weigh 110 tons, fire shot 16¼ inches in diameter, weighing 1800 lbs., and costing £190 each. The advance thus shortly chronicled is due to several workers, prominent amongst whom may be mentioned Sir Joseph Whitworth, Sir William Armstrong, and Sir William Anderson. The production of ordnance of such a character has been due to the introduction of steel, and the possibility of producing steel in large masses by means of the open-hearth steel process, with which the name of Sir William Siemens will always be connected. The quick-firing machine guns are known by the names of their inventors, as the Gardner, Nordenfelt, Maxim, Gatling, and Hotchkiss.

The President also drew attention to the circumstance of the inventive talent of the country having been taken advantage of here, and ignored in France until after the Franco-German war; now, however, there as here, many works have found it to their profit to establish gun factories which supplement the Government factories to a large extent.

Two papers were read at the meeting on prime movers, the one by Mr. F. Brown, of Montreal, on "The Construction of Canadian Locomotives," and the other, by Major T. English, R.E., detailing experiments on the distribution of heat in a stationary steam-engine. The former, as its name denotes, refers to details of construction; the latter is illustrated by thirty-five figures, mainly of indicator diagrams, and distribution of heat diagrams showing in one view the applied and wasted heat. The series of trials extended altogether over fifty hours' working of the engine; but out of this trial, various results, representing in the aggregate twenty-eight hours' working, were rejected, on account of doubtful measurements at some point or other. The remaining trials are sixteen in number, in two sets—one condensing and one non-condensing—each with and without the steam-pipe jacketed, and each with a cut-off at approximately one-quarter, one-eighth, and one-sixteenth of the stroke respectively, thus making twelve different combinations. The conclusions drawn by the author are: that, in order to obtain the best results for any given range of temperature, there should be a definite relation between the surface of the steam passages, the diameter of the cylinder, and the length of stroke; and that in the design of a steam-engine the adjustment of these proportions is perhaps the most important point to be considered as regards economy. The calculated results of varying the length of the stroke of the engine which was experimented on—while the diameter of the cylinder, the absolute clearance volume, and the clearance surface exposed, remained unaltered—were tabulated for two different points of cut-off, and show that the same number of expansions may give widely different results as regards the ratio of efficiency and the water consumed per indicated horse-power per hour; and also that with the same length of stroke these results are but slightly affected by doubling the number of expansions.

NOTE ON THE SPECTRUM OF DIDYMIUM.[1]

IT is well known that the absorption spectrum usually ascribed to didymium shows six bands in the blue and violet with approximate wave-lengths 482, 476, 469, 462, 444, 428, according to Lecoq de Boisbaudran.

The evidence that we at present possess shows, I think, that these bands belong to at least five different fractions of didymium.

Welsbach (*Monatshefte*, vi. 477) has shown that the band 428 occurs in the absence of all the others mentioned above in the spectrum of the fraction which he names neodymium. On the other hand, Crookes (Proc. Roy. Soc., 1886, 502, Fig. 1) has shown that all the other bands of neodymium can be obtained in the absence of the band 428. This band, therefore, belongs to a distinct fraction, and should be obtainable quite by itself.

Crookes has shown that the band 444 varies in strength independently of all others, and is therefore distinct. The same conclusion is arrived at by a slightly different argument. Welsbach's praseodymium shows the bands 482, 469, and 444, together with a faint band in the orange. Crookes (*ibid.*, Fig. 1) has shown that 482 and 469 can be got in a fraction which does not show 444. It is possible that the faint orange band of praseodymium belongs to the same fraction as 444, since its presence or absence would make little difference in the appearance of the dark orange band of the ordinary didymium spectrum, one part of which it forms.

The band 462 is shown to be distinct by a comparison of Crookes's Figs. 1 and 2, taking into account that 444 and 428 have been shown to be distinct.

