THURSDAY, OCTOBER 5, 1882

FLUIDS

Experimental Researches into the Properties and Motions of Fluids with Theoretical Deductions therefrom. By W. F. Stanley. (London: E. and F. N. Spon, 1882.)

THE aim and general scope of this work is well described in its modest and explicit preface. It is essentially a tentative and qualitative treatise, the author expressing a wish in his preface that some highly educated mathematician who may care to follow him, will clothe with his skill the rude, but as he believes, natural underlying forms he has brought in some cases to light. Modesty such as this, undoubtedly tends to disarm criticism, but after a careful perusal of the work, we cannot help cherishing a sincere regret that the author does not himself happen to be the much desired mathematician. We feel certain that if this had been the case, many mistakes would have been avoided, much speculation curtailed, and the value of the work considerably enhanced. Thus while the author admits that "the eighth chapter is very incomplete on certain points for want of sufficient research into the works of others and more experiment," we find the work characterised throughout by a lack of the same knowledge of what is already known, or has been done by others.

Too often also the deductions appear to have been preconceived, and the experiments from which they are supposed to follow are either too rough, or of too special a nature.

As the author speaks disparagingly of his own educational acquirements, it would be unfair perhaps to criticise too harshly a literary style, which certainly detracts very much from the pleasure or comfort of studying his work. He might, however, have tried to be a little more clear, and somewhat less pedantic in the construction of his sentences. Almost every idea has to be disinterred from a heap of polysyllabic adjectives and adverbs, which most effectually obscure its meaning, while very often we meet with paragraphs of, at any rate at first sight, a most incomprehensible character. Such as the following:—"Such *equilibrium* acts as a *condensation* upon the surface of a liquid, thereby increasing the molecular surface density," or "the *area* of efflux of the liquid will be the mean of the directive *impulses* of vertical and horizontal pressures." Elsewhere he speaks of "a narrow *vacuous* plane" and "*motive* quiescence."

On the other hand there is much that is novel and worth perusal in the book, more especially in Chapters IV., V., VI., and VII., and in Section III. on waves.

One very prominent fault which we notice all through the work, is the almost entire absence of any distinction between the physical properties of compressible and incompressible fluids. The words fluid and liquid are used quite indifferently, and whatever principles the author deduces for water, are immediately and without trial assumed to be true for air and gases, and *vice versâ*. Again, the experiments which are mostly of a very simple and rudimentary character, are not sufficiently differential. Thus in experiments on liquids, water alone is employed, and in like manner air is the sole representative of the gaseous state, though in a work dealing with fluids generally, one might have expected to hear *something* at least of the properties of *all* the more easily procurable gases and liquids.

The first three chapters deal with the theory of the constitution and motive properties of fluids, and are, as the author admits in his preface, "speculative and even in parts hypothetical." In opposition to Clerk Maxwell and others, he holds that "Fluids are composed of *static* atoms, infinitely tough and elastic, their fluidity depending on the presence of gases or liquid vapours held by attractive forces upon the molecular surface and intruded intermolecularly, the surrounding envelope of gas acting as a lubricant to the motions of the molecule composing the liquid proper."

This system of gaseous atmospheres surrounding the molecules is supposed to extend to all matter, and expansions by heat forces to vary as the powers of evaporation of the separate molecules. From this point of view the author attacks the theory which has been considered to satisfactorily explain the phenomena observed by Mr. Crookes in high vacua. He maintains that such phenomena are not due to the projection of the molecules of the residual gas, but to convection currents of gas formed of metallic matter composing the negative pole. He does not, however, attempt to give any adequate explanation of several of the accompanying appearances observed, such as molecular shadows, and phosphorescence, the circumstances attending which, so strongly favour the theory of the rectilinear propagation of the free molecules of residual gas, which depends, as Mr. Tolver Preston has lately suggested, on "the relative dimensions of the containing vessel to the mean path of the molecules," and are so completely inexplicable by the physical properties of any ordinary convection current.

In his preface, the author says he ventures to differ from the generally accepted theory of tensile surfaces for liquids, and prefers to consider them extensile. In Chap. II. he thus defines these words:—

> "By tensile I intend a disposition of the parts of a system of matter to draw themselves together as a stretched drumskin does. By extensile I intend the reverse of this, or the disposition of the parts of a system of matter to separate, and thereby to engender external pressures."

He then proceeds to show how, according to his theory of the constitution of liquids, the surface (except in the case of free films) has a tendency to extend by virtue of surface condensation arising from the cohesive force between the superficial molecules.

We fail, however, to see how this assumed surface condensation gives rise to extensibility, since no force other than a strictly lateral one can act at the surface of a liquid without being equally felt all through it, while it would obviously be arguing in a circle to say that *lateral* attraction of superficial molecules produced *lateral* extension of the surface.

Moreover the author assumes that a tensile surface is one which is so stretched already, that it would give way under any additional pressure, while extensile is used to mean not so much disposition to extend, as capability of stretching.

Thus the familiar experiment of the needle floating on water, would the author thinks, be impossible were the surface tensile. Doubtless, according to the author's definition of tensile, it would be so, but we think it would be equally impossible unless the surface were endowed with a tolerably high tension, such as water is known to possess.

We find it impossible also to accept the author's explanation of the various capillary phenomena on the same hypothesis. To take the case of capillary elevation and depression alone. If the surface force on a liquid is extensile, it can be easily shown by reversing the reasoning given in the ordinary physical text-books, that in the case of capillary elevation, the free surface would be convex, and in the case of capillary depression, concave, conditions, precisely the opposite of those which actually take place. The same hypothesis is equally unsuccessful when applied to the resolution of jets into drops. Mr. Stanley considers drops to be formed when the mass cohesion of a jet is equal to the extensibility of its surface, and in order to show that this is the principal cause, he falls into the serious error of imagining that a jet of liquid (water is the only one mentioned) issuing from a small orifice, *continually* expands in sectional area beyond the vena contracta, whether the stream be directed *upwards* or *downwards*, the final resolution into drops being due to such expansion caused by extensibility. We know, however, that this cannot be the case, since although the jet expands slightly beyond the vena contracta, in accordance with the equation of continuity it again *contracts* if flowing downwards, and the reverse if flowing upwards, and since in either case, whether in waterfalls or fountains, the jet ultimately becomes converted into spray, the author's explanation is obviously erroneous. It is to be regretted for many reasons that in dealing with this interesting though difficult subject of surface tension and capillarity of liquids Mr. Stanley makes no mention of the researches of Van der Mensbrugghe, Tomlinson, Duclaux, or of the very remarkable results obtained not long ago by Cintolesi, and that while the names of Young and Laplace are mentioned once, not the smallest account is given of their researches

Chapter III. chiefly relates to the conditions of the efflux of liquids through orifices. A great deal of it is almost unintelligible from the obscurity of the language employed, and the loose way in which the expressions, energy, weight, velocity, force, and volume are employed as though they were identical.

As far as it is possible to glean anything definite from such a chaos, it would seem that the author thinks the known contraction which takes place in the area of efflux of a liquid through a vent, is due to horizontal elastic compressions caused by the reaction of the vessel against the pressure of the liquid it contains. No reference is made to the Torricellian equation, which according to the author's notation should take the form $v^2 = 4gh$; instead of $2gh$ as ordinarily; or to the theoretical results got with different forms of orifices on the parallel section hypothesis. We do not think the author has got on the right tack here. The horizontal velocities which must necessarily arise, either from the natural or artificial narrowing of the descending column, and which are disregarded by the parallel section hypothesis, may be readily conceived to act so as to contract the area of vertically descending liquid, and not elastic compressions, which have little place in the dynamics of a practically incompressible liquid.

In Chapter IV. the author tries to show that the general relative motion of fluids on solid surfaces or in other fluids is effected by means of rolling contact. The hypothetical case of a plane supported on equal rollers, and moving on a parallel plane is taken, and the analogy to this pointed out in different cases, such as where a river moving relatively to its bank causes small lateral eddies, or where larger rotatory movements are produced in the bays or widenings through which it flows. Several instances apparently exhibiting this kind of motion are noticed, but we cannot agree with the author that such examples conclusively prove his theory, and that no sliding takes place. The internal molecular friction or viscosity of most liquids, must necessarily cause rolling contact, if it occurs at all, to take place in a very imperfect manner, and at the same time admit of sliding with a certain amount of friction.

In Chapter V., which treats of the resistance of fluids to the projection of fluids or solids within them, Mr. Stanley develops some novel nomenclature, and a principle of considerable importance which may be briefly enunciated as follows :—When a mass of matter strikes a fluid such as water, it fractures a conical part immediately in front of it, called the cone of impression, from the surrounding mass called the conoid of persistion, and intrudes itself into the fracture, which is called the plane or cone of infraction. This principle, which is frequently appealed to in subsequent portions of the work as one of fundamental importance, and on which a host of minor propositions depend, is derived from an analogous principle of conic fracture in the case of solids, and is supported in the case of liquids and gases by various experiments, such as the shape assumed by a leaden bullet shot vertically into water, the ring formed by a drop of coloured dropped into uncoloured water, and the phenomena of smoke-rings as shown by Prof. Tait. The experiments are clear, and the idea is skilfully and consistently worked out as far as it goes.

Whether all the properties of vortex-rings will be found to accord with this principle, is a question which may be safely left to those who make such matters their special study, but at all events the explanation given of the smoke rings, and the experiments showing the absence of a motive axis, are decidedly ingenious.

From the foregoing principles the author proceeds to deduce in Chapter VI. the conditions for the *continuous* motion or projection of fluids within fluids, in which rolling contact again comes into play, through the final rotation of the conoid of persistion, and the formation of whirl and biwhirl systems. Several interesting experimental examples of such systems are described and figured, and some of the laws which apparently regulate such systems are proposed, though the proofs appear to rest solely upon a somewhat limited ocular experience.

Towards the end of this chapter is introduced the well-known paradoxical fact first noticed by Clement Désormes and Hachette in 1826, that a blast of air or stream of water flowing in their respective fluids, apparently attract towards themselves flat bodies placed directly in their paths, and an endeavour is made to account for it in a not very obvious manner, by means of certain backward forces arising from induced whirl-systems. Whether some small portion of the phenomenon may not be due to an induced reflex action, is a point worthy of investigation, but the major portion is generally admitted to be due to a principle with which, the author, since he entirely omits all reference to it, is apparently unfamiliar, viz. that the pressure both of compressible and incompressible fluids is diminished by an increase of velocity. A conclusion drawn by the author from an experiment on p. 276 is similarly invalidated by the omission of the same principle.

The way in which fluid moves in pipes or channels is described in Chapter VII., and is concluded to be by rolling contact on a continuous system of lateral whirl-rings, "these being alternately collected by reflex action, that converts these whirls into loops, which permit the deflected fluid to re-enter (in a hypercycloidal curve) the central system by traction."

The same principle of rolling contact and the development of whirl-systems is, in Chapter VIII., applied to the motions of solids through fluids, more particularly of ships, through water. The eddies, for example, which we ordinarily observe at the rear of boats are regarded by Mr. Stanley, not as resulting from the meeting of two relatively opposed currents, but as friction rollers engendered by the passage of the body through the liquid. The general effects of rudders on the motion of ships, and the peculiar cases noticed by Prof. Osborne Reynolds and others, are ascribed to the position and influence of such whirls, and not to the mere deflection of stream lines. Although a good deal of what the author says on this point is, as he admits himself in the preface, very speculative, and though the theoretical action from which it all proceeds is not very plain, there is much that is suggestive and worthy of study.

Section II. is devoted to a consideration of Oceanic and Aërial Systems of Circulation, which are assumed to be gigantic whirl systems arising from the projection of water within quiescent water, or against solid areas of resistance such as capes and promontories. A good deal of the matter usually found in treatises on physical geography is here reproduced, as to the general forces in action to disturb equilibrium, but in the case of general oceanic circulation, too much importance is, we think, attached to the thermal causes of circulation discussed by Lenz and Dr. Carpenter, and too little notice taken of the effect of prevailing winds in causing at least superficial ocean currents. Nothing very fresh is adduced in explanation of the causes of the currents as they are at present known. The main currents, such as the Atlantic equatorial, are assumed to exist, and all the author does, is to try and arrange them as large circles or whirls to suit his whirl theory, and which please the eye just in proportion as they diverge from the truth and irregularity of nature.

We do not doubt that the currents occasionally take the form of whirls such as those exhibited by the author, since their deflection by continents and the continuity of the circulation, requires the water to flow more or less in closed curves, but we cannot agree with the author's view that the Southern Polar drift current is simply a huge whirl, set spinning round by the tangential forces exerted by the whirl systems of the South Atlantic and South Pacific. We prefer the simpler and more rational view that it is a result of the constant and similarly directed wind system of that region. Another view indulged in by Mr. Stanley on p. 377 that the southward pointing of the continents is due to action of ocean currents acting through countless ages, is not more probable than the astronomical hypothesis that this is due to a northward motion of the earth in space. Besides, the abyssal character of marine basins shown by Sir Wyville Thomson, forms a positive objection to any such notion.

The author's views of atmospheric circulation are not happy. For example, in his chart of the general system of air motion, which he tries to reduce to two large "ellipsoidal whirls" having their southern foci in June, near the east of the United States and China respectively, and which correspond roughly to the general motions traceable over the sea areas, we find the motion of the air over the western part of North America and the Indian peninsula distinctly contrary to what is known to occur at this season from observation.

It would indeed be a tedious task to point out all the questionable hypotheses or erroneous conclusions with which this part of the work teems. One or two, however, we cannot overlook. For example, the absurd idea that the prevailing south-west winds over the flat plains of Northern Europe, are an indraught to feed the cold and therefore contractile area of Central Europe and Asia. The author travels in vain all round Asia, in search of a current to satisfy the cravings of this contractile area; and this is the only one which has an approach to the necessary direction. We need hardly say that we are totally unable to credit our south-west winds with the ability to perform such a feat. Areas of cold air, are areas of contraction in a *vertical*, not *horizontal*, direction, and are fed by *upper*, not *lower* currents.

In another place we are told that directly under the sun in the tropical region there should be no cloud, owing to the vapour remaining *uncondensed under vertical solar rays*. At about 30° N. and S., however, there should be bands of cloud and constant precipitation. Now, as a matter of fact we know that the actual conditions are precisely the reverse of these. Thus in the tropics, whenever the sun becomes vertical over any region, he is invariably accompanied sooner or later by a band of cloud and consequent rainfall, while the areas 30° N. and S. are notably those of small precipitation and almost constant sunshine.

Again, we cannot agree with the statement on p. 444 that "all cloud systems by their superior weight will be descending," or that "condensation of vapour causes a descending area." The very continuity of the existence of a cloud is dependent on its forming part of an *ascending* area, since by well-known physical principles, if such an area once began to descend, the cloud would, *cæteris paribus*, almost immediately be re-absorbed and become invisible.

Another conclusion of the author's is in striking opposition to the doctrine ordinarily held by meteorologists; viz. that the cyclonic area is one of ascent, and the anti-cyclonic one of descent. Mr. Stanley says: "Upon the principle of whirl motions they would be the reverse of this," but we entirely fail to see how or why.

Altogether we are not favourably impressed with this part of the work, and do not deem it likely to accomplish the author's forecast in his preface, viz. "aid in the elevation of the sciences of physical geography and meteorology, now sciences of *observation*, to sciences of *principle*."

The last part of the work, treating of aqueous surface-waves, which we have not space to notice in detail, is a considerable improvement on the foregoing chapters. We are surprised, however, to see that while some notice is taken of the researches of M. Flaugergues and Mr. J. Scott Russell, no reference is made to those of the late Mr. Froude.

In conclusion, the type and illustrations are decidedly good, and though we cannot describe it otherwise than as a preliminary investigation into certain portions of the dynamics of certain fluids, accompanied by a good deal of speculation and deduction which still requires verification, and which is sometimes palpably erroneous, it nevertheless represents a very laudable, and to some extent successful endeavour on the part of the author to fill up a gap that admittedly exists in this abstruse branch of science. E. D. A.

HANDBOOK OF INVERTEBRATE ZOOLOGY

Handbook of Invertebrate Zoology for Laboratories and Sea-side Work. By W. K. Brooks, Ph.D. (Boston, 1882.)

THE series of notes and directions issued under this title by Mr. Brooks, of the Johns Hopkins University, Baltimore, is an interesting evidence of the progress which the practical study of zoology is making in American universities, and more especially of the valuable services which the Baltimore University is rendering to education in science. The book consists of brief notes describing the appearances of a series of invertebrate animals before and during successive stages of dissection or development, as the case may be. Diagrammatic sketches (for the most part original, or copied with a few original touches from English authors) are introduced into the text. The animals chosen by Mr. Brooks are the following:—Amœba, Paramecium, Vorticella, Sycandra (Calcispongiæ), Eucope (Leptomedusæ), Mnemopsis (Anthomedusæ), Asteracanthion, Arbacia (Echinid), Lumbricus, Macrobdella (Hirudinean), Callinectes (Brachyurous Decapod Crustacean), Cyclops, Acridium (Orthoptera), Anodonta, Loligo.

Concerning each of these forms the reader will find original remarks and often detailed observations illustrated by sketches. At the same time the writer does not pretend to offer us a series of monographs, but merely such notes as will be eminently serviceable to students in the laboratory. It is no doubt to American students and especially to Mr. Brooks's own pupils that this work will be useful. Such descriptions as that of the development of Arbacia, and those relating to the Medusæ, have their value immensely increased when it is possible to place in the hands of the student the identical material—or perhaps we should say the counterpart of that material—which has served for the preparation of the descriptions which re to guide the student's observation.

Though class-students in this country will not gain much assistance from Mr. Brooks's notes, professed zoologists will be interested in his treatment of the subject, and may glance with advantage at the more detailed sections, such as that on the Lamellibranch gill, on the anatomy of the Squid, and on the Medusæ.

If we ventured on a criticism, it would be to suggest a doubt as to whether the types selected and the relative importance given to their treatment are altogether such as would commend themselves to a teacher who aimed at introducing students to a wide view of animal morphology. Naturally enough, Mr. Brooks has given notes and drawings relating to several animals which he has been able to study attentively. It is, however, hardly wise on his part to repeat in a student's handbook the account of the development of the oyster which he has already published elsewhere. This account, which was inconsistent with the previous results of other investigators of molluscan embryology (my own included) has been recently shown by Horst to be based upon error. So, too, it would be well if in a new edition of his notes Mr. Brooks were to take into account the later results which have been obtained as to the anatomy of the earth-worm and of leeches, and would revise both his drawings and statements in various sections of the book, where they touch upon distinctly histological matters.

The day is not far distant when we shall see inscribed over the door of every zoological laboratory, "Let no one enter here unversed in histology." Geometry was not less indispensable for the intelligent student of Greek science than histology is rapidly becoming for the modern zoological student. The question is how to find time (except in countries where time is *not* money) to make the student first a histologist, and then a zoologist.

E. RAY LANKESTER

OUR BOOK SHELF

Cameos from the Silver-land; or, The Experiences of a Young Naturalist in the Argentine Republic. By E. W. White. 2 vols. Vol. II. (London: J. Van Voorst, 1882.)

THIS second volume has been slow to make its appearance, having been printed at Buenos Ayres. It gives an account of the author's voyage up the Uruguay, his trip to Rioja, Catamarca, and Tucuman, a journey to Salta, and a voyage down the Paraná. There is a good deal of interesting information in this volume, though it contains very much less natural history than we expected. The wonderful resources of the Republic are well brought befoie us, resources only too feebly made use of; for it is a land of promise teeming with treasures, with a splendid river porterage, and needing only labour and capital to become very great. To a reader wishing to know the actual state of things at present existing in this country we can recommend these two volumes of Mr. White's as most instructive reading.

