THURSDAY, NOVEMBER 16, 1893.

ROMANES ON WEISMANN.

An Examination of Weismannism. By G. J. Romanes, M.A., LL.D., F.R.S. (London: Longmans, Green, and Co., 1893.)

DR. ROMANES is a most competent hurler of hard words, and in this volume is concerned at least as much to convince the reader that Weismann is an uncertain guide as to be to him himself a certain guide. In the preface he states his intention to publish his criticisms "in separate form and in comparatively small editions, so that further chapters may be added with as much celerity as Prof. Weismann may hereafter produce his successive works." In the text, writing of the relations between the views of Galton and Weismann, he talks of those immense reaches of deductive speculation, which, in his opinion, merely "disfigure the republication of stirp under the name of germ-plasm" (!) The mention of certain occurrences which are believed in by Dr. Romanes, but the admission of which he considers illogical on the part of Weismann, "seemed attributable to mere carelessness on the part of their author." Another consideration is "made by Weismann for the sole purpose of saving as much as he can of his previous theory of variation." Another is "an obvious equivoque." The mechanism of heredity is planned out (in Weismann's latest volume) "in such minuteness of detail and assurance of accuracy that one is reminded of that which is given by Dante of the topography of the Inferno."

Of the actual criticism the last chapter and the two appendices alone require special treatment, as they alone were written after the publication of "Amphimixis" and "The Germ-plasm."

It does not seem useful to insist with Dr. Romanes that the continuity of the germ-plasm is the inverse of the basis of the theory of pangenesis. The most important part of the continuity theory has no parallel in Darwin's provisional hypothesis. It is the attractive suggestion of a material basis of heredity which can be identified with structures visible under the microscope; which can be seen, in some cases, to separate immediately from the fertilised ovum to form the foundation of the germ-cells of the new individual, or, in other cases, to move along "germ-tracts" to the foundation of the germ-cells of the new individual. What is directly comparable in the two theories is the picture each gives of the phenomena of inheritance viewed in pangenesis as a rolling up of gemmules from an existing body to form germ-cells; in the germ-plasm as the unrolling of germ-plasm to form a developing body. In this, as Dr. Romanes points out, the one theory is the inverse of the other, and very naturally similar groups of facts may appear in the one as stages of rolling up, in the other as stages of disintegration. But here again Weismann, aided no doubt by the vast advance in microscopical science, constantly is more in touch with observed facts of microscopical detail than was Darwin.

Dr. Romanes uses a good deal of space for a minute and interesting comparison of Weismann's germ-plasm with the "stirp" of Galton. He urges that natural selection, so potent in the organic world, probably does not cease in the separate parts of a body during development, and therefore supports Galton's view of a competition among many gemmules of the same order as to which shall actually cause development. But natural selection is not a force: it is merely an aspect of certain occurrences, and while there may be many (as Galton thinks) or few (as Weismann thinks) units of germ-plasm each capable of causing development, and only one of which does cause development, the aspect of the occurrences on which Weismann wishes to direct attention is that the process of development goes on by an orderly disintegration of the germ-plasm through various stages of units, and that the order is determined by the "historic architecture" of the germ-plasm. This "historic architecture" is the material representation (on Weismann's theory) of the observed fact that ontogeny does to some extent repeat phylogeny. A continual struggle among innumerable units would account for too much variation, and would leave unrepresented the habitual fixedness of heredity.

In his criticism of Weismann's view of evolution Dr. Romanes first states how recent further investigations (those of Maupas and others) into the conjugation of Protozoa have led to an identification of conjugation with sexual reproduction, so far as they both result in a mingling of germ-plasm, but he quarrels with Weismann for not abandoning the potential immortality of the Protozoa. But whether Protozoa conjugate or not, on the broad average they divide by fission. That means that Protozoa alive to-day have come down in a continuous chain of cell-life from primeval Protozoa, unless indeed there have been continual re-creations of Protozoa. Even if it were proved that spore-formation invariably interrupted at long or short intervals chains of simple fission, still practical immortality may be held by regarding spore-formation as merely multiple fission.

In a more important criticism Dr. Romanes seems to me to misinterpret Weismann's position. When the continuity of germ-plasm first presented itself to Weismann's mind, and brought with it the idea that the somas of each generation were mere pendants of the chain of germ-plasm, it became difficult to see how the impression of outside nature on the soma could be impressed in turn on the germ-plasm. This led to an examination of a new kind into acquired characters, and the result of that examination satisfied Weismann and many others that there was no sufficient reason for supposing that characters acquired by the individual were transmitted to the progeny. Of course this is still a matter of argument, and as Dr. Romanes in this book refers to a full treatment of the question, the publication of which has been delayed by his regrettable illness, it may well be that he will adduce fresh and important considerations. But the fact remains that Weismann, driven back from acquired characters as a cause of phylogenetic variation, came to regard the mingling of germ-characters in amphimixis (traceable back to the direct influence of the environment upon organisms antecedent to amphimixis) as the source of all variation. The germ-plasm lived as a parasite within the soma, and was related to it only by the fact that it got food from the soma. In the more developed doctrine

Weismann retains the original conception. But the germ-plasm is now a particulate substance, and *inequalities of nutrition affecting the separate elements cause variations in it.* The original conception has now become more definite, and this increase in definition has effected a reconciliation with some strong objections to the generalised idea. It seems to me extraordinary that a critic so acute as Dr. Romanes, not in the heat of controversy but in a deliberate book, should call this "removing stone by stone, his doctrine of descent," and "turning upside down the fundamental postulate." In order to reach such a view he has had to be much more certain than Weismann, about what Weismann meant, and to attribute to "mere carelessness" the inclusion in Weismann's earlier writings of indications pointing in this direction.

In Appendix I. the germ-plasm is discussed specially in so far as Weismann considers pangenesis a less conceivable and a more formal explanation. I think the key to the criticism is again to be found in a misconception by Dr. Romanes. He quotes from Weismann:—

"How can such a process (*i.e.* the passage of gemmules into growing germ-cells) be conceivable when the colony becomes more complex, when the number of somatic cells becomes so large that they surround the reproductive cells with many layers, and when, at the same time, by an increasing division of labour, a great number of different tissues and cells are produced, all of which must originate *de novo* from a single reproductive cell?"

He goes on:—

"Here again the obvious answer is that no one has ever propounded such a statement. Far from supposing that 'all the different cells and tissues of a complex organism must originate *de novo* from a *single* reproductive cell,' the theory of pangenesis supposes the very contrary—viz. that somatic changes in the past history of the phyla had *not* thus originated in *any* reproductive cell. The idea of somatic changes originating in reproductive cells belongs to the theory of *germ-plasm;* but even this theory does not suppose all the great number of different cells and tissues which compose a complex organism to have ever originated *de novo* from a *single* reproductive cell."

What Weismann means seems clear enough, although it is dark to Dr. Romanes. The whole of a complex organism grows out from an ovum, and this origin occurs *de novo* in each generation. Pangenesis supposes that gemmules from each cell in the body somehow come together to form the ovum, and they come together so that they unroll in proper order. For this process there is no trace or shadow of evidence: to many it seems *à priori* inconceivable.

According to Weismann's theory the germ-plasm has been slowly built up in phylogeny, and slowly unrolls in the individual development. On any supposition the process is wonderful: on Weismann's hypothesis the evolution of germ-plasm has actually followed the evolution of living things from simple to complex, and there is no new wonder in its complexity, nor is the unrolling of the historically elaborated germ-plasm more wonderful than the actual development of the historically elaborated soma. The hypothesis of pangenesis supposes that in each living organism there is a new wonder, the giving off of gemmules, and their building up into an ovum which reproduces not only the structures which gave off gemmules, but many an embryonic structure dating far back in phylogenetic history.

Appendix II. deals with Telegony, and practically consists of Dr. Romanes' recent controversy with Herbert Spencer. In the mass of confused data about this subject it seems fairly established that at least it is very rare. The influence of a first sire does not as a rule affect children to a second sire. Herbert Spencer thinks that the established cases are fatal to Weismann's theory, inasmuch as they prove that influences impressed on the soma can be transferred to the offspring. Romanes thinks that they are not fatal, inasmuch as germ-plasm from spermatozoa of the first sire coming in contact with the ovary when a spermatozoon caused impregnation, might, as they disintegrate, allow some of their germ-plasm to penetrate the ovary and reach other ova. The actual explanation seems, to the present writer, a much simpler one, but as he is collecting facts he will only mention it. In the best established cases, as for instance Lord Morton's mare, and the sow quoted by Mr. Spencer, the first sire was of a more ancestral type than the second sire, and the characters in the progeny attributed to the influence of the first sire were atavistic, and in ordinary cases would have been simply referred to as throw-backs. But as at present Dr. Romanes' criticism of Weismann is the matter in hand, it is enough simply to point out that in this most difficult case for followers of Weismann, Saul also is among the prophets—Dr. Romanes agrees with Weismann! P. C. M.

EXTRA-TROPICAL ORCHIDS.

Icones Orchidearum Austro-Africanarum Extra-tropicarum; or Figures, with Descriptions of extra-tropical South African Orchids. By Harry Bolus, F.L.S. Vol. i. Part 1. (London: William Wesley and Son.)

THIS is an excellent work, devoted to the orchids of extra-tropical South Africa, and arranged on the lines of the "Refugium Botanicum" of Mr. Wilson Saunders. The first part includes fifty plates, containing figures and dissections (partly coloured) of fifty-one species. The text comprises descriptions in Latin and English, references to original descriptions, synonymy, geographical distribution, with critical and explanatory notes. The author's many years of careful study of South African orchids, as well as his previous writings on the subject, are sufficient guarantee of the quality of the work; and as regards the plates, a decided improvement is noticeable, both in the drawings and lithography, as compared with his previous "Orchids of the Cape Peninsula" (reviewed in NATURE, vol. xxxix. p. 222). The work will be of great use to the systematic botanist, for, as Mr. Bolus has well pointed out, few orders of plants stand more in need of illustration from living specimens than orchids, because of the high degree of specialisation of many of the parts, some of which are very fleshy, and seldom recover their shape after soaking or boiling. Nine new species are described in the present part, *Angræcum caffrum*, *A. Maudæ*, *Habenaria Galpini*, *Satyrium Guthriei*, *S. ocellatum*, *Pachites Bodkini*, *Disa sabulosa*, *D. conferta*, and *Brown* *leea Galpini*. There are strong grounds, however, for suspecting that *Satyrium Guthriei* is not a true species, but a natural hybrid. It was described from a single living specimen found growing with *S. candidum*, Lindl., in burnt-off places on the Cape Flats, Tokai, near Cape Town, by Mr. F. Guthrie. Mr. Bolus remarks that the column "resembles in some degree that of *Satyrium bicallosum*, Thunb., while both are in this respect very different from that of any other Satyrium known. In every other character this differs greatly from *S. bicallosum*, and I very much doubt if it is a natural hybrid." This remark shows that Mr. Bolus had suspicions about the matter. It is a remarkable fact, however, that in every character in which *S. Guthriei* differs from *S. bicallosum* it approaches *S. candidum*; in fact, with the exception of the column, it bears a much closer resemblance to the last-named species, and as the organs generally are intermediate in character between those of the two species, there seems little doubt that it is a natural hybrid between them. Many such organisms are now known, and as both the species grow in the district, there is nothing improbable about the matter.

There are several points of interest about the work, one or two of which may be mentioned here. The discovery of a new species of Pachites is very interesting, as the original one has only been met with on four occasions. Burchell found a single specimen in 1815; Krausse met with another twenty-four years later; and now, after a lapse of fifty years, Mr. Schlechter has discovered two more specimens. Mr. Bolus hopes to publish a figure in the next part of his work. It is a curious coincidence that the new species is only known from a single specimen. An interesting note is given as to the affinities of Schizochilus. Sonder had indicated it as a member of the Habenarieæ, but Bentham transferred it to Diseæ. Mr. Bolus again places it near to Habenaria, and his drawings unmistakably show that this is its real position. Mr. Bolus calls attention to a very curious character found in *Satyrium pumilum*, Thunb., which Lindley referred to a separate genus. The flowers are transversely striped with brown, like a Stapelia, and to make the resemblance more complete, they also have a heavy odour of putrid flesh. As it differs so markedly from its allies in these characters, it is evident that we have here an adaptation to secure the visits of the insects which fertilise the Stapelias of the same region. And this reminds us that scarcely anything is known of the fertilisation of South African orchids. Mr. Bolus figures a beetle on the plate of *Disa elegans* (t. 35), which he found upon one of its flowers, with a pollinium attached to its thorax. It is said to be a species of Peritrichia, belonging to a group of well-known fertilisers. "This being only the second instance," remarks the author, "of an insect actually carrying orchid pollen which I have seen during many years' study of Cape orchids, I have thought it desirable to figure it with the plant." Among the undoubtedly handsome species may be noted *Disa ferruginea*, Swartz, and *D. graminifolia*, Ker. The former is noted as "abundant on Table Mountain," and its dark orange-vermilion flowers are "largely sold in bouquets in the streets." The latter was called *Herschelia graminifolia* by Lindley, though Mr. Bolus considers Herschelia as only a section of Disa. We are told that "it is one of the commonest species within our limits, has a rather long flowering period, and attracts universal observation by its beauty and brilliancy; so much so, that Lindley, in dedicating it to the great astronomer Herschel (who also was a great orchid-lover and cultivator), felicitously speaks of it as "species hæc pulcherrima *colore cœli australis* intense cæruleo superbiens!" Future parts of this useful work will be awaited with interest.

R. A. ROLFE.

OUR BOOK SHELF.

An Astronomical Glossary. By J. E. Gore. (London: Crosby Lockwood and Son, 1893.)

FIFTY years ago it was the fashion to insert a glossary or dictionary of astronomical terms in every work on astronomy, but few of the books published in late years include these helpful explanations. Mr. Gore endeavours to supply the need in the volume before us. And if the science of astronomy had made no advances during the last half-century, we should have been able to give the highest commendation to his compilation. But since celestial science has had its limits considerably extended, and the old astronomy is giving place to the new, we naturally expect to find the new terms defined in a glossary which pretends to contain "an explanation of all the terms and names generally used in books on astronomy." We were greatly surprised therefore, upon looking through the book, to notice the omission of many common and important words to be found in almost every work on astronomy. Among other omissions are the words corona, prominences, chromosphere, photosphere, spectroscope, and prism. Zones are correctly described, and are exemplified by "torrid zone," "frigid zone," and "temperate zone," but the term "sun-spot zone" is unexplained. No mention is made of spectroscopic binaries, or of motion in the line of sight, or of zodiacal constellations. Stereograms are defined, but not spectrograms—that useful word coined for spectroscopic negatives. Neither meridian instrument, nor meridian circle are indexed. In fact, so many words constantly employed in astronomy at the present time are omitted, that we have come to the conclusion that Mr. Gore has only attempted to include in his glossary words used when he was a schoolboy. The tables of data merely refer to members of the solar system, and their value would be increased if the solar parallax were given which formed the basis of their computation. Lists of remarkable red stars, variable stars, and stars for which orbits have been computed, conclude the book—a book that might have been very handy to latter-day astronomers, but which in its present form is of no use whatever.

With the Woodlanders and By the Tide. By "A Son of the Marshes." Edited by J. A. Owen. (Edinburgh and London: William Blackwood and Sons, 1893.)

THE author of this book is well known as a close observer of nature; and a more enthusiastic lover of natural creatures and things for their own sake it would be difficult to find. To look at flocks of bramble finches feed in some particular old beech-woods at sunrise, he trudged for five miles through snow-covered woodlands; and the book is filled with accounts of similar sights observed at all times of the day and seasons of the year. In fact, "A Son of the Marshes" is imbued with the true spirit of a naturalist—the spirit that leads men to sacrifice everything in order to obtain a clearer insight into nature.

An interesting instance of protective colouration is given on p. 163. Some broken egg-shells of the fern-owl having caught the author's eye, he looked closer into the fragments, and saw what appeared to be a short, crooked bit of dead furze stem. As he was bending over it, the supposed withered stem moved slightly, and gave him the impression that he was looking at the back of a large viper that had half buried itself in the furze. A still closer scrutiny showed that the semblance of a crooked piece of furze was two fern-owls about three days old.

We have read the book from cover to cover, and have been interested throughout. The author has looked to animate nature for his facts; hence his work possesses the sterling ring which every student of science delights to hear.

Pitt Press Euclid, V.-VI. By H. M. Taylor, M.A. (Cambridge: Univ. Press, 1893.)

WE have previously had occasion to refer to the earlier issues of this series of books on the elements of Euclidian geometry. The present publication is quite up to the standard of the former ones, and contains some important variations from the usual mode of treatment. In dealing with the fifth Book, Mr. Taylor rejects altogether the use of figures, since, as he rightly says, the book is not essentially geometrical. With a general knowledge of proportion as derived from treatises on algebra, a student is sufficiently equipped to follow its applications in Book vi. The numbering of the propositions is somewhat altered owing to the omission of some of the propositions in the Greek text. With regard to Book vi. Mr. Taylor has made some modifications in the treatment of similar figures, and many theorems are more briefly proved by adopting the definition of similar polygons there enumerated. The additional theorems which are inserted have been arranged in series—one, for instance, giving the student a sketch of the theory of transversals, harmonic and anharmonic ranges and pencils, leading up to Pascal's theorem; another of nine propositions, concluding with Gergonne's neat solution of the problem to describe a circle to touch three given circles. The method of inversion, Casey's extension of Ptolemy's theorem, properties of coaxial circles, and some porismatic problems follow next in order, the book concluding with a capital set of exercises and an index for the first six books.

The Out-door World, or Young Collector's Handbook. By W. Furneaux, F.R.G.S. (London: Longmans, 1893.)

A GREAT deal of information useful to the young collector, for whom Mr. Furneaux has prepared this handbook, is to be found in its four hundred pages. There are sixteen coloured plates, some of which are excellent and none bad, and more than five hundred illustrations in the text. Those of birds are somewhat unequal; some indication of relative size would have been helpful. The linnet and the cuckoo are placed side by side, and the former is apparently the larger of the two, while on the opposite page the great tit is considerably bigger than the lark, and rivals the cuckoo in apparent proportions. If the length of the bird had been given in brackets after the name under each figure, it would have prevented misapprehension. We have dipped here and there into the letterpress, and found the information accurate and clearly put.

Worked Examples in Co-ordinate Geometry. (Univ. Corr. Coll. Tutorial Series.) By William Briggs and G. H. Bryan. (London: W. B. Clive and Co., 1893.)

