THURSDAY, JULY 19, 1883

CHOLERA PROSPECTS

THE early history of cholera is involved in a good deal of obscurity, and it was not until 1817, when the disease caused a terrible mortality amongst our troops in India, and subsequently spread into different parts of the Asiatic continent, that any noteworthy attention was given to it by European observers. It is very possible that even previous to the present century cholera had made its way into Europe, but the first trustworthy record of its course westwards was in 1831, when it travelled by way of Russia and the Baltic, and, as far as we know, made its appearance for the first time in England. In the following year it became widely prevalent in this country. In the years 1848-49, and again in 1853-54, cholera travelled to Europe and England from the East, taking much the same route as it did in 1831-32. The last outbreak from which we have suffered was in 1865-66, the disease being imported into Southampton in 1865, and reappearing both in the metropolis and in several other parts of the United Kingdom in the following year. But on this occasion the infection for the first time reached us through Egypt, having travelled there in the track of the Mohammedan pilgrims, who were on their return from Mecca, and being then distributed along the lines of steamboat traffic which, starting from Alexandria as a centre, radiate towards ports in the Mediterranean and on our own shores. In 1866 the disease became epidemic in the metropolis, and its special incidence in the East End was shown to be in the main due to the polluted character of the water delivered to that part of London.

The disease is once more prevalent in Egypt; it has already caused over 2000 deaths in a few towns in the delta of the Nile, and the prospect of its spread to the several ports of Europe is regarded with universal concern.

The etiology of cholera, in so far as relates to its influence in this country, does not admit of much doubt. The infection must be actually imported into our midst; it has never yet been imported except through human agency, and the poison appears to be all but, if not entirely, limited to the discharges from the bowels and to the matter vomited by the patients. Where these go the poison goes; hence sewers and drains receiving them tend to become channels for conveying the disease; soil fouled by them may, by leading to the pollution of well and other waters, as also by aërial emanations, favour its diffusion; and, to a less extent probably, the bed-linen and personal clothing of the sick may become vehicles of infection. In all essential respects the disease appears to spread under much the same conditions as favour the spread of enteric or typhoid fever, and, like that disease, it has in this country mainly been associated with the use of water supplies, which have been subjected to the risk of receiving the specific infection. What that infection consists in is not yet known, but judging from analogy it is a definite organism capable of reproducing its own kind under those conditions of filth which we have adverted to as being associated with the spread of the disease. In the case of anthrax, which causes the so-called wool-sorter's disease in man, and in the case of relapsing or famine fever, the microscope has succeeded in showing the organisms which lead to the production of those specific affections; but in the case of cholera no such results have as yet been attained, and this notwithstanding the laborious microscopic and other researches which have been made in India and elsewhere.

Having regard to the fact that cholera is as yet confined to Egypt, and that any spread may be expected to follow on the lines of human intercourse, the most obvious means of staying its spread to this country would at first sight appear to consist in quarantine measures. Such measures are already in force all along the Mediterranean, and even on the Atlantic coasts of Portugal, Spain, and France, but England has decided to adopt no such course, and our Government have acted wisely in arriving at this decision. Quarantine, in order to be efficient, must exclude all the healthy as well as the sick who arrive in our ports after having passed through the infected area, and if there be really reason to believe that vessels so arriving contain within them the germs of infection, and that those on board are liable to contract cholera, the result of detaining suspected fleets of merchant and passenger ships at the entrance of our ports until the last of those who are susceptible have suffered from the disease can be more readily imagined than described. In point of cruelty and selfishness such a practice could probably not find its equal. But, as a matter of fact, quarantine invariably fails to effect its intended purpose; those countries which practise it most rigidly are those to which cholera has almost invariably spread, and the line of loaded rifles and fixed bayonets by which quarantine measures have surrounded Damietta and Mansurah, the two first towns infected in Egypt, have certainly not succeeded in preventing extension of the disease along the lines of railway in the direction of Cairo and of Alexandria. For some thirty years we in England have trusted to a different system; and that system, which is known as one of "medical inspection," has received the formal assent of the delegates of the Cholera Conference which met at Vienna in 1866. Instead of herding the healthy together with the sick, we endeavour to deal with the sick and their infected things in such a way as to prevent the spread of infection to the healthy. To take an example. A ship arrives from Port Said in the Thames. Off Gravesend it is boarded by a Customs officer, to whom written statements as to the health of all present or previous passengers must be made. If any case either of cholera or of suspicious diarrhœa has occurred, the vessel is detained for a period sufficient to allow of a medical examination of all passengers and the crew by an official of the Port Sanitary Authority, who in turn have power to remove to their hospital ship all infectious patients, to detain for a period of probation all suspicious cases of sickness, and to disinfect the vessel and all infected articles. The really healthy are however permitted to land, and the vessel itself is detained no longer than is needed in the interests of health.

So far as the importation of the disease is concerned, our national system tends to greater security than a process of rigid quarantine, which would certainly be evaded as it has been heretofore. It remains for all who are concerned to see that our water sources, whether public or private, shall be free from all risk of contamination, and so to arrange our means of house and of public drainage as to secure all dwellings against the entrance of sewer air into them. Much has been done in these directions since cholera last threatened our shores, but more remains to be done if we are to rid ourselves of all the conditions which will tend to favour the spread of that disease should it succeed in finding an entrance into our country.

MODERN PERSIA

The Land of the Lion and Sun: or, Modern Persia. By C. J. Wills, M.D. (London: Macmillan and Co., 1883.)

ONE of the "Fathers," the great Austin we believe of Hippo, when asked which was the first Christian virtue, replied, Humility! And the second? Humility! And the third? Still Humility! So Dr. Wills would seem consciously or unconsciously to think that of travellers the first, second, and third virtue is *anecdote!* The result of this belief is one of the most graphic and entertaining books of travel ever published. With anecdote it begins, with anecdote it ends, and its substance is anecdote, and all these endless anecdotes are themselves distinguished by three cardinal virtues. They are characteristic, they are well told, and they are infinitely varied. By way of experiment we have opened the book at haphazard at twelve different places, and at every place there was an anecdote, some pithy story or other illustrating the social customs and habits of the Persians and even of the very plants and animals of the Iranian world, where the author's lot was cast for the space of fifteen years (1866–1881) as "one of the medical officers of Her Majesty's Telegraph Department in Persia." On one of the pages thus exposed occurs the subjoined incident bearing directly on the "scorpion controversy" recently carried on in the correspondence columns of NATURE:—

"A story was told me by the late Dr. Fagergren, a Swede who had been twenty-five years in Shiraz, to the effect that scorpions, when they see no chance of escape, commit suicide; and he told me that when one was surrounded by a circle of live coals, it ran round three times and then stung itself to death. I did not credit this, supposing that the insect was probably scorched and so died. I happened one day to catch an enormous scorpion of the black variety, and to try the accuracy of what I supposed to be a popular superstition, I prepared in my courtyard a circle of live charcoal a yard in diameter. I cooled the bricks with water, so that the scorpion could not be scorched, and tilted him into the centre of the open space. He stood still for a moment, then to my astonishment ran rapidly round the circle three times, came back to the centre, turned up his tail where the sting is, and deliberately by three blows stabbed or stung himself in the head; he was dead in an instant. Of this curious scene I was an eye-witness, and I have seen it repeated by a friend in exactly the same way since, on my telling the thing, and with exactly the same result. For the truth of this statement I am prepared to vouch" (p. 249).

More startling is the account at p. 307 of the "house-snake and sparrow."

"One morning I heard a great twittering of birds, and on looking out I saw some thirty sparrows on the top of a half-wall. They were all jumping about in a very excited manner, and opening their beaks as if enraged, screaming and chattering. Presently I saw a pale-yellow coloured snake deliberately advancing towards them from the ornamented wooden window from which he hung. They appeared *all* quite fascinated, and none attempted to fly away. The snake did not take the nearest, but deliberately chose one and swallowed him. I got my gun, and notwithstanding the entreaties of my servants, some of whom wept, assuring me that the reptile was inhabited by the late master of the house, I gave him a dose of duckshot. He was a big snake, some four feet long. I cut him open and extracted the sparrow. After some ten minutes' exposure to the sun, the bird got up, and after half an hour flew away apparently unhurt. The snake was not a venomous one, nor do we find venomous ones in houses in Persia."

Suitable also for the columns of a *scientific* journal may be the subjoined about the "transit of Venus":—

"On the high road to the capital from the Caspian the members of the expedition sent by the German Government to observe the transit of Venus met a lovely vision in habit and hat on a prancing steed. They halted, saluted, and declared their errand.

"'To observe the transit of Venus, ah, well, you can go home now, gentlemen, *your duty is done*, good bye;' and the pretty vision disappears at a smart canter 'away in the ewigkeit,' as Hans Breitmann says. *That* joke dawned on those Germans after some hours" (p. 331).

Dr. Wills has naturally a good deal to say about the Persian system of medicine, which "has its advantages in its delightful simplicity. All diseases are cold or hot. All remedies are hot or cold. A hot disease requires a cold remedy, and *vice versâ*. Now if the Persian doctor is called in, and has any doubt as to the nature of the disorder, he prescribes a hot treatment, let us say. If the patient gets better, he was right; if worse, then he prescribes a cold remedy, and sticks to it. He thus gets over all need for diagnosis, all physiological treatment, and he cannot, according to his own lights, be wrong. . . . His fee is a few pence, or more generally he undertakes the case on speculation: *so much*, of which he is lucky if he gets half, if the patient gets well; nothing if he doesn't. . . . Remedies and contrivances of a barbarous nature, such as putting the patient in fresh horse-dung, or sowing him up in a raw hide, are the rule rather than the exception" (p. 34).

Talismans, spells, and charms of all sorts are also much relied upon, in connection with which a characteristic story is told:—

"During the cholera in Shiraz I was attending the daughter of the high priest, who was sitting surrounded by a crowd of friends, petitioners, and parasites. He was writing charms against the cholera. I, out of curiosity, asked him for one; it was simply a strip of paper on which was written a mere scribble, which meant nothing at all. I took it and carefully put it away. He told me that when attacked by cholera I had but to swallow it and it would prove an effectual remedy. I thanked him very seriously, and went my way. That day he called and presented me with two sheep and a huge cake of sugar-candy weighing thirty pounds! I did not quite see why he gave me the present, but he laughingly told me that my *serious* reception of his talisman had convinced the many bystanders of its great value, and a charm desired by an unbelieving European doctor must be potent indeed. 'You see, you might have laughed at my beard; you did not. I am grateful. But if I could only say that you had *eaten* my charm, ah—then!' 'Well,' I replied, '*say so* if you like,' and our interview ended" (p. 291).

Like most Europeans who have lived long amongst them, our author learnt to regard with very kindly feelings the simple-minded natives who with all their faults are endowed with many noble qualities of head and heart. The Persian is here described as "hospitable and obliging, as honest as the general run of mankind, and especially well disposed towards the foreigner. Home virtues amongst the Persians are many. He is very kind and indulgent to his children, and as a son his respect for both parents is excessive. But the full stream of his love and reverence is reserved for his mother; and an undutiful son or daughter is hardly ever known in the country" (p. 314). Here of course follows a flood of anecdotes, some of which serve also to illustrate the character of the Armenians, of whom he has little good to say. "I will not trust myself," he writes, "to give my opinion of the Armenians. Of course I have known brilliant exceptions; but when I say that I indorse all that Morier, Malcolm, Lady Shiel, and the standard writers on Persia have said of these people, I need not add that my impression is unfavourable in the extreme. They possess one good quality, however, thrift" (p. 316).

In a work professing to give little more than personal experiences, valuable because derived from a lengthy residence in every part of the country, it would be unfair to look for any systematic information regarding the physical features, products, or natural resources of the land. Nevertheless, many useful details connected with these points occur here and there, and the statements made regarding the abundance and extraordinary cheapness of good provisions in all the fertile provinces would seem to justify the conclusion that Persia is not yet quite "played out." Cheese and butter at twopence a pound, flour and bread at a penny in the towns and much less in villages, eggs at ninepence per four or five dozen, quails and partridges at fourpence a brace, hares at fourpence each, lamb and mutton at proportionately low rates, make Persia "the poor man's paradise, in fact, *to live in, the cheapest country in the world*" (p. 298).

The work is furnished with a convenient glossary and an index, which contains some rather amusing entries; but there are neither maps nor illustrations beyond a solitary *chupper-khana* (posthouse) facing the title-page. But no such attractions were needed to render the "Land of the Lion and Sun" a far more entertaining book than most of our fashionable three-volume novels.

A. H. KEANE

CHLOROPHYLL CORPUSCLES AND PIGMENT BODIES IN PLANTS

Ueber die Entwickelung der Chlorophyllkörner und Farbkörper. By A. W. F. Schimper. (*Bot. Zeitung*, 1883.)

Ueber Chlorophyllkörner, Stärkebildner und Farbkörper. By A. Meyer. (*Bot. Centralblatt*, 1882.)

CONTRIBUTIONS to a more exact knowledge of the contents of the vegetable cell have increased of late to an extent which justifies the hope that some generalisation of the facts may before long be possible; meanwhile, botanists must have experienced a feeling akin to dismay at the scattered condition of much of the literature, and the apparent hopelessness of collating the facts dealing with normal and abnormal cell contents. The works of Strasburger, Schmitz, Schimper, and others have already cleared the way to a better comprehension of many details, especially with regard to the cell nucleus and starch grains; but with each step it has been felt that the pushing back of the phenomena towards a common cause has raised other difficulties hitherto unforeseen.

In the isolated position of such structures as chlorophyll grains and pigment corpuscles as unexplained cell contents, we have an illustration of wide significance in this connection, and the attempt to bring all such bodies as these and the "starch-forming corpuscles" of Schimper into definite relationship one with another must be welcomed as promising much simplification of nomenclature and discussion, the more so, since these relationships are now shown to be genetic, and therefore real. Schimper in Bonn, and A. Meyer in Strasburg, proceeding independently, have arrived at the conclusion that the chlorophyll corpuscles, "starch-forming corpuscles," and pigment bodies of the higher plants are simply the more or less modified and mature conditions of certain minute protoplasmic structures found together with the nucleus in the youngest cells of any meristem.

Whereas botanists have assumed that chlorophyll grains, starch-formers, nuclei, &c., are produced free in the protoplasm of the cell, we are now called upon to note that such is not the case; but that these bodies arise from distinct structures present in the young cell from its earliest existence, and that any pigment (green or otherwise), starch grains (directly assimilated or not), &c., found in connection with the structures named, arise by later changes in the substance of the protoplasmic corpuscles produced by continuous growth and division of the few, minute "plastids" found in the young cell.

Meyer and Schimper agree in all essential points regarding the relationship and development of these bodies, and the slight differences in details and nomenclature between the two investigators in no way affect the main question.

To quote an example, we may take Schimper's description of the development of the pigment bodies occurring in the flower of *Hemerocallis fulva*. The cells of the perigone contain brick-red crystalline needles or three-pointed tablets, which arise as follows:—

In the very young flower bud, the cells contain, besides the nucleus and cell-protoplasm, minute bodies which Schimper names *plastidia*—a general term for these bodies in all meristems, and independent of any function afterwards performed by them. When the flower bud is already green the *plastidia* nearest the light have acquired a distinct green colour, and function, no doubt, as chlorophyll corpuscles; all such green *plastidia* are called by Schimper *chloroplastidia*. The *plastidia* in the cells more deeply situated, however, remain pale, and may be called *leukoplastidia*. All stages intermediate between *leukoplastidia* and *chloroplastidia* occur. The small lenticular *chloroplastidia* increase in size, become flatter, and divide as the cell grows. They then become narrower and pointed, some becoming needle- or spindle-shaped;

a few remain broad, and finally acquire a triangular form with sharply pointed corners.

Meanwhile, the colour passes through intermediate dirty shades from green to brick-red; and, some time before the flower bud opens the ultimate shape and colour are attained, and the bodies are now called *chromoplastidia.* Many similar instances have established the connection between the three kinds of *plastidia,*[1] *e.g.* petals of *Senecio, Bellis, Tropæolum,* fruits of *Sorbus, Rosa, Lonicera,* &c.

The primitive *plastidia* are universally present in the meristems of the higher plants, and have now been found in so many seeds and embryos, that Schimper suggests that they no doubt exist in the embryo-sac and oosphere from the first. All the *chloroplasts* of the plumule and stem-axis, &c., arise by division of the plastidia in the *punctum vegetationis* of the young stem; these may be green from a very early stage, or acquire their green colour later, or remain colourless (*leukoplasts*). In cases where the *leukoplasts* form large starch grains, we have the *Stärkebildner* discovered by Schimper in 1880; all the kinds of *plastidia,* however, may be fou id in connection with starch grains, which often become resorbed later.

In the same way, all the *chloroplasts, leukoplasts,* and *chromoplasts* of the roots arise by division and differentiation of the few primitive *plastidia* in the *punctum vegetationis* of the radicle.

Since *chloroplasts* or *leukoplasts* are found at a very early age in the embryos of *Crucifers, Leguminosæ, Geraniaceæ,* and many others, Schimper considers it probable that they arise from primitive *plastidia* in the oosphere. *Chloroplasts* and *leukoplasts* (as starch-forming corpuscles) are visible in the embryo of *Linum austriacum* when it consists of eight cells only, and the minute starch-grains observed in the embryo sac and oosphere of that plant are no doubt contained in *leukoplasts*—which become green afterwards and are then visible. Schimper finds that the primitive *plastidia* may remain colourless as *leukoplasts*—which, if they form starch grains, are the *Stärkebildner* of his earlier papers—or may become *chloroplasts,* as is usual (but by no means universal) in cells exposed to light, which remain green, or pass over into *chromoplasts* (most flowers and fruits). Nevertheless, the order of change is not fixed, and no sharp lines can be drawn—thus, a *leukoplast* may become green, and function as a *chloroplast* for a time, and finally lose its colour again, and become a *leukoplast.*

The *Characeæ* seem to be the earliest plants in which all three forms of these bodies occur; the apical cells containing *leukoplasts,* and the antheridia red *chromoplasts.* Schimper suggests that if the oosphere is proved to contain already-formed *plastidia,* it will support the view that the higher green plants owe their origin to symbiosis of green and colourless organisms. The author enters into no particulars, however, concerning this hypothesis, which appears by no means obvious in the light of other considerations.

[1] A. Meyer terms the bodies ana-plasts (= leucoplastidia), auto-plasts (= chloroplastidia), and chromo-plasts (= chromoplastidia) respectively. He uses the generic term *trophoplasts* to embrace all collectively. We may call them leuko-, chloro-, and chromo-plasts, since these names imply no functional peculiarities.

The following may be selected as further illustrations of Schimper's work:—

1. *Leucoplasts* arise from colourless *plastidia* (roots, &c.) or, more rarely, from *chloroplasts* (*e.g.* fruit of *Symphoricarpus*). They may become green *chloroplasts* (many embryos), or function as *Stärkebildner* (*e.g.* deeply-situated cells), or remain apparently without function (*e.g.* epidermis cells). In many flowers they become *chromoplasts.*

2. *Chloroplasts* (*i.e.* chlorophyll corpuscles) arise from the growth and division of primitive *plastidia* which are already green, or by the development of green colouring-matter in *leukoplasts* exposed to light. They often become *chromoplasts* later.

