THURSDAY, MARCH 28, 1895.

ORB-WEAVING SPIDERS OF THE UNITED STATES.

American Spiders and their Spinning Work; a Natural History of the Orb-weaving Spiders of the United States, with Special Regard to their Industry and Habits. By Henry C. McCook, D.D. Vol. iii., with descriptions of orb-weaving species and plates (pp. 1–284, pl. 1–30). (Published by the Author, Academy of Natural Sciences of Philadelphia, A.D. 1893.)

VOLS. i. and ii. of this work have been already noticed in these columns. (See NATURE, vol. xlii., p. 244, 1890; *Ibid.* xliii., p. 74, 1890.) The volume before us completes the work, and bears date 1893; but it was only issued to the public at the end of 1894. To the general reader this is a matter of little consequence, but to the specialist it is often important, for it frequently happens, as in this instance, that new genera and species are characterised and described; it then often becomes necessary to decide, on the questions of priority that may arise, as exactly as possible when such descriptions were made, and the date inscribed on the work, it is manifest, cannot be implicitly relied upon.

In the preface to the present volume, it is stated that the work has engaged the author's thoughts for more than twenty years, and to this the amount of research and observation testified to in three large volumes amply bears witness. The first six chapters of vol. iii. (pp. 1–131), being part i., are a kind of supplement to vols. i. and ii., and are "on various natural habits and physiological problems" of spiders. Part ii. (pp. 132–277) carries out the prospectus of the work at first issued, viz. *descriptions* of the American "orb-weavers," illustrated by thirty coloured plates of great beauty and accuracy, especially in regard to the anatomical details; two, however, of these plates are of spiders of various groups and species alluded to in the foregoing part of the work, though without special description. The author speaks of this portion of his task (part ii.) as in many respects its most difficult part; but this may be taken as tolerably certain, that though vols. i. and ii. and the first half of vol. iii. will always be the most popular part, the latter portion of vol. iii. will prove of most value to the scientific world. The observation and detailing of habits, manners, and general economy, whether of spiders or any other group in the natural world, afford unlimited scope for imagination, sentiment, as well as popular and picturesque description, all of which the true scientific worker has resolutely and wholly to shun, or, at any rate, to repress with a strong hand. It seems almost a pity that these two distinct portions of Dr. McCook's work had not been issued separately, as the total cost of the whole—50 dollars—is a heavy sum to pay for the 136 pages and thirty plates, which will alone be indispensable to the systematic working araneologist. Nor will it be possible (we are told in this vol.) to obtain vol. iii. apart from the other two.

All that was said in the notices, above alluded to, of vols. i. and ii. can be again here repeated in praise of the execution of the work in this third volume. Chap. i. is "on toilet, drinking, and social habits"; chap. ii. on "memory, mimicry, and parasitism"; chap. iii., "biological miscellany"; chap. iv. "on weather prognostications, sundry superstitions, and the commercial value of spiders' silk"; chap. v., "on moulting habits of spiders"; chap. vi., "regeneration of lost organs, and anatomical nomenclature." On all these subjects there are many most interesting and useful observations.

In chapter i., p. 1, speaking of spiders' habits of cleansing themselves of objectionable matters by their having a spiny armature of the legs and mandibles (*falces*), so evidently well adapted for the purpose, it is asked, "Did the habit of cleanliness arise from the possession of these implements, or were the implements developed out of the vital necessity for a cleanly person?" In the first place, it suggests itself as hardly tenable to assume, *à priori*, such a vital necessity in respect to spiders, any more than with regard to some Acarids, or the larvæ of certain insects, whose habit it seems to be not only to need no cleansing, but to encourage the accumulation upon their bodies of various kinds of adventitious and, at times, of even excrementitious matter; but not to dwell on this view of it, the case of the spiders might perhaps be simply presented in this way. The accumulation of dust, or soil, or what not about them, arises mainly from their having clothing and spinous armature, in which those substances become entangled and retained, while at the same time those very causes of the inconvenience become the means of obviating it; for we may take it that the first efforts of a sentient being are to rid itself of whatever may adhere to it, to its hindrance or annoyance; in this process, whatever existing portion of structure came handiest would necessarily be the first used, whether, as in the case of cows and other horned cattle, the lashing of its sides by a heavily-tipped tail, or the muscular movements of the ears, or the action of the hinder hoofs; but it would scarcely be argued, either, that the ears, tails or hoofs of cows were developed just for the purpose of ridding them of insect or other inconveniences, or that the habit of so using them arose out of the animals' possession of ears, tails, and hoofs. Nor can we, it is conceived, argue either that spiders' habits of using hairs and spines in cleansing themselves arose from the possession of such implements, nor that these implements were developed from those habits. All that we can say with any certainty, seems to be that while hairs and spines, &c., were developed by various means and for various ends, the more perfect adaptation of some of them for special functions would no doubt be effected by natural selection; such, for instance, as the development of the calamistrum on the metatarsi of the fourth pair of legs in numerous widely separated genera, and even families of spiders, for the utilisation of the silk-matter of the supernumerary spinners, which last are always found correlated with the calamistrum. Under the heading of "Burrowing Spiders," pp. 31-35, we have a very interesting and important account of trap-door nests made by Lycosid spiders; those hitherto known as "trap-door spiders" having been exclusively of the family Theraphosidæ. A remarkable account of a spider apparently voluntarily changing its colour, is given at p. 51. This account, it seems, is taken from NATURE, April 13, 1893, p. 558; but it appears to need corroboration.

Among other points in respect to spiders' spinning work, the use and commerical value of the product is naturally referred to (pp. 83-89), and the various experiments (already published from 1709 to the present time) made to ascertain their use and value are noted; but the subject does not seem to have attracted much attention since Prof. Wilder's experiments in 1865-1869. Some subsequent researches made by a Mr. Stillbers, an Englishman (quoted in a paper by M. Guatier), appear to need more circumstantial reference and explanation. It may, however, be mentioned here, that in 1884 a small mass of spider's silk was received, through Prof. Thiselton-Dyer, by the present writer, from Almora, Saharunpur, India. This was mixed up with the débris of dead insects and spiders, as well as with portions of the plants among which the silken webs were spun. Some of this mass was examined by Mr. Thomas Wardle, who reported upon it in the *Journal* of the Society of Arts, May 1885 (pp. 679-680). In an exhaustive paper in that journal, on "Researches on Silk Fibre," Mr. Wardle says, in the course of his report:—

"I believe, if it can be obtained in quantity, it might be packed in bales and sent to England, where it would readily find a market for being carded and spun into silk threads for sewing or weaving purposes. It is difficult to estimate its market value. I dare say it would, at any rate, realise one shilling to two shillings per lb. It is rather dirty, and this would to some extent detract from its value as compared with silk waste."

The spider to which this silken mass was referable is *Nephilengys* (*Epeira*) *Malabarensis*, Walck., a species of very wide tropical distribution, and apparently in great abundance where it occurs. There seems to be no reason why almost any amount of this silk should not be obtainable from the low plants and scrub on which the spiders spin their snares, and, with a little care in gathering, much less intermixed with dirt and other adventitious matter than the sample above alluded to. In fact, we may easily conceive that it would be possible, with a little trouble, to form a kind of spider-farm for the purpose of producing this silk in the greatest possible perfection and abundance. From Mr. Wardle's analysis and treatment of this silk, it may be seen that it possesses some very valuable and curious characters.

The chapter on "Moulting Habits" is full of exceedingly interesting details, both from published works and the author's own observations. Moulting is a critical operation in spider-life, and is usually attended with a great demand on the vital powers of the spider; and though spiders probably seldom succumb when in a state of nature, moulting, when in confinement, frequently proves fatal, especially when the spider is advanced in age. A large Theraphosid, for eighteen months kept in confinement in the gardens of the Zoological Society of London some few years ago, died at length in its last moulting process. After the last moult, which completes the structural development of the spider, it seems that no further ecdysis takes place, whatever age the spider may attain. The number of moults appears to vary, not only with the species, but with individuals of the same species; food, temperature, and other conditions no doubt affecting it. Chapter vi., on "Regeneration of Lost Organs," is based chiefly on the researches of Voldemar Wagner ("La régeneration des organes perdus chez les Araignées," *Bull. Soc. Imp. Moscow*, 1887, No. 4) and the observations of H. Heineken (*Zool. Journ.* iv. 1828-29). Papers on the subject by the late Mr. Blackwall are also noted.

Part ii. consists of "Descriptions of Genera and Species." In his introductory remarks to this part, Dr. McCook defines the extent of the group comprised in his "Orb-weaving Spiders." This is coextensive with the "Orbitelariæ" of Dr. Thorell, and includes *Uloborus*, which is far removed structurally from the *Epeiridæ*, as well as *Pachygnatha*, which, so far as known, spins no snare at all. The difficulty of drawing any decidedly marked line between the *Retitelariæ*, and *Orbitelariæ* is no doubt great. Witness the results arrived at by M. Eugène Simon in his work now in progress—"Histoire des Araignées," second edition, 1893-4—in which these two enormous groups are fused, and again subdivided; the materials being recast in a way which upsets all the previously conceived ideas of araneologists. However, until these new views are better understood and generally adopted, the old division into geometric web weavers and those whose snares are not geometric, but net-like, with exceptions such as the *Uloboridæ* and *Pachygnatha*, are sufficient for popular as well as faunistic purposes.

At pp. 8 and 133, reference is made to drawings of American spiders made by John Abbott early in the present century, and the descriptions of which are contained in Baron Walckenaer's Ins. Apt., A.D. 1837. It appears from Dr. McCook's remarks that he was under the impression that some drawings which he saw in the British Museum in 1887 were the original drawings of John Abbott's spiders. This, however, is not so. The British Museum set of drawings are either a copy of those of Abbott, or, may be, a duplicate set done by Abbott himself. The originals (or, at any rate, those from which Walckenaer drew up his descriptions of the spiders) are in the possession of the authorities at the Jardin des Plantes, Paris. Many years ago it was proposed to the present writer by the late Dr. John Gray, of the British Museum, to prepare and publish descriptions of the spiders from the British Museum copy, along with plates engraved some years previously from that copy, under Dr. Gray's orders. Such descriptions, however, it is quite obvious, could not possibly be done satisfactorily from the drawings alone—witness Baron Walckenaer's efforts—though no doubt numbers of the spiders delineated can, with more or less certainty, be specifically determined from them. The result of an inquiry made at that time, was that the French nation has Abbott's original drawings, which were presented, directly or indirectly, to Baron Walckenaer by Abbott himself; but what the British Museum set was, or how it was acquired, seemed to be very doubtful.[1]

In a general notice like the present, part. ii. of the vol.

[1] Dr. McCook evidently was not aware that the present writer, in a review of N. M. Hentz's "North American Spiders" in 1876 (NATURE, vol. xiii. p. 232), mentions these facts and considerations respecting John Abbott's drawings.

under consideration needs but little remark. The descriptions are full and accurate, and the figures are nearly all engraved from drawings beautifully executed by Miss Elizabeth F. Bonsall, and leave but little to be desired. Three, however, of the plates—Nos. 2, 10, and 15—are from the author's own drawings, and are fully equal, if not superior, to the rest. 123 species of spiders of the orb-weaving group are described, and, of these, twenty-four are considered to be new to science. Four new genera are also characterised. In every way, part ii. will be of great use and importance to systematic araneologists. A portrait of Nicolas Marcellus Hentz (justly called the father of American araneology) forms a most appropriate frontispiece. O. P. CAMBRIDGE.

THE SEA AND ITS COASTS.

Sea and Land, Features of Coasts and Oceans, with special reference to the Life of Man. By N. S. Shaler, Professor of Geology in Harvard University. Illustrated. (London: Smith, Elder, and Co., 1895.)

IN more than one sense this book is a thinner one than "Aspects of the Earth." Of the seven essays which it contains—in the main re publications—the first four deal with familiar subjects—the work of the sea, its beaches, its depths, and icebergs; the last three treat of harbours, and introduce some questions which are less hackneyed and more interesting. Prof. Shaler writes pleasantly, and his sentences flow easily, but it is sometimes possible to read through several paragraphs without much progress in knowledge, or to find a rather large number of well-turned phrases expended in stating what amounts to a truism. But as the preface informs us that the object of the book is "to introduce unprofessional students of nature to certain interesting phenomena of the sea-shore and of the depths of the ocean," it is very possible that babes in science will find well-sweetened pap more digestible than strong meat. We must, however, protest against the liberties which Prof. Shaler takes occasionally with our mother-tongue. He is too fond of "telephonese" or "telegraphese," as it might be called. This tongue may be good American, but it is not good English. We do not mean to assert that no improvements could be made in the latter, or to pose as prudes of etymological purity, but we object to the coinage of new words, or, rather, the misuse of old words, where grammatical expressions already exist, longer only by a few more letters or, at most, syllables. Brevity may be the soul of wit, but it is not always an adornment in speech. Is there any real gain (to take a few examples) in such an adjective as "pivotal," such participles as "fiorded," "forested," "peninsulated," "well-harboured" (*i.e.* with many harbours), and such a verb as to "raft off" in the sense of transport or carry off like a raft.

Prof. Shaler is a picturesque writer, and his descriptions usually are clear and vivid; but dangers lurk in the attempt to be graphic when a locality is known only at second-hand. Of this the book before us affords an amusing instance. Speaking of the advance of dunes, he quotes the well-known case of Eccles (Norfolk), saying: "Thus in Britain one of these dunes in the last century invaded the village of Eccles, and buried the dwellings and the parish church, so that even the top of the spire was hidden. After a number of years the summit of the church began to reappear on the leeward [? windward] side of the hill, and in time the remote descendants of the dispossessed people may be restored to their heritage." But the dwellings had practically disappeared before the dunes rolled over them: the church had been a ruin for at least two centuries; of its body only the foundations remained; there was no spire, and apparently never had been one; and the octagonal lantern of the tower was never wholly buried, unless the well-known engraving in "Lyell's Principles of Geology" represents an exceptional condition of the sandhills. So if the descendants of the original villagers do return to their ancestral domiciles, they will find themselves "Lords of the sands, an heritage of waves." Indeed, since Prof. Shaler wrote, even the old tower has tumbled down, destroyed by the waves during a gale last January.

We venture also to think that Prof. Shaler takes rather too much for granted in assuming, without a hint that this has been disputed, that great rock basins have been excavated by glaciers. Moreover, he is hardly correct in saying that fjords are restricted to ice-worn regions, for Cornwall can show more than one very respectable imitation of such an inlet, and on the Dalmatian coast they are not rare; yet we can hardly suppose that even in the coldest part of the Great Ice Age, precipitate glaciers descended from the Montenegrin Highlands to scoop out the Bocche di Cattaro. But perhaps an inlet of the sea only becomes a fjord when it shallows towards its mouth; if so, that should have been clearly stated. Doubtless these basin-like fjords are difficult to explain; but as Prof. Shaler admits the existence of submerged moraines, no excavation need be required. At any rate it would be well, as a preliminary step, to prove that glaciers are agents of excavation to any important extent, for this has been denied by many geologists, who vainly ask to be shown any proofs of such effects in the subaërial part of their course.

But we must not dwell too much on blemishes, which after all are light. Even the four earlier essays, already mentioned, exhibit a certain freshness, for Prof. Shaler, as an American, selects the majority of his examples from the other side of the Atlantic, instead of using those which have become the stock-in-trade of every European geologist. By this means more than one point is brought out more clearly than is usual in English books, because illustrations are difficult to obtain from our own islands, or any readily accessible part of the neighbouring continent. For instance, his remarks on the action of vegetation in a shallow estuary or bay, and particularly on the growth of "mangrove swamps" are valuable. He describes how the large tapering cylindrical seed of the mangrove, floats in a vertical position, settles down and becomes entangled on the bottom by means of the numerous hooklets which arm its lower extremity, then sends a shoot up above the surface of the water, from which come wide-spreading, low-growing branches. From these long runner-like processes are thrown off, which at last curve sharply downwards through the water till they strike root at the bottom, and then support new crowns, each having its own trunks and branches. "Thus a single tree may rapidly march away from the original planting-point until its outer verge may be an indefinite distance from its place of origin." This method of growth enables the grove to resist even fairly strong waves, and facilitates the accumulation of organic débris and inorganic sediment.

Again, there are some striking remarks on the accumulation of molluscs, especially bivalves. Prof. A. Agassiz has already called attention to this process on the great Florida plateau, and Prof. Shaler particularly mentions the special importance of the oyster as a rock builder along the whole coast from New York southwards.

"In its maximum development" he says, "the larger part of the shallow bottom inside the ocean beach is occupied by beds of these shells. So crowded are these forms, that they push their growth above the level of low-tide mark, and in the region where the mangroves abound they cluster on the roots of the trees to such numbers as often to hide them from view. . . . Between Charleston, South Carolina, and Biscayne Bay, Florida, there is an aggregate area of nearly a thousand square miles which, when the shore assumed its present elevation, was occupied by tolerably deep water that has now become filled to near the level of high water, by sediments composed in large part of oyster-shells."

In fine, these three essays contain not a few interesting and suggestive passages. The illustrations often are very good.

THE CHEMISTRY OF COD-LIVER OIL.

Cod-liver Oil and Chemistry. By F. Peckel Möller, Ph.D. (London: Peter Möller, 43 Snow Hill, E.C., and at Christiania, Norway, 1895.)

THIS book is divided into two parts—the title of part i. is "Cod-liver Oil"; the title of part ii. is "The Law of Atomic Linking, diagrammatically illustrated," and the heading of the first chapter of the second part is "Chemistry." There is a separate preface to each part, and, though bound together in one volume, each forms an independent treatise, and is separately paged. One hundred and eleven pages are devoted to "cod-liver oil," and rather more than five hundred to "chemistry."

In the preface to the first part the author gives two reasons for the publication of the work: (1) to deal with all matters connected with cod-liver oil, and especially with those likely to be of interest to members of the medical profession; and (2) to give the results of the investigations lately undertaken by Mr. Heyerdahl, which "throw the first and only true light on that mystery, the real nature of the oil."

The first and second chapters give an interesting account of Norway, which is styled "the land of the mid-night sun and cod-liver oil"; its people, past and present; its social customs; the Gothenburg system in every town; its land question; its fisheries, fishermen, and fishing boats, their tackle and bait; its tourist visitors, and its "oldest established visitor," the cod-fish.

The next chapter is on "cod-liver oil,' and the reader is instructed, as pleasantly as in the preceding chapters, in the ancient and modern methods of preparing the oil for use. The older method, it appears, was in use until so late as the year 1853, when a great improvement was effected by the introduction of the steam process of extraction, by which means the pure oil only is obtained from the livers, instead of oil mixed with a great number of decomposition products. This steam process was a great advance. The resulting oil had lost much of its objectionable taste and smell, but it still retained one very bad characteristic—it was still very apt to give rise to nauseous eructations. Unwelcome flavours continued to assert themselves after a dose of such oil, not once only but again and again, till, as the author says, the unhappy recipient was tempted to say, "life is not worth living if it is to be only at the cost of taking cod-liver oil." Hence the host of attempts that have been from time to time made to treat the oil so as to abolish these disagreeable properties. These are dealt with in the chapter called "Pharmaceutical Annotations," and some forty different ways of disguising or improving the oil are described in detail—the ingredients for mixing with the nauseous article including such diverse things as beer, iron-water, peppermint oil, coffee, eucalyptus oil, wood-tar, ammonia, ketchup, celery-seed infusion, vinegar, iodoform, saccharin, acetic ether, &c.; and, besides all these, every conceivable form of emulsion seems to have been tried. It will be welcome news to many that, in Dr. Möller's opinion, all these elaborate preparations are now quite uncalled for, and that Heyerdahl's investigations have at length led to the possibility of an oil being produced more curative than the old oil, and quite free from nauseating powers. These researches are fully described in a separate chapter, and are considered to have revealed the presence in the oil of two hitherto unknown glycerides, which have been named, respectively, *therapin* and *jecolein.* They are both exceedingly unstable compounds, and easily become oxidised, and these oxidation products are believed to be the real cause of the too well-known unpleasant after-effects of the drug. As a result of these discoveries an apparatus has now been devised by which cod-liver oil can be produced on a large scale without even the slightest oxidation taking place. Air is excluded from the beginning to the end of the operation, the process being conducted in a current of carbonic acid from the moment the livers enter the apparatus until the oil obtained from them is safe within the bottles.

