrines of Darwin were true or not. This may have been an exaggerated way of putting the matter, but already we see in how many directions the doctrine of evolution is capable of application to social problems.

There is one aspect of the increasing attention to the cultivation of science which perhaps the students of science have not sufficiently considered, but which certainly merits their careful attention—the growing tendency to decentralisation which is in progress among us. To realise what this tendency is and what it is leading to we should contrast the present condition of things with what existed twenty years ago or more. For one school in which science was taught then, there are a hundred wherein it is taught now. New colleges have been founded in various centres of industry for special instruction in science. New professorships for the cultivation of different branches of science have been established at some of the older seats of learning. Parliament votes an annual sum of 4000*l.* for the encouragement of original research. New journals for the illustration of scientific progress have been started. Almost every large publishing firm has organised a series of science class-books.

As a result of this accelerated activity a great stimulus has been given to local effort in the prosecution of scientific studies. Field clubs and societies have sprung up all over the country. From modest beginnings some of these organisations have attained not inconsiderable importance. Their membership has steadily grown. Their funds have proportionately increased. They have not contented themselves with merely meeting for pleasant gossip, though this too they have been far from despising. They have encouraged original observation among their members, and have published in their annual volumes of *Proceedings* some really valuable contributions to science. Year by year these volumes make their appearance, until they now form a notable feature in the scientific literature of our time. The local character of the organisation stimulates a local *esprit de corps*. The flora, or fauna, or geology of the locality attracts the activity of the members, who are proud to add to what may already have been known on the subject. But topics of a more general kind are likewise included, and sometimes a paper of high importance makes its appearance side by side with the local contributions. In this way an outlet is furnished for the scientific ardour of the district. The meetings and discussions keep alive a general interest, and the publication of the *Proceedings* encourages the working members to continue their researches.

The rapid appearance and multiplication of these local centres of scientific activity must materially influence the future progress of science among us. In what various directions this influence may make itself felt remains to be seen. But there is one in which it cannot but be potent, and to which brief allusion may be made here. Not many years ago the metropolitan scientific societies were justly regarded as the great centres of progress in science—the heart that sent its intellectual life-blood to the remotest parts of the kingdom. But even their most devoted champions must admit that in this respect they do not now generally fulfil the part they formerly played, and that they are doing so less and less every year. Of course the Royal Society has always stood and will always stand alone and without rival. But such a society as the Geological has competitors all over the country, which, though they may not be individually formidable, yet collectively withdraw not a little of the energy which would otherwise have gone to recruit the parent society here. Every English geologist is proud of the part which the Geological Society of London has taken in the progress of geology, and would like to see the Society retain its influence and position. But the circumstances under which it was founded seventy-six years ago have entirely changed, and its preeminence and continued usefulness must depend upon other conditions than those which gave it so honoured a place in the early part of the century.

It would of course be absurd to speak of the existence of any rivalry between the provincial and metropolitan societies. There is ample room for all. But if there is no rivalry among them there is just as little cooperation. They all act with the most complete independence of each other, and if in some cases they occupy the same ground and do the same work, there is no means at present of preventing this. Now the question arises, whether the general progress of science could not be benefited by the establishment of some concert between the older or mother societies here and the numerous societies, institutes, field clubs, and other organisations of the provinces. These provincial associations have increased and are increasing so rapidly, they are becoming so important a factor in the cultivation of the natural sciences throughout the country, absorbing as they do so much of the talent, energy, and money of the well-wishers of these sciences, that the time has probably come for asking whether some scheme of cooperation might not now be devised whereby they and the London societies would in some way be conjoined for the furtherance of their common objects. Obviously subjects which are preeminently local should be left in the hands of the local organisations. On the other hand, general questions, especially those bearing on scientific theory or classification, might be most effectually dealt with by the more important metropolitan bodies. We refer of course mainly to publication. The local societies would feel justly aggrieved were they asked to deprive themselves of the pleasure of starting new hypotheses and running down old ones. But they might be content with this pleasure at their meetings without wasting their funds and loading scientific literature by printing their vagaries in the *Proceedings*. The central societies also, by giving up the publ

cation of unimportant and especially of local details, would be better able to concentrate their strength on large questions, to the notable increase of the value of their *Transactions* or *Proceedings*. That such a re-arrangement of effort would involve many practical difficulties is sufficiently obvious, and that the machinery might never be made to work smoothly may likewise be granted. Yet surely it would be well worth while to try whether some of the energy which at present is wasted or misdirected could not be utilised to the manifest advantage of that progress which all have sincerely at heart.

Students who have occasion to keep themselves acquainted with the current literature of their respective sciences naturally grumble at the constant increase in the number of journals, *Proceedings*, *Transactions*, &c., which they must painfully look over. But this increase is inevitable. What we should aim at is not its curtailment so much as its methodical arrangement. If certain societies would only publish papers in particular departments of a science, it would be infinitely easier to follow the yearly advance made in that science. The metropolitan societies might annually issue with their own *Proceedings* brief digests of the additions to our knowledge made by the country organisations and otherwise, so as to comprise within the boards of one volume a view of the whole progress in theory and detail achieved by each science in this country. At all events some means should be devised of enabling the older and the younger and less ambitious societies to draw together into concerted action, either by formal arrangement or by informal and friendly correspondence.

ESSAYS IN PHILOSOPHICAL CRITICISM

Essays in Philosophical Criticism. Edited by Andrew Seth and R. B. Haldane, with a Preface by Edward Caird. (Longmans, Green, and Co., 1883.)

ONE of the most interesting among the intellectual movements now taking place in this country is the growth and development of that system of philosophical thought which began with Kant, flourished in Germany, and, spreading to England, has only just begun to take root in the minds of some of our ablest thinkers. It is a curious thing to see this exotic springing up thus vigorously side by side with our endemic productions—the one like a vine creeping with the tendrils of its subtle and sensitive analysis; the others, like our British oaks, contented sturdily to rest in the stiff soil of experience without seeking for any supports in the thin air of metaphysics. So rarely has this foreign plant found its way across the Channel that until within the last few years it was scarcely ever to be met with even in the more cultured of our philosophical pleasure-grounds. Probably the last of all the gardens into which it is likely to find its way is that of natural science, and therefore we publish this short notice in order to inform any of our readers who may desire to see the plant in question where they may profitably go to see it, and have all its main features explained to them in admirable English and with the least possible expenditure of time. For these "Essays in Philosophical Criticism" only cover 277 pages, are all written by men of marked ability, who are well saturated with the philosophy which they undertake not only to expound but to extend.

The pages of NATURE, however, are not adapted to a criticism of such a "Criticism" as a whole; were such the case we should of course have taken the works of Professors Green and Caird as the representative expositions in this country of the German school of philosophical thinking. But there is one important point of contact between this school of thinking and that of natural science which does come within the province of the latter to examine, and it is because this point is prominently put forward in the book before us that we have chosen these "Essays" as the subject of our review. The point to which we allude is the doctrine that science can no longer afford to disregard the revelations of transcendental analytic; that if any considerable progress is henceforward to be made in the investigation of the facts of nature, it can only be done in the light which is shed by the "theory of knowledge," and that if "a man of science" does not happen to be acquainted with the use of the "categories," his education is in as sorry a case as that of a young lady who has never been taught the use of the globes: "he perpetually raises difficulties insoluble for himself in his own department by the dogmatic application of mistaken categories." Now we have had the good fortune to meet no small number of young ladies who know their geography sufficiently well without ever having attained to the use of the globes, and we have met with a still greater number of "men of science" who have done exceedingly good work "in their own department," without ever having heard of the "categories." May it not be that both the schoolmistresses and the philosophers are alike in somewhat unduly magnifying their office? As regards the philosophers, this is the only point with which we are here concerned.

In the concluding paragraph of a highly interesting and ably written essay by Mr. R. B. and Mr. J. S. Haldane, on "The Relation of Philosophy to Science," it is said by way of summary: "Such considerations point towards what seems to be becoming the conclusion of the present time—that science and philosophy can no longer be kept wholly apart from one another." The considerations which lead to this conclusion briefly stated are as follows:—Science has hitherto been concerned only with the lower categories of substance, quantity, causation, mechanism, &c., to the exclusion of those higher conceptions of organism and teleology, without which it is impossible to take a full or comprehensive view of all the facts which fall to be explained. Thus, for instance, if biology restricts itself to investigating the phenomena of life only under the categories of mechanism and causation, it can never attain to the all round understanding of the facts of its own subject-matter as afforded by that changing of the points of view which is rendered possible by the use of the conceptions above mentioned. These conceptions amount to regarding an organism as something more than a mechanism which stands to be investigated by measurement and the tracing of physical causation alone—to regarding an organism as that which exhibits the peculiarity of every part being acted on by the other parts, and by the environment, so as to form a self-conserving system, of which it is "the essential feature of each part that it is a member of an ideal whole"—morphological structure, physiological function, growth, development, decay, and death

being all teleological factors in the expression of this "ideal."

Now in the first place we do not require a revelation from another sphere to tell us that "there's ne'er a villain dwelling in all Denmark but he's an arrant knave," and biologists may similarly remark that they do not require any transcendental analytic to inform them that an organism is something more than a mechanism. But it is indeed a startling announcement to be told that in the investigation of an organism we are to rise above "the category of causation," and carry into our inquiry the conception of teleology. And still more startling is this announcement when we are told that the teleology which we are thus to embrace is not in any way connected with the hypothesis of a designing mind, but is a something which we ourselves are, as it were, to read into the facts which we investigate, by means of a "creative synthesis of thought." It is here, we think, that the "men of science" ought to take their stand; we are all agreed that an organism is something more than a mechanism, but we are not agreed that in any department of science are we justified in quitting the category of causation. On the contrary, for our own part we decidedly maintain that this is the category the limits of which mark the limits of all scientific research, and that in whatever degree science presumes to overstep these limits, in that degree has it ceased to be science and become metaphysical speculation. Moreover, we should say that the speculation is, so far as science is concerned, of an exceedingly vicious kind. It was bad enough to have the "final causes" of the older teleologists posited as the ultimate touchstones of scientific truth; but it seems to us much worse to have a system of teleology of our own manufacture put into its place. Thus, to take an illustration, it is the outcome of a judicious "application of the categories" to assert that a great gulf is fixed between the living and the not living in nature, and therefore that "we can never hope to find a case of *abiogenesis* as a matter of fact." Now we conceive it is the part of a man of science as such to entertain no such bold statement as this. It is, to use a term of which this school of philosophers is particularly fond, the worst form of "dogmatism" thus to affirm, on grounds of metaphysical speculation alone, the antecedent impossibility of any discovery in science—most of all with reference to a matter touching which we are so much in the dark. If our working biologists were ever to adopt the categories as guides to their methods of inquiry, here is a case in which all attempts at inquiry would be barred by an *a priori* dogma; and the same is true of every other case where the "category of causation" is sought to be overshadowed by "the higher categories." Thus, to take another example, in order to show the necessity for the employment of these higher categories in science, it is argued that the regeneration of the amputated limb of the newt is "wholly unintelligible," save as an expression of the teleological impulse to the reconstruction of our ideal type or organism. But, without waiting to ask what becomes of such an impulse in the case of any of the higher Vertebrata when similarly mutilated (perhaps the matter in this case *is* "wholly unintelligible," but whether or no the illustration can scarcely be deemed a happy one), we object, in the first place, that by discarding the category of causation an *a priori* barrier is arbitrarily set up against any scientific inquiry into the facts; and in the next place, that the higher categories cannot possibly furnish any semblance of what may properly be termed an "explanation." To say that "each cell is directly determined in its action simply by what it has to do in order that the vital activity of the newt may be restored to its normal condition," is not to explain the process; it is merely to restate the fact. And in all similar cases the so-called "explanation" which is furnished by the higher categories amounts to nothing more than saying that the thing to be explained is what it is The truth, in short, is that outside the category of causation we cannot explain anything in a scientific sense. We may change our "point of view" as often as we choose by regarding a thing now as mechanism, now as organism, now as beautiful, again as moral, and (if we may be allowed to add to the categories) lastly as comical. But by thus changing our point of view we are in no wise adding to our knowledge in the way of explanation; we are merely regarding one aspect of a thing to the exclusion of its other aspects.

Let it not be thought that in making these remarks we are actuated by any *animus* against the transcendentalists. In the region of philosophy their "Copernican change of thought," which makes the universe revolve round the philosopher, may be a change fraught with all the importance which its adherents claim for it. With this, as we have said, we are not here concerned; we are only considering the system "from one point of view," or in its relation to science, and here we find that its teaching appears to be seriously at fault. We have endeavoured to show that it is not only of no use to puzzle the "plain man" of Locke in the person of the modern biologist by telling him that "the organism, *quâ* organism, is not in space at all;" but that even if the biologist could be made to understand what is meant by such a statement, his acceptance of the meaning would be worse than useless to him in his work. Far, therefore, from feeling with our authors that for "such a class (*i.e.* specialists in science) the mastery of the critical investigations of Kant and Hegel, or at least of conceptions which have been profoundly influenced by these writers, will in the near future be absolutely essential," we believe that the less men of science, in their capacity as such, have to do with these investigations the better will it be for the progress of their own. And, on the other hand, seeing that the critical philosophers are so ready with their advice, we may in our turn conclude with a word of advice to them, by observing that it will be the better for the credit of their system if they cease from their kindly endeavours at teaching our Hannibals to fight.

GEORGE J. ROMANES

LETTERS TO THE EDITOR

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

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

Simultaneous Affections of the Barometer

I HAVE just read in the columns of your journal the very interesting communication (Part II.) from Mr. A. N. Pearson

regarding the transmission eastwards of barometric movements, and in which he likewise alludes to simultaneous affections of the barometer. Speaking of these latter he says: "As to the cause of the e widely distributed simultaneous movements of the barometer . . . I have no evidence of any value. The most natural idea is that a connection direct or indirect may be traced between them and changes in the state of solar energy. . . . I have not a sunspot curve for the years under consideration, and cannot therefore make the necessary comparisons."

I may mention that simultaneous affections of atmospheric pressure were fir t observed by the late John Allan Broun, and that I have compared his instances with sunspot records. The results of this comparison were published last year in the *Proceedings of the Literary and Philosophical Society of Manchester*. I have not the volume here with me, but if my memory does not deceive me an increase of pressure was found to be associated with increasing sunspots and a decrease of pressure with decreasing sunspot. BALFOUR STEWART

Devonshire, Augu-t 17

Dreaming

INSTANCES have lately been described in NATURE of remarkable formation or perversion of dreams at the instant of waking. Allow me to offer you the following, which was vividly impressed on my mind, and which I still remember with the utmost accuracy:—

In the summer of 1822, when an undergraduate of Trinity College, Cambridge, I was permitted to reside in College rooms during the summer long vacation. As fires were not wanted in our sitting-rooms, it was customary for each resident's bedmaker or other officer to carry his water-kettle for breakfast and tea to the College kitchen, and bring it back with water boiling. On one occasion I had overslept my usual hour, and I dreamed a dream. I was at the gate of a country farmyard well known to me, and there came a long procession of horses, asses, oxen, hogs, sheep, and all the animals usually to be found in a farmyard, followed by a north-country drover with his plaid or maude crossed over his shoulder, who walked up to me and said, "Sir, I have brought your cattle." In an instant I perceived and actually heard (so intimately were the auditory sounds and the intellectual interpretation intermixed) that my bedmaker was at my chamber door calling to me, "Sir, I have brought your kettle." The hearing had been confused; there had been no reasoning; but there had been instantaneous vigour of creative imagination.

An admirable instance of the same kind is described in the last chapter of Scott's "Rob Roy." Scott appears to have been in some measure a student of dreams. I refer with pleasure to the description of FitzJames's dream, after a day of labour and an evening of excitement, at the end of the first canto of "The Lady of the Lake." A. B. G.

August 18

Thunderstorms and Auroræ

I WOULD like to ask if any observer has ever suggested a possible connection between thunderstorms and the aurora? Last evening a very heavy shower, accompanied by much lightning, passed to the north of this place. Other black clouds were seen to the south and west, and at nine o'clock flashes of lightning might be seen darting across the clouds in nearly all directions. It was evident that the air was heavily charged with electricity. Just before retiring, about midnight, I looked from my window to see if a shower was still threatened at this point. I found the heavens quite clear except in the north, where a dark mass of clouds still hung. At the eastern extremity of this cloud-bank a rift several degrees wide commenced and extended nearly to the north-western horizon. Frequent flashes of lightning lit up the edges of this rift, while beyond the clouds the clear sky was seen to be brightly illumined by a steady auroral glow. The glow continued nearly unchanged during the several minutes which I watched it, and it was quite evident that it was a genuine aurora, and not a reflection of the lightning flashes. Is it not probable that the same electrical state of the atmosphere which produces the thunderstorms may also cause the aurora, and that the two phenomena may often occur together?

Lewiston, Maine, U.S.A., July 6 E. R. CHADBOURN

"Elevation and Subsidence"

QUOTING Prof. Geikie's "Text-book," Mr. Starkie Gardner says: "Strata of sedimentary origin which have accumulated to thousands of feet in thickness, may be depressed deep beneath the surface and brought within the influence of metamorphosis. . . ." He continues: "This is an absolute admission that at some depth, relatively not great, pressure converts solid into viscous or fluid strata." A few lines further: "If the mere pressure of overlying strata can anywhere or at any depth render rocks molten or fluid, they will become molten or fluid wherever the required pressure occurs." But is not the supposition the exact reverse of what is really the case, viz. that not only does pressure *not* liquefy rocks, but actually *prevents* their melting at a temperature at which they *would* melt were the pressure removed? Mr. Gardner himself admits this in the case of the nucleus, *i.e.* when we come to very extreme pressures; how then can pressures of an intermediate order of magnitude have the opposite effect? This is surely not the view of Prof. Geikie. The passage quoted by Mr. Gardner from his work refers to the fusion of rocks by the *high temperature* found at great depths.

If Mr. Gardner means to imply, as some of his expressions strongly suggest, that the *cause* of the high temperature of the interior of the earth is the pressure of the superincumbent rocks, it would be interesting to know how he reconciles his theory with the principle of the conservation of energy. Heat is energy, pressure is force. Force can only give rise to a manifestation of energy by acting through a finite distance, the energy manifested, or "work done," being the product of the force and the distance through which it acts. If either factor be zero, the other not being infinite, the product is also zero. The application to the case in hand is too obvious to require statement.