LETTERS TO THE EDITOR

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

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

The Recent Aurora

LAST night, between 8 and 9 p.m., there was visible here a very fine display of Northern lights, the finest indeed that I have yet witnessed. The sky was nearly unclouded, and the moon had not yet risen; a band of light forming an arc extended from west to east, under the Polar Star. It just touched, by its upper boundary, the stars γ and β of the Great Bear, and nearly touched by its lower fringe the star Cor Caroli; this gives some idea of its breadth. Beams of light extended from the upper fringe towards the North Star, with greater or less intensity, fading away, however, very rapidly. Towards 9.30 p.m. the eastern end of the arc became very luminous; immense beams spread up into the heavens, mostly parallel to the direction of the pointers. On the extreme east, a portion of the aurora presented that beautiful violet tint which is so relatively rare in these latitudes. Some of the beams towards the centre of the arc also presented this colour, but only momentarily.

The arc, varying in intensity from moment to moment, rose towards the North Star, and became diffused, and towards 9 o'clock, the moon then appearing, nearly entirely disappeared; faint beams still, however, showing themselves from time to time. The summit of the arc was as nearly as possible under the North Star. J. P. O'REILLY

Royal College of Science for Ireland, Dublin, October 3

A BRIGHT aurora was seen here last evening (October 2). When first observed, at 7.0 p.m., the arc in the north-west was very distinct; at the same time two cloud-like patches of light were seen in the north-east at an elevation of about 30°. At 7.10 the display reached its greatest brilliancy, narrow streamers extending upwards from the arc, as frequent intervals; several pale flashes of light taking place over the arc. At this time the light patches had been replaced by others, and several new ones had appeared rapidly, the whole series forming a large arc springing from the east-north-east point, and extending towards the west-south-west, at 7.20 nearly forming a complete arch. By 7.30 the sky had become much overcast; still the strong glow continued in the north-west, while a lighting up of the clouds indicated the continued occurrence of the light patches. At 9.30 the sky was clear again, and every trace of aurora had vanished. The light of the aurora was quite colourless.

Kenley, Surrey, October 3 SYDNEY EVERSHED

LAST night, the 2nd inst., I here witnessed a very fine specimen of the *Aurora Borealis*. It was in the form of radiating lines or ribs, having spaces between, equal to the width of the ribs, namely, equal light and equal shadow; the whole springing from a centre about 15° from the zenith in a south-westerly direction. When I first perceived the light, at 6.45 p.m., it was faint and of the colour of moonlight, and was not distinctly traceable all over, but by filling up the void, in the mind's eye, the whole gave the appearance of an immense dome. Fifteen minutes later it had all disappeared, but at 7.15 it began to flash out in different places like slow lightning, principally at the zenith, much brighter than before, but still of the same colour, and around the centre the light took the shape of a sort of eccentric vortex ring. W. J. LINEHAM

University Club, Newcastle-on-Tyne, October 3

ABOUT a quarter to seven this evening I became aware that an aurora was in the sky. A clear, persistent light showed itself near the northern horizon, whilst in the eastern sky fluctuating luminous regions formed an arc between 7h. and 7h. 15m. I noticed the position of that arc with respect to the constellations Aries and Pegasus. It began under α and β Arietis, at about, say, 5° north of the equator, and stretched parallel to a line through γ and α Pegasi, also at about 5° north of the equator. At times the arc extended further towards the south-western horizon. At about 7h. 30m. a remnant of the arc shot a ray diagonally to the square formed by the four stars of Pegasus, *i.e.* from γ to β Pegasi. The colour of the aurora was pale white in the northern light; in the arc it was white, approaching slightly to a green approximate to that of the magnesium light.

GUSTAVE PLARR

22, Hadlow Road, Tunbridge (Kent), October 2

A RATHER uncommon display of aurora was seen here last evening, from about 7.15 to 7.40 p.m. Large patches of light, brilliantly white, were seen in the south and south-east, at a rough guess, extending from 10° to 15° in length and breadth, sometimes shifting quickly from place to place, at others remaining stationary for a minute or two, but not attaining a greater average altitude than 30° or 40° from the horizon. They were slightly convex at the base, giving the appearance of a bank of clouds below. On looking to the north, a long, low arch of light was visible, with one or two long streamers, which rapidly disappeared, but the brilliancy was nothing compared with the patches before mentioned.

In connection with this display, perhaps it may be as well to mention that not only is there an enormous sun-spot passing over the sun's disc, but five other groups, one of which was nearly central yesterday, and showed signs of great disturbance in the course of a few hours. ELIZTH. BROWN

Further Barton, Cirencester, October 3

An Insect Attacking a Worm

ON September 19, 1882, I was waiting for a train at Laqueville, in the Puy-de-Dome district of France, when I noticed a very large worm in the meadow, moving very rapidly from side to side. I touched it with my umbrella, expecting to see it retire into its hole, but, taking no notice of my touch, it continued its forward movement, and drew itself out of its hole with a jerk. I then saw that attached to the end of its tail was a caterpillar-like insect—no doubt the larva of some beetle—about 1¼ inch long, the back covered with a series of shining black bands, and the belly, which was furnished with a few short feet at the head and tail, was of dull greenish yellow. This insect, without relaxing its hold of the worm, which was moving along more rapidly than I ever saw a worm move before, gradually shifted its bite along the belly of the worm till it had bitten about two inches, or rather less than one-third the whole length of the worm, which was more than six inches long. This it accomplished in about ten minutes, the bitten portion turning livid and swelling considerably, the worm's power of motion gradually ceasing. The insect then relaxed its hold, and crawled back along the back of the worm, and, seizing its tail, attempted to drag it backward, but finding the worm had still the power of slightly moving forward, it rapidly bit the belly of the worm where it had previously bitten it, and by this time the worm's power of forward motion had entirely ceased. The insect then appeared to survey the ground for some two feet behind the worm, and again seizing the tail, and fastening its own tail to a stalk of clover, it pulled strongly, not directly, but bending the worm sideways round a stalk of grass; gradually, very gradually, the swelled tail of the worm lengthened, and then I saw the whole body come back as it were a ring at a time, with a sort of resilient motion. The insect thus gained about one quarter of an inch, and in an hour and a half had drawn the worm in a sinuous line about 9 or 10 inches. I was unable to observe longer, but I have no doubt the insect would eventually drag the worm back into the latter's own hole, where it had first attacked it.

No doubt such an incident is extremely common in France, where there are few birds, but I fancy the numerous birds in England may have nearly extirpated such an enemy of worms, which would form with the dead worm a somewhat conspicuous object for two or three hours. EDWIN LAWRENCE

White Ants

HAVING observed in NATURE (vol. xxvi. p. 343) some remarks regarding White-ants' nests, it has occurred to me to put on record the following fact, which came under my observation.

A lady residing in Madras had a set of plain table glass ware in a cupboard, which had not been opened for some time. On looking into it one day, she found the glass more or less covered with the mud indicative of the presence of white-ants. The glass articles were at once removed and washed, but wherever the mud had been applied by the insects, it was found that the glass had a frosted appearance, which no amount of scrubbing would remove. Some of the articles were then sent to me for inspection, and I found that the lustrous surface of the glass had been completely destroyed, as if by some powerful corrosive, wherever the ant-mud had been in contact with it.

We know well enough the substances used for etching on glass, but I shall feel obliged if any of your correspondents will explain how these insects managed to act on it in the destructive manner specified. G. BIDIE

Museum, Madras, September 3

BRITISH SPONGES[1]

NEARLY twenty years have elapsed since the publication of the first volume of Dr. Bowerbank's "Monograph of the British Sponges" by the Ray Society, and the posthumous fourth volume, just published, has been edited, with additions, by the Rev. A. M. Norman. That these four volumes contain an immense mass of facts and observations about our native sponges; that they in addition possess a really splendid series of illustrations, few will care to deny, and yet it must be difficult for a student of the more modern school of biological science to fairly appreciate them. The descriptive and physiological portions of the first volume, despite the quarter of a century spent by the author thereof in the preparation of his work, are apt to excite one's surprise, while the profound ignoring by Dr. Bowerbank of the work of co-temporary authors, leaves the description of the species in the second and third volumes often quite delusive.

Those naturalists who can look back for some thirty years or more will not find it difficult to account for all this. Leaving out of the question for the moment how little was then known about sponges, how clumsy and unscientific were the attempts to examine them, it is more important still to recollect how few were the opportunities in these islands of scientific biological training. Which of our universities gave any training in modern biological research? and the anxious inquirer as to the beginnings of life, as to the structure of its lower forms, as to the proper method of such research, could find no voice crying in the many colleges of our country.

Things have changed greatly since then, and the man who at the period referred to might have been treated as a master would now probably not be tolerated at all. The late Dr. Bowerbank, though as a youth fond of astronomy, chemistry, botany, and geology, received no scientific education. A partner in an extensive business concern, he amused his leisure hours with the pursuit of science as an amateur; of an active and pleasant turn of mind, we owe to him in great measure the origin of our Palæontographical Society, of the Microscopical Society, and also of the Ray Society.

In 1841 a storm occurring while he was at Brighton threw a mass of sponges on the beach, and for the next thirty-five years Dr. Bowerbank made the group of sponges his favourite study. "He was a pioneer," writes his friend, the editor of this volume, "who struck out a new line. As he had begun alone, so he went on alone in his own way, not so much disregarding as seldom or rarely noticing the views of others." It is for this reason that hardly any synonyms will be found in the previous volumes of this work; indeed Dr. Bowerbank was in the habit of not even referring back to his own predescribed species.

However differently the first three volumes of Bowerbank's British Sponges may be regarded, all will agree that this fourth volume is one not only indispensable for the correct understanding of its predecessors, but that the editor's own special additions have made it a work that must be in the hands of every student of this group.

Of the special editorial work we would notice the complete list of species described in all the volumes, with references so complete that it forms as it were a key to the whole. The supplying of recent synonyms, though a most laborious undertaking has been accomplished in a manner to call for the warmest praise. The giving a table of geographical distribution, in which the columns "Abyssal" and "100–500 fathoms" have been partially filled in from Mr. Carter's Report of the Sponges dredged in the *Porcupine* Expedition of 1869 and 1870. This table makes it clear that the Sponge Fauna of many parts of our seas remain almost wholly unexplored, and it is to be much hoped that the very deficiencies exhibited here will have a tendency, among other causes, to induce our younger naturalists to take up so fine a field of research. Mr. Norman, who has a more extended knowledge of the zoology of our coasts than any living naturalist, unhesitatingly asserts "that no other class of animals offers to the student so rich a field for exploration, or one in which he is so likely to meet with so many new and strange forms."

Another important addition to this volume is the catalogue of all works and papers published on the sponges. To the specialist this forms a deeply interesting appendix, and while some few memoirs have escaped the patient research of the author, the pains he had to take to find this out only increases our admiration of the fulness of the list.

Through all the four volumes such frequent mention is made of Mr. Norman's name that it may be not without interest to state that while he gave Dr. Bowerbank all the aid in his power during the progress of the work, placing his collection unreservedly in Dr. Bowerbank's hands, yet that he found himself frequently obliged to dissent from the conclusions of the author. It was hard indeed to convince Dr. Bowerbank against his will, as the writer knows, from a vain attempt carried on through the whole of a winter's evening, to persuade him to see a Cœlenterate structure in what Dr. Bowerbank regarded as the "oscula" of Hyalonema.

It will be useful to specialists in the group of sponges to know that Dr. Bowerbank's collection is now preserved in the British Museum. A brief notice of Dr. Bowerbank is appended to this volume. In calling attention to it the editor writes: "Few naturalists of the present generation will be aware, until they have read it, how much the progress of natural history in Great Britain in years gone by was fostered and furthered by the energy, zeal, and enthusiasm of our late kind friend," and perhaps on reading it some may be inclined to follow in his footsteps only working out the history of our British Sponges on modern methods and with our new lights.

[1] "A Monograph of the British Spongidæ," by the late J. S. Bowerbank, LL.D., F.R.S., &c. Edited, with additions, by the Rev. A. M. Norman, M.A., F.L.S. Vol. iv. Supplementary. (London: For the Ray Society, 1882.)

EXPLORATION IN SIAM

A CORRESPONDENT sends us the following:—

Mr. Carl Bock has just returned to England, after a long and difficult journey from Bangkok to the northern frontiers of Siam and Laos. Leaving Bangkok on November 9 last, in a steamer placed at his disposal by the King of Siam, Mr. Bock ascended the Menam as far as Raheng, whence he proceeded overland to Lak'on, which was reached on December 27. Here he was delayed for twelve days by a dispute with the local chiefs, who imposed on him a fine of fifteen rupees for an alleged assault on a Phya or notable; but on January 7 he succeeded in getting away, and reached Chengmai on the 11th. Here he remained, making geological observations till February 2. He found the country fertile, and well cultivated in parts, but the people, as a rule, lazy and superstitious. Leaving here with a caravan of 6 elephants and 20 coolies, he pushed through a hilly, rugged country, to a new settlement at Muang Fang, the site of an ancient city, at one time the capital of Western Laos. Here the few inhabitants were busy clearing the forest and jungle, and Mr. Bock had excellent opportunities of adding to his collection of the fauna of the country. Tigers were abundant and bold, and their raids on the newly-introduced cattle were attributed to the presence of the traveller. Near here he visited the famous cave of Tam-tap-tau, the entrance to which is some 70 or 80 feet up the side of a limestone hill of about 300 feet high, and which is most difficult of access. In the middle of the cavern is a gigantic figure of Buddha, in a reclining posture, thickly gilded, and surrounded with a curious assortment of water jars, cloths, and idols of bronze, wood, and stone, brought there by devotees. Behind this, again, is another figure of Buddha, erect, and in the act of giving a blessing. From Muang Fang Mr. Bock went to Tatong, a small Ngiou village on the River Mekok, which is here only 150 feet across. This stream he followed down to its point of junction with the Mekong, which is twice as wide here as the Menam at Bangkok. Ascending the Mekong, Mr. Bock went to Chen Tsen and Chengmai', where again he had difficulties with the natives, who destroyed nearly all his collection of animals, &c. Hence he returned down the valley of the Mekong, and ultimately reached Bangkok on June 14.

THE COMET

MERIDIAN observations of the comet which was first detected in this country by Mr. Ainslie Common, at Ealing, at 10.45 a.m. on September 17, were made at the Observatory of Coimbra on the 18th, 19th, and 20th, and the following first approximation to the orbit has been deduced from them by Dr. Hind :—

Perihelion passage September 17·1047, M.T. at Greenwich.

	° ′
Longitude of perihelion	271 39·5
,, ascending node	347 44·6
Inclination	37 9·6
Logarithm of perihelion distance	8·09201

Motion—retrograde.

These elements bear a striking resemblance to those of the great comet of 1843 and 1880, and it hardly admits of a doubt that we have here a return of that body, which will have experienced an amount of diminution of velocity at the perihelion passage on January 27, 1880, sufficient to cause the last revolution to occupy only two years and eight months, and which if experienced to the same extent on the 17th of last month, may bring the comet round again in October 1883.

The comet was perceived in the forenoon of September 18, at many places in the South of France, Spain, Portugal, Italy, &c. From Nice we read :—"Toute la ville a admiré aujourd'hui (September 18), pendant cinq heures, un astre nébuleux brillant vers 3° à l'ouest du soleil." It was seen a day earlier at Reus. M. Jaime Pedro y Ferrier reports : "Le dimanche, 17, à 10h. du matin, les habitans s'arrêtaient avec étonnement sur les places pour admirer la comète visible près du soleil vers 1°·5 à l'ouest. Elle était si brillante qu'on l'apercevait à travers de légers nuages. En l'examinant à l'aide d'une jumelle munie d'un verre noir, on distinguait la queue qui s'allongeait en s'élargissant." The comet was observed at 11 a.m. on September 22, by Prof. Riccò, with the refractor of the Observatory at Palermo : its approximate position at noon was in R.A. 11h. 5m. 39s., and Decl. −1° 51′, according to a communication in the *Giornale di Sicilia* of the 24th, from Prof. Cacciatore, director of the Observatory ; it was not then visible without a telescope, but on the following morning, shortly before sunrise, it was visible to the naked eye, exhibiting a very distinct nucleus, and a tail about 6° in length, leaning towards the south.

A circular from Prof. Krueger, editor of the *Astronomische Nachrichten*, states that the comet was observed at Vienna on September 28, at 17h. 15m. Vienna mean time, in right ascension 161° 28′, and declination −5° 51′. Prof. Auwers observed it at St. Vincent, on his voyage from Hamburg to Punta Arenas, to take part in the observation of the coming transit of Venus. Signor Luciano Toschi found it very distinct to the naked eye at Imola, in Italy, on the morning of the 25th, the apparent length of the tail being equal to the distance between Sirius and κ Orionis, which assigns it an extent of more than 15°.

The Coimbra meridian observations, to which reference has been made, furnish the following places :—

Greenwich M.T.		Right Ascension. h. m. s		Declination. ° ′ ″
Sept. 18·01062	...	11 30 58	...	+1 22 24
19·00166	...	11 21 59	...	+0 24 38
19·99437	..	11 15 24	...	−0 25 32

It appears probable that between the time of Mr. Common's observation on the 17th, some hours before the perihelion passage and the meridian observations at Dun Echt and Coimbra on the following day, material perturbation of the elements defining the position of the plane of the orbit may have taken place ; at any rate, the above orbit deviates considerably from the Ealing observations. Assuming that the comet is identical with that discovered by M. Cruls at Rio de Janeiro on the morning of September 12, and that he has obtained a good series of observations of position on the following days, it will be interesting to compare the elements deduced from them with those calculated upon observations made subsequent to the perihelion passage.

From a circular which we have received from the Observatory of Palermo, it appears that Prof. Cacciatore utilised the appearance of the comet in an unwonted manner ; we read : "Mentre l'Italia tutta commuovesi per la grande sciagura toccata ai nostri fratelli delle provincie venete e lombarde, ed in ogni regione constituisconsi con nobile e patriottico slancio comitati di soccorso per venire in aiuto a tanti mali, a secondare il pietoso intento, l'Osservatorio aprirà la sue sale all' alba del 26 alle ore 5 precise, a quei genorosi visitatori, che versando una contribuzione di L. 200 vorran godere del sorprendente spettacolo osservandolo al grande e magnifico nostro Refrattore. Siam certi che la sperimentata filantropia della classe agiata di Palermo non renderà vano l'appello dell' Osservatorio. Per tal guisa l'apparizione di questa cometa, che in altri tempi sarebbe stata segnata come foriera dell' ira divina, e causa delle attuali miserie verrà invece registrata come apparizione benefica alla umanità."

[Since the above was in type, we learn by a communication from Mr. David Gill, dated Royal Observatory, Cape of Good Hope, September 11, that the comet was remarked by Mr. Finlay, the First Assistant, at 5h. a.m. on September 8, or four days before it was found by M. Cruls, at Rio de Janeiro. An exact determination of position on the following morning gave—

Cape M.T. h. m. s.		R.A. ° ′ ″		Decl. ° ′ ″
Sept. 8, at 17 13 58	...	144 59 51·4	...	−0 45 30·0

Observations were made on the morning of discovery, but the comparison star was not identified with certainty.

Prof. Riccò reports marked changes in the spectrum of the comet from day to day, from Palermo observations.

In the *New York Daily Tribune* of September 21, the identity of this comet with that of 1843 and 1880 is pointed out by Prof. Lewis Boss.]

SPECTROSCOPIC WEATHER DISCUSSIONS

TO readers of NATURE who have attended years ago to Mr. Norman Lockyer's most accurate quantitative determinations, by spark spectroscopy, of the relative proportions of silver and gold in certain alloys ; and to Prof. Hartley's similar quantitative analyses more recently by photographed spectra of the strength of different solutions of metallic salts—there need be no difficulty in allowing, that if a meteorological spectroscope can ordinarily show the standard fact of watery vapour being in the atmosphere, it may also, by a little extra nicety and tact in its use, be able to quantify to some extent the proportions of such aërial supply of water-gas at different times, and so to become, in conjunction with the natural philosophy of rainfall, a "rain-band," or rain-predicting spectroscope.