THE examples which are here brought together are intended to serve as a graduated course on the right line and circle, forming thus a useful companion to the book on Co-ordinate Geometry already published by the same authors. The work line is specially designed for the private student, and this is why the problems have been dealt with in such detail, every step in their solution being clearly explained. The examination papers may fairly be taken as good test papers, for the questions seem to have been carefully selected, and the more important ones on book work are not lacking. For those teaching themselves this subject by working out the problems given, a good insight should be obtained, while the references to the author's work on co-ordinate geometry, above referred to, will be found very useful to those possessing that book.

LETTERS TO THE EDITOR.

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Sir Henry H. Howorth on "Geology in Nubibus."

HAVING given my views on glacial geology in the current issue of the *Fortnightly Review*, to be followed by one dealing at some length with the ice-origin of lake-basins, I should not have thought any reply to Sir Henry Howorth's "Appeal" necessary except for the consideration that my articles may not be seen by many readers of NATURE. And first, I would remark, that the mental attitude which Sir H. Howorth imputes to extreme glacialists I have myself been unable to detect in their writings. In fact, I was under the impression that the "scoffing" and "jeering" was chiefly from the other side; but it seems I was mistaken, and I must apologise for my ignorance. Those who read my articles will see that I make no appeal to "transcendental ice," but judge of its powers and properties by its admitted effects. Sir H. Howorth says that "ice is known to crush under moderate pressure," implying that a glacier a mile or perhaps half a mile thick is impossible. But will he or anyone else tell us what happens to the ice after it is crushed, and the pressure that crushed it is continued and slowly increased? Will it not suffer re-gelation and become denser ice; and if by sudden increase of pressure it is again crushed, will it not by still further pressure again suffer re-gelation? He stops at the first "crushing," as if that were the end of all things so far as a glacier is concerned. All this, however, is beside the question from my point of view. The work of ice on the rocks is as clear as that of palæolithic man on the flints; all the difficulties that may be suggested as to how he lived, or how he shaped the flints do not in the slightest degree affect our conclusion that the palæolithic flint implements are the work of *man*; and there is equally clear evidence that ice *did* march a hundred miles, mostly uphill, from the head of Lake Geneva to Soleure, whatever transcendental qualities it must have possessed to do so.

As to "perhaps the largest and most remarkable collection of rock-basins in the world"—the largest being of 50 acres and the deepest 30 feet deep—I must really decline to occupy your space in showing how simply these may have been produced by ordinary denuding agencies, or in denying that any glacialist, even of "the most extreme and aggressive school," would claim them as proofs of glaciation. As regards the question of Tasmanian glaciation, my last communication to NATURE (Nov. 2) seems to me to render any further observations unnecessary. No doubt the conclusions of the various writers will be fully harmonised by a more complete study of the whole region.

The last point touched on by Sir H. Howorth—whether the advocates of the ice-origin of certain groups of lakes are "extravagant" in their views, following the methods of Aristotle rather than those of Bacon, and founding their beliefs on "purely hypothetical properties of matter and forces of nature"—I will leave to the judgment of those who do me the honour of reading my forthcoming article in the *Fortnightly Review*.

ALFRED R. WALLACE.

The Erosion of Rock-Basins.

MR. T. D. LATOUCHE's letter (page 39) is very interesting as a more than usually independent contribution (for the reason given therein) to the interesting question of glacial erosion, and as showing how similar (allowing for the difference in size) are the phenomena of the Himalayan and the Alpine glaciers. But I think that moulins, as a rule, are not likely to be very important agents in the formation of the rock-basins in which lakelets and tarns are often lodged. So far as my experience goes, the range over which the moulin-torrents can act is very restricted; for the crevasse, which gives the opportunity to the water, is generally formed very nearly at the same part of the glacier. Thus after the moulin has travelled for a very short distance down the glacier, a new crevasse opens out behind it and cuts off the torrent. I have frequently seen four or five dry shafts in advance of the working moulin. The lateral range also of the moulin must be small. Hence I think that the giant's-kettle (as is usually supposed) more accurately represents the ordinary product of a moulin. An excellent illustration is afforded by the well-known "glacier-garden" at Lucerne. I think, also, that the rock-basins, of which we speak, are more commonly found in situations where moulins would not be numerous or large, viz. in cwms and corries. It is, however, true that in certain undulating rock districts, as parts of Scandinavia and the Scotch Highlands, lakelets are common. The form of these, however, does not appear to bear much relation to the hollow produced by a moulin. So that I doubt whether we can regard a moulin as an agent of primary importance in the production of an ordinary rock-basin, though it may sometimes be a minor contributory. As I have more than once discussed the question of the probable cause of the formation of tarns as well as of large lake-basins, it is needless to repeat what has appeared in print. T. G. BONNEY.

23 Denning Road, N.W., November 13.

"The Zoological Record."

IN your Notes for October 26, on p. 621, you follow the Editor of the *Zoological Record* in suggesting that, under the present financial conditions, palæontology should be removed from the volume issued by the Zoological Society, and provided for by the palæontologists themselves. Against such retrogression we desire to protest. "Everyone knows," as you say, "that an incomplete record is of very little use"; and how absurdly incomplete a record would be that took no account of palæontology! The objectors probably spring mostly from the ranks of systematic zoologists. We will deal with them on their own ground. The systematic position of *Limulus* has long been a vexed question, which no one can attempt to solve without consulting the work of Malcolm Laurie on the fossil Eurypterids. The classification of the Crinoids has troubled zoologists since the days of Johannes Müller; but neither he nor anyone ever dreamed of settling it without reference to palæontology. Students of recent Bryozoa will not be grateful to those who keep them in ignorance of J. W. Gregory's lately published work on the Bryozoa of the early Tertiary rocks. And so we might go on *ad infinitum*. Another argument that may affect the systematists is that if they reject all names of fossil genera and species from the record, they will have no means of knowing whether the new names they may wish to propose have been used before or not. It is even possible that some of them may unwittingly describe as new forms already described by some unknown palæontologist. It is hardly necessary to remind the morphologists, embryologists, and zoögeographers of the help that they constantly receive from the palæontologists; they, at least, will not wish to have the record made incomplete.

It is suggested that every branch of science should have a record, and that palæontologists should undertake the compilation of a separate one. This would as good as double the work, both for recorders and students. What we have said above shows that palæontology is not a separate science. Zoologists and palæontologists ought to be the same people, and when they have strength enough they are so, as the names of Cuvier, Owen, and Huxley sufficiently testify. The palæontological recorder would still have to work through the writings of the zoologists, while even the pure neontologists would have perpetually to refer to the palæontological record.

What is really wanted is to complete the *Zoological Record*, not to make it incomplete—to go forward, not backward. It is admitted that some of the recorders do tackle the palæontological literature. Why should not all? If a group is too large for one man, then give it to two, and if a second man cannot be got to work on half-pay, then double the pay.

To prevent the record becoming too big, make it merely an index, and cut out the abstracts, which are rarely correct. If more money is wanted, appeal to other societies which might naturally be supposed interested in the work. It is unfair that a single society should bear the burden of a work that is of value to all, and one can hardly suppose that it would refuse kindly offers of help. We believe, indeed, that the only reason why some of the recorders abstain for the present from the palæontological work is because they feel that part, at least, of the expense ought to be borne by the society more directly interested.

R. I. POCOCK,
F. A. BATHER,
B. B. WOODWARD.

British Museum (Nat. Hist.), October 30.

Recognition Marks.

A QUESTION in natural history has occurred to me, which, I think, might with advantage be discussed in your columns.

It is usual to account for the white tail of the rabbit (*Lepus cuniculus*) by saying that it is useful as a danger signal to others of the species. Wallace, in his "Darwinism," speaking of rabbits, says that "the white upturned tails of those in front serve as guides and signals to those more remote from home."

Now, there appear to me to be two objections to this theory. The first is that the tail of the hare (*Lepus timidus*) is also white, and is turned up in precisely the same manner when running; but it is obvious, from the habits of this animal, that in its case it would be quite unnecessaary for such a purpose.

And in the second place, if this were so, how could it have been produced by evolution? The object of the white tail is said to be to assist other rabbits to escape, not the possessor of the white tail itself. But the principle of evolution is the survival of the animal fittest to preserve its own life, not of the fittest to preserve the lives of others of the same species.

G. J. MACGILLIVRAY.

3 Belford Park, Edinburgh, November 6.

MR. MACGILLIVRAY has failed to grasp the principle of natural selection when he thinks that it cannot produce a character useful to other animals of the same species. The action of natural selection is to preserve the *species*, as well as each individual separately; and, consequently, every character useful to the species as a whole would be preserved. This is obvious when we consider such characters as nest-building in birds, and milk-secretion in mammals, which do not benefit the individual possessors, but their offspring; and the same principle applies to every character which is mutually useful to individuals of the same species, as are what I have termed "recognition characters." Neither can I admit that the habits of the hare render the white upturned tail "quite unnecessary." The hare is a nocturnal feeder, and a mark which readily distinguishes a friend from an enemy, and enables the young during their short period of infancy to keep within sight of the mother, must be of considerable importance.

ALFRED R. WALLACE.

Correlation of Solar and Magnetic Phenomena.

IN writing on this subject (NATURE, vol. xlix. p. 30), to save space I omitted to refer to one other case of presumed connection. But as such omission might be misunderstood, may I here briefly allude to it? M. Trouvelot, on June 17, 1891, observed changes going on in connection with a luminous appearance near the western limb of the sun, such as he had not before seen. But the magnetic movement was in this case insignificant (see *The Observatory*, vol. xiv. pp. 326-328). The same reasoning as before may be applied. If the smaller magnetic motions do really directly depend on solar changes of so marked a character, how does it happen that many greater recorded magnetic movements remain without corresponding solar change having been seen? It is a very interesting, indeed critical point, but much more information is necessary to prove that such close connection really exists.

The appearance was seen by Trouvelot near the sun's limb. There is a significant sentence ending a letter from the Rev. Walter Sidgreaves, of Stonyhurst (*The Observatory*, vol. xiv. page 326), as follows:—"But there are no indications of magnetic disturbance accompanying the solar eruptions seen through the spectroscope. Even the brilliant display on the western limb, of the 10th [September 10, 1891], has left nothing that can be considered a record of itself on the magnetograph curves." WILLIAM ELLIS.

Greenwich, November 9.

[With regard to the case cited by Mr. Ellis, it is worth remark that at the time of Trouvelot's observation, the writer of our "Astronomical Notes" asked Mr. Whipple whether the eruption was accompanied by any anomalous magnetic movements. Mr. Whipple replied: "There was not the slightest magnetic disturbance on June 17, 1891, at the hour you mention, or for days before or since." The point was again raised at the beginning of last year, and to make assurance doubly sure, Mr. Whipple again referred to the Kew curves, but failed to find any trace of what could be termed a magnetic disturbance at the hour in question. (See NATURE, February 25, 1892.)—ED.]

THE NEW BIRD-PROTECTION BILL.

SENTIMENT is a beautiful thing in its way, and when that way happens to coincide with the way of common sense, the man must be a brute who defies it. But unluckily that does not always happen, as is testified by several instances that could but here shall not be cited, for they will come uncalled to the recollection of many of our readers, and indeed to some they are ever present. These need not to have the difference between a sound and an unsound sentiment pointed out. But there is also a sentiment that is perfectly sound at the start, and yet, chiefly through want of knowledge—we hesitate to call it ignorance, because that might imply blame—sooner or later begins to betray symptoms of running on the wrong track, when, if the brakes cannot be applied, it comes into violent collision with common sense. As the latter is the weightier mass the harm it gets from the impact is not often very serious, and the injuries received seldom cause more than delay, however annoying that may be; but the effect on the lighter body is apt to be destructive, and though in some cases it may be only repelled with slight damage, in others it may be shattered. In either event, seeing that it set out with good intentions, the result is to be regretted.

Of this kind of sentiment is that which actuates the extreme advocates of Bird Protection. Time was when the sickening slaughter of sea-fowl at their breeding-stations around our coast appealed alike to sentiment and to common sense—to say nothing of science—to interfere. First carried on for what was called "sport," but soon for the sake of mere lucre, the feathered denizens of our cliffs and beaches were shot down by the thousand, to do nobody any good but the "plume-trader." The Act of Parliament which received the Royal Assent in June 1869, and is always to be remembered in connection with the name of Mr. Christopher Sykes, was just in time to save from extinction the population of many a thronged resort which has always presented, and we trust always will present, a spectacle of delight to the large and increasing class of our fellow-countrymen who appreciate the harmonies of nature, even if the resorts on the English coast cannot compare with those

——where the Northern Ocean in vast whirls
Boils round the naked melancholy isles
Of sea-girt Thule, or the Atlantic surge
Pours in among the stormy Hebrides.

That Act may have had its shortcomings: few Acts are without them; but nobody can doubt it was effective to do good, and it was followed by other Acts, based on the same principle, and tending to relieve persecuted beings from persecution. An exception indeed must be made as regards one of them, but that one (which was commented upon at the time in these columns[1]) only serves to support the allegation in our introductory paragraph. In 1872 some enthusiasts followed the line of sentiment regardless of common sense, and succeeded in converting a well-considered and practical measure into one that was specious and useless. They had their reward, for in the next session their parliamentary leader obtained a Select Committee of the House of Commons to enquire into the subject, and the result of the investigation showed every reasonable person the baselessness of the points for which the extreme party had contended, while three years later the very Bill which they had mutilated and mauled passed through Parliament almost exactly in the form in which it had been originally introduced. The enthusiasts, however, had the satisfaction of stopping useful and much wanted legislation for four years in order to gratify their own gushing and unintelligent sentiment, while their Act, always a dead letter, was superseded by the Act of 1880 which consolidated all previous legislation. Still the spirit that moved the enthusiasts is not dead. In one way or another it shows itself every year—sometimes, though not often, it confines itself within the bounds of common sense, but of late it has become we may say rampant. None of the former Acts had done anything to stay the taking of birds' eggs. Indeed, birds' eggs had been, and that purposely, wholly left out of consideration, and this in the eyes of many excellent people has seemed to be a glaring defect—even a crime. Let us stop birdsnesting, say they, and the number of our birds will be indefinitely increased. Nightingales will multiply, Goldfinches will be as plentiful as Sparrows, and Skylarks will swarm. Little do these good people realise the state of things. Let us grant that in the immediate neighbourhood of towns and large villages, where birds are already at a disadvantage, boys will emerge, and successively rob nest after nest as it is built with an effect that may be called devastating. The case, however, is very different in the country at large. There the first species of those we have just named already enjoys a protection incidentally yet almost invariably conferred upon it by the law of trespass. We can believe almost any act of folly or stupidity on the part of some gamekeepers, and the widely-told story that one of that profession once declared that he destroyed Nightingales because their singing disturbed the nights' rest of his pheasants may have some foundation; but nearly all observers who have informed themselves by experience will agree that the part of England which Nightingales choose to occupy is generally as fully stocked with them as the place will hold. It is certain to those who watch that the number of Nightingales which return to this country with each returning spring is greater than that which can find room. Hence those ever-recurring contests of melody that we hear from rival cock birds on their first coming, to say nothing of the actual conflicts, often ending in the death of one of the combatants, that take place between the competitors. And it is only natural that it should be so. That if a Nightingale's nest be taken the same birds immediately build a second, and if need be a third, is a perfectly well-known fact, and it would be a very unlucky pair of Nightingales to have their nest robbed thrice in a season. At a very moderate computation the number of young Nightingales that must annually attain their full growth in this country doubles that of their parents, since from five to six are commonly reared in each nest; and, with a large allowance for casualties in youth, it is safe to calculate upon four of each brood having reached maturity when the time of emigration arrives. What happens during their absence from this country is of course beyond our ken, but the certainty with which migratory birds return to their home is now well-recognised; and it is not less certain that of this species more return to England in spring than are able to find accommodation in our woods, coppices, and shrubberies, as the conflicts just mentioned testify. Hence it would follow that were the taking of a Nightingale's egg made a capital offence, we should not have, one year with another, more Nightingales, though, to retain the number we have, it is impera-

[1] NATURE, viii., p. 1, (May 1, 1873).

tive that the old birds should have protection at the breeding season.

To take the second case we have cited, that of the Goldfinch, the details are not the same, though the final result be so. Until some fifteen or twenty years ago the diminution in the numbers of this species was notorious; but the reasons of that diminution are easily revealed to any enquirer, though it may be hard to say which of them be the stronger. The practice of netting in spring time, now illegal though probably still used in some places, was carried on to an extent that if it were not supported by the clearest evidence people would hardly believe. Combined with this disastrous practice was the fact that so much heath and common land had been brought under the plough, and the mode of agriculture so much improved, as sensibly to affect the Goldfinch's supply of food, for its fare was truthfully termed by the poet "the thistle's downy seed," combined however with that of other weeds hated by good farmers. But no doubt, at the hands of the bird-catchers, the Goldfinch, being so great a favourite for the cage, still suffers severely, and it may be true that enough do not leave this country at close of summer to satisfy the waste of life that occurs during its migration and in its winter-quarters; though as to any considerable diminution in its numbers being caused by birdsnesting, the notion of such a thing will be scouted by all who have had opportunities of observing its breeding-habits. Our third instance, the Skylark, is without doubt one of those birds that needs protection least. Nobody persecutes him so soon as he ceases to flock and settles with his mate in their chosen spot. Their nest in the growing corn, or the wide pasture, is safe from even the predatory rat, and the open country they haunt is no place for the Sparrow-hawk, that deadly foe to so many small birds. There, in the course of the season, they make their three or four nests, and rear in each as many young, so that the annual increase of the species may be safely computed as five-fold, and when we also consider that thousands if not tens of thousands arrive every autumn on our shores and spread over the whole country, with a safe conscience the most devoted lover of birds may, if he has a mind to it, eat lark-pudding in winter without compunction.

We have cited these three cases—the Skylark, the Goldfinch, and the Nightingale, because we have them so frequently put forward by sentimentalists as birds that all right-minded people would wish to see more numerous. We should like to count ourselves among the right-minded, but the sentimentalists must forgive us for refusing to believe that the number can be increased in the way they advocate—visiting with punishment the schoolboys who would take the nests of any one of them. Far otherwise, however, is it with many birds of which the enthusiasts never think. Those, for instance, that habitually breed in places open to all comers, and especially on islands near our coast, on the sea shore, and by the side of inland but navigable waters. In such places there is no law of trespass; and, as all who have been at the pains to inform themselves know, these birds suffer from the way their exposed nests are ravaged, and are surely decreasing in number. Yet by the general public they are little heeded, chiefly because the general public knows nothing about them—not even their names—and moreover encourages the ravages by blindly buying the booty of the ravagers. Thus it is that many a beach, and many a heath, and many a marsh and mere, is made desolate, for the ravage is continued throughout the whole of the breeding-season, with the result that scarcely an egg is left from which a young bird—be it Duck or Gull, Tern or Plover can be hatched. Yet it is obvious that it would not be so very difficult to stop this destruction, and that without interfering with the long-established practice, which we hold to be no more detrimental to their species than it is illegitimate, of taking toll of their eggs. Pick out the places at which the practice is carried on, and limit the time during which the eggs may there be lawfully gathered, so as to give each pair of birds the opportunity of bringing off their brood.