Trinity College, Cambridge, August 4 F. YOUNG

Insects and Flowers

HAVING this morning received the last number of the *Proceedings of the Linnean Society* containing Mr. A. W. Bennett's and Mr. Christy's observations on the constancy of insects in their visits to flowers, it occurred to me, after reading only the first page, to see how insects behaved in my own garden, where there is a great variety of plants. I had not read the conclusions of either author, and had no preconceived opinion on the subject. The results were noted at once, and were as follows:—

1. *P. rapæ* (small white butterfly) on a bed containing white and rose-coloured double and single stocks also, scarlet pelargoniums and pink phlox; visited single white stocks only, going all round the circle in which they were planted; then flew off, made a dive at a white phlox, but did not alight, hovered about some little time without alighting, and finally went out of sight.

2. Same species; two individuals on a bed of scarlet pelargoniums edged with sulphur-coloured pansy (? *Viola lutea*, var.). One butterfly kept to the pelargoniums, paying repeated visits; the other did the same with the pansies.

3. Same species on a bed of dark purple pansies with bright yellow eye, crossed and edged with orange French marigolds. Two individuals visited both plants promiscuously, but the marigolds oftenest. A *P. napi* (green-veined white butterfly) did the same. *Vanessa urticæ* (small tortoiseshell butterfly) on the same bed visited only the marigolds. This species seems remarkably partial to yellow.

4. *P. rapæ* on a bed of scarlet pelargonium and pale blue pansy with dark centre and pale yellow eye intermixed. Visited the pansies very often; the pelargoniums once only during observation.

5. Same species on *Lythrum salicaria* remained a long time visiting different spikes, then flew round, neglecting all other flowers till it found another plant of the same kind, which it continued on as long as I watched it.

Bombus lucorum. This bee was very abundant, both workers and females. I watched them on a mixed bed which contained *Pentstemon barbatum* (dull scarlet), African marigolds (yellow), *Antirrhinum majus* (crimson), pansies, both dark purple and yellowish white, and mignonette. The favourite plant was the pentstemon, especially with the ♀. They got at the nectary by inserting the proboscis in a hole cut near the base of the corolla. The next favourites were the marigolds. One individual confined himself exclusively to the antirrhinum. In one case only did I observe a bee to change from one kind of flower to another, though I looked out especially to see if they did so. This was a bee which went from a crimson petunia to an antirrhinum of very nearly the same shade of crimson.

Apis mellifica (hive bee) on the above bed confined itself to the mignonette. This remark applies to several individuals.

Chester, August 17 ALFRED O. WALKER

A Meteor

A BEAUTIFUL meteor was seen from this place on Sunday evening, August 19, at 10.3 precisely. Owing to the brilliancy of the moon, stars of the first magnitude were but faintly seen. I should say the size and brilliancy of the meteor was greatly in excess of the planet Venus at its best. It was visible as far as I could conjecture about three seconds, and pursued a course of probably 45 or 50 degrees, proceeding from a point a few degrees to the eastward of, and higher than, the north star. It moved almost in a straight line downwards with an inclination to the left. When it had got about half of its whole visible course, it seemed to get blue in colour, and threw off a mass of red sparks, and continued for the rest of the distance, when it appeared to burst, and the disjected fragments were red and visible for a few moments. The colour for the most part was very much like that of Venus, indeed, for the whole of the course, except where it seemed to turn blue. A. TREVOR CRISPIN

Lansdowne Road, Wimbledon, S.W., August 21

I SAW a very brilliant meteor from the promenade here last night (Sunday, August 19), at 10.3 p.m. It passed along the eastern sky and vanished over the summit of the Little Orme. The meteor was, I think, more brilliant than Venus at her brightest, though the full moon was shining not far off and very few stars were visible. The path was northward, nearly horizontal, inclined a little downwards, about 10° or 12° above the horizon, apparently much foreshortened, for the motion was very slow—not faster than that of balls falling from a rocket; white light, slightly tinged with blue. The meteor divided, and left one large and I think several smaller portions behind it, all vanishing together. It should have been seen overhead towards the coast of Yorkshire. ALBERT J. MOTT

Llandudno, August 20

Animal Intelligence

A CIRCUMSTANCE exceedingly illustrative of the sagacity of the horse was witnessed by myself in the neighbourhood of Nottingham. I had been out for a stroll by way of recreation, returning home across some fields by the Trent side, and when nearly opposite Clifton Grove I stopped a short time to watch a man angling in the river, when suddenly my attention was drawn to a mare with her foal, not many yards distant from where I was standing, open two gates which were *vice versâ*, closing with a strong spring. Her *modus operandi* was to place her nose in between the two gates and force one gate open with her side, while she had no little difficulty in opening the other for the purpose of getting through. I have learnt that the animal had not been trained to do this, but taught by natural instinct, and so cleverly was it done that man could scarcely have performed the action better. Thinking this instance of sagacity might be interesting to some of our naturalists, I take the liberty of forwarding same in order that you may insert it in your valuable paper.

9, Charlotte Street, Nottingham F. WELCH

MR. H. CECIL'S communication respecting the cat and the chicken, at p. 320 of your present volume, reminds me of an instance of the attachment of a cat to its natural prey which is still more remarkable, as there was no "maternal *στοργή*" in question.

Some years ago we had a young emasculated tom cat. When it was nearly full grown we had two young white rabbits brought in which had lost their mother. These were kept in the kitchen, and fed by pouring milk into their mouths with a spoon. They were placed in a basket at night and covered up to protect them from the cat, which was in the habit of catching wild rabbits. One morning the cover was found to have been removed by the cat, which was lying in the basket with the little rabbits. From that time he took charge of them, teaching them to lap milk and watching over them like a mother, even to the extent of driving them home when they grew older and rambled out from the kitchen. The friendship continued till the rabbits grew up, when we lost them by disease. ALFRED O. WALKER

Chester, August 17

"Birds and Cholera"

IN refererence to "H. M. C's." letter in this week's NATURE (p. 366), it is interesting to recall how the traveller Jackson, speaking of the plague that occurred in West Barbary when he was there, says, "The birds of the air fled away from the abodes of men." Thomas Moore, in "Paradise and the Peri," refers to this fact. E. S. T.

August 18

LIQUID FILMS AND MOLECULAR MAGNITUDES

SIR WILLIAM THOMSON'S lecture on "The Size of Atoms," which has recently been published in NATURE, will undoubtedly increase the interest felt in measurements which throw any light upon the values of molecular magnitudes.

We have for some time been engaged in investigating the properties of very thin liquid films, and in our last communication to the Royal Society (of which only an abstract has been hitherto published, but which will appear in a forthcoming number of the *Philosophical Transactions*) we have described two independent methods by which we have obtained concordant measurements of the thickness of soap films in the last stage of tenuity, viz. when exhibiting the black of the first order of Newton's rings.

The paper had not been sent in to the Royal Society at the time when Sir Wm. Thomson's lecture was delivered, but, on receiving the abstract, he has been good enough to express his approval of our methods and interest in our results, and to raise some questions as to the relation between the observations of Newton and ourselves, the further discussion of which he thinks would be interesting to the readers of NATURE.

We propose therefore briefly to discuss the facts which bear upon the points raised by Sir Wm. Thomson, and to describe our methods of experiment so far as may be necessary to make the discussion intelligible.

For thicknesses greater than those which correspond to colours of the first order, the tint displayed affords to a practised eye (when combined with a knowledge of the angle of incidence and refractive index) a very accurate measure of the thickness of a film. In some experiments of our own, in which on more than 500 occasions two independent but simultaneous measures were made of film-thicknesses by means of two beams of light, incident at different angles, we found that the two values obtained agreed to within 1 per cent. in 52 measures out of every hundred, to within 2 per cent. in 84, and to within 3 per cent. in 95. All these observations were made in the second and higher orders. The colours of the first order vary from point to point too slowly to enable trustworthy estimates of the thickness to be made, and when the black of the first order is reached the eye informs us only that the thickness must be less than a certain value, but affords no further indications as to what it really is. The fact that it is extremely small, and the possibility that it may be related to the magnitude of the so-called "radius of molecular attraction," invest the problem of the determination of this thickness with special interest. We have succeeded in solving it by two methods. In each an assumption has to be made for which there is no direct experimental evidence. In each case, however, the assumption is different, and the fact that the mean results obtained by the two methods are in close accord is sufficient to show that, although there is still room for further inquiry, the mean thickness of the black soap films examined was correctly determined to within a fraction of a millionth of a millimetre.

The first method consisted in measuring the electrical resistance of a cylindrical black soap film, and deducing the thickness from Ohm's law, on the assumption that the

specific resistance of the liquid, when drawn out into so thin a film, is the same as that determined under ordinary conditions.

We have, by direct experiment, proved that this assumption is true for films the thickness of which exceeds 374×10^{-6} mm. (*Philosophical Transactions*, 1881, p. 447). The investigation was considerably protracted by the great difficulty experienced in maintaining the constitution of the films even approximately constant. Every change in temperature, every slight alteration in the hygrometric state of the air in the glass chamber in which the bubbles were formed, involved a loss or gain of water which affected the specific resistance so largely as to make any certain conclusion impossible. It is only in our latest apparatus that we have secured the requisite constancy in the conditions. In it the films are formed in a chamber surrounded by water to keep the temperature constant. The base of the inclosed space is covered by the solution used, and the complete saturation of the air is further secured by an endless band of linen passing over rollers which can be worked from the outside. The lower roller is immersed in the solution employed, and thus every part of the linen can in turn be dipped into the liquid and kept completely saturated without opening the case. The films are blown as spherical bubbles with air which has been caused to pass over some of the liquid in order to insure saturation; they are converted from spheres into cylinders adhering to two rings, and are further put in communication at any desired point with the electrical apparatus without opening the case, and thus without affecting the temperature or saturation of the air with which they are in contact. A thermometer and a hair-hygrometer, placed in the closed chamber, serve to detect any change of conditions which these precautions fail to obviate.

The earlier form of apparatus described in our paper "On the Electrical Resistance of Thin Liquid Films" (*Phil. Trans.*, *loc. cit.*), was in some respects less perfect. By it, however, we were able to show that the specific resistance of a film differed less and less from that of the liquid from which it was formed, as the temperature and hygrometric state of the air become more and more constant, and that in the case of the six films in which the desired constancy had been most successfully attained, the difference amounted only to 1·8 per cent.

It was also shown that there was no indication of any change in the specific resistance between thicknesses corresponding to the middle of the red of the sixth and of the yellow of the second order respectively. As the smaller of these thicknesses is nearly the same as the wave-length of the rays which bound the spectrum at the blue end, this result may be roughly stated as proving that the thickness of a film may be reduced to the length of the shortest visible light wave without any change in the specific electrical resistance of the liquid of which it is composed.

In the course of some of our earlier experiments (*Proc. Roy. Soc.*, 1877, p. 334) we had been fortunate enough to make a soap solution, giving very persistent films, which frequently thinned to the black of the first order. The resistance of the black portion was measured on several occasions, and it was found that the thickness was in all cases nearly the same (the variations amounted to about 5 per cent.), and differed but little (if the specific resistance was assumed equal to that of the liquid in mass) from 12 millionths of a millimetre (12×10^{-6} mm.).

We were anxious to try this experiment again with our improved apparatus and methods of measurement, but great difficulty was experienced in obtaining a liquid which would both thin and last sufficiently for our purpose. We have not, in fact, succeeded in again making a solution, containing the proportion of glycerine recommended by M. Plateau, which would behave in the desired way, but we find that a liquid of similar constitution, in which the glycerine is replaced by water, will allow a measurement of the resistance of the black to be made in the case of about one film out of every three or four.

Films which do not contain glycerine generally exhibit greater irregularities of behaviour than those which do, and thus our later experiments are not in as close agreement as the earlier ones. They indicate that, whereas the thickness of the black portion of a film remains constant however much its area may alter, it is different in different films. All the values obtained lay between $14{\cdot}5 \times 10^{-6}$, and $7{\cdot}2 \times 10^{-6}$ mm., and the mean value $11{\cdot}7 \times 10^{-6}$ differed only by two ten-millionths of a millimetre (2×10^{-7} mm.) from our previous result.

In spite of this close agreement these results were open to criticism. It is a long way, in terms of molecular magnitudes, from the yellow of the second to the black of the first order. We had no right to argue from results on the specific resistance at the greater thickness to its constancy at the less. It was, therefore, very important to attempt to check our observations by some independent method.

We had often observed that plane circular films formed in a glass tube thinned very readily to the black. This was perhaps due to the fact that the small aggregation of liquid all round the film affords a channel by means of which the liquid can readily escape. However this may be, it occurred to us that, though it was probably impossible to measure the thickness of a single black film by any optical method, it might nevertheless be possible to determine the total thickness of a number of parallel films in a tube. This we have succeeded in doing. The tube and its contents were placed on an apparatus for producing interference by thick plates. One of the interfering rays passed through the tube. A few steel sewing needles were included within it. When the films became black, a number of them were broken by moving the needles with a magnet, and the thickness could be calculated by observing the positions of the interference fringes before and after the rupture. By this method the mean thickness of the films was measured, on the assumption that the refractive index of the films was the same as that of the liquid in mass. Various considerations led to the conclusion that this was probably correct, but in any case the complete independence of the electrical and optical methods made each a valuable check on the other, though—if the fundamental assumption was correct—the former was by far the more accurate.

The result showed the two methods in most satisfactory accord. The mean of all the electrical observations gave a thickness of $11{\cdot}8 \times 10^{-6}$ mm., that of all the optical $11{\cdot}4 \times 10^{-6}$ mm., an agreement which places it beyond doubt that the mean value for all the films observed was really about $11{\cdot}6 \times 10^{-6}$ mm.

The methods employed then afford a definite measure of thicknesses much smaller than the smallest that Newton's scale of colours allows us to estimate. That scale is very uncertain when colours of the first order are employed. The difficulty or impossibility of obtaining perfect contact between the lenses in the fundamental experiment, and the possible distortion of their form in the neighbourhood of the points of closest contact, make colour estimates of thickness in the first order very doubtful. The few observations we have made, on films exhibiting the red and orange of the first order, show a discordance with Newton's results in striking contrast to the agreement obtained in the case of most greater thicknesses.

Our estimate of the thickness of the middle of the red of the first order (284×10^{-6} mm.) differs from Newton's by 20 per cent. In the blue of the second order our own observations on Newton's rings differ from those on the soap films by 6 per cent., and we were obliged, when aiming at an accuracy of 1 per cent., to discard all observa-

tions below the border of the yellow of the second order (374×10^{-6} mm. when the light is incident at 45°).

On the other hand, our electrical observations of a black film often give the same thickness to within 1 or 2 per cent., again and again, in a series of observations extending over an hour or more.

This constancy may be taken as proving that the film is not absorbing nor losing moisture, and if its composition thus remains unaltered it is not too much to say that the electrical method extends to $7\cdot2\times10^{-6}$ mm. (the smallest thickness measured by us), with an accuracy previously attainable only above 374×10^{-6} mm. In other words, it carries the accurate measure of thickness fifty times nearer molecular magnitudes than Newton's scale of colours does.

We now come to the interesting point raised by Sir William Thomson, which we may perhaps be allowed to state in his own words as follows :—"Newton, in the passage I have quoted (NATURE, vol. xxviii. p. 250), being Observation 17 of the Second Book, Part I., of his 'Optics,' says (1) he found in the *large* black spot smaller black 'round' spots which were blacker still ; (2) he saw sunlight reflected from even the small darker spots ; (3) the black spots would break out in the middle of white, without any intervention of blue, and sometimes within the yellow or red or blue of second order. This (3) agrees with your (1) of p. 151. But the (1) above of Newton's shows a higher grade of thinness than that of the main black spots, which I presume is that which you have found as $\cdot1\times10^{-5}$. I do not know if you have noticed these smaller and blacker spots. It would be exceedingly interesting if possible to find their thickness, and to see how they seem to be related to the main black spots."

It may be well when answering this inquiry as to whether we have observed the smaller black spots, to state such facts as we have observed connected with the formation of the black.

In the first place we have noticed that the boundary between the film proper, and the small aggregation of liquid which connects it with the solids by which it is supported, is the place where, under ordinary circumstances, discontinuous spots, *i.e.* spots having a thickness different from that of the surrounding film, are most readily formed. The small circular masses of liquid which surrounded the gold wires by which the film was connected with the electrometer were sometimes themselves surrounded by a very narrow ring, showing the white of the first order when all the film immediately outside it was much thicker. Small specks of white would frequently break off from the topmost point of this ring, and either rise through the film to its highest point, or if, as was often the case, the liquid of the film was in a state of internal motion, the white flecks would be carried round the cylinder in spiral paths. Some liquids almost invariably gave films which, shortly before rupture, became thus covered with white flecks. Occasionally a white band, several tenths of a millimetre in breadth, was formed all round the upper ring which carried the cylindrical film, when the portion of film next it showed colours of the second and higher orders, and it was owing (among other reasons) to the frequent presence of this ring that we abandoned the Wheatstone's bridge method used in our first experiments (*Proc. Roy. Soc.* 1877, p. 334), and adopted the electrometer method which we now always employ. The necessity of having to make an allowance for the resistance of the white ring, the thickness of which was much more uncertain than that of the coloured portion was thus avoided. We may remark that irregularities of all kinds are more likely to occur if all parts of the apparatus are not frequently and scrupulously cleaned. We have also examined the lines of discontinuity between the black and the coloured portions, using a microscope with a three-inch object glass. In many cases the discontinuity was seen to be only apparent. Bands of colour were visible, which proved that the missing tints were really there, but on so small a scale as to be invisible to the naked eye.

The phenomenon of the white band was sometimes still further complicated by the presence of spots in the white, differing in colour both from it and the film next it. Thus on one occasion when the colour next the white was the green of the fourth order (mean thickness 893×10^{-6} mm.) we made the following remarks in our notebook :—"At the top a narrow film of white was observed between the green and the solid cylinder. In this, small pieces of deep blue were moving slowly backwards and forwards. The lower part of the white was marked by two small rings of colour, so narrow that the colours were indistinguishable." Later on, the green at

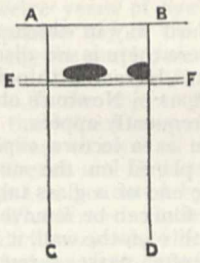

FIG. 1.

one point broke through the white and completed contact with the top. This contact was in turn broken, and, after a while, the white appeared continuous without spots or bridges. A rough, highly enlarged sketch of the spots was made at the time, of which Fig. 1 is a copy.