The two bands 482 and 469 seem always to accompany each other. They occur together in Welsbach's praseodymium and in all the spectra of didymium fractions published by Crookes. They are distinct from 476, since they occur in praseodymium in the total absence of 476. They may belong to the same fraction as the faint orange band of praseodymium.

The band 476 does not occur in Welsbach's neodymium spectrum.

In fact the two bands 476 and 462 seen in the didymium spectrum are not accounted for by Welsbach at all in the spectra of praseo- and neodymium. Since 462 is distinct, 476 must also be distinct.

I have repeated Welsbach's experiments up to a certain point, and can confirm his results as regards praseodymium in every respect. There is no indication whatever that the three main bands belong to different fractions. I have not been able to satisfy myself quite that the faint orange band of praseodymium really belongs to the same fraction as the others, even supposing that the method of fractionation is not changed. In the didymium spectrum the orange band is much darker than the green, and the difficulty of getting a really concentrated praseodymium solution, which does not show a trace of the green band, is extreme. A small remnant of some other fraction of didymium might therefore cause a faint band in the orange some time after the band in the green had disappeared. Nevertheless, there is no doubt that by Welsbach's method the orange didymium band is split up, for the maximum absorption with didymium is not at the point in the orange where the band of praseodymium occurs.

I have not yet obtained the neodymium fraction free from praseodymium, but I have no reason to doubt that Welsbach's observations are correct. A study of the intermediate fractions brings out a point which Welsbach does not refer to. As we pass from the praseodymium end the bands 482 and 469 become fainter, whilst 476 and 462 first appear and then grow stronger, till they become distinctly stronger and much broader than 482 and 469.

It appears then that the absorption spectrum of didymium is splitting up just as the fluorescent spectrum of yttrium is. I have only discussed a few of the bands, but there is no doubt that the other bands will also in time be separated. Indeed, this separation has already been partially effected by Crookes for some of the bands in the red.

Perhaps the most surprising result arrived at by Crookes is that the splitting up of the fluorescent yttrium spectrum is unaccompanied by any change in the spark spectrum. On the other hand, Welsbach states that the spark spectra of praseo- and neodymium are parts of the didymium spectrum, and that, though similar in general appearance, they are really quite distinct. There does not appear to be any theoretical reason for this difference between yttrium and didymium, and it is to be hoped that the different fractions of didymium will be got pure enough to show whether the spark spectra can be still further split up.

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UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The first election to the Harkness Scholarship for Geology and Palæontology will be made in June. All B.A.'s of Cambridge not beyond M.A. standing are eligible. The Rev. Osmond Fisher is appointed an elector to the scholarship.

The report of the Council of the Senate on the teaching of geography is to be voted upon on June 9.

SCIENTIFIC SERIALS.

American Journal of Science, May.—On red and purple chloride, bromide, and iodide of silver; on heliochromy and the latent photographic image, by M. Carey Lee. To this paper we have already called attention. It is the first of a series of important papers, the object of which is to show (1) that chlorine, bromine, and iodine may form compounds with