Early in the present Session a "Bill to amend the Wild Birds' Protection Act, 1880," was brought into the House of Commons by Sir Herbert Maxwell, which Bill, owing to the well-deserved popularity of its introducer, ran its course unchallenged, and achieved the almost unexampled success of being read a third time and passed with scarcely an alteration of importance. The scope of the Bill was to enable any County Council to prohibit "the taking or destroying of any species of wild bird or the eggs of any species of wild bird." This Bill, of course, attracted the attention of the Committee which had been appointed the year before by the British Association "to consider proposals for the Legislative Protection of Wild Birds' Eggs," and in the opinion of that Committee, as subsequently reported at the late meeting of the Association at Nottingham, the Bill was declared to have been framed on a mistaken principle "in that it sought to effect the desired object by empowering local authorities to name the species,[1] the eggs of which were to be protected, thus requiring in every case of prosecution proof of identity, which in the majority of cases would be difficult, if not impossible to supply."

The House of Lords at first took almost precisely the same view as the British Association Committee; and, chiefly at the instance of Lord Walsingham, than whom there could scarcely be a more competent peer, amended the Bill accordingly, producing what would, in the opinion of many experts, be a very workable measure. But unhappily in the subsequent process of passing the Standing Committee of the Upper House, their lordships were induced, by those who were not experts, to go a great deal further, and nobody acquainted with the facts of the questions involved, can doubt that on this occasion the efficacy of the Bill was not a little damaged in various ways. In this condition it in due course returned to the House of Commons, where the British Association Committee, as stated in their report, hoped it would, in spite of its transformation, still find favour; but its original parent, Sir Herbert Maxwell, would have none of it, and consideration of the Lords' Amendments having been adjourned on August 21 for three months, it stands by the accidental prolongation of the Session, for further discussion in a few days. In the meanwhile the British Association Committee has been reconstituted and strengthened by the substitution of several ornithologists of repute in place of some naturalists who had never paid any special attention to the matter, while Sir John Lubbock has accepted the post of chairman, and Mr. Dresser, who was for many years Secretary to the Old "Close-Time" Committee of the Association that effected so much good, undertakes the same duty in the new body, the other members of which are Mr. Cordeaux, Mr. W. H. Hudson, Prof. Newton, Mr. Howard Saunders, Mr. T. H. Thomas, Canon Tristram, and Dr. Vachell. With a chairman at once so conciliatory and so influential, and a secretary of so much experience, it may be hoped that the difficulties, great as they are—for they involve a contest between the two Houses of Parliament—will not prove insuperable, and that some way may be found of saving this Bill, for all will admit that if it be not passed this Session a long while may elapse ere a House of Commons is good-humoured enough to let a measure of the kind slip through its entanglements, as did that of Sir Herbert Maxwell at the beginning of this year. This is surely a case where sentiment should yield to common sense.

[1] It may be remarked that the Bill was so carelessly worded as to leave it open to doubt, though this was certainly not the intention of its supporters, whether a County Council could by one act make it apply to all Wild Birds, or only to some that should be named.

LIGHT-WAVES AND THEIR APPLICATION TO METROLOGY.

EVERY accurate measurement of a physical quantity depends ultimately upon a measurement of length or of angle; and it will readily be admitted that no effort should be spared to make it possible to attain the utmost limit of precision in these fundamental quantities. At present, lengths are measured by the microscope, and angles by the telescope; and the extraordinary degree of accuracy already attained by the use of these instruments depends entirely on the properties of their optical parts in their relation to light-waves; so that, in fact, light-waves are now the most convenient and universally employed means we possess for making accurate measurements. It can readily be shown that this high degree of accuracy is especially due to the extreme minuteness of these waves.

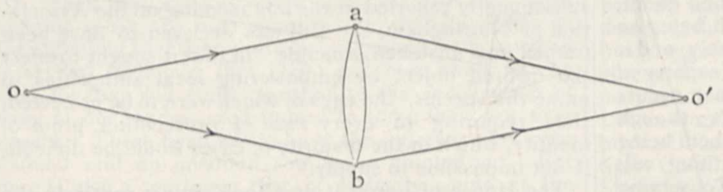

FIG. 1.

Thus it is well known that the image of a luminous point consists of a series of concentric coloured rings surrounding a bright central disc which is smaller the smaller the ratio of the wave-length of the light to the diameter of the objective employed. In fact, it can be shown that the radius of the bright central disc contains as many wave-lengths as the distance of the image from the objective contains the diameter of the objective. Thus in a telescope twenty diameters long, the diameter of the bright disc is forty wave-lengths or 0·02 mm. If the image be magnified by increasing its distance from the objective, or otherwise, these diffraction rings are magnified in the same proportion; so that nothing is gained thereby in *distinctness*, beyond the point where the rings are just large enough to be visible. But, were it not for the inevitable loss of light, it would be advantageous for *measurements of position* to increase the magnification much further.

This can be accomplished by an extremely useful instrument which has been misnamed the "interferential refractometer." It will be interesting to note that notwithstanding the apparent difference in form, this apparatus, when used as a measuring instrument, differs in no essential particular from the microscope or the telescope, or (what is perhaps a trifle unexpected) the spectroscope; and it is possible to change any one of these instruments into the other by unimportant modifications.

Thus, let *o*, Fig. 1, be a source of light, *a b* a lens which forms an image of *o* at *o′*. The operation of the lens, when used to distinguish minute objects, depends upon the accuracy with which all its parts contribute to make the elementary waves reach the focus in the same phase of vibration; but to determine the position of *o* with respect to *a b*, this is not at all necessary; and in fact, if we disregard the possible inconvenience due to the dissimilarity between the phenomenon observed and the object whose position is to be measured, it would be as well to entirely annul the central portions of the lens, leaving only an external annular ring, or better still, only two small portions at opposite ends of a diameter.

This involves no sacrifice of accuracy, but on the contrary a very considerable gain; for it is now possible to increase the size of the interference fringes up to any desired limit without diminishing the intensity of the light, the result being the same as could be obtained with a perfect microscope of unlimited magnifying power with a source of unlimited intensity.

For this purpose the two small portions to which the lens is reduced are replaced by plane mirrors or prisms, whose office is simply to bring the two interfering pencils into coincidence. Further, the pencils, instead of starting from a point or a line, may be separated by a plane transparent surface; and a second similar surface may be used to reunite the pencils after reflection. Thus the telescope or microscope will have been converted into a refractometer. The exact nature of the analogy will be apparent by a comparison of Figs. 1 and 2.

It may be assumed that under the most favourable circumstances the utmost attainable limit of accuracy of a setting of the cross-hair of a microscope on a fine ruled line is about $\frac{1}{20}$ of a micron. Now, it is usually admitted that the middle point of an interference fringe, if it be sufficiently broad and clear, can be determined within about $\frac{1}{30}$ of the width of a fringe. In the refractometer this would mean only $\frac{1}{60}$ of a light-wave, or about $0{\cdot}01\mu$, from which it would follow that the refractometer is about five times as accurate as the microscope. But a number of trials with the form of refractometer shown in Fig. 8 gave as the mean error of a series of ten observations:

	Fr.			Fr.			Fr.
Morley	0·0056	...	Nicholson	0·0059	...	X	0·0110

The third observer had no previous practice in this kind of measurement.

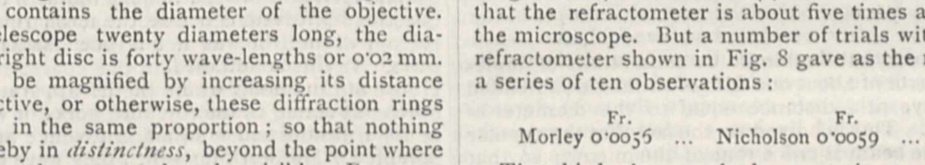

FIG. 2.

It is evident from these results that $\frac{1}{30}$ of a fringe is too large an estimate of the average error of a setting, and that it is, in fact, less than 0·01 of a fringe, corresponding to an error in distance of about 0.003μ.

For angular measurements the microscope is replaced by the telescope.

Fig. 3 represents a disposition sometimes adopted for observing minute angular displacements of the mirror *d c*; the light starts from *o*, is reflected by the plane parallel glass plate *p* to the objective *a b* of a telescope, whence the now parallel rays proceed to the mirror *c d*. Thence they retrace their path to the plate *p*, through which they are transmitted, forming an image of the source at *o′*, which is viewed through the eyepiece.

Fig. 4 is the exact analogue in the form of a refractometer; and Fig. 5, though slightly different in aspect, is still essentially the same instrument. The path of the rays is *o p a c a p o'* for one of the pencils, and *o p b d b p o'* for the other.

From considerations quite analogous to those employed in the former case, it can be shown that the limit of accuracy attainable in the estimations of angles involves an error of about one-fifth of the angle subtended by a light wave at a distance equal to the diameter of the objective. This is halved by the fact that the angular motion of the beam is twice that of the mirror; so that with a telescope of 10 cm. aperture the limit of accuracy may be estimated at $\frac{1}{2000000}$, or say 0.1″. But taking 0.01 fr. as the smallest perceptible displacement of the mirrors *c d*, the corresponding angle of rotation of the line *c d* (10 cm. long) would be only $\frac{1}{20000000}$, or say 0.01″.[1]

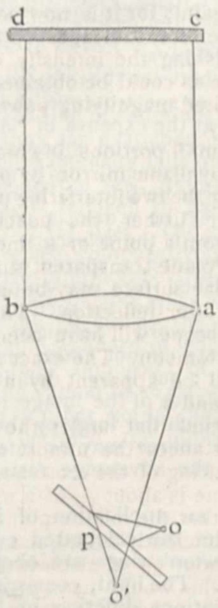

FIG. 3.

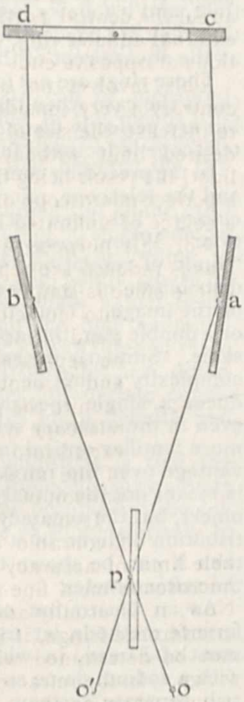

FIG. 4.

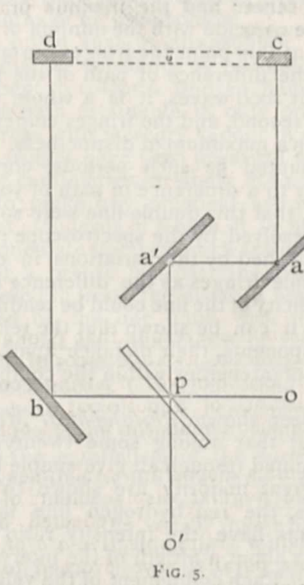

FIG. 5.

It is not at first evident that there is any relation between the refractometer and the spectroscope. A comparison of Fig. 6 and Fig. 7 shows, however, that there is a strict analogy. Fig. 6 represents a disposition sometimes adopted to observe the spectrum by means of a concave grating, and Fig. 7, with unimportant modifications, is the arrangement actually employed in the analysis of radiations by means of their "visibility curves," as will be explained below.

Exactly as in the case of mirrors and lenses, we may here, too, sacrifice "resolution" and "definition" by using only the extreme portions of the surface, with an actual gain in "accuracy." To compare numbers, it appears that the average error in the comparison of

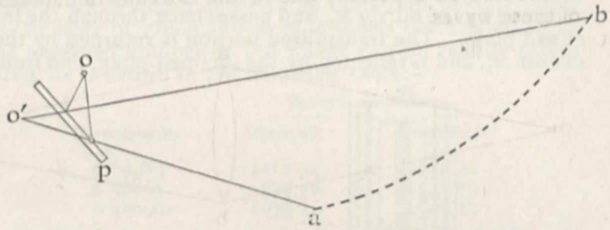

FIG. 6.

wave-lengths by a grating with 250,000 lines is about one part in half-a-million. With this number of waves in the difference of path of two interfering pencils, the corresponding error in the refractometer observations are of the order of one twenty-millionth.

The name "interferential refractometer" seems rather inappropriate to an instrument which has so many important applications beside the measurement of indices of refraction; but as it has been sanctioned by long usage it will be retained.

Among the many forms of the apparatus which have been rendered classic by the works of Arago, Fresnel, Fizeau, Jamin, and Mascart, and which are so admirably adapted to the work for which they were designed, there are none which are not open to serious objections when applied to the solution of such problems as the measurement of lengths and angles, for the analysis of the constitution of the light of spectral lines, and especially for the determination of wave-lengths in absolute measure. For these, the form of instrument shown in Fig. 8 has many important advantages, among which the following may be mentioned:—It is simple in construction, and is easily adjusted; it may be used with a broad luminous

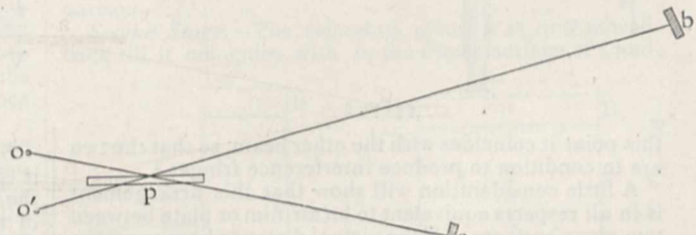

FIG. 7.

[1] In the use of the revolving mirror as in galvanometers, gravity and torsion balances, &c., the accuracy can be increased by enlarging the surface of the mirror; but the moment of inertia is thereby increased, and in greater proportion. But in the refractometer the mirrors *c d* may be made insignificantly small, and yet, with the same distance between the outer edges, the accuracy may be increased at least tenfold. It is important to note that any linear motion of the line joining the mirrors, or even a rotation about this line, has no effect on the fringes. It seems probable that this form of instrument may be of service in such problems as the measurement of the moon's attraction, constant of gravitation, variations of the vertical, &c.

surface as source of light; the pencils may be separated as far as desired; its range of difference of path between the interfering pencils is unlimited; and when properly adjusted the position of the interference fringes is perfectly definite, so that there is no uncertainty on account of parallax, and no difficulty in counting the number of fringes passing a given point. Finally, it may be added, that this is probably the only form of instrument which permits the use of white light (and consequently of the identification of the fringes) in the determination of the position or inclination of a surface without risk of disturbance due to contact or close approximation.

As shown in Fig. 8, the refractometer consists essentially of a plane parallel plate of optical glass G_1 and two plane mirrors $M_1 M_2$. The beam of light to be examined falls on the plate G_1 at an angle, usually 45°, part being reflected and part transmitted.[1] The reflected portion is returned by the mirror M_2, and passes back through the inclined plate. The transmitted portion is returned by the mirror M_1, and is reflected by the inclined plate, and from

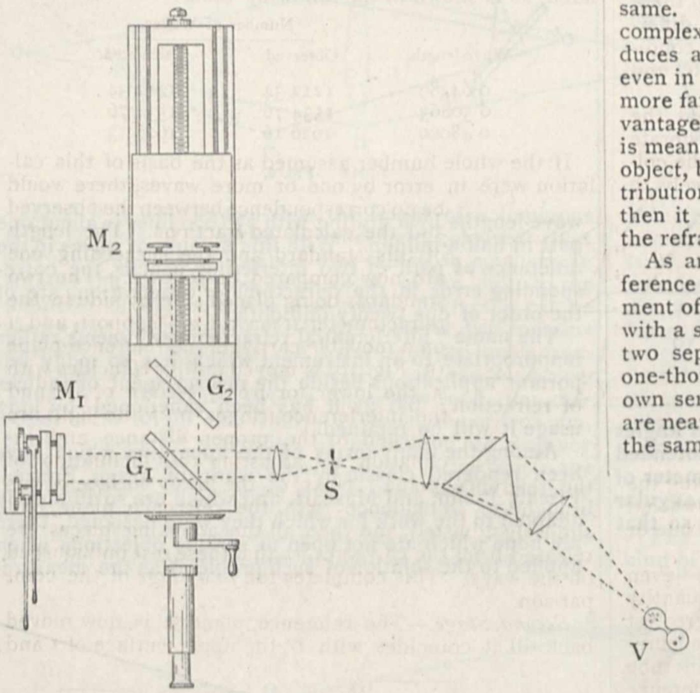

FIG. 8.

this point it coincides with the other beam, so that the two are in condition to produce interference fringes.[2]

A little consideration will show that this arrangement is in all respects equivalent to an air-film or plate between two plane surfaces. If the virtual distance between these surfaces is small, white light may be employed, and interference fringes may be observed similar in all respects to those between two plates of glass pressed nearly into contact.[3]

[1] The front surface of the plate G_1 is lightly coated with silver. The light which leaves the refractometer is a maximum where the thickness of the silver film is such that the intensities of the transmitted and reflected portions are equal. The silvering has another important advantage in diminishing the relative intensity of the light reflected from the other surface; and for this reason the thickness of the film may be advantageously increased, which permits also a more uniform surface. The ultimate ratio of intensities of the two pencils is not affected, for what is lost by transmission on entering the plate is made up by reflection on leaving it.

[2] One of the beams has to pass twice through the thickness of the glass plate G_1, and in order to equalise the two paths, a similar plate G_2 is introduced in the path of the other beam.

[3] If the plate G_1 be not silvered, the colours follow the same order as those of Newton's rings, but if the silvering be sufficiently heavy, the colours are complementary; this, if the plates G_1 and G_2 are exactly equal and parallel. Otherwise, the excess of path in glass of one of the pencils disturbs the order of colours by the effect of achromatism due to the dispersion of the glass, as was first pointed out by Cornu.

If, however, the distance exceeds a few wave-lengths, monochromatic light must be employed. In this case the fringes are in general invisible, unless they be viewed through a small aperture. If, however, the two surfaces are very accurately parallel, the fringes are always distinct, and it follows from the symmetry of the conditions that they are concentric rings. Their diameters increase as the square root of the order of the ring.