A B is the lower edge of the platinum cup which supports the film. A C and B D are the boundaries of the bright line produced by the light thrown upon the film at a known angle for the purpose of measuring its thickness. E F is the edge of the white. Two of the blue spots which appeared to float in it are shown, and the narrow line of colour is indicated. Below E F the thickness was about nine times greater than that in the white space above it.

Our reason for describing this observation at length is to draw attention to the curious phenomenon of the blue spots separated by an apparent discontinuity from both

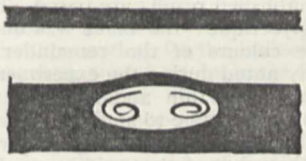

FIG. 2.

the white and the green. From the green they were no doubt separated by a thin line of white, and through this frail band, perhaps a few hundredths of a millimetre broad and one ten-thousandth of a millimetre thick, they were unable to sink into the green below.

In the same way white flecks have been observed to rise and to be separated for some seconds from the white ring above by a thin band of colour. Such flecks, examined by the microscope, sometimes show colours of higher orders within them, arranged in curves owing to a regular vortical circulation. The appended sketch (Fig. 2), drawn from memory, gives some idea of the appearance displayed, the size being of course greatly exaggerated.

Turning now from the formation of the white to that of the black, many of the phenomena observed in the

case of the cylindrical films are closely similar. Specks of black also readily form in the neighbourhood of the solid in contact with the film. They, too, rise through the surrounding liquid, and the growth of the black ring at the top of the film is sometimes caused as much by additions of black spots from below as by a downward motion of the lower edge. These phenomena are only observed on a large scale shortly before the rupture of the film.

The black appears at times in other ways. Sometimes when the white of the first order was in contact with and below the black, a small portion of it would rapidly disintegrate. It would become streaked with black lines, the white portions would fall down through the rifts thus formed, and a sudden extension of the black would thus take place. In films containing small quantities of glycerine this phenomenon is sometimes observed on a very large scale.

There is also a third way in which the black appears, namely, in cases where there is no discontinuity between the white and black. Here the thinning takes place in the normal way, but, as in Newton's observations, specks of a deeper black frequently appear. This phenomenon may easily be shown as a lecture experiment. If a few drops of water be placed on the surface of a piece of yellow soap, and the end of a glass tube ground plane be dipped into them, a film can be removed. On throwing a magnified image of this on the wall, it is observed to thin rapidly. The white often passes through gray into black, and then the deeper black spots appear and rise to the top of the film. Within our experience, however, this phenomenon occurs only in the case of transient films formed of a liquid which does not allow any high degree of persistence. It is for this reason that in the summary of results with which we conclude our paper, and which is given in the abstract (see NATURE, vol. xxviii. p. 142), we limit our statements to "persistent soap films." It is on these only that we have been able to make measurements, and of these only that we have any certain knowledge.

While, therefore, in answer to Sir Wm. Thomson, we are able to say that we have often observed the same phenomenon as Newton, viz. that of a deeper black separated by a line of apparent discontinuity from the less intense black which surrounds it, this observation has only been made in the case of liquids like that used by Newton, which he describes as "water made tenacious by dissolving a little soap in it."

We have made use of two liquids in the experiments on which our published results are based. In the case of the "liquide glycérique" the black was under continual inspection, the colours of the remainder of the film being frequently noted during the experiments, and when the film became very thin and uniform in colour, the observer had plenty of time to study its appearance. We have no recollection of ever having observed any black specks deeper than that of the main mass of black, either stationary, or moving about in it. Had they been formed in large quantity, our electrical measurements must have detected them. They would have risen through the thicker black as the white or black specks do through the coloured parts of the films, and would have congregated in the upper part and formed a ring of greater tenuity at the top. If, as analogy would lead us to suppose likely, they had appeared in greatest quantity towards the end of the film's existence, the resistance of the black area would have increased more rapidly than its length. We tested this by grouping our experiments according to the length of the black area (*Proc. Roy. Soc.*, June 21, 1877, p. 344), and found that the resistance per millimetre was, to within the limits of the errors of experiment, constant, whether the black was less than two or more than ten millimetres in length.

The second liquid, which was formed only of oleate of soda and water, was more similar to Newton's and more likely to give similar results. With this we could obtain such large areas of black that the electrometer method enabled us to measure the resistance of a portion of the black alone, without regard to that of the coloured portions of the films. These films were therefore observed much less closely than those formed of "liquide glycérique," but no eye observation or electrical measurement ever gave any indication of more than a single thickness of the black for each particular film.

Coming now to the optical observations, we have indeed noticed in the earlier stages of the history of the black films a bending of the interference fringes in the lower parts of the black region, which might indicate that near the coloured part of the film it was somewhat thicker than at some distance from it. It is, however, very doubtful whether in this part of the field the light was passing through black films only. The area of the black was not exactly the same for all the fifty or sixty films inclosed in the tube, and thus near the boundary of the black the light might pass through a few white films, which would account for the apparent thickening. We were unable to satisfy ourselves as to which of these explanations is the true one, though the latter is the more probable. The question is fully discussed in our paper, in which we show that if the apparent thickening were really in the black, that colour must begin to show itself at a far greater thickness than that ordinarily assigned to the "beginning of the black," which is unlikely, though not, in view of the great uncertainty which attaches to this part of Newton's scale, impossible.

On the whole, then, we incline to the opinion that the number given by our experiments is the least thickness of the black in the liquids we observed. We also think that the tint our persistent films displayed is decidedly deeper than that of the less intense black shown by comparatively non-persistent films, though to make certain of this would require careful comparative observations. It is possible that the spots of deeper black in non-persistent films may be thinner than that we have measured, and the very fragility of the films in which they appear gives some colour to the supposition that it is so. It is, however, significant that, in two liquids differing so much in composition as those we employed, the one containing two parts of glycerine out of five, and the other no glycerine at all, the means of the optical and electrical measurements give results differing so little as $11{\cdot}13\times10^{-6}$ and $11{\cdot}9\times10^{-6}$ mm. It would be very interesting to settle the question by direct experiment, but the nature of the films which show the two kinds of black would make it no less difficult. We are, however, at present studying the composition of what we may perhaps call black-forming liquids in the hope of extending our investigations further, and if we can obtain one suitable for the purpose we will certainly attempt the measurement suggested by Sir William Thomson.

In conclusion we may point out two deductions from our measurements. The first refers to their connection with the subject of Sir William Thomson's lecture. If the size of the molecules of which the liquid is composed is between 2×10^{-6} and 1×10^{-8} mm. (the limits given by him), it follows that the thinnest film measured by us, which was $7{\cdot}2\times10^{-6}$ mm., must contain not less than three and not more than 720 molecules in its thickness. The smallness of the smaller of these numbers tends to show that the real size of the molecules is considerably below Sir W. Thomson's superior limit.

The second deduction is a good illustration of the magnitude of the stress in a liquid surface. The surface tension of Plateau's "liquide glycérique" is about fifty-seven dynes per linear centimetre (cf. "Statique des Liquides," t. i. p. 200). This force must not be considered as acting on a mathematical line, but as the resultant of forces which are in play in the thin layer of liquid which

constitutes the surface, the thickness of which is the so-called radius of molecular attraction. If the magnitude of that radius were known, the average longitudinal tension per unit of area parallel to the surface in the outer layer of liquid could be calculated. We hope before long to apply several tests as to whether the thickness of a black soap film is or is not less than twice the radius of molecular attraction. Various considerations, the discussion of which we defer, indicate that it is not much less, while if the size of an atom approaches Sir William Thomson's lower limit it is probably much greater. If, however, we assume that the thickness of the thinnest film measured by us, say $7{\cdot}2\times10^{-7}$ cm, was just equal to twice the radius of molecular attraction, it follows that the average stress parallel to the surface must be $2\times57/7{\cdot}2\times10^{-7}=1{\cdot}6\times10^{8}$ dynes per square centimetre. This tension is eight times greater than that required to tear brick or cement asunder (cf. Everett's "Units and Physical Constants," p. 56), and one-half of that required to tear cast tin. If the radius of molecular attraction is the same for all substances, the stress in the surface of mercury in contact with air must be nearly ten times greater than in liquide glycérique, or one-fifth of the tension required to rupture steel bars. If the radius is less than half the thickness of the black films, these tensions would be greater.

In many of the ordinary calculations on capillarity the surface tension is treated as acting in a surface of infinite tenuity. In reality it acts in the matter of a liquid shell of small but definite thickness. Our experiments prove that the average magnitude of the stress in this shell is at least of the same order as that required to rupture the less tenacious metals.

A. W. REINOLD
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JAPANESE LEARNED SOCIETIES

NEARLY two years ago we described in NATURE a few of the principal of the scientific and learned organisations which had sprung up in recent years in Japan, in imitation of the societies of western countries. The faculty for combination and organisation would appear to be possessed in a high degree by the Japanese, for on all hands we find them establishing societies for political, self-help, philanthropic, industrial, commercial, scientific, and literary purposes. The comparative infancy of the press, and the consequent slowness and difficulty of the interchange of ideas, have rendered these organisations of great value in the social and political life of the country. The extent to which they have spread into every department of national life is well shown by a paper recently contributed by Herr P. Mayet to the *Transactions of the German Asiatic Society of Japan*, to which we are indebted for most of the facts in this article. Societies for philanthropic and political purposes, though probably more numerous and powerful than any others, are entirely omitted as beside the present purpose, which is to show how the thirst for knowledge and research is penetrating everywhere amongst this interesting people. It is important, too, to note that these societies are everywhere fostered and promoted by the leading men of the country, including most of the Imperial princes and the Ministers of State, and that they appear to be due in all cases except one to native initiation, unassisted by foreigners. The exception is the Seismological Society, which owes its existence and its excellent work to the efforts of Prof. Milne of the Engineering College of Tokio. Recently, as we learn from Herr Mayet, a Japanese section of this society has been formed, with numerous native members, papers in Japanese, and a native journal containing original as well as translated contributions. Three of the societies at present in existence have come down from ancient times. These are the Numismatic and Archæological Societies, and an association of *Go* players, similar to our own chess clubs. A society for the protection and restoration of ancient buildings, nearly all of which are naturally temples, has recently been founded, with the energetic support of the present Foreign Minister. As might have been expected, there is a society for the cultivation of Chinese literature; but the more practical spirit of Young Japan is exhibited in the association for propagating the employment of the *kana* or syllabaries in Japanese literature. The importance of the object of this society will be evident when it is mentioned that a Japanese boy of the scholarly class takes fr m five to seven years to learn the sounds of the Chinese characters, and then he has to commence to learn their meaning. Herr Mayet well observes that so long as the Japanese youth are so heavily handicapped in the race for knowledge they can hardly hope for victory against western lads, who, according to this writer's estimate, are at twelve years of age nearly six years in advance of the Japanese boy of the same age. To remove this obstacle by the employment of the system of forty-seven syllables, now in use in books intended for the common people, is the object of this society, which has for president the Vice Finance Minister. Passing over some art societies, we come to two intended for the cultivation of the French and German languages respectively. One of these is honoured by the support of an Imperial prince. The French Society is working on a French-Japanese dictionary, while both aim at the publication of translations from useful works in these languages. Those hitherto published appear to deal chiefly with political science, a study which appears to attract much of the energy and intellect of the rising generation. A Statistical Society appears also to be very successful, with its periodical publication. The Polytechnic Association has for its object the extension of knowledge with regard to mechanical inventions, and their application to the increase of production in Japan. Agricultural, dendrological, and forestry societies are also in existence, and we may specially note, as a result of the recent Fisheries Exhibition in Berlin, the establishment of a society for the study and improvement of the Japanese fisheries. Many of these associations are, it will be observed, exceedingly practical in their aims, and if the members can succeed in having their discussions and researches circulated among the people, much good will undoubtedly result. The Geographical Society of Tokio has been frequently mentioned in these columns, but there is also a Biological Society under the presidency of the native Professor of Zoology in the University of Tokio. Medical societies also are numerous, whether for purposes of study or to afford aid and relief to the indigent sick. The society for the collection and publication of books with regard to domestic industries must be of much public utility. Of a more purely scientific cast is the association for publishing a dictionary of technical terms in various departments of science and the mechanical arts. The process of finding these *termini technici* is far from an easy one. They have to be obtained from the Chinese, and have frequently, perhaps generally, to be *manufactured* by combinations of the Chinese ideographic signs, which often have but a strained or fancied resemblance to the object to be named.

In concluding his paper Herr Mayet says: "Our glance at the Japanese societies of Tokio exhibits a wealth of active ideal life and earnest endeavour. A warm patriotic pulsation is perceptible everywhere, and gives an assurance of the healthiness of the Japanese popular mind. We have here, it is true, only the beginning of association, but it promises much, and the movement will undoubtedly be a constantly growing one." After all, however, the ultimate value of any learned society is measured by the work which it has done, and we have as yet but little opportunity of applying this test to the associations of Japan.

RESEARCHES ON THE DEEP-SEA FAUNA FROM A ZOOGEOGRAPHICAL POINT OF VIEW

DURING recent years surprising and very remarkable discoveries have been the result of expeditions despatched from various countries by official and private bodies, in order to examine the zoological condition of the oceans of the globe. Thus, below the line of three hundred fathoms' depth, where biologists for many years believed with Edward Forbes that all animal life ceased, a fauna rich both in forms and individuals has been brought to light, and the theories once common enough among *savants* of a total absence of life at a certain depth in the sea have thereby in two decades suffered a complete revolution. Many objects which had previously been looked upon as biological impossibilities have been discovered, and the systematic science of zoology has been enriched with copious materials, from which hitherto unknown animal varieties have been described, recorded, and placed in their true position in the system, whereby many a gap in the zoological scale has been filled up, and science in a remarkable space of time made rapid progress. Besides this merely scientific gain, which can only be fully realised by men of science, the zoological museums have obtained valuable and fruitful treasures. The researches of the fauna of the oceans have been of double advantage, viz. as both enriching science and museums, and zoologists are delighted at both. The interest which various countries have taken in the study of the fauna of the sea has been shared between England, the United States, Sweden, Norway, and Holland, while lately even France and Italy have taken steps to assist in promoting this branch of biology, and there can be no doubt that similar researches will in the immediate future be carried on as indefatigably as heretofore.

It is my intention, with this prospect in view, to point out in these columns some methods of research in studying the fauna of the sea, which I believe will be of great advantage to science.

The manner in which the dredging of the sea is carried on from a vessel is generally this. The deposit on the bottom which the trawl or other similar appliance brings up is carefully sifted, and its animal contents placed in suitable vessels filled with spirits or other fluid for preservation. If time serves, a sorting of the various objects takes place at once, so that animals of various groups are deposited in separate vessels. These latter are either fully marked or else simply ticketed with a number, which is interpreted by an entry in the "dredging-log" kept for that purpose. The object of this log is, in the first instance, to fix exactly the spot—latitude and longitude—where the sample was taken, the time of the capture, the condition of the bottom, the depth, the temperature of the water, and if possible also the contents of salt both at the depth from which the sample was taken and at the surface. These are the annotations which have up to the present time been made by scientists when dredging. When the samples or collections thus obtained reach *terra firma* their scientific examination commences, and it becomes a matter of great moment to extract from these laboriously collected fragments a scientific whole which will be of value to zoology. The various groups of animals are consigned to different hands, *i.e.* taken in hand by specialists, the result of whose researches will naturally vary according to the lines of study they pursue. In nearly every instance the result of the same is a descriptive or anatomical work, as well as a work of the fauna; varieties and forms new to science are described, delineated, and placed in their true position in the system, while some previously known are shown to exist in places where they had hitherto been unknown. Science has thereby made a double gain, viz. a systematic and a zoogeographical. With regard to the systematic gain, it is no doubt considerable. The descriptions, with or without illustrations, may be long or short, and refer either to the exterior forms or interior construction, *i.e.* its anatomy in a limited sense; still they are invariably fruitful if they are only sufficiently complete and, what is of most consequence, methodical. Both anatomy and morphology will in most instances obtain from them what is demanded by these sciences. But on the other hand the zoogeographical gain is very unsatisfactory. What do we thus, for instance, learn from such a statement as this, that *Yoldia arctica* has been met with in lat. 73° 0′ north, and long. 68° 15′ east? Nothing more nor less, in fact, than that it has been found in this particular place along with many others. By comparing, however, this locality with the others where it has previously been found, I no doubt gain a certain knowledge of its horizontal distribution, but I do not in the least degree learn from this statement the laws which govern the same. If, on the other hand, I am informed that the bottom in the place of discovery is brown sand mixed with clay, that the depth is eight fathoms, that the temperature of the water was −2° C., and its specific weight 1·0273, I have at once materials for a far wider knowledge. These particulars furnish me with a basis for ascertaining the external conditions which regulate the existence of this species; and if I, besides these particulars, also learn with what animals of the same and other genus the *Yoldia* has been found in that particular place, I obtain a certain imperfect idea of the animal life existing there. I said imperfect, as, in order that the description should be complete, it is necessary I should also know the number of each species found. If I had thus information of how many individual *Yoldia* were taken in this place, and how many of the other species of animals were taken, and also if specimens of *every one* of the animals existing in this place had come up in the trawl, then I should possess an approximate knowledge of the animal fauna existing in such a place. The knowledge of the relative number of the species in a certain place is, in my opinion, a factor of essential importance to the science of zoogeography.

The example I have just quoted shows sufficiently how very incomplete the zoogeographical statements are which only record the exact place where certain species were taken. On such a basis nothing of any scientific value can be founded.

It would, I consider, be of immense value to zoology if dredgings during the larger expeditions were effected by men skilled in every branch of this science. It is clear that the more copious and varied the knowledge of the zoologist is the greater will the gain be to science on this point, especially if the student is able at the moment to take full note of what is brought to the surface. If this be the case, he would be able there and then to classify the varieties caught and particularly record the number of individuals taken, which is naturally of most consequence where it is not possible to preserve all species. Such records would be of great value to students of zoogeography, and I am under the impression that as yet no zoologist has conceived this idea, or at all events not carried it into execution.