3. *Chromoplasts.*—All shades occur between pure carmine-red and greenish-yellow—never blue—the earlier statements being based on errors of observation.[1]

The development of the colouring matter is frequently attended by a disappearance of the starch grains on or in the *leukoplast* or *chloroplast* from which the *chromoplast* arises. As sometimes occurs with other bodies, the spindles, needles, and tablets produced as the ultimate forms of the *chromoplasts* appear to proceed from a process of crystallisation of certain of the proteid contents of the *chromoplast* from a formless matrix of living protoplasm. In these cases the pigmented tablets, needles, rods, &c., must be regarded as crystalloids. More rarely the proteids of the *leukoplasts* and *chromoplasts* separate in the same crystalline form.

Schimper distinguishes three types of *chromoplasts*:—

1. The spherical type, found in the arillus of *Taxus,* fruit of *Solanum,* &c.

2. Two or more pointed needles, tablets, &c., of *Hemerocallis, Lilium, Tropæolum,* and other flowers. In the fruits of *Rosa, Lonicera,* &c., both these types occur together.

3. In this type the *chromoplasts* are rod-shaped—*e.g.* flowers of *Tulipa,* root of *Daucus,* &c.

No relations can be discovered between the form, &c., of any of these bodies and the natural groups in which they occur.

H. MARSHALL WARD

[1] Schimper points out how easily such bodies as these are altered by processes hurtful to the cell: they must be observed in perfectly fresh, uncut, and uninjured cells.

OUR BOOK SHELF

The Forests of England and the Management of them in Bygone Times. By John Croumbie Brown, LL.D. (Edinburgh: Oliver and Boyd, 1883.)

French Forest Ordinance of 1669, *with Historical Sketch of Previous Treatment of Forests in France.* Compiled and Translated by John Croumbie Brown, LL.D. (Edinburgh: Oliver and Boyd, 1883.)

THESE two little books, published almost simultaneously but in the order in which their titles are given above, have been written, as Dr. Brown tells us, "as a small contribution to the literature of Britain on subjects pertaining to forest science." The author has shown in previous writings on kindred subjects the scarcity of English literature on forestry as compared with that of France and Germany, and he again draws attention to this fact by copious extracts in "The Forests of England" from a little work of his on "The Schools of Forestry in Europe," published in 1877.

The forests of England, exclusive of their practical utility, have played a not unimportant part in the history of our country, and consequently any records or facts connected with them have a charm both for the forester as well as for the general reader. Dr. Brown's book on "The Forests of England" is therefore far from dry reading, treating as it does of such well-known forests and parks as Sherwood, Epping, Dean, and the New Forests, Woolmer, Whitlebury, Windsor, Malvern, Cannock, and Hatfield Chases, &c.

A good deal of attention is being directed at the present time to the preservation of our forests in their natural beauty, and we should hope that Dr. Brown's books will at least have the effect of sharpening the interest of those who have hitherto been indifferent about the works of draining and planting that are always ready to be put forward as improvements, but which are for the most part of a character that should not be allowed to be carried out without deep and serious consideration by those qualified to advise.

"French Forest Ordinance" is a book of a more practical character than the preceding, inasmuch as it deals more with forest treatment and legislation in France, nevertheless it contains much of interest. The following extract from Chapter III. will explain : "It has been mentioned that the forests were exploited at that time [middle of seventeenth century] on a system of exploitation known as *jardinage* or *furetage*. The method of exploitation so designated is that which is generally followed in the management of woods in England, and of forests in our colonies—felling a tree here and there, and leaving the others standing—and is called in French forest economy *jardinage*, or gardening, from its similarity to the procedure of a gardener gathering leeks, onions, turnips, carrots, cabbages, or cauliflowers—taking one here and there, not at haphazard, but with some principle for his guidance—it may be to thin them—it may be to gather in the mature, and leave the others to grow; and called *furetage*, or ferreting, from the similarity of the woodman's procedure in seeking out what trees to fell—to what is called, from the conduct of a ferret, ferreting out what is wanted when it does not at once appear."

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.*]

"Waterspouts" on the Little Bahama Bank—Whirlwind at Grand Cayman

We have received the following communication, by an officer of H.M. surveying vessel *Sparrowhawk*, employed in the West Indies, from the Hydrographer to the Admiralty :—

Being much interested in the subject of waterspouts and their formation, and having failed to find anything about them in the works of recognised authorities, I venture to record some personal experiences together with what information I have been able to collect from the inhabitants of Al aco and the adjacent bays.

During the summer months waterspouts are common on the Little Bahama Bank. I have seen seven at once in water varying from ten feet to over a hundred fathoms, and I am informed that fifteen have been observed.

I have noticed that the first movement which eventually produces a waterspout is a whirlwind on the surface of the water gradually increasing in velocity of rotation and decreasing its diameter as it travels along before the prevailing wind. The spray is lifted to a height of from five to ten feet, and then gradually melts away, assuming the appearance of hot air, which is visible (still rotating) to a similar height above the spray. A motion amongst the clouds soon becomes apparent, a tongue is protruded, and the spout becomes visible from the top downwards.

On one occasion a portion of a spout appeared for a moment in mid air above the disturbance on the surface of the water.

Although these appearances are commonly called "waterspouts," I am informed by men who have been caught in them that they contain no water, and should be properly called "windspouts;" the small fore-and-aft-rigged schooners that ply on the bank do not fear them, although a prudent captain would probably shorten sail to one. I have been unable to hear of an accident having occurred through a vessel being caught in a waterspout.

They frequently cross the land, but no water falls; they take up any light articles, such as clothes spread out to dry, straw, &c, that happen to be in their course, but have never been known to carry anything along with them for a distance.

At Grand Cayman Island I noticed a whirlwind on the water, of somewhat similar appearance to those of the Little Bahama Bank just mentioned, though there was no cloud above it; the place where it appeared was a sheet of shoal water between the fringing reef and the shore, about one cable in breadth and three to ten feet deep. The whirlwind passed about fifty yards from where I stood; its estimated diameter was fifteen feet, and it whirled rapidly from left to right; the spray was lifted from the surface in a revolving sheet to a height of ten feet, but appeared to get thinner towards the top, and gradually melted away till it looked like the air over a boiling cauldron visible to a height of ten feet above the spray. I estimated its rate of progression at five knots; the wind was light (force 2). The whirling spray made a continuous hissing noise like a fast boat under sail passing close; it caused no particular wave on the beach and left no wake; its character was unchanged for half a mile, when I lost sight of it by its passing a point.

The inhabitants informed me that in their memory several whirlwinds had passed, but none had been known to cross the land. MORRIS H. SMYTH

A Remarkable Meteor

A METEOR was seen at Hendon on the 6th inst., at 8.53 p.m., in a clear sky, and broad daylight. The course by compass was from north-east to east, at an altitude of about 27° above the horizon when first seen, and 22° when it disappeared, after being visible six or seven seconds. I drew the attention of a friend, in whose garden we were standing, to it. He saw it about three seconds, and compared it to a stream of fire. I learnt later that it was also seen by parties boating on the waters at the Welsh Harp, but could not get any particulars beyond the fact that it was seen. Its passage appeared attended by intense combustion. It first appeared as a circular ball of fire, but speedily lost a spherical shape, and became pointed, resembling somewhat a spear head, as though the change in appearance were due to the resistance of the atmosphere. From a deep red at first it became of a decided golden colour, to change to a brilliant white just before or as it disappeared. There was nothing special about the disappearance. P. F. D.

London, W.

The Function of the Sound-Post in the Violin

I READ with much interest the part of Dr. Huggins's paper which relates to the above subject, having myself tried numerous experiments in the same direction. The conclusions I arrived at do not so much differ from those set forth in the paper, as that I venture to think they go a step further. It is on this plea that I ask for the acceptance of the following observations :—

It is undoubtedly true that the sound-post of a violin does communicate the vibrations from the belly of the instrument to the back; but, as will be hereafter seen, these vibrations are not of an order to reinforce the *sound* except to a limited extent. By far the most important function of the sound-post is that it acts as a prop to the belly in such a position and in such a manner as to enable the latter to give out a more resonant *order* of waves. The back may, and does, give out a modicum of sound, but it is especially the belly which becomes more resonant under the influence of the prop than without it.

In the first place, when the sound-post is removed, the belly of the violin is then an uninterrupted elastic table with a vibration rate of its own, its greatest elasticity being just at the part where the bridge is situated. Now it may safely be predicted, without resorting to experiment, that this specific rate of vibration of the belly itself will interfere with the varying rates of vibration communicated to it by the strings. That it is so, however, I have conclusively proved by actual experiments in great variety, and when such interference takes place the tone is always meagre, as described by Dr. Huggins.

But it will naturally occur that there must be *one* note in the scale of the instrument which will coincide in its vibrations with those of the belly when in this unsupported condition, and that this note ought to be exceptionally loud. It is so in fact, but not to the extent that might at first be supposed. This is because in reality, as I shall try to explain, the injurious effect of interference does not include the whole question. When a tuning-fork is struck and held out of contact with a resonant body, it gives out a very feeble sound. The cause of this, as is well known, is that each half-wave is compensated and partly annulled by the succeeding half taking place in the opposite direction. A string stretched between two non-resonant supports does the same when plucked or bowed in the middle. In like manner, the belly of a fiddle, when unsupported by a sound-post, is under conditions which are very similar to those of the string. The most yielding part is immediately beneath the bridge, under the impulses of which every point of every longitudinal fibre moves up and down in the *same phase*, and every half-vibration cancels the effect of the half immediately preceding. The sound is correspondingly feeble. The wave, in fact, is not a true one. It is a to-and-fro, self-compensating motion all along the line. If the bridge were placed near one end of the instrument, the case would be different. Its nearness to a support or fulcrum on one side would cause the free part on the other side to break into a wave of progression, which is the true dynamic sound-giving wave. The office of the sound-post is precisely this. It forms a node at a particular part under the influence of which the wave is converted into one of *contrary phases* all over the surface. Such a wave travels in wood at amazing rapidity, and the consequence is that every half vibration reaches its limit and strikes the air almost before the other half has commenced its career, and therefore before it has had time to interfere with its dynamic effect. The best position of the node is found to be just behind the E string, because the higher the note the greater is the firmness required. The G string is further removed from the support, because the lower notes require greater freedom of motion, but it still partakes of its advantages.

I have never met with a satisfactory explanation of the cause of resonance in sound-boards. It cannot be due to extended surface in the sense that there are more extended vibrations or more numerous ones, because the greater the quantity of matter put in motion the more is the motion diluted. The investigation is practically a difficult one, owing to the extreme minuteness of the oscillations which have to be traced, but so far as the experiments indicate which I have been able to devise, the true cause does seem to be what I have been endeavouring to explain. A resonant wave is a *travelling* wave—the crest is always in advance of the depression, and expends itself dynamically before the latter has time to neutralise it. On the other hand, the depression succeeds in due order and produces a similar effect. It is in this sense only that an extended surface is useful and necessary.

If we need confirmation of the principle thus advanced, we have it in every wind instrument without exception. The type of all such instruments is the reed, the only difference being that in some it is aërial, and in others substantial. Take therefore an ordinary harmonium reed, and vibrate it with the finger. However elastic it may be, the sound is of the feeblest character. The double vibration is a compensated one—but let a current of air traverse the point of disturbance, the reed then speaks, or rather the current of air speaks. The half vibration has proceeded so far from its origin that it expends its dynamic force before the succeeding half is able to reach and neutralise it—the crest of the wave, as it were, has smitten the shore, before the depression has had time to overtake it. The depression then succeeds and does its own work. R. HOWSON

Middlesbrough

Waking Impressions

THE accompanying experience may be of interest to some of your readers; and that it may be the more genuine in the recounting of it, I copy the little entry I made in my notebook some few hours only after the occurrence, as it was so distinctly impressed on my mind that I could not but be struck by it as being worth taking note of.

I have not unfrequently been on the point of noting down similar visual impressions between sleeping and waking time, but have hitherto always found that they were really of so fugitive a nature, or the mind so little sensitive as not to be retentive, that the mere effort to recall them and put them into uttered words (whether audibly or only mentally uttered) was quite sufficient to dispel the impression totally; though by a long directing of the memory I could sometimes *nearly* recover it, not perfectly enough, however, to feel confident that imagination had not added somewhat to the picture. But the present case has been so vividly impressed on my mind that it has been fairly caught, to my own satisfaction at any rate, and I hope that it may be not unworthy of a corner in your valuable paper.

"*Reigate, July* 13

"This morning I woke up suddenly with the end of a dream and found myself reading, as if from a printed book, only there was no book, merely printed words, thus: '*So while he was enjoying himself at . . . . she was in deep depression at Kaÿ-ro.*' The 'Kaÿ-ro' looked quite right, and I quite naturally pronounced it Cairo, and knew I meant that town. I was so struck by the clearness of the visual impression that, for fear of losing it, as one generally does, I instantly recounted the thing to my husband; but in the uttering of it when wide awake I could not at the moment, *even so soon* after the dream, recollect the name of the other locality (marked here by '. . . .'), though I knew that it had been printed and read by myself in the dream. But about four minutes later, as we were talking it over, I said, 'It is so strange, for I'm sure I've not been talking or thinking either of *Beloochistan* or Cairo!' and at once it flashed upon me that Beloochistan had been the other name, and I had then and there reseen the impression after an interval of total oblivion of it.

"There had been no idea of book or sheet to carry the printing, nor, I fancy, even *solidity* of any kind in the letters; but that the whole phrase was conveyed to my mind through a printed form and by a process of reading I am quite certain. We were on a visit, and the night before had been greatly entertained by the conversation of our host, who had been a great traveller, and we had certainly talked much of India, Cashmere, and Assam; but as far as I can now, or could then, recollect, we had most certainly *not* mentioned either Beloochistan or Cairo, nor had I been reading a novel before going to sleep or during the previous day."

Collingwood, Hawkhurst, July 14 J. MACLEAR

Tertiary Corals

I SHALL be obliged if you or any of your readers would kindly inform me the best authority to consult on the tertiary corals of Piedmont and Liguria; also the age of the beds in the lower part of Val d'Andona. W. E. BALSTON

Bearsted House, Maidstone, July 15

Wild Fowl and Railways—Instinct and Intelligence

I AM happy to find that my experience of "ducks and railways" is confirmed by so high an authority as Mr. Goodsir from observations made on the other side of the world. Agreeing so far, we differ as to the cause by which the birds are influenced, Mr. Goodsir attributing it to "quick and unerring instinct," whilst I credit the ducks with "quick intelligence" or reasoning powers. If caused by the "teaching" of instinct, the ducks should show no alarm on the sudden and first appearance of a smoking, roaring train in their midst. They certainly do at first show alarm, but as they receive no injury, their intelligence teaches them, after a brief experience, that there is no danger.

I may perhaps be permitted to give one of many instances known to me of the quickness of birds in acquiring a knowledge of danger. Golden plover, when coming from their breeding-places in high latitudes, visit the islands north of Scotland in large numbers, and keep together in great packs. At first they are easily approached, but after a very few shots being fired at them, they become not only much more shy, but seem to measure with great accuracy the distance at which they are safe from harm; the sportsman, however, not unfrequently takes an unfair advantage of them by loading with a wire cartridge, which adds twenty yards or so to the distance at which the gun will kill when charged in the ordinary way.

It would be easy to adduce many cases of what may be considered pure and true instinct, of which the following is perhaps not a bad example, and not unworthy of mention, if it has not already appeared in the columns of NATURE or elsewhere:—

If the eggs of a wild duck are placed with those of a tame one under a hen [1] to be hatched, the ducklings from the former, on the very day they leave the egg, will immediately endeavour to hide themselves, or take to the water if there is any near, should any person approach, whilst the young from the tame duck's eggs will show little or no alarm, indicating in both cases a clear instance of instinct or "inherited memory."

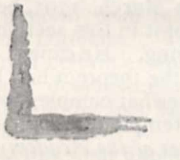
4, Addison Gardens, July 16 JOHN RAE

Clouds

THE following notes of a cloud action, which, so far as I am aware, is not common, may be considered worthy of record.

The occurrence took place at Chatham at about 1 p.m. on Sunday the 1st inst., and attracted attention more particularly from its following a week of strong electrical disturbance in the neighbourhood, accompanied by two fatal results.

At the hour named above, and apparently at a considerable height, certain semi-transparent clouds arranged themselves in thin columns at right angles to each other, some of the columns giving off shoots throughout their length, in shape somewhat resembling blades of grass. Whenever fleecy clouds passed between the foregoing formation and the earth, they were quickly



broken up into small, attenuated components which gradually reunited on getting out of the influence; but on one occasion a very small cloud thus acted upon set itself in the form of a right angle also and remained so. R. Y. ARMSTRONG

July 7

Extraordinary Flight of Dragon-Flies

AN English gentleman writing from Malmö, in Sweden, on July 3, says:—

"On Sunday, June 24, we had an extraordinary flight of the *Trollslända* (*Libellula quadrimaculata*, Linn.), . . . a brown dragon-fly an inch and five-eighths long and three inches from tip to tip of the wings. . . . They passed over or through the town and neighbourhood for about half an hour in the afternoon. The next day about 1 o'clock they reappeared for more than an hour, but on Tuesday the 26th, at 7.30 a.m., they again began in millions, and notwithstanding the wind had shifted to the south during the night, they held the same course from north-west by west, heading south-east by east. The streets, shipping, and every place were full of them. They did not fly very high, and seemed to avoid going into open doors and windows. Some hundred or so alighted on the gooseberry bushes, apple and pear trees in this garden, but never touched the fruit. I observed one sitting on the dead tip of an apple-twig, and I pushed it off with my stick *thirteen* times, the insect returning each time after flying away about five or six yards. . . . The flight ended that night about 8 p.m., having been incessant for more than twelve hours. On the 27th they appeared again about noon, flying the same course, but in much reduced forces. Each day since I have seen a few, but very few. . . . The papers say they were observed in all southern and Central Sweden, and in many places in Denmark, and they swarmed about the ships in the Sound. With their disappearance came the hot weather."

The foregoing extracts seem to me worthy of record in the pages of NATURE, and I accordingly forward them with that view. ALFRED NEWTON

Magdalene College, Cambridge, July 11

Sheet Lightning

WE had here last night a violent rain and lightning storm without thunder. The lightning was very vivid and incessant, and seemed nearly overhead, but there was no sound but that of rain. We are near the crest of the Apennines, and the storm seemed to have gathered along that crest, having been preceded by a furious sirocco suddenly supervening on a north-west wind.

I have twice before witnessed the same phenomenon of electrical storms with vivid lightning overhead and no thunder. Both instances occurred on the abrupt edge of the Montenegrin highlands, where they fall off into the low, wide plains of the Scutari district, and where thunderstorms are more common than in any other country I have ever visited. On these nights we were encamped on the edge of the hill country, on broken rocky land, with much low scrubby vegetation, but the lightning was so incessant and vivid that we were able to walk about, choosing our way amongst the stones and shrubs as readily as by daylight, the intervals between the flashes being, I should judge, never more than a minute, while much of the time they seemed absolutely continuous, the landscape being visible in all details under a diffused violet light. Looking overhead the movements of the lightning were easily discernible, the locality of the discharges varying from one part of the vault to another in a manner which it was impossible to confound with the reflection of lightning from a distance. Like the storm of last night those were followed by copious rain, but not a single peal of thunder was heard during the whole night. W. G. STILLMAN

Cutigliano, Pistoiese Apennines, July 11

ALGÆ [1]

DR. BERTHOLD tells us in his preface that he was induced by his discovery of the processes of fructification in *Erythrotrichia obscura* to study the small but interesting group of the Bangiaceæ, in the knowledge of which so many gaps still existed. The Zoological Station at Naples afforded him every facility for carrying on his researches on these algæ, not only in what may be called their wild state, but also under cultivation. To these advantages may be added, although in an inferior degree, that of the use of a great number of dried specimens. The results of his two years' study are embodied in the work mentioned at the head of this notice.