These rings are not formed at the surface of the mirrors (as is the case when the distance between them is small), but are perfectly distinct when the eye or the observing telescope is focussed for parallel rays.

In the preceding comparison between the refractometer and the telescope, microscope, or spectroscope, the "accuracy" has been increased at the expense of "definition." When, however, the object viewed is beyond the "limit of resolution" of the instrument, its form and distribution of light can no longer be inferred from that of the image. Thus, if the object be a disc, a triangle, or a double star, the appearance in the telescope is the same. Similarly in the spectroscope, a source of great complexity cannot be distinguished from one which produces a single spectral line. So that for such objects, even in the ordinary sense of the word "definition," the more familiar optical instruments cannot claim any advantage over the refractometer; but if by "definition" is meant not the actual resemblance of the image to the object, but the accuracy with which the form or the distribution of light in a minute source may be inferred, then it can be shown that all the advantage rests with the refractometer.

As an illustration of such an application of interference methods, let us consider the celebrated experiment of Fizeau, in which Newton's rings are observed with a sodium flame as source. The light, consisting of two separate systems of radiations differing by about one-thousandth in wave-length, each system produces its own series of interference fringes. When the surfaces are nearly in contact, the difference of path is very nearly the same for both systems, and the fringes coincide, and the clearness is a maximum. When, however, the difference of path reaches about 500 waves for one of the systems, it is a half wave more for the other; and the maxima of intensity of the one coincide with the minima of the other; hence at this point the fringes are faintest. But when the difference of path of the first system is about 1000 waves, it is a whole wave more for the second, and the fringes coinciding, there is again a maximum of distinctness. M. Fizeau has counted 52 such periods, corresponding roughly to a difference of path of 50,000 waves.

Suppose, now, that this double line were so close that it could not be resolved by the spectroscope; then from the evidence furnished by the variations in distinctness of the interference fringes as the difference of path increases, the duplicity of the line could be readily detected. But beside this, it can be shown that the relative intensities of the components, their distance apart, and even the distribution of intensities within the component lines can be inferred.

Thus it has been shown (*Philosophical Magazine* for September, 1892) that among some twenty radiations which were examined (though all give simple lines in the spectrum) the great majority are shown to be highly complex. Thus, the red hydrogen line is a double whose components have the intensity ratio 7 : 10, and whose distance is about a fiftieth of the interval between the sodium lines. Each component of the yellow sodium lines is itself a double whose components are in the ratio 7 : 10, and whose distance is about one-hundredth of that between the principal components. Thallium gives a double line whose components are in the ratio 1 : 2, at a distance of about a fiftieth of that of the sodium lines, while each component has a small companion whose intensity is about a fifth of that of the principal lines, at a distance of about one three-hundredth of that of the sodium lines. The green mercury line is made up of a group of five or six lines, the strongest of which is itself double (or perhaps triple) the distance of the components, being less than a five-hundredth part of that between the sodium lines.

These distances, small as they are, can be measured within about a twentieth part, so that by this means it is possible to detect a change of wave-length corresponding to the ten-thousandth part of that between the two sodium lines.

The red line of cadmium is the simplest of all the radiations thus far examined, consisting of a single narrow line whose intensity falls off symmetrically according to an exponential law, its width (at the points where its intensity is reduced to half its maximum value) being only 0·002 (D_1–D_2). The green and the blue cadmium lines are also comparatively simple, and all three of these lines give interference fringes clearly visible at a difference of path of 100 mm., and under appropriate conditions they all satisfy the requisites for a definite and inalterable standard of length.

The most important of these conditions is that the radiating vapour be so rare that the molecules may vibrate freely; in other words, that the time occupied in the collisions between the molecules be so short relatively to that of the free path, that its influence in disturbing the free vibration may be neglected. Experience shows that in general this limit corresponds to a pressure of one or two thousandths of an atmosphere.

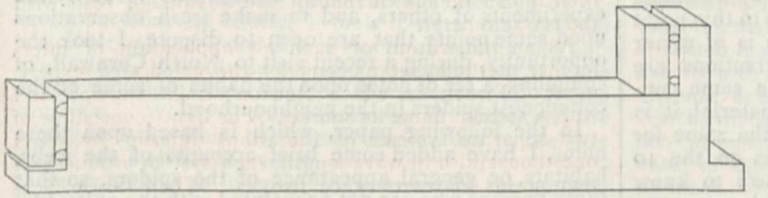

FIG. 9.

It may be noted that at atmospheric pressure—even when the radiating substance is introduced in quantity barely sufficient to colour a Bunsen flame—the greatest difference of path attainable is only one or two centimetres, whereas with mercury vapour in a vacuum tube interference fringes have been observed with a difference of path of 47 centimetres, or about 850,000 waves.

In order to make any practical use of these minute quantities for standards of length, it is necessary to employ an intermediate standard, such as that shown in Fig. 9, consisting of a bronze bar carrying two plane-parallel glasses, silvered in front, the distance between which can be compared on the one hand with the fundamental standard in actual use—the metre or the yard—and on the other with the length of a light-wave.

The former process is accomplished by moving the standard (whose length it is convenient to take at 10 centimetres) ten times through its own length, the coincidence and the parallelism of the surfaces being controlled at every step by the interference fringes in white light formed between these surfaces and that of the *reference plane* (the virtual image of the mirror MM in G_1, Fig. 8). The position of a fiducial mark on this standard is compared by means of two micrometer microscopes with the lines defining the standard metre at the first and last steps.

In the second process the only difficulty encountered is due to the very great disproportion between the length of a wave and that of the 10 centimetre standard, and the consequent difficulty in keeping the correct count of the very large number of waves which pass as the reference plane is moved from one surface to the other.

This problem has been solved in the following manner. Nine standards were constructed similar in all respects to that of ten centimetres, save that each succeeding one was half as long as the preceding. The last of the series is thus approximately 0·39 mm. long, corresponding to a difference of path of 0·78 mm. The number of waves in this distance in red cadmium light is 1212 plus a fraction, which is corrected by direct observation of the difference of phase of the circular fringes on the upper and the lower (front and rear) surfaces of the standard. This verification is also made with the green and the blue radiations.

It is important to note that the measurement of these fractions alone is sufficient to fix the whole number, even if there be an uncertainty of several waves. Thus, the relative wave-length of the three radiations being known, the number of green and of blue waves corresponding to the observed number of red waves can be readily calculated, as is shown in the following table:—

	Number of Waves.	
Wave-length. μ	Observed.	Calculated.
0·64389	1212·34	1212·34
0·50863	1534·76	1534·76
0·48000	1626·16	1626·13

If the whole number assumed as the basis of this callation were in error by one or more waves, there would be no correspondence between the observed and the calculated fractions. The length of this standard and the succeeding one are now compared as follows:—The two standards being placed side by side in the refractometer II on a fixed support, and I on a movable carriage, the reference plane (R, Fig. 10) is moved until it coincides with A, the lower (or front) surface of II, and the interference fringes in white light are adjusted to the proper distance and inclination by adjusting the inclination of the reference plane. Next, C, the lower surface of I is brought to coincidence with the reference plane, and similarly adjusted, and then all the adjusting pieces are released from the carriages, so that these rest undisturbed on the ways. This completes the *first stage* of the comparison.

Second Stage.—The reference plane R′ is now moved back till it coincides with D, the upper surface of I and the adjustment of the interference fringes carried out as before.

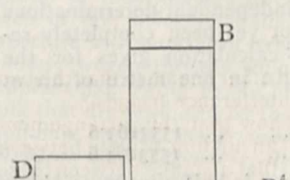

FIG. 10.

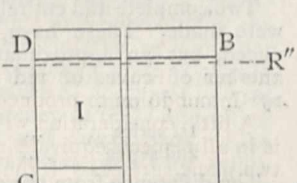

FIG. 11.

Third Stage.—The standard, I, is moved back till its lower surface (C, Fig. 11) once more coincides with the reference plane, R′, and its inclination is again adjusted by the interference fringes.

Fourth Stage.—The reference plane is finally moved back till it coincides with D, the upper surface of I, and its inclination is again adjusted. If now the standard II is just twice as long as I, the fringes will appear simultaneously on *both* upper surfaces, D and B.

The adjustment of the length of the standards is usually made to within a few waves, and the outstanding difference is measured by a compensating device.

This is furnished by the rotation of the compensating plate, G_2, Fig. 8. The plate is held in a metal frame which is supported at one end by a short thick rod firmly fixed to the bed. At the other end a delicate spiral spring is attached; the tension of the spring *twists* the rod through a minute angle, and thus alters the thickness of glass traversed by one of the interfering pencils. The other end of the spring is attached to a flexible cord passing over a pulley which is connected with a graduated circle. The angular motion is thus reduced about 100,000 times, and yet the proportionality is preserved.

Suppose the outstanding difference is ϵ a fraction of a wave-length known to within one or two tenths, then

$$\text{II} = 2\text{I} + \epsilon$$

and consequently the number of red waves should be $2 \times 1212{\cdot}34 + \epsilon$. This fraction is corrected by direct observation, as in the case of standard I, and the same control is furnished by the concordance of the results for the three colours; so that an error in the whole number of waves is well-nigh impossible.

The process of comparison and correction is repeated in the same way with the other standards, until we finally arrive at the whole number of waves and approximate fraction in the 10 centimetre standard. Up to this point the question of temperature and pressure is of minor importance, for the comparisons and corrections are made while both standards are under the same conditions; and being all made of the same material, it is sufficient to know that the temperature is the same for both. In the measurement of the fractions on the 10 centimetre standard, however, it is necessary to know the temperature and pressure with all possible accuracy, and it is also important that the comparison of this standard with the metre should be made, as nearly as may be, under the same conditions as that of the determination of the standard in light-waves.

The author having been honoured by an invitation from the International Bureau of Weights and Measures to undertake a series of experiments upon the lines here briefly indicated, the necessary apparatus was constructed in America, and shortly afterward installed in the Bureau International des Poids et Mesures at Sèvres.

Two complete and entirely independent determinations were made. These have not yet been completely reduced, but an approximate calculation gives for the number of waves of red light in one metre of air at 15° C. and 76 mm.

1st series	1553163·6
2nd series	1553164·6

The difference from the mean is half a wave, or about one fourth of a micron.[1]

From these results it follows that we have at hand a means of comparing the fundamental standard of length with a natural unit—the length of a light-wave—with about the same order of accuracy as is at present possible in the comparison of two metre bars.

This unit depends only on the properties of the vibrating atoms of the radiating substance, and of the luminiferous ether, and is probably one of the least changeable quantities in the material universe.

If, therefore, the metre and all its copies were lost or destroyed, they could be replaced by new ones, which would not differ from the originals more than do these among themselves. While such a simultaneous destruction is practically impossible, it is by no means sure that, notwithstanding all the elaborate precautions which have been taken to insure permanency, there may not be slow molecular changes going on in all the standards; changes which it would be impossible to detect except by some such method as that which is here presented

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[1] The error in the determination of the *relative* wave-lengths of the three radiations is very much smaller, probably less than one twenty-millionth.

FURTHER NOTES AND OBSERVATIONS UPON THE INSTINCTS OF SOME COMMON ENGLISH SPIDERS.

MANY of what would otherwise be most interesting anecdotes respecting the habits of spiders have been related by persons who, being unacquainted with the immense number of "kinds" of this group that there are in England, not to mention the rest of the world, have apparently considered that all needful information in the way of the animal's identity has been supplied by the simple statement that it is a spider.

Such anecdotes have of course a certain value, inasmuch as they furnish some general information respecting the instincts of the class as a whole. But to those who are anxious to compare together the instincts of individuals of the same or different species, genera, and families, who are anxious to acquire in short some little knowledge of the comparative psychology of the group, they are distressingly incomplete.

To remedy in part these deficiencies, to verify the experiments of others, and to make fresh observations upon some points that are open to dispute, I took the opportunity, during a recent visit to North Cornwall, of compiling a set of notes upon the habits of some of the commonest spiders in the neighbourhood.

In the following paper, which is based upon these notes, I have added some brief accounts of the webs, habitats, or general appearance of the spiders, so that those persons who are not acquainted with the animal by name, may yet, with but little trouble, ascertain what the species are that are under discussion.

Agalena labyrinthica.—This spider may be looked upon as the country cousin of the common house spider, *Tegenaria atrica*, which being essentially a lover of bricks and mortar, is found in lofts, disused rooms, &c., where it spins in corners and other angles a horizontal, triangular sheet of web, a familiar structure which must be associated in all minds with the word cobweb.

The snares of *Agalena* are essentially like those of *Tegenaria*, consisting of a short silken tube or funnel, one end of which is buried in the bush that the spider has chosen to build in, while the other opens upon, and is continuous with, a widely extended horizontal sheet composed of fine closely woven silken threads. During the daytime the spider, if cautiously approached, may usually be seen squatting at the entrance of her funnel. She is, however, remarkably wary, and this, coupled with her equally remarkable agility, makes the task of capturing her by no means an easy one. For, by means of the further open extremity of the tube, she can make her escape into the bush beyond. Wherever I have had an opportunity of observing this spider, I have noticed that it appears to have a special liking for furze bushes; and it seems reasonable to suppose that this selection of so prickly a site for the building saves the young and also the nest from destruction at the hands, or rather the noses and legs, of cattle.

Upon examining the *débris* of prey, with which the orifice of the funnel was usually strewn, I was surprised to find that it consisted more often of the remains of bees than of flies—generally, indeed, the limbs, wings, &c., were those of some species of Bumble-bees (*Bombus*). Being curious to see how the spider would manœuvre to overcome so redoubtable an adversary, I captured upon one occasion a small specimen of a bumble-bee and placed it upon the snare. The *Agalena* immediately darted forth; but upon touching the insect with her fore-legs, quickly drew back as if to keep out of harm's way. Meanwhile, the bee, by making vigorous efforts to escape, had nearly succeeded in breaking away the web with which its legs were entangled—a fact of which the spider seemed well aware. For, rushing at it once more, she rapidly, and, by some dexterous movement that I could not follow, attached a thread either to the insect or to a portion of the web hard by, and then started to run rapidly round and round her prey, letting out the thread as she went, and literally winding the insect up. Having by this safe and satisfactory process speedily put a stop to all immediate likelihood of escape, and having also achieved the desired end of hampering the bee's movements, she again rushed two or three times at it, although still evidently bearing in mind the desirability of not coming to close quarters, and ultimately succeeded in inflicting a bite on one of its legs. From that moment all anxiety on her part respecting the probability of the escape of her prey seemed to disappear, for instead of keeping madly on the move, as she had done up to the time of dealing the wound, she quietly retreated to her funnel and sat down to wait. Nor was an explanation of this behaviour long in presenting itself. For the bee's struggles became more and more feeble, and in about one minute ceased altogether. There was very little doubt in my mind that this was attributable to poisoning; but to make sure that its quiescence was not due to exhaustion from its efforts, I took it from the web for examination, and found that it was to all intents and purposes dead, the only perceptible movement that it made being a slight twitching of the extremities of the antennæ. Whilst I was examining it I noticed the *Agalena* issue from her funnel and return to the spot where she had left her victim.

Subsequently to discover to what extent the spider's behaviour on this occasion was to be explained by her knowledge of the formidable nature of the bee, I placed a blue-bottle fly in the web of another specimen. The spider immediately rushed out, touched the insect with her fore-feet, and falling upon it without further delay, dragged it to the entrance of her tube, and proceeded to devour it.

As a further experiment I introduced an example of the drone-fly (*Eristalis*) into the web of a third example of this species; but, curiously enough, instead of instantly slaughtering the harmless insect, as the second one had the blue-bottle fly, this spider treated it with the same caution that the first had shown towards the bee. She did not, however, wind it up, but, keeping at a respectful distance, and watching for an opportunity, she ultimately bit it in the foot and killed it by this means in a few moments.

From these observations I think three conclusions may be legitimately drawn:—(1) That the first spider avoided contact with the bee for fear of being stung; (2) that the other mistook the *Eristalis* for a bee, as ninety-nine uninitiated human beings out of a hundred would also do; and (3) that the spider's bite rapidly compassed the death of the insects owing to the injection of poison. I wish to draw special attention to this last conclusion, not but that the others are more interesting, because Dr. McCook, when recently investigating the question of spider-venom, was inclined to reject the conclusion that the mandibular fluid of these Arthropods possesses any poisonous property.

His suggestion that the death of an insect results from mutilation caused by the bite clearly will not apply in the present instances where only a leg was bitten. For myself, I do not doubt that the fluid in question is poisonous, although probably in a varying degree to the insects upon which the spiders prey, and that the use of the poison is—as it also is, I think, in the case of scorpions—to put a speedy end to struggles, so as firstly to remove all chance of escape on the part of the prey, and secondly to lessen the probability of injury being done to the Arachnoid by a captive which might also be armed with jaws or stings.

When watching a couple of *Agalenas* pairing I was much struck by the extreme pertinacity with which the operation was carried on. As above stated, specimens of this species are usually exceedingly shy and very difficult to approach, but at this period both male and female seemed utterly oblivious to all their surroundings. They even permitted me to tear away portions of the web, and even to touch them without flinching. A cloud of tobacco smoke made them separate for a short time, but no sooner had it dispersed than they resumed operations as before. I repeatedly pulled the male from the female with my forceps; whereupon she would in alarm retreat to the further extremity of her tube, but he, seemingly, very little disconcerted by the compulsory interruption, would, when placed again in the web, quickly follow her, and presently both would appear again at the entrance of the tube, she lying perfectly passive and he hoisting her along with the patellæ of a pair of her legs grasped in his mandibles. Nor was she apparently much less eager than he, for on two occasions, when he was a little longer than usual in following her, she came forth herself apparently in search of him. It was noticeable that they invariably took up the same position in the same spot at the entrance of the tube, the female lying on her right side with her head towards the posterior extremity of the tube, the male standing over her facing the opposite way. A sketch made of them in this position agrees almost exactly with a figure that Dr. McCook has given of the attitude assumed under similar circumstances of the North American species, *Agalena nævia*. When I left this interesting couple the female had retired to the back of the tube, while the male sat on guard at the entrance. I say on guard, because when touched with my forceps he, instead of running away, raised high his forelegs, striking the instrument with them, and snapping at it with his mandibles. The way in which all the instincts for the preservation of the individual were overridden in this instance by the instinct for the preservation of the race brought very vividly before me the force of Prof. Lloyd Morgan's happy paraphrase of Shakespeare—"To breed or not to breed, that is the question."