It would undoubtedly be a matter of some difficulty, from the copiousness of the existing zoological literature, and the consequent impossibility of mastering the same, to find men who are experts in every branch of descriptive zoology, and at the same time prepared for such work as I have indicated here. While the mere mechanical act of dredging must necessarily be effected by younger men, the careful sifting of the deposit brought up is of such importance that it should only be done by a zoologist of advanced years and study; but as it seems an impossibility to combine the two conditions, the only possible way out of the difficulty is for the zoologist to preserve all

which comes up if the material shall be of any use to zoogeography.

Having indicated my views in general on this subject, I will proceed to state those cardinal points of which the zoologist should always give exact and as detailed particulars as possible, which I consider essential to the development of zoogeographical science. They are :—

1. *Place of Discovery.*—This should preferably be fixed by latitude and longitude, but, if this is not possible, by other exact means. In works describing certain sea fauna I have often found expressions as vague as these : "Bohuslän (province of Bohus)—Bergen," or "Kullen—Finmarken," "Norway and Greenland." The former of these descriptions may be satisfactory enough, if thereby is meant that the species in question are to be found between Bohuslän and Bergen, and from Kullen to Finmarken, although it would have been of more value if, even with the commonest kind, *each* place of discovery had been enumerated. It is a well-known fact that both common and rare species alike are found in smaller or larger quantities in different places, and it is information of this circumstance which it is necessary to have if a student shall be able to determine the horizontal extension of a certain species and its numerical relation to others within a certain area. With regard to the latter it implies, I suppose, that the species in question may be found along the whole coasts of Norway and Greenland, but the real meaning is, however, that they have been found somewhere, perhaps in several places, within the specified limit, and information of such vague character is to say the least of it imperfect. The physical conditions of the coasts of Greenland below the level of the sea *may* be the same from the most southern to the most northern point, but, on the other hand, it must not be forgotten that the known extent of Greenland from south to north is 23 degrees, *i.e.* 345 geographical miles, and that it is, therefore, just as likely that what applies to the development of the fauna in Davis Sound does not apply to that in Baffin's Bay ; less still in Smith's Sound, not to mention that of the east coast. The extent of Norway covers 11·5 degrees, or 172 geographical miles, and the physical conditions around the coast are very variable, and as regards the fauna of the sea here it is a fact that there is a great division in the southern and the arctic element.

An exact fixing of the place of discovery has only been quite recently effected. Thus, K. Moebius's work, "Die wirbellosen Thiere der Ostsee," F. Meinerts's "Crustacea isopoda, amphipoda, et decapoda Daniæ," and A. W. Ljungman's "Förteckning öfver Spetsbergens Holothurider" leave nothing to be desired in this respect ; but these cases are only exceptional, as most zoologists, whether treating the anatomy or the fauna, are satisfied with a mere enumeration of places of discovery. It is, however, true that zoological literature, as well as all other, deals with many extraneous matters, while some writers are anxious to adopt a very brief style ; but in the matter of detailing the place of discovery no brevity should be observed. If zoogeography is to be something more than a mere knowledge of the horizontal distribution of the species, the places of discovery must be exactly detailed.

2. *The Depth.*—The depth at which the sample was taken should also be exactly stated as, while the place of discovery teaches us the horizontal distribution of a species, the depth indicates the vertical one. It is a well-known fact that most species are confined within certain vertical limits, which are in some instances not far apart. It certainly was to be expected that information of this nature would be found in modern works, but this is not the case. G. O. Sars' "Mollusca regionis arctica Norvegia," F. Meinerts's above-mentioned work, and O. Harger's "Report on the Marine Isopoda of New England and Adjacent Waters" are, however, remarkable exceptions to this fault. The accuracy and minuteness of these authors on the vertical distribution of the species deserve every commendation, while it must be regretted that such a work as A. Boeck's "De skandinaviske og arktiske Amphipoder," which is undoubtedly the fruit of many years' practical study and research, gives in most cases no account whatever of the vertical distribution of a species. One attempts thus, for instance, in this work unsuccessfully to learn within what limits such a common species as the *Gammarus locusta* occurs on the Scandinavian coast. R. M. Bruzelius, in his work, "Skandinaviens amphipoda gamonaridea" (1858), and A. Göes, in his "Crustacea amphipoda maris Spetsbergiam allnentis, &c." (1865), had both set excellent examples in the way of describing the distribution of species in the deep ; still Boeck has paid no attention to this important question. He has only dealt with the synonymy, genus, and the horizontal occurrence of the species, and even as regards the latter his statements are very summary. With such statements as these, that *Diastylis Rathkei* has been found between 3 and 540 fathoms, *Idothea Sabieni* between 4 and 1215 fathoms, *Axinus flexuosus* between 3 and 450 fathoms, *Xylophaga dorsalis* between 10 and 650 fathoms, and *Caryophyllia Pourtalesi* at 100 and 980 fathoms depth respectively, it may at first sight appear a matter of little importance to state at what depth they have in each individual case been found. This is, however, one of great importance. The vertical distribution of species is variable in different seas, and it must depend on subsequent research to determine on what this variability depends. The causes may be several, and are no doubt complicated ones, as the pressure of the water, which for a long time was considered one of them, does not in any way affect their existence. The causes must be of a very different nature, and before any of them can be ascertained it is necessary to obtain exact particulars of individual instances. The following comparison of the vertical distribution of a few species in various seas may illustrate this :—

Tellina solidula appears in the Arctic waters of—

	Novaya Zemlya		Norway	
	at from 4– 26 fathoms		at from 0– 10 fathoms	
Cardium ciliatum	,, 2– 60	,,	,, 5– 10	,,
Cardium grönlandicum	,, 2– 20	,,	,, 5– 10	,,
Rhynchonella psittacea	,, 5– 60	,,	,, 20– 80	,,
Margarita obscura	,, 2–120	,,	,, 120–300	,,
Fusus tornatus	,, 8– 10	,,	,, 20–100	,,

The difference in five of these cases is not very great, but in one—*Margarita obscura*—it is very considerable, and even if we are unable to explain it, it should nevertheless be recorded.

3. *The Nature of the Bottom.*—This is a factor of great moment in the fauna of the sea and the division of the species. I have thus on the coast of Novaya Zemlya and in the Siberian seas personally observed that a clean sand bottom without admixture of clay is very poor in fauna, but if mixed with some clay somewhat richer, while where the clay predominates it is greatly richer. The most copious and varied is, however, that of the pure clay bottom. In shallow water on the coasts of Scandinavia the student has many opportunities of observing the variations in the copiousness of the sea fauna, both as regards the numerousness of the species and their individuals on bottoms of various natures. Possibly the nature of the bottom at greater depths, below the line where the higher orders of Algæ cease to exist, is not of such influence as above the same, but that it is in most instances of great moment to the fauna I am firmly convinced. To animals which do not live on prey the quantity of the organic elements in process of decomposition in their place of vegetation must be of consequence ; to most of them the organic composition

of the bottom must be of the greatest consequence. The colour of the bottom does also, I believe, affect the existence of certain species. I therefore recommend that the nature of a bottom is not *alone* recorded, as, for instance, thus, "clay bottom," "clay mixed with sand," "stones with Algæ," and "globigerina ooze," but that a sample of the bottom is also in every case taken for future chemical analysis. It should, however, be seen that the sample is from the surface layer, and not from those below, which may of course be of a quite different nature.

4. *The Temperature and Saltness of the Water, as well as its Chemical Composition near the Bottom.*—Particulars of these circumstances should always be given exactly, as they do, no doubt, have a considerable share in the production of a species. This is so evident that it requires no further discussion.

5. *The Period of the Research.*—This is a point which zoologists in most instances fail to record, and yet it appears to me in several respects to be of great interest. Everything in life is subjected to a gradual organic change, and I believe that the fauna of the sea in this respect does not differ. Those species of animals which to-day appear within a certain locality are undoubtedly not the same which were found there, say, a hundred years ago, and still less the same as those which existed there a thousand years ago, and what applies to the past applies with equal force to the future. The struggle for existence causes the immigration of new forms, while others must, so to say, make room for the newcomers and thereby disappear. This lies in the progress of historical development. For this reason it is necessary to state the period of the research, and although science may have no immediate gain from such dates, it will no doubt come in course of time, and it is the duty of the student of zoogeography to work as much for posterity as for the present. It is with these particulars as with those of meteorological observations, viz. that one must possess a number of observations, extending over a long period, before the deductive result becomes of scientific value.

But apart from the ultimate benefit which may be derived in the future from these details, disputed perhaps by some, the record of the time when the specimens are taken is of great importance to modern science. It is thus well known that many of the inhabitants of the sea, not only those which possess perfect organs of locomotion, but also those which live a somewhat stationary life, undertake, during certain periods of the year, shorter or longer migratory wanderings. This is, however, as regards the lower Invertebrates, a circumstance which has been so little attended to, that hardly any information exists on this point in print. In connection with this peculiarity the records which I advocate would be of great use. The causes of the migratory movements may be very difficult to ascertain; but it is necessary in the first instance to demonstrate a fact—the explanation will follow in course of time. I have further indicated under (7) why I consider these statements as to time of such importance.

For the study of zoogeography in general it may be sufficient alone to know what species occur within a certain area, whether large or small. The student of zoogeography compares those species which are to be found either near or far from one another, he shows that some of them are common to all those parts which he has under consideration, that others belong to a few, and with these data before him he attempts to discover the causes of their appearance or absence in certain places. If possible, he takes the most recent palæontological phenomena into account too, he views the fauna of the present day by the light of the past, and obtains thereby remarkable and perhaps unexpected results.

6. *The Relative Plurality of the Individuals and the Colonies.*—It cannot, however, be denied that, should the mode of research indicated above be fruitful in some respects, it will not give a complete account of the animal life existing within a certain sphere. To obtain this it is necessary to know the relative plurality of the individuals and their colonies in every individual locality within the sphere. On this point my opinion is that, in order to understand correctly the composition of a fauna, it is not enough to know those species which it embraces, the zoologist must not be content with a mere enumeration either with or without descriptions of the various species and their distribution within a certain sphere, but he must also take into consideration the relative plurality of the individuals of each, *i.e.* he must, in other words, study the *statistics* of the species. It is clear that zoogeography must be based on these two propositions, as the science would not advance far, if it should, for the comparison of the fauna of two localities, rest on a mere enumeration of the species occurring in such localities. A case might certainly occur in which two localities could approximately possess the same species, while their fauna were very different in composition. To the student of zoogeography this is no improbability.

It cannot, of course, be demanded that the zoologist occupied in dredging should immediately record the number of every species the trawl brings up, as he must for this purpose possess special qualifications, but science is greatly benefited too by the course that, when the various groups of species are distributed for research and classification, the specialists in question in their works on the same record exactly the number of individuals taken of each species, and, with regard to animals forming colonies, also how many colonies were found in each place. When all the groups of the species had thus been dealt with, the student specially interested could compare the various species in every place investigated, and also the individuals and colonies in each, and by such a comparison we should obtain a really complete knowledge of the animal life in the locality investigated. If, however, no notice be taken of the relative plurality of the individuals, whether from want of study or attention to the importance of the point, the picture which the reader of his work obtains of the animal life in a certain locality will be very vague and unsatisfactory indeed.

7. *The Relation between Males and Females in the Same Place, and, if possible, at Various Times and Seasons.*—The attention of zoologists should, in connection with the study of the relative plurality of individuals and colonies, also be directed to this interesting circumstance, which of course is not related to zoogeography, but to biology. No doubt investigations of this relation would lead to valuable discoveries. In some species, with sexual difference, the males predominate, in others the females, while in some they are evenly balanced. Another point also of interest connected herewith is at what period of the season the process of fertilisation takes place, how long the pregnancy lasts, and when the females cast their eggs; whether these functions are confined to certain seasons or not. Investigations of this point show that in some cases these functions are regulated most punctually, but in others not, and consequently it would be a matter of great scientific interest to ascertain the relations of the species on this point. For this reason it is also of importance to state the exact time when the examination of a certain locality took place.

I consider that the points I have here discussed are the principal ones for which the zoologist should, in order to advance zoogeography, collect materials when making researches on the fauna of the sea. They form in my opinion the basis on which this science shall be founded for a higher and more extended knowledge, and if the researches I have here indicated are executed in a systematic manner and with due care, my belief is that zoogeography will in a short space of time reap excellent benefits and fruits therefrom; but here, as in every other branch of study, it

is necessary to work with patience and in co-operation with others, as the labour is one demanding both time and exhaustive study.

ANTON STUXBERG

Gothenburg Museum

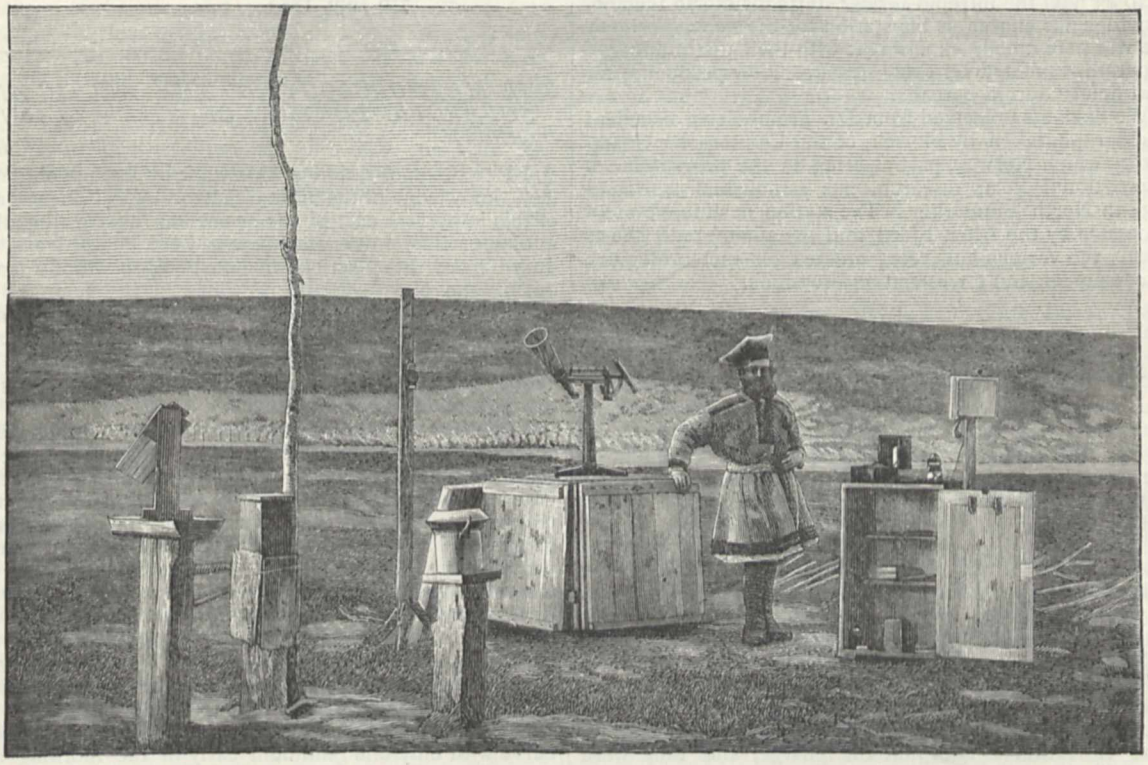
DR. TROMHOLT'S AURORAL OBSERVATORY AT KAUTOKEINO

WE are indebted to Dr. Sophus Tromholt for the photograph from which our engraving has been made of his auroral observatory at Kautokeino in Finmarken, Norway.

The Norwegian *savant* has, as may be remembered from his communications to NATURE, during last winter sojourned in Lapland for the study of the aurora borealis, simultaneously with which observations of this remarkable phenomenon have been made at the Norwegian and Finnish Circumpolar Stations at Bossekop and Sodankylä.

Dr. Tromholt writes :—"Since September last I have, for the sake of the aurora borealis, been residing here in North Finmarken (69° N. lat., 23° E. long.), in a zone therefore where the auroræ attain their maxima, and where the phenomena, consequently, are so frequent and on such a scale that there cannot be a question of selecting and analysing one in particular.

"My winter sojourn here has two objects in view, viz. firstly to frame a pendant to the observations of the aurora borealis made at Bossekop, 1838-39, by the French Commission du Nord under Lottin and Bravais ('Voyages en Scandinavie,' &c.), and, secondly, by means of altitudinal measurements corresponding with those being made at the Norwegian Meteorological Station at Bossekop, to procure sufficient materials for fixing the parallax of the aurora borealis. I choose the remote Kautokeino for my observatory for several reasons, viz. : that the place is almost due south of Bossekop, while the distance between the two is very nearly a degree, a distance which



Auroral Observatory at Kautokeino.

is exactly suited to the theory I have formed of the height of the aurora borealis—150 kilometres ; and also because it possesses a remarkably free horizon and an inland climate insuring favourable weather conditions.

"As previously stated, observations are made simultaneously here and at Bossekop on a common prearranged plan, and measurements made in the same vertical plane by the so-called auroral theodolite constructed by Prof. Mohn. A similar arrangement has also been made with the Finnish station at Sodankylä, which is, however, situated at a great distance from this place, and in a direction somewhat unfavourable (about 45° S.E.). We shall not of course be able to compare notes before the spring, so I am unable at present to give the final results of my observations ; but judging by own researches here I feel convinced, in spite of scientists' assertions to the contrary, that the height of the aurora borealis may be measured by the method I advocate, and that from the observations made at these three stations we shall obtain the materials required for the solution of a problem hitherto deemed an insoluble one.

"The photograph which I forward you shows the little 'scientific temple' I have raised in these lonely tracts, which have hitherto only seen Lapps and reindeer. In the centre stands my most important instrument, viz. a combination of the auroral theodolite and the passage instrument, fixed on a stone column and inclosed in a small wooden box, the upper half of which may be lowered at will. Here are, besides the necessary apparatus for meteorological observations, also to be found every requisite instrument and appliance required for my researches, such as chronometers, spectroscopes, lanterns, &c. Between them all stands the writer himself, clad in the tasteful summer costume of a Lapp, viz. pointed leather shoes, breeches twisted around the leg at the ankle, the blue frock ornamented with red and yellow borders ; and to crown it, the smart cushion-shaped cap.

