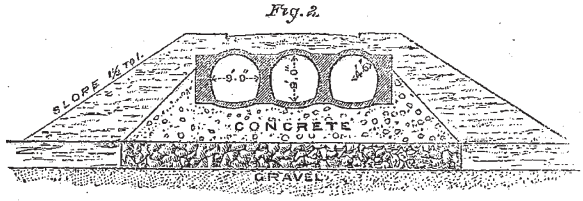
deep, covered in by brick arches, the floor being paved with stone. Attached to each is an outlet fitted with penstocks, &c. The Abbey Mills pumping station is a work of such magnitude and importance that but a scanty idea can be given of it here: suffice it to say, that there are eight engines employed, of a gross power of 1,140 horse-power, which work sixteen double-acting pumps of 3ft. 10½in. diameter and 4½ft. stroke. The engines are supplied by sixteen boilers, each being 8ft. diameter and 30ft. long. The engine and boilers, coal stores, &c., are enclosed in a fine block of buildings beautifully decorated.

Fig. 2.

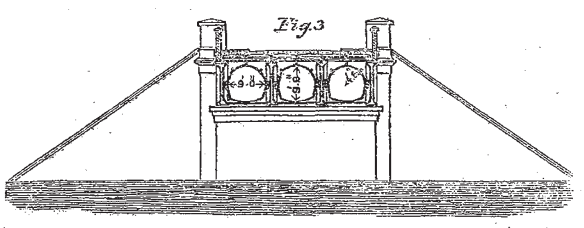


The Southern High Level, or Effra Branch Sewer, commences at Dulwich, and flows in a south-easterly direction to a junction with the Middle Level or High Level main line at New Cross. It is 4½ miles in length, ¼ mile of which is in tunnel. It varies in size from 7ft. diameter to a form similar to one of the culverts in Fig. 2, only the dimensions are 10ft. 6in. by 10ft. 6in.

The Southern Middle Level, or High Level main line, commences at Clapham, and flows under Deptford Creek to the Outfall Sewer. It, together with the High Level, drains an area of about 20 square miles. It is carried under Deptford Creek by four 3ft. 6in. diameter iron pipes. Overflows for storm waters are provided, which discharge into the Creek, if necessary.

The Low Level Sewer South commences at Putney, and flows to Deptford pumping station, where its contents are pumped up a height of 18 feet, by four engines 125 horse-power each, into the Outfall Sewer. Its length is about 10 miles, and it drains an area of about 20 square miles, the greater portion of which is considerably below high-water mark. It varies in size from one culvert 4 ft. in diameter, to two, each 7ft. by 7ft. The soil in which it was executed was exceedingly treacherous in places, being greatly charged with water: in one case sufficient engine-power had to be employed to pump ten million gallons per day, in order to keep the works clear of water. The Bermondsey branch of this sewer is two miles in length,

Fig. 3



and from 5ft. to 5ft. 6in. diameter. It joins the Low Level at High Street, Deptford.

The Southern Outfall Sewer, which receives the contents of the High, Middle, and Low Level sewers, flows from Deptford to the reservoirs at Crossness. Unlike the Northern Outfall, it is underground for its entire length. It is 11ft. 6in. diameter, and 7¾ miles in length. One mile of it was constructed in tunnel under the town of Woolwich. The outfall of this sewer is of such a level as to allow of the sewage being discharged at low water, but it will be pumped into the reservoirs, and there stored till high water.

The Crossness pumping station reservoirs are situated on the northern side of Erith Marshes at the point marked P on the map. They extend over 6½ acres. The reservoirs are similar to those at Barking. There are four beam engines employed of 125 horse-power each, which drive eight pumps, each pump having four compound plungers. The engines are supplied by twelve Cornish boilers 30ft. long and 8ft. diameter. The ordinary amount of sewage to be lifted is about 60,000 gallons per minute, the lift varying from 10ft. to 30ft., which necessitated a peculiar construction in the pumps. The sewage is delivered from the pumps into the reservoirs till high water, when it is discharged into the river. The foundations for the reservoirs, &c., had to be sunk 25ft. below the surface, as the ground consists of peat and sand. On the top of the reservoirs are built the manager's, schoolmaster's, and labourers' cottages, coal stores, school, and workshops, the centre space being laid out as ornamental gardens, the whole forming quite a village of some hundred inhabitants.

