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THURSDAY, APRIL 1, 1875

DEEP-SEA FISHING

Deep-Sea Fishing and Fishing Boats. An Account of the Practical Working of the various Fisheries around the British Islands. With Illustrations, &c. By Edmund W. H. Holdsworth, F.L.S., &c., late Secretary to the Royal Sea Fisheries Commission. (London: Edward Stanford, Charing Cross, 1874.)

MR. HOLDSWORTH, having officiated as secretary to the Royal Commissioners who inquired into the state of the British fisheries in 1863, and whose report was presented to Parliament in 1866, has had access to the very best information and to people who have all the "ins and outs" of the fisheries at their fingers' ends. As might be expected, therefore, from the opportunities of its author, this is an excellent work of its kind, forming a complete directory to the fishing ports of Great Britain and Ireland; and persons about to embark in any kind of fishery enterprise could not have a better guide. Although the author makes no parade of being scientific, and has no pretension to unfold other than an unvarnished tale of our fishery resources, the book is not devoid of interest for scientific persons, seeing that it contains some account of Prof. Sars' discoveries with regard to the floating of fish spawn. Moreover, Mr. Holdsworth's work appears opportunely enough, seeing that the daily newspapers are indulging in discussions regarding oyster-spat, over-dredging, and cognate subjects.

The question of "over-fishing" is of the first importance, because we are dependent on the sea for a vast proportion of our food supplies. On this subject the author of "Deep-Sea Fishing" is evidently at one with his late masters, but in discussing it he is compelled to admit a large increase in the machinery of capture; indeed, the book is very much a record of that fishery improvement which, so far as the catching apparatus is concerned, has now become pretty general. Although it is wise to accept, discuss, and analyse all the information we are able to lay hands upon which bears on the question of our daily supplies of food, we shall not at present say more about "over-fishing," so far as that question is incidentally alluded to by Mr. Holdsworth, than that his inferences and his facts are very much at variance. Put in a nutshell, nothing can withstand the logic of the case for those who say we are "over-fishing;" it is, that the supply of fish being equal to what it was, an increased number of boats and an improved mode of capture, with constant multiplication of the apparatus of capture, should, in a given ratio, add to the supplies of fish which are brought to market. Issue has been joined between those who say our fisheries are not so productive as they ought to be, and those who aver that we are "over-fishing;" and, so far as the evidence we have seen goes, the latter party have, we think, the best of the argument.

It is of the greatest importance to the present and future of our fisheries that we should fish with economy, and, above all, that we should fish in such a manner as will not wantonly waste the spawn of our best table fishes. At present the waste of spawn, through the capture of gravid and immature fish, is so enormous as to be incalculable. It has been said of the salmon, that although an individual may be of the value of ten shillings per pound weight on a Bond-street counter, it is worth five times that price when it is on the spawning "redds." The same may be said of all fish, even of those which we least esteem for food purposes. In times past, fish have been held so cheap, in consequence of the liberal ideas which were prevalent as to their great abundance, that men thought it of no importance whether the fish they ate were or were not full of spawn; indeed, customers thought themselves rather ill-treated when their fish-merchant sent them a fish without its roe; and, as a rule, fishmongers cannot do otherwise than send "full fish" to all who purchase, for the very excellent reason that it is at the season when they are about to become reproductive that man obtains easy access to them. It is also the season when they are most unfit for food. No grazier or cattle-feeder in his right mind would kill a cow when large with calf, or a mare big with foal. And putting the case another way, if all our oxen were killed as calves, and our sheep while they were lambs, should we not very speedily be on the verge of famine? Yet these are the modes of doing business which prevail in our fisheries. It is well that the inhabitants of the sea are so prolific in their seasons of reproductiveness; were they less so than they are, a very few years would exhaust even the productive cod banks of Newfoundland.

As regards salmon, the percentage of eggs which come to life and yield fish is pretty well known, as is also the percentage of young fish which is destroyed. The number of salmon (*Salmo salar*) which escape infantile perils and become reproductive is very small, not ten per cent. Out of every hundred eggs spawned in the natural state, it may be calculated that at least one-third escape the action of the fecundating milt, that another third never, from various causes, come to life, which leaves only one-third to produce fish; and of the thirty-three tiny animals thus left, a full half will be killed by enemies, which are numerous, leaving, say, sixteen young smolts to become grilse, and as these have to make one voyage to the sea, or probably two, before they become reproductive, their number in the end becomes sadly reduced, so reduced that probably not five of them will be able to repeat the story of their birth and so provide future supplies. If the mortality incident to fish life be so great in a salmon river, what must it not be in the ravening depths of the ocean? A large cod-fish we know yields more than a million of eggs, but when we consider the fact of these eggs being entrusted to the boisterous waves of the sea, we have little hope that the yield of reproducing fish will be greater than in the case of the salmon, which enjoys the comparative tranquillity of inland streams. Much ignorance has hitherto prevailed as to how fish spawn. The salmon we have been able to watch day by day, and to note every action whilst it is engaged in that great function of its nature, and we also know a little about the reproduction of the herring, but as regards the reproductive *modus operandi* of our larger sea-fish, much that we know, or think we know, is only the result of guessing or of reasoning from analogy. M. Sars has discovered that the ova of some fishes, notably the ova of the cod (*Gadus morrhua*) and of the plaice

(*Pleuronectes platessa*), are hatched whilst floating on the waves. Ova of these and other fishes have been found floating in different stages of development. There is no doubt of this fact, and in some of the larger rivers of China the spawn of fishes is known to float on the surface, for it is collected at certain places for piscicultural purposes, by means of bunches of grass and soft matting. These, it is known, become the recipients of large numbers of fish eggs, and are easily removed to other waters; which, being barren of fish, are in this mode repopulated. There cannot, we think, be a doubt that various fishes spawn in various places, some at the bottom of the sea, some on the surface; and it is very likely, by this diversity, that the varied species are best preserved. The herring (*Clupea harengus*), and probably all its congeners (but this is not quite certain), spawn on the bottom, and the eggs remain there, adhering in masses to the rocks and stones. The eggs of the salmon, we know, when not washed away during deposition by flooded water, sink, by means of their weight, to the bottom, where the parent fish instinctively covers them up with gravel in order to protect them from their numerous enemies. Most sea-fish, we have a strong impression, emit their spawn in the same manner, whatever future direction it may take in the way of motion. All the fish eggs which we have seen gathered from the surface of the water were almost at maturity; and the late Mr. Robert Buist, of the Tay fisheries, informed the writer that he had seen salmon eggs, as the time approached for the *eclosion* of the fish, rise to the top of the water in the breeding boxes at Stormontfield, *but they always sank again before the birth of the fish.*

What practical bearing has all this on the economy of our fisheries? will be asked. There is one *point* which Mr. Holdsworth makes in detailing M. Sars' discoveries, and it is, briefly stated, "what becomes of all the complaints against the beam trawl net"? That ponderous instrument, as all of us are aware, has been accused of breaking up the spawning beds and killing the fry; but naturally, if there is truth in the discoveries of M. Sars, and if the spawn float on the waves, that accusation must fall to the ground. That the trawl net "hashes" the fish which it captures, and destroys a large number that it does not capture, is well known, but not any of our modes of fishing are perfect. It is not possible to dictate to the fish as to which are to enter or stay out of the death chamber. Nor, if a hundred hooks be set with bait for the line fishery, can we dictate as to what size of cod-fish or haddocks should take the hook. One thing we can do: we can reject all fish which are of insufficient size or have not had an opportunity of multiplying their kind. Most of the line fish when taken on board are alive, and also a large percentage of fish that are trawled. Those which are too small might be restored to their native element. We are ourselves recommending this plan. So far as we understand Mr. Holdsworth, he only confines himself to an exposition of how we fish: as to how we *should* fish he is silent; in fact, he is satisfied with the deliverance of the Royal Commission of 1863, of which he was the secretary, that our fish supplies have increased and are likely still further to increase. We should not in the least object if the increased supplies kept pace with the augmented machinery of capture.

JARDINE'S "PSYCHOLOGY OF COGNITION"

The Elements of the Psychology of Cognition. By Robert Jardine, B.D., D.Sc., Principal of the General Assembly's College, Calcutta, and Fellow of the University of Calcutta. (Macmillan and Co., 1874.)

MR. JARDINE has seemingly had some personal reason for writing this treatise; for in the preface he asks the critic to bear in mind "that the book has been written with considerable haste, in order to secure its publication within a certain limited time." It would have been wiser to ignore the critic: for this unsympathetic personage is only too certain to meet this innocent confidence with the unfeeling remark that perhaps the interests of science would not have suffered had the author taken a little more time over his work. Had nothing been done before Mr. Jardine began to write "to show the inadequacy and unsatisfactoriness of a prevailing system of psychology," he would have required to make a much more thorough and more direct attack on the teachings of Mr. Mill and Prof. Bain, in order to accomplish "one principal object" that he had in view. Again, we think Mr. Jardine would have better consulted the interests of his readers generally, including the "students," for whom the book was "principally designed," had he made more explicit reference to the writers to whom he is indebted for the weapons he has employed in this attack on "phenomenalism." Another general criticism that must be made is, that there is not a sufficient wealth of concrete illustration, and that, though the writer has "endeavoured to express himself in as clear and simple language as possible," his words are, nevertheless, often dark and difficult enough. What will readers "beginning their philosophical studies" make of such a sentence as this?—"It must be borne in mind that it is in their character as modes of the non-ego that objectified sensations are localised. The localising is, therefore, not so much an act of consciousness as a precept of consciousness and a form of the non-ego."

We do not find it easy to review this book fairly. For one thing, the author has no personality; then, while on the one hand it would be very easy to speak of the excellence of many pieces of exposition, on the other hand nothing could be easier than to select a few passages for unmitigated censure. On the strength, for example, of the following sentence, one might almost question the claim of the writer to rank as a scientific student of the subject on which he has written:—"In the scientific mind of modern times," says Mr. Jardine, "there has arisen, through the influence of a long-continued and exclusive study of phenomena, a predisposition to doubt the occurrence of events which are plainly beyond the sphere of phenomenal laws." The worst of it is that long before we reach this sentence, which occurs near the end of the book, we have come to regard Mr. Jardine as a man of such respectable ability that we have the greatest difficulty in believing that he can really think that anything he has said can carry him a single step towards the goal he now seems anxious to reach. The scientific men of modern times are innocent enough of having their minds "vitiated by the prevailing phenomenalism" represented by Mr. Mill and Prof. Bain. They have indulged in an exclusive study of phenomena for the very sufficient reason that they can never get at anything else. In justice to the author, however, it must be said that he several times gives pretty distinct evidence that he has never quite grasped the question at issue between our modern realists and idealists. Compare the following sentences with the one just criticised:—"Light, heat, electricity, force, *as studied by physicists, are non-phenomenal powers*, and the object of science is to ascertain their laws and relations." "Realism, as found in Herbert Spencer, *and as supported by recent investigations of science*, demands a belief in real objective non-phenomenal forces." Mr. Jardine does not tell us, and we cannot conceive, what recent scientific investigations he could have been thinking of; but that he should suppose that Mr. Spencer's doctrine of the unknowable could be supported by any recent discoveries, or by anything ever to be discovered, shows conclusively that he has still to learn what that doctrine really is.

We agree with Mr. Jardine in rejecting the idealism of Mr. Mill; and we must say that some of Mr. Jardine's criticisms are very happy. Here is an example. Mr. Mill says that the possibilities of sensation that make up a given group "are conceived as standing to the actual sensations in the relation of a cause to its effects." On this Mr. Jardine remarks: "We have, for example, the sensation of a particular figured colour, which is associated with the name orange. Connected with this sensation there are a number of possible sensations of smell, taste, touch, sound, &c. *The possibility of those sensations is the cause of the colour*. What does this mean? Is the possibility of a smell the cause of a colour? Is the possibility of a taste the cause of a colour? Or is the possibility of all the other sensations of the group taken together the cause of colour?" No doubt some of Mr. Mill's disciples may object that Mr. Jardine has misunderstood Mr. Mill; they will, however, find it hard to give any definite meaning to the words of their master without either making him a realist or letting in some such criticism as the above.

But though we cannot always agree with Mr. Mill, we can never think of him without feelings of profound admiration and respect. We have therefore no sympathy with Mr. Jardine when he tells us how easy it is "to show the absurdity" of Mr. Mill's attempt to explain our notion of extension. A more modest self-appreciation in the presence of Mr. Mill would have been becoming; the more so as Mr. Jardine has none of that cleverness of expression which may at times do something to cover the audacity of the critic. Mr. Mill will not fall before the word "absurdity"; and Mr. G. H. Lewes will not be seriously damaged by being loosely classed with "a set of visionary speculators called phrenologists," who, acting upon a "hasty and crude hypothesis," have made a very great blunder.

There only remains to say that Mr. Jardine seems to be himself unacquainted with the psychology of our own day. He may sneer at Mr. Lewes for giving "prominence to the study of physiology as a means of becoming acquainted with mental laws," but if he would entitle himself even to a hearing, he must, as a first condition, make himself master of the knowledge that has been laboriously acquired by the school of investigators to which Mr. Lewes belongs.

DOUGLAS A. SPALDING

WHITE'S "SELBORNE"

White's Natural History of Selborne. Edited by J. E. Harting, F.L.S. Illustrated by Bewick. (London: Bickers and Co., 1875.)

ALTHOUGH we have no evidence that, within the last century, there has been any considerable change in the average standard of human mental power amongst civilised nations, the surroundings of every-day life have so greatly altered, both in their quality and in the rapidity of their occurrence, that the standard of ordinary existence has undergone a corresponding modification. The introduction of steam locomotion, the electric telegraph, and the penny post have developed such a condition of unrest in humanity at large that the unalloyed repose of a continuous rural life is rarely sought for, and as infrequently obtainable. We can hardly conceive it possible that anyone, such as a life-fellow of a college, as was Gilbert White, of Oriel, Oxford, should at the present day settle down in any out-of-the-way part of the country, satisfied with nothing more than an opportunity of observing and recording the surrounding phenomena of nature. More would be expected of him, and he would be continually led to feel that he was but one of the instances of the vegetating influence of an antiquated system, whose advantages were being daily disproved by his individual existence.

The same influences have affected the mental world. Facts have a less intrinsic value than they used to have in the time of Gilbert White, the Addison of natural phenomena. More must now be extracted from them in their mutual relations. They must be manipulated into the web of some inclusive hypothesis, or otherwise they may as well die an unrecorded death, because their independence only helps to block the already but too narrow path which leads towards omniscience. In this period of revulsion against encyclopædic knowledge, a remark by the author of the work before us, when writing of the otter, indicates a tenour of thought which is antiquated, to say the least. "Not supposing that we had any of those beasts in our shallow brooks, I was much pleased to see a male otter brought to me, weighing twenty-one pounds, that had been shot on the bank of our stream below the Priory, where the rivulet divides the parish of Selborne from Harteley Wood." No inference is drawn, no comment made; whence the source of pleasure?

We cannot well conceive a more efficient editor, at the present time, than Mr. Harting. That author's considerable experience and his great love for the study of the ornithic fauna of the British Isles has already made his name well known in connection with the birds which reside amongst us, and those which visit our shores. He also tells us in his preface, as may be equally well inferred from his annotations throughout the work, that he is well acquainted with the neighbourhood of Selborne, which enables him to correct a few of Gilbert White's inaccuracies, and bring to the foreground those slight changes in the fauna and flora of the district which have occurred since the book was originally written. Amongst the latter, special attention is directed to the reintroduction into Wolmer Forest, by Sir Charles Taylor, of black game, "which I (Gilbert White) have heard old people say abounded much before shooting flying became so common"; and the non-applicability to present visitors to the Devil's Dyke, of the remark that "there are bustards on the wide downs near Brighthelmstone"; and to those who spend their summer at Eastbourne, that "Cornish choughs abound and breed on Beachy Head, and on all the cliffs of the Sussex coast." A lengthy list of references is given with regard to the habits of the cuckoo, a subject on which further reliable information is much needed.