The small group of algæ, now included by Dr. Berthold under the general name of Bangiaceæ, consists of the three genera, Bangia, Porphyra, and Erythrotrichia; under the last genus are included *Bangia ciliaris*, and *B. ceramicola* of Harvey ("Phyc. Brit.," Pls. cccxxii. and cccxvii.). To these genera may probably be added Goniotrichum.

The exact systematic position of these algæ has, from the fact that little was known of their fructification, been hitherto uncertain. While their red colour induced Cohn, Thuret, and Bornet to place them with the Florideæ; other algologists, among whom may be mentioned J. Agardh, Kützing, Harvey, and Zanardini, grounding their opinion on the structure of the vegetative thallus, have classed them with the Chlorosperms.

For the first information relative to the fructification of the Bangiaceæ, we are indebted to Derbès and Solier, who had discovered in *Bangia fusco-purpurea* and *B. lutea* two different kinds of fructification, namely, the "common spores" and antheridia. Then followed the researches of Nägeli, Thuret, and Janczewski on Porphyra. Janczewski had actually discovered and described the carpospores of Porphyra, to which he gave the name of

[1] I mention a hen as foster-mother because the ducklings can have no instinctive knowledge of any note of alarm or warning she may give.

[1] "Die Bangiaceen des Golfes von Neapel." Eine Monographie von Dr. G. Berthold. Fauna und Flora des Golfes von Neapel. (Leipzig: Wilhelm Engelmann, 1882.)

octospores; but he failed to interpret their true significance as reproductive organs, and laid down his pen under the firm conviction that the cystocarpic fruit was entirely absent in Porphyra. Thuret's representation of this kind of fruit proved that Janczewski was mistaken. Dr. Berthold mentions that he was fortunate enough to obtain by his researches at the Zoological Station at Naples satisfactory proof that the reproductive processes in the Bangiaceæ correspond exactly with those of the other Florideæ; he further states (p. 21) that they are true Florideæ, but that they undoubtedly occupy the very lowest position in the class.

The first part of the work describes at some length the structure of the vegetative thallus of each of the three genera. A minute description follows of the organs of fructification, namely, the tetraspores, cystocarps, and antheridia, and of the mode in which the cystocarps are fertilised. The fructification of all the genera is illustrated by a plate containing twenty-five figures. We have then an account of the germination of the spores and of their development into plants, followed by observations on the systematic position occupied by the Bangiaceæ and their relation to the Chlorosperms. To these are added descriptions of the genera and species, with a notice of the habitat and time of appearance of the several species.

This very interesting work concludes with some remarks on Goniotrichum, and short descriptions of the two species *G. elegans* (*Bangia elegans* of the "Phyc. Brit.," Pl. ccxlvi.) and *G. dichotomum*. MARY P. MERRIFIELD

GAUSS AND THE LATE PROFESSOR SMITH

IN the centenary notice of Gauss (NATURE, vol. xv. pp. 533-537) I more than once refer to notes placed in my hands by the late Prof. Henry Smith. These took the form of two MSS. (*A*), (*B*). The former of these I used in its entirety (p. 537), the latter I withheld, with Prof. Smith's sanction, on account of the length to which the article had already extended. Many mathematicians may now like to read these further criticisms on Gauss by such a kindred genius. R. TUCKER

We proceed to give brief references to some of the most important points which have caused a new epoch in certain branches of analysis to date from the publication of the "Disquisitiones Arithmeticæ," and from the researches with which, some years later, Gauss supplemented or further developed the theories contained in that work. It may be proper to premise that Gauss found the theory of numbers as Euler and Lagrange had left it. Of these the former had enriched it with a multitude of results, relating to diophantine problems, to the theory of the residues of powers, and to binary quadratic forms; the latter had given the character of a general theory to some at least of these results, by his discovery of the reduction of quadratic forms, and of the true principles of the solution of indeterminate equations of the second degree. Legendre (with many additions of his own) had endeavoured to arrange as much as possible of these scattered fragments of the science into a systematic whole in his "Essai sur La Théorie des Nombres." But the "Disquisitiones Arithmeticæ" was in the press when this important treatise appeared, and what in it was new to others was already known to Gauss.

The first section of the "Disquisitiones," "De Numerorum Augmentiâ in genere," occupies hardly more than four pages of the quarto edition, and is of the most elementary character. Nevertheless, the definition and the elementary properties of a congruence, which were for the first time given in it, have exercised an immense influence over all the branches of the higher arithmetic; an influence which is perhaps surprising when we remember that it is a question of notation only, and that (as Gauss has said himself in a letter to Schumacher) nothing can be done with this notation which cannot (though less conveniently) be done without it.

The second section, "De Congruentiis Primi Gradus," contains applications of the definition and of the elementary properties of congruences to linear congruences, and to systems of such congruences. The problems solved in it are of an elementary kind, and may be regarded as either well known, or as lying within the scope of what was well known, at the time of the publication of the "Disquisitiones Arithmeticæ."

The same remark applies to the third section, "De Residuis Potestatum," which, notwithstanding the immense advantage of clearness and simplicity obtained by the use of the congruential notation, may be said to lie almost wholly within the aid of ideas to be found in Euler's memoirs. The demonstration of the existence of primitive roots (a demonstration which Euler had failed in rendering rigorous), is, however, a very noticeable exception.

The fourth section—"De Congruentiis Secundi Gradus"—opens with an exposition of the elementary theorems relating to quadratic residues and non-residues; and so far we are still entirely within the ground already occupied by Euler. But the greater part of this section is occupied with a research which of itself alone would have placed Gauss in the first rank of mathematicians. "If p and q are positive uneven prime numbers, p has the same quadratic character with regard to p that q has with regard to p, except when p and q are both of the form $4n + 3$, in which case the two characters are always opposite instead of identical." This is the celebrated Fundamental Theorem of Gauss, known also as the law of quadratic reciprocity of Legendre. Gauss discovered it (by induction) in March, 1795, before he was eighteen; the proof given of it in this section he discovered in April of the year following. He cannot at the earlier date have been aware that the theorem had been already enunciated (though in a somewhat complex form) by Euler; and that Legendre had attempted, though unsuccessfully, to prove it in the *Mémoires of the Academy of Paris* for 1784. But the question to whom the priority of the enunciation is due is of even less moment than questions of priority usually are; for the discovery of the theorem by induction was easy, whereas any rigorous demonstration of it involved apparently insuperable difficulties. Gauss was not content with vanquishing these difficulties once for all in the fourth section. In the fifth section he returns to it again; and obtains another demonstration reposing on entirely different, but perhaps still less elementary, principles. In January of the year 1808 he submitted a third demonstration to the Royal Society at Göttingen; a fourth in August of the same year; a fifth and sixth in February, 1817. It is no wonder that he should have felt a sort of personal attachment to a theorem which he had made so completely his own, and which he used to call the gem of the higher arithmetic. His six demonstrations remained for some time the only efforts in this direction; but the subject subsequently attracted the attention of other eminent mathematicians, and several proofs, differing substantially from one another and from those of Gauss, have been given by Jacobi and Eisenstein in Germany, and by M. Liouville in France, the simplest of all perhaps being that which has been given by a Russian mathematician, M. Zeller, and which is of the same general character as the third proof of Gauss (see *Messenger of Mathematics*, vol. v. pp. 140-3, 1876). It would certainly be impossible to exaggerate the important influence which this theorem has had on the subsequent development of arithmetic, and the discovery of its demonstration by Gauss must certainly be regarded (indeed it was so regarded by himself) as one of his greatest scientific achievements.

The fifth section—"De Formis Æquationibusque Indeterminatis Secundi Gradus"—consists, as has been said with great truth by Dirichlet, of two distinct parts. Of these the first (Arts. 153-222) contains a complete exposition of the theory of binary quadratic forms, as far as it was known from the researches of Euler and Lagrange; although even these known results are completed in many respects and are exhibited from a new and independent point of view. The second part (Arts. 223-305) contains investigations which are entirely Gauss's own: the distribution of the classes of binary forms into genera; the determination of the number of ambiguous classes; the demonstration that only one-half of the genera possible *a priori* actually exist, and the proof of the fundamental theorem deduced from this result; a disquisition on ternary quadratic forms, introduced as a digression; the theory of the decomposition of numbers into three squares; the solution of indeterminate equations of the second degree in rational numbers; the determination of the mean number of the genera and classes; the distinction between regular and irregular determinants. Such is a brief list of the subjects treated of in these marvellous pages, each of which has been the starting-point of long series of important researches by subsequent mathematicians.

In the *Additamenta* to this section, Gauss intimates that he had succeeded in determining the relations between the determinant and the number of classes; and in a manuscript note he characteristically adds: "Ex voto nobis sic successit ut nihil amplius desiderandum supersit, Nov. 30-Dec. 3, 1800." It is remarkable that he should never have published the wonderful researches to which he here alludes. These researches first saw the light sixty-three years later in the second volume of the collected edition of his works; but the theorem to which they refer had in the interval been rediscovered and demonstrated by Lejeune Dirichlet. The demonstration of Dirichlet had been to a certain extent simplified by M. Hermite, and the form of demonstration found in Gauss's papers after his death approaches very nearly to that adopted by M. Hermite.

The sixth section contains some applications of arithmetical principles to various practical questions. Of these the first two are comparatively elementary, and relate to the resolution of fractions into simpler fractions, and to the conversion of vulgar into decimal fractions; the others consist in systematic methods of abbreviating certain tentative processes, such as the solution of quadratic congruences, the decomposition of numbers into their prime factors, the solution of certain indeterminate equations, &c. The methods of Gauss still remain the least unsatisfactory that have been proposed for the indirect treatment of these difficult problems, of which any direct solution seems impossible.

The seventh section, "De Æquationibus Circuli Sectiones Definientibus," is that which at once made the reputation of the "Disquisitiones Arithmeticæ." It is not too much to say that till the time of Jacobi the profound researches of the fourth and fifth sections were passed over with almost universal neglect. But the well-known theory of the division of the circle comprised in this section was received with great and deserved enthusiasm as a memorable addition to the theory of equations and to the geometry of the circle. One of Gauss's manuscript notes is interesting, "Circulum in 17 partes divisibilem esse geometrice, deteximus 1796, Mart. 30," because it shows that he was not yet nineteen when he made this great discovery. Even more remarkable, however, is a passage in the first article of the section (Art. 335), in which Gauss observes that the principles of his method are applicable to many other functions besides the circular functions, and in particular to the transcendents dependent on the integral $\int \frac{dx}{\sqrt{1-x^4}}$. This almost casual remark shows (as Jacobi long since observed) that Gauss, at the date of the publication of the "Disquisitiones Arithmeticæ," had already examined the nature and properties of the elliptic functions (the inverses of the elliptic integrals), and had discovered their fundamental property, that of double periodicity. This observation of Jacobi's is amply confirmed by the papers on elliptic transcendents now published in the third volume of Gauss's collected works.

The "Disquisitiones Arithmeticæ" were to have included an eighth section. This eighth section was at first intended to contain a complete theory of congruences, but subsequently Gauss appears to have proposed to continue the work by a more complete discussion of the theory of the division of the circle. Manuscript drafts on each of these subjects were found among his papers; the first of them is especially interesting, as it treats of the general theory of congruences from a point of view closely allied to that subsequently taken by Evariste Galois and by MM. Serret and Dedekind. This draft appears to belong to the years 1797 and 1798.

To complete this hasty outline of the arithmetical works of Gauss it only remains to mention (1) the remarkable geometrical interpretation of the arithmetical theory of positive binary and ternary quadratic forms, which will be found in his review (1831) of the work of L. Seeber ("Werke," vol. ii. p. 188), and (2) the two important memoirs on the theory of biquadratic residues (1825 and 1831). In the second of these memoirs Gauss introduces into arithmetic *complex* numbers of the form $a + bi$. He finds that in this complex theory every prime number of the form $4n + 1$ is to be regarded as composite, because, being the sum of two squares, *e.g.* $p = a^2 + b^2$, it is a product of two conjugate factors, $p = (a + bi)(a - bi)$. Thus the true primes of the complex theory may be defined to be the real primes of the form $4n + 3$, and the imaginary factors of real primes of the form $4n + 1$. Availing himself of this definition, Gauss discovered a theorem of biquadratic reciprocity between any two prime numbers, no less simple than the quadratic law, viz. "If p_1 and p_2 are two primary prime numbers, the biquadratic character of p_1 with regard to p_2 is the same as that of p_2 with regard to p_1."

Both this theorem of reciprocity itself and the introduction of imaginary integers upon which it depends are memorable in the history of arithmetic for the number and variety of the researches to which they have given rise.

It may perhaps seem remarkable that Gauss should have devoted so few memoirs to subjects of an algebraical character. If we except a comparatively unimportant paper on Descartes' rule of signs which appeared in *Crelle's Journal* in the year 1828, his only algebraical memoirs relate to the theorem that every equation has a root. Of this he gave no less than three distinct demonstrations, one in 1799, one in 1815, and one in 1816; the demonstration of 1799 was given in his first published paper—his dissertation as a candidate for the degree of Doctor of Philosophy in the University of Göttingen. This demonstration he repeated over again in 1849, with certain changes and simplification. There can be no question that these three demonstrations are prior to any other, though for various reasons those subsequently given by Cauchy have been justly preferred for the purpose of insertion in our modern text-books.

ANTHROPOLOGY IN AMERICA

WE cannot speak very highly of Prof. Otis T. Mason's "Account of Progress in Anthropology in the Year 1881," which was originally embodied in the Smithsonian Report for that year, and is now issued in a separate form. There is no comprehensive survey of the work done in this wide field during the period indicated, and the bibliography, of which the paper mainly consists, is vitiated by too many subdivisions. These subdivisions are dealt with in the introduction, where a bewildering scheme of classification is proposed "in order to ascertain the opinion of anthropologists as to its merits." First the science is grouped under three main heads, indicated by terminations furnished by the three Greek words, γραφη, λόγος, and νόμος. Then each group is split up into thirteen minor divisions, yielding altogether thirty-nine distinct segmentations, and of course involving the whole subject in dire confusion. The student is expected, for instance, to distinguish between anthropography, anthropology, and anthroponomy; between pneumatography, pneumatology, and pneumatonomy; between hexiography, hexiology, hexionomy, and so on. However in the bibliography the author considerately limits himself to eleven headings, which will certainly be amply sufficient to try the patience of those who may have occasion to consult these alphabetical lists. Thus Nesbit's "Antiquity of Man" is entered under *Anthropogeny*, while Ameghino's "Antiquedad del hombre in La Plata" must be sought for in the section *Archæology*. These lists should obviously be fused together in one general catalogue, and all the nice subdivisions left to the fancy or ingenuity of the reader. To show their utter absurdity it may suffice to add that under the heading *Hexiology* there occurs the solitary entry—Buckley, "Climatic Influences on Mankind." Why, it may be asked in conclusion, does B. B. Redding's "Californian Indians and their Food," appear in the section *Technology?* The interests of science are not furthered by these minute subdivisions and barbarous nomenclatures, which are especially uncalled for in the case of a science whose broad divisions are already marked out with sufficient clearness and accuracy to serve all present practical purposes.

Prof. Mason has been much more usefully employed in the preparation of a series of "Miscellaneous Papers Relating to Anthropology," which also consist of reprints from the Smithsonian Report for 1881. Most of them have reference to the sepulchral mounds, earthworks, fortified lines, shell-heaps, and other remains of prehistoric and historic man so thickly strewn over the Mississippi basin, the eastern States and seaboard of North America. The great number and magnitude of these remains, their universal diffusion over an enormous area, and the character of the objects found in them, all tend to confirm the impression now generally entertained regarding the vast antiquity of man in the New World. On the other hand the views of those anthropologists who still attribute the old works to some superior pre-Columbian race of "mound-builders" distinct from the present aborigines are not strengthened by a more careful examination of these relics. Speaking of the mounds examined by him in Cass County, Illinois, Dr. J. F. Snyder remarks that "the intrinsic evidence of many prehistoric remains of this county sustains their claim to extreme antiquity; but no work or specimen of art of a former race has yet been found here above the capacity or achievement of the typical North American Indian. And in studying the life, habits, and burial customs indicated by these relics, I can see no necessity for ascribing them to the agency of a distinct or superior race, when they express so unmistakably the known status of Indian intellect" (p. 53). This conclusion is amply confirmed by the contents of the enormous shell-heap at Cedar Keys, Florida, which has been carefully examined by Mr. S. T. Walker. Here the pottery found in the successive layers, down to a depth of over twelve feet, shows a continuous advancement in the art from the rude heavy earthenware often mixed with coarse sand or small pebbles occurring in the lowest stratum, through the better finished and slightly ornamented types of the middle stage, to the delicate and beautifully ornamented specimens found near the surface. These objects thus show a progressive improvement *upwards*, not *downwards* as would be required by the theory of an extinct pre-Columbian civilised race, precursor of the present aborigines. A. H. K.

THE SIZE OF ATOMS[1]

III.

WE must then find another explanation of dispersion. I believe there is another explanation. I believe that, while giving up Cauchy's unmodified theory of dispersion, we shall find that the same general principle is applicable, and that by imagining each molecule to be loaded in a certain definite way by elastic connection with heavier matter,—each molecule of the ether to have, in palpable transparent matter, a small fringe, so to speak, of particles, larger and larger in their successive order, elastically connected with it,—we shall have a rude mechanical explanation, realisable by the notably easy addition of the proper appliances to the dynamical models before you, to account for refractive dispersion in an infinitely fine-grained structure. It is not 17 hours since I saw the possibility of this explanation; I think I now see it perfectly, but you will excuse me not going into the theory more fully under the circumstances.[2] The difficulty of Cauchy's theory has weighed heavily upon me, when thinking of bringing this subject before you. I could not bring it before you and say there are only four particles in the wave-length, and I could not bring it before you without saying there is some other explanation. I believe another explanation is distinctly to be had in the manner I have slightly indicated.

Now look at those beautiful distributions of colour on the screen before you. They are diffraction spectrums from a piece of glass ruled with 2,000 lines to the inch. And again look; and you see one diffraction spectrum by reflection from one of Rutherford's gratings, in which there are 17,000 lines to the inch on polished speculum-metal. The explanation by "interference", is substantially the same as that which the undulatory theory gives for Newton's rings of light reflected from the two surfaces, which you have already seen. Where light-waves from the apertures between the successive bars of the grating, reach the screen in the same phase, they produce light; there, again, where they are in opposite phases, they produce darkness

The beautiful colours which are produced, depend on the places of conspiring and opposing vibrations on the screen, being different for light waves of different wave-lengths; and it is by the measurements of the dimensions of a diffraction spectrum such as the first set you saw (or of finer spectrums from coarser gratings), that Fraunhofer first determined the wave-lengths of the different colours.

I have now, closely bearing on the question of the size of atoms, thanks to Dr. Tyndall, a most beautiful and interesting experiment to show you—the artificial "blue sky," produced by a very wonderful effect of light upon matter, which he discovered. We have here an empty glass tube—it is "optically void." A beam of electric light passes through it now; and you see nothing. Now the light is stopped and we admit vapour of carbon disulphide into the tube. There is now introduced some of this vapour to about 3 inches pressure, and there is also introduced, to the amount of 15 inches pressure, air impregnated with a little nitric acid, making in all rather less than the atmospheric pressure. What is to be illustrated here is the presence of molecules of substances, produced by the decomposition of carbon disulphide by the light.