The chapter giving a synopsis of the chief researches on the oil since 1822 is very complete, and will no doubt prove of great interest to medical men and pharmacists.

The conclusion arrived at as to the therapeutic agent in cod-liver oil is that "it is the oil itself," and that its remarkable power as a nutritive food is the cause of its medicinal efficacy, and not any special active principle contained in it. This opinion is in agreement with that of the late Prof. J. Hughes Bennett, of Edinburgh, who published, in 1841, a pamphlet on cod-liver oil, which had much to do with the general introduction of the oil as a medicine into this country. It is one of the omissions in the present volume that no reference is made to the work of Dr. Bennett in this direction.

The object of the second part of this work, as set forth in the preface, is mainly to bring the facts of organic chemistry, freed from unnecessary difficulties, within the grasp of busy medical practitioners. With this object graphic formulæ are profusely employed, so that "a glance will lay bare to the eye of the novice the whole details of the constitution of the most complicated compounds," and the practical preparation of the compounds has been generally omitted "because the much tried patience of medical men need not be burdened with things chiefly of interest to the chemist." With these exceptions a large proportion of organic chemistry is very fully treated, and a careful reading of the work in leisure moments would doubtless give any one, who had some previous knowledge of the science and some liking for it, a fair grasp of somewhat more than the outlines of this vast and ever-increasing field. Especially interesting, though demanding more than cursory reading, is the concluding chapter on atoms, linkage, and stereo-chemistry. In our earlier days chemists did not so much concern themselves with these things. The determination of mere composition and formulæ furnished enough occupation. But with advance of knowledge it has been found necessary to study what has been called the "atomic architecture of molecules." In the concluding pages this subject is very ably and lucidly discussed. A new hypothesis is suggested, to which the name of the "screw theory" is given, which, it is pointed out, may satisfactorily explain those cases of optical activity which are met with in certain bodies, *e.g.* some terpenes and glycerides, where there is no asymmetrical carbon-atom, and which are consequently not clearly met by van't Hoff's ingenious theory.

The volume is one in the production of which great labour and care must have been expended, and both parts are worthy of commendation. Possibly, however, it would have been advantageous to both, if they had been published separately. JAS. CAMERON.

OUR BOOK SHELF.

Astronomische Chronologie. By Walter F. Wislicenus. (Leipzig: B. G. Teubner, 1895.)

HISTORIANS, archæologists, and astronomers will hail with delight this work, as it fills a gap which for some time past has been very apparent. At the present day, to take one case only, archæologists are busy in Egypt deciphering and unravelling the legion of myths which are there recorded in the many forms and ways peculiar to that country. Many of these myths are, as has been recently more clearly pointed out, purely astronomical in their nature; and this is perfectly natural when one considers that the Egyptians, or, at any rate, the priests, for these were the chief writers, were astronomers. Archæologists in fathoming these depths are perfectly at home when archæology is in question, but as soon as the astronomical boundary is reached, and astronomy pure has to be attacked, then perfectly different problems are met with. In like manner, the astronomer himself, going from the astronomical to the archæological side, is also nonplussed, unless he wishes to enter somewhat generally into the study of Egyptology. In the book which we have before us, Dr. Wislicenus gives the historians and archæologists a helping hand, and presents them with the necessary means and ways of solving some of the problems which are generally encountered.

Without entering too minutely into the contents of these 150 odd pages, a general survey of the text will best give the reader an idea of their character.

The two parts, into which the book is divided, deal respectively with the fundamenta of astronomy, and the different methods of computation.

The former part is concise and brief, and the author in forty-four pages presents the reader with a general summary of the different systems of coordinates used, the different kinds of years, the course of the moon, eclipses, daily and yearly rising and setting of the heavenly bodies.

The methods of computation in the second part are so arranged that they follow, in the same order, the text in the first. At the commencement of this part Dr. Wislicenus brings together a list of the numerous tables which are used for the solution of chronological problems. These are here given with their full titles, and are explained further on. The remainder of the book is devoted to the solutions themselves, and these are arranged as follows: First, the known and the unknown quantities are separated, then the tables to be used in the problem in question are explained; following these, typical examples are taken and worked out by the use of the different tables.

A very full index makes reference easy, and completes what will prove a very useful book. W. J. S. L.

Die ältesten Karten der Isogonen, Isoclinen, Isodynamen. By Prof. Dr. G. Hellmann. (Berlin: A. Asher and Co., 1895.)

THIS is the fourth of the elegant series of reprints devoted to classical contributions to meteorology and terrestrial magnetism. It contains seven maps, all excellently reproduced, and representing old standard charts of isogonic, isoclinic, and isodynamic lines. The maps portrayed are Halley's Declination Chart of the World, published in 1701; Whiston's two maps (1721), showing lines of equal magnetic Dip in the South of England; J. C. Wilcke's Isoclinic Chart of the World in 1768; a chart by Humboldt, published in 1804, showing Isodynamic lines over part of South America; and Hansteen's Isodynamic Charts (1825-26) of North-West Europe and of the world.

Halley's description of his "New and Correct Sea-Chart of the Whole World, ſhewing the Variations of the Compass," is reprinted, and brief descriptions are given of the other maps.

Whiston, it may be remembered, suggested that longitude might be determined from magnetic inclination, this element being preferred to declination for reasons which he stated as follows: "When, therefore, I considered that the Lines of equal Dip could hardly be more irregular than those of the Variation; I well knew that Mutation was a great deal slower; and that these might probably be useful over all the World; I conceived great hopes that this way of Application of the Power before us might very probably discover the Longitude."

Prof. Hellmann contributes a number of bibliographical notes, and these, with the maps, make the reprint a compact and useful work of reference.

An Elementary Text-book of Hydrostatics. By W. Briggs, M.A., and G. H. Bryan, M.A. Pp. 208. (London: W. B. Clive, 1895.)

THE portions of hydrostatics and pneumatics usually taught to beginners, and required for the matriculation examination of the London University, are concisely and clearly treated in this book. Though evidently constructed for examinational purposes, the book contains a number of good points. The mathematical formulæ are deduced from first principles instead of being stated dogmatically; so the student is led to rely more upon his real knowledge, and less upon mere memory. This and other commendable features distinguish the volume from ordinary text-books of hydrostatics, while the numerous problems, covering a wide field, furnish clear evidence of originality.

LETTERS TO THE EDITOR.

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The Statistical Investigation of Evolution.

MR. THISELTON-DYER states that Prof. Weldon has shown that "selective destruction" takes place in early life amongst individuals which deviate from the "mean specific form." He further says that the actual statistical demonstration of the fact that "minimum destruction is in position coincident with the mean of the whole system," deserves to rank amongst the most remarkable achievements in connection with the theory of evolution. But, to judge from the paper by Prof. Weldon, printed in NATURE of March 7, he does not claim to have made this remarkable achievement. He says that, according to the results of the statistical investigation, in two dimensions of the shore crab, the frequency of deviations increased during an early period of growth, and that in *one* case the increase was followed by a decrease; in the other case it was not. Prof. Weldon states that if a certain law of growth can be shown to be true by experimental tests, *then* the result implies a selective destruction in the one case and *not* in the other. So that all we have is the possibility in the future of a statistical demonstration of selective destruction in the case of one particular dimensional character, and the rigid proof in the present that in the case of the other dimensional character selective destruction does not take place. Surely every man of science must admit that Prof. Weldon's results, on his own showing, have done more against selective destruction than for it.

Prof. Weldon says that if we know that a given deviation from the mean is associated with a greater or less percentage of death-rate, we do not require to know how the increase or decrease of death-rate is brought about, and all ideas of functional adaptation become unnecessary. This may be his own state of mind on the subject, but I venture to state that it is not Darwinism, and that he cannot shut out others from the most interesting and most important fields of biology in this way. Darwinism states that selective destruction is caused by the struggle for existence, and that a selected character confers an advantage in the competition to get food and beget offspring. If a certain deviation is shown to be associated with an increased or decreased chance of life, we want to know how it acts, and no statistical Gallio can prevent us trying to find out.

It does not require much search to find deviations which are associated with an increased death-rate. In the human subject cyanosis, due to the retention of the fœtal communication between the two sides of the heart, is a well-known abnormality or deviation in the infant; but I believe few, if any, children born in that condition reach the age of 20. Here we have no difficulty in understanding the reason: the deviation necessarily leads to death. But now, in comparison, take the case of a child born blind, or deaf and dumb. Here there is no intrinsic reason why life should be shortened; but in a severe competition, if the individual depended entirely on his own exertions, he might be, probably would be, starved or trampled to death before he had lived very long. I think it is of some interest and importance to know of any given character or deviation, whether it is intrinsically harmful or beneficial, extrinsically so (*i.e.* in the struggle for existence and reproduction), or quite indifferent.

Prof. Weldon is silent, to some extent, about the cases which tell against the idea of selective destruction. He found that deviations in Aurelia were as numerous in the adult as in the Ephyræ. He told me in conversation, and did not say it was in confidence, that he abandoned some experiments on the selection of Daphnia, because he found that the mere fact of keeping a large number in the same water caused a progressive disappearance of a certain conspicuous spine. His investigations also entirely ignore the diagnostic value of the characters he deals with. It seems to me that a more valuable result would be gained if a parallel investigation were made of two characters—one obviously diagnostic, the other obviously adaptive. Such characters could be found in a swimming crab.

But above all, what we want is a comparative investigation of the results of selection without change of conditions, and of change of conditions without selection. I began, not long ago, to try to inaugurate a society for carrying on a thorough investigation of this kind, but have not at present received enough support to carry out the scheme. The method of the investigation is fairly obvious and not difficult, but the difficulty is to get the money and the time to carry it out. I differ from Prof. Weldon in thinking that the questions raised by the Darwinian hypothesis are not purely statistical, but experimental, and I agree with Mr. Thiselton-Dyer—that to talk of experimentally checking the hypothesis by the statistical method is a contradiction in terms.

J. T. CUNNINGHAM.

Cleethorpes, March 15.

A True Spectrum Top and a Complementary One.

To make a true spectrum top—which is not copyright, so far as I know—take a disc of white paper, and one of black, of equal size. Spin the white one on a disc of cardboard mounted on a nail, and while it is spinning draw a small brush well charged with lamp-black water-colour paint, steadily and not too slowly from centre to circumference of the disc, thus describing a spiral line. Make a radial cut in each of the discs, and after interlocking them as in the well-known colour discs, place them on the top. We thus obtain a top in which the lines are spiral, and the relative sizes of black and of white areas are easily regulated by turning one disc to right or left, while the other is held still. If the lines be not too thin or too thick, and not too near together, and if the relative areas of black and white be adjusted suitably to the light, the top exhibits, when spun, broad bands of colour, each band containing all the colours of the spectrum in their natural order. The spaces between the lines should be not less than five times as broad as the lines themselves. The brightest effects are produced in my own case, by lamplight, with the areas of light and dark almost equal; by daylight, with the dark area about three times as great as the light. Other proportions, however, seem to give better results with other people.

A "complementary top," yielding colours complementary to those of the spectrum (*i.e.* the colours of mother-of-pearl) in a continuous band ranging from lemon-yellow, through puce to electric-blue-green, is made in the same way, except that the spiral line is to be drawn in white on the black disc.

In both cases the colours are somewhat dilute, but the proper regulation of the relative areas of black and white reduces this defect very considerably, and I have obtained bands on my spectrum top brighter and purer than any which I could get by painting a spectrum with colours on paper.

I communicate this description before my experiments are complete, in order to prevent anyone who may make the same discovery, from obtaining a copyright for the design of either these tops or of earlier ones which I made, in which one half the disc was black and the other white, with a white spiral on the black, or a black spiral on the white, or with both at different distances from the centre on the same top. Anyone who wishes to do so may make as many tops or lantern-discs as he chooses from the above description, provided he does not attempt to hinder anybody else from making or selling similar ones.

C. HERBERT HURST.

Owens College, Manchester, March 24.

A Foucault Pendulum at Dublin.

IT may perhaps interest some of your readers to learn that Foucault's pendulum experiment has recently been performed in Trinity College, Dublin, with complete success.

Immediately under one of the glass domes, by means of which the hall of the New Building is lit, a cast-iron bar was securely bolted, which terminates in a cylindrically-shaped piece of metal the axis of which is vertical. Into this cylinder a steel plug was inserted, which was drilled to receive the upper end of the wire supporting the bob, which was fitted with a screw. By placing the upper end of the wire in this position, Prof. FitzGerald and I secured a length of 45 feet for our pendulum; but, under the circumstances, we were unable to use the same weight as that adopted by Sir R. Ball when making the experiment, viz. 300 lbs., and were obliged to content ourselves with a bob weighing 16 lbs., which, however, answered admirably.

The experiment is made in the following manner:—About two feet behind the position of equilibrium of the bob, we place the electric lamp, and at a suitable distance in front a lens, so arranged that when the bob is swinging, and in the position of maximum amplitude nearest the lens, the shadow of a portion of the wire immediately above the bob, thrown on a screen some 32 feet distant, is clear and distinct, and coincides with a vertical black line thrown on the white screen.

The bob is drawn back towards the lamp about eight inches, by a loop of thread, and when we wish to experiment the thread is then burned in the usual manner.

When the pendulum completes its first oscillation, the shadow falls exactly on the black line traced on the screen. In about *five* minutes the shadow has moved to the left of the line, and in ten minutes conspicuously so. In this time the maximum amplitude has decreased so little that the image on the screen is still distinct and clear when the pendulum is in a position nearest the lens. W. R. WESTROPP ROBERTS.

Trinity College, Dublin.

Snake Cannibalism.

I HAVE read with interest the numerous accounts of snake cannibalism which have lately appeared in NATURE. During my residence in South Africa, I have come across several instances of a similar nature. A few weeks ago I received a large roughals (*Sepedon hæmachate*) which had swallowed another one of the same kind and of nearly its own length. As the swallowed individual was too long to disappear completely before the front portion of its body was digested, its tail was sticking out of the mouth of the swallower by about six inches. I have dissected two yellow cobras (*Naja haji*), each of which had swallowed a puff adder (*Vipera arietans*) more than three feet long. This case is very interesting, as the puff adder has much larger fangs than the yellow cobra, and in a fight the latter would probably succumb. To mention only one more case, I received, some years ago, the skins of a cross-marked schaapsticker (*Psammophis crucifer*) and a spotted schaapsticker (*Psammophylax rhombeatus*), the former of which had swallowed the latter. In all cases which have come under my personal observation the swallowed snakes had entered head first, and thus probably they were simply drawn in after having caught hold of the same prey as the swallowers. In conclusion, I may mention that cases similar to the above are frequently described in the South African newspapers. J. SCHÖNLAND.

Grahamstown, South Africa, March 1.

American Fresh-water Sponges in Ireland.

A SHORT time ago, Dr. R. F. Scharff, Dublin, sent me a small collection of Irish Spongillidæ. The examination of the material resulted in the discovery of two or three American species, obtained from the West of Ireland, viz. *Heteromeyenia ryderi*, Potts, *Tubella pennsylvanica*, Potts, and (?) *Ephydatia crateriformis*, Potts, the first of these three species having been identified by Dr. W. Weltner, Berlin. All these species are new to Europe, and as they were found in a small collection taken more or less at random, it is probable that if the freshwater fauna of the West of Ireland were thoroughly investigated, a great many more American species would be discovered.

Details will be published in the May number of the *Irish Naturalist*. R. HANITSCH.

University College, Liverpool, March 13.

Peripatus in the West Indian Islands.

WEST INDIAN records show that occasionally single specimens of various species of Peripatus have been found in the different islands. During the past week, Mr. Lunt, my assistant, found a single specimen, and a further search being organised, resulted in the capture, by two collectors, of fifty specimens. These, it is believed, belong to two different species, and a goodly number of the specimens have been sent for determination to the British Museum.

Either the animals are more numerous than usual, or the previous search for them has not been a very careful one, as the whole of our specimens were found within the precincts of the Gardens. J. H. HART.

Royal Botanic Gardens, Trinidad, March 6.

Planetary Photography.

I UNDERSTAND that in photographing a planet, such as Mars, only a short exposure can be allowed, because there is no way of compensating the planet's *axial* rotation. But, while following the planet with the equatorial, would it not be possible to compensate this axial movement by slowly sliding the plate, so that certain features of the planet should fall always on the same parts of the plate? If this is so, an exposure of some length might be available for the more central portions of the disc, those portions for which, during the interval, no serious alteration due to foreshortening comes into play.

Cardiff, March 23. C. T. WHITMELL.

Cleaning Tobacco Pipes.

I HAVE discovered a new method for cleaning pipes which have become foul. A shallow cork, through which a hole is bored large enough to enable it to fit tightly on to the nozzle of a soda-water syphon, is fitted into the bowl. The nozzle is inserted, the mouth-piece directed into a vessel, about a wineglassful of soda-water forced through, and the pipe is clean!

This is not a scientific discovery, but it may be of use to those scientific men who are smokers. Rubber stoppers answer better than corks. CECIL CARUS-WILSON.

THE HABITS OF LIMPETS.

SOME observations made by the present writer at the Scottish Marine Station during July 1884, were published in NATURE for January 1, 1885. These observations confirmed the statements previously made by various naturalists, from Aristotle onwards, that the common limpet (*Patella vulgata*) settles down on some eligible spot (its "scar") between tide-marks, and makes a home, to which it returns after having been out to feed. The conclusion was drawn from various data that this "locality sense" is independent of smell, sight, and touch so far as the head-tentacles are concerned. Prof. Lloyd Morgan, in a letter to NATURE ("Homing of Limpets," December 6, 1894), has shown that the limpet possesses an even greater power of "homing" than previous observers have suspected, and he believes that the head-tentacles are the sense-organs concerned.

Since 1884, I have made further notes, and aided by a grant from the Research Grants Committee of the Royal Society, to whom my best thanks are due, have pursued the subject with some care during the past year. The results, apart from those connected with histology, here follow.

The limpets observed live on a reef, which extends several hundred yards seawards (practically west) from the front of Aberystwyth College. The rocks are Silurian grits and imperfect slates, alternating in a very regular way, striking north and south, and tilted at high angles. At low tide the *Laminaria* zone is well exposed, and for some yards above this the rocks are somewhat bare, except that they are thickly encrusted with small *balani*. Nearer the land various brown seaweeds (mostly *Fucus serratus*, *F. vesiculosus*, and *Ozothallia nodosa*) thickly cover the reef, except towards high-water-mark, where they become scanty. Throughout this area limpets of all sizes abound, being specially numerous, however, on the barnacle-encrusted rocks above mentioned. Groups of them were here marked with enamel paint, and watched. A number of observations were also made on the small limpet, which lives on *Laminaria*, and has its shell marked by three diverging blue streaks (*Helcion pellucidum* = *Patella pellucida*).