The typography, paper, and binding of the work are all that can be desired, and Bewick's drawings add further to its general interest.

OUR BOOK SHELF

Microscopical Notes regarding the Fungi present in Opium Blight. By D. D. Cunningham, M.B., Surgeon H.M. Indian Medical Service. (Calcutta: Office of the Superintendent of Government Printing. 1875.)

DR. CUNNINGHAM has devoted much care and attention to the study of the fungi present in the opium blight, and the results of his labours are given in the present pamphlet. The most important fungus present, and the one really causing the blight, is a species of Peronospora, and thus belongs to the same genus as our own too well-known potato-disease fungus. As in India the Peronospora affects the opium crop very seriously, it is a matter of the highest importance to have the life-history of such a pest worked out thoroughly by a competent observer. The *Peronospora arborescens*, which in India attacks the opium poppy, is to be met with in this country on the red poppy (*Papaver Rhœas*). Dr. Cunningham invariably found the Peronospora present in blighted leaves, and he describes fully the mycelium and the conidia of the fungus. The mycelium spreads through the intercellular spaces of the leaf, branches coming to the surface through the stomata, which ramify and produce the conidia. The conidia apparently do not produce zoospores. The sexual mode of reproduction by antheridia and oogonia was not observed, even although De Bary has already described the oogonia of this fungus. The life-history thus is imperfect, and we must urge Dr. Cunningham to persevere and not rest satisfied until he has observed the whole of the stages of this fungus.

After the parasite has done its work, the leaves of the poppy become infested with a number of other fungi, chiefly saprophytes, and Dr. Cunningham carefully describes and figures several of the forms.

W. R. M'NAB

Logarithmic and Trigonometrical Tables for Approximate Calculation. By J. T. Bottomley, M.A., F.R.S.E. (London and Glasgow: Collins and Co., 1875.)

THESE tables were primarily arranged by Mr. Bottomley for the use of the students of the Natural Philosophy Class in Glasgow University, but we believe many other students will feel grateful to the author for having published them.

An easy, handy book of tables such as this has been much wanted for Mathematical and Natural Philosophy Classes in the Universities and for advanced schools. There is no reason why, with a really convenient book, boys should not all learn logarithmic arithmetic as soon as they know decimals. But the books hitherto in use are too formidable. Moreover, practical calculators will find much use for four-figure logarithms, sines, &c., and many people who never use logarithms will be able to do so with ease when they have a four-figure table.

Mr. Bottomley has in this manual arranged (on the plan of De Morgan, we believe, who first applied it to logarithms) sines, tangents, logarithmic sines, and logarithmic tangents, and has printed them, with the logarithms and antilogarithms, each table on *two facing pages.*

We heartily approve of Mr. Bottomley's plan, and recommend his manual to all teachers and students who wish for an easily consulted scientific ready reckoner.

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.*]

A Gyrostat Problem.*—Answer

LET W be the weight of the fly-wheel.

k its radius of gyration.

ω its angular velocity in radians per second.

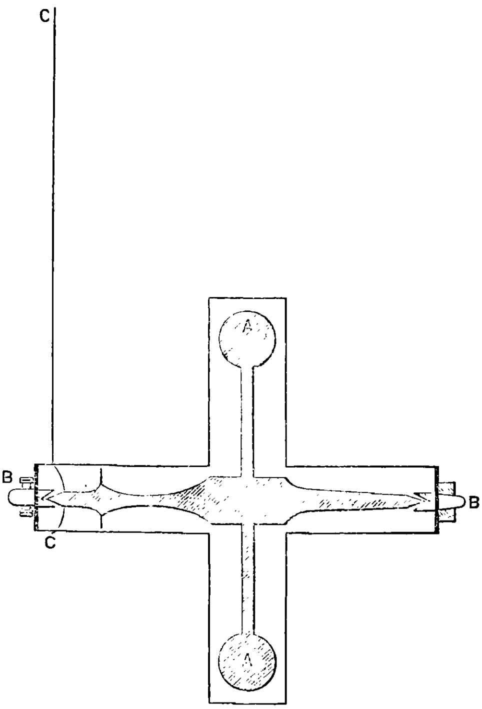
W' the weight of wheel and case together.

a the distance from the centre of inertia to the point of attachment of the string.

g the force of gravity.

The moment of momentum of the wheel round its axis is $\omega W k^2$.

The rate of generation of moment of momentum round a horizontal axis perpendicular to the axis of the wheel, by the couple produced by the action of gravity and the tension of the cord by which the gyrostat is suspended, is equal to the moment



of the couple (see Thomson and Tait's "Elements of Natural Philosophy," § 236), and is therefore, $g W' a$. Therefore the moment of momentum generated in a small time τ is $g W' a \tau$.

Compounding these two moments of momentum by the parallelogram of moments, we obtain—

$$\tan\theta = \frac{g W' a \tau}{\omega W k^2}$$

where θ is the angle described in azimuth by the axis of the wheel in the small time τ; and since, when θ is small, $\tan\theta = \theta$, we have by the question—

$$\frac{g W' a \tau}{\omega W k^2} = \frac{1}{4}\tau$$

* For Problem, see NATURE, vol. xi p. 385.

Hence $\omega = \frac{4gW'a}{Wk^2}$ in radians per second.

Hence number of revolutions per second $= \frac{2gW'a}{\pi Wk^2}$

Substituting the numbers given in the question, we have for the answer—

$$\frac{2 \times 981 \cdot 4 \times 2250 \times 6}{3 \cdot 1416 \times 1800 \times 16}$$

= 293 revolutions per second.

University, Glasgow D. M'FARLANE

The Sounds of the String Organ

MR. BAILLIE HAMILTON'S invention of a conjoined string and reed which is now being carried out in a musical instrument to be called the string organ, has caused a marked interest both in its musical and in its scientific aspects. My attention was attracted to it strongly, for one reason, that it promised to add a new member to the family of keyboard instruments, and for another reason, that the study of its possibilities and practical working showed conditions so close in analogy to those of the organ-pipe as viewed under the theory advanced by me in NATURE, that the corroborative evidence thus furnished might with truth be called palpable. By the last word I refer to the visible displacement and travelling of the node, which can be affected at will in obedience to changes in the relative conditions of reed and string. I find that "tension" on the string is equivalent to "scale" in organ-pipes. To give high tension to a string is in effect the same as to use a narrow scale of pipe; thus, keeping the reed-force constant, we may respectively, by giving higher tension to the string, or by using a narrower pipe, drive the node higher, and conversely, slackening tension or using a wider scale of pipe, we may displace the node to a lower position. In the conjoined reed and string we can see this change taking place, order how it shall take place, and may clip the nodal point with our fingers without disturbance of the continuity of vibrations. The process is visible, the result tangible.

The estimate Lord Rayleigh * has given of the instrument as "modified reed" is undoubtedly right, yet it can scarcely be said that the opposition estimate is undoubtedly wrong. An orthodox organ is a pipe-instrument, and also is a wind-instrument, yet in acoustical relations the pipe is out of theoretical conformity, is a modified pipe; the air-reed likewise, according to the kind of pipe it is allied with, is a modified reed, and similarly in this novel organ the string and reed modify each other; sever the union, and the manifestations of the two independent forces will be wholly different. Specifically it is a wind-instrument, and I cannot but think we should admit it to be both "modified reed" and "modified string;" they work together as a system, each contributing its own character, and each in degree determining, through compromise and affinity, the issue of the union. Strongly impressed with this belief, my explanations will consequently differ from those generally current concerning this ingenious combination.

Lord Rayleigh, in explanation of his estimate, says, "the intermittent stream of air, which does not take its motion from the reed, gives rise to a highly compound musical note." Either I do not understand this affirmation, or I misunderstand it; I have always considered the intermittence of the stream to be the result of the reed's motion. And further on, another sentence to strengthen his distinction: "The fact that the *pitch* of the system is mainly dependent upon the string seems to have distracted attention from the important part played by the stream of air, and yet it is obvious that wind cannot be forced through such a passage as the reed affords without the production of sound." Speaking, not without experience in varieties of free reeds, I cannot recall a single instance of the wind forced through the passage afforded by the reed producing anything like a musical sound. Our views probably differ in expression and in interpretation more than in perception.

With some temerity I think I may say that the working of the free reed is not fairly estimated by scientific observers. It is generally supposed that the *pressure* of the wind originates the vibration of the reed in instruments, whereas the fact is that the free reed may be so set that although perfectly free to pass, as may be seen on holding it up to the light, perfectly free to sound, as may be proved by percussion, yet, placed within the instrument, it will be dumb to all pressure of the wind. The essential condition for speech is for the reed to be so set that a sufficient amount of air shall with velocity pass the sides and through the mortice of the reed equal to causing a suction on the under side of the reed; then only will the reed proceed on its course, and the check given to the stream when the reed reaches the level of the block intensifies the suction, the development whereof progresses until the back-lash or return of the reed creates a stronger partial vacuum with a promptness of power effectual for establishing the condition of vibration. There are peculiarities, too, in the process of the suction, not lightly to be passed over by the scientific observer. The true test of action is the degree of quickness in speech. The most prompt articulation is that in which the process of suction is most gradual; this is not paradoxical, though it may seem so. If a large amount of wind is allowed to pass, the action will be sudden, yet, notwithstanding, the speech, comparatively estimated, will be slow. The suction should first attack the tip of the reed and gradually draw upon the stem. If you allow passage to the wind near the root of the reed, or if you hollow or arch the stem, permitting wind more freely to pass the middle of the reed, it is inevitably at the sacrifice of quickness of speech, and nothing is more fatal than allowing extra opening for a rush of air between the tip of the reed and the frame, for you thereby impair the perfectness of the suction at its most vital point.

In the case of a reed and string conjoined, the string is a weight to be moved; the force of wind will effect the displacement if the string has held the reed in position to allow passage of wind; and when the equilibrium of the string has been in the least degree disturbed, the return motion becomes a source of additional impetus, inducing the reed to follow by reciprocation; yet even here we do not escape the demand for suction; the value for this purpose of a tube or a channel beyond the reed is as evident as in the harmonium. The difference between the modern harmonium and the old seraphine is, that the former has pipes or channels to every reed, the latter had its reeds placed over apertures in plain boards; the reed conjoined to a string when so placed over a simple aperture will sound as would the reed in the old seraphine, but generally with the exhibition of the same defect, slowness of speech. Select an instance of such a string and reed so sluggish that the attainment of speech to the semblance of a musical note is a trial of patience; then add a tube of suitable character, and, in comparison of condition, the promptitude of response and power of tone will give certain evidence of its value, for here, as in all musical instruments, the function of the tube is to aid and to develop more strongly the force of suction. The suction I mean is that which is caused by the issue of a current of compressed or condensed air into the atmosphere.

A very curious problem is afforded in the peculiar quality of tone given by the new mechanical action of "reed-and-string" working linked together, and I have not heard, from any of the numerous thinkers and observers who have commented upon it, a satisfactory solution. Lord Rayleigh truly states, "it is certain that the note actually heard is compound," and also that "the peculiar character of the string, that its notes form a harmonic scale, does not come into play."

What is it, then, that we hear, and how comes this highly compound musical note into being? Let me offer this solution, if only as a suggestion. It is generally agreed that "there is a great deal of octave in the tone," sometimes the fifth, and frequently and most strikingly a beautiful major tenth, so clear that it seems to sing away by itself as if in independent existence; this, whilst it is certain that the string is not vibrating in forms either of the octave, fifth, or tenth or of any other of the accessory tones so often present to the ear. Rightly to apprehend the action of strings in musical instruments, it is, I think, desirable to regard every string as a tuning-fork acting upon the sound-board through the bridge, which, thus considered, is its stem for the communication of its vibrations. The intensity of sound from a tuning-fork or from a string depends not alone on amplitude of movement, but on pressure, the amount of such pressure being mainly determined in the case of the string by the angle the string makes in its strain upon the bridge under the particular tension to which it is subjected. A tuning-fork sounds loudly or softly, according as its stem is pressed strongly or lightly by the hand upon the sound-board. A string deflected right and left delivers each way its pulse through the bridge to the sound-board; a free reed, moving forward and backward, gives an effective impulse as musical vibration one way only—in the back-lash, or return; consequently, in this matter of conjoined reed and string, it appears to me we have always two fundamentals—two tones

* See NATURE, vol. xi. p. 308.

having distinct powers, and either of which may take the position of root or prime; these coexistent tones, whatever the previous independent ratio of string and reed as regards pitch, will always, when thus yoked together, be one an octave higher than the other. Singularly, too, it is not necessary that the lower of these fundamentals should be the pitch-note to the ear; its apparent character may be that of a sub-tone. Generally, the higher fundamental is the leading tone, and for this reason, that the predominance of one or of the other may be determined by character and by condition. In the reed, amplitude of excursion is the measure of its attainment of strength. In the string, tension is more effectual for power than amplitude is. String-tone thus gains by limitation of excursions of the string, whilst at the same time reed-tone is at a disadvantage from the restriction imposed by tension on the play of the reed. Contrariwise with a lighter string, power may be allotted to the reed, also by tubes, by partial occlusion of orifice, by coverings or shadings, the reed-tone can be modified in a variety of degrees; it may lead in trumpet-like vigour, or be heard only in quiet undertone accompanying the higher sound.

These two notes are rigorously exact in relative pitch, and when both have intensity, although different in kind, they produce other tones, as in the stop of the organ called the "Great Quint," the tone of one pipe added to another that produces a tone a fifth higher, gives rise to a third tone an octave lower, but never perfectly, except on the same conditions, exactness of pitch and intensity, with, as a rule, the higher note voiced the strongest. The reed and string necessarily, if preceding propositions are true, being in relation an octave apart, give rise to summation tones, first to the fifth, and these again to octave, tenth, and the rest in due order, but differing in intensity. In harmonic scale those possible would be octave, twelfth, superoctave, seventeenth, &c., and so here, if reckoned from the lowest tone as the root; but summation tones seem to require for their perfect production the same conditions as named above for difference tones; so that relatively the octave becomes by its voicing the leading tone, it fixes the pitch for the series in reference to itself, and thus the ear has cognisance of the tenth, not of the seventeenth. This major tenth to the tonic, so unmistakeable that it could not be gainsaid, was always a puzzle viewed as harmonic. Why it was so clear will readily be perceived when calculated as summation twice fulfilled.

The general supposition is, that because it is a string that is in action with the reed, therefore a stringy tone is in consequence obtained, the proof being that a stringy tone is actually heard. On the contrary, the true action of the string, whence arises the peculiarity of violin or violoncello, does not take place. What then? In a curious way effects are gained which naturally simulate the quality. By stringy quality musicians mean the tone of the bowed string. Amateurs talk eloquently in their way of the string-tone and its beautiful purity, of the reed-tone and its abominations, not heeding that the best judges of quality in sound class the stringy quality as the nearest allied to reed quality. Hence, organ-builders regard all the stops which best imitate the viola tribe, the geigens and gambas, as decidedly reedy in character, otherwise they would be poor representatves. The violoncello so characteristic in tone has always its introductory harmonics; these are sharp to the fundamental tone in which they merge, even as, I have shown in a former paper, the harmonics of the gamba organ-pipe are. Octaves of a free-string are always sharp to the note of the whole string. Then we have also the roughness, the grip, and bite of the bow. The sharpness is minute, yet sufficiently potent to give definite character. The ear is as easily deceived as the eye—the imitation may pass for the real. If we consider what is the effect on the ear of this sharpness, which does not reach the region of beats, we shall find it to be a breezy effect; in the delicate "voix celestes" of a fine organ when finished by true artists, we have it displayed—just a freshening touch of sharpness, and no more. From a breeze to a rough wind is only gradation of similarity. Return now to the combination of reed and string: the effect as of a stringy quality is gained by the breeziness of the outward stream of air distinctly heard, by the roughness of the abrupt closing and opening of passage to a highly-excited reed, by the tendency of a highly resilient reed to a more rapid pace, curbed though it inevitably is to the pace possible to the string it is paired with, thus adding an element of roughness to the sound-board, and in completeness of likeness there are the summation-tones mimicking those harmonics which are present in the fulness of the violoncello tone.