silver of beautiful peach-blossom, rose, purple, and black coloration; (2) that these compounds (except under the influence of light) possess great stability, and may be obtained by purely chemical means in the entire absence of light; (3) that the red chloride shows a tendency to the reproduction of colours, and may probably be the material of the thin films obtained by Becquerel and others in their experiments on heliochromy; (4) that these substances constitute the actual material of the latent or invisible photographic image, a material that may now be obtained in any desired quantity without the aid of light. They also form part of the visible product resulting from the action of light on the silver haloids. This first contribution deals with red silver chloride, and with the relations of photochloride to heliochromy. The author considers that in the reactions here described lies the future of heliochromy, and that this beautiful red chloride may ultimately lead to the reproduction of natural colours.—On the inter-relation of contemporaneous fossil floras and faunas, by Charles A. White. A chief object of this paper is to show that successive orders of fossil floras and faunas do not necessarily correspond so absolutely with given geological epochs as is generally assumed. On the contrary, the rate of progress of biological evolution from epoch to epoch has necessarily been variable, some contemporary species dying out at an early date, while others live on into subsequent epochs, according to the different conditions of their environments. Living species of land mollusks, for instance, are found also associated in the same strata with those of extinct genera and families of Miocene vertebrates. It is also incidentally shown that no European palæontological and geological classifications are entirely applicable to the conditions prevailing in the American continent.—The Eozoonal rock of Manhattan Island, by L. P. Gratacap. An examination of the rock recently exposed in New York when the cisterns were being constructed for the Equitable Gaslight Company, leaves little room to doubt that here a bed of hornblende has undergone a more or less complete conversion into serpentine, the change being in some places accelerated by the elimination of lime carbonate as calcite, and probably elsewhere the double carbonate of lime and magnesia as dolomite.—Terminal moraines in Maine, by George H. Stone. The generally unequal distribution of the glacial drift in Maine is well illustrated by the detailed description here given of its chief terminal moraines.—Note on the enlargement of hornblendes and augites in fragmental and eruptive rocks, by C. R. Van Hise. While recently studying the eruptive rocks of the Penokee-Gogebic iron-bearing series in Michigan and Wisconsin, the author met with cases of new growths occurring upon augite and hornblende, corroborating the observations made by Fr. Becke amongst the eruptive rocks of Lower Austria in 1883. In some instances the augite has been completely, in others partly, changed into hornblende, the rocks where these new growths occur being altered diabases.—The great Acadian Paradoxides, by G. F. Matthew. An almost complete specimen of this gigantic species has recently been found in the Cambrian basin of St. John, differing from any hitherto described, and mostly resembling the *P. bennettii* of Newfoundland and *P. harlani* of Massachusetts.—On the kin of *Paradoxides* (*Olenellus?*) *kjerulfi*, by G. F. Matthew. The object of this paper is to throw some light on the comparative age of the Paradoxides beds in Europe and America, and the probable position of Olenellus in relation thereto, the allies of *P. kjerulfi*, Linrs., being chiefly considered.—On Taconic beds and stratigraphy (continued), by James D. Dana. This second communication, which is accompanied by a large map of the Taconic region in Berkshire, Massachusetts, deals specially with the middle and northern part of that region. The author concludes generally that the limestone must be the underlying rock for the lower and narrower portions of the Taconic range, the schists of which are the same in kind, and essentially continuous. Most of the limestones are referred to the Lower Silurian age, some Cambrian also occurring.

Rendiconti del R. Istituto Lombardo, March 31.—On some methods of testing the purity of drinking-waters, by Prof. L. Maggi. Koch's method by cultivation in gelatine is shown to be greatly inferior in efficacy to that of Fol and Dunant by cultivation in meat extract, the former detecting only 5700 bacterial germs where the latter finds 100,000. The author points out further that Fol and Dunant's is substantially the same as the method already adopted at a much earlier date (1867) by himself and Prof. Giovanni Cantoni.—Meteorological observations made at the Brera Observatory, Milan, for the month of March.

April 14.—Effects of a thunderbolt, by Prof. R. Ferrini. During a recent thunderstorm in Milan some planking placed over the mouth of a dry well and covered with cultivated earth was removed by an electric discharge in such a way that the earth was precipitated bodily into the well. A lightning-conductor from a neighbouring building had its terminus in the well, where it is suggested that the explosion took place with the result described.—On the second derivatives of the potential functions of space, by G. Morera. A simpler method than that of Hölder (*Beiträge zur Potentialtheorie*) is here proposed for determining the existence of the second derivatives of the potential function of a mass distributed in a space of three dimensions.—The migrations of the tunny, by Prof. Pietro Pavesi. The commonly-accepted view that the true tunny (*Orcynus thynnus*, L.) is an oceanic fish migrating periodically from the Atlantic through the Strait of Gibraltar round the Mediterranean basin is shown to be erroneous. This fish is, on the contrary, essentially an inhabitant of the Mediterranean, where it migrates between the shallows in the spawning-season and the deep waters for the rest of the year, but rarely passing in large numbers beyond the Strait of Gibraltar.