Food and Feeding.—As before, the chief food noticed consisted of the minute algæ coating the *balani* and rock-surfaces. Specimens were also found feeding on the calcareous seaweeds *Corallina* and *Melobesia*, on *Fucus*, and on *Laminaria*. It was suggested in the previous notes that the great length of the radula is perhaps correlated with the large amount of wear and tear entailed by the constant "scraping" of barnacles, &c. This appears to be confirmed by comparison with *Helcion*, in which *Laminaria* constitutes the chief, if not the only, food, and in which the radula is relatively somewhat shorter.

At Granton, in July, the larger limpets appeared to feed most frequently; but at Aberystwyth, during the colder months, the small individuals are far more active. Sheltered corners and warm days afford the best chance of watching the movements. Though limpets undoubtedly regain their scars, or secure places, as the tide advances, I am inclined to think they must also often feed when covered by the water, for (1) the finest specimens are found low down, and their time for feeding when uncovered is limited; (2) I have seen a small limpet feed on *Corallina* in a tide-pool.

The scraping sound heard on the rocks during warm weather is not entirely due to feeding limpets. *Purpura lapillus* is also busy at work "sawing out" *balani* from their shells.

Locality-Sense.—I still think, *pace* Prof. Lloyd Morgan, that the head-tentacles are not indispensable to homing, though it must be admitted that they may commonly help in the process. One limpet observed homing by me, certainly seemed to be "feeling" its way along by means of these organs, which were extended and waved about and applied to the rock from time to time, not by the extreme tip only, but also laterally for about $\frac{1}{16}$ of an inch from this. This individual was No. 2 of a small group living among the barnacles, and kept under observation from November 26 till the present time. The dimensions of these limpets are as follows:—No. 1, $\frac{3}{4}'' \times \frac{5}{8}''$; No. 2, ditto; No, 3, $\frac{4}{5}'' \times \frac{2}{3}''$; No. 4, $\frac{7}{10}'' \times \frac{3}{5}''$; No. 5, $\frac{17}{30}'' \times \frac{7}{15}''$. On November 28, at 3.15 p.m., I found No. 2 feeding $1\frac{1}{2}''$ from its scar. About half of each tentacle was excised (*i.e.* the part previously noticed "feeling"), and the animal was replaced where found. On November 29, at 2.55 p.m., it was found back on its scar. A similar operation was performed on No. 5, found feeding $2\frac{1}{4}''$ from its scar, on December 12, at 3.15 p.m. On my next visit, at 2.55 p.m. on December 14, the animal was found to have regained its scar, which, by-the-by, is permanently submerged, being in a small tide-pool. It is true the tentacles were not entirely removed, as was the case with the two Granton limpets which homed after excision. It now appears to me probable that the *mantle-tentacles* may help in homing. These are small conical structures lodged in pits in the mantle edge (Harvey Gibson, *Trans. R.S. Edin.* 1885), and capable of retraction and extension. About 100 of them are present. In submerged limpets I have seen these tentacles protruded for about $\frac{1}{16}''$ beyond the margin of the shell, and executing active "feeling" movements. These were particularly noticeable in an individual which, having regained its scar wrong end on, was shuffling round into the right position. When the front end of the limpet came to point in the right direction, one side of the shell was lowered, and the mantle-tentacles on that side were withdrawn; the same events then happened on the other side. These tentacles appeared to be of two kinds, longer and shorter, the latter being two or three times as numerous. Prof. Herdman first suggested to me that the mantle-tentacles might have to do with the locality-sense, and it at any rate appears probable that they are concerned with accurate adjustment on the scar. It is worth noting that very small limpets home as well as large ones, *e.g.* No. 5 above, and much smaller ones which have fallen under my notice. Prof. Lloyd Morgan's observations, so far as they refer to knowledge of local surroundings which limpets possess, are confirmed by an experiment made on No. 1. On December 16, at 4.5 p.m., this animal was busy scraping barnacles 3" west of its scar. It was removed and placed 10 inches from home, near the top of a nearly vertical barnacled surface (on which it had been seen feeding at 3.15 p.m., November 28), which rises north of its scar. The next visit was deferred till December 26, 12.25 p.m., when the limpet was at home.

The homing faculty is not confined to *Patella*, but is also possessed by *Helcion pellucidum*. This fact is new, so far as I am aware. The animal in question eats out a sheltered home in the bulb, or more rarely in the stalk of *Laminaria*, and wanders out from this along the thallus, rasping a "track" as it goes. I found, for example, one individual at the end of an "eaten road" 3 inches long, and at the other end a very snug dwelling-place drilled out in the side of the stalk. *Helcion* mostly feeds under water. Like *Patella*, it possesses mantle- as well as head-tentacles.

The object of homing appears to be protection from the assaults of the incoming or outgoing tide. There is no danger when the animals are completely covered or uncovered. In many cases the barnacles would otherwise completely cover the rock, and afford very insecure foothold. Once washed loose, a limpet presents a very large surface liable to injury, unlike its neighbour *Purpura lapillus*, which, withdrawn into its thick operculated shell, can stand a good deal of knocking about. The force with which limpets adhere is illustrated by the fact that the five small limpets to which allusion has been made were quite uninjured by the terrible gale and high sea of December 21 and 22, to which they were fully exposed. The much thinner shell of *Helcion* is explained by the sheltered position of its home. The depressed conical shape of a limpet-shell is probably better fitted than any other to resist the waves, but this statement is made under correction.

Formation of, and Adhesion to, Scars.—An examination of the 'tween-tide rocks at Aberystwyth would readily convince the most sceptical as to the power which *Patella* possesses of excavating depressed scars. Limpets are able to adhere very tightly to a smooth surface which is much smaller than the foot, and by examination of such cases, and of specimens allowed to fix themselves to a piece of plate-glass, I have come to the conclusion that fixation is neither due to secretion of a glutinous substance, nor to the formation of a vacuum under the foot. It appears, in fact, to be a case of "adhesion," like that between two smooth glass surfaces brought very close together. The muscular foot is, so to speak, rolled out on the rock, with which it is thus brought into close contact. Prof. Michael Foster suggested to me the possibility of this method of explanation, which is most probably the correct one.

J. R. AINSWORTH DAVIS.

TERRESTRIAL HELIUM (?).

WE have received the following statement from Prof. Ramsay:—

"I have been trying for clues to compounds of argon. Mr. Miers, of the British Museum, called my attention to Hillebrand's paper on Cleveite, a rare Norwegian mineral, which Hillebrand said gave off 2 per cent. of nitrogen on warming with weak sulphuric acid. Cleveite consists chiefly of uranate of lead, with rare earths. My idea was, if the so-called nitrogen turned out to be argon, to try if uranium could be induced to combine with argon.

"The gas, on sparking with oxygen in presence of soda loses a trace of nitrogen, probably introduced during its extraction; the residue consists of a mixture of Argon and Helium! The brilliant yellow line, of which Mr Crookes makes the wave-length 587·49, is identical with the Helium line. I am collecting the gas, and shall shortly publish regarding its properties."

NOTES.

THE Bakerian Lecture will be delivered before the Royal Society on Thursday, May 9. The research upon which the lecture is to be based has been conducted by Messrs. A. Vernon Harcourt and William Esson, and the title is announced as "The Laws of Connection between the Conditions of a Chemical Change and its Amount."

AN abstract of the paper in which M. Berthelot describes his investigations of chemical combinations with argon, will be found in our report of the meeting of the Paris Academy of Sciences (p. 527).

PROF. ADOLPHE CARNOT has been elected into the Paris Academy of Sciences, in the place of the late M. de Lesseps.

THE late Mr. William Bolitho, of Gulval, Cornwall, has bequeathed £500 to the Geological Society of Cornwall, the income of which sum is to be applied each year in "the production of a gold or richly-gilded silver medal, to be presented to the member of the Society whose attainments, labours, or discoveries in geological or mineralogical science are found most deserving." He has also left a like sum for the Penzance Library.

THE death is announced o Mr. E. Turner, Chairman of the Council of the Sanitary Institute.

WE also notice the death of Dr. E. D. F. Meissel, at the age of sixty-nine. He made a number of important contributions to mathematical astronomy, and his tables of Elliptic Functions, as well as the table of Bessel's Functions, published in the *Abhandlungen* of the Berlin Academy, stand as examples of his work.

MR. H. H. HAYTER, C.M.G., the well-known statist, died at Melbourne last week. He was the first president of the economic and social science section of the Australasian Association for the Advancement of Science. His numerous and valuable statistical publications earned for him the honorary membership of statistical societies in various parts of the world.

DR. CANINI, of Leghorn, a well-known Italian specialist in diseases of children, who died recently, has, says the *British Medical Journal*, bequeathed his entire estate, amounting to 2,300,000 lire (£92,000) for the foundation of a hospital in which poor children suffering from diphtheria may have the advantages of the serum treatment gratuitously.

WE take the following news from the same source:—The late Dr. Alfred L. Loomis, of New York, has left real estate to the value of 400,000 dollars (£80,000), and personal property amounting to 600,000 dollars (£120,000). The income of 25,000 dollars (£5000) is given to the Loomis Laboratory, and whatever part of the income is not used is to be paid to the Professor of Pathology of the University of New York. A sum of 10,000 dollars (£2000) is bequeathed to the New York Academy of Medicine, the bequest to be known as the Loomis Entertainment Fund, and the interest to be used in providing entertainment for the Fellows of the Academy.

M. NILS EIKHOLM, who was at the head of the Swedish astronomical and meteorological expedition for observing the transit of Venus in 1882, has accepted a place in the Andrée balloon, which is to start from Spitzbergen for the North Pole in July 1896. The ascent is to take place from Norskoarna, the distance from which to the North Pole is about 600 miles. But it is not expected that the balloon will travel in a direct line. M. Andrée will visit France in July next, and he will probably be present at the Ipswich meeting of the British Association.

DR. M. A. VEEDER writes: "In the table of 'Days with maximum temperature not over 32° at Greenwich,' on page 174 of NATURE (February 28), the curve rises sharply and decidedly at intervals of exactly twelve years—namely, in 1854, 1866, 1878, and 1890. These years also fell in the well-known period of sun-spot and auroral minimum, but did not comprise the entire periods of such minimum in each case. There seems to be a clue here that is important, and that is in a line with the study of current phenomena of this sort in which I have been engaged, some of the results of which were presented in a paper entitled 'Periodic and Non-Periodic Fluctuation in the Latitude of Storm Tracks,' read at the Chicago Congress of Meteorology in 1893."

THE following are among the lecture arrangements at the Royal Institution, after Easter:—Prof. George Forbes, three lectures on "Alternating and Interrupted Electric Currents"; Prof. E. Ray Lankester, four lectures on "Thirty Years' Progress in Biological Science"; Prof. Dewar, four lectures on "The Liquefaction of Gases"; Dr. William Huggins, three lectures on "The Instruments and Methods of Spectroscopic Astronomy" (the Tyndall Lectures); Mr. Arnold Dolmetsch, three lectures on "Music and Musical Instruments of the Sixteenth, Seventeenth, and Eighteenth Centuries: 1. English; 2. French; 3. Italian" (with illustrations upon original instruments). The Friday evening meetings will be resumed on April 26, when a discourse will be given by Dr. John Hopkinson, on "The Effects of Electric Currents in Iron on its Magnetisation." Succeeding discourses will probably be given by the Earl of Rosse, Veterinary-Captain Frederick Smith, the Hon. G. N. Curzon, M.P., Mr. J. Viriamu Jones, Prof. Alfred Cornu, and other gentlemen.

A STRONG earthquake shock was felt at 1.16 p.m. on Saturday last at Comacchio, in the province of Ferrara, Italy. Several houses and a church were slightly damaged. At Mirabella Imbaccari, in the province of Catania, in Sicily, the earthquake caused the collapse of a building.

DR. B. BRAUNER, Professor of Chemistry in the Bohemian University, Prague, suggests to us that argon possibly exists in nebulæ. He points out that a strong argon line, measured by Mr. Crookes, has practically the same wave-length as the chief nebula line, and thinks that the line at λ 3729·8 in the "blue" spectrum of the new substance represents the line at λ 3730, found in the spectra of nebulæ and white stars.

HERR W. SIEBE has started on a botanical exploration of Asia Minor, with the special object of making collections of the almost unknown flora of Cilicia Trachea. Setting out from Cyprus, he proposes to visit Mersina in southern Asia Minor, proceeding then to the Kalykadnos Valley and the adjacent mountains, the steppe-district of Konia, the maritime district of Egerdir, and finally, in the summer, the elevated alpine region of Geigdagh.

A STORM of unusual severity passed over these islands on Sunday last. At 8h. a.m. on that day it was central over the south of Ireland, and by 6h. p.m. of the same day the centre had reached Denmark, having traversed a distance of 600 miles in ten hours, which gives an average rate of progress of sixty miles an hour. Much damage was done to life and property over the whole country; but its greatest violence was felt over the southern and midland counties. The maximum force at Greenwich was at 2h. 20m p.m., when the anemometer registered a pressure of 36 lbs. on the square foot, which is equivalent to an hourly velocity of eighty-five miles. Thunder and lightning occurred at several places in the rear of the disturbance.

THE project of a great free public library in New York City has just taken shape, and been adopted by the several persons and boards of trustees interested. It contemplates the union of the Astor, Lenox, and Tilden funds, aggregating 8,000,000 dollars. The site of the library is not yet determined, owing to some restrictions on the use of the block facing Central Park, on which the Lenox Library now stands. This site is preferred if available. Boston, with its 5,000,000 dollars free library, just completed, has already taken the lead. Brooklyn has in the library of the Pratt Institute the nucleus of an admirable free library, for which a new building is nearly ready.

WE are glad to learn of the continued growth and development of the Brooklyn Institute, due in great measure to the stimulus imparted by the Brooklyn meeting of the American Association for the Advancement of Science last summer. Since that time the membership of the Institute has increased many hundreds, bringing it up to very near four thousand, and making it one of the largest scientific associations in the world. Plans for a new building and museum, to cost several million dollars, have been for some time ready, and only await funds. Probably work will begin during the present season. The site is secured, and it is hoped that aid from the city will be obtained as soon as the condition of finances justify it. Meanwhile the Institute, in its geographical section, is foremost in promoting far-reaching plans of exploration toward both poles. Besides the arctic expedition mentioned in NATURE last week (p. 488), a well-digested plan for antarctic exploration has been presented by Dr. Fred. A. Cook, who is already familiar with travel in the north. He proposes to start next September, equipped for a stay of three years, but with the intention of returning in two years unless accidentally detained. It seems probable that the expense of the expedition will be provided for, and that it will be the best equipped that has ever ventured into that region.

IN the February and March numbers of the *Geological Magazine*, Miss Agnes Crane gives an account of the results of recent research on the geological distribution of the Brachiopoda, and their bearing on the evolution of the group. The simple *Paterina* of the Cambrian is regarded as the actual root-stock of the group, and the descent of the chief lines is traced from it, with some breaks here and there from imperfection of knowledge. According to Beecher, almost all Brachiopoda pass through a "paterine" stage of development. *Lingula*, which (in the proper generic sense) does not occur below the Ordovician, passes in its development through a stage in which it resembles its predecessor *Obelella* of the Cambrian, and the latter is said to have a transient "paterine" stage. *Terebratulina* is also stated to pass through a "linguloid" stage, yet its branch is not regarded as derived from *Lingula*, but independently from *Paterina*. Numerous other genera are dealt with, and the paper is illustrated by two plates, one giving the genealogical tree of the Brachiopoda, and the other some examples of the relation of forms.

THERE is an interesting note in the *Bulletin* of the Royal Gardens, Kew, on the use of green glass in plant-houses. The use of glass of a green tint has been for half a century a characteristic peculiarity of the plant-houses at Kew, having been adopted in 1845-46 on the recommendation of Mr. Robert Hunt, F.R.S., on the ground that while admitting light and chemical power in the same proportions as white glass, it would obstruct the passage of those rays which produce scorching. Recent investigations have, however, shown that the green glass used at Kew intercepts about one-half of the effective influence of ordinary sunlight on the processes of plant-life. Of late years the increasing haziness of the sky, due to the smoke produced by the rapid extension of London to the south-west, has produced the same effect at Kew as the use of green glass; and it has become obvious that in the future the plant-houses must be so constructed as to exclude as little of the available sunlight as possible. Since 1886 the use of green glass has, therefore, been discontinued in all the houses except the fern-houses and the palm-house; and, it having been proved by experiment that even filmy ferns thrive better under white than under green light, if direct exposure to the sun is excluded, the use of green glass will now be altogether abandoned at Kew.

THE action of light in producing an electric discharge through a vacuum tube has been further investigated by Messrs. Elster and Geitel, who communicated some very suggestive results to the Berlin Academy at a recent sitting. They used a "photo-electric cell," consisting of an exhausted glass globe with an anode of platinum wire and a kathode of an alloy of sodium and potassium in equivalent proportions, which is liquid at ordinary temperatures. This alloy was illuminated by a beam of white light from a piece of zircon rendered incandescent by an oxy-coal gas blow-pipe flame. This was condensed and made parallel, and then sent through a Nicol prism so as to polarise it in a certain plane. It was then found that a current passed through the cell on connecting its terminals with a battery giving some 400 volts. The strength of this current depended very much upon the angle of incidence and upon the plane of polarisation. It was greatest when the plane of polarisation was perpendicular to the plane of incidence, *i.e.* when the electric displacements constituting light took place in the plane of incidence, and when the angle of incidence was about 60°, *i.e.* the polarising angle of the alloy itself. The phenomena have probably some connection with the fact discovered by Quincke, that light polarised normally to the plane of incidence penetrates furthest into metallic sheets.

OF late years the transmission of electricity through gases has been attracting a considerable amount of attention, and numerous papers have appeared dealing with this subject, one of the last being by G. Vincentini and M. Cinelli. Their paper, which appears in the *Nuovo Cimento* (3) vol. xxxvi., deals with the transmission of electricity through the gas surrounding a wire heated to redness by an electric current. The authors first describe experiments they have made on a long platinum wire surrounded either by air or carbon dioxide. The wire was protected from draughts by a series of screens, and a movable platinum electrode, connected to a quadrant electrometer, gave the potential of the air at different distances above and below the heated wire. It was found that the potential assumed by the electrode connected to the electrometer was higher than the mean potential of the heated wire. When the current passed through the wire was sufficiently intense to heat it to incandescence, the potential of the insulated electrode when placed above the wire did not vary with the distance from the hot wire to any sensible extent, only the maximum electrification was attained at different times after starting the current, and the greater the distance from the hot wire the greater the time which elapsed before the steady state was reached. When, however, the insulated electrode is below the incandescent wire, the difference of potential decreases very rapidly with the distance, so that at 15 m.m. it almost vanishes. In order to carry on observations on other gases besides air and carbon dioxide, the authors have devised a modified form of apparatus in which the incandescent wire is placed inside a globe which is silvered on the inside. This globe has four tubuli, two of which serve for the introduction of the electrodes for the hot wire; while of the remaining two, one admits the insulated electrode, and the other a wire which is connected to the silver coating of the globe, and serves to put this to earth. The authors consider that their experiments show that the gaseous molecules which leave the surface of the incandescent platinum wire in the case of hydrogen are positively electrified, their potential being about 0·25 volt higher than the mean potential of the incandescent wire. In the case of air and carbon dioxide the increase above the mean potential of the wire is about one volt. With hydrogen at a somewhat high temperature an inversion of the phenomenon takes place, since the potential of the insulated electrode becomes less than the mean potential of the wire.