[1] A lecture delivered by Sir William Thomson at the Royal Institution, on Friday, February 2. Revised by the Author. Concluded from p. 254.

[2] Farther examination has seemed to me to confirm this first impression; and in a paper on the Dynamical Theory of Dispersion, read before the Royal Society of Edinburgh, on the 5th of March, I have given a mathematical investigation of the subject.—W. T., March 16, 1883.

At present you see nothing in the tube; it still continues to be, as before the admission of the vapours optically transparent; but gradually you will see an exquisite blue cloud. That is Tyndall's "blue sky." You see it now. I take a Nicol's prism, and by looking through it I find the azure light, coming from the vapours in any direction perpendicular to the exciting beam of light, to be very completely polarised in the plane through my eye and the exciting beam. It consists of light-vibrations in one definite direction, and that, as finally demonstrated by Professor Stokes, it seems to me beyond all doubt, through reasoning on this phenomenon of polarisation,[1] which he had observed in various experimental arrangements giving minute solid or liquid particles scattered through a transparent medium, must be the direction perpendicular to the plane of polarisation.

What you are now about to see, and what I tell you I have seen through the Nicol's prism, is due to what I may call secondary or derived waves of light diverging from very minute liquid spherules, condensed in consequence of the chemical decomposing influence exerted by the beam of light on the matter in the tube, which was all gaseous when the light was first admitted.

To understand these derived waves, first you must regard them as due to motion of the ether round each spherule; the spherule being almost absolutely fixed, because its density is enormously greater than that of the ether surrounding it. The motion that the ether had in virtue of the exciting beam of light alone, before the spherules came into existence, may be regarded as being compounded with the motion of the ether relatively to each spherule, to produce the whole resultant motion experienced by the ether when the beam of light passes along the tube, and azure light is seen proceeding from it laterally. Now this second component motion, is clearly the same as the whole motion of the ether would be, if the exciting light were annulled and each spherule kept vibrating in the opposite direction, to and fro through the same range as that which the ether in its place had, in virtue of the exciting light, when the spherule was not there.

Supposing now, for a moment, that without any exciting beam at all, a large number of minute spherules are all kept vibrating through very small ranges[2] parallel to one line. If you place your eye in the plane through the length of the tube and perpendicular to that line, you will see light from all parts of the tube, and this light which you see will consist of vibrations parallel to that line. But if you place your eye *in* the line of the vibration of a spherule, situated about the middle of the tube, you will see no light in that direction; but keeping your eye in the same position, if you look obliquely towards either end of the tube, you will see light fading into darkness, as you turn your eye from either end towards the middle. Hence, if the exciting beam be of plane polarised light—that is to say, light of which all the vibrations are parallel to one line—and if you look at the tube in the direction perpendicular to this line and to the length of the tube, you will see light of which the vibrations will be parallel to that same line. But if you look at the tube in any direction parallel to this line, you will see no light; and the line along which you see no light is the direction of the vibrations in the exciting beam; and this direction, as we now see, is the direction perpendicular to what is technically called the plane of polarisation of the light. Here, then, you have Stokes's *experimentum crucis* by which he has answered, as seems to me beyond all doubt, the old vexed question—Whether is the vibration *perpendicular to*, or *in* the plane of polarisation? To show you this experiment, instead of using unpolarised light for the exciting beam, as in the previous experiment, and holding a small Nicol's prism in my hand and telling you what I saw when I looked through it, I place, as is now done, this great Nicol's prism in the course of the beam of light before it enters the tube. I now turn the Nicol's prism into different directions and turn the apparatus round, so that, sitting in all parts of the theatre, you may all see the tube in the proper direction for the successive phenomena of "light," and "no light." You see them now exactly fulfilling the description which I gave you in anticipation. If each of you had a Nicol's

[1] Extract from Professor Stokes' paper, "On the Change of Refrangibility of Light," read before the Royal Society, May 27th, 1852, and published in the *Transactions* for that date:—

"§ 183. Now this result appears to me to have no remote bearing on the question of the direction of the vibrations in polarised light. So long as the suspended particles are large compared with the waves of light, reflection takes place as it would from a portion of the surface of a large solid immersed in the fluid, and no conclusion can be drawn either way. But if the diameters of the particles be small compared with the length of a wave of light, it seems plain that the vibrations in a reflected ray cannot be perpendicular to the vibrations in the incident ray. Let us suppose for the present, that in the case of the beams actually observed, the suspended particles were small compared with the length of a wave of light. Observation showed that the reflected ray was polarised. Now all the appearances presented by a plane polarised ray are symmetrical with respect to the plane of polarisation. Hence we have two directions to choose between for the direction of the vibrations in the reflected ray, namely, that of the incident ray, and a direction perpendicular to both the incident and the reflected rays. The former would be necessarily perpendicular to the directions of vibration in the incident ray, and therefore we are obliged to choose the latter, and consequently to suppose that the vibrations of plane polarised light are perpendicular to the plane of polarisation, since experiment shows that the plane of polarisation of the reflected ray is the plane of reflection. According to this theory, if we resolve the vibrations in the [horizontal] incident ray horizontally and vertically, the resolved parts will correspond to the two rays, polarised respectively in and perpendicularly to the plane of reflection, into which the incident ray may be conceived to be divided, and of these the former alone is capable of furnishing a . . . . . ray reflected vertically upwards [to be seen by an eye above the line of the incident ray, and looking vertically downwards]. And, in fact, observation shows that, in order to quench the dispersed beam, it is sufficient, instead of analysing the reflected light, to polarise the incident light in a plane perpendicular to the plane of reflection."

[2] In the following question of the recent Smith's Prize Examination at Cambridge (paper of Tuesday, Jan. 30, 1883), the dynamics of the subject, and particularly the motion of the ether produced by keeping a single spherule embedded in it vibrating to and fro in a straight line, are illustrated in parts (*a*) and (*d*):—

"8. (*a*) From the known phenomenon that the light of a cloudless blue sky, viewed in any direction perpendicular to the sun's direction, is almost wholly polarised in the plane through the sun, assuming that this light is due to particles of matter of diameters small in comparison with the wave-length of light, prove that the direction of the vibrations of plane polarised light is perpendicular to the plane of polarisation.

"(*b*) Show that the equations of motion of a homogeneous isotropic elastic solid of unit density, are

$$\frac{d^2\alpha}{dt^2} = (k + \tfrac{1}{3}n)\frac{d\delta}{dx} + n\nabla^2\alpha,$$

$$\frac{d^2\beta}{dt^2} = (k + \tfrac{1}{3}n)\frac{d\delta}{dy} + n\nabla^2\beta,$$

$$\frac{d^2\gamma}{dt^2} = (k + \tfrac{1}{3}n)\frac{d\delta}{dz} + n\nabla^2\gamma,$$

"where k denotes the modulus of resistance to compression; n the rigidity-modulus; α, β, γ the components of displacement at (x, y, z, t); and

$$\delta = \frac{d\alpha}{dx} + \frac{d\beta}{dy} + \frac{d\gamma}{dz},$$

$$\nabla^2 = \frac{a^2}{dx^2} + \frac{d^2}{dy^2} + \frac{d^2}{dz^2}.$$

"(*c*) Show that every possible solution is included in the following:

$$\alpha = \frac{d\phi}{dx} + u, \quad \beta = \frac{d\phi}{dy} + v, \quad \gamma = \frac{d\phi}{dz} + w,$$

"where u, v, w are such that

$$\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} = 0.$$

"Find differential equations for the determination of ϕ, u, v, w. Find the respective wave-velocities for the ϕ-solution, and for the (u, v, w)-solution.

"(*d*) Prove the following to be solutions, and interpret each for values o r $[\sqrt{(x^2 + y^2 + z^2)}]$ very great in comparison with λ (the wave-length).

$$(1) \quad \begin{cases} \alpha = \dfrac{d\phi}{dx}, \quad \beta = \dfrac{d\phi}{dy}, \quad \gamma = \dfrac{d\phi}{dz} \\ \text{where } \phi = \dfrac{1}{r}\sin\dfrac{2\pi}{\lambda}[r - t\sqrt{(k + \tfrac{4}{3}n)}]. \end{cases}$$

$$(2) \quad \begin{cases} \alpha = 0, \quad \beta = -\dfrac{d\psi}{dz}, \quad \gamma = \dfrac{d\psi}{dy} \\ \text{where } \psi = \dfrac{1}{r}\sin\dfrac{2\pi}{\lambda}[r - t\sqrt{n}]. \end{cases}$$

$$(3) \quad \alpha = \left(\frac{2\pi}{\lambda}\right)^2\psi + \frac{d^2\psi}{dx^2}, \quad \beta = \frac{d^2\psi}{dx\,dy}, \quad \gamma = \frac{d^2\psi}{dx\,dz}.$$

prism in your hand, you would learn that when you see light at all, its plane of polarisation is in the plane through your eye and the axis of the tube; and I hope you all now perfectly understand the proof that the direction of vibration is perpendicular to this plane.

Now I want to bring before you something which was taught me a long time ago by Professor Stokes; and year after year I have begged him to publish it, but he has not done so, and so I have asked him to allow me to speak of it to-night. It is a dynamical explanation of that wonderful phenomenon called fluorescence or phosphorescence. The principle is mechanically represented by this model (described above

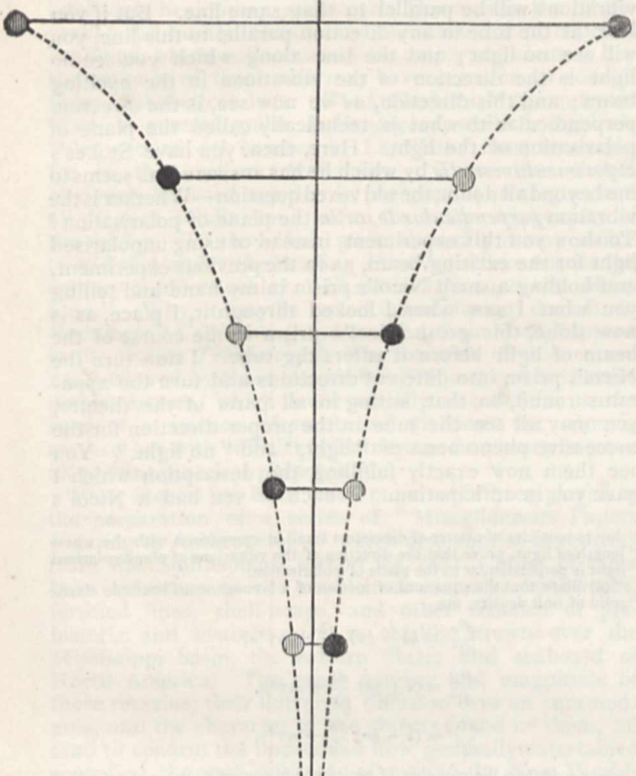


FIG. 10.—Diagram showing the different amplitudes of vibration of a row of particles oscillating in a period less than their least wave-period.

with reference to Fig. 2). A simple harmonic motion is, as you now see, sustained by my hand in the uppermost bar, in a period of about four seconds. You see that a regular wave-motion travels down the line of molecules represented by these circular disks on the ends of the bars; and the energy continually given to the top bar, by my hand, is continually consumed in heating the basin of treacle and water at the foot. I now remove my hand and leave the whole system to itself. The very considerable sum of kinetic and potential energies of the large masses and spiral springs, attached to the top bar, is gradually spent in sending the diminishing series of waves down the line, and is ultimately converted into heat in the treacle and water. You see that about half of the amplitude of vibration, and therefore three-fourths of the energy is lost in half a minute.

You will see on quickening the oscillation how very different the result will be. The quick oscillations which I now give to the top bar (the period having been reduced to about one and a half seconds), is incapable of sending waves along the line of molecules; and it is that rapid oscillation of the particles which, according to Stokes, constitutes latent or stored-up light. Remark now that when I remove my hand from the top bar, as no waves travel down the line, no energy is spent in the treacle; and the vibration goes on for ever (or, to be more exact, say for one minute) as you see, with *no loss* (or, to be quite in accordance with what we see, let me say scarcely any sensible loss). This is a mechanical model correctly illustrating the dynamical principle of Stokes' explanation of phosphorescence or stored-up light, stored as in the now well-known luminous paint; of which you see the action in this specimen, and in the phosphorescent sulphides of lime in these glass tubes kindly lent by Mr. De La Rue. (Experiments shown.)

Now I will show you Stokes' phenomenon of *fluorescence* in a piece of uranium glass. I hold it in the beam from the electric lamp dispersed by the prism as you see. You see the uranium glass now visible by being illuminated by invisible rays. The rays by which it is illuminated even before it comes into the visible rays are manifestly invisible so far as the screen receiving the spectrum is a test of visibility; because the uranium glass, and my hands holding it, throw no shadow on the screen. Also you see the uranium glass which I hold in my hand in the ultra-violet light, while you do not see my hand. I now bring it nearer the place where you see the air (or rather the dust in it) illuminated by the violet light: still no shadow on the screen, but the uranium glass in my hand glowing more brilliantly with its green light of very mixed constitution, consisting of waves of longer periods than that of the ultra-violet, which the incident light, of shorter period than that of violet light, causes the particles of the uranium glass to emit. This light is altogether unpolarised. It was the absolute want of polarisation, and the fact of its periods being all less than those of the exciting light, that led Stokes to distinguish this illumination, which you see in the uranium glass,[1] from the mere molecular illumination (always polarised partially if not completely, and always of the same period as that of the exciting light) which we were looking at previously in Dr. Tyndall's experiment.

Stokes gave the name of fluorescence to the glowing with light of larger period than the exciting light, because it is observed in fluor spar; and he wished to avoid all hypothesis in his choice of a name. He pointed out a strong resemblance between it and the old known phenomenon of phosphorescence; but he found some seeming contrasts between the two, which prevented him from concluding fluorescence to be in reality a case of phosphorescence.

In the course of a comparison between the two

[1] The same phenomenon is to be seen splendidly in sulphate of quinine An interesting experiment may be made by writing on a white paper screen, with a finger or a brush dipped in a solution of sulphate of quinine. The marking is quite imperceptible in ordinary light; but if a prismatic spectrum be thrown on the screen, with the ultra-violet invisible light on the part which had been written on with the sulphate of quinine, the writing is seen glowing brilliantly with a bluish light, and darkness all round. The phenomenon presented by sulphate of quinine and many other vegetable solutions, and some minerals as, for instance, fluor spar, and various ornamental glasses, as a yellow Bohemian glass, called in commerce "canary glass" (giving a dispersed greenish light), had been discovered by Sir David Brewster (*Transactions*, Royal Society of Edinburgh, 1833, and British Association, Newcastle, 1838), and had been investigated also by Sir John Herschel, and by him called "epipolic dispersion" (*Phil. Trans.*, 1845). A complete experimental analysis of the phenomenon, showing precisely what it was that the previous observers had seen, and explaining many singularly mysterious things which they had noticed, was made by Stokes, and described in his paper, "On the Change of Refrangibility of Light" (*Phil. Trans.*, May 27, 1852).

phenomena (sections 221 to 225 of his 1852 paper), the following statement is given:—"But by far the most "striking point of contrast between the two phenomena "consists in the apparently instantaneous commencement "and cessation of the illumination, in the case of internal "dispersion when the active light is admitted and cut "off. There is nothing to create the least suspicion of "any appreciable duration in the effect. When internal "dispersion is exhibited by means of an electric spark, it "appears no less momentary than the illumination of a "landscape by a flash of lightning. I have not attempted "to determine whether any appreciable duration could "be made out by means of a revolving mirror." The investigation here suggested, has been actually made by Edmund Becquerel, and the question—Is there any appreciable duration in the glow of fluorescence?—has been answered affirmatively by this beautiful and simple little machine before you, which he invented for the purpose. The experiment giving the answer is most interesting, and I am sure you will see it with pleasure. It consists of a flat circular box, with two holes facing one another in the flat sides near the circumference; inside are two disks, carried by a rapidly revolving shaft, by which the holes are alternately shut and opened; one open when the other is closed, and *vice versâ*. A little piece of uranium glass is fixed inside the box between the two holes, and a beam of light from the electric lamp falls upon one of the holes. You look at the other.

Now when I turn the shaft slowly you see nothing. At this instant the light falls on the uranium glass through the open hole far from you, but you see nothing, because the hole next you is shut. Now the hole next you is open, but you see nothing; because the hole next the light is shut, and the uranium glass shows no perceptible afterglow as arising from its previous illumination. This agrees exactly with what you saw when I held the large slab of uranium glass in the ultra-violet light of the prismatic spectrum. As long as I held the uranium glass there you saw it glowing; the moment I took it out of the invisible light it ceased to glow. The "moment" of which we were then cognisant, may have been the tenth of a second. If the uranium glass had continued to glow sensibly for the twentieth or the fiftieth of a second, it would have seemed, to our slow-going sense of vision, to cease the moment it was taken out. Now I turn the wheel at such a rate that the hole next you is open about a fiftieth of a second after the uranium glass was bathed in light; still you see nothing. I turn it faster and faster and it now begins to glow, when the hole next you is open about the two-hundredth of a second after the immediately preceding admission of light by the other hole. I turn it faster and faster and it glows more and more brightly, till now it is glowing like a red coal; further augmentation of the speed shows, as you see, but little difference in the glow.

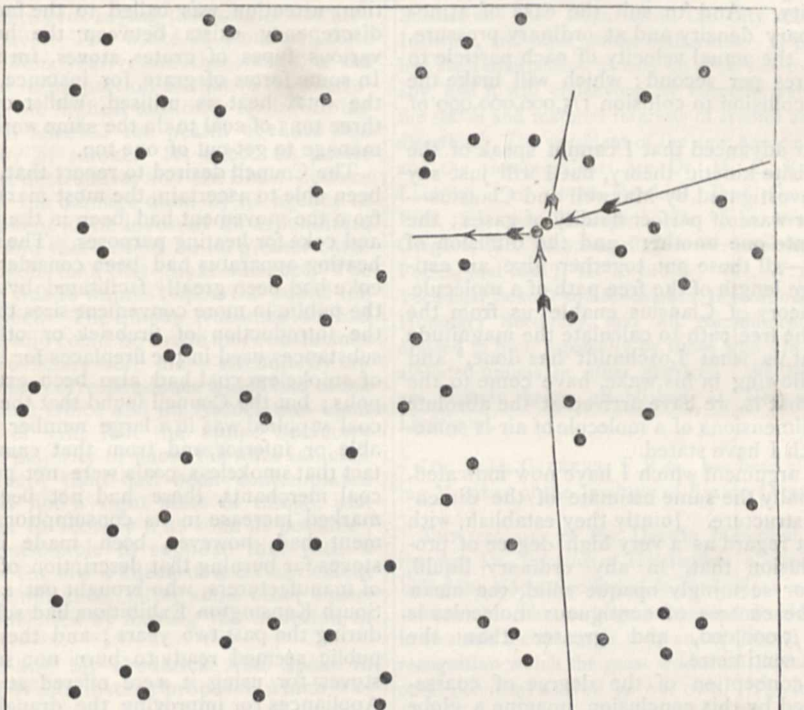


Fig. 11.—Diagram illustrating the number of molecules in a space of 1/10,000 of a centimetre square and 1/100,000,000 of a centimetre thick.

Thus it seems that fluorescence is essentially the same as phosphorescence; and we may expect that substances will be found, continuously bridging over the difference of quality between this uranium glass, which glows only for a few thousandths of a second, and the luminous sulphides which glow for hours, or days, or weeks after the cessation of the exciting light.