There are some persons who will persist in opening the slits of their spectroscopes too wide, and obtaining thereby, when they look at the light of the sky, only a brilliant continuous spectrum of showy colours, or who let the sun, or some strong light glance across the slit, and can then see nothing satisfactorily. But all those others who narrow down the slit almost to extinction, and focus the eyepiece nicely to their own eye, looking from a shaded corner out to a portion of the low, day illumined sky in front of them—all who in fact just do the simply right and proper thing to begin with, have no trouble in seeing, as they extend across the spectrum strip of the daylight, besides the thin solar Fraunhofer lines, and certain hazy lines and bands parallel thereto, and depending on the absorption of the dry gases of our atmosphere—they all, I say, agree and acknowledge that they can also see one, two, or three other bands, which from their places amongst the colours and solar lines, are known to be the spectroscopic imagings of watery vapour. Hence among the recent discussions in the *Times*, the *Scotsman*, and other daily or weekly papers, there was practically no disputation that the spectroscope has the faculty of showing the presence of the otherwise quite invisible watery vapour in the atmosphere. But some of the writers contended that it showed the fact either so faintly, or so capriciously, that the method was of little use even as a hygrometer; could only give deceptive disheartening results in predicting the probable occurrence of rain, and must be looked on merely as one of a number, and by no means the best, of "weather prognostics." Is it worth while, therefore, to pursue the method further?

If with the hope of overcoming the already formed idiosyncratic prejudice of some one human mind, it is not worth while. For there is nothing so easy for an unwilling observer, as to ignore the nicety, and overlook the precision of any quantitative spectroscopic observation; especially when this mode of employing the instrument in our present inquiry has been loudly condemned in public under a depreciating name, which would bring it into the same category as the herd-boy's confident advice to Dean Swift: "Sir, when you see that bull turn his tail to the hedge, then you may be sure it is going to rain."

But we need not after all be offended at the mere name of "prognostic;" for are there not prognostics *and* prognostics in meteorology! What are not the risings and fallings of the wind-compelling barometer itself, but a weather prognostic for those who can interpret them. And even a chart of isobars collected instantaneously from the whole extent of Europe by telegraph, and mapped down in a central office in London, is only another weather prognostic—of a very grand and expensive kind truly; but neither perfect in its forecastings for every part of the country, nor so generally available as could be desired to each private individual therein. I myself, though charged with the meteorological reductions for all Scotland, have never been favoured with a single telegraphic communication of fore-casted weather from the London Office since its establishment. And if I wait, as I did recently, for the isobar map in the *Times*, it arrives here twenty-four hours late of the meteorological events it records; an interval quite long enough to allow of an unwarned-for cyclone having meanwhile entered the country on one side, and left it on the other, after a devastating course across it.

Wherefore a very good apology may surely be set up for many, very many persons in the provinces continuing to observe and speculate on the weather for themselves at their own places of abode, supplementary to any forecasts that may be issued once a day from London. And if such worthy persons do propose to take up the study of the atmospheric water-vapour, or rain-band spectroscope, I do beseech them not to trust to it alone; but endeavour to observe simultaneously with it barometer, thermometer, and wet-bulb hygrometer, not forgetting both wind and cloud. But in that case do you ask, "can the spectroscope give such an observer anything he has not yet already?" It can; for it gives him an instrument far more portable than any other, seeing he can carry it (in its most usual form) literally in his waistcoat pocket; can use it at a moment's notice, when in motion as well as at rest; besides which it gives him such a feeling of certainty and security to know, that even from ever so confined a crib or cabin, with no more than a few cubic feet of peculiar, and for science-purposes vitiated, air about it—he is nobly looking through the whole atmosphere from the surface of the earth right through to space outside, and analysing its condition as to watery vapour (the raw material of rain, as the *Times* happily phrased it) in one instantaneous, integrating glance.

On the other hand, no doubt there is the drawback that no meteorological spectroscope can be used at night, nor in a London fog. It is a daylight instrument, and requires the best part of the daylight too. But such natural light usually lasts long enough to enable anyone to make fifty observations a day, and more too if he be so inclined; though *one* will be usually quite enough in all ordinary weather, if the observer attend to such necessary precautions as these, viz.:—

Observe always low down near the horizon, for atmospheric effects in the spectroscope are there nearly twenty times as strong as in the zenith. Get an opening between clouds if you can to observe through. Prefer that the sun itself shall be angularly distant from your observing direction; and behind a cloud also, if possible, at the instant, so as not to illumine the motes in the air of your neighbourhood with its high altitude light. Especially avoid the minutes of sun-rising or setting, for that act, or rather position, brings certain of the dry gas bands into a short-lived maximum of intensity, without any other signification than that the sun *is* then on the horizon. But good observations may often be taken through falling rain, though not through falling snow, and also between the earth and the under sides of the clouds, if they entirely shut out all view of the air of the heavens beyond them.

Sometimes dense coal smoke, or thick low fogs and mist may prevent the observer obtaining his usual spectroscopic shot at a very low angle of altitude; and if he then points the instrument higher, the telluric rain-band is necessarily weaker. How then is he to eliminate that mere accidental, though most forcible, effect? Simply by making his notation of the strength of the rain-band not absolute or solitary, but differential in terms of another band which is not connected with watery vapour. And herein he will find himself much assisted by the arrangements of nature, or thus:—

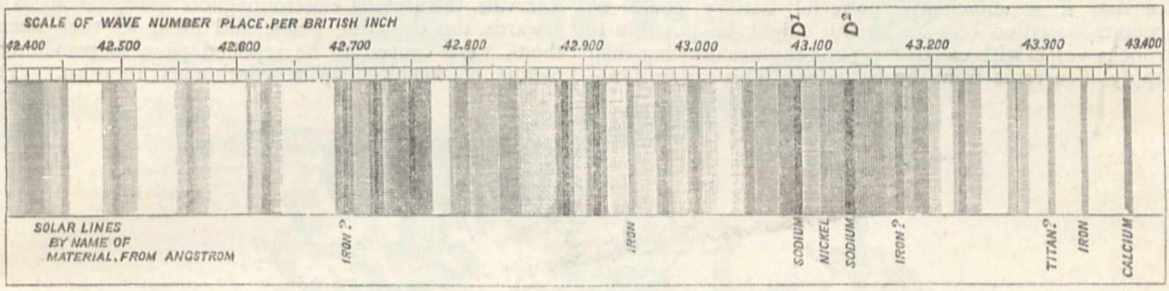
The strongest of the water-vapour or rain bands in the spectroscope is on the red side of the solar D line, and apparently attached to it; while at a very little distance, removed away on the yellow side occurs a dry gas band, called at home, in a lady's journal, the "low-sun band." But throughout the greater part of the day forming only a faint, constant shade, in terms of which the rain-band may be entered; and as they are both affected in the same degree by merely being looked at in a high or low sky, the proportion between the two, which is all that we require for the intended quantification of watery vapour, remains the same.

Again, before deciding on what conclusion, as touching rainfall, is to be drawn from any particular degree of darkness of the said water-vapour band, let the observer consider the temperature of the air at the time. Run down the columns of Mr. Glaisher's invaluable tables for reducing hygrometric observations, and obtain thereby a vivid idea of how rapidly the power of the air to hold moisture in invisible suspension increases with the temperature; and remember that it is not until the quantity of watery vapour accumulates to a still greater extent than what air of such temperature can assimilate, that there is spare material enough for producing rainfall. Hence, while in Scotland a rain-band of intensity marked 2 usually produces a little rain, and 3 produces much, yet in Lisbon during the same months the so-called rain-band, but really only water-vapour band, may mark 4, and yet no rain fall. But with 5 or 6, the temperature remaining the same, down rain will come even in that usually arid country.

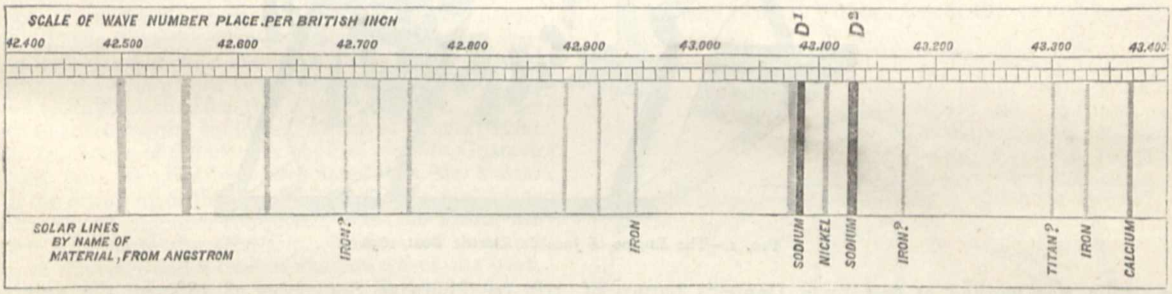
Again, whatever number of supernumerary observations any person may take, when his enthusiasm-fit is upon him, he should never neglect his usual, regular observation at a fixed hour, say 9 a.m. For if the wet-bulb depression goes through a diurnal rise and fall according to the hour, something of the same kind may be looked for in the strength of the spectral water-vapour band; though fortunately it is not so very marked a feature there, because the upper strata of the atmosphere are more constant in their composition from hour to hour, than its lower beds in contact with earth and water.

But why should I go on wearying readers of NATURE with these little details, when they can far better find out such things for themselves, and often realise improvements therein. See how well Mr. Rand Capron has mastered the subject, in his "Plea for the Rain-band" in Mr. Symon's Meteorological Magazine. How acutely Colonel Donnelly appears to have detected in the second water-vapour band of the spectrum, viz. that near the solar C line (a darker part of the spectrum than that occupied by the band near D, and therefore more difficult to observe), an indicator of a different order of precipitation from the atmosphere than ordinary rainfall. And again I trust to be excused for mentioning here that my friend, Mr. T. Glazebrook Rylands, has now accumulated an immense deal of experience as to the advantage of supplementing spectroscopic rain-band observations with a polariscope equally portable.

At present, when experimenting for further advance, I rather prefer the spectroscope alone, but of greatly increased size and power; and it was not until very lately that I fully experienced what can be done in this way upon merely the faint light of the sky near the northern horizon, a region seldom seen here without more or less clouds and much manufacturer's coal-smoke, yet forming a better constant of daylight than if I had attempted to look southward into the neighbourhood of the sun.



The Water-Vapour band on the Red side of D^1 and D^2; as seen in the faintly illuminated North-Western sky at 5° above the horizon, from Royal Terrace, Edinburgh, through the average of August 1882, at 10 a.m. each morning, with a powerful spectroscope. Temp. = 62°·0, depression of wet bulb = 3°·0.



The same as seen on September 4, 1882, on the eve of a whole week of very dry weather; temp. = 55°·0, depression of wet bulb = 5°·2.

On direct sunlight, whenever it can so very rarely in this country be enjoyed, of course almost any spectroscope will show multitudes of lines, and even split up telluric bands into many fine lines; but to see a large spectroscope accomplish nearly the same fact on merely low sky illumination, gave me a new idea of the discriminating powers of this marvellous modern apparatus, and impressed me with the positive duty of trying to use it quantitatively, as well as qualitatively. I append, therefore, a map of the lines and bands of the chief "rain-band," so called, of the ordinary spectroscope, but now as seen in the larger instrument through the average of last August; and again, for a contrast, as it was seen on one particular day, September 4, when a week of the driest and coldest weather of the season was about to begin.

The hygrometer readings taken elsewhere conformed pretty well to these descriptions; but in their whole variations from 2° or 3° for the earlier, and 6° for the latter time, there was nothing to call up such intense interest as the spectroscope's astounding fact of the almost entire sweeping away on September 4 of the many and rich details of the previous month, in so far, of course, as they were water-vapour spectral details. Nature herself does therefore offer in the way of groundwork for rainfall forecasting in the spectroscope, so large an amount of material, that I do trust no one will undervalue it, until they have had practice, with an equally powerful instrument with that I have just alluded to. Its main features are, that the object-glasses of both collimator and telescope are 2·25 inches in diameter; each of its two prisms is 7 inches long and 3·5 inches square at the end, and contains bisulphide of carbon at a refracting angle of 104°, while the telescope's magnifying power is 15°. The definition of the prisms had been previously tested on bright hydrogen lines in a dark field, and found to be admirably perfect, much to the credit of their maker, Mr. Adam Hilger.

Take it all in all, nothing less powerful should be employed in critical researches; and as these prisms give together a dispersion of 24° between A and H, the pictures they offer, with the further assistance of the telescope, have a physiognomy comparable at once with either Angstrom's or Kirchhoff's standard solar spectrum maps, so universally respected over the whole world.

C. PIAZZI SMYTH
Astronomer Royal for Scotland

ELECTRIC NAVIGATION

THE idea of propelling a boat through water by the motive power of electricity is no new one. The invention of the electromagnet showed the power of an electric current to produce a mechanical force. It was no very difficult matter, therefore, for the electricians of fifty years ago to utilise the force of the electromagnet to drive small electromagnetic engines; and from the small beginnings of Dal Negro, Henry, Ritchie, and Page, grew up a group of electric motors which only awaited a cheap production of electric currents to become valuable labour-saving appliances. Nor was it a very long stride to foresee that if a sufficiently powerful battery could be accommodated on board a boat, it might be possible to propel a vessel with electromagnetic engines drawing their supply of currents from the batteries. This suggestion—one of the earliest, indeed, of the many applications of the electromagnet—was made by Prof. Jacobi of St. Petersburg, who, in 1838, constructed an electric boat. Fig. 1, which we here reproduce from Hessler's "Lehrbuch der Technischen Physik," represents the rude electro-magnetic motor or engine, which Jacobi devised for the driving of his boat. Two series of electro-magnets of horse-shoe form were fixed upon substantial wooden frames, and between them, centred upon a shaft which was connected to the paddle-wheels, rotated a third frame, carrying a set of straight electro-magnets. By means of a commutator made of notched copper wheels, which changed the direction of the current at appropriate intervals, the moving electro-magnets were first attracted towards the opposing poles, and then, as they neared them, were caused to be repelled past, so providing a means of keeping up a continuous rotation. This

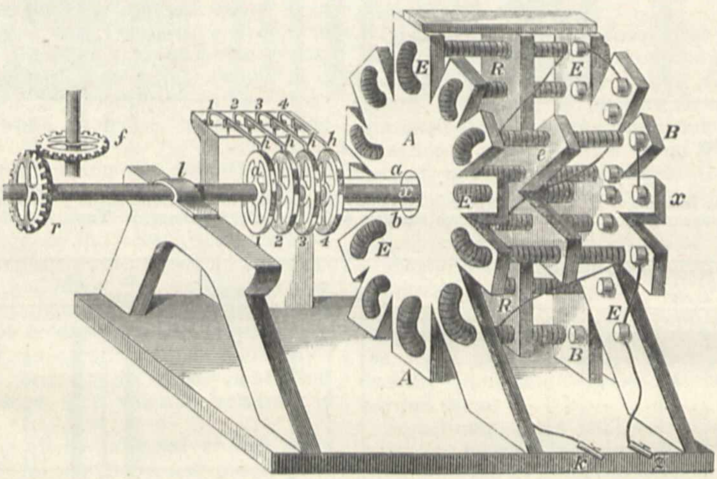


FIG. 1.—The Engine of Jacobi's Electric Boat, 1838.

machine was worked at first by a Daniell's battery of 320 couples, containing plates of zinc and copper, 36 square inches each, and excited by a charge of sulphuric acid and sulphate of copper. The speed attained with this battery did not reach so much as 1¼ miles per hour. But in the following year, 1839, the improvement was made of substituting 64 Grove's cells, in each of which the platinum plates were 36 square inches in area. The boat, which was about 28 feet long, 7½ broad, and not quite 3 feet in depth, was propelled, with a convoy of fourteen persons, along the River Neva, at a speed of 2¼ (English) miles per hour.

A second attempt at electric navigation was made on a much smaller scale about two years ago by M. G. Trouvé, the well-known manufacturer of electric apparatus, of Paris, who constructed an electric skiff, in which he placed one of his small and compact motors, and drove it by means of a battery of Planté's accumulators, previously charged.

The Neva and the Seine having been respectively the scenes of the first and second efforts at electric navigation, it was fitting that the Thames should be the scene of the third, and most recent one.

The electric launch *Electricity*, which made its trial trip on Thursday, September 28, 1882, on the waters of the Thames, is certainly a great advance upon that which had been previously attained. This boat, the arrangements of which have been designed and carried out by Mr. A. Reckenzaun, C.E., mechanical engineer to the Electrical Power Storage Company of Millwall, is of iron, and is a trifle less in length than the wooden boat which Jacobi propelled. She will carry twelve persons, though at the trial trip but four were on board. The screw-propeller is calculated to run at 350 revolutions per minute, the two Siemens' motors running at 950 revolutions. The accumulators, which weigh 1¼ tons, are calculated to supply the necessary current for seven or eight hours of continuous work.

Having been one of a privileged party of four, the first ever propelled upon the waters of the river Thames by the motive power of electricity, I think some details of this latest departure in the applications of electric science may be of interest. At half-past 3 on the afternoon of Sept. 28 I found myself on board the little vessel *Electricity*, lying at her moorings off the wharf of the works of the Electrical Power Storage Company at Millwall. Save for the absence of steam and steam machinery, the little craft would have been appropriately called a steam launch.

She is 25 feet in length, and about 5 feet in the beam, drawing about 2 feet of water, and fitted with a 22-inch propeller screw. On board were stowed away under the flooring and seats, fore and aft, 45 mysterious boxes, each a cube of about 10 inches in dimensions. These boxes were nothing else than electric accumulators of the latest type as devised by Messrs. Sellon and Volckmar, being a modification of the well-known Planté accumulator. Fully

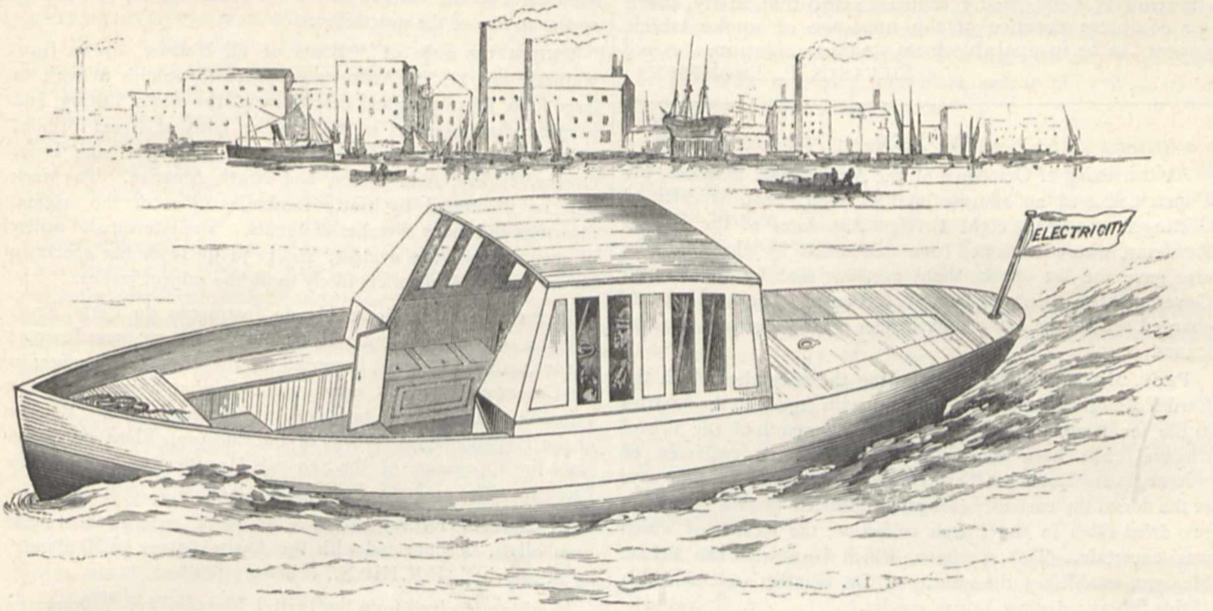


FIG. 2.—The Electric Launch.

charged with electricity by wires leading from the dynamos or generators in the works, they were calculated to supply power for six hours at the rate of four horse-power. These storage cells were placed in electrical connection with two Siemens' dynamos of the size known as D 3, furnished with proper reversing-gear and regulators, to serve as engines to drive the screw propeller. Either or both of these motors could be "switched" into circuit at will. In charge of the electric engines was Mr. Gustave Phillipart, jun., who has been associated with Mr. Volckmar in the fitting up of the electric launch. Mr. Volckmar himself and an engineer completed, with the writer, the quartette who made the trial trip. After a few minutes' run down the river and a trial of the powers of the boat, to go forward, slacken, or go astern at will, her head was turned Citywards, and we sped—I cannot say steamed—silently along the southern shore, running about eight knots an hour against the tide. At 4.37 London Bridge was reached, where the head of the launch was put about, while a long line of onlookers from the parapets surveyed the strange craft that without steam or visible power—without even a visible steersman—made its way against wind and tide. Slipping down the ebb the wharf at Millwall was gained at 5.1, thus in 24 minutes terminating the trial trip of the *Electricity*. For the benefit of electricians I may add that the total electromotive force of the accumulators was 96 volts, and that during the whole of the long run the current through each machine was steadily maintained at 24 amperes. Calculations show that this corresponds to an expenditure of electric energy at the rate of 3·11 horse-power.

