THURSDAY, DECEMBER 2, 1875

THE GOVERNMENT AND THE POLLUTION OF RIVERS

Pollution of Rivers. What Means can be adopted to prevent the Pollution of Rivers? A Paper read at the Social Science Congress, Plymouth and Devonport, September 1872, by William Hope, V.C. (London, 1873.)

Food Manufacture versus River Pollution. A Letter addressed to the Newspaper Press of England, by the same Author. (London : Stanford, 1875.)

THE question of River Pollution, one of undoubted importance to the country at large, has been once again raised by Mr. Hope, so well known for his untiring zeal in the cause of sewage farming, in the two above-named pamphlets. As involving questions of science—or at least of applied science—we feel called upon to offer some remarks upon the subject, the more so as it is one having such unquestionable sanitary bearings as to have been made the subject of Select Committees, Royal Commissions, and of at least three Parliamentary Bills.

We shall in the first place give a brief abstract of Mr. Hope's pamphlets, in order to lay before our readers the present state of the sewage question, before proceeding to consider the manner in which the subject has been handled by the Legislature.

In the first-named pamphlet the author passes in review the chief processes which have been proposed for preventing the pollution of rivers by sewage, classifying all systems under two divisions—"those which profess to deal with part only of the sewage, and those which profess to deal with the whole." The inefficacy of the former is summed up in the following words (page 5) :—

"But supposing that they really accomplished all they are intended to effect, the sewage question would still be as far from solution as ever, for the part of the total refuse which they profess to deal with is only about a half per cent. of the whole."

Of processes professing to deal with the whole of the sewage the first noticed are those precipitation schemes in which the sewage matter is supposed to be precipitated by the addition of some chemical substance. The so-called "A B C" process is considered at some length, and its not very creditable history traced ; analyses of the various precipitating mixtures employed by this company are given, beginning with that first employed which the author distinguishes as "Moses" (because stated by the patentee to have been first revealed to Moses in the wilderness and communicated by him to the children of Israel !), and concluding with that in use at Leeds at the time of reading the paper.

When we state that this mixture consists of alum, blood, clay, and charcoal refuse from Prussian blue works, our readers will at once perceive the justice of the sentence pronounced by Mr. Hope—that none of the ammonia in solution is precipitated, but runs away in the effluent water. We may furthermore recall to mind the fact that the process as carried on at Leicester and Leamington, with a mixture containing the same ingredients in different proportions, was made the subject of an exhaustive inquiry by the Rivers Pollution Commission, and justly condemned by that body in their second Report, on the grounds of its failing to remove the organic polluting substances in the state of solution. The same objections are applicable to Forbes' phosphate of alumina process, and to Anderson's process, which are the next considered. Mr. Whitthread's phosphate of calcium process is spoken of somewhat more hopefully, although at the time of reading the paper it was in a very early stage of development, while Weare's peat charcoal process is unhesitatingly condemned—"the effluent water resulting from it is, as a matter of fact, still sewage."

General Scott's hydraulic cement process, which consists in precipitating lime and clay in the sewage, is effective in clarifying and to a great extent deodorising the sewage by the removal of suspended matters in the form of "sludge," but from a sanitary point of view the sewage question is untouched, as the inventor does not profess to deal with the effluent water.

The purification of sewage by its direct application to land as effected by irrigation next receives consideration, the author pointing out that this is really an effective means of disposing of sewage—a statement fully borne out by every scientific authority who has examined into the method. Without at present entering too fully into details, we may state that the author's experience has led him to the conclusion that the successful treatment of sewage as a manure depends upon its thorough intermittent downward filtration through the soil, with due precautions against overflooding the land. By those who have followed the question from the beginning, it will be remembered that the chemical principles of "downward intermittent filtration" were first discovered in the laboratory of the Rivers Pollution Commission, and its efficiency made known in their first Report. The chemistry of the process, it is scarcely necessary to add, is accelerated oxidation, and Mr. Hope had been independently led to adopt this principle as applied to irrigation on an experimental sewage farm at Romford. The remainder of the pamphlet is chiefly devoted to what we cannot but consider as a fruitless discussion upon the precise meaning of the terms "irrigation" and "intermittent downward filtration," it being contended that the two processes are really identical—an opinion in which we feel constrained to differ from the author, since, although the involved principles are most probably the same, the methods of application are essentially different. The results of the early experiments upon the Romford farm were made known to the British Association Committee at the Brighton meeting, and are thus summarised by the author :—

"Although the soil is exceedingly siliceous, and ill-adapted for the retention of manure, yet out of every 100 parts of nitrogen applied in the sewage, no less than 40 were actually converted into crops, 50 parts were unaccounted for (remaining chiefly in the soil), and only 10 parts escaped in the effluent water, of which again only a fraction was still in an organic form."

The second pamphlet is a spirited appeal to the press to take up the sewage question, but as it relates chiefly to the financial aspect of the matter, it is not well adapted for abstracting in these columns. It may be stated, however, that the author therein admits that he has met with heavy losses in the working of the Romford farm, because, in his own words, "he has not had the sewage of Romford to convert." The original outlay, it seems, had been based

upon the assumption of his receiving the sewage from a population of 8,000, instead of which the amount actually received was that due to a population of about 3,000.

Mr. Hope has thus done excellent service in continually directing attention to and practically demonstrating, often at great pecuniary sacrifice, the applicability of the irrigation scheme to the disposal of sewage. It is true that the Towns Sewage Commission of 1865, in their third Report, did not speak favourably of the process, stating that their analyses proved that the effluent water from the Rugby works contained about the same quantity of dissolved organic impurity as the raw sewage, but it is now known that the process of analysis employed by them gave fallacious results, and analyses by the Rivers Commission (First Report) show that the process removes an average of 81·7 per cent. of the nitrogen, and 68·6 per cent. of the carbon contained as *dissolved* organic impurity, and 97·7 per cent. of the *suspended* organic pollution.

So much for irrigation. The other plan recommended by the Commission, Frankland's "downward intermittent filtration," is equally if not more effective. An average of 87·6 per cent. of nitrogen and 72·8 per cent. of carbon contained as *dissolved* organic pollution is removed by the operation, and *all* suspended impurities. We may further state that the plan has been applied by Mr. Bailey Denton to the sewage of Merthyr Tydvil, and has been in successful operation at that town for a period of three years.

Two effective schemes for the treatment of sewage—either of which might be employed according to the locality—are thus offered, so that, the sewage question being practically settled, let us now consider the action of the Government in the matter.

It is at least fifteen years since the efficacy of irrigation was first made known, and seven years since the discovery of intermittent filtration. In a letter on the sewage question published in 1865 by Mr. Hope, it is stated that "there have already been six Select Committees and two Royal Commissions on the question, independently of the Main Drainage Committee of the Metropolitan Board of Works, which has investigated the subject for five long years, and these Committees and Commissions have published no less than ten reports." A Rivers Pollution Commission was formed in 1865 and replaced by another in 1868, which continued its work down to 1874. These Commissions have cost the country from 40,000*l.* to 50,000*l.*, and in their laboratory the various processes devised for the purification of sewage and other foul liquids have been quantitatively examined and the results made known in no less than nine consecutive reports. Remedies for the different forms of pollution have been clearly and consistently pointed out, and various recommendations suggested for legislation. The standards of polluting liquids proposed by the Commission to be fixed by Act of Parliament have been substantially approved of both by English and Continental chemists of eminence. Now the members of a Royal Commission are presumably appointed because specialy qualified for the inquiry, a presumption which has been amply testified in the case of the Rivers Commission. Notwithstanding this—notwithstanding that a code of standards has been proposed for legislative enactment—in spite of the fact that practical and efficient remedies do already exist for the disposal of sewage, down to the present time nothing whatever has been done by the Government. The Duke of Northumberland's Bill of 1873 embodied, it is true, all the recommendations of the Rivers Commission, but, most wonderful to relate, in the Rivers Pollution Bill brought in last session, the whole of the work done by that Commission is totally ignored; and the Bill moreover shows that its framers were totally unacquainted with the advancement of science in this direction during the last twenty years.

Confronting these facts with a statement in Mr. Hope's second pamphlet, that "the Registrar-General's returns, confessedly incomplete from various causes, show that 'sanitary authorities' have been killing by means of enteric fever no less than 14,000 persons per annum," we now leave the subject to the serious consideration of the Legislature.

THE MANCHESTER SCIENCE LECTURES

Science Lectures for the People, delivered in Manchester. First, Second, Third, Fourth, Fifth, and Sixth Series. 1866-74. 3 vols. (Manchester: Heywood.)

IT is now nine years since Prof. Roscoe made the bold experiment of ascertaining whether the working men of Manchester would appreciate the value of scientific instruction given in a plain but correct manner, and illustrated by suitable experiments and diagrams. The magnificent success that attended the early efforts of Prof. Roscoe has led the experiment to be repeated yearly until it is now, we hope, a settled institution. In the preface to one of the series we learn that each lecture, on an average, has been attended by nearly 1,000 persons, and an additional and wider audience has been secured by the verbatim reports of the lectures which are bound together in the volumes before us. Published at a penny each, from 5,000 to 10,000 of each of these lectures have been sold, and the demand for back numbers still continues.

Certainly it is to be hoped, as Prof. Roscoe remarks, "that the example of Manchester may be followed by other large towns, for surely nothing can at the present time be more important than to infuse into the minds of the people an idea of that scientific truth which is rapidly being recognised as not only lying at the foundation of our material welfare, but also of our social and moral well-being." We are aware that many of our large towns are doing good work in this direction by the lectures regularly arranged in connection with some local institution; witness, for example, the immense audiences attracted by the admirable lectures yearly given in connection with the Midland Institute at Birmingham. But the lectures at these and similar institutions are chiefly frequented by the middle classes, whereas we are assured that at the Manchester lectures the class of persons present was chiefly working men, for whom the lectures were designed, and who by their marked attention and interest invariably showed how keenly they appreciated the information that was given. It is said that to make working-men lectures a success, a very low entrance fee must be charged, and this involves a pecuniary loss that must be met by local subscriptions. This must necessarily be true of the first course or two, when the people will not pay for that of which they have had no experience. But

we question the wisdom of not allowing these Manchester lectures to be self-supporting. Working men are now absolutely better paid than the great majority of clerks and *employés* in the Civil Service, and their expenditure is less heavily taxed than those who esteem themselves in a higher social scale. Mechanics and others can therefore well afford to pay whatever is necessary for these lectures, and we cannot but think it is an unwise thing to establish the idea that fustian can have for a penny what is charged sixpence or a shilling to cloth. If a penny entrance-fee is too firmly rooted to be dislodged with impunity, boxes might be put in the room for contributions by the audience, who might be urged to make the lectures self-supporting. Moreover, the profits on the sale of these reports of the lectures must be large and ought to go some way towards meeting the expense of the lectures themselves. After all, the main secret of success in any popular lecture scheme is to have some one responsible person, like Prof. Roscoe, who, year after year, has unsparingly used his influence and his time in this good cause.

We must add a few words about the books before us. When upon opening our parcel we found the editor of NATURE had sent us these lectures with a request for a review of them, we felt he had set us to a hopeless task. What sane solitary reviewer dare venture to criticise the collective wisdom of Professors Huxley, Tyndall, Roscoe, Gladstone, Geikie, Balfour Stewart, Odling, Clifford, W. C. Williamson, Wilkins, Ward, Jevons, Drs. Carpenter and Huggins, Mr. Spottiswoode, Sir John Lubbock, and other famous men who make up the brilliant array of Manchester lecturers?

It is hardly needful to say that all the lectures in these volumes are good, and some well repay careful perusal. Many of the lectures are so fascinating that it is difficult to put the volumes aside. What, for instance, can be more charming than Prof. Geikie's lecture on the Ice Age in Great Britain, or Sir John Lubbock's lecture on Modern Savages, or Prof. Stewart's on the Sun and Earth? And we envy those who were present at such experimental lectures as Prof. Tyndall's on Crystalline Forces, Prof. Abel's on Gun Cotton, or at Prof. Roscoe's or Dr. Huggins', and others we have not space to name. The books before us are therefore well worth preserving, for though the lectures are popular they are in no instance claptrap; and whilst within the comprehension of all classes, they will also be found not unworthy of perusal by men of culture.

Mr. Pitman, who reported the lectures, has evidently done his work faithfully and well, and Mr. Heywood who publishes them has clothed the volumes in a new and attractive dress.

We would venture, however, to suggest to Prof. Roscoe—whose name at the foot of each preface is the only editorial mark—that it would be desirable to have a responsible editor when such permanence, as these volumes indicate, is given to the lectures. Reading one of Dr. Carpenter's lectures, for example, there is a continual reference to diagrams and maps which, though present to the audience, are not so to the reader; and to some other lectures the same remark applies. Moreover, before binding up the lectures, the authors, we think, ought to have been informed that a volume was to be issued, and so the opportunity afforded them of making any corrections or additions to their lectures they might find necessary. Then a better table of contents of each volume would be an advantage, and the names of the lecturers should be attached to the titles of the lectures in the contents. In the first series the names of those who gave the short courses on Chemistry, Zoology, and Physiology are entirely omitted both in the index and in the lectures themselves. A reader opening on p. 119 of the first volume finds the course on physiology beginning, "The subject, my friends, upon which I am going to speak to you this evening, &c.," but who the speaker is he will be perplexed to find. Incidentally the omitted names happen to be mentioned by Prof. Roscoe in the preface. Such little matters as these might readily be amended by proper care on the part of the publishers.

W. F. B.

RECENT AUSTRALIAN EXPLORATIONS

Explorations in Australia; with an Appendix on the Condition of Western Australia. By John Forrest, F.R.G.S. (London: Sampson Low and Co., 1875.)

DURING the last three years there has been an admirable activity among the Australian colonists in the exploration of the great tract of unknown land in the centre of the southern continent. It was long ago surmised that this interior was either occupied by a great lake or lakes, or was in the main a barren desert, but only within the last two years has its real condition been conclusively demonstrated. The most prominent names in recent exploration are those of Giles, Gosse, Ross, Lewis, Warburton, and Forrest. The first two were baffled in their attempts to cross the country; even though Gosse was provided with camels, he only reached close on the 130th degree of E. long. when he had to return eastwards. Ross, in 1874, explored a considerable previously unvisited tract to the S.W. of the Neale River, while Lewis explored, in 1874-5, the region to the W., N., and N.E. of Lake Eyre. Col. Warburton has the honour of having been the first to cross the country, starting from Alice Springs on the telegraph line in April 1873, and eight months after, reaching the west coast. His narrative we noticed in vol. xii. p. 46. Mr. John Forrest though yet a young man, has perhaps done more than any recent explorer to make known the real nature of the hitherto unknown or imperfectly known regions. He is, we believe, a native of West Australia, a member of the Colonial Survey, and well qualified in every respect for the trying task of Australian exploration, and the Colonies would do well to make liberal use of his services in order to obtain a satisfactory idea of the resources of their country.

The volume before us contains an account of three separate exploring journeys made by Mr. Forrest. The first of these was a comparatively short trip to the north-east from Perth, as far as the 123rd degree of E. long., accomplished between April and August 1869. The object of this journey was to endeavour to find some traces of the unfortunate Leichardt, who twenty-seven years ago quitted Moreton Bay to cross the continent, but whose fate is still a mystery. We need hardly say that Mr. Forrest's journey was in vain, so far as this

object is concerned, though he brought back much valuable information concerning the country traversed. The latter portion was over comparatively unknown ground; and Mr. Forrest discovered a remarkable series of salt lakes extending from about 119° to 122° E. long., and between 28° and 29° S. lat. The country is somewhat hilly along the 29th parallel, with granite and sandstone rocks. Here he was on the edge of the dreary spinifex desert which has daunted so many explorers.

Mr. Forrest's second journey was a much more important and extensive as well as hazardous one; it was indeed along the same route as that in which the dauntless Eyre suffered so terribly thirty-five years ago. With a small party, and after making excellent arrangements with a vessel to meet them at a certain point, he set out from Perth on March 30, 1870, came S.E. to the coast, and travelled along the great Australian Bight, reaching Adelaide on Aug. 24, without loss. He kept considerably more inland than did Eyre, and was in every respect more fortunate, though there was frequently considerable suffering from want of water. His report of the country traversed is much more favourable than Eyre's; large grassy tracts, extending many miles inland, being found along nearly the whole length of the Bight. Water is the great want, yet, since Forrest's journey, settlers have been attracted to the region, and we believe preparations are being made to connect West Australia with the eastern colonies by means of the telegraph.