Bulletin de l'Académie Royale de Belgique, March.—Memoir on bichlorureted alcohol, by Maurice Delacre. To ethylic alcohol, $CH_3—CH_2(OH)$, correspond the three chlorureted derivatives of alcoholic nature: (1) $ClCH_2—CH_2(OH)$; (2) $Cl_2CH—CH_2(OH)$; (3) $Cl_3C—CH_2(OH)$. The first of these having been determined by Würtz, and the third by Garzarolli-Thurnlack in 1881, the author has now succeeded in obtaining the second, resulting from the action of zinc-ethyl on anhydrous bichlorureted aldehyde, $Cl_2CH—CHO$. His description of the process adopted is accompanied by analytical data and experimental determinations leaving no doubt as to the nature of this compound.—On some derivatives of propane, by C. Winssinger. During his protracted studies of this substance the author has determined, contrary to the observations of Pierre and Puchot, the existence of a hydrate of propylic alcohol boiling at 87° C. He has also prepared in a pure state the sulphuret of orthopropyl with boiling-point 142° instead of the hitherto accepted 130° to 135°. He further shows that a solution of the organic hydrosulphates in alcohol is continuously decomposed during ebullition at contact with the alkaline hydrosulphates, yielding organic sulphur with liberation of hydrosulphuric acid. Lastly, he has determined some new compounds, such as the oxysulphide of propyl, which is dissolved at 14°·5 to 15°, and combines with the nitrate of calcium; a mono-orthopropylphosphoric acid, and a tri-orthopropylphosphoric ether. These substances are formed by the action of the pentachloride of phosphorus or orthopropylic alcohol, and have the respective formulas, $C_3H_7PO_4H_2$ and $(C_3H_7)_3PO_4$.—Researches on the localization and function of the alkaloids in plants, by MM. Errera, Ch. Maistriau, and G. Clautriau. For several years the authors have been engaged with the study of the alkaloids, especially in *Colchicum autumnale*, *Nicotiana macrophylla*, *Aconitum Napellus*, and various species of Narcissus. They have so far arrived at the general conclusion that the alkaloids are formed chiefly in the more active tissues where the albuminoids are incessantly decomposed and transformed. From these tissues the alkaloids gravitate towards the periphery, where they become more easily oxidized, and serve to protect the plant against attack. Physiologically they are analogous to the alkaloids developed in some animals, such as snakes, to an extraordinary degree; and must be regarded as the waste or refuse of the protoplasmic activity afterwards turned to account for protective purposes.

April.—Discovery of instruments of the Stone Age in the Congo State, by Ed. Dupont. Some specimens of rude implements are described, which have recently been discovered by Capt. Zboinski on the left bank of the Lower Congo in the region of the cataracts below Stanley Pool. They occurred in a district covered with chips of quartzite in the neighbourhood of South Manyanga, where this rock crops out, indicating the site of a former quarry or manufactory of such objects, such as have frequently been found in other parts of the world, but very seldom in Africa. They are unpolished, belonging to the Palæolithic epoch, the presence of which along the west coast of Africa has also been recently confirmed by similar finds, but in silex, in the Mossamedes district much further south.—On a case of chemical decomposition produced by pressure, by J. H. van 't Hoff and W. Spring. Under a pressure of 6000 atmospheres at a temperature of 40° C. the authors have succeeded in decom-