Fig. 2 gives a general view of the electric launch afloat. The arrangements of the driving machinery are shown in Fig. 3, which is a section of the boat, taken amidships. The accumulators, B B, are stowed as low as possible, and form an admirable ballast. The two Siemens' dynamos are connected by belts with an overhead countershaft, and arranged with a friction-clutch, by means of which one dynamo can be thrown in or out of gear at will. From the countershaft a third belt passes down to a pulley on the axis of the screw. Each of the engines is provided with two pairs of brushes at the commutators,

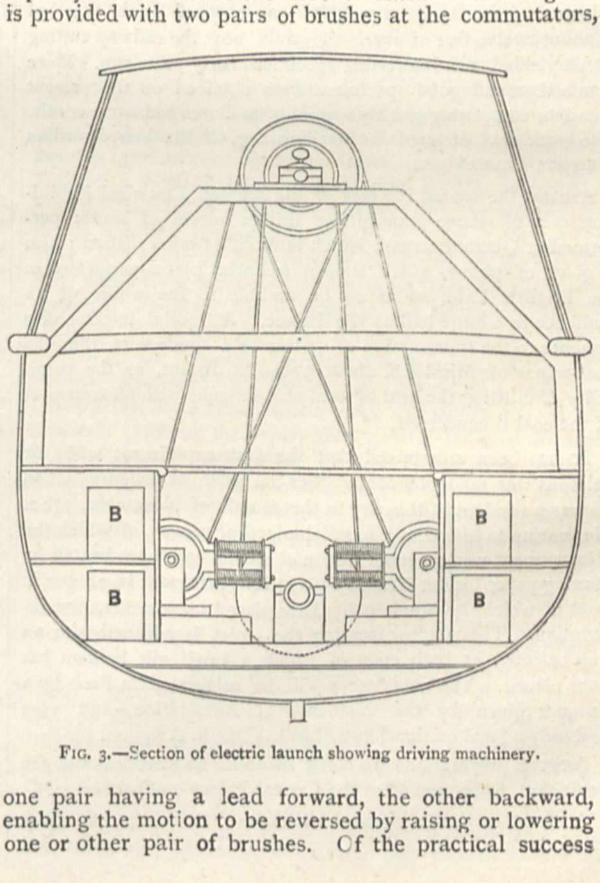


FIG. 3.—Section of electric launch showing driving machinery.

one pair having a lead forward, the other backward, enabling the motion to be reversed by raising or lowering one or other pair of brushes. Of the practical success of this little craft there can be no question. Of its economy it is premature to speak. It is, however, greatly in favour of electric navigation, that such machinery may be both lighter and more compact than that of steam-engines of corresponding power; that the noise and vibration is very greatly reduced; and that, lastly, there is a complete absence of the nuisance of smoke, which appears to be inseparable from steam navigation.

SILVANUS P. THOMPSON

NOTES

AT the sitting of October 2 of the Academy of Sciences, M. Dumas delivered an address on his friend, Prof. Wœhler, of Göttingen, one of the eight Foreign Associates of the French Academy, whose death had been announced by telegram. He also gave the list of the eight missions sent by the French Government to observe the transit of Venus. The total expense charged against the national exchequer is estimated at 1,200,000 francs.

PROF. MOSELEY, who is conducting the researches which the Cardiff Naturalists' Society is making with regard to the fisheries in the sea beyond Lundy Island and the mouth of the Bristol Channel, has been successful in obtaining a specimen of "Arnoglossus Lophotes," a Pleuronectid with the anterior rays of the dorsal fin curiously elongated, hitherto known only from two dried skins in the Couch collection, the locality of which was uncertain. This specimen, which is now in the British Museum, establishes the validity of Dr. Günther's classification of this fish as a distinct British species.

AN excavation for geological purposes was made in the New Forest during the last fortnight of September by Mr. J. W. Elwes of Otterbourn, and Mr. T. W. Shore of Southampton, who obtained special permission for this purpose. A considerable area of the Brockenhurst bed was exposed by the removal of about twelve feet of overlying strata near the railway cutting which yielded such interesting specimens forty years ago. More than a thousand good specimens were obtained on the present occasion, comprising seventy species of molluscs and some corals. The work was directed by Mr. Keeping, of the Woodwardian Museum, Cambridge.

AMONG the special features of the Munich Electrical Exhibition is a telephone transmitting thither pieces of music performed at Oberammergau, which is about 63 miles distant; also a giant telephone, which transmits concert pieces performed in the English Café, so as to be audible to the whole of an audience in a large hall at the Palace. A special interest also attaches to the transmission of power by a single wire from the coal-mines of Miesbach, about 37 miles distant, as the possibility of utilising the heat of coal at a distance without transport of the coal is concerned.

IT has been ascertained that the first experiment with air balloons was made by Montgolfier the elder, at Avignon, when he was a resident in this city in the month of November, 1782. He sent up in his room a parallelopiped of canvas, of which the measurement was 40 cubic feet, and which had been heated by burning paper inside. The room is still in existence, in a house in front of which the Municipality have placed a commemorative inscription. The window fronting the street is adorned with an iron balcony, at both ends of which a small gilt balloon has been placed. The anniversary will be celebrated in Paris by a banquet given by the Academy of Aërostation, and very probably a local celebration will take place in Avignon.

ACTIVE preparations are being made for an electrical and gas exhibition, to be opened at the Crystal Palace on October 24.

A WORK on South African Butterflies—"A Monograph of the Extra-Tropical Species," by Mr. Roland Trimen—is announced by Messrs. Trübner. It will be much more than a new edition of the author's former work; the plates will be entirely new.

WE are asked to state that an article by Dr. James Croll, F.R.S., entitled "Evolution by Force Impossible; a New Argument for Theism," written before his recent illness, will shortly appear in one of the quarterlies.

UNDER the title of "Boats of all Nations, drawn from Nature," Mr. G. H. Andrews proposes to publish a work in large folio, illustrative and descriptive of the origin, history, and peculiar characteristics of the smaller craft of Great Britain, Norway, Denmark, Hanover, Holland, Belgium, Spain, Italy, Greece, Turkey, Asia Minor, and North America. The work will be illustrated by thirty facsimile copies of the original drawings and many sketches of details. The interest and utility of such a work are evident, and to judge from the specimen before us Mr. Andrews is likely to do the subject justice.

IN the *Revista* da Sociedade de Instrucção do Porto, Prof. Oliveira regularly continues his Catalogue of Portuguese Insects; in the current number it is carried to the end of *Bembidium* in the *Coleoptera*. In this same number is what appears to be a valuable contribution to botanical bibliography, viz. a "Review of the Hepaticological Works of the European Flora published since the appearance of the Synopsis Hepaticarum," printed in English. The author is P. Stephani, who dates from Leipzig.

IN *Natural History Notes*, a series of articles on "Plant Symbolism, as connected with the Early History of Mankind," by S. Marshall, F.R.Hist.S., is being published.

WE have received from the Bristol Museum and Library the Syllabus of the usual course of lectures on scientific and literary subjects, to be delivered in the Lecture Theatre, on Tuesday evenings during the winter. It is as well arranged as in previous years.

IN reference to our correspondence on the aurora we may say that Mr. E. J. Stone, director of the Radcliffe Observatory at Oxford, telegraphed to the *Times* on Monday night:—"An aurora has been visible this evening, extending over a large portion of the sky. It appeared in bright patches towards the south, which were continually changing. The spectrum was linear."

AT her country house in Sussex, Lady Dorothy Nevill, so well known for her active interest in natural history, has two pairs of choughs which are allowed full liberty. They fly about the grounds, but are quite tame, and come to a window or into a room to be fed. One pair has taken to a small tower on the roof of the house as a roosting place, and prevents the other pair, which has to roost in a shed, from approaching it. This year the pair built a nest on the top of the wall of the tower in a corner under the roof and laid eggs, but unfortunately failed to hatch them. Although the chough is familiarly known as a bird readily tamed, it has apparently not been observed to nest in the domestic condition before. It is hoped the birds may rear a brood next year in the tower. The nest they made is an extremely neat one, deep and secure, and lined with hair and wool. It is curious that the one pair should drive the other away from the tower, where there is plenty of room for several nests. The pairs keep apart all day, and seem to lose, when thus domesticated, their natural gregarious instincts.

SHOCKS of earthquake occurred at St. Louis and parts of Illinois and Indiana on September 27.

ADVICES from Montevideo announce the arrival there of the French Venus Transit expedition. Part will observe the transit at Carmen de Patagones, and another party will go to Santa Cruz. The Brazilian astronomers will observe the transit of Venus from four stations, viz. one at Rio Janeiro, one at Pernambuco, one in the West Indies, and one about Cape Horn.

ACCORDING to the Report of the Government Central Museum at Madras for the year 1881-82, by Surgeon-Major Bidie, the number of visitors was 211,246, and therefore 37,348 in excess of the attendance in the previous year, and 23,051 above the average of the preceding five years. Of the visitors, 40·17 per cent. were women and girls, and 59·82 men and boys; the corresponding rates in 1880-81 having been 39·36 and 60·63. There was thus a slight increase in the number of female visitors on the days on which the Museum was open to all classes. As in former years, the building was cleared of males, and reserved exclusively for native ladies on the afternoon of the first Saturday of each month, but on these occasions the average daily attendance was but 37 against 114 in the previous year. It is difficult to explain this decline, in the face of the anxiety expressed by native gentlemen for extended means of intellectual culture and amusement for the ladies of their families. In some cases it was evidently considered undignified to visit the Museum when other ladies were also allowed to attend, as I had various importunate requests to have the building specially opened for a single family on Sunday, which I was obliged to refuse. All visitors before leaving the lobby are required to write their names in the door-book, or if unable to sign, their numbers are counted During the year 26·45 per cent. of the total visitors, against 27·77 per cent. in 1880-81, entered their names in the book, and 73·54 per cent. professed their inability to write. In looking at these figures as a gauge of popular education, it has to be pointed out that in many cases one member of a family or party signs for the whole, and that a small proportion consists of children too young too be able to write. As stated last year, a large number of the more intelligent ordinary visitors pick up scraps of useful knowledge as they pass through the rooms, and may come for the express purpose of acquiring information. As a whole the Museum is perhaps the most popular public institution in Madras, and there can be no doubt that its popularity and utility will increase as the education of the lower classes advance. Tables B and C in appendix show the monthly attendance and other results as regards visitors. The report contains a list of the numerous additions in all departments, made to the Museum during the year.

THE mucous membrane of the larynx is known to be extremely sensitive, so that, when touched, violent reflex movements are produced, the glottis contracting spasmodically, and the whole larynx rising forcibly. M. Brown Séquard has lately made the interesting observation (*Comptes Rendus*) that complete local anæsthesia may be obtained in the larynx by directing on the upper part of that organ (through an incision at the back of the animal's mouth), a rapid current of carbonic acid, for fifteen seconds to two or three minutes. It becomes possible to introduce a tube and even a finger (in the case of a large dog) into the cavity of the larynx, and to turn it about without producing reaction. Chloroform vapour gives the same effect, but the other gas is preferred. There is some irritation at the outset. The local anæsthesia, which is accompanied by incomplete general anæsthesia, lasts several minutes (two to eight) after stopping the current. The experiment was repeated several times, at intervals, on the same animal, and no evil results were apparent. M. Brown Séquard proposes to experiment on the human subject by introducing carbonic acid into the larynx by the mouth or nostrils.

IT has been recently observed by Prof. Feichtinger of Munich (*Polyt. Jour.*) that of a number of different kinds of writing and printing paper examined, all those kinds that had been sized with resin had a more or less acid reaction, while this property was never met with in paper with animal sizing. (Paper can be easily tested in this respect by placing moistened blue litmus paper between folds of it.) The acid reaction was found to be due to free sulphuric acid, and it is thought probable that in the use of alum, in resin-sizing, free sulphuric acid is formed in the mass of paper, and remains there. The durability of a paper must undoubtedly be injured by presence of free sulphuric acid. Some of the papers with a strong acid reaction were kept fourteen days in a water bath, which was heated only by day, and they became quite brittle. The acid also acts prejudicially by gradually destroying the black colour of writing on the paper, especially in damp places.

M. GAUTHIER VILLARS has just published a translation of M. Cully's "Handbook of Practical Telegraphy," by Mr. Henry Berger and Paul Bardonnant, of the French Postal Telegraphic Service. This translation contains some useful supplements on the peculiarities of French telegraphy and the pneumatical service as established in Paris.

WE have received the *Proceedings* of the Norwich Geological Society for 1880-81, together with the anniversary address of the president, Mr. J. H. Blake. The former contains several good papers on local geology.

A USEFUL "Table Générale et Systematique des Matières" contained in the first fifty-six volumes (1829-81) of the *Bulletin* of the Imperial Society of Naturalists of Moscow, has been prepared by M. E. Ballion, and published at Moscow by Archipoff and Co.

MR. R. ANDERSON is preparing for publication the papers read by him at the British Association, on Lightning Conductors.

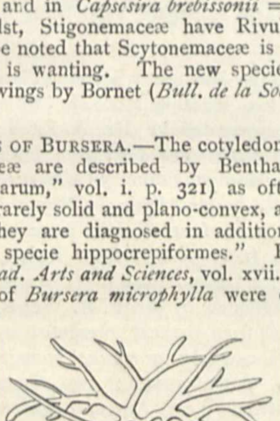
THERE are now 375 naphtha wells on the Apsheron peninsula of the Caspian, their aggregate yield being 9,600,000 cwts. per year.

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus* ♂ ♀) from India, presented by Mr. A. Fitch; two Macaque Monkeys (*Macacus cynomolgus* ♂ ♀) from India, presented by Mr. L. Bennett; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mrs. Paris; a Nisnas Monkey (*Cercopithecus pyrrhonotus* ♂) from Nubia, presented by Mrs. F. Dixon; a Glutton (*Gulo luscus*) from Russia, presented by General Astashoff; a Hairy Armadillo (*Dasypus villosus*) from South America, presented by Mr. F. R. Warre; four Barbary Mice (*Mus barbarus*) from Barbary, presented by M. Pichot; a Blue and Yellow Macaw (*Ara ararauna*) from South America, presented by Mrs. Attenborough; two Common Waxbills (*Estrelda cinerea*) from West Africa, presented by Miss E. à Court; six Florida Tortoises (*Testudo polyphemus*) from Florida, presented by Mr. G. E. Manigault; eight —— Lemurs (sp. inc.) from Madagascar, deposited; two Malabar Squirrels (*Sciurus maximus*) from South India, a Violaceus Plantain Cutter (*Musophaga violacea*) from West Africa, a Greenland Falcon (*Falco candicans*) from Greenland, a Razor-billed Curassow (*Mitua tuberosa*), a Crested Curassow (*Crax alector*) from Guiana, three Elliot's Pheasants (*Phasianus ellioti* ♂ ♀ ♀) from Ningpo, purchased; a Black-faced Spider Monkey (*Ateles ater*) from East Peru, an Eland (*Oreas canna* ♀) from South Africa, received on approval.

BIOLOGICAL NOTES

ON A NEW GENUS OF CRYPTOPHYCEÆ.—A freshwater algæ recently discovered in Brazil, belonging to the group of the Stigonemeæ, has been described by Drs. E. Bornet and A. Grunow, under the name of *Mazæa rivularioides*. This algæ, remarkable in various ways, externally resembles *Rivularia plicata*, Harv., its fronds rounded, more or less irregularly knobby, attain to a diameter of about twenty-five millimetres, at first solid and somewhat firm; later they become hollow and soft. The colour of moistened specimens is of a sombre green, inclining to olive. The trichomes, immersed in a homogenous colourless jelly, spread themselves around a central space; they increase towards the periphery, and become lost in the interior. These trichomes give origin to branches, either scattered or unilateral, which elevate themselves to the one height and to heterocysts either sessile on the side of the articulations, or borne on a pedicel of one to three cells; intercalary heterocysts were not observed. The heterocysts were oblong in form, easily to be distinguished from the ordinary articulations by their size, and above all, by the nature of their contents, which is more homogeneous; when old, they assume a yellowish tint; the chloro-iodide of zinc solution colours them purple. When an articulation forms a heterocyst or a branch, it first forms a lateral enlargement, which is very early isolated. This new cell may at once change into a heterocyst, and then it will be directly applied to the side of the articulation, as are the heterocysts of Capsosira and those on the large branches of Stigonema, or it may be divided once or twice before the formation of the heterocyst, which will be then pedicellated, or it may even form the cell from which a branch may arise. The branches, like the heterocysts, are not uniformly arranged along the length of the filament. At certain intervals they become closer and they become level at the same height. Some remain simple, others ramify, none terminate in a hair. No distinct trace of a sheath was observed around any of the younger portions of the trichomes, but at the base the articulations are sometimes surrounded with a somewhat thick envelope. None of the specimens (not very numerous) examined showed the least trace of spores or homogones. Two characters of this genus are particularly interesting its Rivulariaceous appearance, and its pedicellated heterocysts. This latter peculiarity, which to this time was not yet met with among the Cryptophyceæ, indicates in Mazæa a degree of specialisation of the parts of the trichome more eminent than that in any other genus of Stigonemaceæ, in fact represents the highest development in the group. Now that in this form and in *Capsosira brebissonii = Stigonema zonotrichioides*, Nordst, Stigonemaceæ have Rivularioid representatives; it may be noted that Scytonemaceæ is the only tribe in which this type is wanting. The new species is beautifully figured after drawings by Bornet (*Bull. de la Soc. Bot. de France*, tome xxviii.).

SEED LEAVES OF BURSERA.—The cotyledons of the natural family Burseraceæ are described by Bentham and Hooker ("Genera Plantarum," vol. i. p. 321) as often membranous contortuplicate, rarely solid and plano-convex, and in the genus Bursera itself they are diagnosed in addition as "interdum trifidæ, in una specie hippocrepiformes." Prof. Asa Gray, (*Proc. Amer. Acad. Arts and Sciences*, vol. xvii. p. 230) mentions that specimens of *Bursera microphylla* were collected at Cape



San Lucas, Lower California,[1] in fruit, and also in Sonora in flower. It appears to have all the characters of Bursera except that the ovules are solitary in the cells. Recently Messrs. Parish have collected it in Arizona, near Maricopa, in fruit, and from some of the seeds sent by them to the Botanic Gardens at Harvard University, young plants have been raised. The cotyledons are very peculiar, and are in the woodcut represented a little larger than life; they are biternately dissected into narrow linear lobes. The second pair are simpler, the secondary lobes being fewer and short, the next succeeding are pinnately parted into seven leaflets, passing toward the adult form of leaf, which is pinnate with numerous very small leaflets on an interruptedly margined rachis.