Mr. Forrest's third journey was a much more formidable undertaking, and in all respects of more importance than either of the two previous ones. Its object was to discover decisively the real nature of the mysterious interior, and thus make an important contribution to scientific knowledge, as well as to let the Australians know what are the resources of their immense continent, not much less in area than continental Europe. The expedition was carefully organised, though it did not cost much above 600*l.*, and consisted of four white men, two blacks, and a large number of horses to carry provisions, equipment, &c., as well as for riding. The party set out from Perth on March 18, 1874, and after reaching 26° S. lat. in 117° E. long., proceeded in a generally eastward direction along that parallel, until on Sept. 27 the telegraph line was struck in 27° 7′ 50″ S. lat. Mr. Forrest's route was thus on an average about 400 miles S. of that of Colonel Warburton. After the first few entries in his journal, Mr. Forrest's narrative becomes somewhat tedious from its sameness, though the intelligent and energetic leader is not to blame for this. As has been the case with nearly all previous inland Australian expeditions, the daily occupation of the present one was to hunt for water; this is the burthen of every day's entry in the journal. Mr. Forrest has the same tale to tell as Colonel Warburton had of the more northerly route—apparently endless spinifex plains, varied with sand-hills, sandstone cliffs, granite rocks, a few trees, and, in Forrest's case, with rare grassy plains, but with scarcely enough of water all the way to fill a fair-sized mill-pond. Forrest's party, however, notwithstanding that they had no camels, fared much better, both in the matter of food and drink, than did Warburton's; only one of the horses actually died, and comparatively few had to be abandoned. Once only were they attacked by the natives, who were dispersed by a shot or two that did little damage. Not many natives were met with, though signs of them were frequently seen, and they seem to have been watching the expedition along most of the route.

Mr. Forrest sums up the results of his third journey as follows:—

"The whole of the country, from the settled districts near Champion Bay to the head of the Murchison, is admirably suited for pastoral settlement, and in a very short time will be taken up and stocked; indeed, some already has been occupied.

"From the head of the Murchison to the 129th meridian, the boundary of our colony, I do not think will ever be settled. Of course there are many grassy patches, such as at Windich Springs, the Weld Springs, all round Mount Moore, and other places; but they are so isolated, and of such extent, that it would never pay to stock them. The general character of this immense tract is a gently undulating spinifex desert—*Festuca* (*Triodia*) *irritans*, the spinifex of the desert explorers, but not the spinifex of science. It is lightly wooded with acacia and other small trees, and, except in a few creeks, there is a great absence of any large timber.

"The prevailing rock, which crops out on the rises and often forms low cliffs, in which are receptacles for holding water, is *light red sandstone* (desert sandstone, tertiary). The only game found in the spinifex is a kangaroo rat, commonly called the 'wirrup;' but in the grassy openings there are many kangaroos, and often emus, also a rat known as the 'wurrung.' These animals are very good eating, and formed a valuable addition to our store department. At the permanent waters there were always myriads of bronze-winged pigeons, and also the white cockatoo with scarlet crest, called the 'chockalott;' also the 'beaccoo,' or slate-coloured parrot. Generally, however, with the exception of the crow and hawk, birds were not very numerous except round water. Whenever a sheet of water was found we found ducks, and in Lake Augusta swans and ducks were innumerable."

Though the expedition became ultimately a race for water and life, yet Mr. Forrest found opportunities of carefully noting some of the principal features and productions of the country passed through, and the geologist and botanist especially will find a good deal in all the three narratives to interest them. There are a few spots on the cross-country route of Forrest where a well-provisioned expedition could encamp for months; and if the Colonial Government were to follow the advice recently given by the German Commission in reference to Arctic exploration, and send out a properly equipped scientific expedition to a suitable centre from which varied observations could be made, the scientific, and therefore the practical results, would, we believe, be of great value. This, we think, is the method that ought now to be pursued, at least in conjunction with ordinary exploring expeditions.

Mr. Forrest has made in his three narratives a contribution of high value to the literature of Australian exploration. We are glad to see he has met with so much honour in his own country, though there was no occasion to increase so largely the bulk of his work by newspaper reports of the various meetings held in his honour. Appended are a scientific list, by Baron von Mueller, of the plants collected in the third expedition; a report, by Mr. Brough Smyth, on the geological specimens; and General Weld's report, of September 1874, on the condition of Western Australia, with three pages of statistics.

The maps of the three routes deserve a word of praise. They have been plotted with great care, and the notes along the route are so numerous and full of information, that they form an admirable epitome of the whole work. The few illustrations are interesting; that especially of the Spinifex Desert gives one a good idea of this horror of Australian exploration.

OUR BOOK SHELF

Official Guide-book to the Manchester Aquarium. By the Curator, W. Saville Kent, F.L.S., F.Z.S. Third edition. Twentieth thousand. (Michaelmas, 1875.)

THE Manchester Aquarium, situated in the Alexandra Park of that city, has now been opened to the public for more than two years, and has attained considerable success, although we believe it has not quite realised the expectations formed of it by its original promoters. Next to the Brighton Aquarium, that of Manchester is the largest amongst the six principal institutions of this kind existing in the country. The series of tanks, including the deep sea, shallow, and fresh-water groups, is sixty-eight in number, surpassing that of any other aquarium, while their linear frontage falls little short of 700 feet, which is but slightly less than that of the well-known establishment at Brighton. The building itself is of the plainest possible design, and at first sight seems as if it had been originally destined for a church of some kind. It consists of a high central oblong nave and two narrow side aisles. Being lofty and well lighted, however, it affords excellent accommodation for the smaller tanks which line it on both sides, as well as for the two fine large tanks, upwards of forty feet in length, which are situated at the two extremities. The proprietors of the Manchester Institution have been moreover fortunate in securing the services of a competent scientific naturalist as its director, an advantage shared by few if any of the sister establishments. Mr. W. Saville Kent transferred his services from Brighton to Manchester some two years ago. One of the last things he did at Brighton was to prepare the excellent Handbook to the Aquarium there which has been already noticed in this journal. We have now before us a copy of the third edition of the same author's "Guide-book to the Manchester Aquarium," prepared somewhat after the same fashion. After a few words of introduction describing the building and the general management, the sixty-eight tanks and their contents are discussed successively. A large amount of information upon the various fishes and other animals which they contain is thrown together in a very popular and readable form, and woodcuts are introduced illustrating the more attractive and noticeable objects exhibited. The Guide-book is concluded by a chapter on the principles of management of aquaria generally, which cannot fail to be of service to those who are interested in such matters, and which proves that Mr. Kent is fully master of the subject of which he treats.

Elementary Science Manuals. Botany for Schools and Science Classes. By W. J. Browne, M.A. Lond. (Belfast: W. Mullan, 1875.)

AN unfavourable impression of this little book is created at first sight by the obvious imitation, in the style in which it is got up, of Macmillan's series of "Science Primers." Such a plagiarism may generally be taken as a confession on the part of author or publisher that the work has not sufficient merits of its own to stand without adventitious assistance. This, however, is not the case in the present instance; and our depreciatory criticisms are almost exhausted. We had, it is true, marked certain passages in the margin for correction; but they are but few. The most important is the resurrection of the old blunder (twice over) of the existence of "spongioles" at the extremities of the root-fibres; and this is the more remarkable as the work from which the illustrative woodcut is copied does not make this mistake. The statement in the preface, however, that the book "contains all the subjects required for the First B.Sc. Examination in the University of London," must be taken *cum grano*. There is no index; and the deficiencies have therefore to be made out by careful inspection; but we find no description whatever of the process of fertilisation (although there is a diagram to represent the entrance of the pollen-tube into the embryo-sac), and no adequate one of that of respiration, this term being erroneously applied, as is so often the case, to the process of assimilation. But what can you expect for eightpence? You get, at all events, a great deal for your money; and the morphological and structural portion is on the whole so well done as to render the little book of great use to the beginner. Indeed we do not know any purely elementary work in which this part is more satisfactory. A few technical errors will doubtless be noticed and corrected in future editions. The illustrations, seventy-six in number, though not new, are very good and serviceable.

A. W. B.

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.*]

Hoffmeyer's Synoptic Weather Charts

WILL you kindly draw the attention of your readers to the fact that the second year of Capt. Hoffmeyer's synoptic charts of the weather in Northern Europe and Atlantic, commencing with Dec. 1874, is now about to be issued.

The subscription, as before, will be 12*s.* 6*d.* per quarter, including postage of the monthly parts.

I shall be glad to receive names of gentlemen who are willing to encourage the undertaking, which is carried on at Capt. Hoffmeyer's own expense. ROBERT H. SCOTT, Director

Meteorological Office,
116, Victoria Street, London, S.W.

Collomia

ON reading Mr. Duthie's communication (vol. xii. p. 494) on the capsules and seeds of *Collomia*, I presumed that some one would be ready to indicate the use of the mucilage and threads of the seed-coat; but I now notice that Mr. Bennett (vol. xii. p. 514) supposes that it "still remains to be discovered." An obvious and sufficient explanation will be found in A. Gray's "Structural and Systematic Botany," as far back as the edition of 1845. In the later editions, all of them now old, it is twice referred to. On p. 40, after mentioning that these gelatinous threads, or the like, occur on many seeds or seed-like fruits of various orders, it is said: "They may subserve a useful purpose in fixing light seeds to the ground where they lodge, by means of the moisture of the first shower they receive." And on p. 321, where forms of this apparatus are described, it is added: "This minute mechanism subserves an obvious purpose in fixing these small seeds to the moist soil upon which they lodge, when dispersed by the wind."

The seed of a *Collomia* or *Gilia*, when wetted, forms a *limbus* of three or four times its diameter; this would involve a multitude of grains of sand, and ballast the seed most effectually in the situations where or at the time when alone it could germinate. A. GRAY

Herbarium of Harvard University,
Botanic Garden, Cambridge, Mass., Nov. 16

Sir Thomas Millington and the Sexuality of Plants

IN your article last week on the Oxford Botanic Garden, reference is made to Sir Thomas Millington, the Savilian Professor of Botany, as having in 1676 "first divined the fundamental fact of sexual reproduction in flowering plants." In a review in the columns of the *Academy*, of the English edition of

Sachs's "Text-book of Botany," by Prof. E. R. Lankester, the Savilian Professor is also spoken of as having "discovered the sexuality of plants." It would interest students of the history of botany to know to what extent the writer of either of these articles is able to corroborate this statement by reference to Sir Thomas Millington's writings. In his recently published "History of Botany," Prof. Sachs gives the following account of this alleged discovery:—"In all histories relating to the subject of sexuality, a certain Sir Thomas Millington—otherwise unknown in the history of botany—is mentioned as deserving of the credit of having first indicated the stamens as the male sexual organs. The only information, however, which we have in support of this is contained in the following statement by Grew in his 'Anatomy of Plants,' 1682, p. 171, ch. 5, § 3:—'In conversation on this subject'—viz., on the part played by the stamens (termed by Grew the 'attire') in the formation of seeds—'with our learned Savilian Professor, Sir Thomas Millington, he gave it as his opinion that the 'attire' serves as the male organ for the production of the seed. I at once replied that I was of the same opinion, gave him some reasons for it, and answered some objections which might be made to it.'" * In the first edition of Grew's work, 1671, he attributes no sexual function to the stamens; but in the edition of 1681 he thus continues, in substance:—It appears firstly, that the "attire" serves to separate certain superfluous portions of the sap in order to prepare for the production of the seed. Just as the foliature (floral leaves) serves to carry away the volatile saline particles of sulphur, so the "attire" serves to diminish and adjust the atmospheric portions, in order that the seed may become more oily and its principles better fixed. The flowers have therefore usually a more powerful odour than the "attire," because the saline is stronger than the atmospheric sulphur, which is too subtle to affect the senses. An analogy drawn from the animal kingdom follows, which is hardly quotable; but Sachs points out how wonderfully any germ of truth in Grew's hypothesis was corrupted by the chemical theories and strivings after a false analogy of the day. It is difficult to see that there was really any advance in this hypothesis upon the state of knowledge in the time of Theophrastus (B.C. 371–286), who distinctly recognised some individual plants as male, others as female. Whatever merit also is due to Millington must, unless there is other record of his services, be at least equally shared with Grew.† It does not appear, however, that either of these botanists even attempted to confirm their conclusions by experiment. The merit of the first discovery of the true function of the stamens is assigned by Prof. Sachs to the German botanist Camerarius, in his "De sexu plantarum epistola," published in 1694. This tract closes with an ode, reminding one of Darwin's "Loves of the Plants," beginning thus—

"Novi canamus regna Cupidinis,
Novos amores, gaudia non prius
Audita plantarum, latentes
Igniculos, Veneremque miram."

ALFRED W. BENNETT

6, Park Village East, London, Nov. 29

The Late Eclipse

ON my return from India I should like to say a few words about some letters which appeared in the *English Mechanic* during my absence. Mr. Proctor, and a writer signing himself "A Fellow of the Royal Astronomical Society," comment in these letters on the result of the late Eclipse Expedition. It would be better if these discussions were postponed until the results are published by the Royal Society, but if writers who have not heard anything beyond a few short telegrams take it upon themselves to enlighten the public as to the value of photographs which they have not seen, a few remarks of one who has seen them become necessary.

If the telegrams written by me have given rise to the misunderstanding, I am sincerely sorry for it. I have had no personal interest either in the success or the failure of the expedition. The Royal Society has done me the honour to entrust me with the task of carrying out a programme sanctioned in detail by the Eclipse Committee. This I have done to the best of my ability, and in wording the telegrams in question I avoided, carefully any expression which might have raised expectations, not to be fulfilled on the arrival of the photographs. If the impression has been propagated that the expedition has not obtained any results of great importance, it is the fault of those who, thinking I had an interest in exaggerating the importance of the results, have taken away from the meaning of my words, which in reality remained far below the truth.

There cannot be the slightest doubt that the photographs obtained by the prismatic camera are full of interest and importance. They solve the question in which part of the spectrum the chief photographic rays of the corona are situated. They open out almost an entirely new field of inquiry, answering questions which could never have been answered by any other method, and suggesting new questions to be answered hereafter.

I should have liked to postpone the question whether it is possible to photograph in all its details the spectrum of the corona in the time available during eclipses, until Mr. Proctor's long-promised mathematical solution has appeared. As, however, we have had to wait for it already a considerable time, I venture to submit to your readers the following considerations:—The prismatic camera is a spectroscope without collimator. It has given us photographs after one minute's exposure, and would have done so in less time under more favourable atmospheric conditions. If we add a collimator and telescope to this camera, we shall have an arrangement similar to that which actually was employed for the photographs of the spectrum. If the lens of the telescope is, as regards diameter and focal length, like that of the camera; if, further, the focal length and diameter of the collimator lens is such that it would collect all the light which passed through the objective of the telescope, if the slit plate was removed, the only diminution the intensity of the light would be caused by the absorption through the two additional lenses and by the diffraction of the slit. The influence of diffraction can be reduced to a minimum by suitably altering the aperture of the collimator lens and by using a slit not too narrow. We should thus have an instrument capable of photographing the spectrum of the corona in one minute.

This is not the place to discuss whether the failure of the spectroscopic cameras was due to atmospheric causes, to the instruments employed, or finally, to my own fault. It will, I believe, be found hereafter, that the experience gained by even these failures will prove useful on future occasions.

In enumerating the results of the expedition the photographs of the corona and the sketch taken by the Hon. H. N. Shore ought not to be forgotten. The time observations were conducted with as much accuracy as the instruments permitted.

Sunnyside, Upper Avenue Road, N.W., Nov. 20 ARTHUR SCHUSTER

Lommel's Optics

I AM indebted to Prof. W. N. Hartley for a correction in my review of Lommel's Optics, the proof-sheets of which did not reach me in time for revision. The translator of the work is evidently right in using the term napthalin red for the body which exhibits the fluorescent spectrum depicted in Fig. 6 in the article. The substance in question, Prof. Hartley states, is also called Magdala red, and has the elegant chemical name of Azotrinaphthyldiamine. I am also obliged to my friend Prof. H. M'Leod for pointing out that the mode of exhibiting the formation of the rainbow described by Prof. Lommel, is to be found in Jamin's "Cours de Physique" (tome 2, p. 782), although the substitution of a spherical flask filled with water for a solid glass globe, as described by Jamin, is more appropriate and convenient. Pouillet (tome 2, p. 769) also gives, I see, a somewhat similar experiment, using a cylindrical glass vessel filled with water.