"I have several times attempted to photograph the

aurora borealis, but without success. Thus, not even by using the most sensitive English 'dry' plates, and exposing them from five to seven minutes, have I obtained a trace of a negative. The cause of this is, I believe, the exceedingly limited substance of light possessed by the auroræ; were thus the entire heavens flooded by the most intense auroræ their aggregate lighting power would not equal that of the moon when full. I may therefore assume that to photograph the aurora borealis is an impossibility."

On a later occasion Dr. Tromholt informs us that he obtained no negative of the aurora borealis throughout his stay at Kautokeino, while he found also, on visiting Bossekop and Sodankylä, that neither had any been obtained at these observatories.

As to the results of Dr. Tromholt's researches on the aurora, we may add that, as soon as he has received certain comparative tables of the observations made at Sodankylä from Prof. Lemström, he will immediately communicate the same to NATURE. In the beginning of October next the intrepid *savant* starts for North Iceland, which he has chosen as his station for the coming winter. He will here chiefly experiment with the "utströmnings" apparatus invented by Prof. Lemström for producing an "artificial" aurora borealis.

We have also received from Dr. Tromholt an excellent photograph, taken by himself, of the Circumpolar Observatory which Norway, participating in the programme of international Polar research, has established at Bossekop, in North Finmarken. The station is situated on an eminence by the Alten Fjord, and the photograph shows clearly the various huts, &c., erected for meteorological, astronomical, and terrestrial observations.

ALDABRA ISLAND TORTOISES

THE following report by the Hon. W. Littleton, addressed to Sir John Pope Hennesy, Governor of Mauritius, has been forwarded by His Excellency in answer to a memorial presented by the late President of the Royal Society, and several other gentlemen, relative to the preservation of the gigantic tortoises on the Island of Aldabra:—

Memorandum on Aldabra Island Tortoises

TO HIS EXCELLENCY THE GOVERNOR,—With reference to your Excellency's request for a report on the Aldabra Island tortoises lately placed on Flat Island, I have been able to get very little information about them.

The Mauritius Acclimatisation Society recently handed over six tortoises to this Government, on condition that they should be placed on Flat Island and taken care of. The Government accepted the charge, and they were accordingly placed there about two months ago. The Storekeeper-General (Mr. Schmidt), who is much interested in them, tells me that they are completely at liberty, that they feed themselves, and are apparently doing well.

Only five of them are Aldabra tortoises; the sixth is from Madagascar. They are all young, and of comparatively small size.

But I may perhaps mention here that there are several specimens of the Aldabra tortoise, besides these, both here and in Seychelles. There is the well-known large one in the garden of the Royal Artillery mess in Port Louis. He was here before the English occupation of Mauritius in 1810. The largest circumference of his shell measures 9 feet 3 inches. He stands 2 feet 6 inches high.

In the Botanical Gardens at Pamplemousses there are two belonging to Mr. Cockburn Stewart, who brought them from Seychelles. They are about ten years old. The largest circumference of their shell is 7 feet 2 inches, and they stand 1 foot 8 inches high. Mr. Schmidt tells me of a very large one belonging to Mr. Castel, at Rivière Sèche, and of a very large pair on the estate "Mon Trésor," near Mahebourg, belonging to Mr. Daruty; but their measurements, which have been promised to me, I have not yet received.

A considerable number are kept by various people of Seychelles, including a pair at Government House, Mahé, the female of which recently laid eggs, and I am told that many of the tortoises kept on the Seychelles Islands frequently breed.

I am sorry not to have been able to collect for your Excellency's information more details of these creatures; but I have stated enough to show that there are many specimens well known and in good keeping.

I have also been unable to ascertain whether there are any of large size known to remain on Aldabra Island; but I am told that it is supposed there are in the thick scrub of the interior.

(Signed) W. LITTLETON

Colonial Secretary's Office, Port Louis,
7th July, 1883

THE METEOROLOGY OF THE ARCTIC AND SUBARCTIC PORTION OF THE ATLANTIC OCEAN[1]

UP to the publication of this work by Prof. Mohn, our knowledge of the diurnal meteorological phenomena of this important part of the ocean was nearly altogether a blank. The interesting results here detailed are deduced from three series of hourly observations made during the Norwegian Expeditions in the summers of 1876, 1877, and 1878, which Prof. Mohn organised and carried out with a skill and a completeness that leave nothing to be desired. The new facts thus brought before us largely extend our knowledge of the physics of this portion of the North Atlantic.

The diurnal phenomena dealt with are atmospheric pressure, temperature, and aqueous vapour, the force of the wind, and the temperature of the surface of the sea. Of these the discussions of the atmospheric pressure and temperature are the most important and satisfactory. The results of the atmospheric pressure present several points of the highest interest. The general curve for the three seasons, if a scarcely perceptible dip about 8–9 p.m. be neglected, shows only one minimum at 4 a.m. and one maximum at 2 p.m., thus roughly approximating to the curve of temperature. The curves for the separate seasons 1876 and 1878 exhibit an evening minimum with greater distinctness. The observations made by the *Challenger* Expedition in the Antarctic Ocean give a curve with only one minimum early in the morning and one maximum early in the afternoon; and it is highly probable that if the observations made by the Norwegian Expeditions quite in the open Atlantic were alone included, the resulting curve would give no sign of a dip in the evening.

Prof. Mohn then examines the observations made at the stations on the coast of Norway at 8 a.m., 2 p.m., and 8 p.m., and it is concluded that the diurnal variation of the barometer during the summer months on the adjacent coasts of Norway, as well as in the Norwegian Sea, has its minimum in the morning and its maximum in the evening, and that possibly there is a tract in the Norwegian Sea including the bounding coasts of Norway and Greenland, thence crossing Iceland, and passing to the west and south of Faroe, where the lines of barometric variation would represent values with plus signs instead of minus signs as elsewhere. In other words, over this region there occurs a state of things the reverse of what obtains over the lower latitudes of the ocean and the land

[1] "The Norwegian North Atlantic Expeditions 1876-78. Meteorology." By H. Mohn. With 13 woodcuts and 4 plates. (Christiania, 1883.)

surfaces of the globe from the time of the morning maximum to the afternoon minimum.

The following are the four phases of the diurnal variation of the pressure in summer at a few of the more strictly insular stations :—

	1st Min.		1st Max.	
	Inch.	Time.	Inch.	Time.
Amsterdam	−·013	4.30 a.m.	+·007	11.30 a.m.
Falmouth	−·019	4 ,,	+·009	0.30 p.m.
Valentia	−·018	4 ,,	+·006	0.30 ,,
Helder	−·018	4 ,,	+·008	1.30 ,,
Sitka	−·006	6 ,,	+·006	2.30 ,,

	2nd Min.		2nd Max.	
	Inch.	Time.	Inch.	Time.
Amsterdam	−·004	5'30 p.m.	+·010	11 p.m.
Falmouth	−·001	6 ,,	+·011	10 ,,
Valentia	−·000	5 ,,	+·014	10 ,,
Helder	+·001	6 ,,	+·010	9.30 ,,
Sitka	+·000	7.30 ,,	+·002	11 ,,

The chief points to be noted here are the large amounts of the 1st min , and the small amounts and retardation in the times of occurrence of the 1st max. and 2nd min. All these peculiarities are presented in a still stronger form by the results of June taken by itself. Thus at Sitka the times of the four phases are 7 a.m., 3 p.m., 7.30 p.m., and 11 p.m., and the 2nd min. and 2nd max. become very small. It is only, however, over the open sea in the higher latitudes where the 2nd min. and 2nd max. disappear, resulting in one minimum in the early morning and one maximum in the early afternoon. This afternoon maximum therefore really represents the a.m. max. of the lower latitudes of the ocean and of land surfaces—which phase of the pressure occurs at different hours from 7 a.m. to 3 p.m. according to latitude and geographical position—and hence subsequent to the a.m. or 1st max. the lines representing the diurnal barometric variation are everywhere to be represented by minus signs.

The highly important result remains that over the open sea in the higher latitudes of the Atlantic and the Southern Ocean the diurnal curve of pressure, as shown by the observations of the Norwegian and *Challenger* Expeditions, exhibit only one minimum and one maximum and that the curve generally resembles the curve of temperature. Hann's remark that "in the daytime the air in the upper strata above the land flows towards the sea, occasioning an increase of pressure, which even on the coast asserts itself by retarding the morning maximum and the afternoon minimum ; in the evening and at night this process is reversed, a current of air in the higher strata flows from the sea to the land ; hence the pressure increases, diminishing on the coast, and the evening maximum becomes inconsiderable," simply accounts for part of the phenomena as observed near the coast and at no great distance out at sea. It leaves, however, the outstanding feature of the diurnal atmospheric pressure over the open seas of high latitudes untouched and unexplained. To this point we shall return on an early occasion.

The curves of the diurnal distribution of the pressure of the aqueous vapour of the air are very interesting. Grouping the three series together and bloxaming the results, we obtain a curve of great simplicity, showing one maximum and one minimum, the maximum rising 0·1 mm. above the daily mean from 11 a.m. to 3 p.m., and the minimum falling 0·1 mm. below it from 10 p.m. to 4 a.m. In other words, the curve of the force of vapour substantially agrees with the curve of temperature, and it agrees with the same curve obtained from the open sea observations of the *Challenger*. The curve for the *Challenger* observations taken near land shows a dip from about 11 a.m. to 3 p.m. which is quite decided, though not of so pronounced a character as is seen over land during the summer months. A slight dip occurs in the separate curves of the Norwegian Expeditions for 1876 and 1877, which doubtless is due to the comparative proximity to land where several of the observations were made. This reduction in the amount of the aqueous vapour which is observed to occur during the hottest hours of the day is due to the descent of the drier air of the upper regions to take the place of the air which ascends from the heated surfaces of the earth. This diminution of the aqueous vapour of the air is not restricted to the air over the heated surfaces, but, as shown by the *Challenger* and Norwegian observations, it extends for some distance out at sea, probably as far as the indraught of air from the sea towards the land heated by the noonday sun is felt.

The curve of the diurnal velocity of the wind deduced from the whole of the observations and bloxamed reveals the fact that the influence of the lower pressure which obtains over the interior of Scandinavia, as compared with that round its coasts during the hottest months of the year and the hottest hours of the day, extends much further out at sea than might have been supposed, and the curve of the force of the aqueous vapour just referred to corroborates this view. The curve of the diurnal velocity of the wind substantially agrees with that of the temperature.

The same overpowering influence of the sun is equally seen in the diurnal distribution of the temperature of the surface of the sea, the curve for which agrees with that for the temperature of the air. The curves for the separate years show, however, such striking differences in the mean amounts of the diurnal variation, and particularly in the hours of occurrence of the maximum excesses above the day means, as to show that a less close approximation to the true diurnal curve has been arrived at for the temperature of the sea than for any of the other meteorological elements. In carrying out this work and discussing the results, Prof. Mohn has clearly made a contribution of the greatest importance to the physical geography of the sea.

ALEXANDER BUCHAN

VIENNA INTERNATIONAL ELECTRICAL EXHIBITION

THE Vienna Electrical Exhibition was opened to-day to the public. The patron of the Exhibition, the Crown Prince Rudolph, the Portuguese Crown Prince, the Princes of the Imperial family, the higher functionaries of the State, and the Foreign Commissioners were present at the opening ceremony. The attendance of the public was small ; only 4000 persons have visited the Exhibition to-day, the weather being rainy. The Crown Prince, in replying to the address delivered by Baron Erlanger, the president of the Exhibition Commission, said that it did not seem to be only by chance that the third and greatest Electrical Exhibition is held in Vienna—in the town in which, in 1833, lucifer matches were invented by Preschel, from which, in 1837, the stearine candle found its way through the whole world, and where the lighting of streets by gas had been suggested by the Moravian, Zinser, before it was carried out in England.

The Exhibition, though still incomplete, promises a good display illustrative of the great progress made in practical electricity during recent years, and showing how the application of electricity for the various purposes of industry and of daily life is becoming more and more common. So far as we can see now, although the work of installation of the machinery and apparatus is not yet completed, the Exhibition will stand comparison with previous exhibitions as to the number and variety of exhibits and the arrangement of the whole. From the official catalogue published to-day we learn that there are 579 exhibitors, 223 of whom are from Austria, 133 from France, 68 from Germany, 27 from Russia, 16 from Italy, 10 from Denmark, 13 from America, and 27 from England. Thus the Exhibition is rather a Continental one,

and it is generally much regretted that so few exhibits have been sent from England, which has played a leading part in the development of applied electricity.

A special feature of the Vienna Exhibition is the building itself—the Rotunda, built by Scott Russell, the eminent engineer, in 1873, covering with its annexes and courts a space of 33,000 square metres. The vast dome is 79 m. in height, and three galleries, the highest—the lantern gallery—being 66 m. above the ground, make it well adapted for illumination by electric lamps. Everything has been done to make the Exhibition as interesting and attractive as possible. Between the Rotunda and the Praterstern an electric tramway will run. The Rotunda is brought into telephonic connection with the Opera. A gallery of the Exhibition building contains a model theatre lighted by incandescent lamps, where ballets will be performed and scientific lectures given by eminent specialists, while another gallery contains beautifully arranged and furnished interiors and the picture gallery. In the machine rooms the great boilers make a gigantic impression; they will supply the various motors with 1400 horse-power to drive the electric machinery for lighting and transmission of motive power. In the nave are arranged the exhibits of different railway companies and also various scientific apparatus, of which further details will be given in subsequent communications.

Vienna, August 16

NOTES

We understand that Her Majesty's Government having through the Foreign Office been invited to appoint delegates to the International Geodetic Congress to be held at Rome in October next, at which the adoption of an international common meridian and common time for railway and telegraph purposes is to be discussed, the Lords of the Committee of Council on Education appointed a Committee to report on the subject. The Committee consisted of the Astronomer-Royal, General Cooke, C.B., R.E. (late Director-General of the Ordnance Survey), General Strachey, C.S.I., R.E. (Member of the India Council), and Col. Donnelly, R.E. (Secretary of the Science and Art Department). In consequence of their Report, the Treasury have consented to provide the travelling and personal expenses of two delegates. We are glad to say that the Science and Art Department, in concert with the Foreign Office, have appointed the Astronomer-Royal and Col. A. R. Clarke, C.B., R.E., F.R.S., to represent this country, and that they have consented to act.

The local secretaries at Southport have been exerting themselves to make the visit of the British Association a success. Excursions are arranged for Saturday the 22nd and Thursday the 27th of September. The Association has not met in Lancashire since the meeting at Liverpool in 1870 under the presidency of Prof. Huxley, and it is believed that the industries of the county have since then so developed and expanded as to open up fresh sources of interest to the chemist, the engineer, and the economist. It is believed that ample and convenient accommodation for a full meeting of the Association has been secured. The Winter Gardens have been engaged for the exclusive use of the Association, and in them will be given the Presidential Address and evening lectures, and in them will also be held the *conversazioni*. The spacious assembly room in the Cambridge Hall will be devoted to the purposes of a reception room, and suitable halls have been acquired for the use of the various sections. Numerous excursions are in process of arrangement. Among these is a visit to Stonyhurst College, the observatory, museum, library, collection of ecclesiastical vestments, and grounds, which are extremely interesting. The Abram Colliery, near Wigan, will be open to inspection, as will also the Wigan Coal and Iron Company's pits and ironworks. Messrs. Platt Brothers and Co. have offered to show a party of members of the Association over their extensive machine works at Oldham, and certain large cotton mills in the same town will be open to visitors on the same day. A geological excursion will be made to the neighbourhood of Clitheroe and the Victoria Caves, which it is hoped will be personally conducted by Mr. R. H. Tiddeman, M.A., F.G.S., who made the geological survey of the district. Another party will visit Furness Abbey and the Lake District. The Earls of Derby, Crawford and Balcarres, and Lathom, and Mr. Weld-Blundell of Ince Blundell, will throw open their grounds to members of the Association, and at some of these places garden parties will be given. There is abundant hotel accommodation of the best kind, as well as good hydropathic establishments and numerous excellent lodging-houses. A list of all these has been prepared and published in pamphlet form.

The French Association began its meetings at Rouen on Thursday last, when the president, M. Frédéric Passy, gave an address on the history of political economy. The revenue of the Association during the past year amounted to 85,677 francs, of which 13,900 francs were devoted to purposes of research. The capital of the Association reaches the large sum of 454,526 francs. On Friday evening M. Hatt, hydrographer to the French navy, lectured on the transit of Venus in December, 1882, while another lecture on the transmission of force was given by Prof. Comberousse. Considerable time was devoted on Saturday in the Engineering Section to proposals for improving the navigation of the Seine. Various excursions have been made during the week, and will be continued to morrow and following days.

Mr. Belt has been commissioned by the *employés* of the late Mr. William Spottiswoode, President of the Royal Society, to execute a monument to his memory, and the site for its erection will be in front of Her Majesty's Printing Office.

Vienna papers announce the death at Botzen, in the Tyrol, on August 10, of the Austrian Vice-Admiral, Baron von Wüllerstorf-Urbair, one of the most learned and scientific officers that the Austrian navy has ever possessed, and who has contributed greatly to its professional improvement. He was not originally intended for a naval life, and was educated in the engineering officers' school at Tulla, where he acquired a great reputation, especially on account of his mathematical talents and proficiency. But a combination of circumstances led to his being transferred to the navy at the age of eighteen. He was almost at once allowed leave of absence to continue his scientific studies at Vienna, where he pursued astronomy and meteorology under Littrow, at that time director of the Vienna Observatory. In 1839, when only twenty-four years of age, Wüllerstorf was appointed to organise the marine observatory, and from that time till 1848 he acted as director of that institution, and as professor of astronomy and navigation at the Naval Academy in Venice. In 1848 he returned to active service, becoming commodore in 1857, when he took command of the *Novara* on the celebrated expedition around the world, the first of the kind undertaken by the Austrian Government. In 1861, being then rear-admiral, he became commander at the Venice station, and in 1864, during the Danish war, he was appointed to the command of the combined Austrian and Prussian squadron in the North Sea. In 1865 he became Minister of Commerce, a position which he held till 1867, when failure of health compelled him to retire from active life at the early age of fifty-two. He was a member of the Austrian Academy of Sciences, and of many other scientific bodies. He was sixty-eight years of age when he died.