A NEW phototheodolite is described by Herr O. Ney in the *Zeitschrift für Instrumentekunnde*. The novel feature about it is the geometrical clamp, which enables the surveyor to exchange the telescope and the camera on the stand with ease and accuracy. Both are provided with three spherical feet, which rest in a hole, a slot, and a plane respectively, made of hard steel, and fixed on the stand. This seems an admirable way out of the difficulty attending the simultaneous use of telescope and camera. Other instrument-makers combine the two by mounting a telescope at the side of the camera, with a counterpoise on the other side. In one instrument the telescope lens is also used for photographic purposes. But these instruments are either too small, or the adjustment is exceedingly unstable. In Ney's phototheodolite, which is made chiefly of aluminium, provision is made for securing the camera or the telescope on the stand after it is mounted in the hole-slot-and-plane clamp, and also for the constancy of the position of the sensitive plate. With these improvements, the instrument is likely to become a most valuable aid to surveying practice.

DR. C. G. DE DALLA TORRE's useful "Catalogus Hymenopterorum" continues to make satisfactory progress. It is proposed to complete it in ten octavo volumes, exclusive of bibliography and index, which will form a separate volume; and five volumes have already been published, including vol. 1, *Tenthredinidæ* and *Uroceridæ*; vol. 2, *Cynipidæ*; vol. 6, *Chrysididæ*; vol. 7, *Formicidæ*; and vol. 9, *Vespidæ*. The remaining families may be expected to follow shortly. The subject of entomology is so vast that little progress can be made without some entomologist from time to time devoting his life to the compilation of these great key-catalogues, which are landmarks in the study of the orders of which they treat, and stand towards them in the same relation as a dictionary to a language. Moreover, such catalogues involve an amount of patient and unremitting toil that no one can appreciate who has not himself experienced it; they are frequently published at a heavy pecuniary loss, and are peculiarly liable to criticism, which may be fair and friendly in tone, or may be just the reverse. Let us hope that Dr. Dalla Torre's labours will meet with the encouragement which he deserves from the hymenopterists, whose labours he has so much contributed to lighten.

THE discovery of the use of fire dates back to the very dawn of human intelligence; therefore the study of the rites and ceremonials which are found among every race in connection with the lighting of new fires, furnishes important facts for the discussion of the primitive history of human culture. But before it is possible to apply comparative methods of treatment to the subject, exact observations are required of the details of the new fire ceremony, wherever it survives, especially in less modified, savage, or primitive peoples. This requirement is fulfilled by an article, by Mr. J. W. Fewkes, descriptive of the new fire ceremony as it exists among the Pueblo Indians of Tusayan (*Boston Soc. Nat. Hist.*, vol. xxvi. pp. 422–458, Feb. 1895). Mr. Fewkes watched two such observances of the Tusayan Indians, one in 1892, and the other in 1893. In both years active ceremonials began on November 13, and continued five days. Two other days, November 8 and 9, were devoted respectively to "smoke assembly" and "official announcement," and November 18, when all serious ceremonials had ceased, was a general holiday. On each of the five days, from November 13–17, various processions and rituals were observed, in many of which the element of phallic worship plays a not inconspicuous part. It is unnecessary to describe these performances, but one or two remarkable points in connection with the dates on which they take place, are of interest. The Tusayan Indians, says Mr. Fewkes, can neither read nor write, and are ignorant of our almanacs and calendars, nevertheless they manage to make the performances commence on the same date, within a day or two, every year, the time of year being obtained by observation of the stars. Another instance of the astronomical knowledge of such rude people as the Tusayan Indians, is afforded by the fact that the culmination of the Pleiades is used to determine the proper time for the beginning of certain rites. This is a further example of the widespread use of the Pleiades for the determination of the time for the celebration of primitive rites and ceremonials.

IT may interest our readers to know that a catalogue of the more important books published in Denmark and Norway during the year 1894 can be obtained from the Skandinavisk Antiquariat, 49 Gothersgade, Copenhagen. The catalogue contains the titles of a number of important works on various branches of science.

A NEW volume, containing the Biological Lectures delivered at the Marine Biological Laboratory, Woods Holl, in 1894, will shortly be published by Messrs. Ginn and Co. The lectures cover a wide range of subjects, most of which are prominent questions at the present time, and all of which are of special interest to teachers and students of biology.

MR. R. F. STUPART, the new Director of the Meteorological Service of Canada, has commenced the publication of a monthly weather map, showing the mean temperature and the difference from the mean average temperature, also total rain and snowfall for the month, and depth of snow on the ground on the last day of the month. It is interesting to note that an extremely cold spell prevailed over Ontario in the early part of February, some of the low readings being almost unprecedented.

MR. H. W. WILEY, the chemist to the United States Department of Agriculture, recommends the cultivation of the cassava, *Manihot utilissima*, in the most southerly of the United States. It furnishes an excellent food for men and for cattle; though, from the small proportion of nitrogen which it contains, it cannot take the place of bread-stuffs. A very good kind of tapioca may be made from it. The yield, in sandy soils, is from four to five tons per acre.

A COLOURED map, showing the density of the population of Ireland at the Census of 1891, has been prepared and published by Mr. E. E. Fournier, Bray, Ireland. The map exhibits at a glance the density of the population, and shows clearly that some of the oldest railways have had a beneficial influence in preserving or increasing the population of the districts through which they run. It is the first of a series intended to exhibit graphically the physical, social, economic, and religious features of Ireland.

"THE Statesman's Year-Book" (Macmillan and Co.)—that handy compendium of statistical and historical information relating to all the States of the world—has attained its thirty-second year of publication. Edited by Mr. J. Scott Keltie, with the assistance of Mr. I. P. A. Renwick, the volume is a standard work of reference in which the man of business can find the commercial statistics he needs, to which the politician can apply for trustworthy statements, and from which the student of geography can obtain the latest geographical information.

DR. A. B. MEYER, of the Royal Zoological Museum at Dresden, has sent us a description of two new birds of paradise from New Guinea. (*Abh. u. Ber. d. K. Zool. u. Anthr.-Ethn. Mus. zu Dresden*, 1894–95, No. 5). One of the birds, shown in its natural size in one of the two coloured plates which illustrate the paper, possesses remarkable characteristics in the form and colour of its plumage, and in the arrangement of two very long feathers which stretch out from the head to about twice the length of the body of the bird. This bird has been named *Pteridophora alberti*, in honour of King Albert of Saxony, and the second one described and figured by Dr. Meyer has been called *Parotia carolæ*, after Queen Caroline.

THE seventh volume of the *Proceedings* of the Royal Society of Victoria has reached us. The volume contains twenty-eight papers, many of them illustrated with plates, communicated to the Society during 1894. With two or three exceptions, the papers belong to the domain of natural science. Among the contributions we notice one on Tasmanian earthworms, by Prof. Baldwin Spencer, and a note, by the same author, on two new forms of marsupials obtained in Central Australia, during the visit of the Horn Scientific Expedition to the Macdonnell Ranges. The geology of Castlemaine is described by Mr. T. S. Hall, and geological notes on the country between Strahan and Lake St. Clair, Tasmania, are contributed by Messrs. Graham Officer, L. Balfour, and E. G. Hogg. The older tertiary rocks of Maude, and the palæontology of the older tertiary of Victoria, form the subjects of two separate papers, and a catalogue of non-calcareous sponges collected in the neighbourhood of Port Phillip Heads is given by Prof. A. Dendy. Mention must also be made of a paper, by Mr. R. H. Mathews, on rock paintings and carvings figured by the Aborigines of New South Wales, in caves and rock shelters; and also of one in which Mr. E. F. J. Love gives the results of observations with Kater's invariable pendulum, made at Sydney. The object of this investigation was to throw some additional light on the question of the difference between the values of g at Melbourne and Sydney. A comparison of the results obtained by the United States Coast Survey officers at Sydney in 1883, with those found by Mr. Baracchi at Melbourne in 1893, has shown that a pendulum beating seconds approximately should lose 8·58 vibrations per day, if transferred from Melbourne to Sydney. Lieut. Elblein found, however, by swinging three of von Sterneck's pendulums at the two places, that the loss was 13·48 vibrations per day. Mr. Love comes to the conclusion that the difference between the vibration numbers at Melbourne and Sydney is 12·2 per day.

THE additions to the Zoological Society's Gardens during the past week include a Sand Badger (*Meles aukuma*) from Japan, presented by Mr. Frederick Ringer; two Polar Bears (*Ursus maritanus*, ♂ ♀) from the Arctic Regions, presented by Mr. John J. Hughes; a Spotted Hyæna (*Hyæna crocuta*, jv.), a Vociferous Sea Eagle (*Haliaetus vocifer*), a Black Kite (*Milvus migrans*), from East Africa, presented by Mr. T. E. C. Remington; a Black-backed Piping Crow (*Gymnorhina tibicien*) from Australia, presented by Mr. J. D. Haggard; a Raven (*Corvus corax*) British, presented by Mr. W. Hillary; a Puff Adder (*Vipera arietans*) from East Africa, presented by Dr. A. Donaldson Smith; a Chimpanzee (*Anthropopithecus troglodytes*, ♀) from West Africa, a Common Marmoset (*Hapale jacchus*) from South-east Brazil, deposited; a Purple-breasted Lory (*Eos riceniatæ*) from Moluccas, a Blue-faced Honey-eater (*Entomyza cyanotis*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

THE MOON AND ATMOSPHERIC WAVES.—Lunar atmospheric waves, or air-tides, as they might be called, can, according to M. Bouquet de la Grye, be distinctly traced in the records of barometric pressure collected at insular stations or stations situated close to the sea, where there are no powerful local disturbances to obscure them. In a contribution to the *Annuaire du Bureau des Longitudes*, he reproduces curves of atmospheric pressure traced at Brest, St. Helena, Cape Horn, Batavia, and Singapore, which distinctly show a regular ebb and flow twice a day in accordance with the position of the moon. The amplitude depends upon the declination of the moon and upon its distance from the earth, and also upon the latitude of the place of observation. The maximum amplitude at Brest is about a quarter of an inch of water, which means a fiftieth of an inch of mercury, a small oscillation indeed, but one which is well within our limits of accurate measurement. At Batavia the maximum heights are half an hour after the passage of the moon through the upper or lower meridian. But the retardation is almost imperceptible in other places. This is probably due to the extreme mobility of the upper strata of the atmosphere, and contrasts with the great retardation experienced by the ocean tides. M. Bouquet de la Grye points out the striking analogy between the ocean tide, with an amplitude of 1 m. under the equator, in an ocean having a mean depth of 5000 m., and the atmospheric tide of 2 mm. of water in a sea of air the weight of which represents 10,000 mm. of water.

STELLAR PHOTOGRAPHY.—A remarkable illustration of the value of photography in astronomical researches is afforded by a recent comparison of one of Dr. Max Wolf's well-known photographs with the same part of the sky as seen with the 36-inch refractor of the Lick Observatory. Prof. Schaeberle finds that an enlarged photograph of the region about Algol, taken with an exposure of five hours, certainly shows stars down to mag. 16·5, assuming that stars of the 17th mag. are at the limit of vision of the telescope. Making due allowance for the loss of detail in the process of enlarging, "it appears probable that practically every isolated star visible at Mount Hamilton can be photographed by Dr. Wolf, at or near sea-level, with his comparatively small telescope." (*Astronomical Journal*, No. 338). The telescope employed by Dr. Wolf has a Voigtlander lens of six inches aperture.

STANDARD TIME IN AUSTRALIA.—The resolution as regards Australian standard time, adopted at Melbourne last October (see p. 278), has come into effect. Queensland, New South Wales, Victoria, and Tasmania are now all using the time of the meridian 150° E., that is, ten hours before Greenwich. Queensland was the first of the Australian colonies to take action, and there the new time came into force on the first day of this year. Mr. H. C. Russell, of Sydney Observatory, has sent us a copy of the Act which established the mean time of the meridian 150° E. of Greenwich as the standard time in New South Wales, on and after February 1. He says that "South Australia has adopted the time of the ninth hour before Greenwich."

NOVA AURIGÆ.—Notwithstanding the enormous velocities in the line-of-sight recorded by the spectroscope, Nova Aurigæ has given no signs of proper motion, such as can be perceived with the telescope and micrometer. Such, at least, is the result of a comparison of the measurements made in 1894 by Prof. Barnard with those made by the same observer in 1893, and by Mr. Burnham in 1892. (*Ast. Nach.* No. 3279.) The magnitude also remains pretty constant, being 10·5, on the scale adopted at the Lick Observatory. The Nova seems to be too far removed from our system to give any appreciable parallax.

NEW COMPOUNDS OF HYDRAZINE WITH FATTY ACIDS.

COMPOUNDS of several of the more important organic fatty acids with hydrazine, analogous to the aromatic hydrazides previously prepared, have been obtained by Prof. Curtius and his pupils Messrs. Schöfer and Schwan, and an account of them is published in the current issue of the *Journal für Praktische Chemie*. The hydrazides of the monobasic fatty acids are distinguished from the aromatic analogues by their greater solubility in water. In all cases they are most advantageously prepared by reacting with one equivalent of hydrazine hydrate upon the ester of the acid rather than upon the free acid itself. The esters of dibasic fatty acids react analogously with two equivalents of hydrazine hydrate, producing hydrazides which contain two NHNH groups.

Formic hydrazide, $HCO.NHNH_2$, is produced when molecular equivalents of ethyl formate and hydrazine hydrate are mixed, considerable evolution of heat occurring. When the product is allowed to stand in a vacuum for some days large tubular crystals of the pure compound separate. The crystals are transparent, very hygroscopic, and extremely soluble in water, alcohol, ether, chloroform, and benzene. They melt at 54°. Formic hydrazide does not form salts with acids; even dilute acids at once decompose it in the cold with formation of formic acid and a salt of hydrazine. The solution of the crystals in water reduces Fehling's solution and ammoniacal silver nitrate readily at the ordinary temperature. Formic hydrazide forms a crystalline compound with benzaldehyde with considerable rise of temperature and with elimination of water. The crystals of the compound, benzalformyl-hydrazine, $HCO.NH.N:CH.C_6H_5$, melt at 134°. When excess of ethyl formate is heated with hydrazine hydrate in a sealed tube to 100°–130° for some hours, another formic hydrazide, diformyl-hydrazine $HCO.NH.NH.COH$, is produced in the form of brilliant colourless prisms an inch or more in length. In the preparation of this beautiful compound care must be taken to strongly cool the tube during the filling with the two components, as their interaction is otherwise of a dangerously energetic character. The crystals of diformyl-hydrazine are very soluble in water, but difficultly so in alcohol, and practically insoluble in ether. They melt at 159°, and reduce ammoniacal silver solution upon warming. Dilute sulphuric acid decomposes them as readily as those of formic hydrazide into formic acid and hydrazine sulphate.

Acetic hydrazide, $CH_3.CO.NH.NH_2$, is prepared by warming equivalent quantities of acetic ether and hydrazine hydrate in a sealed tube for a few hours at the temperature of a water-bath. The product rapidly solidifies in a desiccator to a white mass of crystals. The crystals are colourless needles aggregated in leaves, and melt at 62°. They deliquesce rapidly on exposure to moist air, and are also very soluble in cold alcohol. The aqueous solution reacts neutral to litmus, and is readily decomposed into the original component substances by either acids or alkalies. The compound cannot be distilled without decomposition. The solution reduces Fehling's solution very vigorously on warming. Like the formic compound, acetic hydrazide reacts with benzaldehyde to produce an analogous crystalline compound, acetyl-benzal-hydrazine, $CH_3.CONHN:CHC_6H_5$.

Oxalic hydrazide, $\begin{array}{l} CO.NH.NH_2 \\ | \\ CO.NH.NH_2 \end{array}$, is produced by the action of two molecular equivalents of hydrazine hydrate upon ethyl oxalate. The reaction is a somewhat violent one, and is best moderated by the addition of a little alcohol.

The new compound separates as a white crystalline mass, which is much less soluble in water than the hydrazides of the monobasic acids, and is almost insoluble in alcohol and ether. It is deposited from solution in hot water in very long and thick needles, which decompose at 235°. The solution reduces Fehling's or ammoniacal silver solution much less vigorously than the monobasic compounds. Oxalic hydrazide is much more stable towards acids and alkalies than the last-mentioned substances. The compound may be recrystallised unchanged from dilute sulphuric acid, and concentrated sulphuric and hydrochloric acids only decompose it very slowly. If, however, concentrated hydrochloric acid is allowed to drop upon the powdered substance moistened with water, until the acid is in slight excess, a white crystalline powder is obtained which is found to consist of the hydrochloride of the hydrazide, $\begin{array}{l} CO.NH.NH_2.HCl \\ | \\ CO.NH.NH_2.HCl \end{array}$. Oxalic hydrazide reacts in an interesting manner with nitrous acid (sodium nitrite and glacial acetic acid); an energetic evolution of gas occurs, and a white powder separates. The same white substance may be obtained by acting upon oxalic hydrazide suspended in water with mercuric oxide, and decomposing the mercury compound produced with sulphuretted hydrogen, the filtrate depositing the white powder upon evaporation. Analysis indicates that the compound probably possesses the constitution, $\begin{array}{l} CO—NH \\ |\quad\;\; | \\ CO—NH \end{array}$.

Succinic hydrazide, $\begin{array}{l} CH_2.CO.NHNH_2 \\ | \\ CH_2.CO.NHNH_2 \end{array}$, is prepared similarly to oxalic hydrazide, and crystallises in silver-like crystal aggregates which melt at 167°, and which are more soluble in water than the crystals of oxalic hydrazide. Malonic hydrazide, $CH_2\!\!\begin{array}{l} \diagup CONHNH_2 \\ \diagdown CONHNH_2 \end{array}$, is likewise obtained in a similar manner, the reaction between malonic ether and hydrazine hydrate being very vigorous even in the cold. The crystals melt at 152°. The aqueous solution reduces Fehling's solution, ammoniacal silver solution, and platinic chloride at the ordinary temperature. Both the succinic and malonic hydrazides are as stable towards acids as the oxalic compound, and each yields a hydrochloride with concentrated hydrochloric acid. Both hydrochlorides are obtained in the form of small crystals, and they melt at 203° and 197° respectively with violent evolution of gas. Succinic hydrazide reacts with nitrous acid to form an interesting compound analogous to that of oxalic hydrazide. Its simplest possible constitution is $\begin{array}{l} CH_2.CO.NH \\ |\qquad\quad | \\ CH_2.CO.NH \end{array}$.

Several other more complicated hydrazides are described in the memoir, but the above will afford a sufficiently comprehensive idea of the important addition to our knowledge of the hydrazine compounds which we owe to the labours of Prof. Curtius.

A. E. TUTTON.

THE AURORA OF MARCH 13.

A NUMBER of letters referring to an aurora observed on March 13, have reached us. We select from these communications a few details of value and interest.

Writing from York, Mr. J. Edmund Clark says:—

"I was in a position for observing at 9.10; the display finally ended soon after 10. The latter part was seen, very similarly, at Scarborough, 9.10. Arch, pure white (and so all through) just north of zenith; east end brighter, with well-defined, beak-like apex upon α Coronæ borealis (alt. 17°, az. 13° north of east). Upper edge just grazed ζ and η Ursæ majoris, the lower some 3° below Polaris, a little west of which it became double, the Pleiades lying in the fork, 5° or 10° from the finish at about altitude 20° or 25°, nearly due west. No auroral glow outside, nor later, except as stated. The outer curves, west end, would have met, if continued, in similar "beak" as at east end.