W. F. B. ("the Reviewer of Lommel's Optics")

The Rainfall

IN NATURE, vol. xiii., p. 70, under the head of "The Rainfall," you allude to the extraordinary rainfall for 1875 in Great Britain, and call it a plague of rain; you further call attention to the astonishing fall of 1·287 inches for each of the three hours between 4 and 7 A.M. on the 1st of September last, at Sikawei, in China; and to the total quantity that fell there during the twenty-four hours that elapsed between 4 P.M. on August 31 and the same hour on the day following, viz. 8·59 inches.

I believe that a very heavy rainfall indeed was registered in South Devon in September last, the fall in one hour and in a total of twenty-four being unprecedented; but I have mislaid

* I have not Grew's work at hand, and am therefore retranslating Sachs's translation.

† Grew was born in Coventry in 1628, and died in 1711; in 1677 he was appointed Secretary to the Royal Society.

the record. It would be interesting to have this accurately stated, and more widely published.

At Bangalore, in the Mysore Province, I once registered an inch and a quarter in twenty minutes; and seven and eight, and more inches have been occasionally gauged during a heavy twenty-four hours' fall, notably so in 1856, when disastrous floods occurred. Somewhere about that period a most extraordinary fall of rain occurred at Madras. I regret that I have not the record by me, but I am right in saying that more than twenty-three inches fell in twenty-four hours! and that more than seven inches fell within six hours! This was gauged at the Madras Observatory, and registered every hour; the statement can therefore be easily corroborated by a reference to the superintendent at that place. A coffee planter on the western Ghauts of Mysore told me that at Hoolikul he had gauged, in August 1874, 13¾ inches in one day, and 10¼ the next. He described it as a sullen, intermittent, continuous downpour, the monotony of which was very depressing. At Mahableshwar, on the same line of Ghauts, the average fall is 240 inches, chiefly in the four or five months, from May to September inclusive; while at the Cherrapoonji Hills, not very far from Calcutta, the average fall is over 600 inches, or (say) seventeen yards of rain! My notes are in a book that I left in India, but I am within the mark in what has been stated above.

The meteorology of India would furnish many startling incidents. It has not hitherto been sufficiently attended to, or recorded, and much valuable time has been allowed (like the rainfall) to run by; but attention is now, I believe, being paid to its systematic registry, and to the publication of accurate results. I have some interesting records, however, of the Province of Mysore, which I would gladly place at your disposal should you desire to have them.

J. PUCKLE

A New Palmistry

IT is the old story—"In striving to be concise, I have become obscure." If Mr. Mott will refer to my abstract of Prof. Ecker's paper, he will find directions as to procedure, very briefly stated, I will grant; for I, and others too, more competent to judge than myself, had no idea that the subject would attract the attention which it has done. At Mr. Mott's desire, however, I give him a literal translation of Prof. Ecker's directions (*op. cit.* p. 73) in full:—

"With regard to the method of measurement on living individuals, I will merely remark that the hand must be simply laid, with the fingers closed together, upon a board or a piece of paper, upon which a well-defined perpendicular line has been drawn. With this latter the axis of the middle finger and its metacarpal bone is made precisely to coincide. Every lateral movement of the middle finger naturally alters also the position of the other fingers, and every movement of the fingers upon the metacarpal bones towards the pollex turns to the advantage of the position of the index, while that toward the little-finger-edge of the hand to the advantage of that of the ring-finger. The tips of the fingers (without nails *à la Chinois*) are then outlined with a pencil, halved longitudinally; its cut surface being applied against them."

JOHN C. GALTON

Nov. 29

I HAVE made a number of determinations of the relative lengths of the "index" and "ring" fingers of both hands, the results of which, I think, very decidedly show that there is a great dissimilarity between the two hands. The hands of twenty-two persons were examined; in ten there was similarity between the hands as regards the relative lengths of the two fingers in question; in twelve there was dissimilarity. In the case of eight out of the ten the "ring" was longer than the "index;" in one case the "index" was the longer, and in the remaining instance the two fingers were of equal length. Of the twelve cases which exhibited dissimilarity, six had the "ring" longer than the "index" in the left hand, and five in the right hand; four had the "index" longer than the "ring" in the left hand, and in three the same relation existed in the right hand.

M. M. PATTISON MUIR

The Owens College, Manchester, Nov. 27

Faye on the Laws of Storms

M. FAYE'S paper on cyclones and waterspouts, of which you have lately published a full abstract, seems very unsatisfactory. The statement in NATURE, vol. xii. p. 401, of the laws of the cyclone's motion is no doubt true, but it is avowedly not original. But the succeeding parts, where the dynamics of the subject are treated of, cannot be sufficient—I think I may say cannot be sound—because they take no account of the very remarkable facts of the geographical distribution of cyclones. If M. Faye's theory were true and complete, cyclones ought to be equally common in all equatorial and tropical regions, except perhaps that they ought to be commonest in the hottest parts. So far is this from being the case, that they are strictly local phenomena. They are formed in the West Indian seas, but not in the South Atlantic; in the Indian Ocean, both north and south of the equator, but much oftener on the eastern than on the western side of India; and, I believe, off the coast of California, but not that of Peru. Their periodicity is equally remarkable. In the West Indian and in the Chinese seas they occur chiefly at the end of summer, but in the Bay of Bengal after the equinoxes.

All these facts point to the origin of the cyclone, not, as M. Faye seems to think, in eddies formed in the upper currents of the atmosphere—how could eddies be formed in currents so totally free from obstructions?—but in eddies formed by the meeting and conflict of the two trade-winds where one of them is drawn across the equator. This hypothesis agrees with observation, and harmonises all the geographical facts relating to cyclones.

This simple and true theory is stated in a paper on the Law of Storms by Prof. Maury, in NATURE of June 12, 19, and 26, 1873. It had previously been stated for the Bay of Bengal, as the result of an examination of particular storms, by Mr. Meldrum, in a paper read before the Meteorological Society of Mauritius, and reported in NATURE, vol. ii. p. 151; and a letter of mine in NATURE, vol. iv. p. 305, maintained the probability of all cyclones so originating.

I think M. Faye is as unsatisfactory on waterspouts as on cyclones. I hope to follow this by a letter on waterspouts.

JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, Nov. 16

OUR ASTRONOMICAL COLUMN

SATELLITES OF URANUS.—There are many amateurs in this country who possess instruments quite competent to show the two larger or exterior satellites of the planet Uranus. With the view to facilitate the identification of these objects, their angles of position and distances from the centre of Uranus are given below for 14h. Greenwich mean time for the last ten days of the present year, with the intention of continuing them while the planet is most favourably placed for observation as regards position and distance from the moon's place. They are deduced from the very convenient tables appended by Prof. Newcomb to his discussion of the observations of the satellites with the 26 inch equatorial at Washington, forming Appendix I. to the Washington Observations for 1873:—

At 14h. G.M.T.		°	TITANIA.	"			°	OBERON.	"
Dec. 19 ...	Pos.	48·0	Dist.	20·8	...	Pos.	64·2	Dist.	23·1
20 ...	,,	18·3	,,	32·3	...	,,	33·8	,,	34·6
21 ...	,,	359·6	,,	32·1	...	,,	18·1	,,	43·4
22 ...	,,	329·2	,,	20·5	...	,,	6·1	,,	45·3
23 ...	,,	249·6	,,	16·6	...	,,	352·9	,,	39·4
24 ...	,,	206·1	,,	29·3	...	,,	331·4	,,	28·3
25 ...	,,	186·4	,,	33·9	...	,,	285·2	,,	20·0
26 ...	,,	163·4	,,	25·4	...	,,	233·4	,,	26·1
27 ...	,,	100·8	,,	14·9	...	,,	208·8	,,	37·6
28 ...	,,	36·2	,,	25·0	...	,,	194·7	,,	44·9
29 ...	,,	12 9	,,	33·9	...	,,	182·9	,,	44·6
30 ...	,,	353·2	,,	29·7	...	,,	168·4	,,	36·9
31 ...	,,	311·3	,,	17·0	...	,,	142·2	,,	25·5

The above angles are reckoned as is usual in measures of double stars, *i.e.*, from the N. point round by the east. The apparent diameter of Uranus by the Malta determination of Lassell and Marth will be 3″·87 on December 25th. With this value, should it be found more convenient, the arc values may be reduced to distances in diameters of the planet.

THE MINOR PLANETS.—No. 156 is announced as having been discovered by Herr Palisa, at Pola, on Nov. 22, in R.A. 2h. 54m., and N.P.D. 70° 23′: it is of

the twelfth magnitude.—From observations on Nov. 2 and 7 Herr Palisa has calculated circular elements of No. 153, which place the ascending node in longitude 228° 31′, with an inclination of 6° 57′. The mean diurnal motion assigned on this hypothesis (447″), if it were reliable, would make the period of this planet considerably longer than that of any other member of the group, but it will be necessary to wait till elliptical elements on a fair extent of observation are in our hands, before attributing to No. 153 a revolution so much in excess of the rest.

PUBLICATIONS.—(1) P. A. Hansen. *Ueber die Storüngen der Grossen Planeten inbesondere des Jupiter.* A posthumous memoir published in vol. xi. of the "Proceedings" of the Mathematical Class of the Royal Saxon Society of Sciences. The analytical developments forming the subject of the first part of this treatise are applied especially to the case of the planet Jupiter; the perturbations of latitude by Saturn, and the perturbations by Uranus, Neptune, Mars, the Earth, Venus, and Mercury are exhibited numerically; and from Herr v. Glasenapp, who was engaged in this part of the work up to the time of Prof. Hansen's decease, may, it is announced, be expected the complete calculation of the perturbations of longitude and radius-vector of Jupiter by Saturn.

(2) J. N. Stockwell. *Theory of the Moon's Motion.*—This is a republication in an extended form of an investigation which appeared in the *Astronomische Nachrichten*, Nos. 2,024—2,026, wherein the mathematical developments are given in greater detail, with the addition of those applying to the formulæ for latitude. The author hopes to find time to continue his investigations in the same direction, so as to complete the developments of the perturbations of the moon's motions by means of the differential equations given in this first chapter. In the author's introductory remarks on the labours of those eminent mathematicians who have taken up the lunar theory, in referring to Prof. Hansen, there is no mention of his "Fundamenta nova investigationis orbitæ veræ quam Luna perlustrat," Gotha, 1838; or his "Darlegung der Theoretischen Berechnung der in den Mondtafeln angewandten Storüngen," the first part of which appeared in 1862, and the second in 1864.

(3) Dr. Franz Melde. *Theorie und Praxis der Astronomischen Zeitbestimmung*, &c. (Tübingen, 1875).—The author, Professor in the University of Marburg, explains that in the course of lectures on the determination of time by astronomical observations, he had found the want of a work in which the subject should be treated both in a theoretical and practical point of view, and in the present volume of 500 pages he has presented a very detailed discussion of time-determinations after the methods generally employed. The transit-instrument, its arrangement, mounting, and errors, with the methods of regulating it; the sextant, more particularly as regards its use for ascertaining time by corresponding altitudes of sun or stars, time by occultations, refraction, aberration, precession, &c., are explained at length. The volume, it will be seen, is one of a special character, and will be a desirable addition to an astronomical library.

DR. R. VON WILLEMOES-SUHM

IT is with the deepest regret that I have to intimate the death of Dr. Rudolf von Willemoes-Suhm, at sea, on our passage from Hawaii to Tahiti. He had not been in his usual robust health for some months, having suffered occasionally from indolent boils on different parts of the body. On Sept. 6 he applied to the surgeon for advice. He had had a rather severe shivering fit the day before, and an inflamed spot on the face began to show symptoms of erysipelas. The swelling and inflammation of the face increased during the next week; it extended over the forehead; and the fever and delirium attending erysipelas became more pronounced. On the morning of Sept. 13 he sank into a state of collapse, and died at three o'clock in the afternoon.

This sad occurrence has of course thrown a heavy gloom over our little party. From the commencement of the voyage Dr. v. Willemoes-Suhm devoted himself with unremitting industry and zeal, and in the best possible spirit, to the objects of this expedition. He has already published, in connection with our work, a paper in the *Annals and Magazine of Natural History*, "On a terrestrial Nemertine from Bermudas;" a long paper in Linnean Proceedings, on the deep-sea Crustacea of the cruise; "On the development of *Umbellularia*," in the *Annals and Magazine*: "On the Development of *Lepas fascicularis*," a paper sent to the Royal Society from Honolulu; and the notes on Crustacea which have been incorporated from time to time in my letters and reports. He has also written some interesting letters to Prof. von Siebold, describing the general zoological results of the cruise, which have been published in the *Zeitschrift für Wissenschaftliche Zoologie*. He leaves a fine series of drawings, with full descriptions, chiefly illustrating the development of surface Crustacea. For example, the development of species of the genera *Euphausia*, *Sergestes*, and *Amphion* is traced through all its stages. He leaves also an ample official journal in two large volumes. The loss of his valuable assistance in working up the final results of the expedition must, I fear, seriously affect their completeness.

Rudolf von Willemoes-Suhm was a native of Schleswig-Holstein; his family now reside in the neighbourhood of Rendsburg, where his father holds a high official appointment. He was about twenty-eight years of age when he died. He studied in the Universities of Göttingen and Bonn; he showed very early a strong taste for natural history in all its branches, and when quite a boy he published papers on the habits of European birds. Shortly after he left the University, he was appointed Privat-Docent in Zoology in the University of Munich, where he was associated with Prof. von Siebold, with whom he was extremely intimate, and whose place he frequently took in the lecture-room when the professor was prevented from teaching by indisposition. In 1868 he visited Italy and made zoological observations at Spezzia. In the summer of 1870 he made a series of observations on various marine animals, *Halicryptus*, *Balanoglossus*, &c., which formed the subject of his thesis on being appointed Privat-Docent in Munich.

In the summer of 1872 he went to the Faeroe Islands. He published some of the results of his investigations there in NATURE and elsewhere, but unfortunately a large series of zoological drawings which represented the greater part of his work was lost *in transitu*. It was from the accident of his calling upon me in Edinburgh, on his return from Faeroe, while there was still a vacancy on the staff of the *Challenger*, that he joined the expedition.

Among the more important of his publications are—

"Helminthologische Notizen," I. (Zeitschrift fur Wissenschaftliche Zoologie, Bd. xix., 3 Heft.)

"Helminthologische Notizen," II. (Ibid. Bd. xx., 1 Heft.)

"Zur Entwickelung von *Schistocephalus dimorphus*" (Ibid. Bd. xix., 3 Heft.)

"Biologische Beobachtungen über Niedere Thiere" (Leipzig, W. Engelmann, 1871) contains: "On a young calcareous sponge;" "On the development of an appendiculate Distoma;" "On *Balanoglossus kupferi*;" "On *Halicryptus spinulosus*;" "On *Priapulus caudatus*;" "On the development of some Polychæte Annelids, *Etone*, *Terebella*, and *Spirorbis*;" "On the natural history of *Polystoma integerrimum* and of *P. ocellatum*."

Dr. von Willemoes-Suhm was a man of unusual acquirements and culture; besides having a wide and accurate knowledge of the literature of natural science, he

was a good classical scholar, and could converse with perfect fluency in English, French, German, Danish, and Italian; and could read with ease nearly all the modern European languages. He made some strong friendships among his colleagues, and his acknowledged ability and his manner and address, which were eminently those of a polished gentleman and man of the world, won for him universal respect and esteem.

Altogether I looked upon Rudolf von Willemoes-Suhm as a young man of the very highest promise, perfectly certain, had he lived, to have achieved a distinguished position in his profession, and I look upon his untimely death as a serious loss not only to the expedition in which he took so important a part, but also to the younger generation of scientific men among whom he was steadily preparing himself to become a leader.