The liberality of Finland to science is exemplary. The Senate has voted a sum of about 8000*l.* for hydrographical

researches and measurements in the Gulf of Bothnia. A suitable steamer is to be purchased and fitted with the necessary appliances and instruments. We have received a communication from Prof. Lemström, in which he informs us that the Senate has also voted him a sum of 1500*l.* for the continuance of his experiments in connection with the aurora borealis during next winter at Sodankylä. In a few weeks he will forward the programme of his intended researches to NATURE.

THE arrangements for the autumn meting of the Iron and Steel Institute, to be held on the 18th, 19th, and 20th of September, at Middlesbrough, are now almost completed. An influential local committee has been formed in that town, under the chairmanship of Mr. Bolckow, and has organised a series of excursions and entertainments in honour of the Institute. The new Basic Steel Works of the North-Eastern Steel Company, and the new and very extensive works of Bolckow, Vaughan, and Company, at Eston, will be the chief works to be visited, and as they are the first works that have been established in this country for carrying on the manufacture of steel by the Basic process, it is likely that they will be examined specially by the various members. Another interesting excursion will be made to the South Durham coal district, where a new system of manufacturing coke, admitting of very considerable economy in the yield as well as in the collection and utilisation of all the by-products obtained by the distillation of coal, has been for some time successfully at work. A very good list of papers has been formed for reading and discussion, and a fund of several thousand pounds has been raised to cover the expenses of entertaining the members of the Institute.

PADRE DENZA, the Director of the Observatory at Moncalieri, expresses, in a letter to the Bishop of Ischia, the opinion, based on the information thus far obtained, that no ulterior disasters are to be feared in Ischia for the present; and especially if the forces at work under Mount Epomeo continue to find vents in the two active *fumaroli*. At the same time he adds:—"We have, however, to do with capricious and uncertain phenomena which are still a mystery to science. They are matters which require close study, and I have recommended them strongly to de Rossi's attention." Prof. de Rossi, in his second report, a brief summary of which appeared in NATURE last week, limits himself to the consideration of the many warnings that Nature gave of the catastrophe. His third report will treat directly of the phenomena connected with it. In the meantime he is emphatic in recommending to the Minister of Agriculture and Commerce the completion of that chain of observatories over all the volcanic districts of Italy, for the reception and consideration of the signs and movements noted in which the Roman Observatory was founded. Had that chain been at least more complete, and had the long-talked-of observatory in Ischia constituted a link in it, the Roman Observatory would have recognised the fact that the widely extended subterranean movement, manifested with augmentation during the ten days anterior to July 28, had its centre of greatest, most continuous, and most variously marked activity at Casamicciola, and would have given that timely warning of the approaching storm which might have saved many lives. But, he adds, there is a question as to whether such warnings should be given. The inhabitants of Albano might, for instance, have abandoned their houses in alarm, and have spent the night in the fields, had the extraordinary state of the Solfatara there been known publicly on the 28th. "To this I reply," writes Prof. de Rossi, "that the inhabitants of Casamicciola would also have spent the night in the open air, and many lives would have been saved." But it is evident, according to the *Times* correspondent, from de Rossi's first preliminary report, that there is but little enthusiasm in favour of a system of earthquake warnings, like the storm warnings sent across the Atlantic, being adopted in Italy, where in many districts the inhabitants depend chiefly on strangers for their existence. He does not hesitate to attribute to a selfish fear of frightening strangers away the opposition made to the establishment of an observatory at Casamicciola. It has now been ascertained that the signs of warning at Casamicciola were numerous, and well known to those most interested in concealing them. But the possibility of danger was ridiculed, and part of the performance in the theatre on that fatal evening was Polchinello flying from imaginary alarms of earthquake. Prof. Palmieri summarises his observations on the earthquake in Ischia as follows:—"A small or moderate earthquake causing immense disaster. The continuous wearing away of the soil by the hot subterraneous springs is sufficient to explain the immense catastrophe, which has been enhanced by the very bad construction of the houses. Some damaged by the earthquake of 1881 had remained without repairs. The disaster of July 28 will be recorded more on account of the enormous loss of life and property than of its seismographic importance."

THE Island of Ometepec in the Lake of Nicaragua has just been utterly devastated by a volcanic outbreak, causing an overflow of several lava streams which filled up several valleys and ingulfed in its fiery current farmsteads, cattle, and all the cultivated fields. The eruption began on June 19, when a new crater opened. A continuous earth-tremor resulted in an overflow of lava directed towards Las Pilas. Two days later several other hills opened, pouring out lava in every direction, and the terrified inhabitants fled. Boats were sent from the neighbouring towns to save them. The whole island is described to be at present a heaving mass of molten lava, quite uninhabitable.

A SHOCK of earthquake sufficiently strong to move beds and displace crockery occurred last Thursday at Schuols, Pontresina, and Tarasp, in the Engadine. The shock was preceded by a violent storm and heralded by a peal of subterranean thunder.

A STATUE of Daguerre will be unveiled at his native village of Cormeilles on Sunday.

THE recent inquiry in the United States Patent Office concerning the invention of the telephone has had the following results:—Out of eleven interference cases, eight of them have been decided in Bell's favour, two in Edison's, and one in MacDonough's. MacDonough's award was for the invention of a "telephonic receiver," consisting of the combination of an electric current with a magnet and a diaphragm arranged close to the magnet so as to reproduce accurately the sounds as regards quality and pitch. Edison's awards are (1) for a "hydroelectric telephone"; (2) "for a spring carrying one electrode and constantly pressing against the other electrode, and the diaphragm to maintain the required initial pressure between the electrode and yield to the movements of the diaphragm." The most remarkable of Bell's awards is the art of transmitting and reproducing sounds at a distance by means of an undulating electric current. The remaining awards of Bell's consist of various forms of transmitters.

A NEW galvanometer has been brought out by M. Ducretet, which contains the valuable properties of being dead beat and being used for both strong and high potential currents. Its chief points consist in a movable compound coil, the fine wire coil being near 6000 ohms, and the framework of this coil, which consists of a copper ring, being the low resistance coil. The magnetometer part consists of a box with a very delicately balanced needle immersed in some transparent liquid. The needle is very small, and has attached to it a fine aluminium pointer by which the readings are made. The galvanometer can be used for all strengths of current in practical use.

AMONGST the candidates who have offered themselves to fill the place in the Academy of Sciences vacated by the recent

death of M. Lagournerie, we may note M. Bischoffsheim and Col. Laussedat, Director of the Conservatoire des Arts et Métiers.

M. DE FONVIELLE, writing from Annonay, informs us that at the unveiling of the Montgolfier statue Col. Perier, who was the official representative of the Government of the Republic, was in the chair, and spoke in praise of Montgolfier in the name of the French army. M. Dupuy de Lome delivered a written address, extending over two hours, being a detailed *procès-verbal* of our actual knowledge of aëronautics. Like other speeches delivered on the occasion it will be printed in full in the *Journal Officiel*. M. Tisserand, the astronomer, spoke during a very few minutes, admitting that it would be possible to see celestial bodies better if the observer were carried away from the earth nearer to the limits of the atmosphere. The effect of the statue, which has been cast in bronze, is very happy, M. Cordier having represented the Montgolfiers in the act of inflating a Montgolfière—Joseph is presenting the object to his brother Stephan, who on his knees has in his hand a bundle of burning straw and presents it under the hole. In the evening a banquet took place at the Hôtel de Ville, Col. Perier being in the chair.

THE last number (the 28th) of the *Mittheilungen der deutschen Gesellschaft für Natur und Völkerkunde Ostasiens* contains the first instalment of a paper by Dr. Baels, of Tokio, on the "Physical Characteristics of the Japanese." The writer refers to the extraordinary contradictions on this subject in the ordinary works on Japan. Thus Miss Bird says of the Japanese: "Their physique is wretched, leanness without muscle being the general rule;" while Consul-General Van Buren speaks of them in his reports to the Department of State at Washington as "a race of people of good physique, of stalwart and well-proportioned frames." And so with other writers. This is the more surprising that life in Japan is very public, and the opportunities for accurate observation are accordingly very numerous. In fact, Dr. Baels says, a study of the literature on the subject shows that we know nothing certain about the physical qualities of this people. This is probably to be attributed to the fact that detailed and accurate observations and anthropometrical measurements have not been made; and this defect Dr. Baels's position as professor and surveyor in the principal Japanese hospital gave him ample opportunity for supplying. Accordingly we find that his conclusions are supported by large numbers of statistics. In some cases 1200 persons were measured, and as a rule at least 100 measurements and observations were taken. The whole paper is divided into two sections, the anatomical and physiological, of which we have only the first in the present number. In examining the interesting question as to the origin and position of the Japanese race, the author finds himself confronted with the most perplexing and contradictory assertions respecting the Ainos. In two columns, side by side, he places the statements of two countrymen of his own—Drs. Dœnits and Scheube—as to the Aino characteristics, with the result that one is in flat contradiction to the other, in such apparently simple matters as the hair, its growth and quality, the shape of the nose, &c. After a long examination of the authorities, however, he comes to the following conclusions:—(1) The Ainos were the original inhabitants of Central and Northern Japan, and their influence on the modern Japanese race is small; (2) a Mongoloid tribe, similar to the better class of the Chinese and Coreans, emigrated from the mainland through Corea, and settled the south-western part of the main island, and from thence spread themselves over that island; (3) another Mongol tribe, bearing a resemblance to the Malays, first settled in the south in Kiushiu, and gradually conquered the whole country. This stem is represented now in its purest form in Satsuma, and gave Japan its Imperial House. It also forms the large mass of the Japanese of to day. He further surmises that the second factor, namely those Mongols with the fine features, came from far to the south and west, and were perhaps related to the Akkadians; but he finds no direct connection whatever between the Japanese and any Semitic race. The remainder of the paper is occupied with statistics respecting the size and proportion of the body and its single parts.

WE have received from the director of the Meteorological Observatory of Tokio some of the daily weather maps issued by that institution. The observatory, which is attached to the geographical bureau of the Home Department, is not new, although it was not till 1881 that a plan for a telegraphic weather service was suggested to the Government. From July 1, 1882, the introduction of millimetres and degrees Centigrade, and of three equidistant, simultaneous meteorological observations at 6 a.m., 2 p.m., and 10 p.m. Kioto time were sanctioned. Twenty-two stations were established from Kagoshima and Nagasaki in the south to Hakodate and Sapporo in the north. Each morning one telegram recording the observations of the previous day is despatched to Tokio, and appears in three weather maps. These latter are both in English and Japanese, and are printed with great clearness. It is intended, as soon as sufficient experience has been acquired, to supplement the reports and maps by the issue of warnings and indications.

THOSE interested in the origin and history of the telephone should read Prof. Silvanus P. Thompson's "Philipp Reiss, Inventor of the Telephone," a biographical sketch, with documentary testimony, translations of the original papers of the inventor, and contemporary publications. E. and F. N. Spon are the publishers.

WE have received the last volume of the *Memoirs of the Kieff Society of Naturalists* (vol. vii.), which contains, besides the proceedings and a note on chemical analyses of the Kieff clays, an elaborate memoir, by M. Armashevsky, on the geology of the province of Chernigoff, with a geological map of the province. It is covered with Upper Chalk, more than a hundred feet thick, quite like that of the neighbouring provinces, and the fossils of which prove to be intermediate between the Senonian and Turonian. The chalk appears, however, only in the deeper excavations of the Desna and Sudost Rivers, as it is covered with a thick sheet of Tertiary deposits, which are found throughout the north-eastern part of the province, disappearing towards the south-west under the boulder clay. The Tertiary consists of two parts—the Glauconite sands and sandstones, and the quartz sands with intermediate beds of sandstones. It is most varied in colour and composition, and contains phosphorite, caolin, brown-coal, and boulders of chalk. It is a part of the immense Tertiary basin that covers Southern Russia from Kherson and Kieff to Saratoff and Simbirsk, and bears the characters of shallow-sea deposits, with banks of oysters. The fossils discovered by M. Armashevsky leave no doubt as to its belonging to the Lower Eocene. It is covered in its turn with Post-Pliocene pottery clays, and these last with an immense sheet of boulder clay, which is widely spread throughout the province, as well as throughout the whole of middle Russia. It is an unstratified and unwashed mixture of clay, sand, and boulders, partly of Scandinavian origin and partly brought from all those formations that are met with to the north of Chernigoff; that is, Silurian, Devonian, and Carboniferous. Huge masses of chalk and Cretaceous sands are also met with in it. The boulders reach sometimes the size of ten feet, and are sometimes polished and striated—the local ones as well as those brought from the north. The author, who is well acquainted with the recent literature of the subject, and especially with the numerous researches of German glacialists, does not hesitate to recognise that the province of Chernigoff, as far as Kieff, was covered by the ice-sheet that extended throughout

what is now middle Germany and middle Russia, the continental and glacial origin of the boulder clay being beyond doubt. His remarks on the extension and mode of formation of the loess, which appears with its characteristic features in the ravined parts of the province along the valleys of the larger rivers, are also worthy of notice. It has a continental origin, but rather aqueous than atmospheric.

A FISHERIES EXHIBITION will be held in Lysekil in Sweden early next month.

LAST week at Coblenz experiments were made with young ravens with a view of replacing carrier-pigeons by them. The ravens are not so subject to being attacked and destroyed by birds of prey. The ravens were sent from Coblenz to a small place on the Moselle near Treves, a distance of about forty miles. The experiments proved eminently successful.

THE additions to the Zoological Society's Gardens during the past week include two Silver-backed Foxes (*Canis chama* ♂ ♀) from South Africa, presented by Mr. John Maydon; a Syrian Bear (*Ursus syriacus*) from Thibet, presented by Mr. A. W. Hicks Beach; two Red-backed Shrikes (*Lanius collurio*), British, presented by Mr. D. Bowl; a Sparrow Hawk (*Accipiter nisus*), British, presented by Mr. F. Gunn; two Spotted Salamanders (*Salamandra maculosa*), European, presented by Miss Harris; two Russ's Weaver Birds (*Quelea russi*) from West Africa, three Java Sparrows (*Padda oryzivora*) from Java, two Saffron Finches (*Sycalis flaveola*) from Brazil, two Undulated Grass Parakeets (*Melopsittacus undulatus*) from Australia, a Gray-headed Love Bird (*Agapornis cana*) from Madagascar, a Goldfinch (*Carduelis elegans*), two Bullfinches (*Pyrrhula europæa*), a Chaffinch (*Fringilla cælebs*), a Lesser Redpole (*Linota rufescens*), a Siskin (*Chrysomitris spinus*), British, an Indian Python (*Python molurus*) from India, deposited; five Blue-headed Pigeons (*Starnænas cyanocephalus*) from Cuba, purchased; a Quebec Marmot (*Arctomys monax*), two Gray Squirrels (*Sciurus cinereus*) from North America, a Plantain Squirrel (*Sciurus plantani* from Java, received in exchange; five Common Vipers (*Vipera berus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

VARIABLE STARS.—The following are Greenwich mean times of geocentric minima of *Algol* to the end of the present year, which fall between about 6h. and 15h.; advantage has been taken of the recent observations of Dr. Julius Schmidt, at Athens, in their calculation:—

	h.	m.		h.	m.
1883, Sept. 3 ...	12	56·5	1883, Nov. 5 ...	14	46·9
6 ...	9	45·0	8 ...	11	35·8
9 ...	6	33·6	11 ...	8	24·6
23 ...	14	36·5	28 ...	13	18·2
26 ...	11	25·1	Dec. 1 ...	10	7·2
29 ...	8	13·6	4 ...	6	56·2
Oct. 16 ...	13	5·6	18 ...	15	1·5
19 ...	9	54·3	21 ...	11	50·6
22 ...	6	43·0	24 ...	8	39·7
			27 ...	5	28·9

A geocentric minimum of U Cephei, Ceraski's short-period variable, falls about Dec. 1, 17h. 27m., and this phase takes place earlier in the night, through the winter. On February 19 the calculated time is 11h. 58m. We assume two periods of this star to occupy 4·98559d.

Mr. Chandler having found that the period of Sawyer's variable in Ophiuchus is only 20h. 7m. 41·6s., this object goes through its fluctuations in a shorter time than any other known variable, R Muscæ following next, according to Dr. Gould, with a period of about 21h. 20m. The variation of light of the former star is stated to be about three-fourths of a magnitude. It is Lalande 31384, Weisse XVII. 143, and Santini + 2°, 200. Argelander and Heis call it 6m. The mean place for 1883·0 is in R.A. 17h. 10m. 35·7s., Decl. + 1° 20′ 32″.

The observations of Dr. Schmidt and Mr. Sawyer show that a maximum of χ Cygni occurred on September 2·5, 1882, and the mean period during the last six or seven years having been about 408 days, another maximum may be expected about October 16. The best position of this variable will be that given by a mean of Argelander's places in vol. vi. of the Bonn observations, viz. for

1855·0 ... R.A. 19h. 44m. 59·66s. ... Decl. + 32° 32′ 59″·4.

With Peters' constants we find—

Precession in R.A. 2·3065s. Secular variation + 0·0013s.
,, Decl. +8″·870. ,, + 0″·298

Whence for the beginning of the year 1884 the position becomes R.A. 19h. 46m. 6·5s. Decl. + 32° 37′ 15″.

The confusion that has taken place as to the identification of the true variable χ Cygni is almost ludicrous. Flamsteed attached Bayer's letter to his 17 Cygni, being misled, as Argelander has shown, by the variable star being faint when he observed. In 1816 Olbers referred, in Lindenau's *Zeitschrift für Astronomie*, ii. 185, to the misunderstandings and complications that had taken place through Flamsteed's mistake, pointing out that Pigott first gave the correct position of Bayer's χ; it was soon after determined by Koch, and was observed by Lalande in his zone of August 13, 1793. Further, in 1818, Bessel in the *Fundamenta Astronomiæ*, in a note to 17 Cygni, wrote, "*Flamsteedius* hanc stellam per χ designat; sed stella a *Bayero* ita dicta alia est neque reperitur in catalogo." Notwithstanding these rectifications, Baily, in the British Association Catalogue, falls into Flamsteed's error, calling No. 6784, 17 χ Cygni, and to this circumstance is perhaps to be attributed the confusion in recent popular English treatises as to the identification of Kirch's variable. 17 Cygni is a double star (Σ 2580), without any claim to the letter χ; Bayer's χ is Kirch's variable, and totally distinct from Flamsteed's 17.

A minimum of R Leporis may be expected about December 14; Mr. Sawyer found the star at a maximum about January 25, 1882.