"9.15.[1] Lower edge through β Ursæ minoris, Polaris, and α Persei. Streamers now traversing rapidly from *east to west*, pointing to magnetic anti-pole; passed from η Ursæ majoris to Polaris in 25 to 30 seconds by watch. Constant succession, as bars of light, for some minutes; then temporary cessation, but later intermittent, until 9.45. These were entirely distinct, as is obvious, from the ordinary far more rapid flickering from horizon to magnetic anti-pole. Three rough positions of stationary forms near the Plough, Auriga, and Jupiter, projected on the B.A. Meteor Star Chart, cross at altitude 68½°, azimuth 35° (¼° and 6° respectively from the true magnetic anti-pole, for York, at 68¾ and 18°).

"9.25. Streamers, often as curtain-like fringe on lower edge of arch, now less prominent. Others still streaming from east to west in the arch show no perceptible effect as they sweep by these. New set moved slowly westward, about 1° or 2° per minute.

"9.30. Lower edge again as at 9.25. Upper edge had covered Plough; arch double more or less entirely; varies fast; much fainter to east from 9.25.

"9.37. Lower edge through handle of Plough, Capella, 1° north of Mars and ⅔ on from Mars to horizon. Fringe below now brilliant, but rapid fluctuations.

"9.45. Brilliant short streamers in fringe, from Mars to α Aurigæ, and ⅓ on to Polaris.

"10.0. All gone but one long faint streamer from 3° to left

[1] If others have thought of recording positions at the exact quarters, some altitudes might be obtained from the four given here.

of Aldebaran up to 1° to left of Jupiter, moving slowly westwards as before."

Mr. G. W. Lamplugh observed the display at Ramsay, Isle of Man, and to him the chief feature was "the predominance of a well-defined luminous bar extending across the heavens directly overhead from one horizon to the other—from magnetic east to west.

"The stars shone through this band of pale light with scarcely diminished brightness, but it was occasionally flecked by thin clouds. When I first saw it, at 9·20 p.m., there seemed to be traces of oblique striation crossing it, and Dr. Tellet, who called my attention to the display, states that ten minutes earlier, when the bar was at its brightest, these striations gave the effect of slightly twisted folds. Another informant remarked that the bar was formed shortly before 9 p.m. by the union overhead of rays which shot upwards for the east and west.

"The light waned rather rapidly with slight pulsations, and we thought that we could detect a slow southerly drift in the band before it vanished. The western portion died out before the eastern, which remained quite definite until 9·45 p.m. Meanwhile there had been a faintly diffused illumination of the northern heavens, with occasional suggestions of radiant streamers, but the whole quite subordinate in brightness to the band overhead.

"There was a westerly breeze and a nearly clear sky, with a low cloud-bank in the north-west, at the commencement of the display, but before 9·45 p.m. the wind had backed southward, and shortly afterwards the sky became suddenly overcast, though not before the aurora had faded to a scarcely perceptible glow. Half an hour later a slight shower fell."

The Rev. S. Barber says that the aurora was visible at Westnewton, Aspatria, in great brilliancy, as a band passing nearly over the zenith from the west to the east horizon at about 10 p.m. An arch of light was seen in the north from about 8.30, and some observers saw a shorter band almost north and south preceding the great band west and east.

Mr. J. Cuthbertson saw the display at Kilmarnock, N.B., as early as 7.45, "as a broad arch of light crossing the heavens from east to west. About 7.50 it was a very luminous pencil of light in the upper part of the heavens, through which stars of the second and third magnitude were distinctly visible, As it condensed it grew brighter. About ten minutes after I first observed it, it began to fade, and was invisible before 8 o'clock, leaving a temporary brightness in the western sky."

The aurora appears to have presented features very similar to those of the aurora of November 23, 1894, observations of which were discussed by Prof. A. S. Herschel in NATURE of January 10.

THE U.S. UNITS OF ELECTRICAL MEASURE.

BY a law approved in the Senate of the United States, last July, it was enacted that the legal units of electrical measure in the United States should be as follows:—

(1) The unit of resistance shall be what is known as the international ohm, which is substantially equal to one thousand million units of resistance of the centimetre-gram-second system of electromagnetic units, and is represented by the res istance offered to an unvarying electric current by a column of mercury at the temperature of melting ice fourteen and four thousand five hundred and twenty-one ten-thousandths grams in mass, of a constant cross-sectional area, and of the length of one hundred and six and three-tenths centimetres.

(2) The unit of current shall be what is known as the international ampere, which is one-tenth of the unit of current of the centimetre-gram-second system of electromagnetic units, and is the practical equivalent of the unvarying current, which, when passed through a solution of nitrate of silver in water in accordance with standard specifications, deposits silver at the rate of one thousand one hundred and eighteen millionths of a gram per second.

(3) The unit of electromotive force shall be what is known as the international volt, which is the electromotive force that, steadily applied to a conductor whose resistance is one international ohm, will produce a current of an international ampere, and is practically equivalent to one thousand fourteen hundred and thirty-fourths of the electromotive force between the poles or electrodes of the voltaic cell known as Clark's cell, at a temperature of fifteen degrees Centigrade, and prepared in the manner described in the standard specifications.

(4) The unit of quantity shall be what is known as the international coulomb, which is the quantity of electricity transferred by a current of one international ampere in one second.

(5) The unit of capacity shall be what is known as the international farad, which is the capacity of a condenser charged to a potential of one international volt by one international coulomb of electricity.

(6) The unit of work shall be the Joule, which is equal to ten million units of work in the centimetre-gram-second system, and which is practically equivalent to the energy expended in one second by an international ampere in an international ohm.

(7) The unit of power shall be the watt, which is equal to ten million units of power in the centimetre-gram-second system, and which is practically equivalent to the work done at the rate of one Joule per second.

(8) The unit of induction shall be the Henry, which is the induction in a circuit when the electromotive force induced in this circuit is one international volt while the inducing current varies at the rate of one ampere per second.

The National Academy of Sciences was instructed to prescribe and publish the specifications necessary for the practical application of the definitions of the ampere and volt given in the foregoing, and, to meet this requirement of Congress, a special committee was appointed to consider the subject. The committee, selected from members of the Academy, was as follows:—Prof. H. A. Rowland, chairman, General H. L. Abbot, Prof. G. F. Barker, Prof. C. S. Hastings, Prof. A. A. Michelson, Prof. J. Trowbridge, Dr. Carl Barus.

The report of this committee was submitted to the Academy at a special meeting held last month, and was then accepted and unanimously adopted. We extract the following details from the report, a copy of which has just reached us.

The Ampere.

In employing the silver voltameter to measure currents of about one ampere, the following arrangements shall be adopted:—

The kathode on which the silver is to be deposited shall take the form of a platinum bowl not less than 10 centimetres in diameter, and from 4 to 5 centimetres in depth.

The anode shall be a disc or plate of pure silver some 30 square centimetres in area and 2 or 3 millimetres in thickness.

This shall be supported horizontally in the liquid near the top of the solution by a silver rod riveted through its centre. To prevent the disintegrated silver which is formed on the anode from falling upon the kathode, the anode shall be wrapped around with pure filter paper, secured at the back by suitable folding.

The liquid shall consist of a neutral solution of pure silver nitrate, containing about 15 parts by weight of the nitrate to 85 parts of water.

The resistance of the voltameter changes somewhat as the current passes. To prevent these changes having too great an effect on the current, some resistance besides that of the voltameter should be inserted in the circuit. The total metallic resistance of the circuit should not be less than 10 ohms.

Method of making a Measurement.—The platinum bowl is to be washed consecutively with nitric acid, distilled water, and absolute alcohol; it is then to be dried at 160° C., and left to cool in a desiccator. When thoroughly cool it is to be weighed carefully.

It is to be nearly filled with the solution and connected to the rest of the circuit by being placed on a clean insulated copper support to which a binding screw is attached.

The anode is then to be immersed in the solution so as to be well covered by it and supported in that position; the connections to the rest of the circuit are then to be made.

Contact is to be made at the key, noting the time. The current is to be allowed to pass for not less than half an hour, and the time of breaking contact observed.

The solution is now to be removed from the bowl, and the deposit washed with distilled water, and left to soak for at least six hours. It is then to be rinsed successively with distilled water and absolute alcohol, and dried in a hot-air bath at a temperature of about 160° C. After cooling in a desiccator it is to be weighed again. The gain in mass gives the silver deposited.

To find the time average of the current in amperes, this mass, expressed in grams, must be divided by the number of seconds during which the current has passed, and by 0·001118.

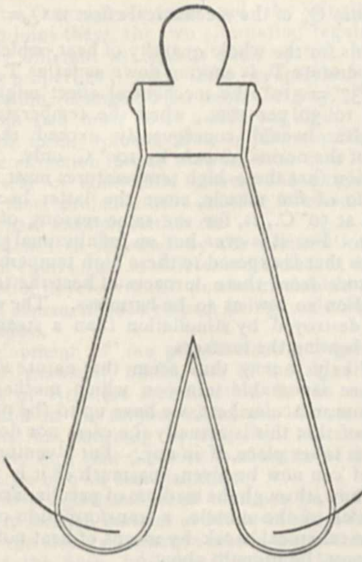
In determining the constant of an instrument by this method, the current should be kept as nearly uniform as possible, and the readings of the instrument observed at frequent intervals of time. These observations give a curve from which the reading corresponding to the mean current (time-average of the current) can be found. The current, as calculated from the voltameter results, corresponds to this reading.

The current used in this experiment must be obtained from a battery, and not from a dynamo, especially when the instrument to be calibrated is an electrodynamometer.

The Volt.

Definition and Properties of the Cell.—The cell has for its positive electrode, mercury, and for its negative electrode, amalgamated zinc; the electrolyte consists of a saturated solution of zinc sulphate and mercurous sulphate. The electromotive force is 1·434 volts at 15° C., and between 10° C. and 25° C., by the increase of 1° C. in temperature, the electromotive force decreases by 0·00115 of a volt.

To set up the Cell.—The containing glass vessel, represented in the accompanying figure, shall consist of two limbs closed at



bottom and joined above to a common neck fitted with a ground-glass stopper. The diameter of the limbs should be at least 2 centimetres, and their length at least 3 centimetres. The neck should be not less than 1·5 centimetres in diameter. At the bottom of each limb a platinum wire of about 0·4 millimetre diameter is sealed through the glass.

To set up the cell, place in one limb pure mercury, and in the other hot liquid amalgam, containing 90 parts mercury and 10 parts zinc. The platinum wires at the bottom must be completely covered by the mercury and the amalgam respectively. On the mercury, place a layer one centimetre thick of the zinc and mercurous sulphate paste described in 5. Both this paste and the zinc amalgam must then be covered with a layer of the neutral zinc sulphate crystals one centimetre thick. The whole vessel must then be filled with the saturated zinc sulphate solution, and the stopper inserted so that it shall just touch it, leaving, however, a small bubble to guard against breakage when the temperature rises.

Before finally inserting the glass stopper, it is to be brushed round its upper edge with a strong alcoholic solution of shellac, and pressed firmly in place.

ON THE NATURE OF MUSCULAR CONTRACTION.[1]

THE subject of this lecture is an inquiry into "The Nature of Muscular Contraction." Like all vital phenomena, muscular contraction is a most complicated process, composed of mechanical, chemical, thermal, and electrical changes in living matter. Hence it will be our task to become acquainted with these changes as completely and exactly as possible, and to ascertain their causal connection. Our inquiry must not be restricted to one special kind of muscle: it will have to extend to all the different forms, for there can be no doubt but that in all these cases the principle of activity is the same. Nay, it will be necessary to deal even with the other phenomena of so-called contractility, such as protoplasmic and ciliary motion, for all these different types of organic movement, however much they may differ from each other in details, are yet so connected by gradual transitions, that, to all appearance, one principle of motion, essentially the same, is applicable to all of them.

The general mechanical principle on which muscular contraction is based, will be discovered when we shall have ascertained in what way the power of shortening proceeds from the potential chemical energy which disappears upon stimulation of the muscle.

There can be no doubt as to the fact that the potential chemical energy of the component parts of muscular substance is alone the ultimate source of this power, for the existence of any other source cannot be proved. The quantity of energy which is imparted to the muscle by the stimulus is too small to be taken into consideration. The early opinion that the power required for contraction was imparted to the muscle through the medium of motor nerves has been refuted by experiments, such as, *e.g.*, on the persistence of contractility after degeneration of the motor nerves, and on the effects of direct artificial stimulation of the muscles; and it had even been refuted long ere the law of conservation of energy had thrown its light on the mutual connection between the phenomena of the living organs.

This law teaches that all the actual energy which appears in the muscle in consequence of stimulation must originate in an *equivalent* quantity of some other form of energy.

Now this form of energy is, in fact, given in the muscular substance liable to physiological combustion. The quantity of the latter is not only theoretically sufficient to produce that actual energy, but it has even been proved experimentally that during contraction that material gives birth to combinations such as carbonic acid, in the development of which potential chemical energy must have passed into other forms of energy. As far as the phenomena have been examined *quantitatively*, they confirm the conclusion that all muscular force must be derived from chemical energy.

Hence there is no difference about all these points. But with this result we have as yet gained only a basis for the proper solution. So soon you inquire in what way, by what transformations, does the mechanical force of contraction arise from chemical energy, difficulties and differences of opinion begin to present themselves.

A great many physiologists hold, with Pflüger, Fick, and Chauveau, that muscular force is a direct manifestation of chemical attraction; others, *e.g.*, Solvay, think that it is produced through the medium of electricity; others again, following J. R. Mayer, believe that the muscle is a thermodynamic machine, not unlike our caloric or steam engines.

The Chemiodynamic Hypothesis.—The first hypothesis, according to which contraction of muscle is a *direct* manifestation of chemical attraction—we may call it the chemiodynamic hypothesis—has to assume that the molecules, on the chemical combination of which this contraction is based, are regularly arranged within the contractile substance in such a way as to make them approach each other at their combination in the direction of the axis of the muscular fibres.

I think that this hypothesis of the identity of chemical attraction and muscular force meets with a fundamental difficulty in the fact that, in a single contraction, only a relatively infinitesimal part of the muscular substance is chemically active; 70 to 80 per cent. of the muscle (and even more) consists of absorbed water, the rest contains substances (albumin, salts, &c.) which, for the greater part, so far as can be proved, are not chemically concerned in the contraction.

This quantitative composition and this minute consumption of the active muscle compel us to assume that relatively only very few molecules of the muscular substance can be considered as sources of energy, and of these again it is generally but a small part that at a certain moment perform their function.

With certain presuppositions we may calculate the quantity of matter through the chemical action of which the amount of actual energy, produced at a certain contraction, must have been generated.

[1] The Croonian Lecture, delivered by Prof. Th. W. Engelmann, at the Royal Society, on March 14.

If we prevent a muscle from doing external work during the contraction, the whole actual energy will present itself in the shape of heat. When there is but a slight contraction, the muscle of a frog, *e.g.*, will grow warmer by about 0·001° C. Supposing the specific heat of the muscle to be equal to that of water (in fact it is less), we find that for a rise of 0·001° C. in temperature a quantity of heat of 0·001 cal. is required for each gram of muscle. No matter whether this quantity of heat results from the combustion of carbohydrates, fats, or albuminous matter, it can be but an infinitesimal part of the muscular substance that produced it. If, *e.g.*, as is ordinarily supposed, the combustion of a carbohydrate into CO_2 and H_2O produced that heat, taking the heat of combustion of one gram of carbohydrate to be broadly 4000 cal., no more than a four-thousandth part of a milligram will have been consumed in each gram of the muscle. Hence only about a four-millionth part of the muscular substance could have been the source of the actual energy set free by the stimulus, and at the same time, according to the above hypothesis, have been the subject of direct attraction.

But whatever may be our conception of the size, form, position, and sphere of action of this four-millionth part in relation to the other soft, watery mass, only passively moved, I fail to understand how, through *direct chemical attraction*, this one minute part should bring about the movement of the rest of the four million parts in such a manner as it does.

The adherents of the chemico-dynamic hypothesis have not answered this objection as yet. And since they can give but an unsatisfactory account or no account at all of many other facts (I will refer to some of these facts further on), we may be allowed to cast about for some other explanation.

The Electrodynamic Hypothesis.—Since Galvani's discoveries, the electric phenomena of muscles have frequently been suspected to contain the solution of our problem. And, indeed, it is not so very difficult to mention a series of facts which seem to bear out the suggestion that the mechanical work done by the muscle may be created from chemical energy through the medium of electric forces.

There is, in the first place, the fact that muscles, when in action, produce regular electric effects. These effects are indeed the first phenomena we can observe after stimulation. They seem to begin at the very moment of stimulation, shortly before the contraction, hence they might in so far be the cause of the mechanical process.

Moreover, as du Bois-Reymond proved, the value of the electromotor force is very high, and in the active particles is probably much higher than the force of the currents we can derive from the surface of the muscle.

Add to this that the economic coefficient of the muscle may attain, just as in the case of electric motors, a considerable proportion. As much as 25 per cent. and more of the potential energy which has been consumed may be transformed into mechanical work.

However, there are weighty objections to this hypothesis also. In the first place, there is the fact that these very same electromotor forces, of equal intensity and direction, appear, under the same influences, not only in the muscles, but also in nerves, glands, and other organs, which do not possess the least contractility. Then there is the important discovery of Biedermann, that the contractility of muscles may be completely neutralised by water or etheric vapours, without doing any perceptible harm to the electromotor phenomena.

In the same way the development of the electric organs supplies us with important proofs of the independence of the electric and the mechanical processes. In most cases these organs are developed out of striped muscular fibres. Now, in this process of development, contractility is gradually lost, whereas the power of producing electrical effects attains a yet higher degree of perfection.

The Thermodynamic Hypothesis.—More probable than the chemical and the electrical hypothesis may be deemed a suggestion, first put forward by Jul. Rob. Mayer, though in an untenable form, according to which the muscle is a thermodynamic machine. Physiologists, however, generally object that this view is not compatible with the second law of thermodynamics, for we cannot expect differences in temperature in the muscle so great as this law requires they should be.

Now I venture to think that, on the contrary, we must ssume exceedingly great differences of temperature in the stimulated muscle. What holds good of the whole body holds good of the muscle also; the temperature, measured with our instruments, is but an arithmetical average, "comprising an infinite number of different temperatures, pertaining to an infinite number of different points" (Pflüger).

From the fact that at the contraction an infinitesimal part only of the muscular mass is chemically active, we infer that the temperature of these particles must, at the moment of combustion, be an uncommonly high one. Great as the specific heat of muscular substance is, it would otherwise be impossible to account for a rise in the temperature of the whole mass even of 0·001° C. only.

Since each thermogenic particle is surrounded by a relatively enormous cool mass, conducting heat and diathermanous, the principal condition for the transformation of heat into mechanical work has been satisfied, and, on account of the enormous differences in temperature which we have to assume, satisfied to such a high degree, that even an economic coefficient of 30 per cent., nay, 50 per cent., and even more, seems to be theoretically possible.

Supposing we have to deal with a Carnot's cycle, the theoretical maximum Q_0 of the mechanical effect is $Q_0 = Q\frac{T_1 - T_2}{T_1}$, where Q stands for the whole quantity of heat, which from the absolute temperature T_1 is sinking down as far as T_2. Taking $T_2 = 273° + 37° = 310°$, the mechanical effect might at $T_1 = 410°$ amount to 30 per cent., when the temperature of the active particles would consequently exceed the average temperature of the normal muscle by 100° C. only.

The objection that these high temperatures must necessarily destroy the life of the muscle, since the latter becomes rigid and dies even at 50° C., is, for the same reasons, of small importance only. For it is ever but an infinitesimal part of the muscular mass that is exposed to these high temperatures. At a small distance from these furnaces of heat the temperature must have fallen so low as to be harmless. The muscle will no more be destroyed by stimulation than a steamer will be destroyed by heating the furnaces.