AFFINITIES OF THE BOWER BIRDS.—The very interesting group of birds known as the Bower Birds is regarded by Mr. Elliott as connected with the Birds of Paradise, and in this view Count Salvadori agrees. Mr. Sharpe in his "Catalogue of Birds" takes a different view, but in a paper on the Ornithology of New Guinea, just published (*Journal Linnean Society*, vol. xvi. p. 443, July 31, 1882), he acknowledges that he has now been convinced that the views of Elliot and Salvadori are right, and states that the following note, by Mr. Goldie, of the habits of *Diphyllodes chrysoptera*, Gould, which is a true Bird of Paradise, has in great measure been the cause of this change of view. Mr. Goldie writes: "The bird is found in very rough and thick scrubby country, at the head of gullies or on steep sidings, where he clears a space of ground, about seven feet by four, by stripping all the leaves and twigs off the bushes, leaving only the heavier branches. The ground is cleared of all leaves and is quite bare, and this seems to be his playground; in it he dances and flutters about as if at play. The natives know his call and attract him, but as soon as he perceives any one, away he flies, and can be tempted no more at that time. When not about the nest he is to be found in exceedingly high trees. His food consists of seeds." These habits are curiously like those of the Bower Birds, and show that Birds of Paradise can flirt on the earth as well as among the tree tops.

GEOGRAPHICAL NOTES

DR. MIKLUCHO-MACLAY has arrived at St. Petersburg after a sojourn of twelve years on New Guinea and neighbouring islands. It is stated that the eminent naturalist and explorer intends to remain only six weeks in Russia, when he will return to Sydney, where, as we have already intimated, he has been the means of founding a zoological station.

DR. EMIL HOLUB is arranging to set out for his new expedition to South Africa in April 1883. He proposes to spend from six to eight months in Cape Colony and in the Bechuana country respectively; after which he intends to penetrate as far north of the Zambesi as possible. Dr. Holub will devote his attention to observations and collections in zoology, botany, geology, and ethnography.

MR. H. K. BANCROFT, author of the well-known work on the Native Races of the Pacific States, is about to begin the issue of a new work in 25 large vols., giving the History of the Pacific States of North America. It is an enormous undertaking. Trübner and Co. are the publishers.

AN expedition under Lieut. Andreyew, sent out by the Russian Geographical Society, has safely reached Novaya Zemlya, where it will pass the winter. Besides Lieut. Andreyew there is a scientific staff and five sailors.

MR. STANFORD has issued the second instalment of Mr. Ravenstein's large map of Eastern Equatorial Africa. It contains sheets 12 to 18, with the exception of sheet 15. These sheets combine all the region around Lake Tanganyika, a large part of the course of the Lualuba, the Mwvtan Nzige, much of the Victoria Nyanza and the country around it, and the wide district lying between the north end of Nyassa, the south of Tanganyika, and the coast to Zanzibar. The routes of all travellers are given, the authorities for every leading feature stated, and the information laid down so detailed that the map serves all the purposes of a special treatise on African geography. The map is a credit to Mr. Ravenstein as well as to the enterprise of the Geographical Society, at whose expense it is being constructed.

THE *Deutsche Rundschau für Geographie und Statistik* has entered upon its fifth year, and appears to be a good example of a popular journal of geography. In the first number of the new volume we find an article on the Ethnography of Central Asia, by Dr. Ujfalvy; an article on Egypt, by Herr Schweiger-Lerchenfeld; an illustrated paper on Land and People in Sikkim; papers on the Transit of Venus and the Sun's Parallax, by Dr. Haletchek; on the Hydrography of Central Africa and the interesting problem of the Welle, by Dr. Chavanne; on

Baron von Richthofen (one of a series on Eminent Geographers)' besides several other papers, and notes on political geography and statistics. The *Rundschau* is edited by Prof. Umlauft, and published by Hartleben of Vienna.

THE steamer *Louise* returned to Hammerfest on October 1 from the southern part of the Sea of Kara. The Captain reports that, owing to the prevalence of a hard frost and the consequent accumulation of ice, vessels are unable to pass. The *Louise* left the Danish exploring vessels, *Varna* and *Djimpha*, on September 22, ice-bound, at a point eighty miles to the east of the island of Waigatz. All was well on board, and hopes were entertained that they would shortly be set free.

IN the October number of the *Proceedings* of the Royal Geographical Society, the leading papers are on the Cameroons District, West Africa, by Mr. George Grenfeld; and on the Coast Lands and some Rivers and Ports of Mozambique, by Mr. H. E. O'Neill, H.B.M. Consul, Mozambique. From the Notes we learn that Mr. H. Whiteley, who has devoted himself for many years to natural history pursuits in the interior of British Guiana, has just returned to England. He resided for upwards of a year among the Indians in the neighbourhood of the famous Mount Roraima, of which in its many aspects he made a numerous series of drawings. The number, we may say, contains a full report of the important paper on the Deserts of Africa and Asia, read by M. Tchihatcheff at the Southampton meeting of the British Association.

PELAGIC LIFE[1]

AS used technically by naturalists, the term "Pelagic" applied to living things denotes those animals and plants which inhabit the surface waters of the seas and oceans. Just as the land surfaces, the sea shores, and the deep ocean beds are each tenanted by assemblages of organisms specially adapted to the conditions of existence there occurring, so the surface waters of the oceans are inhabited by a characteristic fauna and flora. The special modifications in structure which the members composing this fauna and flora exhibit as adapting them to their peculiar environment are of a most interesting and remarkable character: and it is concerning the nature of the Pelagic fauna and flora, the mutual relations between the two, the strange forms which Pelagic animals assume, their curious habits of life, their zoological and geological importance, that the present lecture on Pelagic Life will consist. I have spoken of pelagic life as belonging to the surface waters of the oceans because it is in the superficial strata in which it appears to be most fully developed; but, as we shall see in the sequel, it is impossible as yet to limit definitely the range of pelagic forms in depth, and we shall even have to refer to some connections of the fauna of the deep ocean bottom with that of the surface.

Pelagic life then includes the inhabitants of the whole ocean waters, excluding those belonging to the bottom and shores; that is to say, the inhabitants of an area equal to nearly three-quarters of the surface of the globe. And it may tend to enhance our appreciation at the outset of the importance of the pelagic fauna if we reflect that in point of numbers pelagic animals probably far exceed all others existing. The extraordinary abundance of life, as seen at the surface of the ocean under certain circumstances, when the water is often discoloured for miles and its surface strata absolutely filled with small animals, has often been described by voyagers, but can never be fully realised till it is actually witnessed.

The existence of pelagic animals at all is directly dependent on that of pelagic plants. No animal life can exist without vegetable food as a basis, and the first living substance which came into existence must have been capable of constructing protein for itself from inorganic sources, and been physiologically a plant. Now, in many regions the sea-surface teems with vegetable life. In the Polar waters diatoms swarm, sometimes occurring so abundantly that they render the water thick like soup, and being washed up on the ice in the Antarctic regions, colour it brown, as Sir Joseph Hooker showed. When a fine net is towed overboard amongst them, they fill it with a jelly-like mass that, when squeezed in the hand, leaves behind their skeletons, a mass of fine silica like cotton wool. In the temperate and warmer seas, diatoms, though still present, are scarcer, and their place is taken by other simple minute algæ, mainly Oscillatoriæ. As we passed through the Arafura Sea between Australia and New Guinea in the *Challenger* Expedition, the whole sea for several days' voyage was discoloured far and wide by such algæ, and smelt like a reedy pond; and in the Atlantic we passed for days through water full of minute algæ (*Trichodemium*) gleaming in the water like particles of mica. From these fine algæ the simpler animals, on which the higher animal forms subsist, derive their food. No doubt the food-supply is largely supplemented by organic *débris* of all kinds drifted from shores, and by floating sea-weeds, certain species of which, like the gulf-weed, grow in a pelagic condition. Coccospheres and Rhabdospheres may very possibly be of vegetable nature, and contribute to the pelagic stock of food, together perhaps with some of the Cilio-flagellata, such as Ceratium,[1] which may prove also to be physiologically vegetable. However, in many parts of the ocean vegetable organisms are not markedly abundant, and it had always seemed to me that the ultimately pelagic food supply was scarcely as abundant as it should be to account for the vast extent of pelagic fauna, until the recent establishment by Dr. Karl Brandt, of the existence of the curious condition of mutual relations of certain animals and plants known as symbiosis.

It is found that amongst the tissues of certain animals there are constantly imbedded quantities of unicellular algæ. These algæ are not to be regarded as parasites, but a relation of mutual benefit exists between them and the animal with which they are associated; they are nourished by the waste products of the animal, whilst the animal thrives on the compounds elaborated by them and the oxygen they set free. Such an association of mutual benefit is termed symbiosis, and it was in the case of some of the most abundant of pelagic animals, the Radiolarians, that the true nature of the algæ in question was first discovered by Cienkowsky. I shall throw on the screen a figure of one of these Radiolarians Collozoum inerme. It consists of a rounded mass of jelly traversed by fine radiating pseudopodia with a central spherical sac or capsule, and in the interior of that a large oil globule. One function of the oil globule apparently is to float the animal at the water's surface. The animal has the power by some means of rising or sinking at will, probably by means of a modification in the size of the oil globule. Embedded in the jelly outside the capsule are seen conspicuous bright yellow cells, one of which is shown in the act of dividing. These cells contain starch, and are the unicellular algæ, which Brandt has termed Zooxanthellæ. It is obvious that a compound organism such as this is self-supporting, requiring no external source of organic food; and it would be quite possible to conceive the existence of a vast pelagic fauna having Radiolarians combined with their Zooxanthellæ only as a basis. The single organism here represented on the screen is not larger than a pin's head. In the living condition thousands of such are united, clustered together to form little bolsters of jelly about half an inch long, and on calm days on the ocean the whole surface water may be seen full of such masses for miles and miles, as far as the eye can reach, forming a vast supply of self-supporting food for other pelagic organisms. It is probable that the symbiotic condition in Radiolarians is of great importance in the general economy of pelagic life. There are other pelagic animals, for example, Ctenophora, in some of which unicellular algæ are similarly present. Symbiosis may possibly have been more common amongst pelagic faunas of earlier geological epochs, when diatoms apparently were not abundant or non-existent. The Radiolarians are characteristic members of the pelagic fauna. Most of them are provided with most beautiful siliceous skeletons, as, for example, *Rhizospæra leptomita*, now on the screen. It is, as may be seen, provided with a stock of Zooxanthella like Collozoum.

Animals are pelagic in very various degrees, and may be placed under a series of categories accordingly. There are the pelagic animals *par excellence*, those that are found at the greatest distances from shores, and which are capable of passing their whole existence there, and are floated only accidentally to land. Such are the Radiolarians, Siphonophora, very numerous Crustacea, Alciopa, Tomopteris, Heteropods, Ianthina, Pteropods, the Pelagic Cephalopods, Salpæ, and Pyrosoma, and numerous pelagic fish. These might conveniently be termed eupelagic. Then there are others, such as many Scyphomedusæ and most Ctenophora, which, though thoroughly pelagic in habit, are met with in greatest

[1] Address at the Southampton meeting of the British Association, August 28, by H. N. Moseley, F.R.S., Professor of Human and Comparative Anatomy, Oxford.

[1] Mr. John Murray has observed that species of pelagic ceratium are to be met with, often forming long chains, composed of individuals united in linear series. I observed an instance of the same fact myself. It seems to give some additional indication of the possibly vegetable nature of certain of the Cilio-flagellata.

numbers near land. There are further numerous animals which are pelagic only in their larval condition, and which, swarming at the surface with the strictly pelagic forms during their early stages, sink to the bottom when mature to lead an entirely different existence. With other pelagic forms, the converse is the case: the pelagic snakes, turtles, and birds come on shore to rear their young, spending most of their adult life on the ocean, and certain whales approach the shore at the breeding season. These two last groups may be termed hemipelagic.

It is impossible to draw a sharp line between any of these groups; they run into one another indefinitely. Thus, unlike the abundant flying-fishes (Exocœtus), the flying gurnets (Dactylopterus), are never found very far from land, but lead a partly pelagic existence, taking frequent flights from the surface, and partly inhabit the bottom in shallow water, being taken sometimes at the bottom with a hook and line. Amongst the Hydromedusæ and Scyphomedusæ, all gradations of pelagic habit occur. Many of both are attached at the sea bottom at certain stages in their life history, or rest on it habitually, some possibly in very deep water; others, closely allied, exhibit no fixed condition, and are entirely pelagic.

The Sargasso Sea has a peculiar fauna of its own, which cannot be considered as strictly pelagic, composed of animals specially adapted to cling to the gulf-weed and inhabit it, and differing in general aspect from other pelagic forms. Very much has been written on this fauna, which is so special that it may well be left out of consideration here.

Most characteristic of pelagic animals is the almost universal crystalline transparency of their bodies. So perfect is this transparency that very many of them are rendered almost entirely invisible when floating in the water, whilst some, even when caught and held up to the light in a glass globe, are scarcely to be seen. The skin, nerves, muscles, and other organs, are absolutely hyaline and transparent in these forms, but natural selection seems to have been unable to render colourless the liver and digestive tract in many instances. So these parts remain opaque, of a yellow or brown colour, and exactly resemble, when seen in the water, small pieces of floating sea-weed. A familiar example is Salpa, Pelagonemertes is another.

Certain few pelagic animals are coloured bright blue for protection, so as exactly to resemble the colours of the waves. Such are Minyas cœruleus, Velella, Porpita, Physalia, Glaucus, Ianthina, all of which are forms which float at the very surface, with part of their bodies more or less out of the water. The blue coloration seems to be connected with this latter circumstance, as protecting the animals probably from predatory pelagic birds, to which they would be invisible at any distance. Velella does not, however, thereby escape its enemies altogether, for a young turtle which we caught at sea during the *Challenger* expedition, had its stomach full of Velellas, and we often found them in the stomachs of albatrosses. Ianthina, the well-known bright blue gastropod, constructs a float built in compartments, which is attached to its foot. If this float be detached, the animal sinks and dies. It is said to be devoid of eyes. Glaucus is a nudibranch mollusc, which has the sides of its body modified into curious fin-like fringed lappets. It floats habitually with its ventral surface upwards, its foot being applied to the surface of the water, just as is that of the common pond snail, Paludina, when the animal is creeping at the surface of the water. In consequence of the position thus assumed by Glaucus, its ventral surface is coloured deep blue, whilst its dorsal or under surface is of a glistening lustrous white. One is so accustomed to animals floating with their back upwards, and being coloured accordingly dark on the back and light underneath, that the appearance of the animal is most deceptive, and, indeed, entirely misled Dr. Bennett, who, in his account of the habits of the animal, speaks of the blue aspect of its body as its back throughout. The curious fish, the Remora,[1] which adheres to sharks and ships, is similarly dark on the exposed ventral surface, and light on the back, and one can hardly persuade oneself of the fact when one looks at one in the fresh condition. The circumstance proves how completely the arrangement of such colouring is protective in object.

Glaucus is most persistent in maintaining its position with its back turned downwards. I turned one over several times. It struggled with its fins somewhat like a turtle on its back, and quickly regained its position. Curiously enough, according to Dr. Bennett, it feeds on Velella, which, like itself, is blue. Similarly the blue Ianthina feeds on the blue Velella.

[1] This fact seems not to be recorded by icthyologists nor figured. When the fish is put in spirits the light tint of the dorsal surface disappears.

Some few pelagic animals are most brilliantly coloured, and one small Copepod Sapphirrhina has always excited the admiration of naturalists, being unsurpassed by the brilliant metallic lustre of the humming birds, and displaying all the colours of the spectrum with an intensity like the gleam of the diamond. The figure of this animal now on the screen appears brilliant enough, but it gives but a faint idea of the actual brilliancy of the animal. The colouring in this case is of sexual import, being confined to the males.

A further remarkable fact about pelagic animals is that very many of them have either no eyes or very large eyes, the latter condition being most common. Thus the whole of the Pteropods have either no eyes or mere rudiments of them, and the Siphonophora and Ctenophora have no eyes.

On the other hand, animals with huge eyes in proportion to their size are common in the pelagic fauna. As an example, I shall throw on the screen a representation of the remarkable pelagic Amphipod *Phronima sedentaria*, you observe the enormous size of the compound eyes, which occupy the entire front of the animal's body. The female *Phronima sedentaria* has the curious habit of living in a tub-shaped transparent house, open at both ends, which it forms by gnawing out the inside of a young Pyrosoma colony, and, with its brood of young clustered round it inside, it sculls its tub with great rapidity through the water.

Here you see another crustacean, a Copepod of the genus Corycæus. All the species of Corycæus have a very large pair ot eyes; but in the present form the eye apparatus is so extraordinarily enlarged that a large horn-like outgrowth of the body has been formed projecting from under the thorax, in order to accommodate the nervous structures and get a long enough focus for the lenses. This figure is from an unpublished drawing by my lamented colleague on board the *Challenger*, Rudolph von Willemoes Suhm, who specially devoted himself to the investigation of pelagic animals during the *Challenger* voyage. He names in MS. this curious form, which is apparently as yet undescribed Corycæus Megalops. The animal is of a fine blue tint when living. Most remarkable of all for their eyes are, however, perhaps the pelagic annelids, the Alciopidæ. Their eyes are of enormous size and most perfect construction, and far surpass in both respects those of all other annelids.

In thus being blind or provided with extraordinary organs of vision, the members of the pelagic fauna resemble those of the deep-sea fauna, and there are other points of resemblance between the two assemblages of animals, such as that amongst both a large proportion of phosphorescent animals occur. Prof. Fuchs,[1] in lately-published most valuable papers on the Pelagic Flora and Fauna, and on Deep-Sea Life, has dwelt much on these resemblances, and concludes that they are to be explained by the circumstance that, like the deep-sea fauna, the pelagic fauna is to a very great extent a fauna of the darkness, the deep-sea fauna living where darkness, as far as sunlight is concerned, is perpetual, and the pelagic fauna being nocturnal in its habits. By far the greater part of the pelagic fauna is thus nocturnal in its appearance at the surface. In the day-time the animals composing it sink to considerable depths, and they rise only at night. Certain pelagic animals, however, seem not to mind the sunlight. Radiolarians may be seen at the surface when it is calm, in the full glare of the sun, and so may Velellas and Ianthinas; indeed these latter and some others cannot leave the surface. Some Ctenophora, especially Eucharis, according to Chun, seem rather to like the sun. Flying-fish, again, are at the surface day and night, and the beautiful pelagic fish called dolphins (Coryphæna) show their wonderful colours to best advantage in the full sunlight, as they swim lazily round a becalmed vessel. Winds and storms drive all the pelagic animals below which are capable of descending, and one may sail over wide tracts of sea during boisterous weather and imagine that the water is almost barren of life, whereas a calm night would have shown the whole surface teeming with animals.

The important question of the day with regard to pelagic life is, to what depths does it extend? How far do the animals which come up at night descend, and do any which never come to the surface extend their range below the limit of these again; and do any inhabit the region leading down to the very deep sea bottom?

Prof. Weissmann,[2] from his observations on what may be called the pelagic fauna of Lake Constance, has shown that the

[1] Th. Fuchs, "Ueber die Pelagische Flora und Fauna, u.s.w." J. C. Fischer, Wien, 1882.