NOTES

THE last number of the Proceedings of the Royal Society contains the names of the 53 candidates, from among whom, 15 will be selected by the council for election into the society. The list is a varied one, and there is as usual a large number of medical candidates—21; Art and Literature being also represented. Here is the list:—William Baker, C.E., E. M. Barry, R.A., Rev. Francis Bashforth, B.D., B. E. Brodhurst, F.R.C.S., Samuel Brown, P.I.A., James Brunlees, C.E., F. T. Buckland, M.R.C.S., G.W. Callender, F.R.C.S., Commander W. Chimmo, R.N., F. Le G. Clark, F.R.C.S., Henry Dircks, Alex. Fleming, M.D., P. Le Neve Foster, Sir Charle Fox, C.E., William Froude, T. M. Goodeve, E. H. Greenhow, M.D., E. T. Higgins, M.R.C.S., Rev. Thomas Hincks, Charles Horne, Rev. A. Hume, LL.D., James Jago, M.D., W. S. Jevons, George Johnson, M.D., M. K. King, M.D., J. A. Langridge, C.E., N. S. Maskelyne, M. T. Masters, M.D., Major F. G. Mohtgomerie, R.E., Alfred Newton, Andrew Noble, Thomas Nunnely, F.R.C.S., E. L. Ormerod, M.D., Captain Sherard Osborn, R.N., Rev. Stephen Parkinson, B.D., Captain R. M. Parsons, R.E., W. O. Priestly, M.D., C.B. Radcliffe, M.D., W. H. Ransom, M.D., E. J. Reed, C.B., W. J. Russell, Ph.D., R. H. Scott, John Shortt, M.D., Edward Thomas, C. F. Varley, C.E., G. F. Verdon, C.B., Augustus Voelcker, Ph.D., Viscount Walden, P.Z.S., G. C. Wallich, M.D., A. T. H. Waters, M.D., Samuel Wilks, M.D., Captain C. W. Wilson, R.E., and John Wood, F.R.C.S.

THE *Pall Mall Gazette* has very properly called public attention to Lord Kinnaird's imputation of dishonesty brought against the late Master of the Mint, the lamented Graham. The good old rule, *de mortuis nil nisi bonum*, is one with which Lord Kinnaird does not seem to be acquainted; it is charitable, indeed, to suppose that he sinned in ignorance. He probably also does not know that Graham was a far greater man than he, and that Graham's name will live long after Lord Kinnaird's has been forgotten.

ON Saturday the members of Working Men's Clubs visited the British Museum, under the guidance of Professor Owen and Mr. Henry Woodward. Professor Owen explained the nature of the extinct animals. The next visit will be made to the National Gallery, under the guidance of Mr. Francis Turner Palgrave.

THE examinations for the gold and bronze medals offered as prizes for proficiency in Physical and Political Geography, by the Royal Geographical Society, were held on Monday last, 28th inst. Forty-one schools had been invited to compete, out of which number nineteen accepted, sending a total of fifty-nine

candidates: thirty-four in Physical, and twenty-five in Political Geography. The names of the successful candidates will be announced at the ensuing anniversary meeting.

IN the introductory lecture to his course of Comparative Anatomy, delivered at the Royal College of Surgeons, Prof. Flower discusses the objection to the theory of the origin of species by the process of natural selection, founded on the existence of corresponding types of structure in the Monodelphous and Didelphous sections of mammalia. He considers the probabilities, instead of being against the independent origin of such similar structures, are exceedingly in their favour. The lecturer lays down as a valuable guiding principle in morphological studies, that when we wish to discover the distinguishing characters between different organisms, it is necessary to examine them in their most fully developed condition; if, on the other hand, our object is to trace their resemblance, their intimate relationships, we must study them in their early embryonic stages.