To assure those who would doubtfully accept the above interpretation, let me take an illustration of a practical nature as a verification. Why is it possible to make in a harmonium from free reeds alone a good imitation of violoncello quality? Because an analogous procedure can be adopted. This is the analysis of how it is done. Reeds of "eight-feet tone" of a firm character, rather slow in speech in consequence, but coming into play at a bound without hesitation; then in combination reeds of "sixteen-feet tone," these reeds finely curved, elastic, sensitive, quivering to a breath, their tone comes on at first as a breeze, it is sharp in a minute degree, but as the reeds gain power by amplitude, they flatten in pitch, as is the nature of bass reeds; ascending the scale, a small reed giving the twelfth may be added with advantage. In summary this is what we have: reeds relatively sharp to each other, the roughness, the breezy effect, and the accompanying harmonic offspring, together making the mimaphonic violoncello. Organ-pipe, violoncello, harmonium, and string-organ thus show a family likeness and give countenance to the interpretation.

The beauty of Mr. Hamilton's invention is that it is not limited to string-tone, that by giving predominance of power to either agent, reed or string, through long ranges of variation, many classes of tone as distinct as diapason, horn, flute, trumpet, and others can be satisfactorily imitated, and if its present promises of success are fulfilled, the name of string-organ by which it will be known will be amply justified.

HERMANN SMITH

P.S.—Mathematicians decide that the problem of the instrument is that of a loaded string. This appears to me a one-sided view, taken under limited experiments. Practically, some details of their conclusions are not corroborated; there are several elements entering into the composition not heeded, and a wider experience would show that the problem is equally that of a loaded reed. Here is an instance. I have in action a reed with pin attached; it sounds C sharp; and a string which, independently sounding, gives the F below. These, when conjoined, produce the G between. The note of the string is thus *raised* a whole tone; consequently the weight of the oscillating string is a load on the reed.—H. S.

The Law of Muscular Exhaustion and Restoration

YOUR issue of Jan. 28 is just received, containing a paper (vol. xi. p. 256) by Prof. Frank E. Nipher, wherein he condemns as "entirely unreliable" his first series of experiments on the subject of the exhaustion of the muscles of the arm by mechanical work. A like condemnation he pronounces in the February number of the *American Journal of Science.*

All the experiments in question, new as well as older, having been made at this laboratory, I beg leave to correct the above statements of Prof. Nipher. His new experiments are not so radically different from the old ones; on the contrary, both series demonstrate exactly the same general *law.* The true law is, as Prof. Jevons in his first communication to NATURE already felt it, *logarithmic.* So indeed vary most of the vital processes, because *molecularly* they are comparable to the vibrations of a pendulum in a resisting medium. (See Fechner, Exner, Wundt, Delboef, and others.) That the law has so long been overlooked, so far as muscular action is concerned, is probably due to the fact that the progressive restoration of the muscular tissue disturbs the function for small weights, while structural derangements (evidenced by *pain*) cause a like perturbation for higher values of the weight.

If we consider a system of muscles independent of continued circulation (no restoration) and keep the burden w (kgr.) low enough to cause no pain, then the *time* n (in seconds) during which the statical work can be sustained, or the *number of times* n, that the same *cycle* of motions can be performed until exhaustion takes place, I have found to be—

$$\left.\begin{aligned} n &= \frac{A}{B^w} \\ \text{or} \qquad \log n &= a - b\,w \end{aligned}\right\} \qquad (1)$$

where $\log A = a$; $\log B = b$.

In the five series at hand the following are the values of the constants:—

	a	b
I.—*Statical Work.*		
1. Prof. Jevons, Series III., holding weight ...	2·433	0·1450
II.—*Dynamical Work.*		
2. Prof. Jevons, Series II., pulley and cord ...	1·968	0·0476

3. Prof. Nipher, old series, right arm	... ...	2·080	0·126
4. " " left arm...	... ...	2·060	0·137
5. " new series	... ...	2·560	0·194

Also Jevons : $a = 1·74 + 4·79 b$; Nipher : $a = 1·28 + 6·25 b$, very nearly.

To extend the law beyond the above physiological limits, introduce the *coefficient of restoration*, r, and of *pain*, p, in

$$N = (1 + r - p) n \quad (2)$$

where both from theory and by above series of experiments,

$$r = \frac{H}{K^w} \quad (3)$$

I have no doubt that p is of the same form; but none of the above series have been continued far enough to sufficiently confirm this. It is evident that p vanishes for small values of w, and r for large values of w.

These few remarks may be sufficient to show that the earlier as well as the late experiments of Prof. Nipher constitute a very valuable contribution to Animal Mechanics.

Iowa State University, Feb. 22 GUSTAVUS HINRICHS

The Height of Waves

YOUR correspondent Capt. William W. Kiddle, in NATURE, vol. xi. p. 386, speaking of the height of waves, says:—"This remarkable gale swept over a portion of the Atlantic which the French call 'Le trou de diable.' . When the wind sets strongly in this direction from the north-west, the sea rises in an incredibly short space of time, and at the close of a long winter gale it is a grand sight to watch the great waves," &c. The question is then asked, why this remarkable phenomenon occurs with a north-west gale, whilst with an equally strong south-west or southerly gale the effect is insignificant?

I think an explanation may be given thus:—"Le trou de diable"—whose position, roughly calculated, is 45° N. and 40° W.—is, roundly speaking, about the centre of the Gulf Stream in that locality, and during a strong north-west gale the wind meets the Gulf current at a good angle. The force of this encounter has a tendency to drive the stream out of its course. The velocity of the water-current and its mass are, however, so great that it yields but slightly, if at all; consequently, the force of the wind exerts itself to a large extent in banking up the water to the production of unusually high waves.

From an analogous course of reasoning, it is apparent that a south-west or southerly wind will not have a similar effect; for both stream and wind are then travelling in the same, or nearly the same, direction. The force of a gale from the south-west or south has no counter water-force to oppose it; hence its high velocity tends simply to increase that of the Gulf Stream, as well as to beat down its surface to the prevention of any extraordinary waves. ARTHUR R. GRANVILLE

Islington, March 22

Thermometer Scales

THE thermometric scale referred to by Mr. T. Southwell (NATURE, vol. xi. p. 286) was, I believe, one used and invented by Fowler, in which 0 = 55° Fahr., 75 above = 102° Fahr., and 80 below = + 5° Fahr.

The above equivalents are only approximately given. For full description, &c., see "Essays on Construction and Graduation of Thermometers," by Geo. Martine, M.D, 1772: Edinburgh.

I have failed so far in discovering the scale of Linnæus alluded to, and shall likewise feel indebted to any of your readers who will describe it. S. G. DENTON

34, Foreign Street, Brixton, March 23

Accidental Importation of Molluscs and Insects

I OBSERVE in NATURE (vol. xi. p. 394) a note from the *Saar und Mosel Zeitung* on the introduction of a mollusc into the Moselle near Trèves. Though the name of the species is not mentioned, I presume that *Dreissena polymorpha* is the mollusc in question, a species known to inhabit Britain since 1824, and supposed to have been introduced with timber from Eastern or Northern Europe. It is exceedingly prolific. An instance of how this species may be introduced came under my notice a few years ago. A friend showed me some shells that he had found attached to logs of wood lying on a railway truck. These proved to be alive when put into a cup of water; and if the logs in question had been deposited on the banks of the Tay within reach of the tide, as is often the case (I should have said that the truck was on a siding near Perth Harbour), we would no doubt have found *Dreissena* in abundance in the course of a few years. As this mollusc lives in brackish water as well as in fresh, it is no doubt in a manner similar to what I have mentioned that it has been introduced into and spread through Britain. Another shell, *Planorbis dilatatus*, a North American species, was found a few years ago living in a canal near Manchester, and is supposed to have been introduced with raw cotton. Recently another case of importation of living shells came under my notice. When looking at some bales of *Typha* from the Nile, imported into Aberdeenshire as a material for paper manufacture, I observed some shells sticking in the dry mud adhering to the roots of the *Typha*. On putting some of these into water they were found to be alive, though a good many months had elapsed since the *Typha* had been gathered. The shells appear to belong to *Bythinia*, but I have not yet determined the species. It is, perhaps, not very likely that if these shells had found their way into the Aberdeenshire rivers they would have survived.

Land molluscs are sometimes introduced, and several European species have in this manner become naturalised, in North America.

Apropos of the fears that have been expressed that the Colorado Potato Beetle (*Doryphora decemlineata*) may be introduced into Europe and prove destructive, the Entomological Society of Belgium has been recently discussing the matter, and has arrived at the conclusion that the fears regarding this insect are much exaggerated. M. Oswald de Kerchove, of Denterghem, has just published a very complete memoir upon this beetle. He thinks that it is very improbable that the *Doryphora* will be introduced, and at any rate that the prohibition of the importation of American potatoes is unnecessary, as it lives upon many other plants than *Solanaceæ*. M. de Kerchove further deprecates the use of the arsenite of copper (Scheele's green), so much employed by the Americans for the destruction of the beetle, as such a dangerous substance ought not to be made common.

Is not the "Blood Louse," so destructive to apple-trees, mentioned by the *Kölnische Zeitung* (NATURE, *l.c.*), the homopterous *Eriosoma lanigera*, the so-called American Bug, already too well known in this country?

Perth F. BUCHANAN WHITE

Fall of a Meteor at Orleans

IN the "Notes" of March 18 (vol. xi. p. 396) it is stated that a meteor fell in a street at Orleans on the 9th inst. The time of the fall is not mentioned, but it would be interesting to know if the meteor were the same that was observed from here on the evening of that day about eight o'clock. It was very brilliant, as bright as Sirius, and moved slowly from a position a few degrees to the east of Sirius, in a south-easterly direction, the path making with the horizon an angle of about 60°.

Cooper's Hill, March 27 HERBERT M'LEOD

Proposed Aquarium in Edinburgh

I AM happy to be able to inform you that the suggestion originally made in NATURE, that a large aquarium should be formed in Edinburgh, is likely soon to be adopted. A company named the "Edinburgh Winter-Garden, Theatre, and Aquarium Company (Limited)" proposes to provide at the west end of Edinburgh a large and well-stocked aquarium on a scale not inferior to those of Brighton and the Crystal Palace.

Edinburgh, March 26 RALPH RICHARDSON

Acherontia Atropos

CAN any of your readers throw any light on the *raison d'être* of the dimorphism of the larva of the Death's-head Moth (*Acherontia atropos*)? Some years ago I found five larvæ of this insect on a bush of jasmine. They were all probably offspring of one female. Two of them were of the dark chocolate-coloured variety so strikingly dissimilar to the normal or commoner type. The *imago* of one of the dark-coloured larvæ differed in no respect that I could perceive from the ordinary form. It has occurred to me that the dark variety may be due to its simulating the dead, withered, blighted, or diseased shoots of the potato, as its commoner brother does the healthy leaves and stalks.

Taunton FRED. P. JOHNSON

Destruction of Flowers by Birds

As a sequel to the discussion in the columns of NATURE (vol. ix. pp. 482 and 509) on the destruction of flowers produced by small birds nipping off the bottom of the perianth, I may record that their education in this habit is progressing here.

My own crocuses, in a town garden, have suffered for years, each one being nipped off as soon as it expanded, but the country gardens have hitherto escaped; this year, however, I noticed that a garden five miles from the town and close to a large farm-yard was attacked, and no single flower left uninjured.

Burton-on-Trent, March 30 P. B. M.

OUR ASTRONOMICAL COLUMN

SOUTHERN DOUBLE STARS.—(1) γ Coronæ Australis.—This fine binary must have very much changed its angle of position since the last published measures, if, as is most probable, the late Capt. Jacob's elements afford an approximation to the true orbit. They are as follows:—Periastron passage, 1863·08; period, 100·8 years; node, 352° 13′; distance of periastron from node, 266° 25′ (or its angle of position, 256° 12′); inclination, 53° 35′; excentricity, 0·602, and semi-axis, 2″·549. Calculating from these elements, we find the subjoined angles and distances about the present epoch:—

	°	″
1874·5	155·7	1·98
75·5	153·0	2·04
76·5	150·4	2·09

The last measures recorded by Capt. Jacob gave for 1858·20, angle, 343°·0; distance, 1″·53. Though γ Coronæ Australis is accessible at the observatories of Southern Europe, our information respecting it comes so far, we believe, from India or the other hemisphere.

Amongst the southern binaries, certain or suspected, to which we would also draw attention with the hope of seeing measures put upon record during the present year are *h* 4087, which, as measured by Jacob, showed considerable change since Sir John Herschel's Cape observations; γ Centauri, a difficult object in 1853, but comparatively easy at the end of 1857, though the angles so far are very puzzling; *h* 5014, with the view to decide as to its binary character or otherwise; and *h* 5114, which is in all probability a revolving double-star of short period; it is B.A.C. 6632: if this star is regularly measured, an orbit may soon be feasible. To save trouble of reference, we append the places of these stars for the commencement of 1875:—

	R.A. h. m. s.	N.P.D. ° ′
h 4087	8 17 43	130 35·5
γ Centauri ...	12 34 38	138 16·4
h 5014	17 58 38	133 24·2
γ Coronæ Aust. ...	18 57 48	127 14·3
h 5114	19 17 46	144 34·4

VARIABLE STARS.—In *Astron. Nach.* No. 2031, Herr Julius Schmidt, of the Observatory at Athens, publishes results of his observations of this class of objects in 1874. He has many maxima and minima of the three short-period variables in Sagittarius discovered by him in 1866; the positions for 1875·0 and latest assigned periods are as follows:—

	R.A. h. m. s.	N.P.D. ° ′	PERIOD.
X Sagittarii (3 Fl.)	17 39 41	117 46·8	7d·01185
W "	17 57 2	119 35·1	7·59327
U "	18 24 32	109 12·7	6·74518

There appears to be some confusion in Schmidt's reference to W and X as regards the star which is identical with 3 Sagittarii of Flamsteed. In *Astron. Nach.* No. 1832, where he gives positions for 1870, he calls Flamsteed's star X, and Schönfeld has followed him in his catalogue of 1875, but in the last number of the same periodical Flamsteed's star is called W. With periods so nearly alike, this difference of nomenclature may prove troublesome. The second of the above stars has also been termed by Schmidt γ′ Sagittarii. The period of 68 *u* Herculis, according to this zealous observer, is about forty days; it has been seen as high as the fourth magnitude and as low as the sixth, but the variation appears to be generally within narrower limits: the times of minima are more easily determined than those of maxima. Schmidt fixes the last maximum of the remarkable star χ (Bayer) Cygni to 1874, Nov. 8, and thinks this a pretty certain determination. Argelander's last formula in vol. vii. of the Bonn observations, assigns 1874, Sept. 6, or sixty-three days earlier, but the error of this formula in 1870 amounted to ninety-three days, and had progressively reached this figure since the year 1854, when the calculated and observed time of maximum nearly agreed. Schönfeld gives a formula which still shows errors exceeding forty days and in opposite directions in 1842 and 1871. The interval between the last two observed maxima is 399 days, and another may be expected to occur about the middle of December next; the minimum may be looked for early in June. α Herculis, according to Schmidt, has been more than usually changeable during the past year. β Pegasi continues irregularly variable through not more than a half magnitude in about forty-one days, occasionally remaining a considerable time without perceptible change.