[2] Das Thierleben in Bodensee. Von Aug. Weissmann. Lindau, 1877.

minute crustacea of which it is composed, slowly rise and sink just like the pelagic inhabitants of the sea. They never sink to a greater depth than twenty-five fathoms, but from this depth they rise gradually to the surface in the evening, following the limit of darkness, as the sun sets, and they descend in the same manner in the morning as the sun rises. Prof. Forel has observed the same facts in the Lake of Geneva. Now a depth of about twenty-five fathoms has been shown by Prof. Forel to be the limit at which sensitised paper ceases to be acted upon by direct sunlight in the waters of the Lake of Geneva. Below this depth no sunlight penetrates. Prof. Weissmann, after trying all other apparent explanations, concludes that the reason why the pelagic crustacea oscillate perpetually in this curious manner in depth is in order to economise the light and be able to feed during the twenty-four hours over their whole possible range of feeding-ground. Were they to remain at the surface during the daylight they could not see at all to feed in the depths in the weak light at night. This most ingenious explanation will no doubt apply equally well to all the marine pelagic animals with well-developed eyes, and which feed on the nearly stationary vegetable matter and *débris* held in suspension by the surface strata of the waters. Whilst the numerous blind forms which execute similar diurnal oscillations, such as the Ctenophora,[1] Echinoderm larvæ,[2] Pteropods, and others, must follow the crustacea and other small fry to feed upon them. Indeed the whole pelagic fauna is so closely inter-dependent, that it must needs move together. It is very probable that some forms come to the surface only at night, because thereby, like so many other nocturnal animals, they escape many possible enemies by always keeping in the dark.

Dr. Chun has observed that the Ctenophora of the Gulf of Naples, after being abundant in spring, become extremely scarce and almost disappear during the three summer months, and re-appear suddenly again in great numbers in the autumn. He believes, from having caught them in the summer at considerable depths, that these Ctenophora descend annually at the end of spring in order to feed on the minute crustacea which then remain in deep water (very possibly because the more powerful light allows them then to feed at the lower level), and that, having become fully fed up, and the young having in the depths passed through their metamorphoses and reached the adult condition, they rise together to the surface, and appear in a swarm as if by magic. One of the Ctenophora with this habit is the beautiful venus girdle (*Cestus veneris*). Scypho Medusæ (*Cassiobeia Borbonica*) and other pelagic animals, appear to perform the same periodical migration in depth. Doubtless similar annual migrations in depth occur amongst pelagic animals in various parts of the world, and this may account for the extraordinary scarcity of some few.

It appears probable, therefore, that pelagic animals perform oscillations in depth from three different causes. They perform, firstly, diurnal oscillations in accordance with the changes in light and darkness; these, secondly, are liable to constant interruptions from the occurrence of boisterous weather; and thirdly, they may alter their depth periodically, according to the season of the year.

The great inland fresh-water lakes have each a regular coast or littoral fauna, a deep-sea fauna, and a pelagic fauna, just like the oceans. The pelagic animals of the lakes resemble those of the sea in many interesting particulars. They are, like them, hyaline and transparent, of most curious forms, modified for a constantly swimming existence, and sometimes possess immensely developed eyes. I shall throw on the screen figures of two crustaceans from the pelagic fauna of the Lake of Geneva, from Prof. Weissmann's figures. Both are Cladocera or water-fleas, of the one-eyed family, Polyphemidæ. The first, Bythotrephes, is of most extraordinary shape, having an enormously long tail spine to balance its top-heavy body; it is transparent like glass, but in late autumn becomes covered with beautiful ultra-marine spots. It has a single enormous compound eye in front, and in the brood pouch, under the rounded carapace on the back is born a single egg. The second, *Leptodora hyalina*, is also of most extraordinary form; it is absolutely transparent, like Bythotrephes, and almost invisible in a glass of water. It has an enormous pair of feathered rowing antennæ to sustain it in the water. This curious animal, as well as a species of Bythotrephes, has lately been discovered by Mr. Conrad Beck in Grasmere Lake, in Westmoreland, together with other Cladocera, so that our own lakes have their pelagic fauna. *Leptodora hyalina* had previously been found by Mr. Bolton in the Olton reservoir near Birmingham.[1]

But the most important question, as I said before, is to what depth do the pelagic animals of the ocean descend? This has remained an unsolved problem ever since it first exercised the mind of the great Johannes Müller, though in his time the question was a different one, being directly connected with that of whether there was any life at the deep-sea bottom or not. An open net sent down to any depth, as it comes up may catch animals at any intermediate depth. Hence it is impossible to assign to any particular depth with any certainty any animals found in a tow-net when raised to the surface. What is required is experiments made with a net so constructed as to be sent down closed to a certain depth, then opened, then towed for some distance, and then raised again to the surface. Such a net has been devised by Capt. Sigsbee, of the U.S. Navy, the inventor of nearly all the best deep-sea apparatus now in vogue, and has been used by Mr. Alexander Agassiz, who found that the pelagic animals on a calm day extended pretty uniformly downwards from the surface to a depth of 50 fathoms, but that at depths of more than 100 fathoms nothing was to be caught at all. Unfortunately very few experiments have as yet been made by Mr. Agassiz with the instrument, and therefore no final conclusions can be drawn from them. We look forward with the greatest interest to further prosecution of similar researches.

On the other hand there is evidence pointing to a further extension in depth of deep-sea forms. On board the *Challenger* my colleague, Mr. John Murray, throughout most of the voyage, made very numerous experiments with the tow-net at great depths, and so constantly obtained very different results by these means to those which were shown by nets simultaneously worked at intermediate depths that he is firmly persuaded that the Pelagic Life extends to very great depths, indeed certain animals which he caught such as the Phœodaria which have been described by Prof. Haeckel, were obtained only from nets which had been down to very great depths. It is indeed possible that there is a direct connection between the deep sea fauna and that of the surface and that the young of certain deep sea fish pass their early existence at the surface amongst the Pelagic throng. It is known with certainty that the young of many fish living in tolerably deep water, such as the cod, inhabit the surface water in their early stages, and it is possible that the eggs of fishes living at great depths may similarly rise to the surface for development. Prof. Lütken[2] has described a small fish which was obtained from the stomach of an albacore which appears without doubt to be the young of a deep sea Lophoid, probably *Himantolophus rheinhardtii*, and the young of other deep sea fish have been found under similar circumstances.

Mr. Agassiz, whose authority on the matter is of the greatest weight, is nevertheless convinced[3] "that the surface fauna of the sea is really limited to a comparatively narrow belt in depth, and that there is no intermediate belt so to speak of animal life between those animals living on the bottom or close to it and the surface Pelagic fauna." If this be the case then the limit in depth from the surface must be ultimately due to the limit in the penetration of sunlight, and consequent growth of vegetable organisms. Over this belt the ultimate source of food of the Pelagic and deep sea animals is concentrated; below it a constant rain of organic *débris* is always falling slowly,[4] through an immense interval of absolute darkness to the deep sea bottom, but this rain thus spread out is sparse, and being so, it could scarcely be obtained by animals devoid of or unable to employ vision in sufficient quantity to support life.

If the intermediate zone is permanently inhabited at all, such habitation probably depends on the phosphorescence of the animals dwelling in it whereby they are able to use eyes and pick up the scanty food. It is quite possible that some of the fishes endowed with phosphorescent organs such as the Scopeli which, as Dr. Günther reports were brought up in the *Challenger* nets "from any depth to 2,500 fathoms," and some of which occur on the surface, may roam through the intermediate zone finding food by means of their own light, and that may be the

[1] Dr. Carl Chun, Fauna and Flora des Golfes von Neapel. Ctenophora, s. 239.

[2] A. Agassiz, North American Star Fishes. Mem. Mus. Comp. Zool. Harvard, 1877, p. 28.

[1] E. Ray Lankester, *Ann. and Mag. Nat Hist.*, January 1882, p. 53.

[2] Vidensk. Selsk. Skr., 5te Række 11te, Bd. v.

[3] Bull. Mus. Comp. Zool. Harvard, Vol. VI., No. 8, p. 153.

[4] By experiment I found that a dead Salpa would take about four days to reach the bottom in a depth of 2,000 fathoms. ("Notes by a Naturalist on the *Challenger*." Macmillan, 1879, p. 582.)

reason why they bear the peculiar organs they do, but the food must be so infinitely more scanty over this intermediate zone than in the upper stratum that life cannot be abundant in it anywhere, and no arrangement such as probably exists at the deep sea bottom whereby unphosphorescent animals profit by the phosphorescence of others can occur. At the ocean bottom the organic *débris* falling from above becomes again concentrated and compressed into infinitely less space than in the surface zone, and life in abundance becomes possible again. The existence of a deep sea fauna at any great distance from coasts depends upon that of a Pelagic fauna overhead.

With a net capable of acting like that of Captain Sigsbee a vast amount of most interesting investigation lies open. We know as yet next to nothing certain as to the curious oscillations in depth and migrations of the Pelagic fauna. The matter would be a very pleasing subject for research for any yachtsman so disposed, who would care to investigate the movements of the surface fauna of our coasts, and I would urge any here present to take it up.

With regard to the connection between Pelagic and Deep-Sea Life, a most important question is the still unsettled one as to the true origin of the Globigerina mud by which so vast an area of the ocean bottom is covered. As is well known, Globigerinæ and other Foraminifera with calcareous shells occur in abundance at the surface of the ocean. They were originally discovered there by Johannes Müller, who was the first to observe in the Mediterranean off the French coast the Pelagic Globigerina and Orbulina which are provided with long fine calcareous spines all over their shells, on which to extend their gelatinous tissue and thus by increasing their volume enable themselves to float. Other surface forms are devoid of spines. The well known Globigerina mud is made up mainly of such shells, and the question is whether the main part of this important deposit is derived from the surface, or whether on the contrary the shells composing it belong to animals living on the deep-sea bottom. Mr. John Murray who spent the whole of the *Challenger* voyage and most of the time which has elapsed since in investigating the surface fauna, and comparing with it the deep-sea deposits writes to me, that he is convinced that in a pure Globigerina mud not 3 per cent. of the carbonate of lime it contains is derived from organisms living on the bottom. On the other hand, Mr. H. B. Brady, the great authority on Foraminifera still seems from the tenour of his short report on the Foraminifera of the *Knight Errant* Expedition, to hold an opposite opinion,[1] although he evidently wavers somewhat.[2] The sarcode contained in the undoubtedly living surface globigerinæ is tough and readily preserved in alcohol. It remains firm after the shell has been removed by acids, and may be readily stained with carmine. There is no reason why the sarcode of deep-sea specimens should not be demonstrated with equal ease, yet it is only very rarely that any is found in them, and even then it appears not to be definite and fresh like that so readily procured from surface specimens, and constantly to be seen in other Foraminifera which certainly live at the bottom. I have never discovered any satisfactory trace of it myself, though I have often sought for it in fresh specimens of globigerina mud. The question whether any form of Globigerina does or does not live on the deep sea bottom is one which still urgently requires a definite answer. The subject of the origin of the Globigerina mud is ably discussed by Butschli,[3] in his account of the Protozoa now in course of issue. One of the principal difficulties in the matter is that much thicker Globigerina shells are found on the bottom, than are met with at the surface. He suggests that the additional thickness may be added to the shell as the animal becoming heavy gradually sinks into deep water out of reach.

An important geological question is connected with the deposition of the Globigerina mud. Prof. Haughton, Dr. Croll, and more lately Mr. Wallace in his "Island Life," have made attempts to arrive at the age of the sedimentary rocks by calculating the time during which a deposit of the mean thickness of the stratified rocks of the globe would be formed on the sea bottom at the present average rate of denudation. In working out this problem Prof. Haughton regarded the materials as spread uniformly over the entire sea bed, whereas Dr. Croll and Mr. Wallace maintain that all the deposit worth consideration may be regarded as taking place within a comparatively short distance of the coast, Mr. Croll believing that the deposit taking place beyond a distance of 100 miles on an average is not very great, and Mr. Wallace reducing the area of hypothetical deposition to a very much less breadth. Now both of the latter observers seem to have forgotten that the whole of the organic deep-sea deposits, all over the ocean beds must be taken into consideration in any such calculations, quite as much as any deposits of insoluble silts which may be formed near shore. The vast deposits of calcareous globigerina mud, the siliceous Radiolarian and Diatomaceous deposits and the abundant red clays of the still deeper areas are as much the products of the present denudation of the earth's surface, as the banks formed near the river mouths. There is no other source from which they can be derived. A considerable amount of the results of denudation is carried by the rivers into the ocean in solution, and a further quantity doubtless becomes dissolved by the sea water when the river water is mixed with it, and the Pelagic Foraminifera and other animals assimilating it carry it far from the coasts all over the oceans and deposit it in the deep sea, spreading it evenly over the bottom.

A large quantity of the sedimentary rocks taken into consideration in one side of the calculations referred to, resemble the deep-sea deposits in being mainly ultimately or directly deposited through organic agents.

I cannot but think that some modification of the results attained in the calculations referred to may be required on this consideration, and life allowed to add a few more tens of thousands of years to her age.

The whole existence of the Pelagic fauna depends on the denudation of the land, were it not for this the supply of mineral matter in the sea water would have become exhausted long ago.

The Pelagic animals prey upon one another largely. The voracity of some of the most harmless looking jelly-like forms is extraordinary, Dr. Chun describes the Ctenophor Beroe as swallowing another Ctenophor much larger than itself with the greatest rapidity distending its body enormously in the act. Many of the larger pelagic animals, like the whalebone-whale, feed on large quantities of minute animals, Prof. Steenstrupp has found that certain Pelagic Cephalopods feed on minute crustacea and the use of the wide conical membrane surrounding the arms in the Cirrhoteuthidæ is apparently to catch shoals of Entomostraca. Similarly the Penguins of the southern sea seem to feed largely on minute crustacea. Their stomachs are to be found crammed with them. In catching them they move through the water with immense rapidity, and all such feeders are endowed with immense muscular power. Other pelagic Cephalopods may be seen at the surface in droves pursuing shoals of fish and squirting the water from their funnels into the air in small jets in all directions.

A most remarkable fact is that certain larval forms of shore animals undergo extraordinary modifications under the influence of Pelagic existence. The best known instance in point is that of the Leptocephali, which are small ribbon-shaped fishes absolutely transparent, and in many cases devoid of any hæmoglobin in their blood, whilst the slight skeleton they possess is cartilaginous only, and the whole tissues are soft and pulpy. They are often abundant at the sea surface far from land, but are never found sexually mature. There seems to be no doubt that the most abundant of these forms are the young of conger eels, but off many coasts, as for example, that of Norway, where congers are abundant, no Leptocephali are ever found. Dr. Günther's conclusion is that all these curious fish are the results of the abnormal development of the larva of various fishes (possibly sprung from eggs accidentally shed at the surface instead of the bottom), which continue to grow to a certain size without corresponding development of their organs, and perish without ever becoming mature.

Another instance of similar modification is that of the young flat fish termed Platessæ, which are like the Leptocephali perfectly transparent. These are also often taken in the open ocean and it appears probable that when thus placed under unnatural circumstances their development becomes arrested, and many probably perish eventually, like the Leptocephali, without the arrangement of their eyes ever becoming unsymmetrical. The deep sea is devoid of flat fish and it seems impossible that the larvæ should ever find their way back to shore.

In the case of the young of the Flying Gurnet something analogous occurs. In the minute young a reversion to the ancestral condition is exhibited, the pectoral fins are not longer in proportion to the fishes' body than those of other fish, they only begin to develope into wings when growth has proceeded

[1] Exploration of the Faroe Channel during the summer of 1880, by Staff Commander Tizard, R.N., and John Murray. *Proc. R. S. Edin.*, 1881-82, p. 80.

[2] Notes on Reticularian Rhizopoda (*Quart. Journ Micros. Sci.*, 1881, p. 67.

[3] Bronn Klassen u. Ordnungen des Thierreichs, Protozoa, 1880, p. 166.

very far, but as Prof. Lütken[1] has shown the degree of development of the pectoral fins bears no constant relation to the size attained by the young fish, a great increase in size may occur without a corresponding progress in metamorphosis. In consequence of this the young of the common flying Gurnet *Dactylopterus volitans*, were not for long recognised as such but were considered distinct and named Cephalacanthus. A parallel instance to that of Leptocephalus is possibly that of the curious flattened larva of the Rock Lobster (Palinurus) Phyllosoma, which is also found in the open ocean attaining sometimes gigantic proportions. Possibly also other pelagic larvæ become thus hypertrophied in the larval condition. We may compare with these phenomena the somewhat parallel modifications which occur naturally or may be produced artifically amongst larval Amphibians.

Many of the Pelagic animals carry with them parasites similar to those affecting their littoral allies and which thus are, as it were, imported into the Pelagic fauna, but there are a few definitely pelagic parasites parasitic upon pelagic hosts. The young of the Pelagic annelid Alciopa are parasitic within the bodies of Ctenophora, there is the small parasitic Hydromedusa Mnestra, which adheres to Phyllirhoe, and lastly there are the young Cunina medusæ which cling in dense clusters within the stomach of the Geryonid Medusa Carmarina, and were at first imagined to be the young of the Carmarina itself.

A remarkable feature about Pelagic animals is that very many of them occur in large swarms, some in immense hosts. Further Velellas, Porpites, and Ianthines are always met with in schools, and even Leptocephali, and very many other forms are usually caught in the tow-net, several at a time.

In their almost universal geographical distribution except as regards the colder seas, Pelagic animals resemble the deep-sea fauna; as examples it may be mentioned that according to Prof. Lutken, the tunny of the Mediterranean is identical with that of Japan, and the albacore of the Atlantic with that of the Pacific. Pelagic genera seem to be of almost ubiquitous distribution, though the Atlantic and Pacific species frequently differ.

Some few Pelagic forms seem to be remarkably scarce. As an instance may be cited Pelagonemertes, the curious Pelagic Nemertine with a ramified intestine. This form was obtained in great abundance by Lesson at the surface in 1830, between the Moluccas and New Guinea. By the *Challenger* it was found twice, only a single specimen being got on each occasion. The first was caught to the south of Australia, and the second on the coast of Japan. The animal seems never to have been met with by any one excepting on these three occasions. On each occasion when caught by the *Challenger* it was found in a trawl which had been down to a great depth. It is therefore very possible that it very rarely rises to the surface.

Similarly many Pelagic Cephalopods though known to exist in multitudes are of the greatest rarity, being only known from fragments. Bushels of their horny beaks are found in the stomachs of whales, which subsist on them, and several genera are known to Prof. Steenstrupp only from these quantities of beaks. He has never seen a trace of any other part of them.

Notwithstanding the wide distribution of Pelagic forms, Mr. Murray finds that he is able to form tolerably correct conclusions as to the latitude of any sample of deep-sea bottom which contains organic remains submitted to him, from the nature of the Pelagic debris of which it is composed. He can also form some idea of the depth from which a deposit has been brought up by observing the extent to which the substance of the calcareous shells has undergone solution. Pteropod shells owing to their extreme thinness appear to be dissolved first, and disappear say at 1200 fathoms, then the finest globigerina shells at 2200, then the larger globigerina shells and so on.

Pelagic animals as a rule appear to be extremely sensitive to any lack of saltness in the water. The surface fauna of the Baltic is thus very poor, and in the upper part consists of little else than a few small crustacea, but curiously enough the large Scyphomedusæ, such as Aurelia and Cyanea appear to be unaffected injuriously by a brackishness of the water but rather to prefer it. They extend in the Baltic into places where the water is very little salt and I have seen similar large Scyphomedusæ swimming in shoals at the head of one of the large creeks of the Hawkesbury inlet in New South Wales, in the actual current of a small fresh-water stream which ran in and where the water was quite drinkable. This is all the more remarkable because as Mr. Romanes has shown the one Hydromedusa which we know of as confined to fresh water, the well known Lymnocodium of the Victoria lily tank in the Regent's Park Botanical Gardens, is excessively sensitive to any addition of salt to the water in which it is.

I am informed by Mr. George Baden Powell that the large Medusæ so abundant here at Southampton, shows a curious tendency to crowd up towards the higher part of Southampton water. There are hardly any to be found as a rule in the Solent but they appear always to tend to crowd up at the heads of estuaries. I have noticed in Norway also that they appear to crowd at the heads of the Fjords.