THE *Revue des Cours Scientifiques* reports that the Sars subscription now approaches 9,000 francs. Subscriptions have been received from Germany, Hungary, and America. In France nearly all the professors of higher instruction in science have subscribed to it.

WE have received from the Royal Society a report of Prof. Duncan's important paper on the Madrepores of the *Porcupine* Expedition. We shall return to this subject after completing Dr. Carpenter's report of the more general results of the expedition.

PROF. TYNDALL will have much to answer for in the results that may be expected from the spread of his "dust and disease" theory. It is stated by the *Athenæum* that a new idea has been broached in a recent lecture by Mr. Bloxam, the lecturer on chemistry to the department of artillery studies. He suggests that the committee on explosives, abandoning gun cotton, should collect the germs of small-pox and similar malignant diseases, in cotton or other dust-collecting substances, and load shells with them. We should then hear of an enemy dislodged from his position by a volley of typhus, or a few rounds of Asiatic cholera. We shall expect to receive the particulars of a new "Sale of Poisons" Act, imposing the strictest regulations on the sale by chemists of packets of "cholera germs" or "small-pox seed." Probably none will be allowed to be sold without bearing the stamp of the Royal Institution, certifying that they have been examined by the microscope and are warranted to be the genuine article.

WE have received from Professor H. A. Newton, of Yale College, a report on the meteor-display of November last, from which it appears that the cloudy weather prevented continuous observations in most parts of the United States. In the few stations, however, where the skies were clear, the observers furnish ample testimony to the appearance of unusual numbers of meteors on the morning of Nov. 14, the display continuing for several hours. The most successful observations were made at Pensacola, Florida, where they were observed in extraordinary numbers from 1·15 till dawn, most numerously between 3 and 4 a.m.; at Santa Barbara, California, where 556 meteors were observed between 1·18 and 3·43 a.m.; and at Fredericton, New Brunswick. Prof. Newton remarks that if the whole number coming during the twelve or more hours of the display had been condensed into an hour or two, as in 1866, we should have had a like though not equally brilliant shower.

THE Council of the University of Otago, New Zealand, announces that it is now prepared to consider applications from candidates for two of the professorial chairs to be instituted for classics, including Greek, Latin, the English language and literature; and for Mathematics and Natural Philosophy. The salary attached to each chair will be 600*l.* per annum, which will commence to run from the date of embarkation, besides the class fees, which have been fixed at 3*l.* 3*s.* for attendance on each professor, per term of six months, commencing in the beginning of May of each year. An adequate allowance will be made for passage money and outfit. All candidates must be graduates of some established and recognised university. No religious test will, however, be required from any person to entitle him to hold office in the university, or to graduate or to hold any advantage or privilege thereof. Applications from candidates must be addressed to John Auld, Esq., W.S., Edinburgh, agent of the Province of Otago in Britain, and must be accompanied with testimonials and certificates. They must be in his hands on or before the 1st day of April next. Further information relative to the university and the statistics of the province will be afforded on application to the agent.

BY the provisions of the late Dr. William J. Walker's foundation two prizes are annually offered by the Boston Society of Natural History for the best memoirs, written in the English language, on subjects proposed by a Committee appointed by the Council. For the best memoir presented, a prize of sixty dollars may be awarded; if, however, the memoir be one of marked merit, the amount may be increased, at the discretion of the Committee, to one hundred dollars. For the memoir next in value a sum not exceeding fifty dollars may be given; but neither of these prizes is to be awarded unless the papers under consideration are deemed of adequate merit. Memoirs offered in competition for these prizes must be forwarded on or before April 1st, of the years specified below, prepaid and addressed "Boston Society of Natural History, for the Committee on the Walker Prizes, Boston, Mass." Each memoir must be accompanied by a sealed envelope enclosing the author's name, and superscribed by a motto corresponding to one borne by the manuscript. Subject of the Annual Prize for 1870: "The reproduction and migration of *Trichina spiralis*." Subject of the Annual Prize for 1871: "On the mode of the natural distribution of plants over the earth."