MINOR PLANETS.—Ephemerides of these bodies for 1875, so far as elements were available, were circulated some time since by Prof. Tietjen, of Berlin, in anticipation of the publication of the *Berliner Astronomisches Jahrbuch*, with the preparation of which he is now charged. The brightest of those coming into opposition during the month of April are Thalia on the 1st, of 10th magnitude; Flora on the 7th, of 9½ mag.; Hecuba on the 16th, of 10½ mag.; Lætitia on the 17th, of 9th mag.; Europa on the 18th, of 10½ mag.; and Urania on the 25th, of the same. The only minor planets since No. 7 which rise higher than the 9th magnitude during the remainder of the present year are Metis, Fortuna, and Eurydice in September, Clotho in November, and Massalia in December.

DANIEL HANBURY, F.R.S.

THE memorable list of those who during the past winter have departed from the scientific world, received last week another name for whose loss there is no palliation to be drawn from the consideration of advanced age or of completed work. Daniel Hanbury died on March the 24th, of typhoid fever, aged 49. Hardly any figure was more familiar than his to those who frequented the meetings of the Royal or Linnean Societies at Burlington House. The same simplicity and quiet enthusiasm which will make his death a matter of sincere regret to those who were accustomed to meet him there, influenced and animated his scientific work. A member of a business house which has almost a historic character, he began, a quarter of a century ago, investigating and writing upon subjects suggested by his occupations. Any-one who has had occasion to follow him in such matters will need no defence of the utility of his work; nor can indeed anyone dispute the value of critical and accurate knowledge about the materials of pharmacy. There was no side, whether literary or scientific, from which he left the subjects of his studies unapproached. A few years since he retired from business in order to obtain greater leisure, and he successfully brought what proved to be the work of his life to a close by the publication, at the end of last year, in conjunction with Prof. Flückiger, of the "Pharmacographia." This was reviewed in these pages at the time of its appearance.* It is only

* NATURE, vol. xi. p. 60.

necessary to say now that it is a patient and elaborate investigation from original sources of the usually obscure history and origin of vegetable drugs. Those who best know how to appreciate the book find their admiration everywhere divided between its laboriousness and its perfect conscientiousness.

A life so spent leaves little else to record. He accompanied Dr. Hooker in a tour in Syria; in 1867 he was elected a Fellow of the Royal Society, and was a member of the Council at the time of his death. Of the Linnean Society he was vice-president and treasurer, and his place in it will not be easy to fill. The Society has passed through a somewhat serious crisis for a learned body. The change from the rather old-fashioned retirement of its rooms in Soho Square, and afterwards in the main building of Burlington House, to its present stately quarters, has produced a certain strain upon a constitution always essentially conservative. That difference of temperament between the members of successive generations which is a constant physiological phenomenon, found in Daniel Hanbury an exception. Perfectly cautious, he was perfectly free from prepossession, and no proposition—however revolutionary—seemed to him unreasonable if he could convince himself that it would add to the welfare of the body which he wished to see take the lead as the chief Biological Society of the country.

TWENTY-THREE HOURS IN THE AIR

THE longest aërial trip on record was made by the "Zenith," a balloon which ascended from Paris on Thursday, 23rd March, at half-past six in the afternoon, and landed at Montplaisir, near Arcachon, 700 miles from Paris, on the following evening at half-past five. The aëronaut was M. Sivel, and the passengers MM. Gaston Tissandier, the editor of *La Nature*, M. Albert Tissandier, his brother, an artist, and two other gentlemen.

The balloon drifted southwards from La Villette gasworks for a few miles, when, crossing Paris, it deviated in a westerly direction before reaching the fortifications. It then travelled south-west during the whole of the night, crossing Meudon, Chevreuse, Tours, Saintes, &c., up to the mouth of the Gironde, which was crossed at ten o'clock in the morning, 600 miles having been run in 15½ hours. The wind, which was not strong, having gradually diminished, the crossing of the Gironde occupied not less than thirty-five minutes. As the sun became bright and the weather hot, a brisk wind blew from the sea towards the land, but only up to an altitude of 900 feet. The aëronauts took advantage of this current to escape the upper current drifting towards the sea, and followed the margin of the Gulf of Gascony by alternate deviations obtained by changes of level.

Landing was accomplished without any difficulty by throwing a grapnel, and all the instruments were taken back to Paris. Most interesting observations have been taken, and will be described to the Academy of Sciences at an early sitting. But we are enabled to give a summary of these through the courtesy of our friend M. Tissandier.

A quantity of air was sent by an aspirator through a tube filled with pumice saturated with sulphuric acid in order to stop the carbonic acid and ascertain how many hundreds of grains are contained in each cubic foot. A series of experiments were made at different levels from 2,700 to 5,000 feet, the utmost height reached. The analysis will be made by a new method invented by MM. Tissandier and Hervé Mangon, a member of the French Institute.

The electricity of the air, tested with copper wires 600 feet long, was found *nil*, except at sunrise. It is known that at that very moment an ascending cold current is almost always felt.

The minimum of temperature was about + 25° Fahr.; at Paris, on the same night, it was about + 28° at the Observatory.

The moon was shining brilliantly, with a few cirrus clouds that manifested their presence by a magnificent lunar halo, which was observed from five o'clock to six in the morning.

The phenomenon gradually developed: the small halo (23°) showed itself first, and afterwards the large halo (46°), but as the aëronauts were at a small distance below the level where icy particles were suspended, the larger halo, instead of being circular, was seen projected elliptically. The dimensions of the smaller halo had been somewhat diminished. The horizontal and the vertical parhelic (or rather paraselenic) circles crossing each other at right angles on the moon, a cross was seen in the middle of a circle, and an ellipse concentric to it. The several phases of the appearance were sketched and will be sent to NATURE. The last part of the phenomenon was a cross, that remained longer than the two halos, which had vanished before the rising of the sun.

W. DE FONVIELLE

ON A PROPELLER IMITATING THE ACTION OF THE FIN OF THE PIPE-FISH *

THE peculiar mechanism of the dorsal fin of the Pipe-fish (*Syngnathus*) and Sea-horse (*Hippocampus*), Fig. 1, which is also known to be present in the Electric Eel (*Gymnotus*), has been referred to by more than one naturalist. In his "Handbook to the Fish-house in the Gardens of the Zoological Society," Mr. E. W. H. Holdsworth, speaking of the Pipe-fish, remarks that "they generally maintain a nearly erect attitude, supporting themselves in the water by a peculiar *undulating* movement of the dorsal fin;" and the late Dr. Gray, in the Proceedings of the Zoological Society,† also says that "they swim with facility, but not very rapidly, and they seem to move chiefly by the action of the dorsal and pectoral fins. The former is fully expanded when they move, and in very rapid motion, the action being a kind of wave commencing at the front end and continued through its whole length, continually repeated, so as to form a kind of screw propeller."

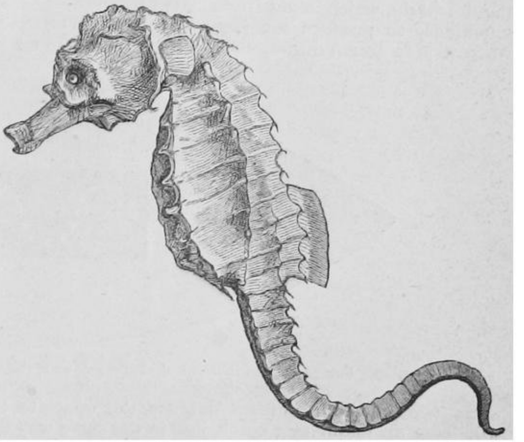


FIG. 1.—Side view of Branched Sea-horse (*Hippocampus ramulosus*), in which the dorsal undulating fin is clearly shown.

* The substance of a lecture delivered by Prof. A. H. Garrod at the Royal Institution, March 16.

† P.Z.S. 1861, p. 238.

That an undulation travelling along a median fin must act as a propeller in a direction the reverse of that in which the wave travels, is evident; because each small section of the fin can be easily recognised to consist, as long as it is in motion, of an inclined plane of which the surface of impact against the water is at all times directed backwards as well as laterally, just in the same way that in sculling from the back of a boat the propelling surface of the oar is always similarly directed.

This undulatory motion of the fin is produced by the lateral movement, in a given constant order, of the spines which go to compose it; the movement being at right angles to the long axis of the body, and consequently at right angles to the direction in which the fish travels. A delicate membrane intervenes between each two spines, which participates in their changes in position, and forms the inclined planes above spoken of.

Each spine is swollen at its base, where it articulates with the corresponding interneural spine which is embedded in the substance of the animal, and runs sufficiently deeply to become situated between the spinous processes of the two nearest vertebræ. An elongate fusiform muscle runs from each side of the swollen base of the moveable spine, parallel to the spinous processes of the adjacent vertebræ, to be fixed at its proximal or deeper end to the body of the vertebra which is situated just beneath it. By the action of the one or other of the pair of muscles attached to each spine, the latter can be moved to the right or to the left of the body of the fish. A similar couple of muscles acts on each of the elements of the dorsal fin, which is not complicated by any additional machinery to produce the elegant movement observed when it is in action during life; this, therefore, must be dependent on the peculiarity in the nerve-supply, with which it is not as yet possible to associate any special structural organisation.

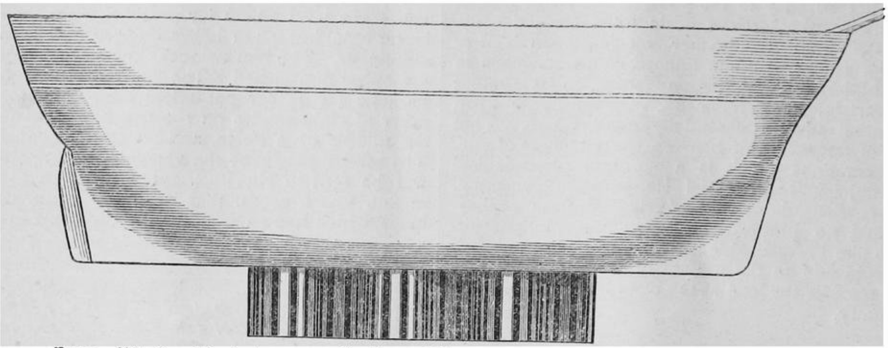


FIG. 2.—Side view of the boat constructed by Messrs. Elliott, with the undulating propeller described in the text.

It is not difficult to imitate artificially this undulatory fin of the above-mentioned fish. A series of rods hinged near their middle on a single axis will evidently represent at one end any movements given to them at the other. Therefore, if they are made to come in contact at one extremity with the side of a screw which is placed perpendicular to their direction, and at the same time is provided with projecting discs at right angles to its axis, one between every two rods, to keep them in place, the opposite tips will form an undulating curve, just in the same way that the ivory balls in the eccentric apparatus so frequently employed by lecturers on experimental physics, are made to represent the undulations of the atoms of the luminiferous æther in the production of light. Like this apparatus also, if the screw be made to rotate, an undulation will travel along the rods, which is exactly similar to that observed in the fin of the Sea-horse. Such a piece of machinery, driven by clockwork, ought theoretically to propel a boat if properly placed. Mr. C. Becker, of the firm of Messrs. Elliott and Co., has constructed such a boat, which is the property of the Royal Institution (seen sideways in Fig. 2 and from below in Fig. 3.) Its speed is slow, as is that of the fish; in the former case this is accounted for by the fac that the machinery is in this particular instance perhaps a little too heavy, at the same time that the friction developed in its action is very considerable. In the artificial fin there are just three complete undulations with eight rods in each semi-undulation, forty-eight in all. Between the rods the membranous portion of the fish's fin is represented by oil-silk. The rods and the other portions of the driving gear are so arranged that the former project, with their undulating ends and the oil-silk, in the middle of the boat, along the line of the keel. They form what may be termed a median ventral fin. The undulations are very complete, the curves being true semicircles. In the different species of Sea-horses and Pipe-fish the number of spines in the dorsal fin differ, being twenty or nineteen in *Hippocampus antiquorum*, thirty-seven in a most eccentric looking species described by Dr. Günther, and named by him *Phyllopteryx eques*, and

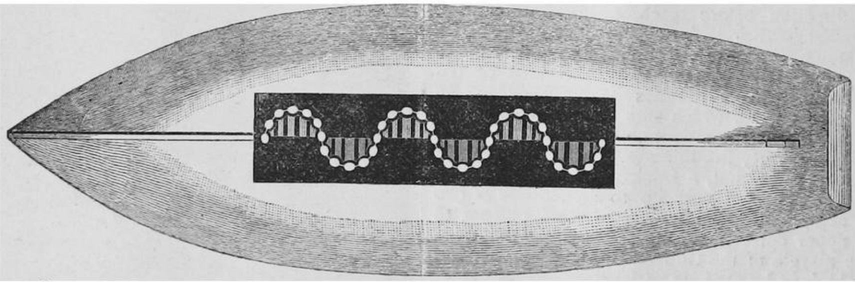
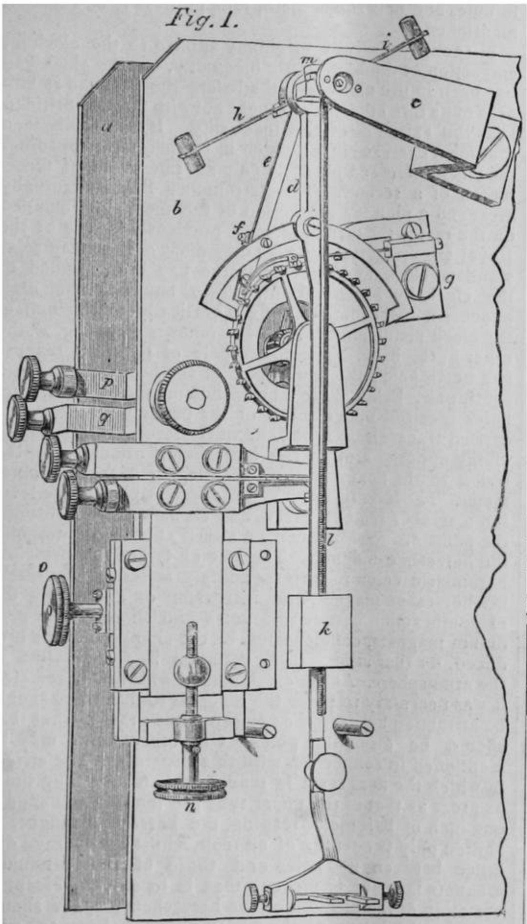


FIG. 3.—The same boat looked at from below, the apices of the rods forming undulating propeller being seen.

about forty in the great Pipe-fish (*Syngnathus acus*). In illustration of the amount of force expended in the working of its propeller, it may be mentioned that Prof. Lankester finds that it is only in the above-described muscles, by which it is moved, and in no other part of the body, that the red-colouring haemoglobin is to be detected.

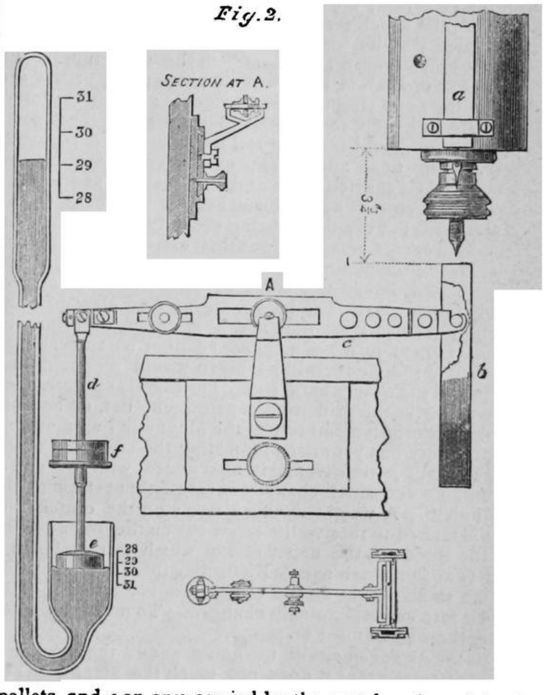
THE NEW STANDARD SIDEREAL CLOCK OF THE ROYAL OBSERVATORY, GREENWICH

THE Royal Observatory at Greenwich has lately acquired a new standard sidereal clock which possesses several peculiarities of construction. The one formerly in use was that made by Hardy, and originally



fitted with Hardy's escapement, although this had many years ago been removed and an ordinary dead beat escapement substituted. This clock was a celebrated one in its day, but of late years it seemed scarcely to satisfy modern requirements, and it was decided that a new one should be constructed. This has now been done. The new clock was planned generally by the Astronomer Royal, and constructed entirely by Messrs. E. Dent and Co., of the Strand. It was completed and brought into use in the year 1871, and both as regards quality of workmanship and accuracy of performance it appears to be an excellent specimen of horological art. As in the galvanic system of registration of transit observations it is unnecessary that the clock should be within hearing or view of the observer, the new clock has been fixed in the Magnetic Basement, in which the temperature varies only a very few degrees during the course of a year.