The most decisive and discriminating method of estimating the size of atoms, I have left until my allotted hour is gone:—that founded on the kinetic theory of gases. Here is a diagram (Fig. 11) of a crowd of atoms or molecules showing, on a scale of 1,000,000 to 1, all the molecules of air, of which the centres may, at any instant, be in a space of a square of 1/10,000 of a centimetre side and 1/100,000,000 of a centimetre thick. The side of the square you see in the diagram is a metre, and represents 1/10,000 of a centimetre. The diagram shows just 100 molecules, being 1/10,000 of the whole number of particles (10^6) in the cube of 1/10,000 centimetre, or all the molecules in a slice of 1/10,000 of the thickness of that cube. Think of a cube filled with particles, like these glass balls,[1] scattered at random through a space equal to 1,000 times the sum of their volumes. Such a crowd may be condensed (just as air may be condensed) to 1/1,000 of its volume; but this condensation brings the molecules into contact. Something comparable with this may be imagined to be the condition of common air of ordinary density, as in our atmosphere. The diagram with size of each molecule, which, if shown in it to scale, would be 1 millimetre (or too small to be seen by you), to represent an actual diameter 1/10,000,000 of a centimetre, represents a gas in which a condensation of 1 to 10 linear, or 1 to 1,000 in bulk, would bring the molecules close together.

Now you are to imagine the particles moving in all directions, each in a straight line until it collides with another. The average length of free path is ten centimetres in our diagram, representing 1/100,000 of a centimetre in reality. And to suit the case of atmospheric air of ordinary density and at ordinary pressure, you must suppose the actual velocity of each particle to be 50,000 centimetres per second; which will make the average time from collision to collision 1/5,000,000,000 of a second.

The time is so far advanced that I cannot speak of the details of this exquisite kinetic theory, but I will just say that three points investigated by Maxwell and Clausius—viz. the viscosity, or want of perfect fluidity of gases; the diffusion of gases into one another; and the diffusion of heat through gases—all these put together give an estimate for the average length of the free path of a molecule. Then a beautiful theory of Clausius enables us from the average length of the free path to calculate the magnitude of the atom. That is what Loschmidt has done,[2] and I, unconsciously following in his wake, have come to the same conclusion; that is, we have arrived at the absolute certainty that the dimensions of a molecule of air is something like that which I have stated.

The four lines of argument which I have now indicated, lead all to substantially the same estimate of the dimensions of molecular structure. Jointly they establish, with what we cannot but regard as a very high degree of probability, the conclusion that, in any ordinary liquid, transparent solid, or seemingly opaque solid, the mean distance between the centres of contiguous molecules is less than the 1/5,000,000, and greater than the 1/1,000,000,000 of a centimetre.

To form some conception of the degree of coarse-grainedness indicated by this conclusion, imagine a globe of water or glass, as large as a football,[3] to be magnified up to the size of the earth, each constituent molecule being magnified in the same proportion. The magnified structure would be more coarse-grained than a heap of small shot, but probably less coarse-grained than a heap of footballs.

[1] The piece of apparatus now exhibited, illustrated the collisions taking place between the molecules of gaseous matter, and the diffusion of one gas into another. It consisted of a board of about one metre square, perforated with 100 holes in ten rows of ten holes each. From each hole was suspended a cord five metres long. To the lower end of each cord in five contiguous rows, there was secured a blue coloured glass ball of four centimetres diameter; and similarly to each cord of the other five rows, a red coloured ball of the same size. A ball from one of the outer rows was pulled aside, and, being set free, it plunged in amongst the others, causing collisions throughout the whole plane in which the suspended balls were situated.

[2] *Sitzungsberichte* of the Vienna Academy, Oct. 12, 1865, p. 395.

[3] Or say a globe of 16 centimetres diameter.

SMOKE ABATEMENT

AN important meeting was held in the Egyptian Hall of the Mansion House on Monday last, to take further steps towards the abolition, or at all events the reduction, as far as possible, of the smoke nuisance. The Lord Mayor presided, and the following among others were present:—The Duke of Northumberland, the Duke and Duchess of Westminster, Sir William Siemens, Sir Frederick Abel, Sir Lyon Playfair, M.P., Sir Frederick Pollock, Sir T. Spencer Wells, Mr. George Cubitt, M.P., Dr. Farquharson, M.P., Col. Makins, M.P., Capt. Galton, Mr. Edwin Chadwick, C.B., Mr. Ernest Hart, Mr. C. Waring, the Hon. Rollo Russell, General Lowry, C.B., Mr. George Shaw (chairman of the City Commission of Sewers), Mr. W. R. E. Coles, Mr. W. Chandler Roberts, of the Royal Mint, and Mr. Gregory, Master of the Clothworkers' Company.

The proceedings were opened by the reading of a Report, which has been carefully prepared by the Council, detailing the steps which have already been taken, and giving particulars of the exhibitions of last year in London and Manchester. The Report also deals with the work which has been done regarding the chemical composition of smoke by Prof. Chandler Roberts, and the many tests of coal made by Mr. Clark. In this important investigation, attention was called to the fact that a very great discrepancy exists between the heating efficiency of various types of grates, stoves, furnaces, and the like. In some forms of grate, for instance, only 22 per cent. of the total heat is utilised, whilst others require nearly three tons of coal to do the same work which other stoves manage to get out of one ton.

The Council desired to report that, so far as they had been able to ascertain, the most marked benefit resulting from the movement had been in the increased use of gas and coke for heating purposes. The improvement in gas-heating apparatus had been considerable, and the use of coke had been greatly facilitated by its being supplied to the public in more convenient sizes than formerly, and by the introduction of firebrick or other slow-conducting substances used in the fireplaces for burning it. The use of smokeless coal had also been extended in the metropolis; but the Council found that the description of such coal supplied was in a large number of instances unsuitable or inferior, and from that cause, coupled with the fact that smokeless coals were not generally supplied by coal merchants, there had not been, so far, any very marked increase in its consumption. Marked improvement had, however, been made in open grates and stoves for burning that description of coal, and one firm of manufacturers, who brought out a cheap stove at the South Kensington Exhibition, had sold upwards of 14,000 during the past two years; and they remarked that the public seemed ready to burn non-smoky coal if proper stoves for using it were offered at a reasonable price. Appliances for improving the draught of chimneys had also been introduced lately, and that tended to facilitate the use of smokeless coal. The Council had examined the present state of the administration of the law for the suppression of smoke, and they considered that in view of the enormous extension of buildings and factories in London and large towns, and in view also of the evidence that smoke could be to a great extent, if not entirely, avoided, the scope of legislative enactments for abating smoke should be extended and their provisions duly enforced.

One part of the Report deals with a matter to which we attach the greatest importance. It is suggested that there should be some place which the public can visit and where they may examine any apparatus that is approved of, or which they may wish to purchase; but above this it is pointed out that a place is requisite where scientific, chemical, and other tests may be made for the information of the public generally, but especially for the help of inventors and manufacturers who may wish to try new suggestions. The Report also suggests that in connection with this there should be some place for discussion and public lectures, for the general advancement and diffusion of knowledge touching smoke abatement. The third proposal is certainly the most doubtful one, but the first and second are so important that the less time that is lost in starting such an institution the better; and we are glad to learn that towards its foundation the Duke of Westminster has promised 500*l*., Mr. C. Waring 100*l*., and Mr. Cubitt 100*l*.

The most important speech, perhaps, was that made by the Duke of Westminster, in moving the adoption of the Report. He pointed out that we are face to face with a very gigantic evil—an evil not only gigantic in itself, but, considering the enormous yearly increase of 40,000 in the population, one of a very alarming character. Therefore it was necessary that some steps should be taken to abate, if not to entirely do away with, that monstrous evil, which affected the health and vitality of the inhabitants of the metropolis. They were all aware of the evil effects of smoke, and how far worse it became when mixed with fog, but they believed that it was an evil which might be considerably modified if not entirely prevented. They had indisputable authority for saying that smoke was very wasteful and destructive. The waste in London alone amounted to one million yearly, and the waste in the country must be taken in proportion to that in the metropolis. They had also the highest authority for informing the public that the evil affected the health of those who lived under the canopy of smoke. Its effect on public buildings was also most destructive, and Mr. Shaw-Lefevre had said that to repair the damage done by its agency to the Houses of Parliament alone involved an expenditure of 2500*l*. per annum, and there could be no greater curse and bane to the metropolis than that smoke nuisance. The object of the meeting was to impress upon the public the importance of the subject. The Smoke Nuisance Act had been useful in the past, and could be made more efficacious in the future if its provisions were more strenuously enforced. Quoting from the correspondence which had taken place between the Home Office and the Association upon the subject, the speaker said that the Home Secretary had stated that in the majority of cases the fines inflicted were far less in amount than had been contemplated by the Act. That was not a right state of things, and efforts should be made to remedy it as soon as possible; and it was not unreasonable to suppose that with a proper enforcement of the law a check to a certain extent might be put upon the nuisance. After some other observations, his Grace concluded by moving the adoption of the Report.

Sir Spencer Wells and Sir Frederick Abel spoke in favour of the Duke of Westminster's proposal, which was carried unanimously.

The next resolution was moved by the Duke of Northumberland, and was to the following effect:—"That the period has now arrived at which systematic inquiry is desirable into the application of the resources of technical science for the abatement of smoke now largely produced in industrial processes and in the heating of houses, as well as into the operation of the existing laws for smoke abatement; and that the Council of the National Smoke Abatement Institution be requested to urge upon the Government the desirability of appointing a Royal Commission for the purpose."

This was seconded by Sir Wm. Siemens and carried.

We are glad to see that it was acknowledged that the stated objects of the Smoke Abatement Institution, and the success which has attended its past efforts, had established a claim not only to the support of the meeting, but to that of the City of London and other great cities and towns.

We must congratulate the Council of the new institution upon the energy which they are displaying, and we believe that in a few years the success they will then have met with will lead one to hope that in process of time the smoke nuisance which kills its tens of thousands annually, and makes life in a great city like London almost unbearable, will to a certain extent be done away with.

NOTES

GREAT efforts are being made by the Council of the Society of Arts and its chairman, Sir William Siemens, who has again been elected to this office, to make their *conversazione*, to be held on the 25th inst. at the Fisheries Exhibition, a great success. The fountains are to be illuminated by coloured fires, and the gardens, as well as the Exhibition Buildings, will be lighted by the electric light. The band of the 6th Thuringian Regiment of German Infantry will perform in the building.

A MEETING which may have an important result upon science and art instruction in this country has been inaugurated at Manchester. An association has been established to effect the general advancement of the profession of science and art teaching by securing improvements in the schemes of study and the establishment of satisfactory relations between teachers and the Science and Art Department, the City and Guilds of London Institute, and other public authorities. It proposes also to collect such information as may be of service to teachers professionally, and it will endeavour by constant watchfulness to advance the status and material interests of science and art teachers in all directions. The president of the new Association is Prof. Huxley, and the vice-presidents are Dr. H. E. Roscoe, Mr. Norman Lockyer, Prof. Boyd Dawkins, Prof. Gamgee, Prof. Ayrton, Prof. Silvanus Thompson, Dr. John Watts, Mr. S. Leigh-Gregson, Mr. John Angell, Mr. W. Lockett Agnew, Mr. C. M. Foden, and Mr. J. H. Reynolds. Mr. W. E. Crowther, of the Technical School and Mechanics Institution, Manchester, is the Honorary Secretary, and all communications should be addressed to him, especially by those who are desirous of forming affiliated unions in other districts. We believe that branches are already being established at Newcastle-upon-Tyne and Liver pool.

DR. J. H. GILBERT, F.R.S., has been elected a Corresponding Member of the Institute of France (Academy of Sciences).

THE treasurer of the Darwin Memorial Fund has received through Dr. Elforing of Helsingfors a cheque for 94*l*. 4*s*., that being the amount collected in Finland as a contribution to the memorial. That so large an amount should have been collected in so small a country is only an additional proof of the ready recognition which the great works of Darwin have received in other countries as well as our own. The fund now amounts to 3300*l*.

THE Lick Observatory, we learn from *Science*, has made much progress during the past year. The dome for the small equatorial has now been finished, and is certainly the most complete and convenient one of its size in America. The building of the observatory in which the great thirty-six-inch equatorial is to be placed is also progressing. The walls of the main building are half completed, and the cellar for the dome has been excavated. The four-inch transit-house and the buildings for the photo-heliographs have been in working order now for some time, as they were used in a successful observation of the transit of Venus last December. In a few weeks the building for the meridian circle will be commenced, as well as a house for the astronomers and buildings to contain the appliances for moving the dome, and for the general heating and lighting of the observatory. Two brick reservoirs for spring water, the one containing 83,000 gallons, the other 20,000 gallons, have been constructed, and another reservoir to contain 83,000 gallons of rain-water will shortly be commenced. The roads have been extended. Some of the original arrangements of the observatory buildings, which were only provisional, have now been replaced by more substantial and permanent structures, and by the end of the season great progress will have been made.

Science announces the death last month of Stephen Alexander, Professor Emeritus of Astronomy at Princetown. He was educated at Union College, where he graduated in 1824. In 1840 he was appointed Professor of Astronomy at Princetown, and more recently he received a Professorship of Mechanics. It was as an astronomer, however, that he was most generally known.

WE have been asked by the local secretaries of the Meeting of the British Association for the Advancement of Science to be held at Southport in September next to call the attention of those who have in their possession scientific instruments, curiosities, and other objects of special or artistic interest, to the fact that there will be an exhibition of such articles in connection with the meeting of the Association. Intending exhibitors and others interested in this matter should communicate with Mr. Ch. de Wechmar Stoess, the Hon. Sec. *Conversazione* Committee, and Mr. Alfred Morgan, the Hon. Sec. for Exhibits, immediately.

THE steamer *Pola* has just called at Reikjavik, in Iceland, on her way to Jan Mayen, to bring away the Austrian observation party wintering there. Towards the end of the present month the Swedish gunboat *Urd* will proceed to Spitzbergen to relieve the Swedish party wintering there. It is reported, both from Iceland and Norway, that the state of the ice in the Arctic seas is very favourable to navigation.

THE *Sophia*, Baron Nordenskjöld's vessel, left Rödefjord, Iceland, for Ivigtuk, in Greenland, on June 10, leaving Count Strömfelt and Drs. Arpi and Flink behind to pursue geological and botanical researches there.

A LETTER from M. Thouard, the well-known French traveller, dated Santiago (Chili), states that he heard from Chiriguanos Indians that a part of the Crevaux party were still prisoners of the Tobas tribe. M. Thouard will try to assist his countrymen.

MR. CROOKES and Professors Odling and Tidy have lately given in their Report on the composition and quality of London water during 1882 to the Local Government Board. In that year they examined 2110 samples of water drawn in nearly equal proportions from the mains of all the seven London Companies; testing generally seven samples daily by their colour according to the registers of the colour-meter, by the quantity of free oxygen and ammonia contained in them, by the amount of oxygen required for oxidation of the organic matter present in them, by their proportions of organic carbon and nitrogen, of nitrates and chlorine, and by their initial hardness in degrees of Clark's scale. The results exhaustively set forth in numerical tables are further illustrated by seven diagrams, in each of which three wave-lines represent the fluctuations throughout the year of discoloration, of the proportion of organic carbon, and of the amount of oxygen required to oxidise the organic matter of the water of the London Company in question. These diagrams show to the eye what the statistics confirm, the remarkable parallelism existing between the degree of discoloration, the amount of organic carbon present in the water as determined by combustion, and the amount of oxygen requisite to oxidation of the organic matter as determined by permanganate. The Report altogether would seem to reflect most favourably on the quality of London water. Throughout the whole year the water of the New River Company as determined by the samples was, without exception, "clear, bright, and well filtered," a character supported by analyses of other kinds, and in only a few cases in the samples of the other Companies was the water describable as "turbid," "slightly turbid," or "very slightly turbid." For the nine months from February to October 1882 the organic matter in the water of all the London Companies is estimated at ·137 per 100,000, and the highest monthly mean for the same period at ·181 per 100,000. There is, however, one important factor in the question with which chemical analysis cannot directly cope, the comparative innocuousness, namely, of the organic matter present in the water according as it is of vegetable origin, or its comparative virulence according as it is of animal origin. As Prof. Huxley, in a lecture in 1880 to the Chemical Society, said, water as regards chemical analysis may be perfectly unobjectionable, and yet as regards its operation on the human body deadly as prussic acid.

WE have received advanced copies of the following books from the Literary Superintendent of the Fisheries Exhibition:—"British Marine and Freshwater Fishes," by W. Saville Kent, F.L.S., F.Z.S.; "Zoology and Food Fishes," by George Bond Howes, Demonstrator of Biology at the Normal School of Science; "On the Capture of Salmonidæ and the Acclimatisation of Fish," by Sir James Ramsay Gibson Maitland, Bart.; and "The Fishery Laws," by Frederick Pollock. We must congratulate the Commissioners of the International Fisheries Exhibition on their activity, and on their care for the scientific aspect of the specimens in their collection. There are two kinds of books published by the Exhibition authorities. Reports of papers read at the conferences and the important discussions which have followed their reading are published, and other books are written in explanation of the exhibits and other subjects bearing upon fish and fish culture.

THERE is an interesting article on "The Import Duty on Scientific Journals" in *Science* for June 29. The writer ventures to suggest that at its next meeting, the American Association for the Advancement of Science should appoint a committee to draw up a definite list of those foreign technical journals of mathematics, physics, chemistry, mineralogy, geology, geography, botany, zoology, physiology, and ethnology which do not compete with similar enterprises of publishing firms in the United States, and urge Congress to pass a special Act putting these journals on the free list. The article goes on to say that, if a suitable Bill were drawn up, there is little doubt that some member of Congress could be found to introduce it, and if framed so that it touched no publisher's pocket, and vigorously supported by the scientific influence of the country, it would certainly become law.

THE earthquake at Voss in Norway on June 13, reported in NATURE last week (p. 233), was felt over the entire district between Bergen and Aalesund, but most severely in the well-known Dalsfjörd. A further shock was felt over the same district on June 15 at 1.50 p.m., and some people assert that another followed at about 11 a.m. on the following day.

ON the evening of the 2nd inst. a terrific cyclone passed over Stockholm. Its course was north-west to north-east. Houses were unroofed, trees uprooted, and a number of people thrown down, while not a shred of canvas was left on the masts of the vessels in the harbour. Barely a mile from the track of the cyclone there was almost a perfect calm.

WE learn that the Dutch Government have decided not to grant the sum of 30,000 guilders which Baron Nordenskjöld claims as the discoverer of the North-East Passage. The decision is founded on the motive which led the States General in 1596 to offer this award, viz. to find a passage of *commercial* value to the nation; Baron Nordenskjöld having, however, discovered what may be termed a purely *scientific* one, the award, it is argued, has not been earned. As several reasons have been advanced for this claim made by the gallant Swedish explorer, we do not think we err when we assert that it was his intention to have expended the sum in the interest of science, viz. on an expedition to the Arctic regions.

A STATE paper recently issued by the Minister of Public Works in France contains some interesting details on the French mineral waters. There are 1027 sources which are worked. Of these 319 are sulphurous, 357 alkaline, 136 iron, and 215 salt; 386 are cold, that is to say, they do not exceed 15° C. in temperature, and 641 are thermal. They are distributed as follows:—Puy-de-Dôme, 94; Ardèche, 77; Vosges, 76; Ariège et Pyrénées Orientales, 69; Hautes-Pyrénées, 64. The paper also states the number of visitors to these different waters. It appears that the Hautes-Pyrénées are the most frequented. During the past year this department alone has had 44,476 visitors, thus distributed:—Puy-de-Dôme, 18,619; l'Alliers, 16,430; la Haute-Garonne, 14,230; les Landes, 12,954. The water flowing from all the 1027 sources is estimated at 46,412 litres per minute.