THE following are the Afternoon Scientific Lectures of the Royal Dublin Society, to be delivered during April and May, at four o'clock on Saturdays, in the Lecture Theatre. April 2nd, Dr. J. Emerson Reynolds, "On Ozone, Nature's bleaching agent and disinfectant." April 9th, Dr. H. Minchin, "On some interesting phenomena of sound. April 16th, Prof. E. Hull, "On the extension of the Coal-fields of England under the newer formations." April 30th, Prof. Wyville Thomson, "On the Cruise of the *Porcupine*." May 7th, Mr. H. N. Draper, "On Colours from coal-tar." May 14th, Mr. C. R. C. Tichborne, "On Atmospheric Dust."

A COURSE of lectures for women on the science and practice of music, by Mr. Sullivan, will be delivered at South Kensington, under the patronage of the Science and Art Department, shortly after the close of Prof. Oliver's course on botany. It will include a class for part-singing.

WE have received a pamphlet entitled "Proposals for the Illumination of Beacons and Buoys," by Mr. Thomas Stevenson, F.R.S.E. The author discusses the different sources of illuminations for beacons and buoys, and the different applications of sound for warnings during fogs. The subject is a highly important one, and we purpose to return to it at an early period.

ACCORDING to the *British Medical Journal*, Sir W. Fergusson is about to resign the chair of systematic surgery at the Medical School of King's College, and Mr. Partridge his appointment as surgeon to the hospital. Sir William will, however, be appointed professor of clinical surgery, while Mr. Partridge still retains the chair of anatomy. Mr. Wood is expected to succeed Sir W. Fergusson as professor of systematic surgery;

he will also be appointed to the rank of full surgeon to the hospital. Two vacancies will therefore occur, that of assistant-surgeon to the hospital, and demonstrator of anatomy.

WE learn from *Van Nostrand's Eclectic Engineering Magazine* (New York) that the Darien Canal project is reviving. The United States steamer *Nipsic*, attached to the South Atlantic squadron, is under orders to proceed to the Isthmus of Darien to make surveys and explorations, with a view to determine the best location for an inter-oceanic canal. A similar survey on the Pacific shore of the Isthmus will be made at a future day.

M. FAVRE has recently detected evidences of the glacial period in the Caucasus, and M. Ed. Collomb finds traces, in the form of moraines and erratic blocks, of its having existed with great severity in the central plateau of France. This plateau forms an almost circular geological island 300 kilometres in diameter; its altitude increases progressively from north to south, and it is terminated on the south and west side by a barrier, the highest points of which, the Mézenc, the Plomb du Cantal, and the Mont d'Or rise to a height of from 1,750 to 1,900 metres (5,700 to 6,200 feet), above the level of the sea.

THE sense of taste has rarely been submitted to scientific examination, or at all events has attracted far less attention than its sister senses of sight and hearing, perhaps on account of the impossibility of treating it mathematically. That it differs to a remarkable extent in different individuals is, however, as every culinary artist would acknowledge, a matter of fact; and it is also well known that it is capable of extraordinary cultivation in some men, as shown by wine- and tea-tasters obtaining lucrative posts from the delicacy of their discrimination. Recently Dr. Keppler has published a paper in Pflüger's "Archives of Physiology," in which he gives the details of a number of experiments he performed with a view of determining the limits of gustatory discrimination for sapid substances in various degrees of concentration. In these experiments he first made a standard solution, and then successively employed weaker or stronger solutions, which were tasted with due precautions, sometimes before and sometimes after the standard solution, until no perception of flavour was distinguished. The substances he selected were common salt, quinine, phosphoric acid, and glycerine, all of them, be it observed, destitute of odour, which plays so important a part, often overlooked, in our ideas of the flavour of particular objects. In one series of experiments the solutions were taken freely into the mouth, rolled over all parts of the membrane lining it, and then discharged. In a second series the solutions, were more carefully applied to the surface of the tongue alone by means of a camel's hair brush. It was found in both cases that when a difference of 2·5 per cent. existed between the standard solution and the experimental one, the observers were able to form a correct judgment on the point that there *was* a difference in 53 per cent. of the trials, but when there was a difference between the two solutions amounting to 10 per cent., the answers were rightly given in 80 per cent. of all the trials. A more correct judgment was given when the standard solution was tasted before than after the experimental one with common salt and quinine, and the acuteness in the perception of a difference was greater when the trial solution was stronger than when weaker, but the opposite held good for the other substances.