posing cuprico-calcic acetate which had previously been finely pulverized. The salt was slowly liquefied, and on the pressure being removed the surface of the instrument in contact with the salt was found covered with a coating of copper. Other experiments at lower and higher temperatures, but still much under the point of transition, showed that this substance is decomposed under the action of pressure, the process being accelerated according as the pressure and temperature are increased.—On forecasting the weather, by B. G. Jenkins. The author publishes a weather chart for London ranging over 62 years, showing, as he claims, that the moon not merely influences but is the actual cause of the weather, and consequently that it can be forecast by studying accurate barometric and thermometric readings recorded for a sufficiently lengthened period of time. He finds, for instance, that the readings for London for 1887 will be practically the same as those recorded for 1825, those for 1885 and 1886 corresponding in the same way with those for 1823 and 1824, and so on. He adds that in December last he issued a forecast for January 1887 based on the readings for January 1825, with the subjoined results:—Forecast: mean bar., 29·98; mean ther., 35°·5; rain, 1·5. Result: mean bar., 29·99; mean ther., 35°·9; rain, 1·3.

Notes from the Leyden Museum, vol. ix., No. 2, April 1887, contains, as usual, a large number of papers on entomology, and also a paper on a collection of mammals made at Mossamedes, from the pen of Dr. F. A. Jentink, the Director of the Museum. Mr. P. J. van der Kellen was one of the members of an Expedition to the Cunene River, which was commanded by Mr. Veth. On Mr. Veth's death, which took place very shortly on the Expedition reaching Mossamedes, Mr. van der Kellen determined himself to explore the district, and to make a collection of the fauna for the Leyden Museum. The country he is collecting in is, from a zoological point of view, unknown, and although none of the twenty-six species of Mammalia enumerated in this paper by Dr. Jentink are new to science, yet they form a most welcome addition to our knowledge of geographical distribution, and several of the forms are still very rare.

Engler's Botanische Jahrbücher, vol. viii. part 4, contains:—A contribution to the botanical geography of South Africa, by R. Marloth. This is a description of the plants growing in the south-west Kalahari district.—Contributions to the knowledge of the *Aponogetonaceæ*, by A. Engler. The chief conclusions arrived at are that the inflorescence of *Aponogeton* is not axillary in position, but two leaves and an inflorescence together form a collective whole, the inflorescence not being in the axil of either of them, but opposite the margin of one of the leaves: that in *A. distachyus*, which is the commonest cultivated species, the large white bract-like organ, which subtends each flower, is not a bract, but the single developed segment of the perianth: and finally that if the *Aponogetonaceæ* be united with the *Juncagineæ* and *Potamogetonaceæ* in the large family of *Najadaceæ*, the *Alismaceæ* should also be included in that family.—Then follows a condensed translation of the memoir on the vegetative organs of *Phylloglossum Drummondii*, by F. O. Bower, already published in the Trans. Roy. Soc., London: the chief result of this investigation is that as regards the vegetative organs, *Phylloglossum* appears to be a permanently embryonic form of Lycopod.—A list of plants found in West Greenland, together with remarks on their distribution, is contributed by Th. Holm, of Copenhagen, who accompanied the Danish vessel *Fylla* in its expeditions of 1884 and 1886.—The part closes with the continuation of the usual extracts from current literature.

SOCIETIES AND ACADEMIES.

LONDON.