THE Chevalier Frédéric Franchetti, engineer at Leghorn, has referred M. de Parville to a curious passage in Galileo's "Dialogues" touching a possible early origin of the electric telegraph. In the dialogue Sagrado says that he calls to mind a man who wanted to tell him a secret which would give him the power by means of a certain sympathy of magnetised wires to speak to any one two or three thousand miles off. The bargain however fell through, as the inventor would not try any shorter distance, and Sagrado declined to go to Cairo or Muscovy to try the experiment. The story is told in the last number of the *Revue Scientifique*. The reference given is p. 97 of the first day, Leghorn Edition, 1874.

THE Executive Committee of the International Fisheries Exhibition has published a penny plan and tour as a complete guide to the leading and most interesting features of the Exhibition, which we think will prove useful.

WE have some very interesting figures before us comparing the different modes of illumination in respect to the amount of products of combustion:—

Light of 100 candles.	Products per hour. Water vapour, kilos.	Carbonic acid in cubic metres.	Heat in calories.
Electric lamp, arc	0	0	57–158
,, ,, incandescent	0	0	290–536
Gas, Argand burner	0·86	0·46	4860
Lamp, petroleum, flat flame	0·80	0·95	7200
,, colza oil	0·85	1·00	6800
Candle, paraffin	0·99	1·22	9200
,, tallow	1·05	1·45	9700

These we think are quite sufficient to show the great supremacy of electric lighting over all other methods of illumination when considered as a matter of health.

WE learn from *Naturen* that a hitherto unknown form of the potato disease, which had been making slow but steady progress near Stavanger during the last ten or twelve years, has recently begun to show increased energy. The stalk of the plant is the part affected, and here Herr Anda has discovered small white fungoid growths, which after a time assume a greenish, and finally a black, colour, after attaining the size of a small bean. While the fungus is rapidly increasing at the expense of the plant, the interior of the stem is first reduced to a pulpy condition, and next shrivelled and hollowed out, until nothing remains but a mere outer shell, which breaks down on being touched. When the ripe black germs of the fungus have remained in the earth through the winter, they are found after the return of the next year's warmth to have developed small stalked fruits filled with minute spores, which penetrate into the young plants before they appear above the ground. The end of July or beginning of August is the time when the ravages of the fungus are most conspicuous, and at those periods whole fields of potato plants are often rapidly reduced to the condition of withered straw.

WE have received from the Minister of Mines of New South Wales the report of the Chief Inspector of Mines for the year 1882. Besides the usual statistics, a great part of the report is occupied with suggestions for the improvement of the present law of the colony for preventing accidents to workmen in mines.

FROM a comparison between the lists of birds observed at Saltdalen in Norway by the ornithologist Sommerfelts, from 1805 to 1825, and those which are now found in the district, it would appear, according to Herr Hageman of the Norwegian Forest Department, that the smaller singing birds are much more largely represented now than formerly. The ortolan and crossbill, *Hirundo urbica* and *rustica*, the common sparrow and the chaffinch, which are now abundant, were then unknown in the district, while the common sparrow was only observed on one occasion by Sommerfelts. Herr Anda ascribes the present increase in numbers and species to the better cultivation of the land and the clearing of the fir-woods.

THE additions to the Zoological Society's Gardens during the past week include a Kinkajou (*Cercoleptes caudivolvulus*) from South America, presented by Mr. H. V. Brackenbury; a Syrian Fennec (*Canis famelicus* ♀) from North Africa, presented by Mr. J. H. James; a Blau-bok (*Cephalophus pygmæus* ♀) from South Africa, presented by Mr. Ernest Honey; a Slender-billed Cockatoo (*Licmetis tenuirostris*) from Australia, presented by Mrs. A. C. Biddle; an Earl's Weka Rail (*Ocydromus carlii*) from North Island, New Zealand, presented by Mrs. Wilson; two Wood Owls (*Syrnium aluco*), British, presented by Mr. J. Metcalfe; two Black Guillemots (*Uria grylle*) from Ireland, presented by Mr. H. Becher; a Vervet Monkey (*Cercopithecus lalandii* ♂) from South Africa, a Moor Macaque (*Macacus maurus* ♂), a Bonnet Monkey (*Macacus radiatus* ♀) from India, two Common Snakes (*Tropidonotus natrix*, var.), European, a Spotted Cavy (*Cœlogenys paca*), two Hairy-rumped Agoutis (*Dasyprocta prymnolopha*) from Guiana, deposited; a Black Howler (*Mycetes caraye* ♂) from Brazil, purchased; a Japanese Deer (*Cervus sika* ♂), a Burrhel Wild Sheep (*Ovis burrhel* ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE TOTAL SOLAR ECLIPSE OF AUGUST 28-29, 1886.—This great eclipse is a return of that of August 17-18, 1868, which was extensively observed in the Bombay and Madras Presidencies and in other parts of its track from Aden to Torres Straits. In 1886 the track of the central line is mainly over the Atlantic Ocean, and at that portion of it where the duration of totality is longest it will not be observable on land. It is therefore of interest to examine the possible conditions of observation. In deducing the results which follow, the places of the sun and moon have been taken from the *Nautical Almanac*, where Newcomb's corrections to Hansen's Lunar Tables are introduced. As will be seen from the Ephemeris, the central eclipse commences in longitude 79° 46′ west of Greenwich, and latitude 9° 48′ north, off Colon, in the isthmus of Panama, thence running in the direction of the Windward Islands across the northern parts of New Grenada and Venezuela; passing over the Island of Grenada, it traverses the Atlantic, and meets the coast of Africa in the Portuguese possessions, not far from St. Philip de Benguela, and crossing South Africa to Sofala, it ends on the east coast of Madagascar. At Cartagena the duration of totality is 3m. 2s., with the sun at an altitude of 5°; at Maracaybo the duration is 2m. 57s., with the sun 9° above the horizon. The southern extremity of the Island of Grenada will have the most advantageous conditions for observation, having regard to length of totality and accessibility. The total eclipse begins there at 7h. 11m. 0s. a.m. on August 29, and continues 3m. 42s., the sun being at an altitude of 20°; at the northern extremity of the island the length of total eclipse is about five seconds less. In Carriacou, the principal island in the Grenadines, the duration of totality is 3m. 21s.; at the northern point of Tobago it is 1m. 51s. On the Atlantic, where the sun is on the meridian at the middle of the eclipse, or in longitude 14° 27′ west and latitude 2° 57′ north, totality, according to the elements we have adopted, will continue for 6m. 31s. Near St. Philip de Benguela, on the central line, we find the sun will be hidden for 4m. 23s., but the locality will hardly attract observers. It would rather appear that we must look for observations of this eclipse to the Windward Islands only. The small island of Blanquilla is close upon the central line, but the sun has of course a less altitude there than in Grenada.

The eclipse of August 7–8, 1850, one of the same series, was observed in the Sandwich Islands, the whole track of totality lying on the Pacific.

TEMPEL'S COMET, 1873, II.—According to M. Schulhof's corrected elements of this comet's orbit, which assigned a period of revolution of 5·200 years, at the last appearance in 1878, the next perihelion passage, neglecting the effect of perturbation, which can hardly be very material during the present revolution, may take place about November 19 under circumstances that will render observations difficult if they are practicable at all. Assuming the comet to be in perihelion on November 19·5 G.M.T., we should have about the following positions:—

1883.	R.A. h. m.	N.P.D. ° ′	Log. Δ.	Log. r.	Intensity of light.
Oct. 18·5	16 38·8	108 59	0·275	0·142	0·146
Nov. 19·5	18 33·1	114 1	0·286	0·127	0·149
Dec. 21·5	20 36·4	113 0	0·313	0·142	0·124

In 1873, under an intensity of light of 0·385, the comet was the *extremum visibile*, in a fine sky, with a 7-inch refractor.

SOLID AND LIQUID ILLUMINATING AGENTS

THE *Journal of the Society of Arts* publishes in a recent number an interesting lecture given by Mr. Leopold Field, F.C.S., on "Solid and Liquid Illuminating Agents." Mr. Field not only deals with the chemistry of these bodies, but he gives also a most interesting account of the means of lighting in use among the ancients, to which a brief reference may be made.

The earliest known method of illumination was in all probability that of the torch, formerly used largely in northern countries, and doubtless still furnishing the Lapp and the Finn with their light. The torch is cut from the pitch pine, and around it clings the exuded resin. When lighted it burns with a large red flame, producing a great deal of smoke. Used for cooking purposes a brand might get saturated with fat, so that it would burn longer without consuming its own fibre.

This, as pointed out by Mr. Field, was the old method of lighting. Substituting for their brand a piece of rope and saturating this with pitch or resin we get the modern link, connecting us on foggy days with the old modes of lighting. The work link itself, and probably also the idea, comes from the Greek λύχνος, or perhaps the Latin *luchnus* (Cicero) as the German *fackel* comes from the Greek φάκελος (faggot), a bundle of sticks —after, a torch. But our own word torch is more evidently from the Latin *tartitium*, a twisted thing, now however more properly applicable to the link. Our pine torch too is obtained from the Roman *tædæ*—slips of the tæda, or Italian pitch pine, that being the usual outdoor light of Rome; whilst *Funalia*, which Virgil tells us were used to light Dido's palace—

> " —— dependent lychni laquearibus aureis
> Incensi, et noctem flammis funalia vincunt."

is evidently from *funis*, a rope. Their composition was rather that of a finer kind of link, flambeaux, consisting of a centre of oakum, which was surrounded by alternate layers of rosin and crude beeswax, outside of all being a bleached coating of the latter. They were more costly than other kinds of torch, and giving a less smoky light were more generally employed for the illumination of halls, staircases, &c.

At what date this torch fell into disuse is a question which cannot be definitely answered, as in old times words applied to various illuminating agents, which have a very fixed and definite meaning in our day, were then interchangeable. In our translation of the Scriptures "candle" and "candlestick" are used indiscriminately with lamp, and, did we not know that candles proper and candlesticks were unknown at this period, we might infer that they were both in use. An explanation of this use of the words "candle" and "candlestick," however, is found in the fact that the Latin *candelabrum* and the Greek λυχνία, Latin *luchnuchus* (Cicero), meant "lampstand."

Again, in Matt. xxv. 1–5, where we find the parable of the Virgins, the word λυχνὸς is rendered lamp. But a study of the etymology of the words shows that they are derived from roots signifying to shine or burn—as *candela*, κανδήλα, akin to *candeo*, to shine (Persian, *kandeel*; Sans., *kan*)—λύχνος, *lucerna*, from *lux*, light (Sans. *lôk*), λάμπας, *lampas*, probably connected with *lame*, and the Hebrew *lapad*, to shine.

But although it is doubtful at what date the torch fell into disuse, it may be concluded that it was succeeded by the lamp. We find evidence of this in studying mythology. Thus Ceres, according to the old legend, sought her daughter in hell with a torch; Apuleius makes Psyche drop hot oil on Cupid from a lamp. Whether candles proper, *i.e.* wicks surrounded with wax, were known before or after lamps had come into use is doubtful. Martial (first century A.D.) speaks thus concerning the candle:—

> " Nomina *candelæ* nobis antiqua dederunt
> Non norat parcos uncta lucerna patres."—(Ep. xiv. 43).

Here, however, torch, *i.e. funalia*—which the old Romans in reference to its shining qualities would rather call *candela* than *funalia*—may be alluded to. In the Greek the word κανδήλα is a derivation from the Latin, not being met with until it is found in the writings of Athenæus. This author lived in the second century A.C., and in his "Deipnosophistæ" he says:—

> "ἐμοὶ δέ παῖ δωροίδειπνε ἀσσαρίου κανδήλας πρίω."

By that time, however, the rushlight had come into pretty general use, and no doubt it is to this that reference is here made.

But it is from a passage in Apuleius's Metam. iv. that we get the most valuable and conclusive information on this point. A noise being heard in the middle of the night, we are told that the household come in with "tædis, lucerna, sebaceis, cereis, et ceteris," that is with torches of pine, lamps, tallow candles, and wax tapers, which therefore clearly proves that candles both of wax and tallow were in use at this date. It seems, however, that the candle was probably used by the poorer people. At all events the lamp was a mark of respectability, as in another verse of Martial (Apoph. 42) we find that an apology is made for the use of a wax light instead of a lamp:—

> " Hic tibi nocturnos præstabit cereus ignis
> Subducta est puero namque lucerna tuo."

Juvenal (iii. 287) also speaks of the "breve lumen candelæ." In the British Museum, too, there is a fragment of a large candle found in Vaison, near Orange, and said to belong to the first century A.C. Such candles were probably provided with wicks consisting of the pith of rushes rudely covered with crude wax or tallow. Candlesticks for these existed, and later on they had a spike to penetrate the butt of the candle. However, the name candelabrum was more generally applied to the pillar on which the oil lamp stood or from which it was suspended. Since no attempt was made to provide for the current of air so necessary for proper combustion, these old lamps smoked exceedingly, so much indeed that it was the duty of one of the slaves of the household to go round each morning and wipe the soot from the pictures and statues. In one case, however, at the Erectheum of the Athens Acropolis, the lamp, which was of pure gold, was provided with a flue. This was a very large lamp, requiring to be filled but once in a year. Callimachus designed it for the new temple about 400 B.C., but the smoke was found to be so great an evil in anything designed for such a purpose, that the lamp was provided with a chimney in the shape of a bronze palm-tree inverted. But however magnificent and elaborate the design, it is certain that the economy of the lamp remained stationary.

It was generally filled with olive oil and provided with a wick either of oakum, or of the dearer Carpasian flax (cotton?). Occasionally, Pliny informs us, bitumen was used to fill the lamp; Italy, in some parts, being rich in springs of that mineral and petroleum. Further east, and especially among the tribes dwelling on the shores of the Dead Sea, bitumen and naphtha were much used as illuminating agents, and for other purposes. It may be suggested that the sacred pit-fire Nepti was of this nature. The well-known Egyptologist, Mr. Basil Cooper, has suggested the following as the origin of the word naphtha, viz. *NA*, water, of *Phtha*, the Hephæstos, or Vulcan of Egypt's deities, the god of fire. This idea receives some support from the fact that the Indians who sold the first petroleum as Seneca oil, and used it largely in their rites of worship, termed it fire-water, which name is now applied to alcohol.

Herodotus (ii. 62), writing of the Lychnokaie (feast of lamps) at Sais, in Egypt, in 450 B.C., only expresses surprise at the number of the lamps, and not at the lamps themselves, so that by this time they were getting into general use. Although their introduction as a means of illumination was very gradual and slow in Greece, yet by the end of the fifth century B.C. they were probably in general use at least among the upper ranks of society. The lamp of which Herodotus speaks, which we have mentioned above, differed in no respect from that in use at Rome, the wick (θρυαλλίς) being made from the woolly leaves of an indigenous plant, which was passed through the nose (μυκτήρ) of the lamp into the crude olive oil.

So much for the methods of lighting in use in ancient times.

It is worthy of notice how the two elements of fire and light have ever been invested with divine attributes and set up for worship. The Persian monarchs have silver fire trays borne before them into battle. The Lychnokaie, the lamp feast of the Egyptians, referred to above, has a representative in the Chinese feast of lanterns, which takes place on the 15th of the first month. Not only this, but lamp festivals have been common to all nations. The Greeks had their λαμπαδη-δρομία, the Romans their Lupercalia, the latter of which gave way to the institution of Pope Gelasius, Candlemas, unless it be, as some have it, that Virgilius supplanted the Proserpina by this festival, but in any case they are both candle festivals. We learn from Pliny's "Natural History" that the Romans used wax candles in certain rites. They lighted lamps too in honour of Prometheus, who caught fire from heaven; of Minerva, who gave them oil; and of Vulcan, the originator of lamps; they had their *fax belli*, the war torch, the *fax nuptialis*, the marriage emblem.

Lamps, too, filled with scented oil were placed on the tombs of the dead. An oracular statue of Hermes in Achaia was "worked" by lighting a lamp before him and placing a small coin at his feet. Then there is the eternal lamp of Vesta, which was tended by damsels of established reputation, the ever-lighted lamps of Mahomet's tomb, Aaron's tabernacle, and Roman Catholic churches. Again there are those lamps in tombs said to have been found burning after the lapse of centuries. Boyle made a series of experiments with the air-pump which demonstrate the absurdity of such a belief. Mr. Field, however, suggests the possibility of an asbestos wick communicating with a supply of light naphtha burning in a tomb not absolutely air-tight as a way out of the difficulty, and concludes by indorsing Lamb's opinion of our badly-illuminated forefathers, that "one can never hear mention of them without an accompanying feeling as though a palpable obscure had dimmed the face of things, and that our ancestors wandered to and fro—groping."

THE ROYAL SOCIETY OF CANADA

THE second annual meeting of the Royal Society of Canada was held at Ottawa during May 22–25. The officers who had been elected at the close of the last meeting were all present, viz.:—President, Principal Dawson, C.M.G., F.R.S.; Vice-President, Hon. P. J. O. Chauveau, LL.D.; Hon. Secretary, J. G. Bourinot, B.A.; Hon. Treasurer, J. A. Grant, M.D. Besides the members of the Society, there were present also delegates from the various local literary and scientific societies of Canada and from several British and foreign societies. Interesting inaugural addresses were delivered by His Excellency the Governor-General, who is Patron and Honorary President, by Principal Dawson, and by the Hon. Dr. Chauveau.

The report of the Council showed that a favourable answer had been received to the memorial to her Majesty the Queen, asking her gracious permission to name the Society the Royal Society of Canada; that an Act of Incorporation had accordingly been passed by the Dominion Parliament, and a sum of 1000*l*. sterling voted to assist in the payment of the expenses of publishing Transactions; and that steps had already been taken towards the formation of a national museum.

A considerable portion of the time of the Society was occupied by the discussion of a draft constitution which was submitted by the Council.

An address was presented by the Society to His Excellency the Marquis of Lorne expressive of the gratitude of the members of the Society to him for the efforts he has made during the time of his Governor-Generalship to further the interests of literature, science, and art.

Several interesting papers were read in the French and English Literature, History and Archæology Sections.