C. WYVILLE THOMSON

H.M.S. *Challenger*, Tahiti, Oct. 1

THE PENIKESE SCHOOL

OUR readers will regret to hear that the Anderson School of Natural History in Penikese Island, U.S., has come to an untimely end, and will no doubt regret still more that it has done so amid much unpleasant feeling between those chiefly concerned. We shall endeavour to state fairly the facts of the case.

Mr. Anderson, who is a wealthy merchant, made a gift of Penikese Island and 50,000 dollars in cash to the late Prof. Agassiz, in order to enable him to start a school for the practical teaching of natural history. This sum, it may well be believed, was only sufficient to start the school, erect buildings, furnish apparatus, and other necessaries. No one can complain that Mr. Anderson did not also endow the school, and during the life-time of the elder Agassiz there seems to have been no difficulty as to funds. On his death, his son, Mr. Alexander Agassiz, undertook to carry on the school. This he did, we believe, very unwillingly, as he knew there were no funds available for the daily business of the school, and he did not consider the island a suitable location for such an institution unless largely endowed. Moreover, it was his father's earnest wish that he should devote most of his time and energy to the Museum at Cambridge. However, he consented to conduct the school on condition that Mr. Anderson would contribute the sum of 10,000 dollars towards its support for the next three years. The first intimation of any dissatisfaction on the generous donor's part seems to have been made to the trustees at the end of 1874, when he sent them 1329·60 dollars to pay off debts which had been incurred, announcing at the same time that this was the last contribution he would make. The trustees seem, nevertheless, to have made every effort to carry on the school. A member of Prof. Agassiz's family contributed a guarantee fund of 3,000 dollars, and appeals were made in all directions, but without anything like success. Clearly the trustees and the teachers themselves could not be expected to carry on the school at their own expense, and all that they had any right to look for from Mr. Anderson was the balance of the 10,000 dollars which he promised; why he failed to contribute this, we are unable to say. Had he done so, those interested in the success of the school would have had time to set about raising something like an endowment fund, and a fine opportunity would have been afforded to the U.S. Government to show their appreciation of practical scientific teachers and scientific research. As it was, the only course which seemed left to the trustees, when everything is taken into account, was to close the school and sell off the furniture and aquaria. Mr. Anderson seems to have considered himself ill used and insulted by the trustees, and Mr. Agassiz in particular; but so far as the facts are known to us, we certainly believe he is mistaken. Mr. Agassiz has duties of the highest importance to attend to in connection with the Cambridge Museum, and he could not possibly be expected to waste his time and energy on an undertaking in whose success no one seemed to be interested. He seems to us to have acted in a straightforward and honourable manner, and only to have given up the school when he saw there was no possible hope of getting funds to carry it on. Mr. Anderson, for some reason which does not appear, seems to have lost his temper, and may naturally have been annoyed that the public did not come forward in support of the school which he so generously founded. The result is certainly to be regretted, but we hope that Mr. Agassiz and Mr. Anderson may come to a better understanding, and that even if the school be not again started, the latter will see that the former has acted all along in the interests of science, whose servant he is. To have touched the Agassiz Memorial Fund, now 347,000 dollars, as some one suggested should have been done, was simply impossible; it was collected for a special purpose.

Mr. Agassiz took two of the most promising Penikese pupils into his laboratory at Newport, and intends, we believe, as soon as the necessary means can be collected, to establish a school at some more suitable locality.

THE THEORY OF "STREAM LINES" IN RELATION TO THE RESISTANCE OF SHIPS*

II.

IT might at first sight appear that I have now the materials for the proof of my chief proposition, the assertion of the unresisted progress of a submerged body; for such a body might be assumed to be surrounded by a system of imaginary pipes, as shown in Fig. 8; and each of these pipes being in equilibrium

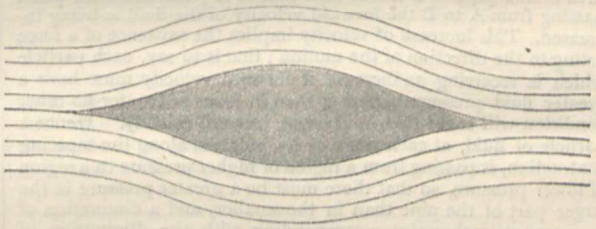


FIG. 8.

endways, that is to say, the flow of fluid through it not tending in the aggregate to move it endways, neither, it might be said, would the flow of fluid tend to move the submerged body endways. But this reasoning would not be sound. The pipes we have hitherto been considering have been of uniform sectional area throughout their length, an assumption which has been necessary to the treatment pursued, as the velocity has in each case been assumed to be uniform throughout the pipe. The section of the pipe may have been square, circular, trapezoidal, or any other form; but the area of the section has been assumed to be the same throughout the length of the pipe.

But pipes of uniform sectional area do not truly represent the flow of a fluid past a submerged body. I shall presently ask you to consider the fluid as flowing past the body through a system of imaginary pipes; but to render the assumption admissible, the sides of the imaginary pipes must not be so placed as to interfere with the established course of the fluid, whatever that may be; in other words, if, for the sake of illustrating the behaviour of the fluid, we assume that it is divided into streams or filaments flowing through imaginary pipes, we must accept such a form for those imaginary pipes that their sides exactly follow the paths of the adjacent particles of fluid.

Now such a rule may, and probably will, require the imaginary pipes to be of varying sectional area throughout their length. Therefore, before we can apply the analogy of the flow of fluid through pipes to the flow of a fluid past a submerged body, it is necessary to consider the behaviour of fluid in pipes of varying sectional area.

It is, I think, a very common but erroneous impression, that a

* Address to the Mechanical Section of the British Association, Bristol, August 25, 1875; by William Froude, C.E., M.A., F.R.S. President of the Section. Revised and extended by the author. Continued from p. 52.

fluid in a pipe exercises, in the case of its meeting a contraction (see Fig. 9), an excess of pressure against the entire converging surface which it meets, and that, conversely, as it enters an enlargement (see Fig. 10), a relief of pressure is experienced by the entire

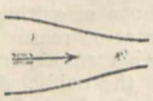


FIG. 9.

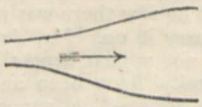


FIG. 10.

diverging surface of the pipe. Further, it is commonly assumed that, when passing through a contraction (see Fig. 11), there is

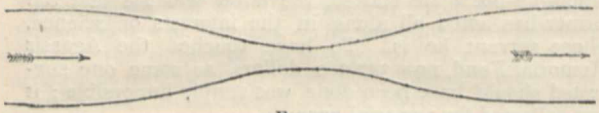


FIG. 11.

in the narrow neck an excess of pressure due to the squeezing together of the fluid at that point.

These impressions are in no respect correct; the pressure at the smallest part of the pipe is, in fact, less than that at any other point, and *vice versâ*.

If a fluid be flowing along a pipe which has a contraction in it (see Fig. 12), the forward velocity of the fluid at B must be

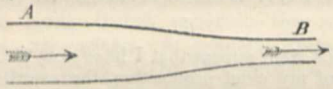


FIG. 12.

greater than that at A, in the proportion in which the sectional area of the pipe at B is less than that at A; and therefore while passing from A to B the forward velocity of the fluid is being increased. This increase of velocity implies the existence of a force acting in the direction of the motion; that is to say, each particle which is receiving an increase of forward velocity must have a greater fluid pressure behind it than in front of it; for no other condition will cause that increase of forward velocity. Hence a particle of fluid, at each stage of its progress along the tapering contraction, is passing from a region of higher pressure to a region of lower pressure, so that there must be a greater pressure in the larger part of the pipe than in the smaller, and a diminution of pressure at each point corresponding with the diminution of sectional area; and this difference of pressure must be such as to supply the force necessary to establish the additional forward velocity required at each point of the passage of the fluid through the contraction. Consequently, differences of pressure at different points in the pipe depend simply upon the velocities at those points, or, in other words, on the relative sectional areas of the pipe at those points.*

It is simple to apply the same line of reasoning to the converse case of an enlargement. Here the velocity of the particles is being reduced through precisely the same series of changes, but in an opposite order. The fluid in the larger part of the pipe moves more slowly than that in the smaller, so that, as it advances into the enlargement, its forward velocity is being checked; and this check implies the existence of a force acting in a direction opposite to the motion of the fluid, and each particle being thus retarded must therefore have a greater fluid pressure in front of it than behind it; thus a particle of fluid at each stage of its progress along a tapering enlargement of a pipe is passing from a region of lower pressure to a region of higher pressure. As is well known, the force required to produce a given change of velocity is the same, whether the change be an increase or a decrease. Hence, in the case of an enlargement of a pipe, as in the case of a contraction, the changes of velocity can be satisfied only by changes of pressure, and the law for such change of pressure will be the same, *mutatis mutandis*.

In a pipe in which there is a contraction and a subsequent enlargement to the same diameter as before (see Fig. 11), since the differences of pressure at different points depend on the differences of sectional area at those points, by a law which is exactly the same in an enlarging as in a contracting pipe, any points which have the same sectional area will have the same pressures,

* See Supplementary Note B.

the pressures at the larger areas being larger, and those at the smaller areas smaller.

Precisely the same result will follow in the case of an enlargement followed by a contraction (see Fig. 13).*

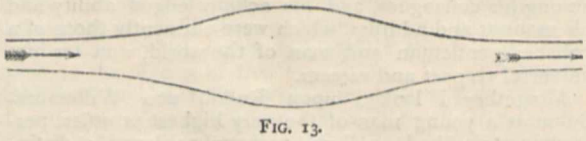


FIG. 13.

This proposition can be illustrated by experiments performed with water.

Figs. 14, 15 show certain pipes, the one a contraction followed by an enlargement, and the other an enlargement followed by

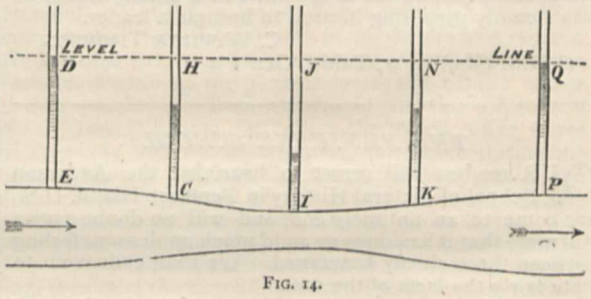


FIG. 14.

a contraction. At certain points in each pipe, vertical gauge-glasses are connected, the water-levels in which severally indicate the pressures in the pipe at the points of attachment.

In Fig. 14 the sectional areas at P and E are equal to one another. Those at C and K are likewise equal to one another, but are smaller than those at P and E. The area at I is the smallest of all. Now, if the water were a perfect fluid, the pressures P Q and E D would be equal, and would be greater

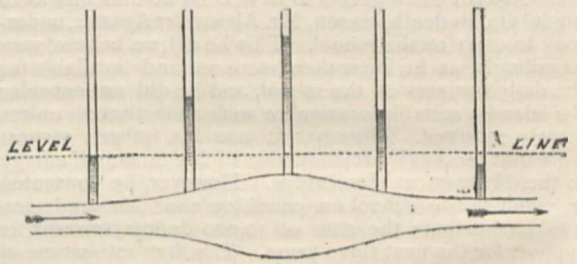


FIG. 15.

than C H and K N. C H and K N would also be equal to one another, and would be themselves greater than I J.

The results shown in Fig. 15 are similar in kind, equal pressures corresponding to equal sectional areas.

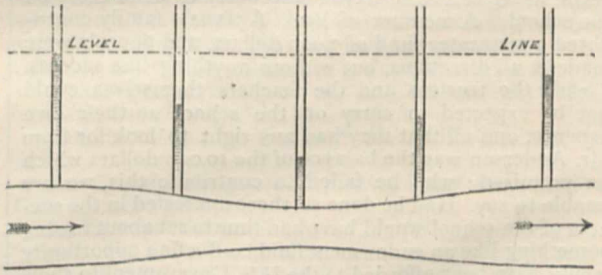


FIG. 16.

As water is not a perfect fluid, some of the pressure at each successive point is lost in friction, and this growing defect in pressure is indicated in the successive gauge-glasses in the manner shown in Figs. 16, 17.

* In a perfect fluid, we may say in a sense, the *vis viva* of each particle remains constant. If the particle is stationary, the *vis viva* is entirely represented by the pressure; if it be under no pressure, the *vis viva* is entirely represented by the velocity; if it be moving at some intermediate velocity, the *vis viva* is partly represented by the pressure and partly by the velocity.

As the pressure of the perfect fluid in the pipe at any point depends upon the sectional area at that point, it follows that the amounts of the pressures are independent of the distance, as

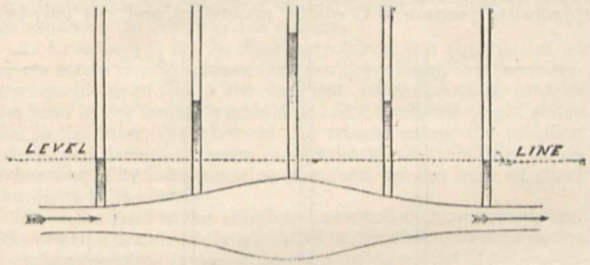


FIG. 17.

measured along the pipe, in which the area of the pipe alters; so that if in the pipe shown in Fig. 18 the areas at all the points marked A are equal, if also the areas at all the points marked B are equal, and so also with those at C and D, then the pressures at all the points A will be the same, the pressures at all the points B will be the same, and so with those at C and D.

Since, then, the pressure at each point depends on the sectional area at the point and on that only, it is easy to see that the variations in pressure due to the flow are not such as can cause any total endways force on the pipe, provided its sectional area at each end is the same.

Take the pipe shown in Fig. 19. The conical portion of pipe A B presents the same area of surface effective for endways pressure as does the conical portion H I, only in opposite directions. They are both subject to the same pressure, being that appropriate to their effective mean diameter J. Consequently the endways pressures on these portions are equal and opposite and neutralise one another. Precisely in the same way it may be seen that the endways pressures on B C, C D, D E, exactly counteract those on G H, F G, E F; and in precisely the same way it may be shown that in any combination whatever of enlargements and contractions, provided the sectional area and direction of the pipe at the two ends are the same, the total endways effect impressed on the pipe by the fluid flowing through it must be *nil*.

In the experiment I am about to show you, the several propo-

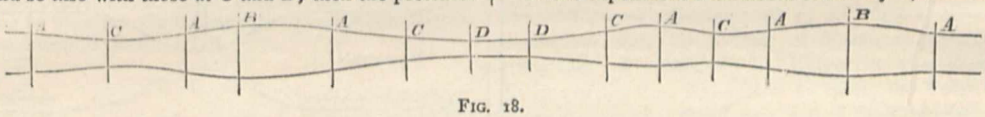


FIG. 18.

sitions which I have been elucidating will be seen to be verified step by step, if due allowance be made for the effect of friction.

A cistern (see Fig. 20), in which a definite head of water is maintained, discharges itself through a continuous series of pipes,

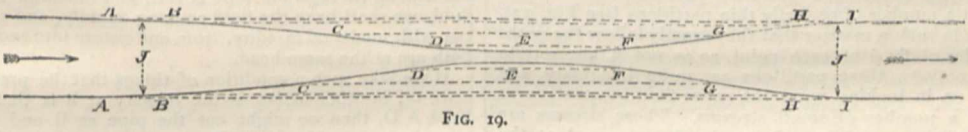


FIG. 19.

which in the local changes of diameter exhibit the several characteristic features which have been under consideration.

From *a* to *b* at the outlet end we have a contraction followed by an enlargement; from *e* to *g* the diameter is uniform, from *h* to *l* we have an enlargement followed by a contraction. At the various critical features are fitted gauge-glasses such as have been described, so that the level at which the water stands in each indicates the pressure in the pipe at the point of attachment.

The series of pipes is laid out on an inclination which represents the mean resistance due to friction, or the "head" lost by friction, between the cistern and the outlet, in other words, the hydraulic mean gradient.