However likely it may thus seem that nature should avail herself of these favourable terms on which mechanical work may result from muscular heat, we have up to the present time no direct proof that this is actually the case, nor do we know in what way it takes place, if in any. But I venture to think that the proof can now be given, inasmuch as it is possible to demonstrate how, through the medium of peculiar arrangements of the material of the muscle, a transformation of chemical energy into mechanical work by means of heat not only can, but actually must, be brought about.[1]

Muscular Structure in relation to Contractility.

The Fibrils are the Seat of the Shortening Power.—For this we need firstly to pay attention to the peculiarities of the microscopical structure of muscle. All muscular fibres of all animals are composed chiefly of two parts: extremely thin, long, albuminous fibrils, and an interfibrillar plasmatic substance, the so-called sarcoplasma. The quantitative relations of both vary, but the fibrils always occur in great number, forming very often the greatest part of the whole mass of the muscle. They always run parallel to each other throughout the length of the fibres.

This fibrillar structure is also presented by all the other formed contractile substances.

Direct microscopical observation during life teaches us that the fibrils, and not the sarcoplasm, are the seat of the shortening power. The fibrils in a state of relaxation are long and thin, and often run in winding curves, but grow short, thick, and straight, in consequence of stimulation. The sarcoplasm passively follows their movements. Moreover, completely isolated fibrils can shorten.

The Fibrils are Contractile because they contain Doubly Refractive Particles.—Thus the question arises: Can there be demonstrated in the fibrils such arrangements of their material as by their mediation contractile force may originate in a thermodynamic way?

Light—*lux optimum reagens*, as Buys Ballot said—solves this

[1] The empirical foundations of the views developed in this lecture will be found in "Versuche über Aenderungen der Form und der elastischen Kräfte doppelbrechender Gewebselemente unter chemischen und thermischen Einflüssen," in the Appendix of my Memoir. "Ueber den Ursprung der Muskelkraft" (2te Auflage. Leipzig. 1893. S. 54-80), and in the literature cited in the same paper.

question for us. If we examine the optic properties of contractile fibrils, with the aid of the polarising microscope, we find that all of them are double-refractive, with one optical axis parallel to the direction of contraction.

This general occurrence of double-refracting power is the more indicative of relations to contractility, since non-contractile cells, as a rule, lack double refraction, even where we meet with a fibrillar structure, as in the axis-cylinder of a nerve-fibre.

Our conjecture gains, I believe, a very high degree of probability by the following series of observations.

In the first place, the fact that contractility and double refraction in the course of ontogenesis always appear at the same time, *e.g.* in the heart of the chick, on the second day of incubation; in the muscles of the trunk and skin on the fifth or sixth day; in the muscles of the tails of tadpoles when the length of their body is 3 to 4 mm.; in the muscles of the stalk of Vorticella, and in cilia so soon as these organs become visible.

Another evidence seems to me to be afforded by the behaviour of the striated muscles. Here the fibrils consist of the doubly-refractive sarcous elements and the singly-refractive material which joins these, the two alternating regularly. The two are wholly different as regards their optical, mechanical, and chemical properties; and these properties, moreover, during contraction, change in an opposite way. Hence the functions of the two must be of a different kind. And since the changes of form, volume, &c., of the doubly-refractive parts during contraction prove that in each case these parts must be the seat of contractile power, the single-refractive junctions will most probably have another function. We will come back to these changes further on.

A third evidence is afforded by the observation that the specific force of contraction in different muscles is, in general, greater, the better developed the power of double refraction, comparison, of course, in each respect being made with parts of the same thickness.

In the development of the pseudo-electric organs of *Raja* out of striated muscular fibres, one of the signs of the incipient change of structure and function is the vanishing of double refraction in the sarcous elements. In an early stage of development this vanishing is, with *Raja clavata*, the very first and the only sign that the fibre is about to be transformed from a contractile into an electric organ.

But particularly significant seems to me to be the behaviour of the obliquely striated muscles of Molluscs and other Invertebrata. Here the doubly refractive fibrils do not run parallel to the axis of the fibre, but describe spiral lines round it; and during a contraction the steepness of the curves decreases, so that the angle formed by the longitudinal axis of the fibril and the longitudinal axis of the fibre may increase from 5° in the relaxed state to 60°, and even more, in a state of powerful contraction. But the optic axis of the fibril, instead of assuming, in this case, a more oblique position also, as might be expected on morphological grounds, remains parallel to the longitudinal axis of the fibre, and consequently to the direction of shortening of the fibre. Hence it is not the morphological axis of the fibrils, but the optical axis of their doubly refractive constituents, which coincides with the direction of the contracting force.

Contractility a General Property of Doubly Refractive Bodies.—More than a score of years ago I pointed out the fact that even non-muscular elements, elements not possessing irritability in the physiological sense of the word, nay, even lifeless, unorganised elements which are uniaxial doubly refractive, may, under certain influences, contract in the direction of the optical axis, all thickening at one time, and contracting with a force and quickness and to an extent rivalling that of muscles, if not surpassing it. Instances of this are the fibrils of the connective tissue, of the tendons, and of the cornea, and others. The same contractile power was found by von Ebner in a great many other doubly-refractive histological elements, nay, even in substances capable of absorption and thereby made doubly refractive, *e.g.*, dried colloid membranes; and finally by Hermann, in fibrils of fibrin.

I have in this way shown that singly refractive, or only feebly doubly refractive histological elements, such as the fibres of elastic tissue, obtain, in the same way as caoutchouc, the power, when made doubly refractive by extension, of contracting under certain influences, and further that the force of shortening will generally be greater in proportion to the amount of the double refraction thus artificially produced.

Since, according to Mitscherlich's discovery, similar changes of form may be observed in doubly refractive crystals, we have apparently to deal with a property pertaining to all doubly refractive bodies as such.

Heat as a General Cause of Contraction of Doubly Refractive Elements.—Now, the influence which in all these cases is able to evoke the mechanical energy of shortening is *elevation of temperature.* Refrigeration has the opposite effect.

Particularly instructive is the thermal contraction of the fibrillar connective tissue, on account of its similarity to muscular movement, even with regard to details.

In tendons and many membranes the fibrils, as well as those of most muscles, are arranged into bundles, all, or nearly all, parallel to each other. For this reason such objects are extremely well fitted for a closer examination of the phenomena of movement. The most suitable material I know is furnished by the catgut strings of violins, which chiefly consist of such bundles, running in steep spiral lines, round the longitudinal axis of the string. They are distinguished from the greater number of naturally occurring objects by their very regular cylindrical shape and their elasticity. On these properties is based their suitability for musical purposes, especially for the so-called "perfect fifth" ("Quintenreinheit").

The Muscle-Model.—With the aid of such a string we can compose a model which in a simple way explains how in the muscle mechanical energy of contraction may result from heat without any perceptible rise of the average temperature of the muscle.

A piece of an *E* string of a violin, about 5 cm. long and previously swollen in water, is fastened to the end of the short

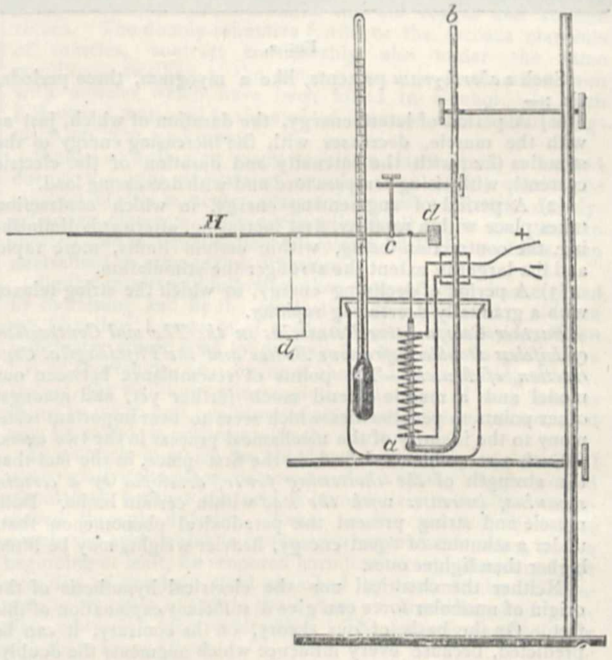


FIG. 1.

rigid arm of a steel rod, while the upper end of the string is fixed to the shorter arm of a lever, turning round an horizontal axis.

To this string different tensions may be imparted by weights or springs, acting upon the lever.

Round the string, but without touching it, runs for a length of about 20 mm., and in about twenty curves, a spiral of thin platinum wire. The ends of this may be connected with the two poles of a Grove or Bunsen battery of three or more cells. The rod, bearing the lever string and spiral wire, is placed in a glass of about 50 c.c. contents, filled with water of about 55-60° C., and closed at the top by an ebonite lid. Through an aperture in the lid, a thermometer is placed in the water in such a position that it will remain at a distance of about 1 cm. from the spiral wire.

The string is now observed for some minutes at a tension of 25 or 50 grammes and at a constant temperature until no further change in the position of the lever can be discerned. If we now close for some seconds the circuit of the battery through the spiral, *the lever rises. Upon opening the circuit, it falls. The thermometer in the glass indicates a hardly perceptible rise in temperature, or no rise at all.*

We see the doubly-refractive string of our model corresponds to the doubly-refractive muscular particle, which we suppose to be the seat of the force of contraction, and therefore may be called "*inotagma*"; the water in the glass represents the watery isotropic substance round the inotagma, doing duty as refrigerant; the spiral wire supplies the place of the chemically active *thermogenic* molecules; the closure of the galvanic circuit corresponds with the process of the stimulation of the muscular element.

The movements may be inscribed on a rotating cylinder. We then obtain curves of the same character as contraction-curves of muscles.

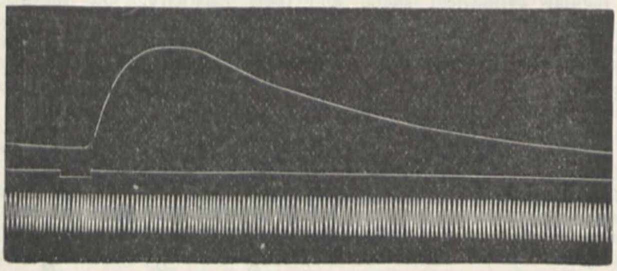


FIG. 2.

Such a *chordogram* presents, like a myogram, three periods, viz.:—

(1) A period of latent energy, the duration of which, just as with the muscle, decreases with the increasing energy of the stimulus (*i.e.*, with the intensity and duration of the electric current), with rising temperature and with decreasing load.

(2) A period of augmenting energy, in which contraction takes place with a rapidity, first increasing, afterwards diminishing, the contraction being, within certain limits, more rapid and the larger in extent the stronger the stimulation.

(3) A period of declining energy, in which the string relaxes with a gradually decreasing rapidity.

Further Comparative Researches on the Thermal Contraction of Lifeless Double Refractive Bodies and the Physiological Contraction of Muscle.—The points of resemblance between our model and a muscle extend much further yet, and amongst other points to peculiarities which seem to bear important testimony to the identity of the mechanical process in the two cases.

Such a resemblance I find, in the first place, in the fact that the strength of *the shortening power, developed by a certain stimulus, increases with the load* within certain limits. Both muscle and string present the paradoxical phenomenon that, under a stimulus of equal energy, heavier weights may be lifted higher than lighter ones.

Neither the chemical nor the electrical hypothesis of the origin of muscular force can give a sufficient explanation of this fact. On the basis of our theory, on the contrary, it can be predicted, because every influence which augments the doubly-refractive power must raise the power of contraction.

Now, von Ebner has proved experimentally that the force of double refraction of tendons and also, between certain limits, of muscles, increases with the load. The same is the case with fibres of elastic tissue and with caoutchouc, and with these also the contractile power increases with the load. The differences of force thus depending on the load are by no means insignificant.

Connected with this point is another fact, viz. that the force of shortening produced in our model by means of a given rise of temperature, is the smaller the more the string has already contracted. The maximum of force is, at all events, displayed when the extension of the string is brought by the whole load being applied at once at the very beginning of the heating, not after the string has already contracted with a smaller load.

The very same thing, as Schwann's experiments showed many years ago, holds good of muscle. On the hypothesis of chemical attraction we should decidedly expect the reverse: viz. increase of force with an increasing mutual approach of the combining molecules; so also in the same way on every other hypothesis which pronounces contraction to be caused by attractive powers increasing in inverse proportion to the square of distance.

In the fact discovered by Schwann, Johannes Müller thought he had found a refutation of the old electro-dynamic hypothesis of Prévost and Dumas, as well as a valid reason for assuming a fundamental relation between the vital power of contraction and physical elasticity.

However, as Hermann has observed, we might in this case get over the difficulty by supposing that between or in the length of the parts attracting each other, there are elastic layers opposing that attraction with increasing force. It is evident that our view of the matter does not require such an auxiliary hypothesis, because, in accordance with Eduard Weber, we regard muscular contraction as only a special case of elastic shortening.

A closer experimental comparison of the changes undergone, on the one hand, by the elasticity of our string during thermal shortening, and, on the other hand, by muscular elasticity during physiological contraction, will teach us that, in each case, the changes are of exactly the same kind.

As regards striated muscles, it was Eduard Weber who, by his classic researches, established that their extensibility increases during contraction. The same is now proved to hold good of strings and other organic doubly-refractive substances during thermal shortening.

The curve of lengthening of all these objects inclines more sharply towards the abscissæ of the loads the higher the temperature. Both curves converge, and may finally even cross, *i.e.* a certain load being exceeded we do not get contraction but lengthening as the effect of heating.

This circumstance explains the fact, sometimes observed by E. Weber, that living, tired, heavily-loaded muscles of frogs, lengthen instead of shorten as a result of electric stimulation. Considered from other theoretical points of view, this observation seems so paradoxical that its very validity has been questioned by some physiologists, but in the face of the direct and exact measurements of so scrupulous an observer and inquirer as Eduard Weber, we have no right to do this. According to our view of the origin of muscular force this fact is not paradoxical at all, but might be foreseen.

The decrease of the shortening power and the increase of extensibility with increasing thermal contraction is, in the case of our lifeless doubly-refractive objects, accompanied by a decrease in the power of double refraction. According to von Ebner's careful measurements, the same thing is the case with muscles during vital contraction. We may consider this fact, too, as an important proof of the fundamental resemblance between the process of contraction in our model and in the muscle, and at the same time as a further evidence of the existence of a causal relation between double refraction and contractility in general. But it is the physicist's task, and not the physiologist's, to penetrate further into the relations between optic and elastic properties. The physiologist may deem his purpose attained when he succeeds in tracing a certain vital phenomenon back to processes which may also be observed in lifeless bodies.

However, though we should, perhaps, be inclined to infer from the foregoing that we have successfully acquitted ourselves of this task with regard to muscular contraction, we will be careful not to overlook the numerous important respects in which a muscle as a *living* body, that is, one subjected to constant chemical transformation, differs from our lifeless strings. The study of these differences is most instructive, since it throws a new light on a series of processes nearly allied to contraction, especially on the phenomena of *rigor mortis* and *tonus* of muscle.

But before entering into this we shall first have to meet another important objection to our views. It is based upon the absolute amount of muscular force. This amount may, as you know, be very high. Human muscles at the strongest tetanic contraction can shorten with a force of about 10 kilogrammes to 1 sq. cm. transverse section. Now such a force must, according to our view, be produced by a small part only of the transverse section of the muscle.

With a maximal tetanus, it is true, the temperature of the whole muscle does rise 1° C. or more. Hence there are, perhaps, 1000 times more particles chemically active than with a moderate simple contraction, where the temperature rises 0·001° C. only. Consequently, during such a tetanus, a much greater part of the muscular substance—perhaps 1000 times as much—will be heated to such a degree as is required for an obvious contraction of the inotagmata. But even in this case the greater part of the whole substance will be only moved passively.

Can such very important mechanical powers as we are obliged to assume in the inotagmata be evolved through the thermical contraction of doubly-refractive bodies? Do we not, as Fick says, in making such a supposition, go too far beyond the bounds of legitimate analogy?

Of course nothing but the measurement of the forces developed by lifeless doubly-refractive bodies under thermal contraction will decide this question. I have made many of these measurements on various objects, and I think the results afford us a refutation of the objection. Strings, moist but not yet contracted through lying in water, with a diameter of 0·7 mm., and loaded with 1 kilogramme, lifted up the weight in a perceptible degree when rapidly heated up to 130° C.; that is to say, they exerted a force about twenty times at least as great as the maximum force of a human muscle of the same thickness.

Still greater forces may be exerted by strips of caoutchouc rendered in a high degree doubly refractive by strong extension. Even by merely heating from 20° to 40° C. powers could be produced sixty times as great as the maximum afforded by human muscles of the same transverse section.

Hence we may sufficiently account for the greatest display of force in the muscle, without having to attribute to the inotagmata higher elastic forces than we observe in highly extended threads of caoutchouc of the same thickness, nay, without even having to assume temperatures reaching the degree necessary for the coagulation of albumin.

It is a pity that we are not able to subject the isolated doubly-refractive parts of the muscle in an unimpaired condition to the influence of heat. Together with the elevation of temperature there occur changes in the chemical processes, and therewith in the material composition and mechanical properties, of the whole muscle substance, which complicate the changes dependent only on the heating of the doubly-refractive particles, or even prevent our clearly recognising them.

Tetanus and Rigor by Heat.—Living muscles, when being *gradually* heated, will, as you know, contract tetanically so soon as the temperature has attained a height which is but little below 50° C. This so-called *tetanus of heat* passes by prolonged heating into the lasting contraction of *rigor*, in this case combined with definitive loss of irritability.

This contraction through heat agrees at so many points with physiological contraction, especially with physiological tetanus, that it was held to be a last manifestation of muscular life. Such points of resemblance are, *e.g.*, the amount and the force of shortening, which in both cases are at least of the same order, and the increased production of heat, carbonic acid, and a fixed acid.

No doubt in this case a very important and general rise of temperature of the contractile particles will take place so soon as rigidity begins to announce itself. Consequently, according to our hypothesis, we must expect a strong and general contraction of the inotagmata.

That the force, with which the muscle as a whole will shorten, is not quite so great as with physiological tetanus, is sufficiently explained by the fact that the inotagmata do not contract simultaneously, and by the increase of internal resistance which occurs, due to coagulation and precipitation in the muscle plasma during the development of rigidity by heat. The latter circumstance seems to explain, too, why the rigid muscle does not perceptibly lengthen, or lengthens very little, upon cooling.

Turgescence by Absorption as a General Cause of Contraction of Doubly-refractive Organised Elements.—On a closer examination, however, we find that matters are still more complicated, and likewise that there is still an important circumstance which, besides the rise of temperature of inotagmata, may act as a cause of contraction, even of permanent contraction. This circumstance, the fundamental importance of which to muscular contraction was disclosed a score of years ago by a rigorous microscopical examination of the processes taking place in the muscle fibres during contraction, is the *turgescence of the doubly-refractive elements by the absorption of watery liquids.*

All histological elements possessing doubly-refractive power tend, even at an ordinary low temperature, to shorten in the direction of the optical axis when their volume is enlarged by the absorption of a watery fluid, and to lengthen when their volume diminishes by loss of liquid. The extent, power, and rapidity of the changes of form depend on the nature and on the dimensions of the turgescent object, and on the nature and quantity of the absorbed liquid.