The pendulum is supported by a large and solid brass casting securely fixed to the wall of the basement, and the clock movement is carried by a platform forming part of the same casting. The Astronomer Royal adopted a form of escapement analogous to the detached chronometer escapement, one that he had himself many years before proposed for use,* in which the pendulum is free, excepting at the time of unlocking the wheel and receiving the impulse. Several clocks having half-seconds pendulum had since been made with escapement of this kind, but the principle had not before been applied to a large clock. The details of the escapement may be seen in Fig. 1, which gives a general view of a portion of the back plate of the clock movement, supposing the pendulum removed: *a* and *b* are the front and back plates respectively of the clock train; *c* is a cock supporting one end of the crutch axis; *d* is the crutch rod carrying the



pallets, and *e* an arm carried by the crutch axis and fixed at *f* to the left-hand pallet arm; *g* is a cock supporting a detent projecting towards the left and curved at its extreme end; at a point near the top of the escape wheel this detent carries a pin (jewel) for locking the wheel, and at its extreme end there is a very light "passing spring." The action of the escapement is as follows:— Suppose the pendulum to be swinging from the right hand. It swings quite freely until a pin at the end of the arm *e* lifts the detent; the wheel escapes from the jewel before mentioned, and the tooth next above the left-hand pallet drops on the face of the pallet (the state shown in the figure) and gives impulse to the pendulum; the wheel is immediately locked again by the jewel, and the pen-

* In the year 1827, in a paper "On the Disturbances of Pendulums and Balances, and on the Theory of Escapements," which appears in the third volume of the *Transactions of the Cambridge Philosophical Society*.

dulum, now detached, passes on to the left; in returning to the right, the light "passing spring" before spoken of allows the pendulum to pass without disturbing the detent; on going again to the left, the pendulum again receives impulse as already described. The right-hand pallet forms no essential part of the escapement, but is simply a safety pallet designed to catch the wheel in case of accident to the locking-stone during the time that the left-hand pallet is beyond the range of the wheel. The escape wheel carrying the seconds hand thus moves once only in each complete or double vibration of the pendulum, or every two seconds.

An ordinary mercurial seconds pendulum was first constructed, with jar of larger diameter than is usually made, but this did not give satisfactory results. Notably it was found, whilst still on trial in the workshop, that when the temperature of the apartment was raised, the clock increased considerably its losing rate, which only slowly returned towards its previous value, showing quick action on the rod and slow action on the quicksilver. This pendulum was finally discarded and another made employing entirely a metallic compensation. A central steel rod is encircled by a zinc tube resting on the rating nut on the steel rod; the zinc tube is in its turn encircled by a steel tube which rests at its upper end on the zinc tube, and carries at its lower end the cylindrical leaden pendulum bob attached at its centre to the steel tube. The weight of the bob is about twenty-six pounds. Slots are cut in the outer steel tube, and holes are made in the intermediate zinc tube, so as better to expose the inner parts of the compound pendulum rod to the action of temperature. For final adjustment of the compensation two straight compensated brass and steel bars (*h* and *i* in the figure) are carried by a collar, holding by friction on the crutch axis, but capable of being easily turned on the axis. The bars carry small weights at their extremities, as shown. Increase of temperature should accelerate or retard the clock according as the brass or steel lamina is respectively uppermost. The bars were at first placed in the upright (neutral) position, and it is anticipated that, by turning them into an inclined position as respects the pendulum rod, power will be given within a certain limit (reached when the bars stand horizontal) of correcting any defect in the primary compensation, but, on account of the uniform temperature of the Magnetic Basement, no opportunity has yet arisen for testing the efficiency of the apparatus. A contrivance is also added with the object of making very small changes of rate without stopping the pendulum. A weight *k* slides freely on the crutch rod, but is tapped to receive the screw cut on the lower portion of the spindle *l*, the upper end of which terminates in a nut *m* at the crutch axis. By turning this nut the position of the small weight on the crutch rod is altered, and the clock rate correspondingly changed. To make the clock lose, the weight must be raised.*

In the arrangement of the going power the ratchet is so constructed that it does not touch the great wheel on its flat part, with the object of avoiding unnecessary friction when the maintaining spring alone is acting. The driving weight of the clock is about 5¼ lb., and in order to avoid sympathetic vibration, it is made to descend in a compartment of the clock-case separate from that containing the pendulum; it also bears slightly against the side of the compartment.

The brass vertical sliding piece shown at the lower left-hand side in Fig. 1 carries at its upper end two brass bars, each of which has at its right-hand extremity, between the jaws, a slender steel spring for galvanic contact; the lower spring carries a semicircular piece projecting downwards, which a pin (jewel) on the crutch rod lifts in passing, bringing the springs in contact at each vibration (these parts are concealed in the figure by the crutch rod); the contact takes place when the pendulum is vertical, and the acting surfaces of the springs are, one platinum, the other gold, an arrangement that has been supposed to be preferable to making both surfaces of platinum. By means of the screws *n* and *o*, which both act on sliders, the contact-springs can be adjusted in the vertical and horizontal directions respectively. Other contact-springs in connection with the brass bars *p q* on the other side of the back plate are ordinarily in contact, but the contact is broken at *one* second in each minute by an arm on the escape-wheel spindle. The combination of these contacts permits the clock to complete a galvanic circuit at fifty-nine of the seconds in each minute, and omit the sixtieth, for a purpose to be hereafter mentioned.

No contrivance was originally applied to the clock for correction of the barometric inequality, but the clock had not been in use many months before the extreme steadiness of its rate otherwise brought out with marked distinctness the existence of the inequality. It was easily seen that for a decrease of one inch in the barometer reading, the clock increased its daily gaining rate by about three-tenths of a second. The Astronomer Royal eventually arranged a plan for correction of the inequality, founded on the magnetic principle long previously in use at the Royal Observatory for daily adjustment of the mean solar standard clock, and the apparatus has been applied to the clock by Messrs. Dent. Two bar magnets, each about six inches long, are fixed vertically to the bob of the clock pendulum, one in front (shown at *a*, Fig. 2), the other at the back. The lower pole of the front magnet is a north pole; the lower pole of the back magnet is a south pole. Below these a horseshoe magnet, *b*, having its poles precisely under those of the pendulum magnets, is carried transversely at the end of the lever *c*, the extremity of the opposite arm of the lever being attached by the rod *d* to the float *e* in the lower leg of a syphon barometer. The lever turns on knife edges. A plan of the lever (on a smaller scale) is given, as well as a section through the point A. Weights can be added at *f* to counterpoise the horseshoe magnet. The rise or fall of the principal barometric column correspondingly raises or depresses the horseshoe magnet, and, increasing or decreasing the magnetic action between its poles and those of the pendulum magnets, compensates, by the change of rate produced, for that arising from variation in the pressure of the atmosphere. As the clock gained with low barometer, it was necessary to place the magnets so that there should be attraction between the adjacent ends; that is, that they should be dissimilar poles. One other point may be mentioned in connection with this apparatus. The cistern in which the float rests is made with an area four times as great as that of the upper tube; so that for a change of one inch of barometer reading, the horseshoe magnet is shifted only two-tenths of an inch, whilst the average distance between its poles and those of the pendulum magnets is about 3¾ inches: that is to say, the extent of variation of the position of the horseshoe magnet should be a small fraction of the whole distance, because, with this condition, the effect produced on the rate by equal increments of distance is then practically uniform. The action of the apparatus on the Greenwich clock has, as regards correction of the inequality of rate, been quite successful; and further, the extent of the pendulum arc, which was before subject to a slight variation, is now very constant, and amounts (the total arc) to about 2° 33′ with scarcely any change.

This account of the clock will scarcely be complete without some brief description of the use made of it. It has been mentioned that the clock completes a galvanic circuit fifty-nine times in each minute, but omits the

* As regards the efficiency of the zinc and steel compensation, it may be here mentioned that the transit clocks made for the Transit of Venus Expeditions were provided with pendulums compensated in this way. Some of these clocks underwent very severe trial at Greenwich before the various expeditions set out, with most satisfactory results. They seemed, indeed, to be superior to clocks fitted with the ordinary mercurial compensation.

sixtieth contact. The currents thus obtained (a small battery only being used on the clock) are used to work a relay from which three independent currents from other batteries are derived. One acts upon the seconds magnet of the chronograph for impress of seconds punctures on the paper on the revolving cylinder. The omission of one second in each minute marks with certainty the commencement of the minute. Observations at all the fundamental instruments are registered on this cylinder, and comparisons of clocks are thus entirely avoided. Another current regulates a half-seconds chronometer on the eye-end of the Great Equatoreal. The third current regulates the pendulum of a half-seconds clock in the Great Equatoreal Room, drives a tapper to make audible the seconds of the clock, and drives also a galvanic chronometer placed in the Computing Room for use in the daily work of comparing and setting to time the mean solar standard clock. The omission of one current in each minute is unimportant as concerns the regulated chronometer and clock, but not so as regards the chronometer which is driven by the current. To accommodate the chronometer to this state of things, its seconds wheel is cut with fifty-nine teeth only, and its seconds circle on the dial correspondingly divided into fifty-nine equal parts. The resting of the hand during one second, which takes place at a particular division of the dial, consequent on the loss of one current in each minute, is therefore compensated for by this construction of the seconds wheel and engraved dial plate.

ARCTIC VEGETATION

A FEW notes on the vegetation of the Arctic regions may not be out of season at the present time. For fuller details we may refer to Dr. Hooker's exhaustive essay on the distribution of Arctic plants, published in the Transactions of the Linnean Society, vol. xxiii., 1862. Since the appearance of this article very little has been added to our knowledge of Arctic vegetation, if we except the flora of Spitzbergen. Several naturalists have since visited the islands of this group, and about thirty additional species of flowering plants have been discovered. The greater part of these additions have been published in the *Journal of Botany*, vol. ii. pp. 130 to 137 and 162 to 176, and vol. i., series 2, p. 152; but a few interesting plants new to the group, collected by the Rev. Mr. Eaton, and now in the Herbarium at Kew, do not appear to have been published. With the exception of the shores of Smith's Sound in North America, Spitzbergen is the most northerly land yet trodden by the foot of restless explorers, and from its relative accessibility its vegetation is perhaps better known than any other part lying far within the Arctic circle. For this reason, and on account of their high latitude, we have chosen the vegetation of the Spitzbergen Islands to illustrate the whole flora of the Arctic regions. We have been influenced in this choice, too, by the fact that many of the species there represented are indigenous in Britain. Most of these species, it should be stated, are confined to the mountains of the north of England and Scotland.

To give a general idea of the whole flora of the North Frigid Zone, we may quote a few of Dr. Hooker's figures. By way of explanation it should be mentioned that Dr. Hooker takes a very broad view of species, and many forms considered as distinct species by some botanists here count as varieties. The more recent additions to the flora of Spitzbergen would not materially alter these figures, because the same species were all, or nearly all, previously known to exist in Arctic Continental Europe or America. A few deductions would also probably have to be made. For instance, the Reed-mace, *Typha*, appears to have been included by mistake in the list of Arctic American plants. The total number of species of flowering plants—with which alone we shall concern ourselves—given, is 762, o which about fifty are exclusively confined to the Arctic regions. A very large proportion of these are found in Scandinavia, south of the Arctic circle, and reappear in the Alps; a few reach the Alpine regions of the mountains of India and Africa, and a few reappear in the extreme south of the southern hemisphere. In a less degree the same thing occurs from north to south on the American continent. Of these 762 species, 616 have been observed in Arctic Europe, 233 in Arctic Asia, 364 in Arctic West America, 379 in Arctic East America, and 207 in Arctic Greenland. From the proportions the respective figures for the five different areas bear to the total, it will be seen that nearly all the areas must have a majority of species in common, and that each area has very few species peculiar to itself. Before proceeding to give a sketch of the flora of Spitzbergen, there is one remarkable fact deserving of special notice. Of the 207 species found in Greenland, 195 are Scandinavian types, and only 12 are American or Asiatic types.

A glance at the map for the position of the Spitzbergen group will enable the reader to realise more fully the interest attached to the investigation of the plants and animals of a small isolated tract of land in so high a latitude—between 76° 33′ and 80° 50′—especially when told that the highest point at which flowering plants have hitherto been seen is about 82°, or within 8° of the pole, in Smith's Sound. The geological formation of the group is of the earliest. So far as at present known it consists of granite and other crystalline rocks, and in the south traces of the Carboniferous and Permian strata have been discovered. The climate of Spitzbergen is modified to a certain extent, like the whole of Western Europe, by oceanic streams flowing from the hot regions northwards. Nevertheless, it is exceedingly rigorous, as may be imagined from the fact that the sun never rises more than 37° above the horizon, and the winter is of ten months' duration. From the observations of Phipps, Parry, Scoresby, and several foreign explorers, the mean temperature of July, the warmest month, has been estimated at about 37° Fahr., and the highest point observed by Scoresby was 51° on the 29th of July, 1815. The mean temperature of the year is about 17° Fahr., and the mean temperature of the three winter months (Dec., Jan., and Feb.) is calculated at about zero of Fahrenheit. Of course the preceding figures must be treated as very rough approximations only.

From the foregoing brief sketch of the climatal and other conditions of Spitzbergen, a very limited number of flowering plants would be expected to thrive, but at least one hundred species have been observed—a comparatively rich flora, when we consider that it is only in the most favourable situations that they can exist at all. Nearly the whole of the vegetation consists of herbaceous perennials, about one-third being grasses, sedges, and rushes. The nearest approach to woody vegetation are the crowberry (*Empetrum nigrum*), two species of willow (*Salix reticulata* and *S. polaris*), and *Andromeda tetragona*, an Ericaceous under-shrub, neither of which rises more than a few inches above the soil. Taking the families in their natural sequence, we have—1. Ranunculaceæ: six species of Ranunculus, and probably seven, a fragment in the Kew Herbarium, collected by the Rev. Mr. Eaton, appearing to be *R. acris*. 2. Papaveraceæ: *Papaver nudicaule*, a pretty dwarf yellow-flowered poppy. 3. Cruciferæ: about eighteen species, including *Cardamine pratensis*, ten species of *Draba*, and one species of scurvy grass, *Cochlearia fenestrata*, perhaps the only esculent vegetable found in Spitzbergen, which has proved most valuable to the crews of the vessels that have touched there. 4. Caryophylleæ: about a dozen species, including the following British—*Silene acaulis*, *Arenaria ciliata*, *A. peploides*, and *A. rubella*. 5. Rosaceæ: four species of *Potentilla* and

Dryas octopetala. 6. Saxifrageæ: *Chrysosplenium alternifolium*, *Saxifraga oppositifolia*, *nivalis*, *cernua*, *cæspitosa*, *hirculus*, *aizoides*, and four other species not found in Britain. 7. Compositæ: four species, including the dandelion. 8. Campanulaceæ: *Campanula uniflora*. 9. Ericaceæ: the little shrub mentioned above. 10. Gentianaceæ: *Gentiana tenella*, discovered by the Rev. Mr. Eaton in 1872. 11. Boraginaceæ: *Mertensia maritima*. 12. Polemoniaceæ: one species of *Polemonium*. 13. Scrophulariaceæ: *Pedicularis hirsuta*. 14. Empetraceæ: the *Empetrum* alluded to. 15. Polygoneæ: two British species, *Polygonum viviparum*, and *Oxyria reniformis*; and *Kœnigia islandica*, which is of annual duration. 16. Salicineæ: the two species of willow given above. The remaining families—(17) Juncaceæ, (18) Cyperaceæ, and (19) Gramineæ—make up the rest, the latter being by far the most numerous, and embracing several British genera and species.