The mean diameter of the contracted part between *a* and *b*

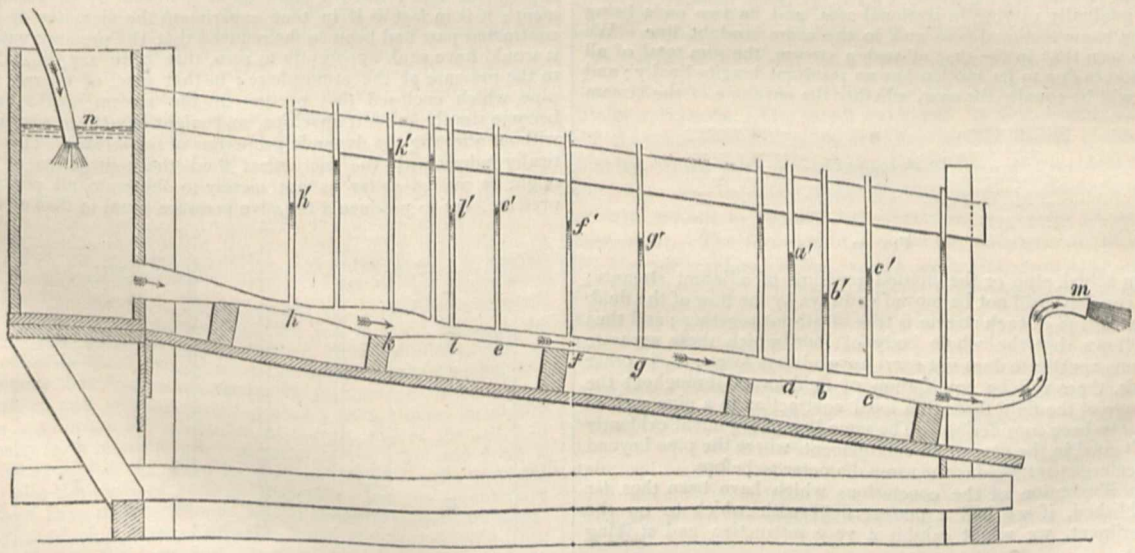


FIG. 20.

has been so determined by well-known hydraulic rules, that when it is compared with the adjoining parallel pipe, the hydraulic gradient shall be the same in each.

You observe that while the levels at which the water stands in the several gauge-glasses corresponds from end to end with the gradient from the head in the cistern to the head at the outlet; when examined in detail, they verify throughout the propositions I have been establishing. Broadly speaking, where the diameter is smallest, the pressure falls most below the mean gradient; at the points where the diameters are equal, the pressures allowing for the gradient are equal, and what is a quantitative verification, the gradient, or loss of head per foot between *a* and *b*,

as indicated by the gauge-glass levels a' and b', is identical with that indicated by e' f' g', the gauge-glass levels connected with the parallel pipe.

In dealing with pipes of varying sectional area I have hitherto treated only of the modifications caused in the forward motion of the particles of fluid; for I have limited the argument to cases where the alteration in sectional area of the pipe is so gradual that, practically, the only alteration in the motion of the particles is that in their forward velocity; but I have previously shown that tortuosity in a pipe of uniform diameter does not introduce endways pressure, provided the initial and terminal directions are the same; and it is easy to see that an elongated system of such gradually tapered pipes as we have been considering, may be also tortuous without introducing endways pressure. Now tortuosity of flow is but another word for sideways deviation of flow.

This leads us up to the case of more sudden contractions or enlargements in pipes, where the particles next the sides of the pipes have to follow their surfaces and must therefore be moved rapidly sideways in their course.

We will, for simplicity, consider the case of a contraction (see Fig. 21), and one in which the pipe resumes the same diameter beyond the contraction.

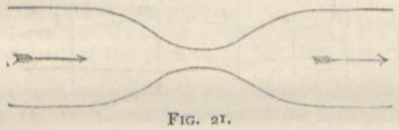


FIG. 21.

The particles along the central line pursue a straight course, and are subject only to the changes of pressure necessary to induce the changes of velocity.

To consider the behaviour of the other particles, let us assume that we insert a number of perfectly thin partitions (see Fig. 22), which we lay in such a manner that they exactly follow the paths of the particles of fluid at each point, so as not in any way to affect their motion; these partitions are quite imaginary, and merely assist us in looking upon the entire fluid in question as divided into a number of small streams. These streams are generally curvilinear, and vary in sectional area; and at the point beyond the contraction where the pipe resumes its former sectional area, we shall naturally find these minor streams occupying the same sectional area as before, and moving with the same velocity as before.

Now each of these small streams is exactly represented by a stream of fluid flowing within a pipe, that pipe being curvilinear and gradually varying in sectional area, and its two ends being of the same sectional area and in the same straight line. We have seen that in the case of such a stream, the sum total of all the forces due to its motion has no resultant longitudinally; and this will be equally the case, whether the envelope of the stream

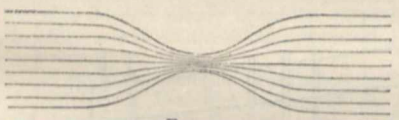


FIG. 22.

be an actual pipe or the mutual pressure of adjacent streams; this envelope will not be moved endways by the flow of the fluid. What is true of each stream is true of all put together; and thus it follows that the whole body of fluid which these separate streams constitute does not exert any endways force; or, in other words, there will be equilibrium of fluid forces throughout the passage of the fluid through a local contraction in a pipe such as we have been considering. The same line of argument evidently holds good in the case of an enlargement, where the pipe beyond the enlargement regains the same diameter as before.

In illustration of the conclusions which have been thus far established, if we had a perfect fluid with which to try the experiment, we might exhibit a very instructive and striking result.

Assume a perfect stream of fluid flowing through a pipe of very large diameter, A B C, with a contraction in it at B, as shown in Fig. 23, and that the equal pressures at A and C on either side of the contraction are indicated by the head of fluid in pressure-gauges A D, C E—the pressure at B, which will be less, being represented by the height B F. Now, the condition of the pipe at A will be just the same if we suppose the pipe supplied from a large cistern G, as shown in Fig. 24; and the appropriate pressure at A will be maintained, if the fluid stands in the cistern G at a height H, equal to the head A D in the pressure-gauge. So, again, the condition of the pipe at C will be the same if the pipe discharges into a cistern, I; and the appropriate pressure at C will be maintained, and can only be

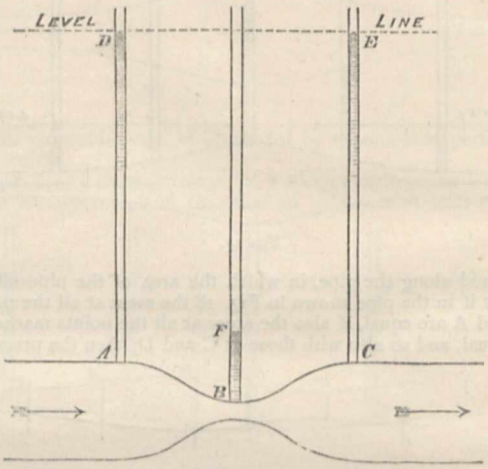
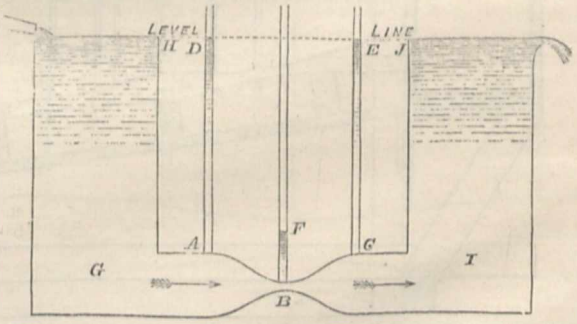


FIG. 23.

maintained, if the water in the cistern stands at a height J, equal to the head C E in the pressure-gauge, which is, in fact, the same level as H in the cistern G; so that if we once establish the motion through the pipe A B C, and maintain the supply of fluid, we shall have the fluid running rapidly, and continuing to run with unabated rapidity, from one cistern into another, though both are at the same head.

If we take such a condition of things that the pressure at B is zero, or, in other words, if the velocity at B is that due to the head A D, then we might cut the pipe at B and separate the two cisterns as shown in Fig. 25, and we should find the fluid issuing at B in a jet, and re-entering the pipe again at K, and rising as before in the cistern I to the same level with a perpetual flow.

The experiment here suggested is, if rightly understood, only a specialised instance of the properties of what in the previous experiment was termed a contraction followed by an enlargement; it is in fact as if in that experiment the diameter of the contracted part had been so far reduced that the pressure within it would have sunk apparently to zero, that is to say, in reality to the pressure of the atmosphere; in that case, of course, the pipe which enclosed that portion of the stream would have become simply an inert envelope, and might have been removed without affecting the dynamic properties of the stream. Theoretically indeed with the frictionless fluid the contraction of jet might be carried so far as not merely to obliterate all positive pressure, but to produce a negative pressure equal to that of the



atmosphere. For in fact the conditions thus brought into operation would be in effect identical with those which would exist were the experiment performed *in vacuo*, and the head in cistern and at the outlet were both increased by 34 feet; but the theoretical possibility thus indicated is greatly curtailed by friction, and the illustrative experiment I am about to exhibit deals only with the case in which the pressure at the contraction is reduced

apparently to zero, or in reality as I have said to that of the atmosphere.

In the apparatus as here arranged, consisting of the discharging and the recipient cistern, with the intervening jet-orifice and recipient-orifice, the overflow of the recipient cistern is at 18 inches above the centre of the orifices.

As I continue to fill the discharge cistern, you observe the jet shoots across the open space between the orifices, and the water-level continues to rise in the recipient cistern; and so long as the head in the former is maintained at a moderate height above that in the latter, the whole of the stream enters the recipient orifice, and there is no waste except the small sprinkling which is occasioned by inexactness of aim, and by the want of exact circularity in the orifices.

When the head in the recipient has reached the overflow, and thus remains at a steady height of 18 inches above the orifices, the complete reception is insured by maintaining a head of 20½ inches in the discharging cistern, or an excess of head of 2½ inches on the discharge side; and this excess, in effect, represents the energy wasted in friction.

You observe that as I diminish the supply of water and allow the excess of head in the discharger to become reduced, a steadily increasing waste becomes established between the orifices; and it is interesting to trace exactly the manner in which the friction operates to produce this result.

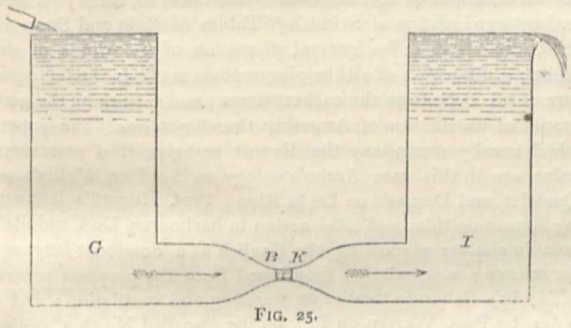


FIG. 25.

If the conoids of discharge and reception are tolerably short as they are here, it is the outer annule or envelopes of the stream which are in the first instance affected, that is to say retarded, by friction, and the escape or waste between the orifices implies that this surface-retardation has reduced the velocity of those envelopes below that due to the head in the recipient; thus an annular counter-current is able to establish itself, and in fact constitutes a counter discharge from the recipient.

As the quantity of water which actually enters the recipient, or in other words the speed of the inflow, is reduced, the friction which belongs to that part of the stream is reduced also, but that which belongs to the issuing jet is unabated, and this circumstance virtually magnifies the waste; it is probable, however, that to the last the velocity of the central zones of the jet remains equal to that due to the head in the discharger, and hence you will observe that unless this is reduced below the level of the overflow, the head in the recipient is fully maintained to that level, though the whole quantity discharged is wasted between the orifices.

When the supply is altogether cut off, both cisterns simultaneously empty themselves, the two jets meeting between the orifices, and becoming spread into a beautiful plane disc or film of water at right-angles to the line of discharge; but you will notice that from some inequality in the commencement of the action, and to some extent probably from a quasi-instability in the equilibrium of the double discharge, one of the jets will presently for a moment get the better of the other and drive it back so as almost to arrest its flow, and thus for the moment arrest also the waste of head on that side; but the momentary excess of head thus occasioned almost instantly asserts its superiority, producing a jet of superior force, and thus driving back for a moment the opponent by which it had just before been mastered. Thus a curious oscillation of discharge ensues, which is to a large extent a true dynamic phenomenon somewhat analogous to that which becomes established in an inverted syphon partly filled with water, if for a moment the head is increased in one of the legs; the reaction which in the syphon is furnished by its continuing through the bend, is, in the case before you, furnished by the dynamic reaction of the jets, but the circumstances here involve an instability which does not exist there, so that the small initial disturbance presently magnifies itself into one of considerably greater range.

This curious corollary phenomenon of the alternated retardation of discharge, though not strictly relevant to the main object of the experiment, is nevertheless highly interesting in itself and tends to enlarge our apprehension of some of the characteristic features of fluid dynamics.

(*To be continued.*)

NOTES

TUESDAY being St. Andrew's Day, the anniversary meeting of the Royal Society, as required by their charter, was held. The President, Dr. Hooker, began his address with a few remarks on the large number of eminent Fellows whose names appeared in the death-list of the past year, and then gave a summary of the numerous measures for "the improvement of natural knowledge" undertaken by the Society. These comprise the publication of papers in the "Philosophical Transactions," in a separate form; preparation of additional volumes of the catalogue of scientific papers; the labours of committees in connection with the Transit of Venus Expedition, and the researches of naturalists in Kerguelen and Rodrigues; the Eclipse of the Sun Expedition to Siam, the Polar Expedition, the voyage of the *Challenger*, and of the Committees appointed to consider the suggested modification of the regulations under which candidates are elected into the Society. The auditors' report showed that the pecuniary resources of the Society were in a satisfactory condition, and Dr. Hooker mentioned the bequests made to the Society by the late Sir C. Wheatstone and Mr. H. Dircks. The medals were then presented, the Copley medal to Dr. Hofmann, a Royal medal to Mr. Crookes, and a Royal medal to Dr. Oldham (at present in India), through Prof. Ramsay. The proceedings terminated with the election of council and officers (comprising the list of names already published) for the ensuing year. We hope to refer at length next week to the President's address. The anniversary dinner was held at Willis's Rooms, Dr. Hooker in the chair, supported by the Marquis of Salisbury, Lord Cardwell, Mr. W. H. Smith (of the Treasury), the Right Hon. Robert Lowe, Mr. Farrer, Admiral R. Hall, Mr. Lyon Playfair, Dr. Hofmann, Mr. Crookes, and a large number of the Fellows of the Society and their friends.

ON Monday night there was a pleasant and lively meeting at the Royal Geographical Society, over Mr. Stanley's work on the Victoria Nyanza. The paper read was by Col. Grant, C.B., the old companion of Speke, and he awarded hearty praise to Stanley, whose work he estimated as of high geographical importance. At the same time he showed that Stanley's discoveries seemed to confirm the discoveries of Speke as far as these went. The former estimates the circumference of the lake at 890 geographical miles, which coincides essentially with Speke's estimates. Sir Samuel Baker spoke much to the same effect as Col. Grant, both as regards Stanley and Speke, as did also Capt. Burton, while Mr. Edwin Arnold acted the part of Stanley's representative. It was announced that the Church Missionary Society are to take advantage of King Mtesa's invitation to send out missionaries; Sir Samuel Baker believes that the good Mtesa mistook Stanley for Livingstone, whom he had been informed might be expected from the south. Sir H. Rawlinson read some extracts from Col. Gordon's letter on the Albert Nyanza, which he trusted would also be explored by Mr. Stanley.

THE Queen has conferred upon Dr. W. B. Carpenter, F.R.S., the honour of the Companionship of the Civil Division of the Order of the Bath.

THE Royal Academy of Sciences of Berlin has elected Dr. Frankland and Prof. A. W. Williamson, of London, corresponding members of the section of Physics and Mathematics.

MANY of the readers of NATURE will be grieved to hear that Prof. Friedrich Albert Lange died at Marburg, after severe suffering, on the 21st of November. A great career was opening before him when he was smitten by the illness which killed him. His principal work is the "History of Materialism," a second edition of which he had completed shortly before his death. This work will long remain a monument of honour to his memory—an ensample alike of comprehensive learning and of profound and elevated thought.

THE three vacant seats on the Senate of the University of London have been filled by the appointment of Dr. Hooker, Pres. R.S., and the Dean of Lincoln (Dr. Blakesley), directly by the Crown, and Mr. J. G. Fitch on the nomination of Convocation.