For the examination of these relations our violin strings again yield fit material. A long series of measurements has now shown that there is a very far-reaching resemblance between contraction by turgescence and thermal and physiological contraction. I may mention the marked extent of the shortening, the high value of the force of contraction, its increase with the initial tension and its decrease with increasing shortening, the increase of extensibility, the decline of refractive power and of doubly-refractive property. The resemblance is by no means exclusively of a qualitative, but also of a quantitative kind.

A change of form generally takes place when the composition of the absorbed liquid changes, and it is of great importance to our question that even the slightest changes of composition can cause marked contractions and great mechanical effects.

Unloaded *E* strings, *e.g.*, contract in pure water to nine-tenths, and in water which contains 0·25 per cent. only of lactic acid to three-fifths of the initial length. At 15° C. they exert, in the first case, forces of about 80 g., in the second of about 110 g. By absorbing a 0·25 per cent. solution of lactic acid at initial tensions of 5, 215, and 425 g. there were exerted powers of 115, 350, and 490 g. respectively, *i.e.* forces very much higher than a muscle of the same thickness can produce during tetanus.

Upon neutralisation or dilution the old length and volume return. The doubly-refractive fibrils, or the sarcous elements of muscles, contract considerably also under the same conditions, swelling at the same time; this is the case even with muscles which have been killed in alcohol. In such instances I measured in the striated fibres of insects shortenings to 50 per cent. and more.

Since, according to many inquirers, lactic acid is formed during the rigor of striated muscles, and at all events the reaction of the muscular plasma becomes acid, the doubly-refractive elements must necessarily swell more and tend to shorten, and this contraction will remain until the acid has been neutralised or removed by diffusion.

Similar results will follow in other cases of rigor characterised by shortening and by the production of much acid. Nay, in the bloodless muscle even a physiological stimulation, when sufficiently strong and long, may be expected to produce a lasting shortening, on account of the gradual increasing acidity. Indeed, the well-known incomplete relaxation of such muscles seems to me to be a symptom of this *chemical contraction*, as it may be called, in contrast with the *thermal*.

In a muscle in which the blood stream is maintained this will not so easily take place, not even under a strong and prolonged stimulation, because the acid is immediately neutralised or removed through diffusion. Even in the isolated, bloodless muscle the acid, which is produced by stimulation, may, in the beginning at least, be rendered harmless through the very large quantity of non-acid fluid absorbed by the muscle. Consequently we must expect in these cases an immediate and complete relaxation after contraction. The facts agree absolutely with these suppositions.

It is, perhaps, not unnecessary to remark that all these observations would also hold good if the material affecting the turgescence were not lactic acid, but another substance arising during the chemical action in the muscle, *e.g.* water.

The different parts played by "Thermal" and by "Chemical" Contraction in the different kinds of Muscular Contraction.—But now the question may be raised, Is not physiological contraction due to turgescence solely?

We have all the more reason to put this question, since we can prove that in the physiological contraction of striated muscle-fibres the doubly-refractive layers swell at the cost of the watery isotropic layers. The microscopical examination of active living muscles and of fixed waves of contraction has proved this fact beyond all question, however much the opinions of different observers may diverge on other points. The swelling would, moreover, account for the slight decrease of muscular volume observed in strong tetanic contraction. For, according to the experiments of Quincke, the absorption of water by organised bodies generally leads to a slight condensation.[1] By this condensation further heat is developed, and this heat might, by raising the temperature of the doubly-refractive elements, be partially transformed into mechanical energy, and in this way contribute to the production of muscular force.

Yet I cannot consider this explanation as sufficient for all the facts. The same argument which in our eyes seems to dispose of the hypothesis of the identity of chemical attraction and muscular force, viz. the infinitesimally small quantity of substance which is chemically active during a simple contraction, seems to me to present a fundamental difficulty here also. It is hard to understand how through a change in the material composition, effected at one infinitesmal point within a soft watery substance, the whole mass should shorten and thicken, *unless there proceeds from the centre of chemical activity a considerable amount of kinetic energy throughout the substance.*

The microscopic appearances which prove the turgescence of the doubly-refractive elements during a contraction, do not exclude a direct thermo-dynamical effect. For the almost complete identity in the changes of form, and of the optical and mechanical properties which the doubly refractive constituents of all histological elements undergo during chemical and thermal contraction, seems to bear out the hypothesis, that in the thermal shortening of doubly-refractive elements, through the absorption of watery fluid, we get a shifting of solid and liquid substances analogous to that of turgescence. With most of the microscopical appearances, especially the so-called fixed contraction waves, we have, moreover, to do with a high degree of tetanic contraction, or even with rigor, in which, on account of the greatly increased chemical action, a chemically-caused turgescence may have combined in a considerable degree with the thermal contraction.

Hence, we may conclude that chemical contraction by turgescence of the inotagmata is most likely a constant concomitant of the thermal contraction of living muscle, but that compared with the latter, in a single contraction at least of striated fibres, the former is of little or no consequence as regards the shortening effect.

Chemiotonus and Thermotonus.—Both processes will probably also take part in varying proportion in the *tonus* of muscle, which in some cases will approach more to pure *chemiotonus*, in others more to pure *thermotonus*.

Causes of the Relaxation of Muscle. Theoretical Considerations. Conclusion.—With regard to the *relaxation* of muscle, according to our theory this must be caused either by cooling, or by the withdrawal of water from the doubly-refractive particles. Indeed, we have found that generally doubly-refractive histological elements, even if they be lifeless like our violin strings, lengthen again upon cooling after they have been contracted by heat, and that they lengthen upon neutralisation or diffusion, after they have been contracted by absorption at an ordinary temperature.

In a normal relaxation the muscle seems to return completely to its initial state. Of course its store of energy has diminished in proportion to the quantity of mechanical work and heat which have proceeded from it, but, on account of the relatively infinitesimal quantity of substance which is thereby consumed, this return will necessarily seem to be complete even in the case of the isolated muscle.

When analysing the phenomena of relaxation more exactly, we shall light on several possibilities, the discussion of which would be very interesting with regard to the theory of muscle-life. I shall restrict myself to the phenomena of the relaxation following on *thermal* contraction.

Here, in the first place, we might conceive that the doubly-refractive inotagmata are destroyed in the thermal shortening, so that each of them performs its function once only. The lengthening of the muscular fibrils would then probably be caused solely by the elastic powers of the parts passively extended or compressed by the shortening of the inotagmata. Upon a fresh stimulation other inotagmata would, in consequence of the combustion of other thermogenic molecules, be active, perish, &c. Through the activity of the formative matter of the living muscle-fibre, the place of the lost inotagmata would be continually or periodically filled by others, probably through the same process of organic crystallisation by which during ontogenesis the doubly-refracting particles in the muscle are produced and disposed.

[1] In the thermal contraction of tendons and strings I have not yet been able to convince myself of a decrease in volume.

Against this hypothesis, however, or at least against its general validity, various objections may be put forward. I will mention two only of the most important of them.

There seems to be no doubt but that the doubly-refractive particles of the muscle consist of an albuminous substance, and that they together make up a sensible part of the whole albumin of the muscle-fibrils. In that case it would be most improbable that a great increase of muscular work should not at all, or very slightly only, increase the elimination of nitrogen. To account for this, we should have to recur to an auxiliary hypothesis, and assume either that the nitrogenous remainder of the destroyed inotagma is retained within the body—perhaps in the muscle—for purposes of anabolism, or, which is most improbable indeed, that other organs saved just as much albumin as was decomposed above the normal quantity during the contraction of the muscles.

A second objection consists in the fact that after heating tetanising muscles until they are rigid, the doubly-refractive power of the sarcous elements will be found still very great.

The other possibility is that the inotagmata may be preserved, and consequently on cooling may return to their former state, and therefore will do work by shortening as often as we choose. In this case muscle would not only seem to offer, but would offer in fact, a most striking resemblance to a thermodynamic machine, the solid particles of the framework of which are not destroyed through the chemical process producing the actual energy. No more than such a machine would the muscle require a perpetual renewal of the framework for the continuation of its activity; it would only want a periodic supply of fresh heating material.

This representation, as you see, will sufficiently account for the fact, which would otherwise remain surprising, that muscular work has such a small influence on the elimination of nitrogen. The facts of microscopic observation also agree with it.

But a further discussion of the two possibilities would lead us too far. The purpose of this lecture was not to record a complete inquiry into all the phenomena of muscular activity. I have wished chiefly to draw attention to a series of facts which I hold to be of great importance for a deeper insight into the essence of muscular contractility, in so far as they prove the existence of certain material dispositions and processes (admitting of closer experimental examination), by means of which mechanical work may be generated in the muscle by chemical energy.

THE SNAIL FAUNA OF THE GREATER ANTILLES.

THE West Indian Archipelago has long been known to present some interesting problems in the distribution of its land fauna. These peculiarities, it will be remembered, led Wallace to infer the previous existence of a land connection of the greater islands with one another and with the mainland; while others have claimed that the islands have always been distinct, and have been colonised by the agency of currents, winds, and other indirect means of dispersal. An interesting contribution on this subject has recently appeared in the form of a study of the distribution of the West Indian land and fresh-water molluscs, by Mr. C. T. Simpson, of the U.S. National Museum, from whose paper we extract the following conclusions. A considerable portion of the land snail fauna of the Greater Antilles seems to be ancient and indigenous. There appears to be good evidence of a general elevation of the Greater Antillean region, probably some time during the Eocene, after most of the important groups of snails had come into existence. At this time the larger islands were united, and were connected with Central America by way of Jamaica and possibly across the Yucatan Channel. There was then a considerable exchange of species between the two regions. At some time during this elevation there was probably a landway from Cuba across the Bahama plateau to the Floridean area, over which certain groups of Antillean land molluscs crossed. The more northern isles of the Lesser Antilles, if then elevated, have probably been since submerged. After the period of elevation there followed one of general subsidence, and first Jamaica, then Cuba, and afterwards Haiti and Puerto Rico were separated. The connection between the Antilles and the mainland was broken, and the Bahama region, if it had been previously elevated above the sea, was submerged, the subsidence continuing until only the summits of the mountains of the four Greater Antillean islands remained above the water. Then followed another period of elevation, which has lasted no doubt until the present time, and the large areas of limestone uncovered (of Miocene, Pliocene, and post-Pliocene age) in the Greater Antilles have furnished an admirable field for the development of the groups of land snails that survived on the summits of the islands. The Bahamas and the Lesser Antilles were subsequently raised above the surface, and have been colonised by forms chiefly drifted in the former case from Cuba and Haiti, and in the latter case from South America, while a few stragglers have been carried by sea no doubt from the Greater Antilles, and have settled on the more northern of the Windward Islands.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A DEPUTATION from the Association of Head Masters of Higher-Grade and Organised Science Schools was received on Thursday last, by Mr. Acland, at the offices of the Science and Art Department; Major-General Sir John Donnelly being present at the interview. The deputation was the outcome of a very large and representative meeting of the association, held at Derby, to consider the new rules for organised science schools lately issued by the Department. The importance of the new regulations lies in the fact that under them a system of secondary schools will be inaugurated and carried on under the control of, and supported to a great extent by, the Science and Art Department. The organised science schools at present in existence include nearly all the more important higher-grade schools, the day schools of technical institutions, and a considerable number of grammar schools. The principal changes proposed in the new rules are the partial substitution of inspection for examination, the introduction of special courses of instruction for women students, the inclusion of a fair proportion of literary work in the curriculum, and the addition to it of practical work in physics and biology. A long discussion, lasting over two hours, took place, at the end of which Mr. Acland stated that he hoped to be able to meet the wishes of the deputation with regard to many of the points raised, and promised, at the end of a week or ten days, to make a definite statement of the alterations the Department would be prepared to make.

GEOMETRICAL Drawing has hitherto been included in Science Subject I. (Practical, Plane, and Solid Geometry) of the Science and Art Department. It has just been decided, however, to make Geometrical Drawing a separate subject under the Art portion of the Department's Directory; so the syllabus of the Elementary Stage of Science Subject I. will in future include only plane geometry, solid geometry, and graphic arithmetic. The changes will come into force for the session 1895-96.

THE Senate of Glasgow University have resolved to confer the degree of Doctor of Laws on the following:—Sir John Neilson Cuthbertson; Mr. James G. Fraser, Fellow of Trinity College, Cambridge; Mr. W. E. H. Lecky; Mr. David Robertson, Millport; Dr. T. E. Thorpe, F.R.S.; Surgeon-Major Lawrence A. Waddell, I.M.S., Bengal.

THE ninth Session of the Edinburgh Summer Meeting is arranged to take place in August. Prof. Geddes and Mr. William Sharp lecture in the section of Philosophy, Social Science, and Anthropology; and the prospectus also includes the names of M. Demolins, editor of the *Science Sociale*, of Dr. Wenley, Dr. Delius, and others. Under Civics and Hygiene are the names of Dr. Dyer, M. Paul Desjardins, M. Elisée Reclus, Dr. Irvine, Miss Jane Hay, and Dr. Stephens. Mr. Goodchild and Mr. Herbertson undertake the department of Geography in its widest sense; while Mr. J. Arthur Thomson and Mr. Turnbull have charge of the Biology. There will be many other features of interest, including a series of educational conferences.

THE Professorship of Natural History at the Royal Agricultural College, Cirencester, rendered vacant in December last by the death of Prof. Harker, has now been filled by the appointment of Mr. Theodore T. Groom, late Scholar of St. John's College, Cambridge, and Lecturer and Demonstrator at the Yorkshire College, Leeds. Mr. Groom at one time occupied the Cambridge table at the Zoological Station, Naples, where he successfully carried out some valuable researches, the results of which were communicated to the Royal Society of London, and published in their *Philosophical Transactions*. The chair of Natural History at the College has been filled by a succession of very able men, among whom, in addition to Prof. Harker, may be mentioned such names as Buckman, McNab, and Thiselton-Dyer.

SCIENTIFIC SERIALS.

American Journal of Science, March.—The Appalachian type of folding in the White Mountain Range of Inyo County, California, by C. D. Walcott. In the broad palæozoic area between the Sierra Nevada on the west and the early palæozoic shore-line on the east (Colorado) a period of folding and thrust-faulting was followed by a period of vertical faulting, which displaced the strata that had been folded and faulted in the preceding epoch. The extent and character of this disturbance can only be determined by a careful study of each of these mountain ranges for a distance of over five hundred miles east and west, and probably one thousand miles north and south.—The succession of fossil faunas at Springfield, Missouri, by Stuart Weller. The rocks studied are beds of grey limestone with lenticular chert concretions, and form part of the Mississippian series. The faunas of the lower part of the section may be correlated with the Burlington faunas of Iowa, and those of the upper part with the Keokuk faunas. The whole series of faunas is continuous, and the whole series of rocks should be designated by a single name. The term Osage, suggested in 1891 by H. S. Williams, is recommended.—Drift boulders between the Mohawk and Susquehanna rivers, by A. P. Brigham. The Archæan and the more northern Palæozoic fragments are strewn over the whole district at all altitudes, but diminishing southward in size, and sparse in amount on the highest hills, especially to the southward, where the tops of the ranges are often surprisingly free from transported material. Actual reduction of the general surface towards base level doubtless proceeded rapidly during glacial time, but even then the process was rapid only in the geological sense, and the result a minute fraction of what has been accomplished since the region became a land surface.

Bulletin of the American Mathematical Society, vol. i. 5. (New York, February 1895.)—On a certain class of canonical forms, by Mr. R. A. Roberts, is a paper, read before the Society at its December meeting, which treats of an interesting class of theorems occurring in the consideration of algebraical quantics.—"Hayward's Vector Algebra" is a review, by Prof. M. Böcher, of the algebra of coplanar vectors and trigonometry, which deals out praise and its opposite in about equal proportions.—Apolar triangles on a conic is a very interesting paper by Prof. F. Morley.—The remaining short notices comprise an instance where a well-known test to prove the simplicity of a simple group is insufficient, by G. H. Miller, and an account of the Lobachevsky Memorial Volume, 1793-1893. Amongst the notes is a bare statement of Prof. Cayley's death.—The usual new publications list concludes the number.

Symons's Monthly Meteorological Magazine for March contains another striking proof of the severity of the frost in February last, as shown by the temperature of the earth at Camden Square, in the north-west of London. The thermometer with its bulb one foot below the surface was first read on January 1, 1871. Prior to 1895, it was never below 32°, and only reached that point in 1880. But in February last there were twelve consecutive days on which the thermometer was below 32°. In country districts, the frost penetrated to a much greater depth, and this subject will probably be referred to in a future number of the magazine. A careful observer at Berkhamsted states that the frost there penetrated to a depth of 1 foot 8 inches.

Internationales Archiv für Ethnographie, Band. vii. Heft v. and vi. 1894.—Prof. H. H. Giglioli, in his "Notes on some remarkable Specimens of Old Peruvian 'Ars Plumaria,'" gives a description of two very fine head-dresses in Ancient Peruvian feather-work, which are illustrated by a beautifully executed coloured plate. It is strange, as the author points out, "that the specimens of old Peruvian 'ars plumaria' unearthed from the hundreds of huacas, excavated but too often by vandalic treasure-seekers, have not attracted more attention." The best specimens of feather-mosaic were made in the sixteenth and seventeenth centuries, and the art has now practically died out. —Mr. S. H. Ray abstracts and annotates "Some Notes on the Tannese," by Rev. W. Gray. Mr. Gray has been a missionary in Tanna for twelve years, and so he can speak from adequate personal knowledge; he gives information on dress, circumcision, political organisation, war, kava, religion, social organisation and marriage, the calendar, the winds, and language. This is a valuable supplement to Dr. Codrington's monograph; the section on religion is of especial value. Dr. H. Ten Kate describes and illustrates a collection of ethnographical objects from the Timor Group. The supplement to vol. vii. of the *Archiv* is an account of the Năng, or the Siamese shadow-figures in the Völkerkunde Museum in Berlin, by Dr. F. W. K. Müller. A transcription and translation (in German) of the rhymes of the drama is given, which is a fragment of the Râmâjana. It is illustrated by eleven plates, eight of which are coloured. Vol. viii. commences with the conclusion of Dr. Ten Kate's paper, which is illustrated by four plates. This part is of more general interest, as it deals partly with the religion and the sacred animals of the Timorese and other Indonesians; the author agrees with Pleyte, that the snake cult is indigenous to Indonesia, and is not borrowed from India. There is a useful little table of the distribution of certain objects.—S. K. Kusnezow writes on the death-cult of the Tscheremisse (a Ural-Altaiic people on the Volga, near Kazan). These numbers of the *Archiv* contain the usual valuable notes and bibliography.

SOCIETIES AND ACADEMIES.

LONDON

Royal Society, January 17.—"On Slow Changes in the Magnetic Permeability of Iron." By William M. Mordey.

The conclusions to which the observations lead, so far as they have gone, are:—

(1) The effect is not fatigue of the iron caused directly by repeated magnetic reversals—it is not "progressive magnetic fatigue."

(2) Neither magnetic nor electric action is necessary to its production.

(3) It is a physical change resulting from long-continued heating at a very moderate temperature.

(4) It appears to be greater if pressure is applied during heating.

(5) It is not produced when the iron is not allowed to rise more than a few degrees above the ordinary atmosphere.

(6) It is similar to the effect produced by hammering, rolling, or by heating to redness and cooling quickly.

(7) The iron returns to its original condition on re-annealing.

(8) It does not return to its original condition if kept unused and at ordinary atmospheric temperatures, whether the periods of rest are short or long.

March 7.—"The Action of Heat upon Ethylene, II." By Prof. Vivian B. Lewes.