I shall now proceed to some remarks on the zoological composition of the Pelagic fauna and its probable history in the past. The present Pelagic fauna may be regarded as consisting of two constitutents, firstly, a number of species belonging to a series of orders and subclasses which are absolutely peculiar to it, that is to say, which have no representatives which are littoral or terrestrial, and are not at any period of their existence other than Pelagic. We may reckon about nine such groups. There is no group which rises undoubtedly to the rank of a class which is thus Pelagic only. The groups are as follows, the Siphonophora, Ctenophora,[1] Chætognatha, Heteropoda, Pteropoda, Larvalia, Salpæ, Pyrosomidæ, Cetacea.

Of the antiquity of the Siphonophora we know nothing directly, for they do not occur at all as fossils, and as they are like most pelagic forms ill adapted for preservation as fossils, it is impossible to conjecture whether they are of quite modern or of ancient origin. They are complex colonies of animals of various forms united together and performing separate functions for the common good of the colony. They are offsets of the Hydromedusæ, and thus derived originally from a pelagic planula ancestor, but it seems uncertain whether they have subsequently sprung from a once fixed hydromedusa stock set free, or have been free and pelagic throughout their history. The Ctenophora are also an offset from the Hydromedusæ; they also have as yet no geological history. Their ancestors have probably always from the planula upwards led a free pelagic life. The history of the Chætognatha (Sagitta) is obscure. The Heteropods and Pteropods are derived from a common pelagic veliger ancestor which existed as early at least as Silurian times, and this ancestor probably descended from a trochosphere also pelagic.

The Larvalia, the Ascidian Appendicularia and its allies, near relatives of the ancestral vertebrata, probably have always been Pelagic and have existed in something like their present form from a very early period, whilst the Pyrosomidæ after branching off from the same stock as simple animals have possibly undergone a fixed sessile condition as compounds before becoming again Pelagic.

If Prof. Ray Lankester is correct in his suggestion (in his British Association lecture on "Degeneration") that very possibly an ancestor of all the vertebrata, including man himself was once pelagic, because the peculiar mode of the development of the eye of vertebrates can only be accounted for by the supposition that the tissues of the head were completely transparent and from other considerations; then the whales are now so to speak for the second time pelagic in the history of life. Their more immediate ancestors, allies of the seals, and sprung from the common progenitor of the stock of placental mammals, took afresh to the sea and gradually relinquished the shore altogether.

The second division of the Pelagic fauna is composed of numerous representatives of various classes and orders of animals, the majority of members of which are inhabitants of the sea bottoms, shores or land surfaces, but which representatives are mostly specially modified in remarkable ways to fit them for pelagic existence. Only a few of these can now be touched on. Although there are abundance of Cilioflagellata which are pelagic, there seem to be very few true Infusoria (or Ciliata) which are so, at least very few have as yet been recorded as such, and none at all known from any great distances from land. The few as yet known all belong to one family of the Peritricha, the Tintinnidæ. Codonella, one of them, of which a representation is now on the screen, is bell-shaped and remarkable for being provided with a siliceous protecting shell.

There are even sea anemonies which have taken to Pelagic existence, and are to be found in great quantities on the ocean surface at times. They are exactly like the ordinary sea anemonies of our shores, excepting that their base instead of

[1] Ch. Lutken, Spolia Atlantica. Copenhagen, 1880, p, 426.

[1] It is possible as suggested by the late Prof. Balfour, that Kowalensky's Cœloplana may prove to be a creeping Ctenophor.

being flat for adherence to rocks is closed in so as to hold a small mass of air. Suspended by the buoy so formed, they float at the surface mouth downwards. The one of which a figure is now on the screen *Minyas cærulea*, is remarable as being one of the small band of Pelagic animals which is coloured deep blue. There are also Pelagic insects of the genus Halobates of the Bug family, and closely allied to the common water bugs which skip on the surfaces of our ponds. Halobates is found clinging to the surface of the waves at all distances from land in the open oceans, and outrides the heaviest storms.

There are many Pelagic fishes; I have already shown you the dolphin (Coryphæna). Here is a figure of one of the Ribbon Fishes, the scarce Regalecus. This fish has usually been supposed to be a pelagic fish, but Dr. Gunther is persuaded that it is a true deep-sea fish, though it has not yet been caught in any deep-sea net, only picked up dead on the surface. There are many similar fishes about which some difference of opinion as yet exists as to their habits. The young of the Ribbon Fishes are found alive at the sea surface, and the group may therefore perhaps yield another instance of the connection of Pelagic with deep-sea forms. The Pelagic snakes are interesting as, to some extent, modern representatives of the Eocene sea serpents (Titanophis), for though they come on shore to produce their young, their existence is mostly spent at the sea surface often far from land, and they are specially modified both in the structure of their lungs, and the ribbon-like flattening of their tails for pelagic existence.

There is one lizard, the well known Amblyrhynchus of the Galapagos Islands, described by Mr. Darwin in his Journal, which though it cannot in any way be termed pelagic swims out to sea, and as the only recent one which does so is worth mention as a sort of representative of the gigantic pelagic lizards of Mesozoic periods such as Mososaurus.

With so many groups of the animal kingdom contributing to the Pelagic fauna, it is remarkable that some large groups should be entirely unrepresented within it. There are no adult Pelagic sponges, no Alcyonarians, no Sipunculids, no Brachiopods, no Lamellibranchs, and lastly no Echinoderms. Considering the curious adaptations to Pelagic life which have been undergone by such forms as sea anemonies, nemertines, compound ascidians and gasteropods, it is most easy to conceive how Lamellibranchs for example taking after the habit of flying as it were butterfly fashion through the water like *Lima hyans*, might have become Pelagic, and how Echini taking after Minyas, or Comatulæ swimming with their arms or Holothurians in various ways might have assumed a Pelagic dress, but no Lamellibranch, and no Echinoderm seems ever in the long record of the past to have been Pelagic since the time of their earliest Pelagic ancestors, unless possibly Saccoma of the lithographic state was Pelagic.

With regard to the history of the Pelagic fauna in the past. There can be no doubt, as Prof. Weissmann so well puts it, that "the birth place of all animal and plant life lay in the sea." It is probable that a considerable part of earliest life which existed must have been Pelagic, and that the ancient Pelagic fauna was to a large extent the parent of all other life. The developmental history of all marine animals points clearly in this direction, closely similar transparent Pelagic larval forms being common to groups of widely different adult littoral forms. The resemblance between the larvæ of these adult forms can hardly be conceived to have been arrived at by natural selection after the adult forms had already diverged from one another. It is only to be explained on the hypothesis of an original Pelagic ancestral condition. One of tire Monera, Protomyxa aurantiaca, is even now a Pelagic form, having been found by Prof. Haeckel adhering to a floating spirula shell.

From the recent interesting researches of Dr. Nathorst,[1] we know that Scyphomedusæ closely like those now swimming in Southampton Water, were already amongst the Pelagic fauna of the Cambrian Sea, whilst the mud at the same time swarmed with annelids very similar to those now existing. At the same remote epoch Brachiopods, Corals, Echinoderms, Crustacea, and other forms were already present on the coasts.

The Precambrian Pelagic fauna must therefore probably have contained sexually mature representatives of the Planula, the Bilateral Echinoderm larva, the Ephyra (which survives as such to the present day), the Trochosphere and the Nauplius. During the Cambrian period or earlier, was added the Cypris ancestor of Cirripeds, and the vertebrate ancestor, and the Trilobite Æglina with gigantic eyes found its place in the dim light somewhere, possibly amongst the Pelagic fauna. In Silurian times Pteropods were added to the Pelagic throng, some gigantic forms of which nearly a foot in length are now extinct, whilst one genus then present still flourishes in modern seas, the Heteropods also appeared (Bellerophon) and Cirriped larvæ, and the Graptoliths, possibly Pelagic, appeared and became extinct. In the Devonian period certain sharks and rays and ganoid fishes probably took to Pelagic life. Pelagic representatives of the sharks and rays still flourish, but the ganoids have retreated to the fresh waters. In the early Secondary period Globigerina appeared and a few Radiolarians, and the dibranchiate cephalopods came into being and soon the sea swarmed with the Pelagic Belemnites. The air-breathing reptiles whose ancestors had quitted sea life and gone on shore came back to Pelagic life and the Ichthyosaurus with enormous eyes chased the Pelagic prey in the depths, or hunted at night. Somewhat later the ancestors of the Mososaurids took to the sea; and their progeny became entirely Pelagic and as huge as whales.

[1] Svenska Vetensk. Akad. Hand., No. 7, Bd. xviii.

In early tertiary times, or shortly before that, various mammalia took to the sea, and amongst them the whales became entirely pelagic and relinquished the shore altogether. Some animals have apparently taken to oceanic life, in very recent times indeed. Ianthina is an instance in point, it has not as yet been discovered in the fossil condition at all, nor any close allies of it.

Somewhat thus has the Pelagic fauna grown up, having been partly composed of animals: the ancestry of which has probably led a Pelagic life from the earliest times, and partly added to, at all ages by inhabitants of the coast, and the dry land which have as it were from time to time run away to sea.

In conclusion, I can only say that it has given me the greatest pleasure to address a lecture to you on the present subject in a city, the population of which is itself so largely Pelagic. It is to a considerable extent through the careful collecting of the Captains of merchant vessels interested in zoology on the high seas, who have gathered specimens for the Museums of their home ports, that many of the facts I have laid before you to-night have been brought to light, and all praise is due to them for the fact.

UNDERGROUND TEMPERATURE

THE Underground Temperature Committee of the British Association have presented a summary (drawn up by Prof. Everett) of the results contained in all their reports (fifteen in number) up to the present date, of which the following is an abridgment:—

The results are classified under the heads: A. Instruments. B. Methods of observation. C. Questions affecting correctness of observations. D. Questions affecting deductions from observations. E. Comparison of results. F. Mean rate of increase of temperature with depth, and mean upward flow of heat.

A. INSTRUMENTS.—Under this head we have: 1. Instruments for observing temperature. 2. Subsidiary apparatus.

1. The thermometers which the Committee have employed have been of two kinds—slow-action thermometers and maximum thermometers. The present pattern of slow-action thermometer consists of a thermometer having its bulb surrounded by stearine or tallow, the whole instrument being hermetically sealed within a glass jacket, and had its origin in a conference between the secretary and Dr. Stapff in the St. Gothard Tunnel.

Our present patterns of maximum thermometer are two—the Phillips, and the Inverted Negretti—both being hermetically sealed in strong glass jackets to prevent the bulbs from receiving pressure when lowered to a great depth in water.

Both instruments are used in a vertical position, and they register truly in spite of jolts in hauling up.

References to Becquerel's thermo-electric method of observing underground temperature were made in three of the reports, and some laboratory experiments were subsequently carried out by the secretary, which led to the conclusion that the method could not be relied on to yield sufficiently accurate results. It may be mentioned that Becquerel's observations are only carried to the depth of 100 feet, whereas we require observations at the depth of 1000 or 2000 feet.

2. Under the head of subsidiary (that is non-thermometric)

apparatus, plugs for preventing convection-current in a bore or well are referred to. Prof. Lebour's umbrella-like plug, in its final form, appears to be very convenient, as it requires only one wire. It remains collapsed so long as the wire is taut, but opens out and plugs the hole when it becomes slack.

B. METHODS OF OBSERVATION.—These have chiefly been of two kinds: 1. Observations in holes bored to the depth of a few feet in newly-opened rock, either in the workings of a mine or a tunnel, or in a shaft during the sinking. The rock should not have been exposed for more than a week when the hole is bored, and a day may be allowed to elapse for the heat generated by boring to escape before the thermometer is inserted. Very complete plugging is necessary to exclude the influence of the external air. It is desirable to use about two feet of plugging, of which the outer part should be made air-tight with plastic clay or greased rag. After the lapse of a few days, the thermometer is to be drawn out by means of a string attached to the handle of its copper case, and the reading taken. The slow-action thermometer above described is employed for this purpose, and there is time to read it with sufficient deliberation before any appreciable change occurs in its indication. It is recommended that the thermometer be then reinserted and plugged as before, and a second reading taken after the lapse of a week. The majority of our successful observations have been made by this method.

2. Observations in deep bores of small diameter. The first report contained a successful application of this method to a bore about 350 feet deep, near Glasgow, which gave very regular results in a series of observations at every sixtieth foot of depth; but in the majority of instances in which it has since been applied, there have been marked irregularities, due apparently to the influx of water from springs at particular points. One of the most valuable of our results was obtained by the application of the method to a bore 863 feet deep, executed at the bottom of a coal mine 1066 feet deep, giving a total depth of 1929 feet. The bore in this case was dry at the time of its execution, though full of water at the time of the observation. It was in South Hetton Colliery, Durham. The instrument generally employed in the observations of this class was a maximum thermometer of either the Phillips or the Inverted Negretti construction.

The larger the diameter of the bore, the more uncertain does this mode of observation become. The South Hetton bore had a diameter of 2½ inches. The Kentish Town well, 1000 feet deep, in which Mr. Symons' observations were made, had a diameter of 8 inches, and the well 660 metres deep at La Chapelle, in the north of Paris, had a diameter of 4½ feet (V., VI., VII.). The temperatures in this last were proved to be largely affected by convection, the water at the top being too warm, and that at the bottom not warm enough. The observations of Herr Dunker, in the bore at Sperenberg, near Berlin, with a depth of 3390 feet and a diameter of 12 inches, proved a similar disturbance, amounting at the top and bottom, to several degrees. As regards the bottom, the proof consisted in showing that when a thermometer at the bottom was protected by a tight plug from the influence of the water above, its indications were higher by 3° R. (= 6¾° F.) than when this precaution was not employed.

C. QUESTIONS AFFECTING THE CORRECTNESS OF THE OBSERVATIONS MADE might theoretically include questions as to the correct working of the instruments employed, and as to the personal reliability of observers; but the latter topic has not come into discussion, and the former has not arisen since our present patterns of instrument came into use. The questions for discussion are thus confined to those which relate to possible differences between the temperature of the point at which the thermometer was placed and the normal temperature at the same depth in its vicinity.

1. The heat generated by the action of the boring tool will vitiate the observation if sufficient time is not allowed for its escape.

A very full discussion of this subject in connection with the great artesian well at La Chapelle will be found in reports V., VI., and VII., clearly establishing the fact that the temperature at the bottom both on the third and the sixth day after the cessation of boring operations, was 7¼° F. higher than after the lapse of four months, though the water had been left to itself during this interval. Further evidence showing that the temperature in the lower part of a bore full of water may thus be raised several degrees, is furnished by the Sub-Wealden bore.

2. The generation of heat by local chemical action is well known to be a powerful disturbing cause when pyrites is present. The observers in the mines of Schemnitz say, "Pyrites and also decaying timber were avoided, as being known to generate heat." The observations in the coal mines of Anzin show a temperature of 70¾° F. in shaft IV. (a very dry one) at the depth of 21·2 metres, or less than 70 feet. This must be about 15° F. above the normal temperature. In shaft II. the observer mentions that there was, at a depth of 90m., a seam of coal in which heat was generated by oxidation.

At Talargoch lead mine, in Flintshire, the discrepancies between the temperatures at the six observing stations are suggestive of local chemical action.

3. Convection of heat has proved a very troublesome disturbing cause.

As to convection of heat by air in a shaft or well not filled with water, evidence will be found in the second report, both in the case of Mr. Hunter's observations in the shafts of two salt mines at Carrickfergus, having the depths of 570 and 770 feet respectively, and in the case of Mr. Symons' observations at Kentish Town, where the first 210 feet of the well are occupied with air. At the depth of 150 feet the temperature was 52·1 in January, and 54·7 in July.

Convection of heat by water in old shafts which have been allowed to become flooded, is very manifest in some of the observations communicated by Mr. Burns in the second and fourth reports. In Allendale shaft (Northumberland), 300 feet deep, with about 150 feet of water, the temperature was practically the same at all depths in the water, and this was also the case in Breckon Hill Shaft, where the observations extended from the depth of 42 feet to that of 350 feet. A similar state of things was found in a shaft at Ashburton (Devon) by Mr. Amery, who observed at every fiftieth foot of depth down to 350 feet.

Convection by water in the great well at La Chapelle, 660 m. (2165 feet) deep, and 1·35 m. (4 feet 5 inches) in diameter at the bottom, appears probable from the following comparisons:—

Very concordant observations (communicated by M. Walferdin to *Comptes rendus* for 1838) at three different wells in the Paris basin of the respective depths of 263 m., 400 m., and 600 m., show by comparison with one another and with the constant temperature in the artificial caves under the Paris Observatory a rate of increase of 1° F. in 56 or 57 feet. These data would give, at the depth of 100 m., or 328 feet, a temperature of 57°, and at the depth of 660 m., or 2165 feet, a temperature of 90°; whereas the temperatures actually observed at those depths in the well at La Chapelle in October, 1873, when the water had been undisturbed for a year and four months, were 59°·5 and 76°. It thus appears probable that the upper part of the well is warmed, and the lower part cooled, by convection. Further light may be expected to be thrown on this point when the well reaches the springs, and the water spouts above the surface, as it does at the Puits de Grenelle. A letter received by the secretary in July, 1882, states that engineering difficulties have prevented any deepening of the well since the above observations, but that arrangements for this purpose have now been made.

More certain and precise information as to the effect of convection in deep bores is furnished by the experiments of Herr Dunker at Sperenberg. The principal bore at Sperenberg has a depth of 4052 Rhenish, or 4172 English feet, and is entirely in rock salt, with the exception of the first 283 feet. Observations were first taken (with a maximum thermometer on the overflow principle) at numerous depths, from 100 feet to the bottom, and showed a fairly regular increase of temperature downwards. The temperature at 700 feet was 16°·08 R., and at 3390 feet 34°·1 R. Plugs were then contrived which could be fixed tight in the bore at any depth with the thermometer between them, or could be fixed above the thermometer for observing at the bottom. Convection was thus prevented, and a difference of one or two degrees Réaumur was found in the temperatures at most of the depths; at 700 feet the temperature was now 17°·06 R., and at 3390 feet 36°·15. We have thus direct evidence that convection had made the temperature at 3390 feet 2°·05 R., or 4°·6 F. too low; and this, as Herr Dunker remarks, is an under-estimate of the error, inasmuch as convection had been exerting its equalising action for a long time, and its effect could not be completely destroyed in the comparatively short time that the plugs were in position. Again, as regards the effect of convection on the upper part of the bore, the temperature 11°·0 R was observed at the depth of 100 feet in the principal bore when no plugs were employed, while a second bore only 100 feet deep in its immediate vicinity showed a temperature 9°·0 R. at the bottom. This is direct evidence that the water near the top of the great bore had been warmed 2° R., or 4½° F. by convection.

Suggestions for observations in filled-up bores will be found in the eleventh report, but they have not yet taken a practical shape.

D. QUESTIONS AFFECTING DEDUCTIONS FROM OBSERVATIONS.—1. In many instances the observations of temperature have been confined to considerable depths, and in order to deduce the mean rate of increase from the surface downwards it has been necessary to assume the mean temperature of the surface. To do this correctly is all the more difficult, because there seems to be a sensible difference between the mean temperature of the surface and that of the air a few feet above it.

In the third report some information on this point is given, based on observations of thermometers 22 inches deep at some of the stations of the Scottish Meteorological Society, and of thermometers 3 (French) feet deep at Greenwich and at Edinburgh. These observations point to an excess of surface-temperature above air-temperature, ranging from half a degree to nearly two degrees, and having an average value of about one degree.

Dr. Schwartz, Professor of Physics in the Imperial School of Mines at Schemnitz, in sending his observations made in the mines at that place, remarks on this point:—

"Observations in various localities show that in sandy soils the excess in question amounts, on the average, to about half a degree Centigrade. In this locality the surface is a compact rock, which is highly heated by the sun in summer, and is protected from radiation by a covering of snow in winter; and the conformation of the hills in the neighbourhood is such as to give protection against the prevailing winds. Hence the excess is probably greater here than in most places, and may fairly be assumed to be double the above average."