WITH reference to Dr. Acland's late pamphlet on the future site of the Oxford Botanic Gardens, in the form of a letter to Dr. Hooker, the Professor of Botany (Mr. Lawson) draws attention to the fact that the question of retaining them upon their present site or of removing them to the Parks is now *sub judice*, and that till Council deems fit to announce the result of their deliberations it would be highly inexpedient for the Professor of Botany to enter into any discussion on the matter, and he requests members of the University to suspend their judgment until such time as the question can be placed before them in all its bearings.

DR. L. S. FORBES WINSLOW has been appointed to the chair of Psychological Medicine at Charing Cross Hospital.

TELEGRAMS from Prof. Palmieri state that the interior of the crater created by the last eruption of Vesuvius has given way. A dark smoke issues from the volcano, and he thinks an eruption is consequently to be expected, but perhaps not immediate.

FROM additional notes on the Meteorological Congress at Poitiers which we have received, we learn that nineteen departments surrounding Poitiers are formed into a permanent meteorological union called "Ouest-Oceanien," for the purpose of organising weather forecasts in the interests of agriculture, and of tracing the paths of thunderstorms. Another similar association will be established at Bordeaux for the south-western provinces. Next year the "Ouest-Oceanien" will hold its second yearly meeting at Tours. It has been decided that a barometer, constructed on an improved plan by M. Redier, shall be sent to each chief town of an arrondissement, as also the telegrams from the Paris Observatory giving the meteorological news transmitted by the international service. The resident meteorologists are to take advantage of these general warnings in issuing special predictions. These efforts will promote the meteorological investigations and multiply the number of observers. It is expected that the Paris Observatory will commence to issue daily bulletins and maps similar to those which for a long time have been issued by the U.S. Signal Service, showing up to what extent their predictions have been warranted by facts. M. Alluard, Director of the Puy de Dôme Observatory, was present at the Congress, and gave interesting details as to the state of the works, which are progressing favourably. In the course of a few months the observations will begin at the top of the mountain, and by the month of May next the works will be opened for inspection by men of science of all nations. The presence of a large number of delegates from various parts of France enabled the Congress to pass resolutions of so general a character as to insure everywhere uniformity of action, and the establishing, on a satisfactory basis, of an *Atlas Météorologique de la France*.

THE *South Australian Register* contains a short account of the exploration of the large river in New Guinea referred to in our last number. The details are given in connection with the report of the return of Mr. Macleay's expedition in the *Chevert*, which became disorganised, Mr. Macleay and Capt. Edwards having disagreed. The scientific portion of the expedition proceeded to New Guinea in a missionary vessel, probably the *Ellangowan*, the same which is reported to have sailed up the Baxter River. The details, evidently supplied by some one who had been on board the *Ellangowan*, published in the *Register*, are substantially the same as those given in Mr. Smithurst's letter. Large cloven hoof tracks are reported to have been seen, as also the monstrous bird referred to by Mr. Smithurst. Lieut. Robert H. Armit, R.N., writing to the *Daily News*, states that the position of the supposed newly-discovered river in New Guinea, as given by Mr. Smithurst—lat. 8·38 S., long. 141·59 E.—clearly proves it to be none other than the one discovered by the officers of her Majesty's ship *Fly*, and which to this day bears the name of that vessel.

PROF. HENRY'S Smithsonian Report for the year 1874, the New York *Nation* states, gives a good account of the management and varied usefulness of the Institution. Among the publications in progress or contemplated are a "complete index to all the species of plants of North America, with their synonyms and all descriptions and important references to them;" a new and enlarged edition of Schott's "Tables of Rain and Snow in the United States;" a general discussion of the winds of the globe; a discussion of all the observations made on the temperature of the U.S. from the earliest times; and a work on the geographical distribution of American thunder-storms. The papers which usually accompany the Report and give it a permanent value are in this case Arago's eulogy on Laplace, Mailly's on Quetelet, and Dumas's on De la Rive; Prof. Hilgard's interesting lecture on tides and tidal action in harbours; De Candolle's notable chapter advocating the English as a dominant language for science; a translation (continued from the previous report) of Morin's elaborate treatise on warming and ventilation; and a letter, by Prof. Warren du Pré, on the so-called North Carolina earthquakes, which literally "made so much noise" in February and March of last year. Prof. du Pré attributes the shakes and explosions to volcanic or earthquake energy, but Prof. Henry inclines to think them caused by either a gradual depression or elevation of the mountain. The stories of issuing smoke and flame were fabulous. The last sixty pages of the Report are given up to Ethnology, with a view to presenting as complete information as possible concerning the location and character of ancient earthworks in America. The accounts here given range from New York to Oregon in one direction, and to Florida and Mississippi in others.

M. BONNAT, a French explorer of the Gold Coast, who had been taken prisoner by the Djuabin, has managed to escape, and is continuing his work along the banks of the Volta, under the protection of Ashantees, amongst whom he is said to have become a favourite.

THE Auricula is said to be the only Alpine plant which has come into general cultivation in the gardens of the rest of Europe. In a pamphlet entitled "Die Geschichte der Aurikel," Prof. Kerner traces the history of the discovery and cultivation of this plant, from the time of L'Escluse (Clusius), who first transplanted this species and the hybrid *P. pubescens*, Jacq., in 1582 from the Tyrolese Alps to Belgium. The latter species, and not the true *P. Auricula*, L., which quickly disappeared from cultivation, is believed by Prof. Kerner to be the real ancestor of the cultivated auriculas of our gardens. The two were known at the time of Clusius under the names of "Auricula-ursi I." and "Auricula-ursi II.," from the supposed resemblance in the shape of the leaves to that of the ear of a bear. The hybrid *P. pubescens*, which had been lost from the German and Austrian Alps for nearly three centuries, was rediscovered by Prof. Kerner in 1867 in a single locality in the Tyrol.

A VERY severe shock of earthquake occurred at Gisborne, New Zealand (east coast), on Sept. 14. Strong shocks were also experienced at Wellington and Blenheim.

A NEW monthly magazine is to be started at Dunedin, of the same character as the *Contemporary Review*.

ACCORDING to a letter published in the *East Anglian Times* of Nov. 24, it would appear that the Corporation of so important a town as Ipswich still authorises the use of local mean time within its liberties, and the business of the place is actually regulated by its edict. Railway time has there a distinct meaning, being 4 min. 40 sec. later than that in general use. We believe that Norwich is in an equally unscientific state as regards time-keeping. It is quite time that an end was put to this absurdity, and we hope some pressure may be brought to bear upon the authorities to effect the long-delayed and desirable introduction of Greenwich time.

IN the October number of the *Quarterly Journal of the Meteorological Society of London*, appear several papers of interest, including one by Dr. Mann, the President, on some practical points connected with the construction of lightning conductors, one by Mr. Symons on a white rain or fog bow, and two very valuable and suggestive papers by the Hon. Ralph Abercrombie, on certain small oscillations of the barometer, and on barometrical fluctuations in squalls and thunderstorms. It may be suggested that the printed "Discussions" on the several papers, however interesting to the members, might be curtailed with great advantage.

THE tri-daily Weather Maps of the United States for the first six months of the present year, issued under the vigorous direction of Brigadier-General Myer, have been received. They show with admirable clearness and distinctness, by the style of printing in colours adopted, the outstanding features of the weather thrice a day. These truly magnificent maps give in every case the weather probabilities for each of the great divisions into which the States have been grouped for this purpose, that are likely to follow within the twenty-four hours then *next ensuing*, and also the actual weather which has been experienced during the *past* twenty-four hours. This method is deliberately adopted by the Office for the express purpose of exhibiting equally its successes and its failures in issuing the weather probabilities, and with the further view of receiving assistance from scientific men, who are thus put in possession of materials for studying the subject, by which the rules that have led to the successes may continue to be followed, and those which have caused the failures may be avoided.

MR. STANFORD has published a handy map of India, showing the route originally sketched for the Prince of Wales's tour. Its moderate price and clearness will recommend it to many who wish to follow the Prince in his wanderings.

THE *Bulletin de la fédération des Sociétés d'Horticulture de Belgique* for 1874, published under the authority of the Ministry of the Interior, gives evidence of the extent to which horticulture is made a scientific study in that little kingdom. It contains the reports of no less than twenty-five horticultural and agricultural societies affiliated to the Federation; and a list of twenty-one practical questions, for the best solution of which prizes, varying in value from 100 to 500 francs, are offered. There is also appended Prof. Morren's biographical notice of Clusius, to which we have already alluded, and a third edition, completed to October 1875, of the list of the Botanic Gardens, chairs of Botany, and Botanical Museums, throughout the world.

AN admirable epitome of our knowledge respecting the vegetable palæontology of the United States is contained in M. Leo Lesquereux's reprint, "A Review of the Fossil Flora of North America," printed under the authority of the Department of the Interior. An idea will be conveyed of the wonderful advance of this knowledge in recent years, by the statement that in 1850 Brongniart described in his "Végétales Fossiles" eighteen species of land-plants from North America, whereas upwards of 1,000 species are now known. Of the numerous fossil plants brought by Dr. H. F. Hayden from his exploration of the Western Territories, and found in strata belonging to the Cretaceous formation, by far the majority are remains of Dicotyledons, and included within all three sections, of Apetalæ, Gamopetalæ, and Polypetalæ; and as far as reliance can be placed on characters derived from the foliage alone, a large number belong to genera widely distributed at the present time. The Lower Lignitic flora, on the contrary, belonging to Tertiary times, presents far less resemblance to that at present prevailing in the northern part of North America, but is of a much more southern type.

A BELGIAN practitioner has published a work on the "Maladies which are special to Mystics," the purport of which is to show that Louise Lateau and other persons of the same description might be really total abstainers from food for a lengthened period. The *Revue Scientifique* announces that the Belgian Society of Medicine has ordered that work to be published in its *Comptes Rendus*. M. Charbonnier, the author, advocates the theory that people may subsist without food because the nitrogen from the air can be admitted into the circulatory system, when the body has been emaciated by long abstinence. Feeding on air is an economical way of keeping soul and body together.

AT the opening of the Belfast Natural History and Philosophical Society, the president, Prof. Hodges, delivered an address, in which he reviewed the industrial progress of the North of Ireland. The address was fully reported in the *Northern Whig* of Nov. 11, and has since been separately reprinted.

WE have received the programme of the Cambridge Higher Local Examinations for 1876, for all who have completed the age of eighteen years before January next. The examinations are for both men and women, and the successful candidates are divided into two groups, those who obtain honours and those who do not. The subjects of examination are divided into six groups, one of which includes botany, geology, zoology, and chemistry. The programme seems to us carefully drawn up; an excellent selection of text-books is given.

PROF. NORDENSKJÖLD ON THE JENISEI

THE following extract from a letter from Prof. Nordenskjöld to Mr. Oscar Dickson, dated Tomsk, Oct. 13, appears in the *Göteborgs Handels Tidning*. It describes his exploration of the river Jenisei after the departure of the *Pröven* on its homeward journey. Nordenskjöld, Lundström, and Stuxberg left the mouth of the Jenisei on August 19, in a boat built for the purpose, and well provisioned and equipped:—

"The course was taken along the shore within the multitude of low bare rocky islands which bound the mouth of the Bay of Jenisei on the north, and are named in the Russian maps, Severo-Wostotschnoi Ostrow (North-east Islands). The sounds between these islands were thought to be sufficiently deep even for large vessels, though perhaps a little fouled by rocky ground. With a favourable wind and smooth water we sailed without any considerable rest in forty-two hours without a break to Cape Schaitanskoj, arriving there the night before the 21st, thoroughly drenched and worn out with our long watch. During this time we landed only at two places, the first time at a point within Jewremow Kamen, the last rocky promontory which occurs on the eastern bank of Jenisei for a distance of 100 Swedish (upwards of 600 English) miles.

"Jewremow Kamen itself consists only of a peculiarly formed dolerite rock fifty or sixty feet high. At the bank were still collected, but for the last time during our passage up the Jenesei, true marine animals; an Appendicularia, Clio, large Beroïdæ, various Medusæ, &c. By a land excursion here we

had already obtained a Harpalus, two species Staphylini, a number of Acaridæ and Poduridæ, a species of dew-worm,* &c., and as at the *Präven's* anchorage, the vegetation has a stamp deviating very much from the flora of Novaya Zemlya. Large bush plants, even the dwarf birch, were completely absent, and the ground was in no case covered with a true mat of grass.

"The other place where we landed for a little was Krestowskoje, a now deserted *simowie* (a place inhabited both summer and winter), which, however, to judge by the number of the houses and the way in which they were fitted up, must once have had its flourishing period. All household articles were removed, and literally there was not to be found an iron nail in the wall; a proof that the inhabitants had not died out, but migrated. The vegetation in the neighbourhood of the huts was extraordinarily luxuriant, the grass and plants forming a real obstacle in walking, certainly occasioned by the quantity of fertilising animal matter which had been collected here during the time when fishing and hunting were carried on.

"The surface temperature of the water was, on our arrival at the mouth of the Jenisei + 7·8° C., but sank during the storm of the following days to + 1·5° C. At Jewremow Kamen it was + 2·5° C., but rose afterwards in the neighbourhood of Krestowskoje to + 11° C., a temperature which it afterwards retained during the whole of our journey. The water was brown in colour, but was often at the sides coloured by clayey streams.

"A little south of Jewremow Kamen the eastern side of the Jenisei is occupied by sand-banks twenty to thirty feet high, and sloping steeply towards the river. At the river bank the tundra commences, an endless, inconsiderably undulating plain, full of low marshes and small shallow pools of water, and overgrown with a sparse vegetation, whose flowering time was now almost completely over. Instead we found at our first night quarters (Cape Schaitanskoj) great quantities of ripe cloud-berries, the taste of which, excellent in itself, was on this occasion heightened by the circumstance that they were for us the first fruit of summer. The red whortleberry (*Lingon*) and the cranberry (*Odon*) were also found here, if in small quantity. Cape Schaitanskoj was the most northerly point on the Jenisei, where we found the dwarf birch; and the same place, by Dr. Stuxberg's discovery of a species of *Physa*, becomes the *most northerly locality for land and fresh-water mollusca.*

"After having rested at Cape Schaitanskoj we sailed on with a favourable wind to Sopotschnaja Korga, where the hard wind and a shallow lying off it, the extent of which it was impossible to distinguish during the dusk of the evening, compelled us to lie to earlier than we otherwise intended.

"Sopotschnaja Korga (the toe of the boot) forms a low promontory projecting far out into the Jenisei, which, as numerous ruins of houses show, was formerly inhabited, but is now deserted.

"A great part of the promontory was occupied by heaps of drift-wood, large stems, with branches and roots broken off, thrown up over each other in an endless chaos, it being possible to go forward between them only with difficulty and care. The trees that lie nearest the water are quite fresh and in good condition. Other tree stems lying farther from the bank and cast up there a century or centuries ago, are in all possible intermediate states from fresh to completely decayed wood. Between the stems there frequently occur deep holes filled with black stinking water. Heaps of drift-wood like those at this place, though perhaps somewhat smaller, are found almost everywhere farther down towards the mouth of the river, but higher up there occur only scattered pieces of drift-wood, and at some places these are entirely wanting. The point was, besides, bestrewn with a number of other fresh-water ponds, more or less grown up with water mosses, and full of sticklebacks, Branchiopoda, and other fresh-water Crustacea, and giving the botanist an opportunity of collecting various grasses and water-plants not found farther north (*Carex chondrorhiza*, *Hippuris vulgaris*, *Juncus castaneus*, &c.) Higher up, on drier places, the ground was sparingly covered with *Empetrum nigrum* and *Andromeda tetragona*, and on the steep slopes with which the ground terminates towards the promontory, there is a luxuriant vegetation a couple of feet high, consisting of grass and other plants. The locality was, on the contrary, extremely poor, as well in Mammalia and birds as in insects, and even the holes and paths of the lemming, by which the land on the coast of Novaya Zemlya is crossed in all directions, are found here only in limited number.

* Its occurrence is remarkable on this account, that the ground here, with the exception of an inconsiderable stratum which thaws in summer, is constantly frozen all the year round.