In a broad sense, the Arctic vegetation closely resembles the flora of the higher Alps, but there is less brilliancy and variety of colour in the flowers, yellow and white largely predominating. The plants assume a dense tufted habit of growth, and increase mainly by lateral branches, which take root and in their turn produce offsets. It is possible some or all of them ripen seeds in certain favourable seasons, but the almost total absence of annual plants, and the habit of growth of the perennials, seem to indicate that this very seldom happens. An attentive study of the distribution of Arctic flowering plants would lead us to believe that few new species remain to be discovered; and probably in the lower cryptogams also, few absolutely new forms will be found, though doubtless many known species occur that have not yet been collected. Therefore there is some justness in the complaints of geologists because no geologist has been appointed to the Arctic Expedition, whereas a botanist has been appointed. We may reproduce here the substance of an interesting note on the most northerly species of flowering plants known, which was communicated to this journal (vol. viii. p. 487) by Dr. J. D. Hooker. The four following plants, collected by Dr. Bessel in 82° N. lat., probably on the east side of Smith's Sound, represent the extreme northern limits of phanerogamic vegetation so far as at present known: *Draba alpina*, *Cerastium alpinum*, *Taraxacum dens-leonis* var., and *Poa alpina*. With the exception of the first, these are also indigenous in Britain. We have one more observation to make. Although there is what botanists term an Antarctic flora, not a single flowering plant has been found within the Antarctic circle, and only a very limited number of the lower cryptogams.

NOTES

THE late Sir Charles Lyell has not been forgetful of the interests of science in his will. He gives to the Geological Society of London the die executed by Mr. Leonard Wyon, of a medal to be cast in bronze, to be given annually and called the Lyell Medal, to be regarded as a mark of honorary distinction and as an expression on the part of the governing body of the Society that the medallist (who may be of any country or either sex) has deserved well of the science. He further gives to the said Society the sum of 2,000*l.*, the annual interest arising therefrom to be appropriated and applied in the following manner:—Not less than one-third of the annual interest to accompany the medal, the remaining interest to be given in one or more portions at the discretion of the Council for the encouragement of geology, or of any of the allied sciences by which they shall consider geology to have been most materially advanced, either for travelling expenses or for a memoir or paper published or in progress, and without reference to the sex or nationality of the author or the language in which it may be written. The Council of the Society are to be the sole judges of the merits of the memoirs or papers for which they may vote the medal and fund from time to time.

LORD LINDSAY, writing from Florence to the Mayor of Wigan, of which place his lordship is representative, states that in order to recover from the severe effect of the Mauritius fever, caught while observing the recent transit, he is obliged to stay in Italy to recruit. He hopes, however, to be able to return to England by the time Parliament resumes its sittings.

PROF. H. E. ARMSTRONG, of the London Institution, well known for his researches in organic chemistry, and Mr. W. N. Hartley, Demonstrator of Chemistry in King's College, are candidates for the Jacksonian Professorship of Experimental Philosophy in the University of Cambridge. It will be interesting to watch what course the Cambridge authorities will take with regard to the appointment to the vacant chair.

MR. E. J. NANSON, B.A., Fellow of Trinity College, Cambridge, Professor of Applied Mathematics at the Royal Indian Engineering College, Cooper's Hill, has been selected by Prof. Adams to succeed the late Prof. W. P. Wilson in the chair of Mathematics at the University of Melbourne. Mr. Nanson was Second Wrangler and Second Smith's Prizeman in 1873.

THE French National Assembly have unanimously voted the funds for the creation of a third Chair of Chemistry in the Faculty of Sciences of Paris. The new chair is to be devoted to Organic Chemistry, which, owing to the arrangements with regard to the other two chairs, has hitherto been somewhat neglected.

A CORRESPONDENT sends us the following query on the subject of Arctic Meteorology with reference to the forthcoming Arctic Expedition:—"I have noted from time to time in the pages of NATURE the various items of information respecting the outfit for the Arctic Expedition, but have failed to ascertain what, if any, preparations are being made for the observation of meteorological phenomena. We know little or nothing about the amount of aqueous deposition in the Arctic regions. Are not the vessels supplied with *rain-gauges?* Surely there will be many opportunities of recording the quantity of rainfall or snowfall, during several months at different stations, or even the hourly rate of deposition at the time of storms. Anemometers, too, might be employed to register the velocity or pressure of wind."

IN reply to Mr. Fisher's query (NATURE, vol. xi. p. 364) as to a satisfactory method of killing *Hoplophora decumana*, a correspondent recommends the following method:—First stupify the insect by dropping it into some benzole, or similar fluid, and then pierce it with a needle that has been dipped into a solution of corrosive sublimate.

AMONG the list of Friday evening lecturers at the Royal Institution noted in last week's NATURE, we should have given the name of Prof. Tyndall, F.R.S., whose subject, however, has not yet been announced.

IN the notice of Mr. Hart's list of the flowering plants and ferns of the Arran Islands, Galway Bay (vol. xi. p. 395), we inadvertently gave *Dabeocia polifolia* as one of the West European or Atlantic types characterising this flora. This is a bog plant found in Connemara and Mayo, but it does not occur in the Arran Islands, nor are there suitable localities for it, neither is it included by Mr. Hart.

AT the next congress of French meteorologists, which is to be held at Paris in a few days, M. Leverrier will propose to experiment on a large scale for the purpose of testing the efficacy of smoke in preventing young plants from being damaged by the frosty mornings so common in April.

On Monday, the 22nd March, the first meeting of the Governors of the London School of Medicine for Women took place on the school premises, No. 30, Henrietta Street, Brunswick Square; Lord Aberdare in the chair. The Dean gave a short history of the school. He stated that during the winter session the same courses of lectures and demonstrations had been given as in the other medical schools of the metropolis, and that the number of women students attending was twenty. It was resolved that the proposed constitution and laws should be referred to a committee for consideration, and that in the meantime the school business should be conducted by the Provisional Council as heretofore. It was then agreed that the next meeting of the governors should take place on the 3rd of May, on which day the prizes will be distributed to those pupils who have been successful in the class examinations.

The Council of the Social Science Association has fixed October 6th to the 13th for holding the Congress at Brighton this year. It has also authorised an exhibition of sanitary and educational appliances and apparatus to be held at the same time in connection with the meeting.

A long and interesting letter, dated Soubat, Feb. 7, appears in Saturday's *Times*, giving some details of Col. Gordon's work in Central Africa. He seems to have been fairly successful in the object of his mission—the reduction of these lawless regions to something like order, and the abolition of the slave traffic. Lieuts. Watson and Chippendale, two young Engineer officers who were at Ragaff, about 1,000 miles above Khartoum, succeeded in making some important observations during the Transit of Venus, which are to be transmitted to the Royal Geographical Society. Lieut. Chippendale, when the letter left, was on his way to Duflé. He was to make his way across the Ashua River to Ibrahimia, and from thence to continue his march with only a few soldiers, striking inland for the Albert Nyanza. He is there to obtain a canoe at any cost, and return, if possible, from the Albert Nyanza down the Nile to Duflé, thus establishing the fact whether the Nile is navigable between these two points.

A telegram, dated Ulm, March 30, states that the African traveller Karl Mauch, who is at present staying in Blaubeüren, has suffered such severe injuries in consequence of a fall that his life is despaired of.

It is stated that a project has been formed, under the sanction of Capt. Sir John H. Glover, Mr. R. N. Fowler, and other well-known gentlemen, for the formation of a canal from the mouth of the African river Belta, on the Atlantic, in the neighbourhood of Cape Bajador, to the northern bend of the River Niger, at Timbuctoo, a distance of 740 miles.

The French are trying to open a regular trade with Timbuctoo and Soudan *viâ* Tusalah, the chief city of Touaregs. They have recently conquered the oasis of Goleah, about 600 miles from the coast. It is from that place that M. Paul Soleillet, the enterprising Sahara explorer, will start for Tusalah, having to march a distance of only 900 miles. The colonisation of Algeria has recently received a strong impulse from more than 10,000 Alsace-Lorainers having settled in the colony. The European population is increasing not only by a sensible flow of emigration, but by the excess of births over deaths. The colonists, exclusive of the army, now number 250,000, while the native population is not more than 2,250,000. The governor of the three provinces is General Chanzy, who has decided on the institution of three annual fairs to be held in the southern part of each province. Goleah being too far south, a city will be founded for that purpose at about 300 miles from the coast, in the eastern province. It is expected that, attracted by these fairs, Arabs and Touaregs of the west will resume the old trade. Another French African settlement is the district south of the Gold Coast, known as Gaboon. The Marquis de Compiègne and M. Marche, who explored this region last year, are shortly to resume their explorations, which had been cut short by hostile tribes.

M. Largeau, another French explorer, left Algiers a few weeks ago for Rhadamez, an oasis in the central part of the Sahara. A letter dated 17th February last has been received from him. He was very well received by the Sheikh and the Djamaa, or national council of natives. Explanations were given to him as to the murder of his fellow-traveller Dournaux-Duperé, whose conduct had been rather indiscreet. The Djamaa is anxious to open commercial relations with France, and M. Largeau will soon begin his return journey by another way in order to ascertain if it is not more practicable than the one by which he travelled southwards.

From the official report of the chamois shooting in the canton of Grisons during 1874, it appears that during the year 918 chamois, 4 bears, and 18 eagles (*Aquila fulva*) were killed in the canton. The highest number of chamois killed by one sportsman was 16; the term for shooting is four weeks in September. In 1873 the numbers were 696 chamois and 4 bears; in 1872, when the shooting term extended two weeks longer, the numbers were 766 chamois and 3 bears. The result of last year, therefore, is decidedly favourable, and evidently owing to the reduced term of shooting.

Mr. F. Norgate has recently published, under the title of "Humboldt's Natur-und Reisebilder," a selection of pictures of nature and travel from A. von Humboldt's personal narrative of travel and aspect of nature. It is edited, with a commentary, scientific glossary, and biographical notice of the author, by Dr. C. A. Buchheim. It is intended to afford to readers of German and to students of the language a pleasant variety and a relief from the standard works which as a rule form the staple of German readings in this country. The idea seems to us a happy one, and the selections are well chosen; Dr. Buchheim has well performed his part of biographer and interpreter.

A new edition has just been issued by Messrs. W. Hunt and Co., of the late Rev. A. B. Whatton's "Memoir of the Life and Labours of the Rev. Jeremiah Horrox," which was first published in 1859. From the present edition the translation of Horrox's Treatise on the Transit of 1639 has been omitted.

Near Cortil-Noirmont (Belgium) two old tombs have lately been investigated; they had the shape of mounds, and were called "the Roman tombs" by the people. In one of them many human bones were found, rusty iron weapons, and many small bronze coins, unfortunately not well preserved. In the other there were only the remains of one human skeleton, but besides this a highly ornamental glass bottle, several large bronze vases, a lamp of the same material, two silver and two gold coins, and a relief cut into rock crystal and representing a lizard. The coins are of the time of Nerva and Hadrianus.

Brick Tea is a large article of commerce between China and Thibet. It is described as being made chiefly in the neighbourhood of Ya-tsow in Szechuen, the tea-plant from which it is made being "a hedgerow tree, fifteen feet high, with a large and coarse leaf." The tea is done up in packets, each containing four bricks and weighing five pounds, and is bought at Tatsien-lu for about 6*s*. 4*d*.; it sells at Lhassa for 1*l*. 4*s*. to 1*l*. 8*s*., and at a much greater sum in the districts which lie off the grand road. From these facts it is apparent that the Darjeeling planters could supply Lhassa with tea at prices to undersell the Chinese article at a very considerable profit, and could make a still larger profit by supplying the country which lies between Lhassa and the frontier of Sikkim. The better class of teas cost at Lhassa about two rupees per pound, but are seldom imported. It is estimated that the annual supply of tea to Thibet amounts to about six millions of pounds, producing an income of not less than 300,000*l.*

A NEW source of caoutchouc reaches us from Burmah, a description of which has been given in a pamphlet published in Rangoon. The plant yielding this caoutchouc is the *Chavannesia esculenta*, a creeper belonging to the natural order Apocyneæ, an order which includes the Borneo rubber plant *Urceola elastica*, the African rubber plants *Landolphia* spp., as well as other genera yielding milky juices. The plant, which is common in the Burmese forests, is said to be cultivated by the natives for the sake of its fruit, which has an agreeable acid taste. It comes into season when tamarinds are not procurable, and finds a ready sale at Rangoon, at an anna per bunch of ten fruits. The milk is said to coagulate more readily than that of *Ficus elastica*, and to be purer and better for most purposes for which rubber is used.

UNDER the title of "Contributions to the Fossil Flora of the Western Territories, U.S., Part I. The Cretaceous Flora, by Prof. Lesquereux," Prof. Hayden has published the sixth volume of the series of final reports of the United States Geological Survey of the Territories. The work is in quarto, and embraces 136 pages and thirty plates. Very many new species are figured and described. The work covers all the known species of the Dakota group, and constitutes an important starting-point for similar monographs of other divisions of the fossil plants of America. Prof. Lesquereux considers the surface and stratigraphical distribution of the species. In accordance with Dr. Hayden's views, the author finds the group to be of marine origin, as shown by the occurrence of various species of marine molluscs. Prof. Lesquereux is not prepared to commit himself in regard to the correlaton of the flora of the Dakota group with that of subsequent geological epochs and their identity, preferring to wait the gathering and examination of other series. He, however, states that this flora, without affinity with any preceding vegetable types, without relation to the flora of the Lower Tertiary of the United States, and with scarcely any forms referable to species known from coeval formations in Europe, presents, as a whole, a remarkable and, as yet, unexplained case of isolation.

THE cultivation of the tobacco plant in Algeria has been carried out very successfully, the soil and climate of that country being well suited to the growth of the plant. In 1874 no less than 4,850,00 kilogrammes, or over 9,700,000 lbs., were produced and passed through the State warehouses. The value of this crop was 141,224*l.*, or nearly double that of 1873. The experiment—though it is no longer merely an experiment, but a practical industry—has been carried on since 1847, and during the past twenty-seven years about 140,000,000 lbs. weight of tobacco has been produced and sold.

IT is stated that the Italian Government, following the course it has already adopted on previous occasions, will gratuitously distribute this year 5,000 plants of the *Eucalyptus globulus*, for cultivation in the Agro Romano, especially in the spot infected by malaria.

THE additions to the Zoological Society's Gardens during the past week include an African Civet Cat (*Viverra civetta*), presented by the Earl of Harrington; an Australian Monitor (*Monitor gouldi*), presented by Dr. Pardoe; three Black-necked Storks (*Xenorhynchus australis*) from Malacca, purchased; a Blue-faced Green Amazon (*Chrysotis bouqueti*) from St. Lucia; two Yellow-fronted Amazons (*Chrysotis ochrocephala*) and a Brown-throated Conure (*Conurus æruginosus*) from S. America, deposited.

ACCIDENTAL EXPLOSIONS *

THE term "accident," applied in its strict sense to disasters caused by explosions, would imply that these were due to some circumstance, or combination of circumstances, entirely unforeseen, and that they were consequently unpreventible. An explosion which occurs during the preparation or investigation of a compound the explosive nature of which is as yet unknown may be purely accidental, but if, after the properties of the substance have been thoroughly ascertained and made known, an explosion occurs during its production, by some person who has not properly made himself acquainted with or has neglected in some point or other those conditions essential to its production with safety, the knowledge of which is within his reach, the term "accidental" can certainly not be properly applied to it, although in all probability it would be so designated popularly, and even by those entrusted on behalf of the public with the investigation of its origin and results.