SECTION OF MATHEMATICAL, PHYSICAL, AND CHEMICAL SCIENCES

The following papers were read in this Section, which was presided over by T. Sterry Hunt, F.R.S.:—(1) Prof. J. G. MacGregor, D.Sc., Halifax, N.S., on "Experiments showing that the Polarisation of Electrodes is independent of their Difference of Potential." The same current was passed through two electrolytic cells (in series) containing dilute sulphuric acid and platinum electrodes. The cells had the same section but differed in length. The electrodes, therefore, differed in potential during the passage of the current, while the current had in both cells the same density. Curves showing the variation with time of the electromotive force of the respective cells after the cessation of the polarising current were drawn, and were found to coincide. The measurements of difference of potential were made by means of the quadrant electrometer. (2) Prof. B. J. Harrington, Ph.D., Montreal, on "An Analysis of two Minerals recently discovered in Canada—Meneghinite and Tennantite." During the discussion of this paper Dr. J. H. Ellis, of Toronto, exhibited a specimen of tellurium which he had extracted from the gold ores of Lake Superior. (3) C. Baillargè, C.E., Quebec, on "Hints to Young Geometers." (4) Prof. E. Haanel, Ph.D., Cobourg, on "Hydriodic Acid as a Blowpipe Reagent." The author had already proposed to use hydriodic acid as a blowpipe reagent in the case of four metals. This paper described the results of experiments made to extend its employment to others. Instead of charcoal he used flat plates of plaster of Paris, and in the case of all the metals which had been at the author's disposal, the blowpipe brought out on these plates easily distinguishable characteristic colours. Owing to the difference of volatility (chiefly) of the products of decomposition, three or four metals could be detected as present in a mineral by a single test, so distinctive are the colours of the iodides and other compounds formed. Prof. Haanel gave most successful experimental illustrations of the new method before the Section. (5) Prof. Coleman, Cobourg, on "The Spectra of certain of the Characteristic Colours of Prof. Haanel's Method of Blowpipe Analysis." (6) Prof. N. F. Dupuis, A.M., Kingston, on "The Construction of a Clock intended to show both Mean and Sidereal Time." The author had constructed the clock described; it gave a much closer approximation to accuracy than any such instrument hitherto proposed. (7) E. Deville, C.E., Ottawa, on "The Measurement of Terrestrial Distances by Astronomical Observations." The author deduced expressions for such distances in terms of differences of latitude and of azimuth respectively, and showed the influence of various sources of error in the use of these expressions. (8) T. McFarlane, M.E., Montreal, on "The Reduction of Sulphate of Soda by Carbon." (9) C. Baillargé, C.E., Quebec, on "Simplified Solutions of two of the more difficult cases in Hydrographic Surveying," and on "The Measurement of Surveys by Spherical Triangles and Polygons on a Sphere of any Radius." (10) Sandford Fleming, C.M.G., Ottawa, on "The Adoption of a Universal Meridian for the Regulation of Time." The author showed that the proposal he had made some years ago was meeting with a favourable reception. In connection with this paper the Section adopted a resolution urging the Society to memorialise the Governor-General, asking that he use his influence to induce the Imperial Government to grant representation to Canada at the International Conference on Standard Time to be held at the invitation of the President of the United States. (11) Reports by Prof. A. Johnson, LL.D., Montreal, and C. H. Carpmall, M.A., Toronto, Superintendent of the Meteorological Service, on "The Preparations made for the Observation of the Transit of Venus in Canada, and on the Observations which had been made." (12) Dr. J. H. Ellis, Toronto, on "A Remarkable Sulphur Spring near Port Stanley," and on "A Method by which the Tannin Determination of Löwenthal might be utilised for the Detection of Impurities or Adulterations in Spices." (13) F. W. Gisborne, Esq., Ottawa, on "Recent Improvements in Practical Telegraphy." (14) T. McFarlane, M.E., Montreal, on "The Decomposition of Zinc Sulphate by Common Salt." (15) T. Sterry Hunt, F.R.S., on "The Mechanical Transfer of Matter in the process of Segregation."

Prof. Cherriman, M.A., Ottawa, was elected president, Mr. T. McFarlane vice-president, and Prof. A. Johnson secretary of the Section for the next year.

SECTION OF GEOLOGICAL AND BIOLOGICAL SCIENCES

A. R. C. Selwyn, F.R.S., Director of the Geological Survey of Canada, presided over this section. The following papers were read:—(1) Dr. Selwyn, on "Notes on the Geology of Lake Superior." The points insisted on were: the conformity of the Laurentian and Huronian divisions of the older crystalline rocks; the Lower Cambrian age of the upper copper-bearing rocks of Logan, called Animikie, Nepigon, and Keweenian, by Dr. Hunt, and the unconformity of the Animikie divisions to the underlying Huronian, by some geologists in the United States supposed to be of the same age. (2) Mr. W. Saunders, of London, Ont., "On the Influence of Sex on Hybrids among Fruits." This paper gave some of the results of Mr. Saunders's experience in hybridising fruits. The facts cited confirmed the view that the influence of the female is more strongly expressed in the habit, character of growth, and constitution of the vine, bush, or tree, while the influence of the male is more distinctly seen in the form, colour, and quality of the fruit, and in the case of hybrid grapes in the size and form of the seeds also. (3) Mr. G. F. Mathew, of St. John, N.B., on "The Method of distinguishing Lacustrine from Marine Deposits," based on careful observations on the deposits now taking place and accumulated since the Pleistocene period in lakes in New Brunswick. (4) Dr. J. A. Grant, of Ottawa, on "The Inferior Maxilla of the *Phoca Grœnlandica* from Green's Creek, near Ottawa. (5) Principal Dawson, of Montreal, on "Spores and Spore-cases, from the Erian Rocks." The author referred to the discussion many years ago by the officers of the Geological Survey of a bituminous shale at Kettle Point, Lake Huron, of vast numbers of minute round disks, which were recognised as the spore-cases of some cryptogamous plant, and named *Sporangites Huronensis.* More recently Prof. Orton, of Columbus, Ohio, Prof. Williams, of Cornell, and Prof. Clarke, of Northampton, have found in the Erian and Lower Carboniferous shales of Ohio and New York beds replete with these organisms, and Prof. Orton has shown reason to believe that they are connected with filamentous stems found in the same layers, and also that they have contributed largely to the bituminous matter present in the shales in which they occur. Similar bodies have also been found associated with the curious plants known as Ptilophyton and Trochophyllum. Still more recently specimens from the Erian of Brazil have been sent to the author by Mr. Darby, of the Brazilian Geological Survey, which seem to throw additional light on these bodies. They are oval or rounded or in the form of flattened sacs, containing numbers of rounded disks, and so closely resembling the utricles or spore sacs of the Rhizocarps as to make it extremely probable that they belonged to plants of this class. Should this conjecture be sustained by subsequent inquiries it would show that this peculiar group is of much greater antiquity than hitherto supposed, and that these plants were extremely abundant in the shallow waters of the Erian period. Dr. Dawson suggests the probable relation of these singular fruits not only with the Ptilophyton, but also with the other Erian and Silurian plants. (6) E. Gilpin, jun., on "The Folding of the Carboniferous Group in the Maritime Provinces." The author described each of its great subdivisions as exposed at various points, and showed that during the Carboniferous period, in addition to the continental changes of level, giving rise to conditions of deposition characterising the carboniferous limestone, millstone, grit, &c., there were extensive foldings of a more local character, apparently in some cases marking the closing of these oscillations. These foldings and their subsequent denudations have played an important part hitherto but little studied in modifying the conditions arising from the larger and more extended movements which have hitherto principally received attention, and present the district as being far from an universal state of quiet and regular succession during the Carboniferous age. (7) Prof. R. Bell, M.D., on "The Causes of the Fertility of the Land in the Canadian North-west Territories." In the Canadian North-west a vast fertile tract stretches, with certain exceptions, from the Red River Valley to the Liard River, a distance of some 1400 miles. The soil of this tract was characterised as a dark loam, of varying depth, and of a nearly homogeneous consistency. The primary cause of the fertility of this region was the abundance of the underlying crude material out of which a finished soil could be made. This was derived partly from the widespreading crustaceous marls which were nearly coextensive with the fertile tract, and probably from the drift during the Glacial period. Dr. Bell next considered the process by which the black loamy soil was formed out of this subsoil, and he considered that the main agency was the work of moles and other burrowing animals. Worms appeared to be absent in the North-west, owing principally to the frost penetrating into the ground beyond the depth to which worms can burrow, but the moles and the ground squirrels, or gophers, more than make up for their absence. In the fertilised tracts the old and new mole-hills cover the whole surface, rendering it "hummocky," which may be easily observed after the prairie has been swept by a fire. The badgers often did what was compared to subsoil ploughing. All the animals referred to were very active in the autumn, digging many more burrows than appeared to be of any use to themselves. Each hummock thrown up by the moles covered about a square foot, and buried all the grass, &c., on this space. In this manner large quantities of vegetable matter were ultimately incorporated with the soil. The work of the moles also acted in another way in refining the soil, for they left behind the stones and coarse gravel, so that these in time became sunk beneath the layer of mould produced. By an interesting coincidence at the season when the burrowing animals are most active, the prairie vegetation is mature, and contains the largest amount of substance. The coldness of the soil during the most of the year tended to preserve the organic matter in it. While the circumstances given were the direct cause of its fertility, the ultimate reason was perhaps to be looked for in the climate of the North-west, for to this was due the growth of the vegetation which formed the manure and the food of the little workers which mingled it with the soil. Thus we could trace a mutual dependence of the circumstances which together have given to our North-west Territories that surpassing fertility of soil which cannot fail to attract to it a vast population. (8) Dr. G. M. Dawson, on "Notes on Triassic Rocks of the West," discussing the question as to the Triassic or Jurassic age of deposits found in British Columbia and the Rocky Mountains, and their correlation with the deposits of similar age in the territory of the United States. (9) Prof. L. W. Bailey, Ph.D., Fredericton, on "The Occurrence of Indian Relics in New Brunswick," probably deposits found at an old camping ground of the Malicete Indians. (10) Dr. T. Sterry Hunt, on "Studies on Serpentine Rocks." (11) Prof. J. Macoun, on "Notes on Canadian Polypetalæ." The geographical distribution of these plants in Canada was discussed, and interesting facts were adduced in connection with the number of species and genera in each order which showed certain relations between the present flora and that which had existed in the Tertiary period. (12) A paper by Mr. R. Chalmers was communicated by Principal Dawson, in which facts were stated showing important erosion on the coast of the Bay des Chaleurs by floating ice in the modern and later Pleistocene periods.

Dr. Selwyn, Prof. Lawson of Halifax, and J. F. Whiteaves, were re-elected president, vice-president, and secretary of the Section respectively.

The following were the officers elected by the Society for the present year:—President, Hon. P. J. O. Chauveau, LL.D.; Vice-president, T. Sterry Hunt, F.R.S.; Hon. Secretary, J. G. Bourinot, B.A.; Hon. Treasurer, J. A. Grant, M.D.

THE HYPOPHYSIS CEREBRI IN TUNICATA AND VERTEBRATA[1]

IN most simple Ascidians the single nerve ganglion is situated near the anterior end of the body, and between the branchial and atrial apertures. In species where the atrial aperture is near or at the posterior end of the body, the ganglion may also be placed far back, but it still lies between the two apertures and always indicates the dorsal side of the branchial. The ganglion is usually elongated, and gives off nerves at both ends—one set anteriorly and ventrally towards the branchial aperture, the other set posteriorly and dorsally towards the atrial. In close relation with the ganglion are found two organs—the neural gland and the dorsal tubercle—which have been much written about, but apparently will bear a good deal of further investigation.

The neural gland lies upon the ventral and posterior face of the nerve ganglion, and consists of a number of more or less ramified cæcal tubules springing from a central space or tube immediately below the ganglion. The presence of this organ was first distinctly pointed out by Albany Hancock in 1868,[2] but until quite recently its function was not only totally unknown, but had been scarcely investigated.

The dorsal tubercle was described by Savigny in 1816[3] under the name of "tubercule antérieur." Since then it has received many names, but has usually been regarded as some sort of ol-

[1] Abstract of a paper read before the Royal Society of Edinburgh, April 2.

[2] *Journ. Linn. Soc.* (*Zool.*), vol. ix.

[3] "Mémoires sur les Animaux sans Vertèbres," pt. ii. fasc. 1. (Paris, 1816.)

factory organ. It is placed on the dorsal edge of the anterior end of the branchial sac, behind the circle of tentacles, and usually in a distinct "peritubercular" area, a diverticulum from the prebranchial zone formed by a bending posteriorly of the dorsal ends of the peripharyngeal bands.

The dorsal tubercle is, in the simplest form known, a funnel-shaped depression having its wider circular open end separated from the prebranchial zone in front of the branchial sac by a raised edge or lip, while its opposite narrower end is continued into a fine canal running dorsally and posteriorly. This simple condition is found in *Molgula pedunculata*; in *Eugyra kerguelenensis* the aperture is still wide, although its edge is square in place of being circular. In other simple Ascidians the anterior half of the edge has been apparently pushed backwards, so as to become invaginated and closely applied to the posterior half, thus reducing the circular aperture to a crescentic or semicircular slit. This condition is found in *Corella parallelogramma*. In most other forms more or less complication is produced by the ends of the slit, or "horns" as they may be called, being prolonged, often to a very great extent, and coiled in various directions, sometimes producing beautifully regular and closely placed spirals. The patterns produced by this curving of the horns are very numerous and often complicated, but their value in classification is slight, since they differ sometimes to a considerable extent in individuals of the same species, and on the other hand are sometimes very similar in members of different genera or even families.

This variously-shaped organ is histologically merely a depression in the connective tissue of the mantle, lined by epithelium continuous with the squamous epithelium covering the prebranchial zone, but modified upon the edges of the slit into cubical or columnar ciliated cells. Since the time of Savigny it has been almost universally regarded as a sense-organ of some kind—probably olfactory or gustatory, or in some way capable of testing the quality of the inhalent current of water. The reasons for this view have been :—

1. The position of the organ at the entrance of the branchial sac where a sense-organ would be of great apparent value.

2. Its structure—a ciliated depression covered in part by columnar cells, some of which closely resemble sense-cells.

3. Its intimate relation with the ganglion, and the presence of a nerve arising from the anterior end of the ganglion, running towards the branchial aperture close past the dorsal side of the tubercle, and presumably supplying it with nerves.

In 1876 Ussow showed that the gland of unknown function lying below the ganglion had a delicate duct, lined by cubical epithelium, which ran forwards and opened into the tubular posterior end of the funnel-like depression forming the dorsal tubercle; so that the slit of the tubercle was thus shown to be merely the aperture of the duct from the neural gland. In 1881 Julin[1] confirmed this discovery, described minutely the condition of the gland, the duct, and the tubercle in several species of simple Ascidians, and declared that there was no connection between the nerve running from the ganglion to the branchial aperture and the tubercle, and that consequently the latter was not a sense-organ, and was nothing more than the opening of the duct. In a second paper, published shortly afterwards, Julin[2] described the condition of these organs in two additional species, and enunciated the theory, suggested to him by E. van Beneden, that the neural gland was renal in function, and was the homologue of the hypophysis cerebri of the vertebrate brain. In favour of this homology may be considered :—

1. The position of the gland upon the ventral surface of the nerve centre and above the pharynx.

2. Its glandular nature.

3. Its connection with the anterior end of the pharynx by a duct—Balfour, Kölliker, and others having shown that the hypophysis or pituitary gland in higher vertebrates arises as a dorsal diverticulum from the stomodæum, but afterwards loses this connection.

From my own observations I can confirm Julin's statement as to the presence of the duct from the neural gland and its connection with the slit of the dorsal tubercle, and, like him, I am unable to find any nerve supplying the supposed sense organ. I have, however, in several cases seen certain of the epithelial cells covering the edges of the slit which had a striking resemblance to sense-cells, such as those in the ectoderm of *Actiniæ*. This observation, taken along with Julin's descriptions, and especially with the condition of affairs in some specimens of *Ascidia mammillata* which I have recently examined, has suggested to me that possibly the dorsal tubercle may be *both* the aperture of a gland corresponding to the hypophysis and also a sense-organ, probably of an olfactory or gustatory nature.

[1] *Archives de Biologie*, vol. ii. p. 59.
[2] *Loc. cit.* p. 211.

Ascidia mammillata is one of the forms discussed by Julin in his second paper. It is a large species with the branchial and atrial apertures rather far apart, and the ganglion at a considerable distance from the anterior end of the body. Julin found that the neural gland in this species did not form the usual compact mass, but was in a somewhat rudimentary condition, and that besides having the usual duct running anteriorly to communicate with the pharynx by the dorsal tubercle it had also a number of short funnel-shaped apertures into the peribranchial or atrial cavity inclosed by the mantle; so that in this species the products of the gland might be excreted either into the branchial sac (pharynx) or into the dorsal part of the peribranchial cavity, the region into which the intestine and the genital ducts also open.

In two specimens of *Ascidia mammillata* which I had an opportunity of examining recently I found the neural gland in exactly the condition described by Julin, but its duct had no aperture into the pharynx, the dorsal tubercle being entirely absent. The small funnel-shaped apertures into the peribranchial cavity were numerous and well developed, so that in the case of these individuals the neural gland was connected with the cloacal part of the peribranchial cavity only, exactly the arrangement to be expected if the gland had a renal function. It seems possible to me that this, or something like this, may have been the condition of affairs in the primitive Chordata previous to the point of divergence of the Urochorda. There may have been a renal gland placed ventrally to the nervous system, not necessarily at the anterior end only, and opening on the surface of the body by one or more laterally-placed apertures,[1] this gland being represented in the Tunicata by the neural gland, and in the Vertebrata by the glandular portion of the pituitary body.

Then the dorsal tubercle apparently is or was a sense-organ—possibly placed at first on the surface of the body, since the anterior part of the pharynx develops from the epiblast as a stomodæum—and I think it probable that the connection of the tubercle with the duct of the neural gland may be an after-change, caused possibly by the enlargement of the pharynx into a branchial sac, and the development of the peribranchial chamber. It may readily be imagined how, as the result of the formation of these cavities, the neural gland would be brought into closer relation with the dorsal tubercle, and one or more of the funnel-shaped ducts of the gland might, after having been carried in from the surface by the formation of the lateral atrial involutions, come to open into the ciliated depression of the tubercle in place of into the peribranchial cavity, thus producing very much the condition described by Julin in his specimens of *Ascidia mammillata*. By suppressing the original openings into the peribranchial cavity and leaving merely the secondary opening into the pharynx by means of the dorsal tubercle, we arrive at the condition found in all ordinary Ascidians. It is not easy to see the reason for this change, as there is no apparent advantage to be derived from it, but there is probably also no disadvantage, since there is abundant communication between the branchial sac and the peribranchial cavity through the stigmata or slits in the wall of the former.

This suggestion as to the origin of the present structure of the neural gland and neighbouring organs in most Tunicata implies that the pituitary body in the Vertebrata, which has lost its connection with the exterior, and probably also its function, has a similar history. In this view I am encouraged by some remarks by Balfour,[2] from which it is clear that he considered the pituitary body, judging from its development, to have been originally a sense organ opening into the mouth, and possibly corresponding to the Ascidian dorsal tubercle. He has also suggested,[3] as an alternative, the possibility that the neural gland in the Tunicata may be the homologue of the vertebrate pituitary body. This is of course the theory supported by van Beneden and Julin, and is open to the objection that it does not account for the remarkable structure of the dorsal tubercle. The view I hold combines both of those above mentioned by considering the pituitary body as the homologue of the neural gland,

[1] The lining of the peribranchial cavity, into which the ducts open in the Ascidian, is derived from the epiblast, being formed in the embryo by a pair of lateral involutions, which afterwards fuse dorsally.
[2] "Comparative Embryology," vol. ii. p. 359. [3] *Loc. cit.* p. 360.

and as being therefore the rudiment of a primitive renal organ,[1] which opened by lateral ducts upon the side wall of the body; while the connection of the pituitary body with the stomodæum in embryo vertebrates is regarded as being not its original and proper duct, but a secondary connection, which has been formed with a lost sense-organ placed at, or in front of, the anterior end of the pharynx, and homologous with the dorsal tubercle in the Tunicata.