Zoological Society, May 17.—Prof. W. H. Flower, F.R.S., President, in the chair.—The President read some extracts from a letter which he had received from Dr. Emin Pasha, dated Wadelai, November 3, relating to some skulls of the Chimpanzee from Monbottu, to some portions of the skeleton of individuals of the Akka tribe, and to some other objects of natural history which he had forwarded (*viâ* Uganda) to the British Museum of Natural History.—Mr. A. Thomson exhibited some specimens of a rare Papilio (*Papilio porthaon*) from Delagoa Bay, reared in the Society's Gardens.—Prof. Howes exhibited a drawing of a head of *Palinurus penicillatus*, received from M. A. Milne-Edwards, and remarked on the assumption of antenniform characters by the left ophthalmite shown in this specimen.—A paper was read by Mr. W. F. Kirby, Assistant in the Zoological Department, British Museum, entitled "A Revision of the Sub-family *Libellulinæ*, with descriptions of new Genera and Species." The last compendium of this group was published by Dr. Brauer in 1868, in which forty genera were admitted. Mr. Kirby now raised the number to eighty-eight, all fully tabulated and described in his paper, which likewise included descriptions of fifty-two new species. Mr. Kirby gave a short sketch of the characters of the *Libellulinæ*, and more especially of the neuration, which he considered to be of primary importance.—Mr. R. Bowdler Sharpe read the third part of his series of notes on the Hume Collection of Birds, which related to *Syrnium maingayi*, Hume, and to the various specimens of this Owl in the British Museum.—A communication was read from Mr. A. Smith Woodward, on the presence of a canal-system, evidently sensory, in the shields of Pteraspidian fishes. Mr. Woodward described a specimen which seemed to prove that the series of small pits or depressions upon the shields of these ancient fishes, observed by Prof. Ray Lankester, are really the openings of an extensive canal-system traversing the middle layer of the shield.—A second communication from Mr. A. Smith Woodward contained some notes on the "lateral line" of *Squaloraja*, in which it was shown that the "lateral line" of this extinct Liassic Selachian was an open groove supported, as in the Chimæroids, by a series of minute ring-like calcifications.

Anthropological Institute, May 10.—Mr. Francis Galton, F.R.S., President, in the chair.—Prof. Flower read a letter received by him from Emin Pasha, dated Wadelai, November 8, 1886.—Prof. Victor Horsley read a paper on the operation of trephining during the Neolithic period in Europe; and on the probable method and object of its performance. The paper was copiously illustrated by photographs of trephined skulls and of implements that may have been used in the operation. The fact that most of the holes are found in that part of the skull that covers the fissure of Rolando heightens the probability that the operation was performed as a remedy in cases of epilepsy, since the curve of brain-matter around that fissure is specially connected with what is known as cortical or Jacksonian epilepsy. It seems probable that the operation was, in the first instance, performed for depressed fractures of the skull, or for the traumatic form of epilepsy, and afterwards in other cases in which similar symptoms were observed.

Mathematical Society, May 12.—Sir J. Cockle, F.R.S., President, in the chair.—Prof. Anderson, Queen's College, Galway, was elected a member.—The following papers were read:—General theory of Dupin's extension of the focal properties of conic sections, by Dr. J. Larmor.—Sur une propriété de la sphère et son extension aux surfaces quelconques, by M. D'Ocagne.—On the motion of two spheres in a liquid, and allied problems, by Mr. A. B. Basset.—Second note on elliptic transformation annihilators, by Mr. J. Griffiths.

Chemical Society, May 5.—Mr. William Crookes, F.R.S., President, in the chair.—The following papers were read:—A contribution to the study of well water, by Mr. R. Warington, F.R.S.—Crystals in basic-converter slag, by Mr. J. E. Stead and Mr. C. H. Ridsdale.—Note on the influence of temperature on the heat of dissolution of salts in water, by Dr. William A. Tilden, F.R.S.—The distribution of lead in the brains of two factory operatives dying suddenly, by Mr. A. Wynter Blyth. At a certain lead factory in the east of London five cases of more or less sudden death at different dates have been attributed to the effects of lead. In two of the cases the author had an opportunity of making a toxicological investigation. There has hitherto been no reasonable hypothesis to explain the profound nervous effects of the assimilation of minute quantities of lead, but if it is allowed that lead forms definite compounds with essential portions of the nervous system, it may then be assumed that in effect it withdraws such portions from the body; in other words, the symptoms are produced not by poisoning in the ordinary sense of the term, but rather by destruction—a destruction, it may be, of important nerve-centres.—Researches on silicon compounds and their derivatives: a new chlorobromide of silicon, by Dr. J. Emerson Reynolds, F.R.S. In purifying a large quantity of silicon tetrabromide prepared by means of crude bromine, the author has separated a portion boiling at 140°–141°, of the relative density 2·432, which analysis shows to be the chlorobromide of the formula $SiBr_3Cl$.