In the present discourse the definition "accidental" is accepted in the loose sense in which it is popularly applied to explosions, with the object of examining into the nature and causes of such explosions, and, if possible, of indicating directions in which there may be hope of successful efforts being made for reducing the frequency of their occurrence.

The phenomena attendant upon an explosion are generally due to the sudden or very rapid expansion of matter, accompanied in most instances by its change of state from solid or liquid to gas or vapour. The most simple classes of explosions are those caused by the sudden yielding to force, exerted from within, of receptacles in which a gas is imprisoned in a highly compressed condition, or a liquid has been raised to a temperature greatly exceeding that at which its molecules have a tendency to fly asunder or to assume the state of vapour or gas. The strength or elasticity of the envelope which confines them suddenly yielding to pressure, the liquid passes with great rapidity into vapour, violently displacing by this sudden expansion the surrounding air and any other obstacles opposed to the expanding molecules.

Similar explosive effects less simple in their origin are brought about by the sudden development of chemical activity in mixtures of gases or vapours, of solids and gases, or of solids only, or in chemical compounds of unstable character, the result in all such instances being the development of intense heat and the sudden or very rapid and great expansion of matter.

Examples of the most simple class of explosions are the sudden failure in strength at some particular point, or generally, of the material composing a vessel in which a gas has either been liquefied or highly compressed. Accidental explosions of this character take place chiefly, and happily not very frequently, in the laboratory or lecture-room, yet instances occasionally occur of disastrous explosions resulting from such causes in manufacturing operations, or in the practical application of compressed air or other gases. The most recent illustration of a serious accidental explosion of this kind is that which occurred in the Arsenal at Woolwich in January 1874, with the air-chamber of a Whitehead, or Fish-torpedo, when one man lost his life and several were seriously injured. In this instance some part of the soft steel diaphragm closing the chamber in which the motive power of this self-propellant torpedo (air) was imprisoned under a pressure of about 800 lb. on the square inch, suddenly yielded to the efforts of the gas to return to its normal condition.

Other explosions of this class, which are of more than weekly occurrence, and but too frequently result not merely in destruction of property, but in more or less serious loss of life, are due to the bursting of boilers at factories, mines, and collieries, to say nothing of those which occur in buildings, in connection with heating appliances and with kitchen ranges, and bath- or other heating-arrangements. The explosion of a boiler may arise either from an exceptionally rapid development of steam or from an absence, or failure in the proper operation, of appliances for relieving the pressure in a boiler, by permitting the escape of steam and giving warning when the pressure begins to exceed that of safety. But by far the chief causes of boiler explosions are defects in their construction or repair, and the reduction in thickness of the metal in parts by corrosion or oxidation, internally and externally, from long use, and neglect of proper measures for periodically cleaning the boilers.

The accidents due directly to the deposits formed from water in boilers have been very greatly diminished of late years by the

* Abstract of a lecture delivered at the Royal Institution, March 12, by Prof. F. A. Abel, F.R.S.

application of preparations called boiler-compositions, of which there are many varieties, their general action being to prevent more or less effectually the carbonate and sulphate of calcium and other impurities in water, which are separated by its ebullition and evaporation, from producing hard impenetrable crusts or coatings upon the inner surfaces of the boiler. The judicious employment of a good anti-fouling preparation, and the thorough periodical cleansing of the interior of boilers, go far to guard against that source of danger; though, in adopting measures to diminish the formation of incrustations, care must also be taken to avoid promoting internal corrosion of the boiler by the agents used.

The operations of the Manchester Steam Users Association for the prevention of steam-boiler explosions, founded, mainly through the instrumentality of Sir William Fairbairn, twenty years ago, and of which Sir Joseph Whitworth has also been a warm supporter from its commencement, appear to have gradually succeeded in very importantly reducing the annual number of boiler explosions by introducing among its members a system of periodical independent inspection. The Association will not allow that the term "accidental," or mysterious, is applicable to steam boiler explosions. Mysterious they certainly are not, as they are generally quite traceable to causes which may be obviated, such as inferior material or defective construction, or local injuries, gradually developing and increasing, which would certainly be discovered before they attained dangerous dimensions, by a proper inspection.

The following data with respect to the causes of boiler explosions are taken from a table prepared by Mr. L. Fletcher, chief engineer of the Association:—40 per cent. were due (from Jan. 1861 to June 1870) to malconstruction of the boilers; 29 per cent. to "defective condition" of the boilers; 15 per cent. to the failure of seams of rivets at the bottom of externally fired boilers; 10 per cent. to overheating from shortness of water; and less than 3 per cent. to accumulation of incrustations.

An examination into the particular nature of the services performed by boilers which have exploded shows that a considerable number of explosions have occurred at ironworks, and a very large proportion at collieries, where plain cylindrical externally-fired boilers are much used. Many of the explosions of these particular boilers arise from places which remain for a time concealed in the overlaps of the seams of rivets, defying detection, but gradually extending from one rivet hole to another, till some sudden strain causes them to extend throughout the entire seam, the boiler splitting in two. The particular description of boiler which gave rise to the largest number of fatal accidents during the year taken as illustration was the single-flued or Cornish boiler; and it was stated by Mr. Fletcher that all these explosions must have been the result of glaring neglect, as there is no boiler safer to use when well made and properly cared for. The simple precaution of strengthening or giving internal support to the sides of the furnace-tube of these boilers, the importance of which was demonstrated many years ago by Sir W. Fairbairn, appears to be still greatly neglected, the result being the frequent collapse of the tube through weakness. Very few explosions in 1873 appear to have been due to the neglect of the attendants, but by far the greater number to that of the boiler owners or the makers.

[The lecturer then gave a number of instances strikingly illustrative of the statements above made.]

The foregoing and other very numerous illustrations of the appalling display of ignorance, neglect, or recklessness in dealing with the application of steam power, point strongly to the importance of legislation connected with this subject. There can be no reason why the responsibility of the proper condition of boilers and steam apparatus generally should not be thrown upon inspectors, just as the proper fencing of machinery in factories, and the proper condition of steam boilers in a passenger steamship, are secured by a system of responsible official inspection.

The explosions which are often recorded as occurring in kitchen ranges and in boilers used in connection with the heating of buildings are not unfrequently attended by fatal results. Much of what has been said with regard to boiler explosions generally applies to accidents of this class.

As the water in kitchen boilers is often used for culinary and drinking purposes, the means employed in boilers used for steam purposes only, to prevent the formation of hard deposits, cannot be resorted to; therefore the only means of guarding against accidents to domestic boilers from these causes consists in frequent and thorough cleaning out, which is especially necessary where the water supply is hard.

Explosions also occur with household boilers of the ordinary circulating class, unprovided with safety valves, through the stop-taps of the pipes which connect them with an overhead cistern being left closed by accident or negligence, in which case steam pressure must speedily accumulate to a dangerous extent, all outlets being closed. Accidents with such boilers are particularly liable to occur during severe frosts in consequence of the circulating pipes becoming plugged up with ice, whereby the outlet for steam pressure is as completely cut off as if the stop-taps were closed. Several accidents due to these two causes, some of them attended by fatal results, were recorded last year. The obvious and simple method of guarding effectually against such explosions is to have the boiler fitted with a reliable safety valve, of the most simple form.

Explosions resulting from the ignition of mixtures of inflammable gas and air constitute even a more formidable class than that just described, for the number of explosions in coal mines which occur in a year is very considerably greater than that of boiler explosions, while the loss of life occasioned by the former is very considerable, and is occasionally appalling in its magnitude.

If marsh-gas, or light carburetted hydrogen, which exists imprisoned in coal-beds and escapes into the atmosphere in the pit-working, either gradually or sometimes under considerable pressure, becomes mixed with the air to such an extent that there are about eighteen volumes of the latter to one of the gas, the mixture burns with a pale blue flame, which will surround that of a candle contained in such an atmosphere; the appearance of such a "corpse light" round the flame of the pitman's candle or lamp-flame is a warning, too generally unheeded, of the presence of fire-damp in quantities likely to be dangerous, for if the proportion of marsh-gas increases much beyond that above specified, an explosive atmosphere will be formed, the violent character of which increases as the proportion of fire-damp approaches that of one volume to ten of air. Marsh-gas requires for its ignition to be brought into contact with a body raised to a white heat; fire-damp, or a mixture of marsh-gas and air is therefore not inflamed by a spark or red-hot wire, but will explode if brought into contact with flame. The fact that this contact must be of some little duration to ensure the ignition of the fire-damp was applied by Stephenson in the construction of his safety-lamp; and a very philosophical application of the property possessed by good conducting bodies, such as copper or iron, of cooling down a flame below the igniting point of the gas, and thus extinguishing it, was made by Davy in the construction of his safety-lamp.

All the efforts of eminent scientific and practical men, for the better part of a century past, to diminish the number of coal-mine explosions by improving the ventilation of the mines and providing the miner with comparatively safe means of illumination, appear to have had very little effect in reducing the number and disastrous nature of these accidents. Since the construction of safety miners' lamps by Davy, Stephenson, and Clenney, repeated and partially successful efforts have been made to reduce the loss of light consequent upon the necessary enclosure of the flame, and thus to lessen the temptation of the miner to employ a naked flame at his work in fiery mines; yet investigations after mine explosions still frequently disclose instances of the employment of candles where they are undoubtedly dangerous, and the regulations which have been made law with the view of preventing accidents through the use of naked lights by miners, where there appears any likelihood of fire-damp escaping and lodging, are in many cases either habitually neglected or very carelessly carried out. One practice which appears to have become very general in mines where fire-damp is known to exist, that of sending *firemen* with safety-lamps to examine the mines, the men then proceeding to work with naked lights in all places marked as safe by those officials, is obviously a most dangerous one, the lives of many being made absolutely dependent upon the vigilance and trustworthiness of one or two; yet it appears to be one almost forced upon the managers of collieries by the men themselves, who often absolutely refuse to go to work with safety-lamps. Of the three colliery accidents which occurred between Dec. 23 and Jan. 7 last, by which twenty-eight men lost their lives, two afford sad illustrations of the fact that the overlookers and the miners themselves are chiefly to blame for the frequency of these accidents, and that the practice of employing "firemen" just referred to is a highly perilous one.

There can be no question that the comparatively dim light afforded even by the best constructed lamps in general use is a cause of great temptation to the men to use uncovered lights; it is therefore much to be hoped that continued efforts may be made to apply the electric light to the illumination of mine workings. Some approach to success in this direction was already attained ten years ago, and one cannot but have great faith in the ultimate feasibility of some portable method of illumination by electric agency.

There are, however, causes other than the use of unprotected lights, which contribute to the production of coal-mine explosions. Efficient ventilation of workings, whether in use or not, whereby all dangerous accumulation of fire-damp is avoided, and any sudden eruption of gas may be rapidly dealt with (the gas being largely diluted and swept away as speedily as possible), is indispensable to the safe working of the mine (without any reference to the health of the men) so long as there is any temptation for the use of naked lights. The original laying out of a working greatly affects the question of efficient ventilation, and explosions have been clearly traced to gas accumulations, which there was sufficient power of ventilation to reduce, if the nature of the working had admitted of its proper application. In arranging for the efficient ventilation of a mine, ample provision for rapidly applying extra artificial ventilating power should be made, and, in connection with this, the interesting and useful series of observations should be borne in mind which have been made public in communications to the Royal Society and the Meteorological Society by Messrs. R. H. Scott and W. Galloway.*

Since the employment of gunpowder as a means of rapidly removing coal, or overlying shale, has come into considerable use, there can be no question that an additional and a very serious source of danger has been imported into the working of collieries. That the explosion of a charge of powder in a blast-hole, or the "firing of a shot," has by no means unfrequently resulted in the production of a fire-damp explosion, has been clearly established by careful inquiry. This has been ascribed to two causes, one of them the direct ignition of the explosive gas-mixture by the flame from the shot, the other the dislodgment of fire-damp from cavities or disused workings by the concussion produced, and its ignition by some naked flame or defective lamp in the neighbourhood. If a shot takes effect properly (*i.e.* if the force is fully expended in breaking the coal or rock at the seat of the charge), there is seldom flame produced, but if the tamping which confines the charge in the blast-hole is simply blown out of the latter like a shot from a gun (which not unfrequently occurs when the rock is very hard or the tamping is not sufficiently firm, or when the charge of powder is excessive), the powder-gas issuing from the blast-hole will produce a flash of fire as obtained with a gun, and if the fire-damp were in the immediate neighbourhood, it would no doubt be ignited thereby. But this combination of conditions is not likely frequently to occur; the second cause above given is therefore more likely to be fruitful of accidents; but the existence of a third cause, to which the majority of explosions connected with blasting in collieries is most probably ascribable, has been very clearly established by the careful inquiries, sound reasoning, and ingenious experiments of Mr. W. Galloway, Inspector of Mines. Mr. Galloway conceived, and has clearly established by experiments in the laboratory and in coal-pits, that the sound-wave established by the firing of a shot (especially by the sharp explosion produced when the tamping is shot out of a hole) will by transmission, even to very considerable distances, have the effect of forcing the flame of a safety-lamp through the meshes of the gauze, and will thus lead to the ignition of an explosive gas-mixture surrounding the latter.† It may be hoped that the miner may be trained to a knowledge of the danger he incurs by the incautious use of gunpowder, although the persistent recklessness with which he sacrifices safety to comfort, in despising the use of the safety-lamp, forbids sanguine expectations in this direction.

Reference has not been made to another very possible source of accidents due to the employment of gunpowder for blasting purposes, namely, carelessness in the keeping and handling of the explosive agent by the men. Personal observation by the lecturer of the reckless manner in which powder is frequently dealt with in mines, leads him to believe that this contributes its quota as a cause of colliery explosions.

* NATURE, vol. v. p. 504; vol. x. p. 157. † NATURE, vol. x. p. 224.

The accidents in collieries have their parallel in domestic life, in coal-gas explosions, which, though at first sight of comparatively small importance if judged by the loss of life and property which they occasion, yet merit serious consideration on account of the great frequency of their occurrence, and the demonstration which they almost always afford of ignorance or culpable carelessness.

The circumstance that the admixture of even minute quantities of coal-gas with air can be at once detected by the unmistakable odour of the gas, should serve as a safeguard against accidents; unfortunately, however, thoughtlessness or want of knowledge frequently causes this very fact to lead to the opposite result. Escapes of gas in comparatively small quantities often occur at the point of union (generally by a ball-and-socket joint) of a hanging burner or chandelier with the gas-pipe, or at the telescope-joint of such gas-fittings; the column of water required in the joints to confine the gas becoming very gradually reduced by evaporation. In such instances an explosive mixture will accumulate in the upper part of the apartment of which windows and doors are closed, while the air in the lower part will continue for a long time free from any dangerous admixture of gas; and instances are continually recorded in the public prints of the deliberate ignition of such explosive mixtures, by persons who, observing the smell of coal-gas upon entering the room, proceed forthwith to search for the point of escape by means of a flame. It need scarcely be stated that such a test is a perfectly safe one in itself, and that if the acceptance of the warning given by the odour of gas in the lower part of the room were promptly followed by the simple precautionary operation of leaving open for some time all windows and doors, so as to afford ready ingress of fresh air, and thus speedily expel, or very largely dilute, the gas-mixture, the leakage could be looked for with no risk of accident.

Gas explosions, generally of a serious nature, do occasionally occur through no fault of those who are the direct agents in bringing them about, as by a person entering with a light a closed apartment in which there has been a very considerable escape of gas for some time, or a building in which gas has been entering from a leakage in the supply-pipe or the main.

The employment of illuminating agents closely allied to coal-gas, namely, liquid carbo-hydrogen compounds obtained by the distillation of coal or shale, or derived as natural products from coal-bearing strata, gradually extended during the earlier part of the last quarter of a century until they became formidable rivals of mineral and vegetable oils and even of gas itself.