Ussow and Julin have conclusively shown that the dorsal tubercle is not *merely* a sense-organ. The complex structure which the tubercle usually presents seems to indicate that it is not *merely* the aperture of a duct. Whether, as I suggest, it may be a sense-organ into which the duct has come to open can scarcely be determined on the evidence at present in our hands. The lines of investigation which may be reasonably expected to throw additional light upon the matter are: (1) the exact course of development of the neural gland and the dorsal tubercle, and further information as to the pituitary body; and (2) the examination of the condition of the gland and its ducts throughout the Tunicata, and especially in a large number of specimens of *Ascidia mammillata*, a species in which these organs appear to be in a variable and highly interesting condition.

W. A. HERDMAN

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Mr. W. H. Caldwell, B.A., Fellow of Caius College, has been selected to proceed to Australia to endeavour to solve the important questions connected with the reproduction and the embryology of the Monotremata, which have so long baffled inquiry.

Mr. S. F. Harmer, B.A., of King's College, 1st Class in the Natural Sciences Tripos 1883, has been appointed Demonstrator of Comparative Anatomy, in the vacancy caused by Mr. Caldwell's resignation.

Mr. W. F. R. Weldon, B.A., of St. John's College, has been appointed Prosector to the Zoological Society.

Mr. J. Bateson, B.A., of St. John's College, is proceeding to North America to study the life-history of Balanoglossus.

Mr. J. Roberts, B.A., of St. John's College, has been appointed assistant to the Woodwardian Professor.

Prof. Macalister will hold a class in Osteology in the long vacation.

Dr. Humphry has been elected Professor of Surgery.

SCIENTIFIC SERIALS

THE *American Journal of Science*, July.—On the genesis of metalliferous veins, by Joseph Le Conte. From his study of the phenomena of metalliferous deposit by solfataric action at Sulphur Bank and Steamboat Spring, the author argues against Dr. F. Sandberger ("Untersuchungen über Erzgänge," Wiesbaden, 1882) that all lodes have been formed by deposit from solutions. In this important paper the conditions under which the deposits take place and the character of the solvents are fully discussed. Besides simple water, whose solubility is greatly increased by super-heat and pressure, the most active agency appears to be alkali in the form of alkaline carbonates or alkaline sulphides, or both. Such alkaline carbonate waters, ascending slowly towards the surface through underground fissures, gradually lose much of their solvent power both by cooling and by relief of pressure, and must of necessity deposit in their courses, and form metalliferous veins. In this way even cinnabar and gold may be precipitated. Other powerful agencies may be organic matter of universal occurrence in subterranean waters, and known to be potent in reducing metallic oxides and metallic salts. Mainly by these methods it is argued that alkaline waters at various temperatures, but mostly hot, circulating in all directions, but mainly up-coming, and in any kind of water-way, but mainly in open fissures, form by deposit mineral veins. Amongst the many subjects incidentally treated are: Association with metamorphism, variation in vein contents; variation of richness with depth; origin of alkaline and metallic sulphides; occurrence of gold; irregular, brecciated, contact, and other kinds of lodes.—Evolution of the American trotting horse, by Francis E. Nipher. By an ingenious process of calculation the author arrives at the conclusion that the maximum speed to which the American trotting horse will constantly approximate without ever reaching it is a mile in ninety-two seconds.—The burning of lignite *in situ*, by Charles A. White. The ignition of the lignite beds still burning in Montana, and of others long extinct in Colorado, Wyoming, Dakota, and elsewhere, is attributed mainly, if not altogether, to spontaneous combustion, according as the deposits become by erosion successively exposed to atmospheric influence.—On the paramorphic origin of the hornblende of the crystalline rocks of the North-western States, by R. D. Irving. An examination of about 1000 sections representing the crystalline schists, and eruptives and basic eruptives of a region 400 miles by 300, and of three distinct geological systems, showed the occurrence of no hornblende not clearly or very probably secondary to augite.—On the constituents of the meteorites which fell at Bishopsville, South Carolina, in March, 1843, and at Waterville, Maine, in September, 1826, by M. E. Wadsworth.—A simple method of correcting the weight of a body for the buoyancy of the atmosphere when the volume is unknown, by Josiah Parsons Cook.—Recent investigations concerning the southern boundaries of the glaciated area of Ohio, by G. F. Wright. The limit is determined by an irregular line running from Aurora near New Richmond, in a north-easterly direction through Chillicothe, Newark, Dunville, and Canton, to New Lisbon, near the Pennsylvanian frontier.—On the variation of the specific heat of water, by G. A. Liebig.

Bulletins de la Société d'Anthropologie de Paris, tom. v. fasc. v. 1882.—On the tribes of Terra del Fuego, by M. O. Beauregard.—A paper by M. G. de Rialle on M. O. Beauregard's views regarding the origin of the Dardous, communicated to the Society in April, 1882, in which M. de Rialle contests the opinion that the Thibetan races are Mongols. He considers that the monosyllabic character of their language is a distinct proof of their non-Mongolian origin, the Mongol being an agglutinated form of speech belonging to the Altaïc linguistic families. In reply to his objections M. O. Beauregard read a voluminous paper at a subsequent meeting, on the ancient and modern ethnography of Cashmere and Thibet, which is mainly based on Stanislas, Julien, Deguignes, and other older French authorities, and on modern English writers, more especially Major Biddulph, to whose important labours and accuracy M. Ujfalvy bore testimony in his defence of M. de Rialle's views.—Observations by M. Hamy on the anthropology of the Comalis of the East African coast.—Exposition, by M. de Nadaillac, of the scope and character of his work, "L'Amérique Préhistorique," presented by him to the Society.—Zoological observations in Equatorial Africa during M. de Brazza's expedition, by M. Cornevin, derived from the notes of the naturalist, M. Michaud. From these it would appear that in the valley of the Ogoone the climate is constant, the temperature standing generally at about 90° Fahr. Maize, manioc, and tobacco are grown. The people are courageous but peaceable. The sheep have no wool and only little hair. A dark, fierce race of cattle, feared by the natives, abounds in the forests, but there are no indigenous horses.—Observations on the Galibis, by M. Dally.—On the anthropological distinctions between the two races confounded under the common name of Kabyles, by M. Sabatier.—On the flint instruments, including a lasso of the Quaternary period, found in the gravel beds of Sarliève, by Dr. Pommerol.—On the horse of prehistoric and historic times, by M. Pietrement.—On the dental mutilations of the ancient inhabitants of Mexico and Yucatan, by M. Hamy.—On social instinct, by Madame Clémence Royer. This paper, intended to supplement the writer's larger work, "L'Origine de l'Homme et des Sociétés" (published in 1870), considers social instinct in relation to plants as well as to animals generally.—Craniological observations on a series of the crania of assassins, by M. Orchanski, considered specially with reference to the relation between the skull and the face. The author's determinaminations are in close accord with those of MM. Ten-Kate and Bordier.—On the existence of a rudimentary cæcal appendage in some of the Pitheci, by M. Hervé.—Remarks on certain differences between Catholics, Protestants, and Jews, as to the relations among them of deaths and births, by M. G. Lagneau. The author finds that the Catholics generally, with a somewhat higher natality, have a considerable infantile mortality, resulting in a correspondingly feeble increase of population, while among Protestants this increase is often much higher, notwithstanding a somewhat smaller natality, which, however, is corrected by a

[1] Not the pronephros, since that is found along with the pituitary body in many vertebrates, but possibly more ancestral. Might it not be the homologue of the provisional trochosphere excretory organs described by Hatschek and others in *Polygordius* and some Mollusca?

lower infantile mortality. The Jews present a much more rapid increase of numbers than either of the other two religious bodies, for, although their natality is less than either, their mortality is remarkably low for all ages, these conditions being probably due to their dietetic and hygienic regulations, the infrequent occupation of women out of their homes, early marriages, and general sobriety.

SOCIETIES AND ACADEMIES

Edinburgh

Royal Society, July 2.—The Astronomer-Royal for Scotland communicated a paper, which was read by Prof. Crum Brown, on the group *b* in the solar spectrum, as observed with the remarkably fine spectroscope which Prof. Tait had recently secured for the University. The main conclusion come to was that the speculations regarding the existence of *basic* lines were unwarrantable, since the lines b^3 and b^4 were both distinctly double lines, each real single line in all probability being due to one of the substances, magnesium, iron, or nickel. The paper gave a complete historical statement of the observations of the *b* group by Swan, Ångström, Thalén, Young, and others, since the year 1830.—Prof. C. G. Knott read a paper on superposed magnetisms in iron and nickel. The experiments were, in part, a repetition of Wiedemann's well-known investigations into the twisting of iron wire under the influence of longitudinal and circular magnetisations. With a steady current along the wire, and a varying current in a helix round the wire, a twist was obtained which in almost every case reached a maximum for an intermediate value of the helical current. The maximum occurred sooner when the longitudinal current was diminished. No such maximum was obtained in the case of nickel, which twisted more and more for greater and greater currents, until the point of magnetic saturation was reached. Again the nickel twisted in the opposite direction to iron, other things being the same—a result in accordance with Barrett's observation that nickel *contracts* when magnetised, while, as Joule first proved, iron extends. The effect of weighting the wires so as to subject them to different tensions, was also investigated, the general result being that the twist was greater for the smaller weight, except for special combinations of current strengths and weights. —Prof. Tait gave further results as to the lowering of the maximum density point of water under increased pressure. By an improved method he estimated the lowering to be 2°·7 C. for one ton's weight per square inch, a result in wonderful agreement with that obtained by the indirect method carried out by Professors Marshall and Smith and Mr. Omond.—In a note on surface emissivities, Prof. Tait drew attention to the apparent lack of data on this subject, which, however, could be largely supplied from the numerous observations by Prof. Forbes and himself on the rate of cooling of the bars used in the conduction of heat experiments.—Prof. Tait also submitted to the Society a photograph of the markings on the arm of the boy who had been struck by lightning at Duns some weeks ago.

Paris

Academy of Sciences, July 9.—M. Blanchard, president, in the chair.—On the pyroelectricity in blende, chlorate of sodium, and borazite, by MM. C. Friedel and J. Curie.—On the separation of gallium from tellurium and silicium, by M. Lecoq de Boisbaudran.—Observations on M. Hirn's recently published work on "The Phenomena due to the Action of the Atmosphere on Falling Stars, Aërolites, and other Meteoric Objects," by M. Daubrée. In this work the author argues that the apparition of all kinds of meteors in space, their luminosity and explosion, and accompanying sounds depend directly and exclusively on their velocity. This general conclusion is questioned by M. Daubrée, who points out that account must also be taken of the chemical action produced at contact of meteoric substances with the atmosphere.—On the infra-red spectra emitted by metallic vapours, by M. Henry Becquerel. The metallic vapours here dealt with are those of sodium, magnesium, calcium, potassium, silver, and thallium. The method of analysis described by the author opens a new and wide field of observation, comprising between the wave-lengths 760 and 1300 an interval of wave-lengths greater than that existing between the extreme red of the visible spectrum and the last-known ultra-violet rays.—Researches on the destruction and utilisation of the bodies of animals that have died of contagious diseases, and especially carbon poison, by M. Aimé Girard. The method here proposed consists in dissolving the carcasses at a low temperature in concentrated sulphuric acid, and then utilising the liquid thus obtained in the production of a superphosphate of azotic lime.—A protest is presented to the Academy on MM. Delattre's recent paper (meeting of May 21) on the treatment of the waters used in woolwashing. MM. Gaillet and Huet claim to be the real authors of the process, and support their claim by sundry documents.—On the conditions of the subsoil under the Berlin Observatory; letter addressed to M. Faye by M. Foerster.—On a method capable of furnishing an approximate value for the integral $\int_{-\infty}^{+\infty} F(x)\,dz$, by M. G. Gourier.—Generalisation of the theorem of Jacobi on the partial determinants of the adjunct system, by M. Em. Barbier.—On the reduction of equations, by M. A. E. Pellet.—On a lever, a new system of Roman balance with automatic slider, by M. A. Picart.—General formulas of centred dioptric systems, by M. Monoyer.—A new method of determining the limits of electrolysis, by M. Ch. Truchot.—On samarium, by M. P. T. Clève.—On the blue colour obtained by the action of chromic acid on oxygenated water, by M. H. Moissan.—On tetric acid and its homologues, by M. W. Pawlow.—On the dimorphism of iodide of silver, by MM. Mallard and Le Chatelier.—On some new characteristic reactions of salts of gold, by M. Ad. Carnot.—On the alcoholates of soda, by M. de Forcrand.—On the pyrogenation of colophany, by M. Ad. Renard. —Researches on the curve of muscular shocks in various maladies of the nervo-muscular system, by M. Maurice Mendelssohn. —Development and structure of tuberculous begonias, by M. Henri Duchartre.—Contributions to the study of the fermentation of breadstuffs, by M. L. Boutroux.—The microbes of the lymph of marine fishes, by MM. L. Olivier and Ch. Richet. The presence of parasites is clearly determined, and the authors conclude that microbes are nearly always present in the lymph, and consequently in the very tissues of the marine fishes.— Method of determining the quality of the wines of the south of France, by M. A. Audoynaud.

Berlin

Physical Society, June 8.—Dr. Martius discussed the two recently-discovered instruments which are employed for the measurement of small frequently-occurring variations of a current, the telephone and the capillary electrometer. The latter, as is well known, was constructed about ten years ago by Mr. Lippmann in the laboratory of Herrn Kirchhoff, and is based on the principle that a current passing through a meniscus changes its surface tension, and causes a movement of the meniscus. The frequent variations of weak currents are indicated with difficulty, if at all, by galvanometers and tangent compasses, but the capillary electrometer can make such variations, especially as they occur in electrophysiology, visible to the eye. It has therefore quite latterly been employed in physiological experiments, and Dr. Martius has undertaken to investigate the capabilities of the apparatus in the form designed by Prof. Christiani, and described below. A glass tube drawn out at one end to a capillary, and partly filled with mercury, stands vertically in a large glass vessel also containing some mercury, and above it dilute sulphuric acid, in which the capillary point of the tube dips, so that the acid passes into the tube and up to the mercury meniscus. The position of the latter is read with a microscope. Metal wires are dipped into the mass of mercury, and a current can then be sent through the capillary tube, the current causing a motion of the mercury meniscus either upwards or downwards according to its direction, on a positive current flowing downward from the mercury in the tube moving the meniscus downwards, a negative current, upwards. In this apparatus care must be taken to keep the current too weak to cause electrolysis of the acid; otherwise the instrument becomes useless and must be refilled. The observations were first made with a constant current which was interrupted at will, and they showed that under exactly similar conditions the displacement which a positive current produced were always greater than those caused by a negative current of like strength. On making and breaking contact rapidly, for instance about twelve times a second, a total displacement of the mercury, corresponding to the direction of the current, was observed, and also oscillations of the meniscus, the number of which was equal to the number of interruptions of the current. If the number of interruptions was increased, a stronger current had always to be used in order to make the oscillations of the meniscus perfectly visible, weaker currents causing a total displacement of the mercury corresponding to the strength of the current, while the oscillations of the meniscus appeared only as a broad undefined rim. Dr. Martius then investigated the action of induced alternating currents, the behaviour of which was much more complicated inasmuch as, with equal intensity of the primary current and equal distances of the induction coils from one another, the four following different cases are to be observed: (1) The current on breaking contact passes through the mercury meniscus in a positive or anodic direction; (2) the current on making contact passes in a cathodic direction; (3) the current on breaking contact passes in a cathodic direction; (4) that on making contact passes in an anodic direction. All these four cases which group themselves in pairs in every experiment, affect the meniscus differently; for besides the difference of the anodic and cathodic current, already mentioned in the case of constant currents, the current on making contact under otherwise similar conditions was more effective than that on breaking contact, the action of the current on the instrument being, therefore, just the reverse of that on the nerves and muscles. The reason of this is that in the capillary electrometer the current on making contact produces a stronger polarisation than that on breaking contact, on account of its longer duration. The total effect which alternating induction currents produce on the capillary electrometer is the result of the individual effects of the current, and is certainly on this account very complicated, but it can be predicted acccording to the rules given above for every direction, strength, and frequency of the induction currents.—Prof. Kronecker demonstrated on a student the audibility of the muscle tone when the muscle was voluntarily contracted, by means of a pair of telephones. The telephones were connected with two needles, which the student placed in his biceps muscle, and the members of the Society convinced themselves that at every contraction of the muscle a deep soft breathing tone was heard.

Physiological Society, June 29.—Dr. Curt Lehmann explained two apparatus, which he had constructed with a view of maintaining artificial respiration in animals upon which other experiments are tried. The former method, which consists in blowing air into the lungs by means of a motor working in a certain rhythm, has the disadvantage that, in order to keep up the efficiency of the ventilation, the pressure must soon be increased, producing emphysema of the lungs, to which the animals succumb. Dr. Lehmann has obviated this by blowing air into some receptacle by means of the motor in question, and by letting it there be condensed to a certain moderate density (say 8 to 10 cm. of water). A second receptacle contains air in a corresponding degree of rarefaction. An indiarubber tube is tied into the trachea of the animal; this tube is forked at the other end, one branch communicating with the condensed the other with the rarefied air. An electric clock, which marks whatever intervals of time are required, is connected by means of a double lever with this tube, and alternately closes the one or the other of the branches. Thus air is either driven into the lung under a gentle pressure or is sucked out of it under the same pressure. In spite of the low pressure, the ventilation is perfect on account of the alternate driving in and sucking out of air; the lung of the animal is in no wise affected, and artificial respiration can thus be kept up without danger for eight hours. The second apparatus, which on the whole, after the same principle, connects the lung alternately with condensed and rarefied air, is constructed in a more complicated manner, as it contains bells for the collection of the respiration products, for the event that these may have to be examined. Both apparatus work automatically; the influence of the respiratory motion upon the blood pressure could be shown when they were used, just as easily as with animals respiring normally. The special experiments in which Dr. Lehmann used these apparatus referred to the influence of temperature upon the bacilli of Septicæmia. Developed in blood outside the body, the number of bacilli increased the more, under equal conditions otherwise, the higher the temperature, up to 43° C. With animals the experiments were made in such a way that in each series of experiments four rabbits were vaccinated with septicæmic bacilli. Of these No. 1 was kept at 42° C., No. 2 at ordinary room temperature, No. 3 strongly cooled by means of water (temperature 35° C. in the interior), and No. 4 poisoned with curare and cooled. No. 1 died first, although about two hours before its death but few bacilli were contained in the blood; soon afterwards No. 3 died, its blood containing many bacilli; a few hours later No. 2 succumbed, having attained the fever temperature of 42° C. much later than No. 1; the number of bacilli in its blood was moderate. No. 4 lived longest, although the number of bacilli in its blood was greatest.—A communication was then read concerning the important observations made by Prof. Pflüger (Bonn) regarding the division of frog's ova by a groove-formation after fertilisation. It is known that fertilised frog's ova turn over in such a way that their black hemisphere is turned upwards and the white one downwards, and that the axis passing through the centre symmetrically to both hemispheres is perpendicular. The normal grooving now begins with a division in a median plane passing through the axis; the second division is at right angles to the first, also passing through the axis; the third one takes place at right angles to the axis, somewhat nearer to the upper end. Prof. Pflüger prevented some fertilised frog ova from turning over by fastening them to glass, so that in the single ova the hemisphere axes pointed in the most varied directions; yet he found that the first division in *all* of them was always perpendicular, without any reference to the position of the axis; the second and third divisions of the ovum remaining in the same relative position with regard to the first anomalous division as if the ova had been in a normal position. The first traces of the groove of the back also invariably showed themselves on the upper side of the first division plane, thus frequently in the white hemisphere. But later on all the ova which were fastened at the bottom perished.

CONTENTS

ERRATUM.—On p. 264, col. 1, line 9, for *rabies* read *tabes*.