WE learn from the *Gardener's Chronicle* that the Royal Horticultural Society has decided to retain a portion of the old Chiswick garden, comprising the ground occupied by the glass-houses, and extending sufficiently eastwards and southwards to include the large vinery and the fruit-room.

M. DUCLAUX has lately been experimenting on the effect of certain gases in retarding the incubation of silkworms' eggs. He has also been trying the effect of cold upon the same organisms, and finds that instead of retarding the period of incubation, it accelerated it: in fact, that eggs laid in autumn and left to themselves would only incubate in spring; but if subjected to the action of a freezing mixture for forty days, they would hatch into larvæ immediately afterwards, on being submitted to the action of a gentle heat. If these experiments are confirmed, M. Duclaux will have undoubtedly discovered an entirely new principle in physiology: that cold has a vivifying influence. Hitherto physiologists have always believed that its action was diametrically opposite.

THE journal of the Proceedings of the Asiatic Society of Bengal for January has an interesting article by Dr. F. Skoliczka on the Kjökenmöddings of the Andaman Islands.

THE *Journal of the Scottish Meteorological Society* has some interesting papers on the cold of last summer in Ireland, and upon the thunderstorms of Scotland. The part also contains a report on the Meteorology of Scotland and a minute of the meeting of the Council.

THE *American Gas Light Journal* reports that at a recent meeting of the Lyceum of Natural History of New York, Mr. Loew stated that ozone is produced copiously by blowing a strong current of air into the flame of a Bunsen's burner. He also communicated that he had observed the decomposition of sulphurous acid with production of sulphuric acid and deposition of sulphur, when an aqueous solution of the gas was exposed for two months to sunlight.

THE hardness of metals may now be ascertained by the aid of an instrument invented by a French engineer. It consists of a drill turned by a machine of a certain and uniform strength. The instrument indicates the number of revolutions made by the drill. From this, compared with the length of the bore-hole produced, the hardness of the metal is estimated. It is said that a great proportion of the rails now employed in France are tested by this instrument.

*ON THE TEMPERATURE AND ANIMAL LIFE OF THE DEEP SEA**

III.

AN enormous addition has been made to the list of British *Echinodermata* by the discovery in our own seas of a number of species which had been previously known only as Norwegian or Arctic; and these often occurred in extraordinary abundance. One of the most interesting of these was the large and beautiful feather-star, the *Antedon* (*Comatula*) *Eschrichtii*, hitherto known only as inhabiting the shores of Greenland and Iceland, but now found over all parts of our cold area. On the other hand, the influence of temperature was marked not only by the absence of many of the characteristically southern types of this group, but by the dwarfing of others to such an extent that the dwarfed specimens might be regarded as specifically distinct, if it were not for their precise conformity in structure to those of the ordinary type. Thus the *Solaster papposa* was reduced from a diameter of six inches to two, and had never more than ten rays, instead of from twelve to fifteen; and *Asterocanthion violaceus* and *Cribella oculata* were reduced in like proportion. But, in addition, several echinoderms have been obtained which are altogether new to science, most of them of very considerable interest. The discovery, at the depth of 2,435 fathoms, of a living crinoid of the Apiocrinite type, closely allied to the little rhizocrinus (the discovery of which by the Norwegian naturalists was the starting-point of our own deep-sea explorations), but generically differing from it, cannot but be accounted a phenomenon of the greatest interest alike to the zoologist and the palæontologist. Another remarkable representative of a type supposed to have become extinct, occurred at depths of 440 and 550 fathoms in the warm area; being a large *echinidan* of the *diadema* kind, the "test" of which is composed of plates separated from one another by membrane, instead of being connected by suture, so as to resemble an armour of flexible chain-mail, instead of the inflexible cuirass with which the

* A Lecture delivered at the Royal Institution (continued from p. 540).