THE GREAT RED SPOT UPON JUPITER'S DISK.—Prof. A. Riccò, of the Observatory at Palermo, in a communication to the *Memorie della Società degli Spettroscopisti Italiani*, gives interesting details of his observations on the features of Jupiter's disk, during the last opposition. The red spot had become very faint, indeed barely distinguishable in April and May, and was *invisible* at the commencement of June. Mr. Marth, in his "Ephemeris for Physical Observations of Jupiter" for the approaching opposition, has retained the same daily rate of rotation adopted in the ephemerides for the last two oppositions, remarking that even if it should be found that the great reddish spot has entirely faded away, it is still desirable that its place should be specially watched, and hence it has not been advisable to make any alteration in the data for the ephemeris at present.

THE MINOR PLANET, No. 234.—Prof. Peters notifies his discovery of a new minor planet on August 12, and strange to say he estimates it as bright as the ninth magnitude. Its place at 18h. 51m. Greenwich M.T. was in R.A. 21h. 20m. 50s., Decl. − 12° 29′.

No. 175 *Andromache*, to which reference was lately made in this column, has so far escaped observation, though carefully sought for at Rome.

GEOGRAPHICAL NOTES

PROF. ALPHONSE MILNE-EDWARDS, chief of the French deep-sea expedition in the *Talisman*, writes from St. Vincent, Cape Verde Islands, under date July 28, that the expedition had met with complete success. After having investigated the deep-sea fauna of the African coast to a distance of some leagues from Dakar, the expedition proceeded to Santiago and St. Vincent, sounding all the way. The island of Branco, where no naturalist had ever been, was investigated, the great lizards of the island receiving special attention in their native habitat. The coast is so rocky the naturalists had to swim ashore. The island is extremely volcanic, with scarcely any vegetation, although the lizards are herbivorous. The *Talisman* was about to proceed on the last section of her voyage, the investigation of the Sargasso Sea.

THE Austrian corvette *Pola* arrived at Hamburg on the 19th from Jan Mayen. The Austrians, who were entertained at a banquet by the Geographical Society of Hamburg, have brought home a large quantity of natural history specimens and photographs, and express themselves highly pleased with the results of their expedition.

THE northernmost of the international meteorological stations round the Pole is that of the United States, in command of Lieut. Greely. It is situated in 81¾° N. lat., close to where Nares wintered, on the coast of Smith's Sound in Lady Franklin Bay. Since 1881, when the expedition took up its quarters, no news of any kind has arrived, as the vessel despatched in order to communicate with the same last summer could not get up for ice. This summer a strong attempt to relieve the party will be made, for which purpose the steamer *Proteus* has just left Franklin Bay accompanied by the U.S. war vessel *Yantic*. Should, however, the condition of the ice also this summer be unfavourable, the relief expedition will be put ashore at a certain point on the east coast of Smith's Sound, and the *Proteus* will return. By the aid of Eskimo the expedition will attempt during the winter to relieve Lieut. Greely and his comrades, who have instructions to depart from their station if not relieved in the autumn. Depots with 1200 rations at each will be established along the route, and as Greely is provisioned up to the summer of 1884, there is no fear of his safety. During next summer a vessel will be despatched from the United States to bring home both expeditions, which will by then, no doubt, be found safe in some spot on the east coast of Smith's Sound.

HEFT VIII. of *Petermann's geographische Mittheilungen* contains a long and interesting report by Dr. W. Junker, dated May 1881, from the country of the A-Madi, in the region of the Upper Nile. In consequence of insuperable difficulties connected with the transport of his luggage, Dr. Junker was unable to reach Bakangai, the destination he had proposed for himself, and had to return northwards after crossing to the south bank of the Wëlle-Makua, in the country of the A-Barambos, to the south of the district of Bahr-el-Ghasal. The greatest difficulties travellers have to contend with is the carriage of their luggage, the natives to the south of that country, including the subjects of Ndoruma, the people of the largest part of the Niamniam region, and all further south being almost quite unavailable for that service. Expeditions sent south from Bahr-el-Ghasal in quest of ivory have, therefore, to take their own porters with them. The travellers Schweinfurth and Miani have generally been under the necessity of attaching themselves to such expeditions, as has also Dr. Junker in all his more extensive travels, though the disadvantages and in particular the delays connected with this mode of travelling are very great. From Palembata, where during ten days he had to live exclusively on sweet batates, Dr. Junker, crossing the watershed which divides the tributaries of the Werre in the north, from those of the Wëlle-Makua in the south, came, after two days' march, into the land of the A-Madi, a mountainous district, watered by a number of streams diffusing a constant moisture over the gentle declivities of their banks, and nourishing vigorous growths of bananas and oil-palms. Dr. Junker stayed with the Prince Masinde for several days, during which he made an excursion to a group of mountains immediately to the south-south-east, ascending the highest peak, Mount Malingde, whence he had a view of three almost equidistant but topographically very diverse points of the Wëlle in its sweep from the west to the direct north. The A-Madi are described as a race largely resembling the neighbouring tribes in manners and customs, but whose speech shows not the least affinity to any one of the many languages of the wide surrounding region known to Dr. Junker. In structure they resemble the muscular and shorter figure of the A-Sandeh. They are brachycephalous, of medium stature, far below that of the tall Dinka, Nuëhr, or even the Bongo. The A-Madi tattoo their breasts according to the most diverse patterns, though the face is generally left intact, with the exception of nose and ears. In the working of iron they are far behind the Mangbattu. The fruit of the banana is used at all its different stages as the principal and sometimes the exclusive food of the people. Letters of Dr. Junker to Dr. Emin Bey, extending in date from Jangasi, in the former Munsa's district, now Niangara's, July 17, 1882, to a provisional station in the land of Semio, November 8, 1882, give us the latest details regarding his stay in Mangbattu, and his plans for the future.

BARON MÜLLER, during his travels in the winter of 1881–82 through Eastern Soudan, was shown some new maps executed by the Egyptian staff, under the direction of Reschid Pasha, and gives an account of them in the present number of the *Mittheilungen*. Reschid Pasha was induced to undertake this work in consequence of the want of maps, available for military purposes, of the country on the borders of Egypt and Abyssinia. The survey of the triangular district defined by the three points, Massowah, Cassala, and Gallabat, was, according to Herr Müller's information, entered upo simultaneously by various surveying parties in 1875. No scientifically accurate set of maps, to be achieved with all the aid of theodolites, astronomical determination of places, and hypsobarometrical measurements, was aimed at, but only such a general plan as would satisfy military requirements. All the maps executed in this way, on the scale generally of 1 : 1,000,000, did not reach Herr Müller's hands, but only those representing (1) Annesley Bay, (2) Gebel Gadam, (3) the caravan road from Massowah *viâ* M'Kullu and Ain, (4) the descent of the land at Samharr from Debra-Bizen as far as Ain, including Sabba Guma, Ailet, the Motad Valley, Assus, and Gumhot, (5) Mensa, extending as far as the Northern Hamsen, Dembesan, and Karmeschim. The map of this country is altogether excellent. Particularly well given is the Bogos country, including the Rora Az-Geret with Zad-Amba, Atirba, and the Boggu Valley, as also Halhal and the district of the Red Marea. These maps, due to the admirable energy of Reschid Pasha, though at present studiously concealed from Europeans, and Englishmen especially, must, in Herr Müller's opinion, before long enable people generally to obtain a distinct idea of that most interesting group of plateaus to the north of Abyssinia.—Among other papers in the same number, Dr. H. Polakowsky gives, as a contribution to the geography and ethnography of Central America, a report of an expedition undertaken by the Bishop of Costa Rica (B. A. Thiel, a German by birth), in company with Lieut. L. Fernandez and D. José Ma. Figueroa, to the wild Indian tribes, the Chirippo Indians, of that Republic.—In a letter to Dr. Emin Bey, Lupton Bey, the Governor of Bahr-el-Ghasal, reports an important discovery made by him in the last months of 1882 in the course of travels in the district of the Kredj tribes—the discovery, namely, of a large river of the name of Parpi. Rising in the mountains to the south-west of Hofra-el-Nahass, it runs south through very fertile lands and receives many tributaries, among others the Wille (marked on Schweinfurth's map to the west of Dem Bekir).—The *Mittheilungen* further report a botanical collection made by G. Ruhner of the Berlin Museum, at Bengasi, a collection which, added to that of Schweinfurth, will materially increase our knowledge of the vegetation of Barka.

IT is announced that Dr. Emil Riebeck, who is well known in the geographical world for his successful travels and magnificent collections, is at present engaged in making the arrangements for an undertaking which promises to be of the greatest importance in the history of the exploration of Africa. The expedition is to be carried into execution by Herr Gottlob Adolf Krause, who is at present in Milan, and the immediate object is described as the investigation of the languages and social state of the inhabitants of the region about the Niger, Benue, and Lake Tsad. Herr Krause intends to follow the Niger from its mouth upwards for a distance of about 300 miles, and then probably to take up his position in some suitable spot, whence he can make a general survey of the surrounding country, decide on his further course of action, and await a favourable opportunity for an advance into the interior. He intends to make his first stop either at Ripo Hill, by Egga, an English mission station, or to choose Shonga, near Rabba.

ACCORDING to intelligence received at Copenhagen, August 18, from St. Petersburg, the Imperial Russian Geographical Society has informed the Danish Minister to Russia that a report is current among the Samoyede inhabitants of the Island of Waigatz that a foreign vessel has wintered on the eastern coast of that island. It was, however, at the same time pointed out that there was nothing to show that the ship in question was the missing Danish vessel *Dijmphna*, which started last year on a voyage of discovery to the North Pole.

THE *Vega*, the famous exploring vessel, returned at the end of last month to Norway from seal-hunting in the Arctic seas with 8750 seals on board.

M. LÉON POIRIER has left to the Geographical Society of Paris one-third of his fortune, the interest on which is to be devoted once every three years to granting an annuity to the Frenchman who shall have most distinguished himself by his travels in the interests of science and commerce.

THE EDISON-HOPKINSON DYNAMO-ELECTRIC MACHINE

THE following abstract of the report by Mr. Frank S. Sprague on the Edison-Hopkinson dynamo-electric machine will be found of interest to electrical engineers :—

Characteristic features of the dynamo are : General arrangements—those of a shortened and differently proportioned Edison dynamo. The pulley, however, is outside of bearing, and with a face of $6\frac{3}{8}$ inches and diameter of 10 $\frac{1}{8}$ inches projects $8\frac{1}{4}$ inches outside the base plate. Field coils wound over a 9-inch core with ten layers of No. 16 copper wire (B.W.G.). Two legs in series. Armature : Diameter of core 9 inches, 74 coils, single turn, 8 strands of No. 16 wire, average length 43 inches. Wire bound. Diameter $10\frac{1}{2}$ inches, with $\frac{1}{16}$ inch clearance from pole faces. Zinc plate connecting pole faces ; ends of magnets not scraped. Resistances : Field cold, 36·5 ohms ; armature cold, ·026 ohms. Field measured ; armature calculated. Field warm, 37 ohms ; armature warm, ·0325 ohms. Power supplied from a Lawrence—Armington and Sims—engine, high-speed and non-condensing, driven by a link belt through an Alteneck tension belt dynamometer.

Engine diameter	$8\frac{1}{2}$	inches accepted.
Stroke	$9\frac{1}{16}$	inches measured.
Piston-rod	$1\frac{3}{8}$	inch ,,
Fly-wheel	40	inches ,,
Indicator spring	56	inches ,,

$$\text{I-H.P.} = \frac{2 \cdot \text{P. L. A. revs.}}{33{,}000}$$

$$= 2 \cdot \frac{\text{P. } 9\frac{1}{16}}{12} \cdot \frac{\pi}{2} (2{\cdot}425^2 - \tfrac{1}{16}{}^2) \cdot \text{revs.}$$

$$= \text{Mean pressure} \times \text{rev.} \times {\cdot}0028107.$$

The magnets were tested by the Poggendorff method.

$$\text{Total H magnetic field} = \text{Gr} \times \text{E} \times \frac{\text{position}}{\text{resis.} \times \text{dif.}}$$

E = 1·457 Clarke's standard
Gr = 6428

Mean force in laboratory—Westminster :—

	Earth.	No. 45.	No. 17.
May 7	·121	9·41	11·40
May 8	·122	9·46	11·45
May 12	·122	9·40	11·52

Total H field for Manchester :—

E and No. 45	9·55
E and No. 17	11·61

The results of three fairly full loads are given. No. 6 Time, about one hour ; load, 192 lamps and ground of about 5 amperes. Lamps not up to candle power.

Potential galvanometer, magnet ...	No. 45	
,, ,, position ...	2	
,, ,, strength ...	9·55	
Average deflection	20·79	
Potential at brushes	99·27	volts.
Current galvanometer, magnets ...	No. 17	
,, ,, position ...	2	
,, ,, strength ...	11·61	
Average deflection	19·39	
Current in lamp circuit	112·56	amp.
,, field	2·68	,,
,, armature	115·24	,,
Resistance, lamp circuit	·882	ohms.
and field...	·861	,,
Total resistance of circuit	·8935	,,
E.M.F.	102·97	volts.
Electrical energy in lamp circuit ...	14·97	H.P.
,, ,, field	·30	
,, ,, armature ...	·58	
Total	15·91	H.P.
Dynamometer spring at rest	112·23	lb.
,, ,, running free ...	115·00	,,
,, ,, load	180·11	,,
Total difference	67·88	,,
Above friction	65·11	,,
Total power to armature	17·34	
Power above friction	16·63	
Friction	·71	

Dynamo speed, 1081 ; engine speed, 289·3 ; efficiency of conversion, 97·7 per cent. ; commercial efficiency, 86·3 per cent.

Dynamo behaved well. Fields cold. Armature moderately warm. Wrist not uncomfortable on coils. Can also be held on commutator. Little sparking.[1] Bearings cool. No increased heating after standing.

The same remarks about the behaviour of the dynamo are pertinent to two later experiments with 192 and 230 lamps respectively. There was no appreciable increase in the heating, and the load could easily have been carried a long while. An increased load of 30 lamps could be carried some time.

Summary of Three Experiments

No.	Time.	Speed.		Current in amperes.			E.M.F. in volts.		Electric H.P. appearing.				H.P. delivered to pulley.		Efficiency.	
		Engine.	Dynamo.	Field.	Lamp circuit.	Total.	Brushes.	Total.	Field.	Armature.	Lamp circuit.	Total.	Absorbed.	Total.	Conversion.	Commercial.
6	1 hour.	289	1081	2·68	112·56	115·24	99·3	103·0	·36	·58	14·97	15·91	16 63	17·34	95·7	86
8	31 min.	309	1157	2·92	123·07	125·99	108·	112·1	·42	·69	17·81	18·92	20·12	20 88	94·0	85
9	1h. 1m.	315½	1179	2·95	144·6	147·55	109·3	114·1	·43	·95	21·18	22·56	23·79	24·56	94·8	86

Means : 94·8 % 86 %

INDIAN METEOROLOGY

I.

EXPERIENCE only confirms what a cursory glance would have led us to anticipate from theoretical and *a priori* considerations—that meteorology, the most modern as well as one of the most ancient of all the sciences, requires to be studied on the largest possible scale. The synoptic charts of the late General Meyer in America, of Hoffmeyer in Germany, and our own Meteorological Office, have graphically and forcibly set before us the variety and complexity of conditions that occur in a horizontal direction, while the observations of balloonists and mountain travellers have equally illustrated the important difference and often complete opposition which exists between the physics of the upper and lower aërial strata. Indeed it may be affirmed of meteorology, with even more truth than of the analogous science of geology, that it recognises neither political nor superficially physical divisions of the land. When, therefore, we confine our attention to the atmospheric conditions of one small political division of the earth's surface and attempt to educe from data collected within that region alone the laws which regulate them, we are in a far worse position—especially if we take the British Islands as our example—than if we essayed to construct the science of geology by a like process, since in the latter case, if our horizontal range is limited, these islands form an almost complete and unique epitome of geological stratigraphy. In the case of meteorology, however, it is far otherwise, since our area is not only microscopic in relation to the scale on which meteorological changes occur, but is situated in a peculiarly unfavourable position for studying those changes with success.

[1] Some lateral play of armature and spindle.

In the matter of vertical range we are no less badly off, our loftiest elevation being less than one-fourth of that attainable in some countries.

Fortunately for us, however, we have a dependency which offers rare facilities for the study, not merely of climate and weather, but of what is acknowledged to be the "highest branch of meteorology," viz. *atmospheric physics*.[1]

India has, in fact, been often specially alluded to by leading meteorologists as a golden field for this line of research, and Mr. Blanford has with evident pride ventured to predict that, "given a few earnest and intelligent workers, this country [India] will one day play a part second to none in the advancement of rational meteorology."[2]

The characteristics presented by India, and which have been specially noticed by Blanford, Buchan, and others, are (1) its great size—more than fifteen times that of what we are pleased to call *Great* Britain; (2) its proximity to the equator; (3) the seclusion of its area by the Himalaya on the north; and (4) the physiographical contrasts it presents. If anything further were needed to show the desirability of investigating the meteorology of India, it would be the fact noticed by Prof. Eliot in his "Report" for 1877 (p. 48), that while in Europe the changes of weather take place mainly in a horizontal direction, the homogeneity of those in India over large areas shows that they are rather the result of vertical (expansive and contractive) actions, from which it follows as a necessary corollary that if the dynamics of the atmosphere are ever to be solved, we must combine the facts obtained from regions of vertical with those from regions of horizontal motion, and, as Eliot says, "the two sets of facts must be regarded, not as opposed to, but as *supplementing each other*." Some idea of the work that is being done and the area it represents may be gathered from the fact that according to the "Report on the Meteorology of India for 1880" there are now 121 stations in the Indian area (including Ceylon and Burmah) where meteorological observations are regularly made, together with 385 raingauge stations, representing in all an area of 1,131,000 square miles.

This work finds an official outlet in the excellent "Annual Reports" published by Blanford, as well as the valuable monographs on the "Meteorology of Bombay," by Mr. Charles Chambers, F.R.S., and those on the "Bay of Bengal Cyclones," by Prof. J. Eliot, and it will, we venture to think, be admitted by all who have carefully examined these works that they not only reflect great credit on the ability of the writers, but go some considerable way towards indorsing Mr. Blanford's prediction.