"We sailed on until we finally succeeded in finding a convenient landing-place in the neighbourhood of a little river, Mesenkin, which there falls into the Jenisei on its right bank." Here they obtained a Cossack, Feodor, as guide. While waiting for the guide, the party employed themselves "in examining the natural history of the locality, in making solar observations to determine the position of the place, &c. It appeared by these that our resting-place was situated only about four Swedish (over twenty-four English) miles south of our former landing-place. Mesenkin's low river valley is, however, much better protected from the winds of the polar sea than the low promontory at Sopotschnaja, and the influence of this was plainly recognisable by its much richer vegetation.

"What first meets the eye on landing is a thicket of dark green bushes about four feet high, which are found to consist of alder (*Alnus fruticosa*). Between the alder-bushes, and protected by them, our botanist found a number of well-grown plants—Sanguisorba, Galium, Delphinium, Hedysarum, Veratrum, &c. The Salix bushes were also higher here than at former places, the mat of grass more abundant, and the slopes of the sandhills in the interior of the country were adorned with a number of new types—Alyssum, Dianthus, Oxytropis, Saxifraga, Thymus, &c.

"As has been mentioned in a former letter, we found at the part of Jalmal visited by us neither small stones nor sub-fossil shells in the fine sand. East of the mouth of the Jenisei the sand is coarser, and contains both sub-fossil shells and large and small stones. The sub-fossil shells, according to information given to me at Dudinka, occur in some places in so large masses that they form true shell banks. At the places visited by us the shells were found not in proper layers, but only scattered through the sand. Immediately at the first glance it appeared that the shells collected by us here belonged in preponderating number to species with which we had become acquainted in the living state during our dredging in the seas of Kara and Obi-Jenisei.

"A sample of the stones which occur in the sandy strata of the tundra was always found at the river bank where we lay, when the lighter particles of sand were washed away, and many important contributions towards a knowledge of the way in which the tundra is formed, and of the nature of the rocks which afforded material for the masses of sand here collected together, were to be obtained. No erratic blocks comparable in size to the erratic blocks in our country occur here, a circumstance which I regard as a proof that the sandy strata of the tundra, at least in these regions, are not of glacial origin. I ought, however, to remark that on a small stone here and there there could be observed striæ and scratches completely resembling those found on moraine blocks. But in such cases these scratches have clearly been formed either by the sliding of the earthy stratum or by the action of the river ice.

"In the northern part of the tundra I could never discover among the stones washed out from the sand any blocks of granite or gneiss, but they consisted for the most part of different kinds of basalt with numerous cavities containing lime and zeolites. Besides there occurred, especially at Cape Schaitanskoj, in not inconsiderable number, blocks of marl and sandstone, containing fossils partly of marine origin, partly containing rolled tree stems, more or less carbonised or petrified. Pieces of brown and pit coal were also found here in not inconsiderable number.

"On Aug. 26, early in the morning, our guide joined us, accompanied by five other Russians settled in that region. . . . After having talked for some time with our friendly guests, who were exceedingly interested in our expedition, we continued our journey, during which we had splendid calm weather, to Cape Gostinoi, where we took our midday rest.

"After resting a little at midday at this place, we sailed on, and came after various wanderings in dusk and mist during the night before Aug. 27, to land at a low promontory, at the mouth of the river Jakowiewa.

"Our next resting-place was a specially attractive fishing station at a small sound between the Briochowski Islands, the most northerly of the labyrinth of islands which occupy the channel of the Jenisei between 69½° and 70⅓°.

"On Aug. 28 we rowed on between a number of islands covered with a luxuriant vegetation, and commonly terminating towards the river with a steep slope, down which large masses of peat tumbled here and there. At such places we could see that the island originally consisted of a sand-bank cast up by the river, which in the length of time was covered first with masses of drift-wood, and afterwards with a luxurious vegetation which gradually gave origin to a thick stratum of peat, of which the

part of the island above the surface of the water is mostly formed.

"Towards evening we lay to at the Nikandrow Islands in the neighbourhood of a fishing-station still inhabited. Jenisei is renowned for its richness in large eatable fish-species. . . . I hope some months after our return home to be able to exhibit to those among us who are interested in fishing, specimens of most of the varieties of fish occurring here. During our sailing up the river between Dudinka and Jeniseisk, I caused specimens of all the species of fish which we could procure from the river to be carefully deposited in a cask filled with spirit. This collection will be sent to Stockholm *viâ* St. Petersburg, by a merchant settled in Jeniseisk.

"Like most of the settlers on the lower course of the Jenisei, the inhabitants at Nikandvow fishing-station kept a number of dogs which are believed to be of the same race as the dogs used on Greenland, for draught. The dogs are employed in summer to tow boats up the river, and in winter for all sorts of carriages. Yet the dog, for reasons stated in the introduction to Middendorff's 'Sibirische Reise,' is considered quite unfit for long journeys over uninhabited tracts, if several hunting or fishing stations are not to be met with in the course of the journey. In such cases reindeer are always employed.

"Early next day we sailed, or more correctly, rowed on, the weather being calm and beautiful. We rested at midday in the neighbourhood of a now deserted *simovie* on the southern part of Sopotschnoi Island. Hence we continued our journey first to Cape Maksuninskoj, where we visited a Samoyede family that had set up their skin tent here in order to collect the necessary stock of fish for winter; afterwards to Tolstoj Nos, a still inhabited, well-built *simovie*, where the people living there received us in a very friendly way, and received the account of our journey with great interest and astonishment."

From here the party made haste to catch the last steamer at Saostrowoskoj, in the neighbourhood of Dudinka, which they did on Aug. 31.

"We were yet far north of the Arctic circle, and as many imagine that the region we had now passed through, the so little-known tundra of Siberia, is a desert waste, either covered by ice and snow or by an exceedingly scanty moss vegetation, it is perhaps the place here to declare that this by no means is the case. On the contrary, we saw, during our passage up the Jenisei, snow only at one place, a deep valley cleft of some fathoms' extent, and the vegetation, especially on the islands which are overflowed during the spring floods, was remarkable for a luxuriance to which I had seldom before seen anything corresponding.

"The fertility of the soil and the immeasurable extent of the meadow land and the richness of the grass upon it had already called forth from one of our hunters, a middle-aged man, who is owner of a little patch of ground between the fells in Northern Norway, a cry of envy of the splendid land our Lord had given 'the Russian,' and of astonishment that no creature pastured, no scythe mowed the grass. Daily and hourly we heard the same cry repeated, though in yet louder tones, when we some weeks after came to the lofty old forests between Jeniseisk and Turuchansk, or to the nearly uninhabited plains on the other side of Krasnojarsk, covered with deep *tschornosem* (black earth)—in fertility certainly comparable to the best parts of Scania, in extent exceeding the whole of the Scandinavian peninsula. This direct expression of opinion by a veritable if unlearned agriculturist may perhaps not be without its interest in judging of the future of Siberia.

"During this very summer three separate Russian expeditions have travelled through Siberia with the view of ascertaining the possibility of improving the river communication within the country. These expeditions have, according to unofficial communications made to me in Jeniseisk, come to the conclusion that it is possible for a sum of 700,000 roubles to make the Angara (a tributary of the Jenisei) navigable to Lake Baikal, and to connect the Obi with the Jenisei and the Jenisei with the Lena. How great an extent of territory the proposed river communication will embrace is best seen by considering that the territory drained by the Obi-Irtisch and the Jenisei alone is of greater extent, according to Von Baer's calculation, than the river areas of all the rivers (the Danube, Don, Dnieper, Dniester, Nile, Po, Ebro, Rhone, &c.), which fall into the Black Sea, the Sea of Marmora, and the Mediterranean. Part of this territory indeed lies north of the Arctic circle, but here too are found the most extensive and finest forests of the globe; south of the forest region proper there stretch out territories, several hundred leagues in extent, level, free of stones, covered with the most fertile soil, which only wait for the plough of the cultivator to yield the most abundant harvests; and farther to the south the Jenisei and its tributaries run through regions where the grape ripens on the bare ground: just now, as I write this, I have before me a bunch of the finest Siberian grapes. May the future show that sea communication between these lands and Europe has now been fairly inaugurated.

"A. E. NORDENSKJÖLD."

SCIENTIFIC SERIALS

Der Naturforscher, October 1875.—In this number is given an observation by M. Coulier, that while a cloud was formed in a vessel containing a little water, when an attached caoutchouc balloon was first compressed, then allowed to expand, no cloud was thus produced if the vessel had stood some time at rest, or if the air had been filtered; and the author's view was confirmed that small particles in the air were what caused the formation. M. Mascart has found that strongly ozonised air is not robbed of its cloud-forming action by filtering.—There are two valuable papers in meteorology, one by M. Hann, on the variability of daily temperature, and another in which M. Kerner offers an explanation of the fact that there is, in the Swiss valleys, in late autumn and winter, a middle warm region limited both below and above by a colder.—In physiology we note some interesting researches by M. Bernstein as to what is the highest pitch of tone a muscle may be made to give by electric stimulation. Above 418 vibrations per second of the spring contact, the muscle tone (the same as that of the spring) was distinct, though weaker; at 1,056 vibrations no distinct tone was observed, only a noise. But if the *nerve* were stimulated to the latter degree the muscle gave a tone, not indeed the same as the spring, but a fifth, sometimes an octave, lower. The upper limit beyond which the muscle ceased to give the same tone with the spring (in this arrangement) seemed to be about 933 vibrations. Under chemical stimulus of a nerve, the connected muscle gave a tone like that in natural contraction.—There is also a suggestive paper by M. Delbœuf on the theory of sensation, and M. Hirschberg describes observations on a boy who acquired sight at seven years of age; they favour, he considers, the empiristic theory of sight-perceptions.—In a paper on the origin of the deep-water fauna of the Lake of Geneva, M. Forel thinks the entire fauna of the Swiss lakes are descended from forms which have migrated (up the rivers) since the melting of the glaciers, and have afterwards been differentiated.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, Oct. 1.—Dr. Wild, Director of St. Petersburg Observatory, relates the circumstances which led to the Imperial assent being given in June last to the scheme for the establishment at Pawlowsk, distant about an hour by railway from St. Petersburg, of an observatory to be affiliated to the central institution for terrestrial physics over which he presides. The Central Observatory was built twenty-six years ago in an open and quiet space outside the capital. Houses and streets have, however, rapidly been constructed around it, masses of iron are in proximity, and noise and smoke disturb physical measurements, magnetic and meteorological observations. Herr Wild knew that there were serious objections to the removal of the whole establishment into the country, as has been done at Vienna, and determined to recommend a separation into two divisions, one observing and the other administrative, in imitation of the London Meteorological Office and Kew Observatory, the relations to the public of the Russian being similar to those of the English Meteorological Department. On his making this proposal at the Academy of Sciences last autumn, Prince Nicolajewitsch generously presented for the purposes of the new observatory a large piece of ground in his park at Pawlowsk. There will be no reduction in the estimate for the Central Observatory, in order that local observations may be continued, and the accumulated records of former years worked out.—Dr. Hellmann contributes a paper on the physical conditions of the higher atmospheric strata, in which he discusses the observations made in May 1872 by the U.S. War Department at the summit (1,915 metres high), and at the base of Mount Washington, New Hampshire. It appears among other results that the mean difference of temperature for 100 metres of ascent between the hours of 6 A.M. and 6 P.M. and 9 P.M. and 12 P.M. at night was ·69° C., and that the difference between 4 and 5 P.M. was ·83 and at 6 A.M. only ·48° C.; that in 17·4 cases per cent. the wind at the top was the same in

direction as that below ; and that the diminution of temperature with increasing height was greater in clear than in cloudy weather. This last result is in agreement with that of Herr Hann, derived from observations taken at Praya West and Victoria Peak.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Nov. 19.—"On some Elementary Principles in Animal Mechanics. No. VII. The Law of Fatigue." By the Rev. Samuel Haughton, M.D. (Dubl.), D.C.L. (Oxon), F.R.S., Fellow of Trinity College, Dublin.

The approximate law of muscular action, which I have called the law of fatigue, is thus expressed :—"*When the same muscle (or groups of muscles) is kept in constant action until fatigue sets in, the total work done multiplying by the rate of work done is constant.*"

The following experiments, in illustration of this law, were performed in Trinity College during the spring of the present year.

I instructed a number of medical students, chosen at random, to raise dumbbells of varying weight, one in each hand, in the transverse plane, with hands supinated, raising and lowering the weights in equal times regulated by the beat of a pendulum. This process was continued until the distress of the fatigue produced became intolerable, and the number of times each weight was lifted was noted. The students were required to count "one-two," in time to the beat of the pendulum, so as to prevent them from counting the total number of lifts of the weight. Prof. Macalister assisted me in these experiments ; and one of us counted the number of lifts, while the other compelled the experimenters to observe the conditions of the experiment, which were :—

1. To keep time with the pendulum.
2. To raise the weight in the transverse plane.
3. To supinate the hands.
4. To abstain from all bending of the knees or spinal column.

For each experiment I chose twenty students at random, using altogether about fifty different students ; and no individual was experimented upon again, until an interval of forty-eight hours had elapsed. The object of this arrangement was to avoid the effects of "training." In my first Table I give the mean result of twenty different students ; and in my second Table I have selected one student, set aside for the purpose, and experimented upon, once a week, so as to prevent the influence of "training."

Let W denote the total work done, and T the time of doing it ; then, by the law of fatigue,

$$\frac{W^2}{T} = \text{constant} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

If w be the weight held in the hand, and α be half the weight of the arm, and n the number of times the weights are lifted ; since the time of raising and lowering the arms is constant, n is proportional to T, and the law of fatigue gives the formula

$$(w + \alpha)^2 n = A \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where A is an unknown constant. In the following Table I give the values of w and the mean value of n for twenty distinct persons. The time of lift is in all cases *one second*.

TABLE I.—*Mean of Twenty Experiments.*

No.	w.	n (obs.)	n (calc.)	Diff.
	lbs.			
1.	2·56	131·80	128·0	+3·8
2.	4·25	87·55	78·3	+9·2
3.	5·87	47·35	53·5	−6·2
4.	6·87	40·25	43·7	−3·5
5.	7·75	34·60	37·1	−2·5
6.	9·75	27·15	26·8	+0·3
7.	14·00	17·20	15·4	+1·8

The column containing the calculated values of n was obtained from equation (2) by using the values

$$\alpha = 3{\cdot}50 \text{ lbs.}$$
$$A = 4699.$$

These values were obtained by finding the value of α, which renders A most nearly a constant, or

$$\frac{\delta A}{A} = \text{minimum.}$$

This Table gives 7 lbs. for the mean weight of the arm of all experimented on, a result which accords with the known facts.

In Table II. I give the results obtained from a single student, as already described, each value of n being a mean of several experiments, closely concurrent.

TABLE II.—*Mr. Samuel Warren.*

No.	w.	n (obs.)	n (calc.)	Diff.
	lbs.			
1.	2·56	140·0	137·5	+2·5
2.	4·25	91·0	86·4	+4·6
3.	5·87	63·0	60·1	+2·9
4.	6·87	43·0	49·0	−6·0
5.	7·75	40·0	42·5	−2·5
6.	9·75	32·0	31·0	+1·0
7.	14·00	18·5	17·9	+0·6

The calculated values of n were found from equation (2), using the values

$$\alpha = 3{\cdot}9 \text{ lbs.}$$
$$A = 5737,$$

which were obtained from the principle of least variation of A, or

$$\frac{\delta A}{A} = \text{minimum.}$$

In the accompanying diagrams I. and II., I have plotted the cubical hyperbola represented by equation (2) ; and also the several observations which lie sufficiently near the curve to justify me in considering the law of fatigue to be a first approximation to one of the fundamental laws of muscular action. I have elsewhere * shown that the law of fatigue corresponds with other experiments based on different data.

If we consider the *useful work* only, we have from equation (2),

$$\text{useful work} = wn = \frac{A\,w}{(w + \alpha)^2} \quad . \quad . \quad . \quad . \quad (3)$$

This equation represents a cuspidal cubic, whose ordinate has a maximum value, when $w = \alpha$ = half the weight of the arm.

The foregoing observations are in accordance with this deduction, as may be seen from Table III.

TABLE III.—*Useful Work.*

No.	w.	wn (20 experiments).	wn (Mr. Warren).
	lbs.		
1.	2·56	338	358
2.	4·25	372	387
3.	5·87	277	370
4.	6·87	276	295
5.	7·75	268	310
6.	9·75	264	312
7.	14·00	241	250

It is to be observed, that in the foregoing experiments the muscles in action were not allowed to *rest* during the whole time of work.