From the results of the experiments described in the paper it is stated that:—

(1) The initial decomposition of ethylene by heat is very rapid, and requires but a short flow through a heated containing vessel, such primary decomposition, however, being but slowly completed, owing to secondary reactions, which tend to reform ethylene.

(2) Dilution has but little effect in retarding the decomposition of ethylene, unless it be very large.

(3) Increase in rate of flow diminishes the amount of decomposition when the heated area is small, but rapidly diminishes in effect as the length of flow through a heated area increases.

(4) The decomposition of ethylene is chiefly caused by radiant heat, the effect of which is very great as compared with the decomposition due to contact with heated surfaces.

March 21.—"The Cause of Luminosity in the Flames of Hydrocarbon Gases." By Prof. Vivian B. Lewes.

The facts which appear to be established in this paper are:—

(1) That the luminosity of hydrocarbon flames is principally due to the localisation of the heat of formation of acetylene in the carbon and hydrogen produced by its decomposition.

(2) That such localisation is produced by the rapidity of its decomposition, which varies with the temperature of the flame and the degree of dilution of the acetylene.

(3) That the average temperature of the flame due to combustion would not be sufficient to produce the incandescence of the carbon particles within the flame.

In a paper on the action of heat upon ethylene, brought before the Royal Society this spring, the author showed that the decomposition of ethylene into acetylene and simpler hydrocarbons was mainly due to the action of radiant heat, and was but little retarded by dilution, whilst he has shown in this paper that the acetylene so produced requires a considerable increase in temperature to bring about its decomposition when diluted, and it is possible with these data to give a fairly complete description of the actions which endow hydrocarbon flames with the power of emitting light.

When the hydrocarbon gas leaves the jet at which it is being burnt, those portions which come in contact with the air are consumed and form a wall of flame which surrounds the issuing gas. The unburnt gas in its passage through the lower heated area of the flame undergoes a number of chemical changes, brought about by the action of radiant heat emitted by the flame walls, the principal of which is the conversion of the hydrocarbons into acetylene, methane, and hydrogen. The temperature of the flame quickly rises as the distance from the jet increases, and a portion of the flame is soon reached at which the heat is sufficiently intense to decompose the acetylene with a rapidity almost akin to detonation, and the heat of its formation, localised by the rapidity of its decomposition, raises the liberated carbon particles to incandescence, this giving the principal part of the luminosity of the flame; whilst these particles, heated by the combustion of the flame gases, still continue to glow, until finally themselves consumed, this external heating and final combustion adding slightly to the light emitted.

Any unsaturated hydrocarbons which have escaped conversion into acetylene before luminosity commences, and also any methane which may be present on passing into the higher temperatures of the luminous zone, become converted there into acetylene, and at once being decomposed to carbon and hydrogen, increase the area of the light-giving portion of the flame.

"On the Changes in Movement and Sensation produced by Hemisection of the Spinal Cord in the Cat." By C. D. Marshall.

"On the Analysis of Voluntary Muscular Movements by certain new Instruments." By Dr. W. R. Jack.

"On the Spark Spectrum of Argon as it appears in the Spark Spectrum of Air." By Prof. W. N. Hartley, F.R.S.

Chemical Society, March 7.—Dr. Armstrong, President, in the chair.—The following papers were read:—Dimethylketohexamethylene, by F. S. Kipping. This substance is a colourless oil boiling at 174–176°, and is prepared by distilling calcium $\alpha\alpha'$-dimethylpimelate with soda-lime.—The use of barium thiosulphate in standardising iodine solution, by R. T. Plimpton and J. C. Chorley. Barium thiosulphate, BaS_2O_3, H_2O is well adapted for standardising iodine solution, inasmuch as it keeps well, has a high molecular weight, and is readily acted on by iodine.—The melting points of racemic modifications and of optically active isomerides, by F. S. Kipping and W. J. Pope. Dextro-rotatory and racemic π-monobromocamphor melt at the same temperature, and the melting point of the one is not depressed by the presence of the other isomeride; the same is true of the inactive and dextro-rotatory π-monochlorocamphors.—Phenyl ethers of methylene- and ethylene-glycols. Synthesis of α-methylbutyrolactone, by E. Haworth and W. H. Perkin, jun. A number of phenyl ethers of methylene- and ethylene-glycol have been obtained by the use of sodium phenate; α-methylbutyrolactone has been synthesised from ethylic sodiomethylmalonate.—Methylisobutylacetic acid, $CHMe_2.CH_2.CHMe.COOH$, by W. H. Bentley and M. W. Burrows. This acid was prepared by the distillation of methylisobutylmalonic acid, which in turn was synthesised from ethylic sodiomethylmalonate and isobutyl bromide.

Geological Society, March 6.—Dr. Henry Woodward, F.R.S., President, in the chair.—A new ossiferous fissure in Creswell Crags, by W. L. H. Duckworth and F. E. Swainson. The fissure explored by the authors is about 30 feet above the level of the artificial lake at Creswell Crags. At the top occurred a white earth (with human and other remains) passing down into a red sand with remains of fox, badger, roe-deer, and other mammals. Beneath the latter deposit, and separated from it by a fairly sharp line of demarcation, came the cave-earth proper with palæolithic implements and bones of *Rhinoceros tichorhinus*, *Bison priscus*, *Ursus spelæus*, *Hyæna*, *crocuta* var. *spelæa*, and *Cervus tarandus*. The authors suppose that this cave-earth was derived from an older deposit, and had been transported to its present place by water, though there is evidence that the transport had been from no great distance. Consequently they followed the fissure inwards, until brought to a stop by a mass of travertine, which they penetrated with a small hole. They hope to explore the fissure beyond this travertine on a future occasion.—Notes on the chemical composition of some oceanic deposits, by Prof. J. B. Harrison and A. J. Jukes-Browne. The authors formerly experienced great difficulty in comparing their analyses of the oceanic deposits of Barbados with those of modern oozes made by Dr. Brazier. Since then Dr. Murray has placed samples of recent red clay and *Globigerina*-ooze at their disposal, and these were analysed by Prof. Harrison and Mr. John Williams. The results of analysis of the red clay were arranged as follows:—Argillaceous constituent 67·85 per cent., pumiceous matter 23·26 per cent., organic constituents 5·88, and adherent sea-salts 3·61 per cent. The authors found that the argillaceous constituent was not a mixture of an orthosilicate of alumina and hydrated peroxide of iron, having the proportion of silica to alumina as 14 to 12, but a more highly silicated compound in which the proportions were as 33 to 12. It was in fact a ferruginous earth, such as would result from the decomposition of palagonite and of a basic volcanic glass, fragments of which were frequent in the Pacific red clays. The pumiceous matter was the débris of an acid pumice containing 7 per cent. of soda, and apparently therefore the pumice of a soda-felsite. Comparing the analyses of the recent red clay with those of Barbadian red clays, they find the differences to be such as would result from mixtures of the palagonitic earth with various acid and basic pumices. A mixture of the palagonitic earth with the pumiceous dust which fell on Barbados in 1812 would have a composition closely corresponding to that of the oceanic clay of Barbados. The recent calcareous ooze closely resembled the more calcareous "chalks" of the Barbadian oceanic series, but the latter contained much colloid silica and fine clay. The differences between the analyses of the recent ooze and of English chalk, when certain allowances are made, were found to be but small. The recent calcareous ooze contained many more *Globigerina*-tests than tertiary or mesozoic chalks, but it is suggested that this is due to our possessing only the surface-layers of the *Globigerina*-ooze. In one important respect all the different kinds of deposit which were examined resembled one another, namely, in the infinitesimally small quantity of quartz which they contained. The authors' examination of the recent oceanic deposits, and a comparison of them with the raised Barbadian deposits, only increased their conviction that the latter were of truly oceanic origin.

Linnean Society, March 7.—Mr. C. B. Clarke, F.R.S., President, in the chair.—Mr. A. Henry was admitted a Fellow.—On behalf of Sir Joseph Hooker, the Secretary exhibited a bronze medal struck in honour of the late Alphonse de Candolle.—Mr. J. E. Harting exhibited a remarkable head and horns of *Cupra ægagrus* recently obtained by Mr. F. C. Selous in Asia Minor, and made remarks on the geographical distribution of this and other allied species.—Mr. G. F. Scott Elliot, who had been absent from England since September 1893, on a botanical exploration of Mount Ruwenzori and the country to the north of the Albert Edward Nyanza, gave an account of his journey and of the results, geographical, botanical, zoological, and political, obtained by him. The country lying north-east of the Victoria Nyanza was described as a large, rolling, grassy plain, some 6000 feet above sea-level, and well adapted for colonisation. He went west from the Victoria Nyanza to Mount Ruwenzori, which is said to have an altitude of 18,000 feet, and spent four months in exploring that district under the great disadvantage of a dense cloud hanging over the mountain the greater part of the day, which often prevented the party from seeing more than fifty feet ahead. The sides of the mountain were clothed at the base with a thick growth of trees resembling the laurel of the Canary Islands; above that, bamboos to the 10,000-feet level; and above that again what the explorer could only liken to a Scotch peat moss in which the traveller sank at every step a foot or more. Large trunks like those of *Erica arborea* of the Canary Islands, but indicating trees 80 feet high, were noticed. Amongst other plants found were a *Viola*, a *Cardamine*, a gigantic *Lobelia*, attaining a height of five or six feet, and a species of *Hypericum* resembling that found in the Canaries; indeed, the similarity of the flora to that of the Canary Islands was remarkable. Mr. Scott Elliot ascended Mount Ruwenzori to the height of 13,000 feet, finding evidence of animal life and numerous insects to a height of 7000 feet. Above 10,000 feet his Swahili porters could not sleep without injury to their health, and it was only with a reduced number of men that he was able to ascend another 3000 feet. Amongst the animals specially mentioned was a species of water buck (*Cobus*), a new chameleon, a new snake, and several new insects.—The Secretary then read an abstract of a paper by Dr. Maxwell T. Masters, on the genus *Cupressus*, illustrated by a number of plants and cuttings which had been forwarded by Messrs. Veitch, Mr. Moore, of Glasnevin, and Dr. Acton, of Kilmacurragh.—Dealing with the zoological collections made during the recent expedition of Mr. Theodore Bent to Southern Arabia, Messrs. Kirby, Gahan, and Pocock presented papers on the insects and arachnida which had been obtained, some of which were described as new.

Royal Meteorological Society, March 20.—Mr. W. N. Shaw, F.R.S., delivered a lecture on "The Motion of Clouds considered with reference to their mode of formation," which was illustrated by experiments. The question proposed for consideration was how far the apparent motion of cloud was a satisfactory indication of the motion of the air in which the cloud is formed. The mountain cloud cap was cited as an instance of a stationary cloud formed in air moving sometimes with great rapidity; ground fog, thunderclouds, and cumulus clouds were also referred to in this connection. The two causes of formation of cloud were next considered, viz. (1) the mixing of masses of air at different temperatures, and (2) the dynamical cooling of air by the reduction of its pressure without supplying heat from the outside. The two methods of formation were illustrated by experiments. A sketch of the supposed motion of air near the centre of a cyclone showed the probability of the clouds formed by the mixing of air being carried along with the air after they were formed, while when cloud is being formed by expansion circumstances connected with the formation of drops of water on the nuclei to be found in the air, and the maintenance of the particles in a state of suspension, make it probable that the apparent motion of such a cloud is a bad indicator of the motion of the air. After describing some special cases, Mr. Shaw referred to the meteorological effects of the thermal disturbance which must be introduced by the condensation of water vapour, and he attributed the violent atmospheric disturbances accompanying tropical rains to this cause. The difference in the character of nuclei for the deposit of water drops was also pointed out and illustrated by the exhibition of coloured halos formed under special conditions when the drops were sufficiently uniform in size.

PARIS.

Academy of Sciences, March 18.—M. Marey in the chair.—Attempts to produce chemical combinations with argon, by M. Berthelot. Argon has been submitted to the action of the silent discharge under the conditions described in the author's "Essai de Mécanique chimique," t. ii., pp. 362-363. The apparatus used was that described in the "Annales de Chimie et de Physique" [5], x., pp. 79, 76, and 77. With benzene vapour, argon is absorbed though more slowly than nitrogen. 87 per cent. of the volume of argon employed in the experiment entered into combination. As the total volume of argon at disposal was but 37 c.c., the products were too small in quantity to allow of any extended investigation into their nature. They appear to be similar in character to the products obtained with nitrogen and benzene. A yellow, resinous, odorous substance condensed on the surface of the two glass tubes; this substance decomposed on heating, yielding an abundant carbonaceous residue and volatile products which reddened litmus paper.—On the lacunæ in the zone of small planets, by M. O. Callandreau.—Transformations of fibrin by the prolonged action of dilute saline solutions, by M. A. Dastre.—On the variations of terrestrial latitudes, by M. F. Gonnessiat.—On the theory of a system of differential equations, by M. A. J. Stodolkievitz.—On a general definition of friction, by M. Paul Painlevé.—On Fourier's problem, by M. Le Roy.—Absorption of light in uniaxial crystals, by M. G. Moreau. The symmetry of uniaxial absorption is not so complete as the theory of the ellipsoid of absorption indicates. The dissymmetry is greater as the crystal is more birefringent.—On the potential of an electrified surface, by M. Jules Andrade.—Apparatus imitating the movements executed by certain animals in turning round without external fulcra, by M. Edm. Fouché. The explanation of the movements of a cat, enabling it to always fall on its feet, given by M. Guyou, is completely borne out by the successful reproduction of the rotatory movement with a strictly mechanical model.—The catoptric and symmetrical objective, by M. Ch. V. Zenger.—On a class of secondary batteries, by M. Lucien Poincaré. The author describes a secondary battery with mercury for poles and sodium iodide in concentrated solution for electrolyte. The mercury iodide formed remains in solution, and the sodium forms an amalgam with the mercury. On discharge the yield is more than 90 per cent. of the theoretical. The battery is not affected by short circuiting or the particular manner of its discharge, but is unlikely to be practically used on account of the expensive nature of the materials, and the necessity of removing the amalgam from contact with the liquid if the battery is to remain long charged.—On the effect of an alternating electromotive force on the capillary electrometer, by M. Bernard Brunhes.—Thermochemical carbon battery, by M. Désiré Korda. By the action of carbon on barium peroxide during the reduction of the latter to monoxide, an E.M.F. of nearly 1 volt is produced when arranged as a cell. In the case given an internal resistance of 13·6 ohms was found. A similar arrangement with copper peroxide, the latter being separated from the carbon pole by dry, pure potassium carbonate, gave 1·1 volt with an internal resistance of 3·2 ohms.—Action of nitrous oxide on metals and metallic oxides, by MM. Paul Sabatier and J. B. Senderens. A table is given showing the comparative reactions of N_2O, NO, and NO_2, and air on a series of metals and oxides. The deduction is drawn that oxidations by means of N_2O are caused by the direct action of this gas without preliminary decomposition into its constituents.—Researches on the heats of combination of mercury with the elements, by M. Raoul Varet.—On the isomeric states of the oxides of mercury, by M. Raoul Varet. It is shown that yellow and red oxides dissolve in dilute HCN with liberation of the same amount of heat, and hence the transformation of yellow into red oxide gives no appreciable thermal effect.—On the heat of formation of some compounds of iron, by M. H. Le Chatelier.—On the chlor-aldehydes, by M. Paul Rivals. A thermochemical paper.—On a mercuric combination of thiophene, permitting the estimation of the latter in commercial benzene and its extraction therefrom, by M. G. Denigès. A very stable combination of mercury and thiophene, having the composition $(SO_4Hg.HgO)_2SC_4H_4.H_2O$, is obtained by treatment of thiophene with an acid solution of mercuric sulphate (made by dissolving fifty grams of mercuric oxide in 200 c.c. of pure sulphuric acid diluted with a litre of distilled water). On account of its insolubility and ease of formation, this compound may be used for the detection of traces of thiophene in benzene and for the purification of benzene.—On the amorphous state of melted substances, by M. C. Tanret.—Derivatives of active α-hydroxybutyric acid, by MM. Ph. A. Guye and Ch. Jordan. A paper giving optical rotations and products of asymmetry.—The production of wine and the utilisation of fertilising principles by the vine, by M. A. Muntz.—On the decortication of wheat, by M. Balland.—On the parts taken respectively by purely physical and by physiological actions in the disengagement of carbonic acid by muscles isolated from the body, by M. J. Tissot.—Therapeutic action of currents of high frequency (autoconduction of M. d'Arsonval), by MM. Apostoli and Berlioz. These currents have a powerful influence on the nutritive activity of the tissues, and hence are of first importance in the treatment of many functional troubles, caused by defective nutrition.—New application of the graphic method to music, by MM. A. Binet and J. Courtier.—Histological researches on the development of the Mucorini, by M. Maurice Léger.—On the geology of Ossola (*Alpes Lépontines*), by M. S. Traverso.—On an application of photography to oceanography, by M. J. Thoulet.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—Bird Notes: late J. M. Hayward (Longmans).—Statesman's Year-Book, 1895 (Macmillan).—Qualitative Chemical Analysis of Inorganic Substances (American Book Company, New York).—Annals of British Geology, 1893: J. F. Blake (Dulau).—A Handbook of Systematic Botany: Dr. E. Warming, translated and edited by Prof. M. C. Potter (Sonnenschein).—Illustrations of the Zoology of H.M. Indian Marine Surveying Steamer *Investigator*, Part 1 (Quaritch).—Stanford's Compendium of Geography and Travel (new issue)—Africa, Vol. 1: North Africa: A. H Keane (Stanford).—Hygienische Meteorologie: Prof. Dr. W. J. van Bebber (Stuttgart, Enke).—Text-Book of Anatomy and Physiology for Nurses: D. C. Kimber (Macmillan).—Chemical Analysis of Oils, Fats, Waxes, &c.: Dr. R. Benedikt, revised and enlarged by Dr. J. Lewkowitsch (Macmillan). Taschenbuch für Flugtechniker und Luftschiffer: H. W. L. Moedebeck, (Berlin, Kühl).—Le Pétrole, L'Asphalte et le Bitume: A. Jaccard (Paris, Alcan).

PAMPHLETS.—Madras Government Museum, Bulletin No. 3: Rámévaram Island and Fauna of the Gulf of Manaar: E. Thurston, 2nd edition (Madras).—Die Entwickelung: Dr. G. Pfeffer (Berlin, Friedländer).

SERIALS.—Royal Natural History, Part 17 (Warne).—Proceedings of the Royal Society of Victoria. Vol. vii. new series (Melbourne).—American Naturalist, March (Philadelphia).—Astrophysical Journal, March (Chicago).—Journal of the Institution of Electrical Engineers, No. 115, Vol. xxiv. (Spon).—Economic Journal, March (Macmillan).—Botanische Jahrbucher, Neunzehnter Band, v. Heft (Leipzig, Engelmann).—Transactions of the Astronomical and Physical Society of Toronto for the Year 1894 (Toronto, Rowsell).—Zeitschrift für Physikalische Chemie, xvi. Band, 3 Heft (Leipzig, Engelmann).—Minnesota Botanical Studies, Bulletin No. 9 (Minneapolis).—Notes from the Leyden Museum, Vol. xvi. Nos. 3 and 4 (Leyden, Brill).—Good Words, April (Isbister).—Sunday Magazine, April (Isbister).—Longman's Magazine, April (Longmans).—Quarterly Journal of Microscopical Science, No. 147 (Churchill).—Bulletin of the Geographical Club of Philadelphia, Vol. 1, No. 3 (Philadelphia).—Bulletin of the U.S. Geological Survey, No. 120 (Washington).

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