Amaurobius similis.—This spider is very common in Cornwall, as elsewhere. It belongs to the same great group of tube-weavers as *Agalena*, spinning a tubular web in ivy, holes in walls, &c., and surrounding the aperture with a tissue of irregularly interlacing somewhat loosely woven threads which present a white thickened appearance, owing to the presence of flocculent tufts of silk that are produced by the agency of those interesting spinning organs, the *cribellum* and *calamistrum*. Like *Agalena* and *Tegenaria*, *Amaurobius* runs with agility on the upper surface of its web. *A. similis* is much smaller than *Agalena labyrinthica*, but does not appear to be so timid. I could never be sure of attracting *Agalena* to a vibrating tuning-fork, but *Amaurobius* would always come and even climb along the instrument. I have enticed this species from its hole by holding the vibrating-fork near the aperture, although not in contact with any part of the web. And all the specimens that were noticed on the external sheet of the web responded invariably when the vibrating-fork was held above them at a distance of about half an inch. But instead of running away from the instrument, or reaching up at it as the *Epeiridæ* do, *Amaurobius* moved excitedly about, apparently searching for the cause of the vibration. One specimen while thus searching came across and instantly seized the old dried-up carcase of a blue-bottle fly, as if perfectly satisfied with the result of its investigation. Another example, discovered away from her web, made no response whatever when the fork was held close to her back. This circumstance, coupled with the fact that no specimen of this spider ever gave the smallest sign of knowing the direction whence the sound proceeded unless its web was actually touched with the tuning-fork, is in favour of Dr. McCook's view, that the *Epeiridæ*, which respond readily to a tuning-fork that is held near them, are only aware of the proximity of the vibrating instrument through the responsive vibration of the web. This may be the true explanation with regard to *Amaurobius*, but there are several reasons, as will shortly be seen, which lead me to think it is not so where the *Epeiridæ* are concerned.

Pholcus phalangioides, belonging to a group by itself, is a common spider in many parts of the south of England. It frequents kitchens and outhouses, where it spins a very untidy-looking web, composed of irregularly interlacing loosely-woven threads. The species cannot be readily mistaken for any other true British spider, on account of the extreme length and thinness of its legs. Owing to this peculiarity, it is probably largely responsible for the popular but erroneous idea that the Opiliones—the harvest-men or long-legged spiders *par excellence*—can spin webs. Whenever any part of the web of a *Pholcus* was touched with a vibrating tuning-fork, the occupant would come clumsily and leisurely up to the instrument, and when it was held close to the back of the spider, the latter would show its perception of the vibration by slowly lifting its legs. One specimen away from its web responded in exactly the same manner as the others did when hanging in the midst of their snares, thus showing that it is not the vibration of the web that informs this species of the proximity of the instrument.

Epeira diademata, *Meta segmentata*, and *Zilla x-notata*, are three very common spiders belonging to the group of Orb-weavers. The first-named—the common garden or cross-spider of England, one of the largest of our species —is known to every one. *Meta segmentata*, too, is very abundant, spinning its web in hedges and bushes; it may be easily recognised from *E. diademata* by its much smaller size and more graceful build. *Zilla* is more like *Meta* than *Epeira*, being a smallish, rather graceful species, which spins its web very commonly in the angles of windows, &c. The structure of its web also affords another clue to its identity, for while in *Epeira* and *Meta* the snare is a complete orb, the concentric lines extending across all the radii from the centre to the circumference, in *Zilla*, as a very general rule, two of the interradial spaces in the upper half of the web are not crossed by the concentrices: the circle of the web thus lacks one sector, and the resulting triangular space is traversed by a free radius, which is continued beyond the circumference of the snare, and connects its centre with a second small irregular web, which is spun in a crevice or beneath some leaf.

Like most other spiders these three species will usually come to a vibrating tuning-fork, if the web be touched with it. And if it be held over the centre of the web where the spider is hanging, the three will readily respond to the sound; but not in the same way. As Mr. and Mrs. Peckham and Prof. Boys[1] have shown, an adult *Epeira diademata* raises its forelegs and snatches at the instrument, while *Meta*[2] *segmentata* instantly drops by a thread from her snare; but *Zilla*, so far as my experience goes, instead of dropping like *Meta*, nearly always climbs quickly along the free radius back to the upper web. One example, however, repeatedly dropped from its web, and two others, one adult and one young, moved excitedly about as if in search of the cause of the sound, exactly as described in the case of *Amaurobius*. Curiously enough the sound affects the examples of *diademata* differently according to their age. Thus quite small examples drop by a thread, but half-grown examples either drop as the young do, or strike at the fork like the adults. It appears therefore from these facts, that as a general rule the small English Epeiridæ fear the sound of a vibrating tuning-fork, while the large ones do not. What is the explanation of this? Prof. Boys, who has previously noticed this same fact in connection with *E. diademata* and *Meta*, thinks that it is perhaps to be explained on the grounds that the vibrating tuning-fork is mistaken for an approaching wasp—an insect which, to use Dr. McCook's words, "is the most persistent enemy of spiders." But a full-grown *E. diademata* is too formidable an opponent for a wasp to attack, and it seems well aware that anything buzzing can be overcome and eaten, or at least repulsed. Not so, however, is it with a *Meta*. A wasp can take one of these small spiders out of its snare while still on the wing, and the spider's life depends upon the quickness with which it can perceive the approach of its enemy and act upon the perception by dropping out of harm's way.

This ingenious suggestion is further borne out by the behaviour of *Zilla* and of the young *diadematas*, for these spiders would have no more chance against a wasp than *Meta* has. Moreover, my friend Mr. Henderson, of Madras, has informed me that he has repeatedly seen examples of a common Indian house spider[1] drop from their webs at the approach of the mason-wasps.

Such a habit, then, of falling or running away would clearly give a spider that possessed it an advantage in life over others of the species in which it was not developed, and the elimination of the latter and the survival of the former, with the consequent chance of breeding, would foster the habit and bring it to the state of perfection in which we now see it.

On the other hand, the loss of the habit in the adult *E. diademata*, may perhaps be explained on the hypothesis that the act of dropping entails the expenditure of energy in the form of waste of silk and of muscular tissue; moreover, it might at the same time on occasions lead to the escape of an insect that would have served for prey if the spider had remained in *statu quo*. The two instincts are seen in a state of transition in half-grown *diadematas*. But the acquired one of fearlessly fighting the enemy would be prevented from appearing too early in life by the destruction of those individuals which, with overconfidence on their growing powers, stayed in the web when they ought to have dropped from it; or, in other words, the runaway instinct would be preserved as long as the spider was too small to cope with a wasp.

Another interesting question connected with this behaviour of the Epeiridæ is the means whereby the vibration of the fork is perceived. The obvious answer is that the sound is heard. But Dr. McCook has recently objected to this explanation on the grounds that the Lycosidæ, which spin no web, and which, in Dr. McCook's opinion, have more need of an auditory sense than the Epeiridæ, make no response when the vibration is brought near them.

It has been objected (*Ann. Mag. Nat. Hist.* Ser. 6, viii. p. 103), however, to this opinion of McCook's that the Epeiridæ which spin their webs in places where flies are likely to be caught, must of necessity at the same time expose themselves to the attacks of wasps. We can therefore imagine that it is of the highest importance to them to be able to perceive the approach of their enemy—of more importance to them, in fact, than to those spiders, which like the Lycosidæ spin no exposed and conspicuous snare, and are therefore more likely to escape the notice of the wasps.

To account for the behaviour of the Epeiridæ when a vibrating fork is brought near them, Dr. McCook has suggested that the vibration of the instrument causes

1 NATURE, vol. xliii. pp. 40-41.
2 This is probably the small unidentified orbicular spider that Prof. Boys speaks of.

1 Mr. Henderson kindly procured examples of this spider for me, and they proved to belong to the genus *Pholcus*.

the threads of the web to vibrate in turn, and that the spider is informed of the nearness of the instrument by the delicate sense of touch in the feet. But so far as my experience goes this hypothesis is not sufficient to account for the facts; for it is difficult to understand how the sense of touch in the feet can merely by being in contact with the threads, which by hypothesis are in a state of vibration, inform the spiders of the position of the fork and of the direction whence the sound proceeds. For of this, to judge by their actions, they appear to have a full knowledge. For instance, one adult example of *E. diademata* that I observed, responded in the manner above described when the fork was held over her back; but when the instrument was brought towards her ventral surface on the other side of the web she drew her body away from it, standing as it were on the tips of her toes. Again, when the fork was brought from below to within a distance of an inch and a half or two inches of a *Meta* suspended by a thread from her web, she instantly dropped again. In this case it is hard to believe that from such a position the fork could throw the web into a state of vibration. On the other hand, no example of the Epeiridæ could ever be attracted along one of the radii of the web, however close the fork was held to it, unless the two were actually in contact. In view of these facts, it seems to me probable that Mr. and Mrs. Peckham's explanation of the behaviour of the Epeiridæ—namely, that they hear the vibration—is the true one.

R. I. POCOCK.

NOTES.

THE Royal Society's medals have this year been adjudicated by the President and Council as follows:—The Copley Medal to Sir George Gabriel Stokes, Bart., F.R.S., for his researches and discoveries in physical science; a Royal Medal to Prof. Arthur Schuster, F.R.S., for his spectroscopic researches, and his researches on disruptive discharge through gases and on terrestrial magnetism; a Royal Medal to Prof. Harry Marshall Ward, F.R.S., for his researches into the life history of fungi and schizomycetes; and the Davy Medal to Messrs. J. H. van't Hoff and J. A. Le Bel, in recognition of their introduction of the theory of asymmetric carbon, and its use in explaining the constitution of optically active carbon compounds. Her Majesty the Queen has been graciously pleased to approve of the award of the Royal Medals. The medals will, as usual, be presented at the anniversary meeting on St. Andrew's Day (November 30). M. Le Bel has promised to attend in person, and it is hoped that all the medallists will be present. The Society will dine together at the Whitehall Rooms on the evening of the same day.

BY the death of Sir Andrew Clark, on the 6th inst., the medical profession has lost one of its most prominent members. The Royal College of Physicians has to mourn the decease of its President, and, outside the faculty, a large and distinguished section of the community is affected by it. Sir Andrew was born on October 28, 1826, at Aberdeen, and pursued his medical career there and at Edinburgh. Subsequently he entered the Royal Navy as a surgeon, and, after making a few voyages, became pathologist to the Royal Naval Hospital at Haslar. There he met Prof. Huxley, who was then professor of biology at the hospital school. In 1853 he accepted the curatorship to the museum of the London Hospital, and was afterwards appointed pathologist to the hospital, then lecturer on physiology, and in 1866 full physician. After this Sir Andrew rapidly came to the front, and from the first his connection was composed largely of men distinguished in science, art, and literature. In 1883 Her Majesty recognised his position in the profession, and his services to medical science, by conferring upon him the honour and title of a baronetcy. Five years later he was elected to succeed Sir William Jenner as President of the Royal College of Physicians, an honour that he valued even more highly than Royal favours. He was a Fellow of the Royal Society, an LL.D. of Aberdeen, Cambridge, and Edinburgh, and honorary M.D. of Dublin. The respect in which he was held is shown by the influential and representative character of the assembly at a commemorative service in Westminster Abbey on Saturday. The pall-bearers included the Prime Minister, Sir Henry Acland (Regius Professor of Medicine at Oxford), Sir James Paget (Vice-Chancellor of London University), Mr. John Whitaker Hulke (President of the Royal College of Surgeons), Sir Richard Quain (President of the General Medical Council, representing by request of the Provost the University of Dublin), and Sir Edward Sieveking. Following these, with the officers of the Royal College of Physicians, came representatives of the Universities, State departments, and various institutions. Prof. Clifford Allbutt attended for Cambridge, Sir Joseph Fayrer for Edinburgh, Dr. Farquharson, M.P., for Aberdeen, Mr. J. N. Dick for the Navy Medical Department, Sir William Mackinnon for the Army Medical Department, Dr. Thorne Thorne for the Medical Department of the Local Government Board, Sir William Flower for the British Museum, and Prof. Michael Foster for the Royal Society. Among the large congregation were Prof. Huxley, Sir Spencer Wells, and Sir Walter Phillimore. Honoured in life, Sir Andrew Clark's memory will be cherished by all acquainted with his wonderful energy, devotion to duty, and self-sacrifice—attributes worthy of emulation by all followers of his noble profession.

THE death of Dr. H. A. Hagen, a well-known entomologist is announced from New York. He was born in Königsberg in 1817, and became an assistant to Agassiz in 1867. Three years later he was appointed Professor of Entomology at Harvard College. It can truly be said that his works furnish a monument to his memory, for he made more than four hundred contributions to scientific literature.

WE have to record that Mr. A. Reckenzaun died on November 11, at the age of forty-three. His name is familiar in connection with papers on accumulators, electric traction, and electric locomotives, for certain of which he was awarded medals by the Society of Arts and the Institution of Electrical Engineers.

WE regret to learn from Sydney of the death of Dr. George Bennett, a distinguished naturalist, and the author of "Wanderings in New South Wales" and other works. He was ninety years of age.

THE death is announced of Mr. J. G. Barford, the author of a number of papers on physiological chemistry.

IN January next, the Botanical Society of Italy will take over the *Nuovo Giornale Botanico Italiano*, at present edited by Prof. T. Carnel, and publish it as the official organ of the Society. No modifications will be made, however, in the character of the journal, which will continue to be issued in quarterly numbers.

A meeting of representatives of technical schools was held at Manchester on the 4th inst., and it was resolved "that it is desirable that an Association of Technical Institutions be formed." With a view to formally constituting the proposed Association, a meeting will be held at the Society of Arts, on Friday, January 26, 1894.

THE new institute of science, art, and literature, established by the corporation of Carlisle at a cost of about £20,000, was opened by the mayor of that city on November 8. The institute includes a museum, a school of science and art, and a free library. In addition to a valuable collection of antiquities, the museum contains a good collection of stuffed birds, the late Prof. Harkness's collection of fossils, and a number of specimens of rocks of the English Lake district.

IT is reported that a seam of good coal has been discovered at Port Jackson, at a depth of 3000 feet below the surface.

AT the second meeting of a conference of the General Lighthouse Authorities of the United Kingdom and their engineers, together with representatives of the Admiralty and Board of Trade, held at the Trinity House on November 10, it was decided to publish in the official list of lights the candle-power of each light as determined by the engineers. By this means mariners will be informed of the relative illuminating powers of all the principal lights on the coast.

A CORPORATION has been formed at Chicago for the purpose of creating and sustaining a museum (says the *American Naturalist*). Prof. F. W. Putnam has been appointed managing director of the scheme. It is expected that he will organise the museum into departments, and will place over each a competent head, who will make it a medium of original research as well as of exhibition.

AT the annual meeting of the New York Mathematical Society, to be held on December 28, Prof. Simon Newcomb will deliver an address on "Modern Mathematical Thoughts."

THE fifth of the Gilchrist Lectures, in connection with the Bethnal Green Free Library, will be given on Thursday, 23rd, in the Great Assembly Hall, Mile End Road, by Dr. R. D. Roberts, his subject being "The Evolution of the British Isles."

THE Christmas course of lectures for juveniles will this year be delivered at the Royal Institution by Prof. Dewar. The subject will be "Air, Gaseous and Liquid," and the first lecture will be delivered on Thursday, December 28.

THE following science lectures will be delivered at the London Institution during the ensuing session: "Birds—Ancient and Modern," by Dr. B. Bowdler Sharpe; "When and Why an Electric Spark Oscillates," by Prof. C. V. Boys; "Crabs," by Prof. W. F. R. Weldon; "The Pond and its People," by the Rev. Dr. Dallinger. Mr. Shelford Bidwell will discourse on "Some Optical Phenomena"; Mr. J. J. H. Teall, on "The Life History of a Mountain Range"; Dr. Klein, on "Cholera," and Prof. Vivian Lewes, on "The Chemistry of Cleaning." The Christmas course for juveniles will be given by Mr. H. J. Mackinder.

IN an interesting report, presented to the Department of Agriculture of New South Wales, Mr. A. Sidney Oliff, the Government Entomologist, deals with the injuries inflicted on the sugar-cane crops in the Clarence River district by the ravages of insects. He finds the larger part of the injury to be due to the attacks of the larva of a moth, the sugar-cane moth borer, *Nonagria exitiosa*, but that its increase is kept in check by two minute hymenopterous parasites, both hitherto undescribed; one, *Apanteles Nonagriæ*, belonging to the Ichneumonidæ, the other, *Euplectus Howardi*, to the Chalcididæ.

TWO recent publications of the Board of Agriculture deal with experiments in checking potato disease in the United Kingdom and abroad. The history and cause of the potato disease are first explained, and a great variety of experiments are described in detail. They form a useful manual for agriculturists in their fight against the *Peronospora*.

MR. J. H. HART, the Superintendent of the Royal Botanic Gardens, Trinidad, has recently been successful in transporting to Nicaragua a selection of the best varieties of Trinidad "cacao." Cacao seed soon loses its vitality, and can only be safely transported long distances by placing it in a suitable position to germinate and grow on the voyage. On April 25 of this year, Mr. Hart left Trinidad with a number of specially-prepared cases containing plants, and seeds planted on the day of departure. The boxes in which the seeds were sown had not glass roofs, but were strongly latticed and covered with a movable sail-cloth cover which could be easily and rapidly fastened or unfastened, to give light, or to protect from wind, rain, and sun. A frame covered with wire-netting was fastened inside each case, so as to press upon the surface of the soil to prevent it shifting and causing the seeds to be disturbed. The seeds germinated ten days after planting, and on June 10, Mr. Hart reached his destination with more than 26,000 healthy plants, which were successfully put out in nurseries. A number of cacao seeds were sown at Nicaragua to develop during the return voyage, and, upon arriving at Trinidad, good healthy plants were obtained from ninety-eight per cent. of the seeds planted. These plants included two species entirely new to Trinidad, and their introduction may eventually prove of great benefit to the colony.

DR. KARL A. VON ZITTEL, Professor of Palæontology in the University of Munich, has at length completed the final volume of his comprehensive "Handbook of Palæontology." The first three volumes are already familiar to all students of palæontology, the fourth volume is devoted to the group of Mammalia. In the *Geological Magazine* for the months of September, October, and November, Dr. G. J. Hinde gives a translation of the concluding chapter, entitled, "On the Geological Development of the Mammalia." The palæontological record from Triassic to recent time is there summarised for the various continents, and Prof. von Zittel advances many additional data in support of Huxley's opinion that the *four* zoogeographical kingdoms of A. R. Wallace, the Palæarctic, Nearctic, Ethiopic, and Indian, form in point of fact but *one* great area of development—the Arctogean. This is the youngest of three areas of mammalian development; the oldest is the "Australian," which was separated from other continents as early as Mesozoic time, while the "South American" area dates as far back as early Tertiary.