Some excellent observations of underground temperature at small depths were made at the Botanic Gardens, Regent's Park, London, for the six years 1871-76, along with observations of air-temperature, and have been reduced by Mr. Symons. They are at depths of 3, 6, 12, 24, and 48 inches beneath a surface of grass, and their joint mean derived from readings at 9 a.m. and 9 p.m. for the six years is 49·9, the mean for the 48-inch thermometer being 50·05. The mean air-temperature derived in the same way from the readings of the dry-bulb thermometer is 49·6. Hence it appears that the excess of soil above air is in this case about 0°·4.

Quetelet's observations for three years at Brussels (p. 48 of his "Mémoire") make the earth, at depths less than 1½ foot, colder than the air, and at greater depths warmer than the air.

Caldecott's observations for three years at Trevandrum, in India, make the ground at the depth of 3 feet warmer than the air by 5°·7 F.

Dr. Stapff, in his elaborate publications on the temperature of the St. Gothard Tunnel, arrives at the conclusion that the mean temperature of the soil on the surface of the mountain above the tunnel is some degrees higher than that of the air, the excess increasing with the height of the surface and ranging from 2° or 3° C. near the ends of the tunnel, to 5° or 6° in the neighbourhood of the central ridge.

2. Connected with this is the question—Whether the mean annual temperature of the soil increases downwards from the surface itself, or whether, as is sometimes asserted, the increase only begins where annual range ceases to be sensible—say at a depth of 50 or 60 feet.

The general answer is obvious from the nature of conduction. Starting with the fact that temperature increases downwards at depths where the annual range is insensible, it follows that heat is travelling upwards, because heat will always pass from a hotter to a colder stratum. This heat must make its way to the surface and escape there. But it could not make its way to the surface unless the mean temperature diminished in approaching the surface; for if two superposed layers had the same mean temperature, just as much heat would pass from the upper to the lower as from the lower to the upper, and there would not be that excess of upward flow which is necessary to carry off the perennial supply from below.

This reasoning is rigorously true if the conductivity at a given depth be independent of the temperature, and be the same all the year round. By "conductivity" we are to understand the "flux of heat" divided by the "temperature-gradient"; where by the "flux of heat" is meant the quantity of heat which flows in one second across unit-area at the depth considered, and by the "temperature-gradient" is meant the difference of temperature per foot of descent at the depth and time considered.

Convection of heat by the percolation of water is here to be regarded as included in conduction. If the conductivity as thus defined were the same all the year round, the increase of mean temperature per foot of depth would be independent of the annual range, and would be the same as if this range did not exist.

As a matter of fact, out of six stations at which first-class underground thermometers have been observed, five show an increase downwards, and one a decrease. The following are the results obtained for the depths of 3, 12, and 24 French feet:—

	3 feet.	12 feet.	24 feet.
Brussels, three years	51·85	53·69	53·71
Edinburgh (Craigleith) five years ...	45·88	45·92	46·07
,, (Gardens) five years ...	46·13	46·76	47·09
,, (Observatory), seventeen years	46·27	46·92	47·18
Trevandrum (India), three years ...	85·71	86·12	—
Greenwich, fourteen years	50·92	50·61	50·28

In calculating the mean temperature at 12 feet for Trevandrum, we have assumed the temperature of May, which is wanting, to be the same as that of April.

Omitting Trevandrum, and taking the mean values at 3 and 24 French feet, we find an increase of ·656 of a degree in 21 French feet, which is at the rate of 1° for 32 French, or about 34 English feet.

3. Another question which it has sometimes been necessary to discuss is the influence which the form of the surface exerts on the rate of increase of temperature with depth.

The surface itself is not in general isothermal, but its temperature is least where its elevation is greatest; the rate of decrease upwards or increase downwards being generally estimated at 1° F. for 300 feet. This is only about one-fifth of the average rate of increase downwards in the substance of the earth itself beneath a level surface. If the two rates were the same, the isotherms in the interior of a mountain would be horizontal, and the form of the surface would have no influence on the rate of increase of temperature with depth. The two extreme assumptions that the surface is an isotherm, and that the isotherms are horizontal, lie on opposite sides of the truth. The isotherms, where they meet the sides of the mountain, slope in the same direction as the sides of the mountain, but to a less degree. Probably the tangents of the two slopes are generally about as 3 to 4.

Further, if we draw a vertical line cutting two isotherms, the lower one must have less slope than the upper, because the elevations and depressions are smoothed off as the depth increases.

The practical inference is that the distance between the isotherms (in other words, the number of feet for 1° of increase), is greatest under mountain crests and ridges, and is least under bowl-shaped or trough-shaped hollows.

The observations in the Mont Cenis tunnel, and the much more complete observations made by Dr. Stapff in the St. Gothard tunnel, fully bear out these predictions from theory. The discussion of the former occurs in the fourth report, p. 15.

As regards the St. Gothard tunnel, Dr. Stapff reports:—"The mean rate of increase downwards in the whole length of the tunnel is ·02068 of a degree Centigrade per metre of depth, measured from the surface directly over. This is 1° F. for 88 feet. Where the surface is a steep ridge the increase is less rapid than this average; where the surface is a valley or plain the increase is more rapid."

4. The question whether the rate of increase downwards is upon the whole the same at all depths, was raised by Prof. Mohr in his comments upon the Sperenberg observations, and is discussed, so far as these observations bear upon it, in the 9th and 11th reports.

Against the Sperenberg observations, which upon the whole show a retardation of the rate of increase as we go deeper, may now be set the Dukinfield observations begun by Sir William Fairbairn, and continued by Mr. Garside. Taking Mr. Garside's observations, and assuming a surface-temperature of 49°, the increase in the first 198⅞ feet is at the rate of 1° in 79·5 feet; in the next 420 feet it is at the rate of 1° in 70 feet, and in the last 283⅓ feet it is at the rate of 1° in 51½ feet.

From a theoretical point of view, in places where there is no local generation of heat by chemical action, the case stands thus:—

The flow of heat upwards must be the same at all depths, and this flow is equal to the rate of increase downwards, multiplied by the conductivity, using the word "conductivity" (as above explained) in such a sense as to include convection. The rate of increase downwards must, therefore, be the same at all depths at which this conductivity is the same.

This reasoning applies to superposed strata at the same place, and assumes them to be sufficiently regular in their arrangement to ensure that the flow of heat shall be in parallel lines, not in converging or diverging lines.

5. If we have reason to believe that the flow of heat upwards is nearly the same at all places, then the above reasoning can also be applied approximately to the comparison of one place with another—that is to say, the rates of increase downwards, in two masses of rock at two different places, must be approximately in the inverse ratio of their conductivities. In the cooling of a heated sphere of heterogeneous composition, the rates of flow would at first be very unequal through different parts of the surface, being most rapid through those portions of the substance which conducted best; but these portions would thus be more rapidly drained of their heat than the other portions, and thus their rates of flow would fall off more rapidly than the rates of flow in the other portions. If the only differences in the material were differences of conductivity, we might on this account expect the outflow to be after a long time nearly the same at all parts of the surface. But when we come to consider differences of "thermal capacity per unit volume," it is clear that with equal values of "diffusivity," that is of "conductivity divided by thermal capacity of unit volume" in two places, say in two adjacent sectors of the globe, there would be the same distribution of temperatures in both, but not the same flow of heat, this latter being greatest in the sector in which the capacity and conductivity were greatest.

Where we find, as in Mr. Deacon's observations at Bootle, near Liverpool, and to a less marked degree in the observations of Sir William Fairbairn and Mr. Garside, near Manchester, an exceptionally slow rate of increase, without exceptionally good conductivity, it is open to us to fall back on the explanation of exceptionally small thermal capacity per unit volume in the underlying region of the earth, perhaps at depths of from a few miles to a few hundred miles.

6. A question which was brought into consideration by Prof. Hull, in connection with the great difference between the rate of increase at Dukinfield and that at Rosebridge, is the effect of the dip of the strata upon the vertical conduction of heat. Laminated rocks conduct heat much better along the planes of lamination than at right angles to them. If k_1 denote the conductivity along, and k_2 the conductivity normal to the planes of lamination, and if these planes are inclined at an angle θ to the horizon, the number of feet per degree of increase downwards correrponding to a given rate of outflow through the surface, will be the same as if the flow were vertical with a vertical conductivity :—

$$k_1 \sin^2 \theta + k_2 \cos^2 \theta.$$

Prof. Herschel finds about 1·3 as the ratio of the two principal conductivities in Loch Rannoch flagstone, and 1·875 as the ratio in Festiniog slate.

The dip of the strata at Dukinfield is stated by Mr. Garside to be $15°$, and we have $\sin^2 15° = \cdot 07$, $\cos^2 15° = \cdot 93$.

If we assume $k_1 = 1\cdot 3\, k_2$, as in the case of flagstone, we find for the effective vertical conductivity $k_2\,(\cdot 09 + \cdot 93) = 1\cdot 02\, k_2$, so that the number of feet per degree would only be increased by 2 per cent.

It is not likely that the two conductivities in the strata at Dukinfield are so unequal as even in the case of flagstone, so that 2 per cent. is a high estimate of the effect of their dip on the vertical rate of increase so far as pure conduction is concerned. The effect of dip in promoting the percolation of water is a distinct consideration, but the workings of the Dukinfield mines are so dry that this action does not seem to be important.[1]

(*To be continued.*)

METAMORPHIC ROCKS OF BERGEN[2]

THE metamorphic rocks of the Bergen Peninsula in Norway continue to attract the attention of Norwegian geologists, and we have before us, as an addition to the well-known works of Naumann, Leopold von Buch, Esmark, Keilhau, Kjerulf, and Hjörtdal, a new elaborate and interesting work by M. Hans H. Reusch, which deals with the same subject. These rocks consist, as is known, of a variety of quartziferous talc-mica schists, diorite, clay-slates, conglomerates, and strongly-developed gneisses and granites. Various and very different opinions have been expressed as to the origin of these rocks. The researches of M. Reusch give a key to this question, as he has discovered in the clay-slates, which seem to constitute the upper part of these vertical strata, numerous fossils belonging to the lower part of the Upper Silurian formations, namely *Halysites catenularia* and *Cyathophyllum*, changed into white calcareous spar, a few tubular bodies (presumably *Syringophyllum organum*), some gasteropods (*Murchisonia* or *Subulites?*) some trilobites, as *Calymene*, also *Phacops* or *Dalmannites*, and some brachiopods. The presence ot these fossils is the more interesting as the whole series of schists was often considered as of igneous origin. As to the gneisses and gneisso-granites of the peninsula, M. Reusch has given great attention to their structure and to the remarkable results of pressure which the rocks have undergone. He shows how granitic veins were folded and crumpled, how a kind of transversal stratification has arisen in beds of stratified gneiss under the influence of pressure, and he concludes, from an accurate study of the subject, that altogether the rocks show a far greater degree of plasticity than might have been supposed. "It seems that there are masses, as, for instance, the gneiss of Svenningdal, that have on one side a true stratified structure (not merely parallel or schistose structure) which could hardly be found in a rock of igneous origin, and on the other side send veins, or have included fragments which have undergone metamorphic changes."

One of the most attractive features of M. Reusch's work is the attention he has given to metamorphic phenomena and to changes caused by the pressure undergone by strata during their folding. The metamorphic phenomena were especially studied in the Osören district. The limestone which contains Silurian fossils has become marble, and the cause of metamorphism was not contact with some eruptive rock, but rather (as was observed in the Bernese Oberland by Swiss geologists) pressure and the molecular movements which pressure has occasioned in rocks. The clay, in which trilobites and other animals were entombed at Vagtdalen, has become a rock like muscovite-schist with porphyritically inclosed clusters of mica. As to the gneiss which appears among undoubtedly Silurian rocks, the author is inclined to consider it as sedimentary and as having been originally formed of loose materials. The granulite is clearly stratified and of sedimentary origin. The changes produced by the folding of strata and by the pressure they have undergone, are described with much accuracy and illustrated by many drawings. The fossils are nearly all compressed and elongated; the formerly conical coralla have received the shape of flat elongated biscuits, in accordance with the direction of pressure and stretching. The same is true with regard to all other fossils. In the green conglomerates at Osören, all the stones are flattened and elongated, acquiring thus a shape which they could not have possessed originally; very many of them have such a shape as to give in a cross-section the form of a lance-shaped leaf. The same structure, remarks the author, may be observed with the aid of a microscope in the "hones" from Eidsmarken in the South of Norway. Altogether the work of M. Reusch, although not rich in conclusions and generalisations, will be a welcome addition to the accurate knowledge of the still little understood metamorphic rocks. The Norwegian text of this work is accompanied with a rather too short *résumé* in English.

P. K.

[1] Though the workings are dry there is a large quantity of water in the superincumbent strata.

[2] Hans H. Reusch, "Silurfossiler og Pressede Konglomerater i Bergenskifrene."—Universitetsprogramm for förste Halvaar (1883). Kristiania, 1882.

CHEMICAL NOTES

CARNELLEY [*Chem. Soc. Jul.* Trans., 1881, p. 317] has repeated his experiments on the effect of pressure on the melting-point of mercuric chloride, and has obtained results which show that this salt cannot be obtained in the solid state at temperatures appreciably above its melting-point.

JAHN [*Berliner Berichte*, xv. p. 1238] has made a series of careful determinations of the density of bromine vapour, which, when compared with similar observations on chlorine made by Ludwig, show that bromine vapour does not attain the normal density (Br = 79·95) until it is heated to 160° above its boiling-point; and also that although chlorine exhibits smaller divergences from the normal density than bromine, it nevertheless must be heated about 240° above its boiling-point before its density becomes strictly normal. From the experiments of V. Meyer and others, iodine vapour appears to be normal a very few degrees above the boiling-point. It appears, therefore, probable that vapour of chlorine, bromine, or iodine at low temperatures, contains groups of molecules which are dissociated as the temperature rises, and that the greater the molecular weight the more easily are these molecular groups dissociated.

REFERENCE was made in a note (NATURE, vol. xxvi. p. 306), to Spring's researches on the expansion of isomorphous compounds; in last number of the *Berliner Berichte* Pettersson draws attention to accurate determinations of the specific gravities of various alums, published by him a few years ago, which proved that the quotients of the specific gravities of the alums by their respective formula weights, are not equal, as assumed by Spring, but show considerable differences. Spring's work on the expansion of alums may lead to interesting results, but it seems evident that he has been too hasty in drawing sweeping conclusions regarding the molecular structure of solids from quite insufficient data.

HERR G. KRUSS describes [*Berliner Berichte*, xv. 1243] a spectroscopic method for determining whether there is, or is not, any chemical action occurring in a solution containing two or more coloured salts. The method consists essentially in comparing the sums of the absorption spectra of the individual salts with the absorption spectrum of the solution containing all the salts.

AN abstract of an important paper by Mendelejeff on thermochemistry appeared in the *Berichte* for July 10 [xx. 1555]. Mendelejeff asserts that the data hitherto attained by Berthelot, Thomsen, and others, regarding the "heats of formation" of hydrocarbons stand in need of correction, because allowance has not been made for the physical changes, involving absorption or evolution of heat, which in every case accompany the chemical changes considered. Mendelejeff gives a table showing the "heats of formation" from marsh gas, carbon monoxide, and carbon dioxide, of a series of hydrocarbons; the chemical reactions, the thermal equivalents of which are set down in this table, are reactions which actually occur, unlike the reactions of formation of Berthelot and others, which as a rule cannot be realised in actual experiments.

MESSRS. SMITH AND LOWE find that when chlorine is passed through a porcelain tube heated to 1030°, and then into potassium iodide solution, less iodine is liberated than is the case when the same quantity of chlorine is allowed to act on the iodide at ordinary temperature; they conclude, therefore, that chlorine is partly dissociated at a temperature of 1030° (*Chem. News*, xlv. 226).

ACCORDING to Mixter (*Amer. Chem. J.*, iv. 35), urea is readily obtained by passing ammonia and carbon dioxide through a red-hot tube: ammonium cyanate is probably produced, and then transformed into urea.

SELMI (*R. Acad. dei Lincei*, v. 174) states that he has found alkaloidal compounds having specific poisonous actions in the urine of patients suffering from paralysis, tetanus, &c. He considers death to be determined by the action of these poisons produced by the progress of the disease.

BY electrolysing water by a powerful current, using a positive electrode of gas-coke purified by the action of chlorine at a very high temperature, Bartoli and Papasogli (*Gazzetta Chim. Ital.*, 1882, 113) obtained a black solution, which, when acidified with hydrochloric acid, yielded a black substance having the composition $C_{11}H_2O_4$ (when dried at 140°). The properties of this substance—*Mellogen*—are very peculiar; in some points it resembles graphitic acid; it dissolves in water to form an inky-black neutral liquid: on exposure to air or by the action of oxidising agents it yields mellitic acid and other acids, which are generally regarded as addition products of benzene.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

PROF. BONNEY begins his course of lectures on Petrology, Physiography, and Stratigraphical Geology at University College, Gower Street, on October 10, at twelve o'clock. The course will extend over two terms. Classes will also be formed for catechetical instruction and for the study of the microscopic structure of rocks.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 25.—M. Blanchard in the chair.—A report was given of the ceremony at the recent inauguration of a statue to Antoine-César Becquerel at Châtillon-sur-Loing, on September 24, when addresses were delivered by MM. Cochery, Dumas, Fremy, Mercadier, Barral, and the Mayor.—On a question of principle which relates to the theory of shock of imperfectly elastic bodies, by M. Resal.—Outbreaks of plague in Kurdistan during the last twelve years, by M. Thalozan. The facts are thought to afford further proof of the independence of most of the plague-centres, the small tendency of the disease to spread beyond a small number of localities, and the limited duration of the epidemics, even in their gravest form. The north and north-west of Persia are the parts where plague-epidemics are less rare.—Possibility of introducing a tube into the larynx without producing pain or any reaction, by M. Brown-Séquard. He produces local anæsthesia in mammalia by directing a rapid current of carbonic acid on the upper part of the larynx (through an incision), for a variable time (fifteen seconds to two or three minutes). The effect lasts two to eight minutes after stoppage.—A telegram from the Emperor of Brazil (dated Rio, September 12, 6h. 10m.), announced the observation (at Rio Observatory) of a brilliant comet; estimated position in the morning, ascension 10h., declination 2° S. "probably Pena's comet expected.—On a comet observed at Nice, by MM. Thollon and Gouy. This was visible near the sun on September 18, at mid-day, to the naked eye, when the direct solar rays were masked. The spectrum had for essential character the presence of the bright lines of sodium (fine and perfectly separate) in the nucleus and parts near. A slight displacement was held to indicate withdrawal from the earth. No part of the comet showed bands of carbon, nor any band or line but those of sodium (probably because of a masking by diffuse light). On the morning of the 21st the comet had become invisible.—M. Flammarion communicated telegrams from Spain, Portugal, the South of France, Algeria, and Italy, announcing observations of a comet on September 17, 18, and 19.—On an observation of the great comet of 1882, seen from a balloon, by M. de Fonvielle. M. Mallet made the ascent at his request (having keener vision), and took some measurements. The diameter of the comet was about two-tenths of that of the sun, and the distance of the comet's centre from that of the sun about 2·3 subjective diameters of the sun. The cometary sphere was penetrated by an isosceles cone, symmetrically placed to the line of centres, penetrating to two-thirds of its vertical meridian plane. The length of the apothem of the cone was about a solar radius.—Description of a complete regular dodecahedron, by M. Barbier.—On the development of Alcyonarians, by MM. Kowalewsky and Marion.—On the histological structure of the digestive tube of *Holothuria tubulosa*, by M. Sourdan.—Analysis of the milk of Galibi women at the Jardin d'Acclimatation, by Mdme. Brès. The milk is rich in butter and lactose, and there is very little caseïn.

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