The several varieties of so-called petroleum spirit which are known as naphtha, benzine, benzoline, gasoline, japanner's spirit, &c., yield vapour more or less freely on exposure to air at ordinary atmospheric temperatures, and even in some cases below 50° F. Although much the largest proportion of the petroleum spirit employed is probably used in lamps of some form or other, there are other important uses to which it is applied in large quantities, especially in various industries.

The so-called paraffin- or petroleum-lamp *explosions*, of which in the earlier days of the employment of these illuminating agents there were so many recorded in the newspapers, and of which one still hears occasionally, were, with very few exceptions, not correctly designated as explosions, and when they were so, were not caused by the employment of the volatile oils or petroleum spirit. As these vaporise very freely at the slightly elevated temperature which a reservoir of a lamp soon attains, air is either entirely expelled from the latter by the vapour, or so diluted by it, that the mixture is not explosive. If therefore flame can have access to vapour escaping from any opening in the reservoir near the wick, in a badly-constructed lamp, it will merely burn as it escapes. If a lamp charged with petroleum spirit be carried incautiously, or accidentally jerked so that the liquid is suddenly brought into contact with the warmer portion of the lamp, near the flame, a very rapid volatilisation may thereby be caused, resulting in a considerable outburst of flame.

If a petroleum oil which has been imperfectly refined, and which, therefore, contains some proportion of the very volatile products, or spirit, be employed in a lamp, a slight explosion may be caused by its yielding up a small amount of vapour at the temperature to which the reservoir becomes heated, and thus producing a feebly explosive mixture with the air in the latter, which may become ignited by the flame of the lamp. An explosion thus produced is not at all of violent character, being generally merely a feeble puff; it may, however, cause the cracking of the reservoir, and the consequent spilling and inflaming of the oil, and may at any rate lead to accident as already described, by the alarm which it occasions to nervous or ignorant persons.

(*To be continued.*)

SOCIETIES AND ACADEMIES

London

Royal Society, March 18.—"On the Behaviour of the Hearts of Molluscs under the influence of Electric Currents." By Michael Foster, M.D., F.R.S., and A. G. Dew-Smith, B.A. The observations were made chiefly on the heart of the common snail.

An interrupted current, applied directly to the ventricle (or auricle), and of such a strength as not to cause tetanic contractions, produces, as has already been pointed out, distinct inhibition, altogether similar to that brought about in the vertebrate heart by stimulation of the pneumogastric nerve.

Single induction-shocks, of a strength insufficient to cause a contraction, produce no *appreciable* effect, in whatever phase of the cardiac cycle they are thrown in; but two or more such shocks, the one following the other at a sufficiently short interval, produce a slight inhibition; that is, the succeeding diastole is prolonged.

When a constant current of sufficient intensity is thrown into the ventricle at rest, a contraction or "beat" is observed at both the making and the breaking of the circuit. But the initial, making, beat starts from, and is confined to the region of, the kathode, while the final, breaking, beat starts from and is confined to the region of the anode. This is the case whatever be the position of the electrodes.

A constant current of sufficient intensity to bring about a making and a breaking beat when applied for, say five seconds, may be applied momentarily without producing any beat at all. The constant current, therefore, requires some considerable time to develop its maximum effect.

When a constant current is applied to a spontaneously beating ventricle, a polarisation of the ventricle results of such a kind that the region of the kathode is thrown into a condition which the authors would wish at present not to define more strictly than by saying that it is "favourable to the production of a rhythmic beat," while the region of the anode is thrown into an opposite condition, unfavourable to the production of a rhythmic beat.

On the withdrawal of the current a rebound takes place at either electrode, the kathode region becoming for a time unfavourable to the production of beats, the anode favourable.

Of these two conditions, the one unfavourable to the production of beats, whether it be in the anodic region during the passage of the current, or in the kathodic region during the rebound, is more easily produced by slight currents than its opposite. Hence the total effect of a slight current, the balance of the opposing agencies, is unfavourable to the production of the rhythmic beat.

Consequently, when a current, as in a single induction-shock, is applied for so short a time that its maximum effect is not reached and no direct kathodic contraction or beat is called forth, the net result is a hindrance to the rhythmic beat, or, in other words, an inhibition, which may be too slight to be recognised with a single shock, but becomes evident when the shock is repeated after a not too long interval, and is very marked when several shocks rapidly follow each other as in the ordinary interrupted current.

The main results obtained with the snail's heart were corroborated by observations on the hearts of *Sepia* and *Aplysia*.

In conclusion, the authors regarding the rhythmic beat of the snail's heart (which they believe contains no differential nervous structures) as a purely protoplasmic movement, call attention to what may be called the principle of physiological continuity, and offer suggestions towards defining the exact function of the intrinsic ganglia of the vertebrate heart, and of other spontaneously beating organs.

"On the Liquation, Fusibility, and Density of certain Alloys of Silver and Copper." By W. Chandler Roberts, Chemist of the Mint. Communicated by Dr. Percy, F.R.S.

The author states that the most remarkable physical property of silver-copper alloys is a molecular mobility, in virtue of which certain combinations of the constituents of a molten alloy become segregated from the mass, the homogeneous character of which is thereby destroyed. These irregularities of composition have long been known, and reference is made to them in the works of Lazarus Erckern (1650), and of Jars (1774). A very complete memoir was published in 1852 by Levol, who did much towards ascertaining the nature and defining the limits of this molecular mobility. He discovered the important fact that an alloy containing 71·89 per cent. of silver is uniform in composition. Its chemical formula (Ag_3Cu_2) and peculiar structure led him to conclude that all other alloys are mixtures of this, with excess of either metal.

The electric conductivity of these alloys was studied in 1860 by Matthiessen, who doubted the accuracy of Levol's theory, and viewed them as "mechanical mixtures of allotropic modifications of the two metals in each other."

The author then describes the experiments he made with a view to determine the melting points of a series of these alloys. He adopted Deville's determination of the boiling point of zinc (1040° C.) as the basis of the inquiry, and ascertained by the method of mixtures, the mean specific heat of a mass of wrought iron between 0° C. and the melting point of silver, which, as Becquerel showed, is the same as the boiling point of zinc.

The mean of three experiments, which were closely in accordance, gave 0·15693 as the specific heat of the iron; and it should be pointed out that this number includes and neutralises several errors which would affect the accuracy of the subsequent determinations.

Melting points of several alloys were then determined by plunging an iron cylinder into them and transferring the iron to a calorimeter. These melting points varied from 840° C. to 1330° C., or through a range of 490° C. The alloys which occupy the lowest portion of the curve contain from 60 to 70 per cent. of silver. The results are interesting, as they show that the curves of fusibility and electric conductivity are very similar.

Mr. Roberts then describes experiments in which alloys were cast in red-hot moulds of firebrick, the metal (about 50 oz.) being slowly and uniformly cooled. The results of these experiments on liquation are elaborate, and cannot be given in a brief abstract.

The density of pure silver and of Levol's homogeneous alloy, while in the fluid state, were then determined by the method described by Mr. Robert Mallet,* the metals being cast in conical vessels of wrought iron. The results obtained were as follows:—

	Density fluid.	Density solid.
Pure silver	9·4612	10·57
Levol's alloy	9·0554	9·9045

In the case of silver, the mean linear expansion deduced from this change of density is ·00003721 per 1° C., which is nearly double the coefficient at temperatures below 100° C.

Physical Society, March 13.—Dr. J. H. Gladstone, F.R.S., president, in the chair.—Mr. W. Chandler Roberts read a paper on the electro-deposition of iron. He referred to the beautiful specimens of electro-iron, the work of M. Eugène Klein, a distinguished Russian engineer and chemist, which were exhibited at the meeting of the British Association at Exeter. In 1870 Mr. Roberts visited St. Petersburg, and had the advantage of receiving from the late M. de Jacobi suggestions which enabled him to deposit iron with much success. He stated that a plate of electro-iron 150 mm. square by 2 mm. thick, was deposited on copper, by Herr Bockbushmann, in 1846. In 1857, M. Feuquières exhibited specimens of electro-iron at the Paris Exhibition. In 1858, M. Garnier patented in England his process, termed *aciérage*, for protecting the surfaces of engraved copper-plates; and in the same year Klein produced the admirable works above referred to. The author then exhibited specimens which he had obtained by Klein's method. The bath consists of a double sulphate of iron and magnesia, of sp. gr. 1·155; the chief conditions of success being the neutrality of the bath and the employment of a very feeble current. Iron so obtained possesses a higher conductivity than any commercial iron (Matthiessen), its sp. gr. is 8·139, and its occludes thirteen times its volume of hydrogen. A tube of the metal deposited on a rod of wax, which was vacuum-tight at the ordinary temperature, allowed hydrogen to pass freely at a dull red heat.—After a brief discussion, Prof. Guthrie described some experiments which he has recently made, with the assistance of Mr. R. Cowper, in continuation of former researches, on salt solutions and attached water. The main object of these experiments was to ascertain the manner in which mixtures of salts act as cryogens, and to study their combination

* Proc. Roy. Soc., vol. xxiii. p. 209.

with water at various temperatures and in various proportions. When two salts to which either the acid or the base is common, and which do not form a double salt, are mixed in equivalent proportion, the cryogen produced has nearly the temperature due to the salt, which alone would produce the greatest degree of cold. Solidification begins at a temperature below the melting-point of the least fusible, and continues at lower and lower temperatures until the temperature due to the other constituent salt is reached. Occasionally a cryohydrate having a constant solidifying point has been obtained by mixing in definite proportions salts which are not known to exist in the form of a double salt. In all such cases the solidifying point of the mixture is intermediate between the solidifying points of the constituents, and its temperature as a cryogen is also between the temperatures of the constituents when separately used as cryogens. When two salts composed of different acids and bases are mixed, and no precipitation occurs, it is generally considered that partial double decomposition takes place, two new salts being formed. It was found that if the salts A X and B Y be mixed in atomic proportion and dissolved in the smallest possible amount of water, a mixture identical with that produced on mixing A Y with B X is obtained. The temperature and composition of the resulting cryohydrate are the same in both cases. But the temperature never falls as low as the point which could be reached by employing whichever of the salts A X, A Y, B X, B Y, forms a cryohydrate with the lowest temperature. Thus a saturated solution of a mixture of nitrate of potassium and sulphate of sodium solidifies at $-5°$ C. A mixture of nitrate of sodium and sulphate of potassium also solidifies at this temperature. Since the solidifying point of nitrate of sodium is $-17°$, this salt cannot exist without partial decomposition taking place in either mixture; for, as has been shown above, its presence would ultimately depress the solidifying point. Dr. Rae remarked that these researches are specially interesting in connection with the salts retained by sea-ice. With a view to study this subject, he has already requested captains of whalers visiting the Arctic regions to bring home samples of ice of different age and from various localities.

Paris

Academy of Sciences, March 15.—M. M. Frémy in the chair.—The following papers were read:—On electro-capillary action and the intensity of forces producing it, by M. Becquerel (fourth paper on the subject).—A note by H. Sainte Claire Deville, on the alloys of platinum and iron.—Researches on the fatty acids and their alkaline salts, by M. Berthelot. The subject is treated at length, and the formation of sodium, ammonium, and barium salts, both in solution and in the solid state, is considered.—On acetic anhydride, by the same; account of new experiments to determine the heat evolved during the transformation of acetic anhydride into acetic acid.—A note by M. de Lecaze-Duthiers, on the origin of the vessels in the tunica of simple Ascidia.—On the simultaneous formation of several mineral species in the thermal source of Bourbonne-les-bains (Haute-Marne), specially of galena, anglesite, pyrites, and silicates of the zeolite family (notably of chabasite), by M. Daubrée (second paper).—On a peculiar mode of excretion of gum arabic, by the *Acacia Verek* of the Senegal, by M. Ch. Martins.—Report by M. Milne-Edwards, on the measures proposed to prevent the invasion into France of the American insect Doryphora, which destroys the potatoes.—M. Mouchez, the chief of the expedition sent to St. Paul to observe the transit of Venus, was then received by the President, who welcomed him in the name of the Academy. M. Mouchez read a long paper on the subject, giving all the details of the transit. He specially described the optical phenomena observed in the vicinity of the contacts, and brings home no less than 489 photographic proofs that can all be utilised for micrometrical measurements. The two interior contacts were observed with great precision, the two outer ones having been rather spoiled by clouds. Altogether this expedition may be considered highly successful.—On the geometrical solution of some new problems relating to the theory of surfaces, and depending upon infinitesimals of the third order, by M. Mannheim (second paper).—On the simplest modes of limit equilibrium which can be present in a body without cohesion and strongly compressed; application to a mass of sand filling the angle between two solid planes and movable round their line of intersection as axis; by M. J. Boussinesq.—A memoir on the formulæ of perturbation, by M. Emile Mathieu.—Micrographic study on the manufacture of paper, by M. Aimé Girard.—On the action of sulphate of ammonia in the culture of beet-root, by M. P. Lagrange.—A note by M. F. Fouqué, on the nodules of wollastonite, fassaite pyroxene, melanite garnet of the Santorin lava.—On the immediate treatment of intestinal obstruction, by the aspiration of the gases from the intestines, by M. Demarquay.—A memoir, by M. Michal, on the determination of the results of several observations, with special reference to the precision of the result.—A note, by M. L. Berthout, on the discovery of a deposit of fossils in the plain of Ecouché, in the arrondissement of Argentan (Orne).—A number of members then made various communications on Phylloxera.—The Minister of Public Instruction addressed to the Academy a project of a medal in commemoration of the Transit of Venus.—The Minister of Public Works sent a report of the Commission charged with the proposal of measures to be adopted to prevent the infection of the River Seine in the neighbourhood of Paris.—On certain left perspectives of plane algebraic curves, by M. Halphen.—On some properties of curves traced on surfaces, by M. Ribaucour.—On diffraction and the focal properties of nets, by M. A. Cornu.—On the magnetising function of tempered steel, by M. Bouty.—On the determination of the quantity of magnetism in a magnet, by M. R. Blondlot.—On the theory of storms; a reply to M. Faye, by M. H. Peslin. M. Faye, who was present, then made some observations on the same subject.—On some double stars whose motions are rectilinear, and are due to a difference in proper motion, by M. C. Flammarion.—On the identity of the bromo-derivatives of the hydrate of tetrabromethylene with those of perbromide of acetylene, by M. E. Bourgoin.—On the quantities of heat evolved in the decomposition of the chlorides of some acids of the fatty series, by M. L. Longuinine, specially referring to butyric, isobutyric, and valeric acids.—On amylogene, or soluble starch, by M. L. Bondonneau.—On a new method of volumetric analysis of liquids, by M. F. Jean.—Chemical researches on the absorption of the ammonia of the atmosphere by the volcanic soil of the solfatara of Puzzola, by M. S. de Luca.—A reply to two recent communications of M. Béchamp, relative to spontaneous alterations of eggs, by M. U. Gayon.—Observation of the life of *Heloderma horridum*, Wiegmann, by M. Sumichrast, reported by M. Bocourt.—On the helminthological fauna of the coasts of Brittany, by M. A. Villot.—Critical observations on the classification of Palæozoic Polyps, by M. G. Dollfus.—MM. Dumay and Martin de Brettes then made some communications relating to the bolide seen on February 10 last.—A note, by M. Neyreneuf, on the combustion of explosive bodies.—A number of scientific works were presented to the Academy by several gentlemen.

BOOKS AND PAMPHLETS RECEIVED

Colonial.—Microscopical Notes regarding the Fungi present in Opium Blight: D. B. Cunningham, M.B., Surgeon H.M. Indian Medical Service (Calcutta).—Geological Survey of Canada; Report of Progress for 1873–74 (Dawson Brothers, Montreal).

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Erratum.—Vol. xi. p. 403, col. 2, lines 10 and 11 from bottom, for "work" read "rock."