A PAPER, by Mr. C. T. Simpson, on some fossil Unios and other fresh-water shells from the drift at Toronto, Canada, is contained in the Proceedings of the U.S. National Museum, vol. xvi. Mr. Simpson finds that the Unio fauna of the Mississippi Valley is remarkably distinct, being nearly related only to a part of that of North-Eastern Asia. It can be traced back to the Laramic group of the Cretaceous in an almost unbroken line of species. Glacialists will be interested in the following conclusion:—"The theory founded by Agassiz and elaborated by Dawson, Upham, Gilbert, Tyrrell, and others, that during the glacial period the archæan region of Canada was elevate from 1,000 to 2,000 feet above its present level, and that it was covered with an ice mantle from 3,000 to 6,000 feet thick, a mantle which in the eastern part of the United States extended down to latitude 38° or 40°; that in the Champlain period which followed there was a subsidence over this area, during which great lakes were formed by the melting ice, whose northern shores were the yet remaining wall of ice, and whose southern borders were the land that sloped northward; and that they drained into the Mississippi system, is most strongly confirmed by the evidence of these fossil Unios, and by every fact of the distribution of the Naiades in this general region to-day. It is believed that the entire system of the present Great Lakes was united, and that at one time it covered a considerable part of Lower Michigan, and extended well into Ohio, Indiana, and Illinois."

The great importance attaching to an accurate knowledge of the precise instant at which an earthquake shock is felt at a given station, has led Dr. A. Cancani, of the Rocca di Papa Geodynamic Observatory, to construct a seismograph which registers the time of the occurrence by an instantaneous photograph of a chronometer. From its description in the November number of *L'Elettricista*, it appears that the face of the chronometer is photographed by the light of an incandescent lamp, lighted for about a quarter of a second by a current established automatically by the shock. A lever of the first order carries on one arm nine small vessels containing potassium bichromate solution, whilst the other arm rests on the armature of an electro-magnet. The latter is connected to all the seismoscopes of the observatory, any one of which may establish the circuit and cause the armature to be attracted down. This raises the bichromate vessels and immerses the zinc-carbon couples fixed above them, thus supplying the lamp with a current. The closing of the circuit releases the lever, and the apparatus is automatically rearranged for the next shock.

AN improved form of rotary air-pump has been constructed by Herr F. Schulze-Berge, and is described and illustrated in *Wiedemann's Annalen*. That chief difficulty in rotary air-pumps, the air-tight junction between the rotating and the stationary parts, has been overcome in a manner which is simple, ingenious, and very efficient. The tube from the vessel to be exhausted is led through the bottom of an inclined cylindrical vessel filled with mercury. A somewhat larger tube, forming the shaft of the rotating pump, reaches nearly to the bottom of the vessel, and surrounds the end of the first tube in such a manner that there is free communication between the two tubes, whilst all communication with the outer air is intercepted by the mercury. This mercury stuffing, while causing no friction, is found to be effective even at the highest vacua. The rotating tube is surrounded by another, which embraces the cylindrical vessel, and revolves on it with an air-tight junction formed by an ordinary stuffing-box or another mercury junction. The interior of this outer tube is exhausted by an auxiliary pump, so as to keep the difference of level in the mercury vessel small. The shaft carries a circular tube rotating in an inclined plane, about one-third of the tube being filled with mercury. This mercury forms a kind of piston for drawing the air out of the inner shaft, and driving it into the outer one and into the auxiliary pump. The tubular ring is interrupted in one place by a mercury valve, consisting of a U-tube or two concentric tubes parallel to the shaft, one of which communicates with the inner shaft and the recipient, the other leading into the space between the two shafts. In an improved form of the apparatus two concentric tubular rings are used, so that the space to be exhausted is separated by the mercury valve from another exhausted to nearly the same extent. The vacua obtained with this pump are beyond the limits of accurate measurement by McLeod's apparatus, and they are obtained much more rapidly than by other mercury pumps. A pump with rings of 60 cm. diameter and a capacity of 0·9 litre could be driven mechanically at a speed of 15 revolutions per minute. The inventor is constructing a pump of 8·5 litre capacity for industrial purposes.

THE *Electrician* contains a description of a method for comparing the capacities of two condensers when they are of so small capacity that it is impossible to obtain, by the ordinary direct deflection method, readings sufficiently large to be accurately measured. The apparatus used consists of an electrically driven tuning-fork, performing about 280 double vibrations per second, one limb of which is provided with a platinised style vibrating between two light platinised springs, whose movements are damped so that their individual vibrations may not conflict with those of the fork. These springs are adjusted relatively to the style on the fork, so that contact shall be made with them alternately, but that when the fork is at rest it shall not be in contact with either. One spring is connected to one pole of a battery, the other to one terminal of a galvanometer, and the fork to one terminal of the condenser, the other terminals of the battery, galvanometer and condenser being connected together. When the fork vibrates, it first charges the condenser, and then discharges it through the galvanometer. The succession of impulses being so rapid (280 per second), the effect upon the galvanometer is nearly that of a continuous current, and the deflection is steady. It is possible with this arrangement to measure the capacity of a person who is insulated from the floor, and to note the increase of capacity due to the approach of other (uninsulated) persons to him.

L'Elettricista for November contains a paper, by Signor G. Brucchietti, on the effect of the absorption of hydrogen on the thermo-electric power and electrical resistance of palladium. The author finds that the resistance of a wire of palladium containing hydrogen increases in proportion to the quantity of hydrogen absorbed, and that when it is saturated the resistance is 1·55 times as great as it was before being charged with the hydrogen. If the same wire is repeatedly saturated with, and freed from hydrogen the resistance seems to tend towards a constant value (whether hydrogen is present or not), which is intermediate between the resistance before being charged, and that after being charged for the first time. In the experiments on thermo-electric force the author used a couple consisting of palladium and nickel, and found that the thermo-electric force of this couple increased with the amount of hydrogen absorbed by the palladium. When the palladium is saturated, the thermo-electric force of the couple is 1·66 times as great as it was before the palladium was charged. In a thermo-electric couple formed of charged and uncharged palladium the current at the cold junction was found to go from the charged to the uncharged palladium. This result is contrary to that obtained by Knott, and the author supposes the divergence to be due to impurity in one or other of the samples of palladium employed.

AN exhaustive study of a problem belonging to the mathematical side of chemistry appears in the current number of the *Annales de Chimie et de Physique*. Here M. Lemoine investigates the influence of heat, unaffected by that of light, on the reactions which take place in aqueous solutions containing ferric chloride and oxalic acid. When these substances are present in equivalent proportions, the interaction is irreversible, and proceeds according to the equation, $2FeCl_3 + H_2C_2O_4 = 2FeCl_2 + 2HCl + 2CO_2$. At any temperature the rate at which decomposition takes place is found to follow the well-known law of mass action, which states that the amount of substance which is being decomposed at any instant is proportional to the amount of unchanged substance contained in unit volume of solution. The rate of change, concentration remaining the same, is found to vary to a most marked extent with variation in temperature. Thus at 100°, in one hour ·16 of the original amount of substance was decomposed, whereas at ordinary temperatures after six years only ·019 equivalents had reacted. The presence of water accelerates the velocity of change according to a law which varies slightly with the temperature, a slight excess of oxalic acid accelerates the rate, a large excess of oxalic acid or of ferric chloride retards it. Excess of concentrated hydrochloric acid almost completely arrests the reaction. The effects which these and other materials exert upon the course of the simple reaction, the author studies both by chemical and thermochemical methods, and shows that they may be explained by the occurrence of secondary reactions. The communication, which extends over more than 100 pages, serves to give some idea of the patient labour involved in elucidating the mechanics of what appears at first sight to be a comparatively simple case of chemical decomposition.

THE Calendar of the University College of Nottingham for the thirteenth session, 1893-94, has just been issued.

A "BIBLIOGRAPHY of the Chinookan Languages" (including the Chinook jargon) has been prepared for the Bureau of Ethnology, Washington, by Mr. J. C. Pilling.

MESSRS. PERKEN, SON, AND RAYMENT have published the eighteenth edition of a little book on "Intensity Coils," and the second edition of "The Magic Lantern: its Construction and Use." Both books are suited to the wants of the scientific amateur.

MR. ALBERT F. CALVERT presents, in his "Mineral Resources of Western Australia" (George Philip and Son), an array of facts of particular interest to the capitalist and emigrant. Beneath the surface of that country lie belts and reefs of gold-bearing rocks sufficient to satisfy the most avaricious, and Mr. Calvert is desirous that the profuseness of these and like mineral deposits should convince people that the country offers "mighty possibilities" to enterprise.

DR. M. C. COOKE'S "Romance of Low Life among Plants," published by the Society for Promoting Christian Knowledge, is an interesting and very readable book on cryptogamic vegetation. Though written in language "understanded of the people," and full of romantic beliefs connected with plants in a bygone age, scientific accuracy is not sacrificed, and scientific words are not strictly tabooed, as they usually are in the diffuse books designed for the popular palate. A larger number of illustrations would render the book still more interesting and valuable.

DR. A. R. C. SELWYN, C.M.G., F.R.S., the Director of the Geological Survey of Canada, has had a catalogue prepared of the fine stratigraphical collection of Canadian rocks exhibited by the Survey Department at the Columbian Exposition. The collection comprised 1500 specimens, illustrating all the formations known to occur in the Dominion of Canada, from the Laurentian to the Pleistocene. Mr. W. F. Ferrier gives a few explanatory notes with regard to the rocks represented in the collection.

IF the number of books published on a particular subject can be regarded as an indication of the interest taken in that subject, we are led to the gratifying conclusion that physical laboratories are rapidly increasing. Books dealing with practical physics are constantly being published, and the last received by us—"Practical Work in Heat," by Mr. W. G. Woollcombe (Clarendon Press)—shares the generally excellent character of works of its kind. It is now believed by all men of science that physics cannot be properly taught by lectures alone, any more than chemistry, and the belief is slowly but surely causing our schools and colleges to give facilities for such necessary practical work. Mr. Woollcombe's book includes sections on thermometry, expansion, calorimetry, evaporation, and radiation. Excellent experiments are described in each section, and their performance does not necessitate the use of expensive apparatus. In fact, the book contains a practical course in heat that we should like to see introduced into every school which includes physical science in its curriculum.

COMPOUNDS of carbon monoxide with potassium and sodium respectively have been obtained by M. Joannis, by the action of gaseous carbon monoxide upon solutions in excess of liquefied ammonia of the peculiar compounds which potassium and sodium form with ammonia. M. Joannis has for several years been investigating the nature and reactions of these latter compounds, potassammonium and sodammonium, and the results of his researches have been referred to in previous notes (see NATURE, vol. xliii. p. 399, and vol. xlv. p. 158). The reactions which occur between these substances and carbon monoxide are of a most interesting character, throwing light as they do upon the nature of the dangerously explosive compound of potassium and carbon monoxide which formerly produced such deplorable accidents during the commercial production of metallic potassium by the method of Brunner. A considerable number of investigations have been carried out with the object of obtaining a complete knowledge of this explosive substance, but the results arrived at can scarcely be termed concordant. Most of the investigators agree in assigning to it the simple formula KCO, but the descriptions of its properties are very diverse. Liebig and likewise Lerch describe it as a black powder, while Brodie endows it with a red colour. The latter chemist found it to react in a most violent manner with water, while Liebig's substance was much more gentle in its demeanour towards that solvent, and actually permitted of the application of a moderate heat with no more serious result than quiet inflammation. More recently Nietzki and Beuckiser have described it as not only explosive but as detonating, when exposed to the moist atmosphere, under the influence of the least concussion in its neighbourhood. The potassium compound now described bears most resemblance to the unstable substance of Brodie and of Nietzki and Beuckiser, although differing in several particulars. The analogous sodium compound does not appear to have been previously obtained.

WHEN dry carbon monoxide is allowed to bubble through a solution in liquefied ammonia of potassammonium, the blue substance of the probable composition $(KNH_3)\,n$ produced by dissolving metallic potassium in liquefied ammonia, the containing vessel being cooled to $-50°$, the deep blue colour gradually diminishes in intensity, and is eventually supplanted by a pale rose tint, the attainment of which signifies the completion of the interaction. Upon removal from the cooling mixture the liquefied ammonia gradually vaporises, depositing as it does so a rose-coloured powder which upon analysis proves to be pure potassium carbonyl KCO. When left undisturbed in a sealed tube for some time this pink powder darkens in colour, then answering very closely to the description of Brodie's substance. It cannot be heated to the temperature of boiling water, explosion ensuing considerably below that temperature. Detonation likewise occurs if the merest trace of air is admitted, and instantly when touched with a drop of water. Air and water both appear to act by causing such an elevation of temperature by their reaction with a small portion as to bring about sudden decomposition of the whole. It is, however, possible to study the reaction with water by admitting a drop of that liquid into an exhausted tube containing potassium carbonyl in such a manner as not to come into direct contact with the substance; the aqueous vapour then slowly reacts with the apparent production of deliquescence and the eventual formation of a yellow viscous liquid. The nature of this liquid is reserved for a future communication.

SODIUM does not resemble potassium in directly uniting with carbon monoxide. Sodammonium $(NaNH_3)n$, is, however, readily decomposed by carbon monoxide with formation of sodium carbonyl, NaCO, a substance which may be isolated in a manner similar to that employed for the isolation of the potassium compound. It is a pale lilac-coloured substance which is powerfully explosive like its potassium analogue. Detonation ensues under the influence of small quantities of either air or water. Under the influence of heat its colour darkens, no gas is evolved, but about 90° sudden explosion occurs, and with such force that no glass has yet been found to withstand it. It also explodes like the potassium compound under the influence of percussion, although not quite so readily as the latter substance. The nature of the changes occurring in the explosion by percussion were ascertained by performing the reaction in a sealed tube of strong glass, also containing a few glass beads. The rattling of the beads was sufficient to induce explosion, and in one experiment out of a large number the tube remained intact. It was found that the products were all solid substances. The main reaction proceeds in accordance with the equation $4NaCO = Na_2CO_3 + Na_2O + 3C$. A small quantity of sodium cyanide was also produced. When a drop of water is introduced into a similar tube detonation immediately occurs, and the whole tube is filled with a red flame, the colour of which may perhaps be accounted for by the fact that a considerable quantity of hydrogen gas is liberated. The other products of the reaction are sodium carbonate, free carbon, and a small proportion of carbon monoxide. Water vapour, however, reacts in a quiet manner, as in the case of potassium carbonyl, the substance successively changing colour to brick-red, reddish-brown, and dark violet, until at length a viscous liquid of a deep red colour is produced, whose nature, together with that of the liquid derived from the potassium compound, M. Joannis is now investigating.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include a specimen of the fine Nemertine *Cerebratulus roseus*, now first recorded for the British Isles. There are clearly hosts of interesting forms in the deeper water off the Devon and Cornish coasts, if only we had a stout steamboat from which to dredge this rich locality. The floating fauna has not been rich, owing to the prevalence of northerly and easterly winds. The presence of *Radiolaria*, in spite of this, has been an interesting feature. Terebellid and Polynoid larvæ, *Sagitta*, and a few Ophiuroid *Plutei* have also been observed.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*, ♀) from India, presented by Mr. James Kendal; a Hairy-nosed Wombat (*Phalascomys latifrons*, ♂) from South Australia, two Marabou Storks (*Leptoptilus crumeniferus*), a White-necked Stork (*Dissura episcopus*) from West Africa, a Javan Adjutant (*Leptoptilus javanicus*) from Java, presented by Mr. E. W. Marshall, F.Z.S.; a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Mrs. B. E. F. Stevens; two and three Hedgehogs (*Erinaceus europæus*) British, presented respectively by Mr. W. Chatterton and Mr. A. S. Bird; two Herring Gulls (*Larus argentatus*) British, presented by Mr. B. Tremble; a Blossom-headed Parrakeet (*Palæornis cyanocephalus*, ♂) from India, presented by Mrs. Osmond Barnes; a White-handed Gibbon (*Hylobates lar.*, ♀) from the Malay Peninsula, deposited; a Mona Monkey (*Cercopithecus mona*, ♂) from West Africa, two Lapwings (*Vanellus vulgaris*), a Common Curlew (*Numenius arquata*) British, purchased; three Dingoes (*Canis dingo*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

BROOKS'S NEW COMET (1893*c*).—In the *Astronomical Journal* (No. 306), Prof. E. E. Barnard briefly describes a photograph of this new comet, which he was able to obtain with a 6-inch Willard lens. The exposure was made under conditions not very conducive to good results, owing to the low position of the comet and the presence of the zodiacal light. The negative exhibits, however, many points of interest, and its characteristic features are described as similar to those shown in the photographs of Swift's comet 1892 I. Prof. Barnard's description is as follows:—"The plate shows the tail to a distance of 3½°. This tail irregularly divides into two slightly divergent branches. There are two narrow straight rays springing out from the head on opposite sides, and nearly symmetrical with the main tail. The north ray, which seems to leave the region of the nucleus, is inclined to the body of the comet by about 45°; the southern, which leaves the comet 10' or 15' back of the head, is inclined about 30°. They are both about ½° long. There are faint evidences of several other rays from the southern side of the comet."

BIELA METEORS.—The return of the "Andromedes" this year is looked forward to with special interest, owing to their great abundance last year. It will be remembered that in 1892, instead of arriving on November 27 or 28, as was expected, the maxima occurred about the 23rd, or four days in advance of the predicted time, so that observers this year must be on the *qui vive* early. The director of the Pulkova Observatory, M. Bredichin, accounts for this retrograde motion by supposing it to be caused by the perturbations of Jupiter, which during 1890 were very great. Besides a retrogradation of the node amounting to 4°, the inclination of the orbit has largely diminished.

THE PLANET JUPITER.—Jupiter's red spot, although preserving its oval form, is very dim, and is less sharp than in preceding years. The general aspect of the disc seems to have sensibly undergone changes and shows many more details, as if the cloudy atmosphere of the planet had been more than usual disturbed. Numerous observers are now scanning his disc, and some recent results are contained in the current number of *L'Astronomie* (No. 11). M. Guiot has made a series of drawings which are there produced; they show how the equatorial belt has gradually advanced to the west relatively to a small black spot indicated in the drawing, and has consequently made the latter appear to have a motion in the opposite direction, *i.e.* eastwards. The motion is clearly shown by a change of inclination in a line connecting the same two spots in the series.