Linnean Society, Nov. 18.—Dr. G. J. Allman, F.R.S., president, in the chair.—The following paper was read :—On the organisation and systematic position of the Ornithosauria, Part i., by Prof. H. G. Seeley, F.L.S. The different results obtained by investigators who have written upon Pterodactyles, led the author to propose a method of research in Comparative Anatomy by which the true nature of these animals could be determined. It consists chiefly in an attempt to distinguish between the characters which make animals members of a class of Vertebrata, and the characters which make those animals members of vertebrate ordinal groups. The class characters were regarded as furnished by the soft vital organs, while the ordinal characters are derived from the skeleton. This was illustrated by an argument tending to show that since the form of brain,

* "Principles of Animal Mechanics" (London, 1873).

and the peculiar respiratory organs of birds, are class characters, any animal would be a member of the class Aves which possessed them; and since the form of skull, of vertebræ, of the carpus and tarsus are ordinal characters in the existing sub-class of birds, they will not necessarily be found in an extinct sub-class or order of Aves. He then showed that Pterodactyles have the brain identical with the bird's brain in every detail; and the pneumatic perforations of the bones for the prolongation of air-cells from the lungs into the bones were identical in both types and are found in no other group of animals. Hence it was concluded that, judged by class characters, Ornithosaurs must be placed in the class Aves. The author then gave an analysis of the characters of the Ornithosaurian skeleton. In the skull, he thought that the bone hitherto named post-frontal is the quadrato-jugal, and that although the malar bone meets the quadrate bone, there are no reptilian features in the skull, and nothing which is inconsistent with the Avian organisation. The vertebral column is the most reptilian part of the skeleton in being procœlous, but the fore limb was shown to be constructed on the Avian plan; the carpus being nearly identical in both groups; while the elongated finger for flight was proved by its carpal articulation to be the index finger as in birds; and in one Pterodactyle it contained two phalanges, as in birds. The petagial membranes of the Pterodactyle were also shown to be extensions of the similar membranes of birds. The characters of the pelvis and hind limb were less unlike those of a bird than had been supposed, the tibia terminating distally in a trochlear end formed as in birds by the anchylosed proximal tarsal bone. From the whole skeleton (excluding the evidence of the cerebral and respiratory characters) the author concluded that it is impossible on morphological grounds to exclude the Ornithosauria from the Avian class, and that their resemblances to reptiles are not more important than their resemblances to mammals.

Geological Society, Nov. 17.—Mr. John Evans, V.P.R.S., president, in the chair.—Mr. Robert Elliott Cooper, C.E., 1, Westminster Chambers, Victoria Street, S.W.; Mr. George Fowler, Assoc. Inst. C.E., Basford Hall, Nottinghamshire; and Mr. William Frecheville, Assoc. Royal School of Mines, 51, Scarsdale Villas, Kensington, W., were elected Fellows of the Society.—On a new modification of Dinosaurian Vertebræ, by Prof. Richard Owen, F.R.S. The peculiar modification of the Dinosaurian vertebra noticed by the author occurs in *Tapinocephalus Atherstonii* and *Pareiosaurus bombidens*. In the dorsal vertebræ of the former the centra are nearly flat on both fore and hind surfaces, a structure to express which the author proposes the term "amphiplatyan." The hind surface is very slightly the more concave. The middle of each surface is pierced by a small foramen leading into a cylindrical canal, first slightly expanding and then rapidly contracting to a point, which meets the apex of the similar hollow cone coming from the opposite surface. Similar characters were observed upon the free surface of the anterior sacral and upon that of the posterior of four anchylosed sacrals. The dorso-lumbar vertebræ of the *Pareiosaurus* had centra relatively longer than those of *Tapinocephalus*. Their articular surface is subundulate, convex along a fourth of the periphery, concave at the centre, where there is an excavation corresponding to that in *Tapinocephalus*, but a relatively wider aperture, a rather more constricted canal, a shorter terminal cone, and an interval of osseous tissue separating the apices of the cones from the fore and hind surfaces. In what is probably the first cervical vertebra of the same Dinosaur, the centrum is so concave on both surfaces as to become amphicœlian. In these unossified tracts of the middle of the centrum in the two genera above mentioned the author sees indications of a persistent trace of the primitive "chorda dorsalis;" and he calls attention to the resemblance thus set up between these probably Triassic Dinosaurs and the lower Ganocephalous reptiles of the Carboniferous series, in which, however, the vertebral centra are more widely perforated.—On the presence of the Forest-bed Series at Kessingland and Pakefield, Suffolk, and its position beneath the Chillesford Clay, by Mr. John Gunn. In this paper the author described a section from the cliff at Kessingland and Pakefield, from the examination of which he arrived at the conclusion that the Forest-bed series underlies the Chillesford Clay and sands. At the foot of the cliff there is an estuarine deposit forming the soil of the Forest-bed, consisting of blue clay and gravel, the "Elephant-bed" of the author's former paper. Above this is the Forest-bed, cotaining large stools and stems of trees, but no fossil bones. This is followed by a fresh-water deposit, consisting of black soil with fresh-water shells, corresponding to a similar bed at Mundesley and Runton known as the "*Unio*-bed," and including the "Rootlet-bed" of oozy clay, regarded by Mr. Prestwich as an indication of the forest. The author considers the supposed rootlets to represent brushwood which succeeded the true forest. Above this come Fluvio-marine deposits, in which Cragshells occur, although but rarely. To this division the author was inclined to refer the Norwich Crag, which at Bramerton underlies the next division, regarded by the author as the Chillesford Clays and Sands. Of the overlying deposits the first is supposed to be the "Pebbly-bed" by the author; it has been regarded as Middle Drift, and the uppermost is Upper Boulder-clay. The paper was illustrated by the exhibition of a fine series of bones, chiefly Cervine, from the lowest deposit noticed by the author.

Physical Society, Nov. 27.—Prof. G. C. Foster, F.R.S., vice-president, in the chair.—The following candidates were elected members of the Society:—Prof. Osborne Reynolds, M.A., Prof. H. J. Smith, M.A., LL.D., Prof. R. B. Clifton, M.A., F.R.S., C. Busk, J. Thomson, J. W. W. Waghorn, W. Esson, M.A., F.R.S., F. W. Bayly, and Prof. R. W. Emerson Mac Ivor.—Prof. Guthrie briefly described Dr. Kerr's recent experiments to show that glass, resin, and certain other substances exhibit a depolarising effect when under the influence of powerful electrical tension, and he exhibited the arrangement of apparatus employed in the research. He also showed certain experiments connected with the investigation.—Dr. Guthrie then made a communication on "Stationary Liquid Waves," in continuation of that which he made to the Society in June last. If water in a cylindrical vessel not less than 9 inches in diameter be agitated by depressing and elevating a flat circular disc on its surface at the centre, a form of oscillation is set up which the author terms "binodal." He finds that these fundamental undulations in an infinitely deep circular vessel are isochronous with those of a pendulum whose length is equal to the radius of the vessel, and further, a fact which is extremely interesting, that the motions of the pendulum and water keep together throughout their entire paths. An arrangement was exhibited for experimentally demonstrating these facts. To the upper end of a short pendulum with a heavy adjustable bob is attached a cardboard sector in the plane of vibration of the pendulum. A silk thread, attached to the edge of this sector, carries a small paraffin disc which rests at the centre of the surface of the water contained in a cylindrical vessel. The pendulum-length is adjusted until the motion of the disc is isochronous with that of the water when the two are not in contact. Two other forms of motion may be produced in cylindrical vessels, namely (1), by alternately compressing and extending opposite ends of a diameter as in the motion of a bell—this gives two diametral nodes at right angles to each other; and (2), by rocking the vessel, which gives a single diametral node. Each of these has its own period of vibration, the last being the slowest. They may be superimposed on each other, and a rotation of the water, however great, does not interfere with their formation. In rectangular troughs a binodal and a mononodal wave system may be established. The former is induced by raising and depressing a wooden lath at the middle of the surface, and the latter by tilting. Binodal vibration in a circular trough may be compared with a vibrating pair of triangular laths, and in rectangular troughs to the balancing of two rectangular laths. In this latter case the nodes are at $\frac{1}{4}$ of the trough length from each end. Some discrepancies are met with when we compare times of vibration in rectangular troughs of various lengths, and these are due to a scraping action which takes place against the ends of the vessel. The result of the experiments on binodal motion in rectangular vessels is to show that the undulations are isochronous with the oscillations of a pendulum whose length is $\frac{2}{\pi}$ times that of the trough. The chief points in connection with this subject to which the author referred as still requiring explanation, are: (1) Why are the motions pendular? (2) How is it that in circular binodal motion the times are identical with that of a pendulum of the given length? and (3) What is the mathematical connection between the individual motion of each particle and that of the mass? Mr. Lodge thought that valuable results might be obtained by treating the mass of moving water as a pendulum with two bobs oscillating about the node. This might be specially useful with small oscillations, when the surface is practically plane.

Anthropological Institute, Nov. 23.—Colonel A. Lane Fox, F.S.A., President, in the chair. The President read a full

report, prepared by himself, on the excavations lately made by the Exploration Committee of the Anthropological Institute in Cissbury Camp, near Worthing, Sussex, and illustrated it by a series of diagrams and models and a large collection of flint implements, flakes, &c. The animal remains found in the excavations, including the skeleton of a woman, were exhibited and described by Professor Rolleston, F.R.S.

Institution of Civil Engineers, Nov. 23.—Mr. Thos. E. Harrison, the president, in the chair. The paper read was On experiments on the movement of air in pneumatic tubes, by M. Charles Bontemps, Engineer in the French postal service.

EDINBURGH

Scottish Meteorological Society, Nov. 15.—At a meeting of the council of this society there was read a correspondence between Mr. Archibald Young, Fishery Commissioner, and Mr. T. Stevenson, the honorary secretary, regarding an investigation into the habits of the salmon.—Besides other elaborate investigations of a national character which the society has at different times undertaken, an inquiry, suggested by the president, the Marquis of Tweeddale, into the meteorological conditions which are supposed to affect the migrations of the herring, is being carried out by Mr. Buchan. For this purpose the temperature of the sea is observed at different parts of the coast; and stations where maximum and minimum thermometers are constantly immersed have been established. The investigation into the habits of fishes is now to be further extended to those of the salmon. For some years back observations have been made by Mr. Paulin on the depth and temperature of the water and the takes of fish in the Tweed, and these are being discussed by Mr. Paulin and Mr. Buchan. Observations were also made for some years on the temperature of the Doon in Ayrshire. But the inquiry suggested by Mr. Young has more especial reference to the question of the earliness or lateness of the different rivers, which among other causes may be found to be due to the temperature of the fresh water as compared with that of the salt water into which the rivers discharge. It is hoped that by means of this investigation the causes which produce late and early rivers may be elicited, and the best times for closing and opening different rivers for fishing may be more satisfactorily determined than at present. On the suggestion of Mr. Young, different late and early rivers have been selected for observation, and the necessary arrangements for carrying these on are being established, and those connected with the river Ugie, in Aberdeenshire, are now completed, and the observations will be commenced immediately. At Peterhead the Harbour Commissioners have on the suggestion of Mr. Stevenson established a station for thermometers under continuous immersion, which has for some years been superintended by Mr. Boyd, who is a member of the Committee, and who has kindly undertaken, in connection with the sea-temperatures at Peterhead, to ascertain those of the fresh waters of the Ugie.

DUBLIN

Royal Irish Academy, Nov. 8.—Dr. Stokes, F.R.S., president, in the chair.—Dr. S. Ferguson, V.P., read a paper On the alleged literary forgery respecting Sun-worship on Mount Callan.—The Secretary read a paper by Dr. Doberck, On the binary stars, 44 Böotis, ζ Cassiopeiæ, and μ Draconis (this paper will appear in an early number of the "Transactions.")—Dr. Macalister read Notes on anomalies in the course and distribution of nerves in man. The following parts of vol. xxv. of "Transactions" were laid on the table:—Part 16, Researches on the Structure of the Spines of the Diadematidæ, by H. W. Mackintosh plates 31* to 33; part 17, on Nine-point Contact of Cubic Curves, by Dr. Hart; part 18, Experiments on the Movements of Water in Plants (part ii.), by Prof. M'Nab, M.D.; part 19, on the Binary Stars σ Coronæ, τ Ophiuchi, γ Leonis, ζ Aquarii, 36 Andromedæ, and ι Leonis, by Dr. Doberck; part 20, Report on the Superinduced Divisional Structure of Rocks called Jointing, and its Relation to Slaty Cleavage, by Dr. W. King (plates 34 to 38); this part concludes vol. xxv., and is accompanied by a title-page and table of contents; also the July and October parts of the "Proceedings."

PARIS

Academy of Sciences, Nov. 22.—M. Frémy in the chair.—The following papers were read:—Thermal researches on citric acid, by MM. Berthelot and Longuinine.—Remarks on the interpretation of two tables of chemical analyses, by M. Duchartre. This refers to treatment of beet.—On the periodicity of great movements of the atmosphere, by M. Sainte-Claire Deville. From two years' observations he shows a quadruple, dodecuple, and tridodecuple period in recurrence of barometric maxima and minima in the year.—Continued observations of eclipses of the satellites of Jupiter, made at the Observatory of Toulouse, by M. Tisserand.—New observations on the law of expansion in steam-engines, by M. Ledieu.—Remarks on the Balænides of the Japan seas, *àpropos* of the cranium of a Cetacean of this group sent to the Museum by the Japanese Government, by M. Gervais.—M. Pierre exhibited a specimen of fibres of remarkable length and tenacity, obtained by setting a stem of *Lavatera*.—On the mechanism and the causes of changes of colour in the chameleon, by M. Bert. There are two sets of nerves, the one bringing the coloured corpuscles out to the surface (and comparable to vaso-constrictor nerves), the other bringing them under the dermis (corresponding to the vaso-dilator nerves). Each cerebral hemisphere commands nerves on both sides of the body, and is generally excited through the eye on the other side; but it acts chiefly on nerves of the vaso-constrictor type on its own side, and the other kind on the opposite side. Blue violet rays act directly on the corpuscles, bringing them to the surface.—Granitic diluvium in the neighbourhood of Paris; Lithology of the sands of Beynes and St. Cloud, by M. Salvetat.—On the electrolysis of bodies of the aromatic series, by M. Goppelsroeder.—On the fixation of atmospheric nitrogen in soils, by M. Truchot.—Water of the Vanne, and distilled water; examination of the salt of brine, by M. Monier.—On the construction of lightning conductors, by M. Saint-Edme.—On the formation, structure, and decomposition of the swellings produced on the vine by Phylloxera, by M. Max. Cornu.—Observations on the planet Jupiter (continued), by M. Flammarion.—New examples of representation, by geometrical figures, of the analytical conceptions of geometry of n dimensions, by Mr. Spottiswoode.—On employment of marine chronometers in the German navy, by M. Peters.—On coordinated surfaces, such that at every point considered as centre of a sphere of constant radius, the normals to the surfaces, form in this sphere the apices of a spherical triangle of constant area, by M. Aoust.—On the numbers of Bernouilli, by M. Le Paise.—On a reaction of the homologues of ethylene, which may explain their absence in the natural petroleums, by M. Le Bel.—Remarks *àpropos* of the discovery of gallium, by M. Mendeleef. In accordance with a law he enunciated in 1869, he thinks the new metal may be ekaaluminium.—On the saccharification of amylaceous matters, by M. Bondonneau.—On stripping off the leaves of the beet, by M. Violette.—Troïlite; its true mineralogical and chemical place, by Mr. Lawrence Smith.—On certain alterations of agates and silex, by M. Friedel—On explosive compounds; influence of the fuse on compressed gun-cotton, by MM. Champion and Pellet.—Researches on the functions of the spleen, by MM. Malassez and Picard. The increase of globular richness in the blood of splenic tissue is not due to concentration of blood, for the quantity of iron diminishes.—On the ichthyologic fauna of the Isle of Saint Paul, by M. Sauvage.—Examination of rain-water in the udometers of Paris Observatory, Oct. 14 to Nov. 15, 1875, by M. Gerardin.—On the action of monohydrated and trihydrated phosphoric acid on coagulation of blood, by M. Oré.

CONTENTS