Besides these strictly official works, there are published a series of papers entitled the "Indian Meteorological Memoirs," which are intended, according to the preface by Mr. Blanford, as "a vehicle for the publication of such portions of the work of the officers of the Indian Meteorological Department as do not form part of the regular Annual Reports on the Meteorology of India."

In the present articles we purpose noticing briefly the first complete volume of these. Before doing so, however, we may observe that their quality is uniformly of a remarkably high order. We know of nothing approaching to them in this country in meteorology, except, perhaps, occasional papers in the *Transactions and Proceedings of the Royal Society*, or a few publications of the Meteorological Council; and we have to go abroad, to the *Repertorium* of Russia, or the *Zeitschrift* of Austria, before we can find papers of equal calibre. This defect is unfortunately more readily explained than remedied. In this country our best men, for reasons which are many of them obvious, and which we need not dwell upon, devote themselves to almost any other science but meteorology. The consequence is that little is done, and that little often indifferently, thus in some measure justifying the scorn which many physicists openly entertain for the science and all its disciples. Before, however, these gentlemen pledge themselves to their verdict, let them look abroad to America, Russia, and India, where more interest is taken in the science, and where the field of operations is vastly more extensive, and the conditions more favourable, and we suspect they will be inclined to modify their views somewhat, and allow that after all this useful and still growing science can not only borrow from their laboratories, but repay with interest, and that it offers a more divergent scope than is often imagined for discoveries tending to throw light on some of the most intricate problems of physics.

[1] *Vide* "Elementary Meteorology," by R. H. Scott, F.R.S., 1883, p. 4.
[2] "Vade Mecum," p. 3.

Vol. I. of these "Memoirs" comprises twelve papers, the first of which is dated December 8, 1876, and the last October, 1881, which we will now proceed to examine seriatim.

Paper I. "The Winds of Calcutta," by H. F. Blanford, F.R.S.

This paper represents an analysis of ten years' hourly observations of the wind vane, and four years' anemograms. One of the first things we notice is that while the annual resultant, calculated by Lambert's formula, which takes no account of variation of velocity but assigns an equal value to all observations, is south 14° west, that derived from the four years' anemograms, where the true resultants enter, is south 18° east, the difference being caused by the greater frequency and less velocity of west than east winds at Calcutta. Another interesting conclusion deducible from the annual figures is that the velocity of the Bay of Bengal (south-east) branch of the monsoons current is considerably less than that of the Bombay, or as it is called Arabian Sea (south-west) branch of the monsoon. This fact was previously noticed by Mr. Blanford in his paper on the "Winds of Northern India,"[1] and receives further confirmation from a comparison of wind-velocities at representative stations in the Bombay and Bengal Presidencies in recent reports. Thus in that for 1877 Prof. Eliot gives the following comparison of velocities for representative stations in August, on opposite sides of the Peninsula:—

Bombay.	Average daily wind velocity —August.	*Bengal.*	Average daily wind velocity —August.
Kurrachee ...	497·8	Sangor Island	251·0
Bombay	408·3	Calcutta	123·4
Belgaum	213·3	Chittagong ...	151·4
Bangalore ...	219·0	Dacca	147·9
Akola	189·5	Patna	80·4
Nagpur	131·9	Allahabad ...	91·6
Jubbulpore ...	127·5	Roorkee	65·5

Prof. Eliot ascribes this defect in velocity of the Bengal branch of the monsoon to the deflection it undergoes by impinging upon the Arakan and Himalayan ranges.

And doubtless this expresses a portion of the truth. It ignores, however (explicitly at least), a circumstance which we think has a good deal to do with the result, viz. the fact that this deflection acts so as to continually rob the current of its *easterly component*, due to the change of latitude, and *which, in consequence of its northerly direction, tends to be continually reproduced*. In consequence of this, the current, instead of rebounding from the Arakan hills once for all, tends to hug the mountains all round the northern borders of Assam, and consequently loses a good deal of its velocity by the friction thus engendered. The importance of this south-east branch of the monsoon current cannot be over-estimated. It depends evidently for its existence on the presence of the Bay of Bengal, so that, were the latter area land instead of water, the now moist and fertile districts of Assam and Bengal would probably be arid wastes like the deserts of Scinde and Rajputana.

In discussing the diurnal variation in the direction and velocity of the wind, Mr. Blanford alludes to Mr. Chambers' discovery of the relation between the double diurnal variation in the wind components and the critical points in the diurnal barometric tide.

M. Rykatcheff not long ago, on the basis of the diurnal variation of the east and west components of the wind, laid the foundations of a most ingenious theory of the cause of the diurnal variation of the barometer.[2] Detailed reference to it here would be out of place, but it may be observed that the fact of the easterly components prevailing at the time of diurnal rise and the westerly at the time of the fall of the barometer, both at Calcutta and Bombay, accords with the daylight conditions at all the stations cited by Rykatcheff, as well as with the view that the air near the surface flows out from the 10 a.m. wave of high pressure, both in its advance from the east and its retreat towards the west.

The explanations of the diurnal oscillation of the barometer, propounded by Rykatcheff and Chambers, while they coincide in attributing it to the proximate influence of the analogous diurnal variation in the velocity and direction of the wind, differ from each other essentially in one or two points. Thus Rykatcheff leaves the north and south components out of account

[1] *Phil. Trans.*, vol. clxiv. part ii., pp. 563-653.
[2] "La Marche Diurne du Baromètre en Russie et quelques Rémarques concernant ce Phénomene en général." *Rep. für Met.*, 1879.

altogether, and only takes the east and west components into consideration. Mr. Chambers, on the other hand, while attaching considerable importance to the meridional components, except very near the Poles, omits curiously enough all reference to the probable corresponding variations in the upper currents of the atmosphere, upon which Rykatcheff discourses most effectively. Each theory alone is defective; a combination of the two would probably form a fairly satisfactory explanation of a considerable part of the diurnal variation, though it will be safer at present to conclude that, while there is a very intimate relation between the diurnal variation of the wind and the barometric tides, we do not as yet know for certain whether either is the cause of the other or whether both are not effects of some common cause.[1]

Mr. Blanford discusses the diurnal variation of the wind at Calcutta through the medium of Bessel's interpolation formula, and by comparing similar terms in the wind and barometric equations deduces several interesting results. Thus the single (semicircular) oscillation of the north and south components, is found to represent in all probability the diurnal land and sea breeze, while the single oscillation of the east component coincides in direction and phase with the rise and fall of the day land wind from the interior of the continent.[2]

Dealing in like manner with the double (quadrantal) terms, it is shown that the variations of both the north and south components and east and west components is very similar to that of the second term in the barometric fluctuation, though the course of the north and south components is exactly the reverse in direction of those at Bombay.

In part ii. of this paper the thermal, baric, and hyetic windroses are discussed. The results may be briefly summed up as follows:—(1) that polar currents play no part in the wind system of Bengal, which indeed might have been anticipated, owing to the presence of the Himalayan barrier to the north isolating India in so unique a manner from extra-tropical influences; (2) that rain is most probable, not when the monsoon current is blowing steadily, but "when it is deflected from its normal direction by some local irregularity of pressure," in other words, when *small* depressions prevail, and in this respect it would seem that the law is one of general incidence; (3) that when the periodic components are eliminated there is no definite relation between the non-periodic variations of pressure and those of temperature and humidity. This result is just what we should expect from a local application of the statistical method, now we know, thanks to the recent development of the synoptic method, that the larger oscillations of pressure which accompany the passage of cyclones and anticyclones, are due to conditions which are in operation over regions widely removed from those where such oscillations prevail. This conclusion, moreover, so far as India is concerned, derives fresh support of late from the fact that certain abnormal features in the pressure over India and adjoining countries during the droughts and famines in Madras and the North-West Provinces in 1876-77 were due to some widespread influence which mainly affected the atmosphere *above* the level of the Himalayan sanitaria (7000 feet), since the variations in the density of the atmospheric stratum *below* this level were not only opposite to those at the higher levels, but to those which prevailed in the total pressures at the lower stations throughout the Peninsula.

Paper II. "The Meteorology and Climate of Yarkand and Kashgar."—This is a discussion chiefly of the registers kept by Dr. Scully, of the Bengal Medical Service, who, in the autumn of 1874, accompanied the mission sent by the Indian Government to Kashgaria under the charge of Mr. R. B. Shaw. The observations were carefully made, and as they represent a district whose meteorology had hitherto been entirely unknown, and of which we can only get samples by the aid of such rare opportunities as political embassies, their discussion is well worth the labour which Mr. Blanford has bestowed upon it.

Where it was possible, on the route, and at Yarkand and Kashgar on four days in each month, horary observations were made.

Some evidence of the laborious nature of the task to which Dr. Scully so nobly devoted himself may be gathered from the fact that in order to get a second observer he was obliged to teach an uneducated hill coolie named Bhola, first the use of English numerals, then decimal fractions, and finally the mode of reading and recording the various instruments in the newly-acquired notation.

Any one who knows the amount of intelligence evinced by the ordinary Indian coolie, will agree with Mr. Blanford in his remark that "it was an achievement which reflected the highest credit on both teacher and pupil."

From the geographical description of the country which accompanies Dr. Scully's report, we gather that the soil is very arid, the rivers are chiefly snow-fed, and that there are deposits of *loess*, similar in all respects to that of the Rhine and the Danube. By many, this loess is inferred to be of subaërial origin, and the peculiar dust-haze which prevails in these regions, is cited in favour of this idea.[1]

The chief points noticed in this paper are: (1) the excessive dryness of the climate and consequent large amplitude of the diurnal temperature oscillation; (2) the abnormally large annual range of barometric pressure; and (3) the fact that the non-periodic oscillations of barometric pressure at Yarkand, unlike those of stations situated to the south of the Kuen-Lun, Karakoram, and Himalaya ranges, appear to have some sort of connection with those of Europe. Such large oscillations are in fact probably confined to the lower and denser portion of the atmosphere, which is effectually partitioned off from the north by ranges of such lofty elevation.

The latter part of the paper deals with the diurnal periodic oscillations in the pressure, vapour tension, and winds, and it may be observed that, in regard to the first of these, Yarkand is found to exceed in range any other place under an equally high latitude. Even in winter it averages 0·07 inches between 10 a.m. and 4 p.m., while in June and July it is 0·098 inches between the same hours.

In other respects the curve is characteristically continental, the fall of the night tide being almost evanescent.

The diurnal variation of the wind at Yarkand also presents a peculiarity worthy of remark, in that, as at Zikawei, in China, and Upsala, in Sweden, it violates the general rule that easterly components prevail in the morning and westerly in the afternoon. Like the sea in these places, the desert stretches to the east of Yarkand, and there is every reason to suppose that something analogous to a sea-coast system of local convection currents exists which overrides the normal right-handed rotation of the diurnal breeze.

(*To be continued.*)

[1] A full account of Mr. Chambers' theory is given in the *Philosophical Transactions*, 1873, and in the *Proc. Roy. Soc.*, xxv., p. 402.

[2] This wind is called an anti-convection current, as will subsequently be seen in our notice of a paper by Mr. Chambers on "The Winds of Kurrachee."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Gilchrist Engineering Entrance Scholarship at University College, London, will be open to competition at the end of September. The conditions of examination are this year somewhat altered in a direction which places the scholarship better within the reach of those for whose benefit it was founded. The detailed regulations can be obtained on application to the secretary of University College; the following is a summary of them:—Candidates must be under nineteen years of age, and must send in notice to compete by September 23. The subjects of examination are (1) elementary mathematics, and (2) any two or more of the following five subjects: mechanics, mechanical drawing, essay on one of three given subjects connected with mechanics or engineering, French or German, the use of tools, either carpenters' tools, or the lathe (wood or metal), or the file. The Scholarship is of the value of 35*l.* per annum, and is tenable for two years. There is also at University College a Senior Engineering Scholarship, awarded at the close of the session, of the value of 80*l.* The regulations affecting this scholarship, as well as those of the Andrews Entrance Prizes, &c., can be obtained on application to the Secretary.

UNIVERSITY COLLEGE, Dundee, has already issued its first Calendar, necessarily a thin one, but bound to increase in size. So far as the science classes are concerned, and these are the prominent features in the College, the arrangements are fairly

[1] Richthofen, in his work on China, similarly attributes the enormously thick formations of *loess* in the northern part of that country, to the action of the winds. It seems reasonable, however, to imagine that, like the analogous European deposits, it might have been originally deposited as Pleistocene glacial unstratified mud from the neighbouring Thian-Shan and Kuen-Lun ranges, and that it has since been redistributed and perhaps in part augmented, by æolian action. The fact that it occurs in North China, and not South China, and that traces of the Glacial period extend as far south as the Himalaya, favours this supposition.

complete, and a good staff of professors has been obtained. That literature will not be neglected is evident from the fact that the Principal of the College, Prof. Peterson, has for his subjects Latin and Greek. We have also received the Calendar of the Mason Science College, Birmingham, a thick volume which shows the institution to be in excellent working order. The Calendar of University College, Liverpool, is much more modest, though its staff of professors and lecturers is pretty comprehensive.

SCIENTIFIC SERIALS

Atti of the R. Accademia dei Lincei, May 6.—Report on Veri and Parona's "Geological Studies of the Fossil Shells of Terni and Rieti," by MM. Taramelli and Capellini.—Report on Dr. Lucchetti's "Crystallographic Notes," by MM. Koerner and Spezia.—A memoir (in French) on the invariants and covariants of a function transformed by a quadratic substitution, by W. Spottiswoode.—On the nature of the expansions of gas produced by the electric spark, by Sig. Villari.—Distribution of matter acting on the surface of an ellipsoid in order to procure in the interior of such a body a given action constant in force and direction, by Sig. Glaser.—On the relations existing between the refrangent power and chemical constitution of organic combinations, by MM. Bernheimer and Nasini.—On a hypergeometrical differential equation, by Sig. Besso.—Some theorems relative to the binary forms of any power, and their application to the study of the multiple roots of equations of the sixth degree, by Sig. Maisano.—On some derivatives of berberine, by M. Bernheimer.—On the distortion of perspective observed in the telescope, by Sig. Govi.—Meteorological observations at the Royal Observatory of the Campidoglio during the month of April.

May 20.—Note on Ugo Balzani's "Early Chroniclers of Europe," by S. Tommasini.—On the commentators on Martianus Capella, by Sig. Narducci.—On the theoretic value of the coefficient of tension, of the atomic specific heat of aëriform bodies, and of the dynamic equivalent of caloric, by Sig. Violi.—Account of the recent archæological discoveries in Ventimiglia, Gussola, Casalmaggiore, Norcia, Tarentum, and other parts of Italy, by Sig. Fiorelli.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, August 13.—M. Blanchard, president, in the chair.—On Kekulé's β-butylglycol $CH_3—CH.—OH—CH_2—CH_2.OH$, obtained as an accessory product of the hydrogenation of aldehyde, by M. Ad. Wurtz.—On the laws of reflection as applied to the displacements of elastic bodies of definite form acted on by external forces, by M. X. Kretz.—A comparison of the hypotheses of magnetic fluids and molecular currents, by M. P. Le Cordier.—Experimental researches on the action of a liquid introduced by a special process into the tissues of the vine for the purpose of destroying phylloxera (continued), by M. P. Lafitte.—Note on a composition employed by Mr. Hatch of San José, California, for the destruction of phylloxera, by M. J. Caire. The constituents of this compound are equal weights of sulphuret of carbon, potash, oxide of iron, and sulphur, mixed with eight times the same amount of mercury.—On copper as a preventative and curative of cholera, by M. V. Burg. After a study of thirty years the author concludes that copper absorbed in various ways into the system acts as an almost perfect prophylactic, the exceptions not being more numerous than in the case of vaccination as a preventative of small-pox. Amongst other precautions he recommends the external application of copper under the metallic form of armatures, plates, or even ordinary coins; the burning of dichloride of copper in alcoholic lamps; wine mixed with the natural mineral water of Saint-Christau; and the use of vegetables rendered green by sulphate of copper. The question of the treatment of cholera patients by copper is reserved for a future communication.—In connection with this subject, M. P. Davin recalls a memoir addressed by him to the Academy in July, 1873, on the bronze dust used in gilding as a specific against cholera.—Observations relative to a previous communication of M. A. Gaillot on the changes produced in the length of the Julian year, by Mr. E. J. Stone of the Radcliffe Observatory, Oxford.—On the determination of the right ascensions of circumpolar stars, by MM. Ch. André and Gounessiat.—On the critical point of oxygen, by M. E. Sarrau.—On the distribution of the caloric liberated or absorbed by oxygen and carbon respectively when combining to form oxide of carbon and carbonic acid, by M. A. Boillot.—On the composition of the asphalt or bitumen of the Dead Sea, by M. B. Delachanal. The presence of sulphur in considerable quantities is determined, implying a mineral origin, and distinguishing this bitumen from all others, which are of organic origin.—On the danger of contagion from the use of cracked stoneware in infectious diseases, by M. E. Peyrusson. It is shown that the germs of cholera, typhoid fever, and similar disorders may be preserved even in the slight fissures on the glazed surface to which all crockery and faïence are liable.—Memoir on wheaten flours (part ii.), by M. Ballard. The author shows that variable quantities of gluten may be obtained from the same flour, according to the different treatments to which it is subjected.—On the origin of individuality in the higher animals, by M. de Lacaze-Duthiers.—On the evaporation of marine and fresh water in the Rhone delta and at Constantine in Algeria, by M. Dieulafait.—On the means employed to determine by continuous registration the slight movements in the crust of the earth, by M. B. de Chancourtois.—On the cultivation of the date-palm in soils charged with marine salt, by M. A. Richard. The present flourishing condition of the palm-groves at Elche and Alicante, on the south-east coast of Spain, shows that this plant thrives well in land saturated with salt water.

VIENNA

Imperial Academy of Sciences, June 7.—C. von Ettingshausen, on the Tertiary flora of Borneo.—Z. von Roboz, on *Calcituba polymorpha*.—G. Tschermak, contribution to classification of meteorites.—H. von Foullon, on the mineralogical and chemical composition of the meteorite which fell at Alfianello on February 16, 1883.—J. Kachler and F. V. Spitzer, on the action of sodium on camphor.—F. W. Dafert, on periodides.—J. Schlesinger, on the causes of inertia and motion of masses.

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ERRATUM.—Vol. xxviii. p. 343, col. 2, line 36 from bottom, for *Linn* read *Linss.*