A NEW VARIABLE STAR.—The Rev. T. E. Espin announces from the Wolsingham Observatory that a red star (anonymous) at R.A. 19h. 7m. 16s., Decl. +25°·46, is variable. Its magnitude on August 21 was 9·0, but it has diminished to 11·0 mag. Photographs taken with the Compton telescope have confirmed the variability of Es. 329 (R.A. 19h. 59m. 6s., Decl. +36°·25).

THE "OBSERVATORY" FOR NOVEMBER.—In the current number of this monthly, Mr. T. Lewis concludes his interesting survey on the various methods of computing double-star orbits. Mr. H. H. Turner describes briefly a short method of obtaining a star's right ascension and declination from a photograph, the results being correct to less than a second of arc. Mr. Dunkin, in a letter to the editors, gives the text of the "Adams Memorial," lately placed in the north transept of Truro Cathedral, and erected at the expense of a few Cornish friends and admirers, both resident and non-resident, as a mark of their high esteem for him as an astronomer and mathematician, and also for the strong affection he always entertained to the end of his life for the hills and dales of his native county. The translation is as follows:—

In this place, as is his due,
We commemorate our own [West] countryman
John Couch Adams
Tracing his way
By the sure clue of Mathematics
Through the boundless night of space
He found the outermost of the planets.
Faithfully pursuing the paths of the Sciences
With single-hearted modesty and clearness of intellect,
He loved God Whom he saw in the Face of Christ;
For him, as well as for Henry Martyn,
Cornwall and Cambridge
Owe each other mutual debts.
He died, dearly loved by all who knew him,
On the 21st of January 1892,
Aged 72 years, 7 months, 16 days.

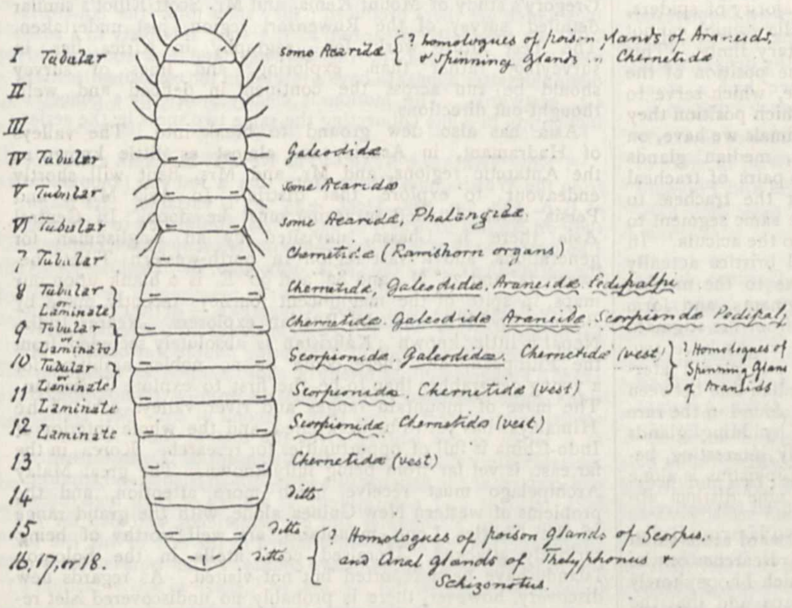
SOLAR OBSERVATIONS AT CATANIA, ROME, &c.—Prof. Riccò, in the August number of the *Memoire della Societa degli Spectroscopisti Italiani*, gives a detailed account of the observations of solar protuberances observed at the Royal Observatory of Catania during the year 1892. The same number contains two of the large diagrams showing the sun's limb as observed at Catania, Palermo and Rome, one for February–March 1892, and the other for March–April of the same year.

THE STIGMATA OF THE ARACHNIDA, AS A CLUE TO THEIR ANCESTRY.

IF on a diagram of an Arachnidan body we mark every segment on which stigmata are said to occur, the result is somewhat remarkable.

The subjoined figure is such a diagram, and stigmata, functional or vestigial, are known on all the segments except the second and third. On the left hand of the diagram I have recorded the form which the tracheal invaginations from each pair of stigmata assume, *i.e.* whether they are tubular or laminate; and on the right hand I have noted the genera in which the stigmata occur, with a straight underline if their tracheæ are tubular, and a wavy underline if their tracheæ are laminate. The marks which represent the stigmata are not intended to denote their real positions on the segments, but only to indicate their presence, although there is reason for thinking that they may well represent their primitive positions.

On the first segment we have stigmata recorded *on the dorsal surface at the bases of the mandibles* in some Acaridæ. This remarkable position may be in in some way connected with the formation and dorsal arrangement of the "cephalic lobes,"[1] which accompanies the translocation of the mandibles from a post-oral to a pre-oral position. All the other tracheæ of the Arachnida are associated with limbs, the Arachnida agreeing in



his point with the Hexapoda and Myriapoda, but differing from the Peripatidæ.

On the sixth segment we have stigmata both in Acaridæ and Phalangidæ behind the last pair of legs. This position may mean either on the last cephalothoracic or on the first abdominal segment. I do not wish to lay special stress on this one case; but, considering the general absence of stigmata on the abdomen in Acaridæ, owing to the rudimentary condition of this region of the body, I think there is something to be said for the position indicated in the diagram. The same argument applies to the Phalangidæ, in which animals also the abdomen is but feebly developed.

On the first abdominal segment (7) we have the remarkable ram's-horn organs which I have elsewhere[2] suggested may be a primitive form of tracheal invagination, from which either laminate or tubular tracheæ may be very easily deduced.

On the following two abdominal segments (8 and 9) we have tubular and laminate tracheæ equally distributed, all those hitherto described having been tubular.

On the tenth segment we have functional laminate tracheæ in Scorpio, tubular tracheæ descending to a medium (? closed) stigma in Galeodes, and vestigial stigmatic scars in the Chernetidæ. These scars are repeated segmentally on all the remaining abdominal segments in the Chernetidæ, and represent the closed stigmata of vanished tracheæ, which tracheæ, if we may judge from the ram's-horn organs and the functiona- tracheæ on the second and third abdominal segments, were all most certainly tubular.

From these facts we are justified in concluding (1) that the tracheal invaginations of the ancestor of the Arachnids were strictly segmental, and (2) that these invaginations were of some simple tubular type, from which the laminate forms could be easily developed. The ram's-horn organs of the Chernetidæ, with the simple air chambers in their epithelial cells as recently described (*l.c. supra*), might well represent such primitive invaginations.

An impartial review of the facts must convince everyone that the laminate form is the more specialised. The tubular form is by far the most widely distributed, being not only universal among the Hexapoda and Peripatidæ, but far more common among Arachnids than the laminate. Tubular tracheæ occur universally in the Acaridæ, which have some claim to be considered as fixed larval forms (*Jour. Linn. Soc. Zool.* vol. xxiv. p. 279); in the Phalangidæ, which are so specialised that they must have branched off very early from the main Arachnidan stem; in the Chernetidæ, which again are very difficult to class, and may claim to be an independent group; and lastly in the Galeodidæ, which in many respects are the most primitive of all Arachnids.

The Araneidæ, with their highly specialised abdomen, possess both laminate and tubular forms, while the Scorpionidæ and related Pedipalpi are the only Arachnids, and indeed the only Arthropods (except a few Myriapods), which have exclusively laminate tracheæ. The laminate tracheæ of the Myriapods cannot possibly be deduced from the laminate tracheæ of the Arachnids, but both forms of laminate tracheæ can be deduced from a primitive tubular organ.

Returning to the diagram, the facts therein epitomised presuppose the existence in the ancestor of the group of simple limbs on every segment. In addition to the six pairs of limbs on the first six segments, clear traces of limbs are well known either in a persistent or a vestigial disappearing form on the first six abdominal segments. Further, we can conclude from the stigmatic scars on the Chernetidæ, that there must originally have been limbs on all the remaining segments of the abdomen. The character of these limbs may perhaps be gathered from those of the nymphs of many Acaridæ, which probably represent the earliest developmental stages in the Arachnida now traceable, and perhaps also from the legs of the Silurian Scorpion, *Palæophonus nuncius*.

We can thus trace the Arachnids back to a segmented ancestor with a pair of limbs and a pair of tracheæ on every segment—*i.e.* to an ancestral form resembling those of the Myriapoda and Hexapoda, but differing from these in having the rows of stigmata ventral instead of lateral, apart, of course, from the profound difference in the specialisation of the oral appendages.

Among the later modifications of this primitive Arachnid we have the differentiation of the body into the cephalothorax and the abdomen. The former consists of the first six segments which have retained their limbs. The segments of the latter have lost their limbs almost completely, rudiments, however, persisting as genital opercula, pectines, and spinning mammillæ. In the former the great development of limbs and musculature and the fusing of the segments together has led to a general suppression of the tracheal invaginations. One pair, however, persists in the Galeodidæ, *which, with the exception of Schizonotus, are alone among Arachnids in retaining the original jointing of the posterior cephalothoracic segments*, and in the Acaridæ and Phalangidæ, in both of which the abdominal region is not fully developed.

The second and third segments appear to be the only ones on which hitherto no traces of stigmata have been found. This may be due to the fact that in the formation of the mouth parts the first three segments early fused together.

The general disappearance of tracheæ from the cephalothorax

1 "The 'Head' of Galeodes," &c. *Zool. Anz.* No. 426, 1893.
2 "Notes on the Chernetidæ." *Linnean Society's Journ.* (in press).

necessarily confined the respiratory organs to the abdominal region. Further, those on the anterior segments of the abdomen would be gradually preferred for specialisation, as being nearer to the cephalothoracic musculature, and to the shelter of the limbs for the protection of the open stigmata. The Scorpionidæ alone, having highly developed musculature in the posterior abdominal segments, have the respiratory invaginations nearly evenly distributed along the middle of the abdominal region.

On the diagram I have further indicated a few suggested homologies. I have elsewhere[1] brought forward evidence in favour of the derivation of tracheæ from setiparous glands. The derivation of poison and spinning glands from similar structures is generally admitted. The consequent homology between the spinning glands and tracheæ requires a slight modification. When, as in the Hexapoda, most Myriapoda, and the Arachnida, the tracheæ are strictly segmental, and intimately associated with limbs, they have probably arisen from the large bristle sacs which secreted the specialised parapodial acicula; spinning glands, on the other hand, are more generally to be deduced from groups of ordinary bristle sacs, although they may also be deduced from acicular glands as well. It is important to bear this qualification in mind, as it helps to throw light on a difficult point in the morphology of the Araneids. While the two pairs of spinning glands on the two pairs of mammillæ are referable to setiparous glands on rudimentary limbs, and probably homologous with tracheæ, there are also, in the majority of spiders, median spinning glands between the mammillæ, which cannot be brought into connection with any rudimentary limbs. This difficulty is, however, fully explained by the position of the abdominal cement glands in the Chernetidæ, which serve to stick the eggs to the abdominal surface, in which position they are carried about by the parent. In these animals we have, on the second and third abdominal segments, median glands (originally paired) occurring *between* the two pairs of tracheal invaginations. In this case I should refer the tracheæ to acicular glands, and the cement glands on the same segment to groups of setiparous glands lying ventrally to the acicula. In the genus Galeodes, rows of short powerful bristles actually occur in the corresponding position, *i.e.* close to the median line on the second and third abdominal segments, and form the stigmatic combs, which are quite distinct from the stigmata themselves. According to this derivation we might have two pairs of spinning glands on each segment, one pair placed laterally on mammillæ, and one pair close to the median line between the mammillæ. This arrangement is actually found in tbe rare spider Liphistius, which has four pairs of spinning glands arranged as here described. This is especially interesting, because in addition to other primitive features Liphistius is alone among known spiders in retaining at least nine distinct abdominal tergites.[2]

The facts and suggestions here briefly set forward are a small instalment of the results obtained during my researches on the comparative morphology of the Galeodidæ, which I hope shortly to have ready for publication. I may, perhaps, add that the net results of these investigations go far to establish that classification which ranks the Arachnids as an independent group of the tracheate Arthrpodos, as distinguished from that which would deduce them from the specialised Crustacean Limulus through the specialised Arachnid Scorpio.

Huxley Research Laboratory. H. M. BERNARD.

THE PRESENT STANDPOINT OF GEOGRAPHY.

MR. CLEMENTS R. MARKHAM, C.B., F.R.S. inaugurated the evening meetings of the new session of the Royal Geographical Society, on Monday night, by a presidential address on the present standpoint of geography. He gave a survey of the state of our actual knowledge of the earth's surface, and pointed out the regions where exploration may still be done. Viewing exact delineation by trignometrical measurement as the crowning work of geography, he pointed out how incomplete the exact mapping of the land surface of the globe still was, while the delineation of the bed of the ocean had hardly been begun. In the Polar regions, of course, lay the greatest unknown areas, and the two expeditions now in the field, Nansen's and Peary's, were referred to with some confidence as to their probable success. Mr. Markham himself believed that land exists between Prince Patrick Island and Siberia, which ought to be discovered, and was inclined to accept Lieut. Hovgaard's theory of extensive land north of Cape Chelyuskin. He indicated the delineation of the north coast of Franz Josef Land as one of the more important pieces of Arctic work for the near future. Consideration of the vast Antarctic field was postponed until Dr. Murray's paper at the next meeting.

In Europe there remained scope for detailed survey in many countries, and Mr. W. H. Cozens-Hardy's recent labours on the frontiers of Montenegro are only a foretaste of what has to be done in the Balkan Peninsula. The Cantabrian mountains on the west, and the Caucasus on the east, contain still many isolated unknown patches.

In Africa the unknown had been diminishing within his memory more rapidly than anywhere else, and the days of suddenly-planned expeditions discovering features of the first magnitude had altogether passed. What remain unknown are two great areas in the Sahara, in the Tibesti, and Ahaggar highlands, the negro kingdom of Wadai, and the region stretching from Southern Abyssinia into the Somali Peninsula. In countless places detailed work has to be done, such as Dr. Gregory's study of Mount Kenia, and Mr. Scott-Elliot's similar detailed survey of the Ruwenzori region, just undertaken. The best future work for geography in Africa lies in surveying rather than exploring, and lines of survey should be run across the continent in defined and well-thought-out directions.

Asia has also new ground to break into. The valleys of Hadramant, in Arabia, are almost as little known as the Antarctic regions, and Mr. and Mrs. Bent will shortly endeavour to explore that district. In Asia Minor and Persia much detailed surveying must be done. In Central Asia there is Lhassa, unvisited by an Englishman for generations, and a vast region in north-western Tibet, between 34° and 36° N., and 82° and 90° E. is a blank upon our maps, in spite of the magnificent journeys recently made by Bower, Rockhill, and the Russian explorers. Nearer India, Nepal is little known; Kafiristan is absolutely secluded from the European, and there could be no nobler ambition for a young geographer than to be the first to explore Kafiristan. The maze of mountain ranges and river valleys east of the Himalayas has yet to be unravelled, and the whole interior of Indo-China is full of opportunities for research. Korea, in the far east, is yet far from being fully known. The great Malay Archipelago must receive much more attention, and the problems of western New Guinea alone, with the grand range of the Charles Louis mountains, are well worthy of being seriously attacked. Upraised coral atolls in the Solomon Islands have been reported but not visited. As regards new discovery, however, there is probably no undiscovered islet remaining in the whole Pacific.

Australia, except some desert patches in the west, has been practically explored, although immense areas have still to be surveyed, and the development of colonial geographical societies gives good promise of that continent being thoroughly studied from within.

In North America, Dr. George Dawson enumerates a number of great stretches of land, aggregating several hundred thousand square miles, absolutely untraversed by any intelligent white man. These lie mainly north of the Arctic circle, between the great rivers that flow into the Arctic Sea and in Labrador. Alaska also has its unknown tracts, and even in the United States there is much room for detailed surveys.

Central America is not well known, and in South America much of the Colombian Andes, the basins of the Japura and Putumayo, the whole tract between the Andes and the Orinoco and Rio Negro, are practically unknown. In Peru whole provinces are unexplored, and many peaks unmeasured.

Oceanography is only beginning to yield results, and other departments of generalised physical geography are of growing importance. The better instruction of intending travellers, inaugurated by the Society, and carried out by Mr. Coles, has done much to confer value on the observations of officials, traders, and missionaries, while the more thorough study of theoretical geography, now beginning, requires great extension and elaboration before its work would be thorough.

[1] *Zool. Jahrb.* vol. v. p. 511, and *Ann. and Mag.* January, 1893.
[2] *Cf.* "Liphistius," R. I. Pocock, *Ann. and Mag. N. H.* October, 1892.

SOME LABORATORIES OF MARINE BIOLOGY.

THE description of some of the Marine Biological Laboratories of Europe, contributed by Mr. Bashford Dean to the *American Naturalist* for July, and reprinted in NATURE, August 24, was continued by the author in the August number of our transatlantic contemporary. Some of the most important laboratories were omitted in the first article, but they are included in the second, from which the following account has been taken :—

"The Stazione Zoologica at Naples during the past twenty years has earned its reputation as the centre of marine biological work. Its success has been aided by the richness of the fauna of the Gulf, but it is due in no small degree to careful and energetic administration. The director of the station, Prof. Dohrn, deserves no little gratitude from every worker in science for his untiring efforts in securing its foundation and systematic management. Partly by his private generosity and partly by the financial support he obtained, the original or eastern building was constructed. Its annual maintenance was next assured by the aid he secured throughout (mainly) Germany and Austria. By the leasing of work tables to be used by representatives of the universities, a sufficient income was maintained to carry on the work of the station most efficiently. A gift by the German government of a small steam launch added not a little to the collecting facilities."

After commenting upon the attractiveness of the Naples station, and the general air of quietness which results from the excellent system that prevails in every branch of the station's organisation, Mr. Dean goes on to describe the aquarium room, which is lighted only through wall-tanks. "There are in all about two dozen large aquaria embedded in the walls of the sides and of the main partition of the room. The water is clear and blue. The background in each aquaria, built of rockwork, catches the light from above and throws in clear relief the living inmates."

"There is no more interesting department of the station than that of receiving and distributing the material. . . . Neapolitan fishermen have learned to bring all of their rarities to the station. The specimens are quickly assorted by the attendants; such as may not be needed for the immediate use of the investigators are retained and prepared for shipment to the universities throughout Europe. The methods of killing and preserving marine forms have been made a most careful study by Cav. Lo Bianco, and his preparations have gained him a world-wide reputation. Delicate jelly-fish have to be preserved distended, and the frail forms of almost every group have been successfully fixed. The methods of the Naples station were kept secret only until it was possible to verify and improve them, as it was not deemed desirable to have them given out in a scattered way by a number of investigators."

There are at present two American tables at Naples, one supported by the Smithsonian Institution, and the other by gift of Agassiz.

"The entire Italian coast is so rich in its fauna that it is due perhaps, only to the greatness of Naples, that so few stations have been founded. Messina has its interesting laboratory well known in the work of its director, Prof. Kleinenberg. The Adriatic, especially favourable for collecting, has at Istria a small station on the Dalmatian coast, and at Trieste is the Austrian station. Trieste possesses one of the oldest and most honoured of marine observatories, although its station is but small in comparison with that of Naples, Plymouth, or Roscoff. Its work has in no small way been limited by scanty income; it has offered the investigator fewer advantages, and has, therefore, become outrivalled. During a greater part of the year it is but little more than the supply station of the University of Vienna, providing fresh material for the students of Prof. Claus. Its percentage of foreign investigators appears small; its visitors are usually from Vienna and of its university."

Dr. Graeffe is the director of this station. With regard to laboratories of marine biology in Germany, Norway, and Russia, Mr. Dean says :—

"The German universities have contributed to such a degree to the building up of the station at Naples that they have hitherto been little able to avail themselves of the more convenient but less favourable region of German coasts. The collecting resources of the North Sea and of the Baltic have perhaps been not sufficiently rich to warrant the establishment of a central station. On the side of the Baltic, the University of Kiel, directly on the coast, may itself be regarded a marine station. At present the interest in founding local laboratories has, however, become stronger. At Plön, not far from Flensburg, is established a small station under the directorship of Prof. Zacharias, and the first number of its contributions has recently been published. In addition the newly-acquired Heligoland has become the seat of a well-equipped Governmental station, under the directorship of Dr. R. Heincke. The island has been long known as most favourable in collecting regions, and its position in the midst of the North Sea fisheries gives it especial importance.

"Norway, like Germany, is strengthening its interest in local marine laboratories. It has succeeded in establishing two permanent stations, one near Bergen, the other, most recently, on an out-jutting point of the North Sea almost westward of Christiana. The former is interested especially in matters relating to the North Sea fisheries, and is supported partly by the contributions of a learned society and partly by a subsidy from the Government in view of its relation to the practical fisheries. The second and smaller station is devoted almost exclusively to research in morphology. It is a dependency of the University of Christiana, and is under the directorship of one of its professors, Dr. Johan Hjört. With the richest collecting resources these new stations may naturally be expected to yield most important results.

"Russians have ever been most enthusiastic in marine research, and their investigators are to be found in nearly every marine station of Europe. The French laboratory on the Mediterranean at Ville Franche, as has previously been noted, is supported essentially by Russians. At Naples they are often next in numbers to the Germans and Austrians. The learned societies of Moscow and St. Petersburg have contributed in no little way to marine research. The station at Sebastopol on the Black Sea has become permanent, possessing an assured income. That near the convent Solovetsky on the White Sea, though small, is of marked importance. It is already in its thirteenth year. Prof. Wagner, of St. Petersburg, has been its most earnest promoter as well as constant visitor. He in fact caused the Superior of the convent to become interested in its work and secured a permanent building by the convent's grant; he was then enabled by an appropriation from Government to provide an equipment. Its annual maintenance is due to the Society of Naturalists of St. Petersburg. The matter of the appointment of a permanent director for the summer months is now being agitated. The station Solovetskaia is said to possess the richest collecting region of the Russian coasts. It is certainly the only laboratory which has at its command a truly Arctic fauna."

The article concludes with a brief description of the Swedish zoological station on the west coast near Gothenberg. The station was founded by Dr. Regnell about fifteen years ago, and Dr. Hjalmar Theel is its present director. The students are mainly from the university of Upsala; indeed, no foreigners are admitted to it.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The accommodation for students in the Radcliffe Library has been improved by the removal of the sub-librarian's office to the room under the central tower and the provision of several new reading tables in the space thus created. But as the numbers of scientific students continue to increase, it is clear that some more extensive and permanent addition will very soon be necessary. The number of regular readers in the library this term is seventy-nine; ten years ago it was only thirty-one, and in the previous decade it was seldom that more than five or six students made use of the library in a single day. These figures give some idea of the gradual growth of scientific studies in the University. A proposal has been set on foot, which, if it is carried out, is likely to affect scientific studies in Oxford very beneficially. It is, that besides the existing means of obtaining a degree by examination, facilities shall be given for obtaining a degree for research in any recognised subject. It is proposed that a residential qualification of two years shall be imposed on any candidate for such a degree, and that evidence must be brought forward of continuous research and study, to the satisfaction of the board appointed for the purpose. At present the scheme has merely been brought before the Hebdomadal Council, and has, as yet, assumed no definite shape.

CAMBRIDGE.—The Local Examinations and Lecture Syndicate have presented to the Senate their twentieth annual report. The most important event of the year has been the establishment of the University Extension and Technical College at Exeter. The college has been established by the co-operation of the Town Council of Exeter, the University Extension Committee of Exeter, and the Syndicate, and Mr. A. W. Clayden, of Christ's College, has been appointed principal. The work done for County Councils under the authority of the Syndicate has been continued during the past year. There has been a considerable diminution in the area covered, as County Councils have been able to utilise to a greater extent than before the services of local teachers, and have spent a larger proportion of their available funds in grants in aid of permanent institutions for technical teaching. On the other hand, the reports received from lecturers indicate considerable improvement in the quality of the work done. About 650 students attended the summer meeting, of whom 150 were men and 500 women. On the whole the work done was satisfactory, though a certain number of students attempted too many subjects. It is not considered desirable to hold such meetings oftener than once in two years, but classes on a smaller scale may satisfactorily be held in the alternate long vacations. From Mr. Arthur Berry's report to the Syndicate it appears that the stimulus given to the work of the local lectures last year by the activity of the County Councils in the matter of technical education has lost a good deal of its effect, as more permanent institutions for educational purposes are gradually being organised. Not only have literature and history thus suffered, but courses on branches of science not of obviously practical utility (such as astronomy) have tended to be displaced by more "technical" subjects. It is satisfactory to learn that such engagements as have already been made for the ensuing winter indicate a distinct reaction against the exclusive study of "bread and cheese" subjects.

In resigning office on September 30, the late Vice-Chancellor, Dr. Peile, called attention to the lack of funds for research in several of the scientific departments. He is now able to announce that an anonymous member of the Senate has placed in his hands £100 for the support of higher work in the Pathological Department during the coming academical year.

A fire, which took place at the Pitt Press last week, has necessitated the temporary evacuation of the room occupied by the Registrar. The Old Library of Pembroke College has been placed at his disposal by the Master and Fellows, and the business of the office will be carried on there during the present term.

The scheme for examinations in agricultural science under a managing syndicate was non-placeted on November 9, but was carried by a very large majority. The proposal to postpone the conferring of Honours degrees to the Long Vacation, in order to give more time for the Tripos examinations, was rejected.

The *University Reporter* of November 14 contains notices of scholarships in Natural Science open for competition to non-residents at Peterhouse, Clare, Pembroke, King's Queen's, St. John's, and Sidney Sussex. The examinations will be held in December and January next.

TRINITY COLLEGE, DUBLIN.—There is during this term a large increase in the number of students interested in the study of biology; so large, in fact, that the accommodation in the Botanical Laboratory has had to be increased. This is a pleasing feature in a university so long devoted to classical pursuits.

At the recent Moderatorship Examinations, three candidates, C. J. Patten, F. K. Boyd, and N. H. Alcock, obtained Senior Moderatorships, and were awarded gold medals in Natural Science (Botany, Zoology, Geology, and Physiology). During the week the University Experimental Science Association held its opening meeting, when a very large audience assembled to hear Dr. Joly, F.R.S., deliver a lecture on "Some Applications of Photography." The Provost, Dr. Salmon, occupied the chair.

THE *British Medical Journal* says that steps are being taken to arrange for a deputation representing the university colleges in England to wait, shortly, upon the Chancellor of the Exchequer, to urge upon him the propriety of increasing the annual parliamentary grant. A sum of £15,000 has been granted annually since 1890, and when this sum was first placed upon the estimates, it was understood that the question would be reviewed at the end of five years. A Treasury Committee, consisting of Sir Henry Roscoe, Mr. George Curzon, Prof. Bryce, Mr. R. G. C. Mowbray, and Mr. W. J. Courthope, have reported recently in favour of the grant being doubled, pointing out that all educational work connected with science is increasing yearly in cost, and that the growth in the number of students and the enlargement of the teaching staff have contributed to strain the resources of the colleges.

SCIENTIFIC SERIALS.

Bulletin of the New York Mathematical Society, vol. iii. No. 1. (New York: Macmillan, October, 1893.)—A congress of mathematics and astronomy was opened at Chicago on August 21, and this number commences with Dr. Felix Klein's inaugural address. It is brief but not witty, and merely sketches some of the papers to be read, and closes with the remark that mathematicians must go farther than to form "mathematical societies." "They must form international unions, and I trust that this present congress at Chicago will be a step in that direction." Prof. T. H. Safford narrates briefly, in his remarks on "instruction in mathematics in the United States," the history of the noteworthy rise in the general standard of mathematical teaching within the last few years. Prof. Ellery Davis reviews four recent geometries, viz. those by Hopkins, Dupuis, W. B. Smith, and Halsted. Prof. Tyler analyses the papers read at the Chicago congress, and Prof. Waldo gives a brief account of the American Association meeting at Madison on August 16-23. Three pages of notes of mathematical doings, and eight pages of new publications follow. This last feature of the *Bulletin* is a very prominent and highly valuable one.

THE *American Meteorological Journal* for November contains an account of the second annual meeting of the American Association of State Weather Services, held in Chicago, on August 21-23, 1893. The meeting was well attended, and resolutions were adopted on various subjects, among which may be mentioned the issue of weekly crop bulletins. It was also recommended that the bottom of thermometer screens should be four and a half feet above the ground; this would make the thermometers about a foot higher than is recommended in this country. It is stated that experiments made during the past year prove the former elevation to give the best results.—Mr. C. E. Linney read a paper on the value of frost predictions, and the best method of making them locally. The author is of opinion that with a knowledge of the ordinary weather signs an observer can, by the aid of the wet and dry bulb thermometers, form a good idea of what minimum temperature to expect during the night.

IN the *Transactions of the Austrian Geological Survey* we remark an important communication, made by Mr. Friedrich Teller, "On the so-called Granite of the Bacher Mountains in South Steiermark." It seems that the familiar term, "granite of the Bacher," has been entirely misapplied. In the eastern part of these mountains the rock is granitic *gneiss*, forming a dome-shaped core beneath the crystalline schists; while the so-called granite in the western part is an intrusive *porphyrite*, younger than the whole series of schists and phyllites, and possibly of the same age as the porphyrite which penetrates Triassic and Jurassic strata in the neighbouring district.—Dr. A. Kornhuber gives the name of *Carsosaurus Marchesetti* to a new Saurian genus from the Karst district. It was found in the same cretaceous shales as Acteosaurus, a genus described thirty years ago by Hermann Meyer, and was erroneously thought to be merely a larger specimen of Meyer's genus.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, November 6.—M. Lœwy in the chair.—On Goubet's joint and its application to marine screw-propellers, by M. H. Resal. This is a mathematical investigation of the action of a joint capable of making the propeller act as supplementary steering gear, and of adapting it to submarine navigation. It is shown to possess several advantages over the similar American Clemens joint.—On a class of differential equations whose general integral is uniform, by M. Emile Picard.—Significance of the variety of organs in the gradation of vegetable species, by M. Ad. Chatin.—On a Nymphæa bed recently found and explored in the Aquitanian of Manosque, by M. G. de Saporta.—On equations of the second order with fixed critical points, and univocal correspondence between two surfaces, by M. Paul Painlevé.—On certain ordinary differential equations, by M. Alfred Guldberg.—On certain families of gauche cubes, by M. Lelieuvre.—On the nature of the reflection of electric waves at the end of a conducting wire, by MM. Kr. Birkeland and Ed. Sarasin.—Observations upon the preceding communication of MM. Birkeland and Sarasin, by M. H. Poincaré. This is an application of Maxwell's theory to the phenomena of propagation of energy into space round the end of a conducting wire along which electric waves are passing. It is shown that the deductions from the theory are in general accord with the facts observed.—On the measurement of coefficients of induction, by M. H. Abraham. The employment of a differential galvanometer in these measurements permits of an accurate determination within 1 per cent., and a reading to within 0·1 per cent. without much difficulty. The induced currents from a commutator regulated by a stroboscopic method are sent through one circuit of a differential galvanometer, the deflection being compensated by a continuous current derived from the same battery. The commutator is then stopped, and a current equivalent to the induced current is derived from the primary circuit through a resistance r, and sent through the secondary circuit, r being chosen so as to establish equilibrium in the differential galvanometer. Then this actual resistance r may be put equal to the fictitious resistance nM obtaining while induction was going on, and we have $M = \frac{r}{n}$ where M is the coefficient of mutual induction, and n the frequency of the commutator. The resistance r may be constituted by a standard ohm coil. M. Abraham has found by this method that the coefficient of mutual induction is reciprocal in the case of two circuits free from iron, but that this reciprocity is disturbed if they contain iron cores.—On vision of opaque objects by means of diffracted light, by M. Gouy. If an opaque and non-reflecting object is examined by means of a microscope or telescope, the object being placed in the path of a beam of light, the image is formed both by the rays following geometrical paths and by those diffracted by the outlines of the object. If the former are intercepted, the diffracted rays only form the image. This may be done by placing a small screen at the focus of the object-glass inside the telescope, so as to intercept the rays from a very distant source which converge there. The outline of the object is then seen as a thin bright line on a dark background, and with sufficient enlarging power this line is seen to consist of two, very close together, and separated by a very sharp black line. This black interval disappears on intercepting the diffracted rays either inside or outside the geometrical shadow, thus showing that it is due to the interference of these two beams. They possess a difference of phase of half a wave-length, and equal amplitudes. An arrangement such as this may prove useful when the outlines of an object require to be sharply defined.—On a new method of preparing methylamine and on the constitution of hexamethylene-tetramine, by MM. A. Trillat and Fayollat.—On the alkaline methyl-tartrates and ethyl-tartrates, by M. J. Fayollat.—Researches on the homologues of gallanilide; preparation of galloparatoluide, by M. P. Cazeneuve.—Experimental hereditary influences, by MM. Gley and Charrin.—On a phenomenon of inhibition in Cephalopoda; paralytic constriction of chromatophores, by M. C. Phisalix.—On the serial craniological continuity in the genus Lepus, by M. Remy Saint-Loup.—On the genus *Polydora* Bosc (*Leucodore* Johnston), by M. F. Mesnil.—The *Callibrachion*, a new reptile of the Permian of Autun, by MM. M. Boule and Ph. Glangeau.—On the glacial and erratic phenomena in the Cachapoal Valley (Andes of Chili), by M. A. F. Noguès. The phenomena of transport by water and glaciers have contributed to the formation of the erratic system in the valleys of the Chili Andes. There must have existed lakes or deep terrace ponds. The glaciers must formerly have descended further than they do at present, and at the Cachapoal they are actually retreating now.—An earthquake shock at Grenoble, by M. Kilian. This happened at 4h. 13m. 40s. A.M., Paris time, on November 5, in a direction from N. to S., and was recorded by the seismometer of the Geological Laboratory of the Faculty of Sciences.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—Social England: edited by H. D. Traill, vol. i. (Cassell).—New Technical Educator, vol. ii. (Cassell).—Guelphs and Ghibellines: O. Browning (Methuen).—Intensity Coils, 18th edition (Perken). The Magic Lantern, 2nd edition (Perken).—British Fungus Flora: G. Massee, vol. 3 (Bell).—Weather Lore: compiled, &c., by R. Inwards (Stock).—Les Courants Polyphases: J. Rodet et Busquet (Paris, Gauthier-Villars).—Pour Devenir Financier: R. Chevrot (Paris, Gauthier-Villars).—Golf: a Royal and Ancient Game: edited by R. Clark, 2nd edition (Macmillan).—Aberration Problems: Prof. O. J. Lodge (K. Paul).—Eighth Annual Report of the Bureau of Ethnology: J. W. Powell (Washington).—Diamonds and Gold in South Africa: T. Reunert (Stanford).—The Incandescent Lamp and its Manufacture: G. S. Ram ("Electrician" Co.).—Eine Botanische Tropenreise, Prof. Dr. S. Haberlandt (Leipzig, Engelmann).—Der Botanische Garten "'s Lands Plnutentuin" zu Buitenzorg auf Java (Leipzig, Engelmann).—Grundzüge der Physiologischen Psychologie: Prof. W. Wundt, Zweiter Band (Leipzig, Engelmann).—Die Allmacht der Naturzüchtung: Prof. A. Weismann (Jena, Fischer).—Australasia, vol. i.:—Australia and New Zealand: Dr. A. R. Wallace (Stanford).

PAMPHLETS.—Fenomeni Geodinamici che precedettero, accompagnarono e Seguirono l'eruzione Etnea del Maggio Guigno 1886, S. Arcidiacono.—Électro-Culture: P. de Puydt (Bruxelles).—Ethnography of the Aran Islands, Co. Galway, A. C. Haddon, and C. R. Browne (Dublin).—Bibliography of the Chinookan Languages: J. C. Pilling (Washington).—Catalogue of a Stratigraphical Collection o Canadian Rocks prepared for the World's Columbian Exposition, Chicago 1893: W. F. Ferrier (Ottawa).—Das Karstphänomen: Dr. J. Cvijic (Wien, Hölzel).—Die Biologie als selbständige Grund wissenschaft: H. Driesch (Leipzig, Engelmann).—Tafel des Integrals: B. Kämpfe (Leipzig, Engelmann).—On the Volcanoes and Hot Springs of India: Dr. V. Ball (Dublin).

SERIALS.—Kansas University Quarterly, October (Lawrence, Kansas).—American Journal of Science, November (Newhaven, Conn.).—Bulletins de la Société d'Anthropologie de Paris, Nos. 8 and 9, 1893 (Paris).—L'Astronomie, November (Paris).—Zeitschrift für Wissenschaftliche Zoologie, lvi. Band, 4 Heft (Williams and Norgate).—American Naturalist, October (Philadelphia).—Morphologisches Jahrbuch, 20 Band, 3 Heft (Williams and Norgate).—Physical Society of London, Proceedings, vol. xii. Part 2 (Taylor and Francis).—American Journal of Mathematics, vol. xv. No. 4 (Baltimore).—Proceedings and Transactions of the Queensland Branch of the Royal Geographical Society of Australasia, vol. 8 (Brisbane).

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