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THE COLOURS OF ANIMALS.

The Colours of Animals: their Meaning and Use especially considered in the case of Insects. By Edward Bagnall Poulton, M.A., F.R.S., &c. With Chromolithograph Frontispiece and Sixty-six Figures in Text. (London: Kegan Paul, Trench, Trübner, and Co., Limited, 1890.)

THIS new volume of the International Scientific Series gives an excellent summary of the most recent researches as to the varied uses of the colours of animals, and more especially of those admirable observations and experiments on variable protective colouring with which Mr. Poulton's name is associated, and which mark an era in this branch of natural history. The main outlines of the subject are so well known, both to naturalists and to general readers, that it will only be necessary here to indicate some of the more important of the matters now first treated in a popular work, and to make a few remarks on some of the more difficult problems discussed in the volume.

The first chapter gives a short but very clear statement of the physical cause of animal colours, and contains some valuable observations on the effect of thin films of air or of liquids in the production of iridescent colours. In some cases dried insects lose some of their metallic colours, but these reappear when the specimen is dipped in water. Even living beetles have been observed to lose their lustre after hybernation, and to regain it after drinking water. Then we have a sketch of the general uses of colour to animals, and it is shown that the frequent dark colour of arctic insects has probably a physiological use in enabling them to absorb as much heat as possible during the brief period of their existence under an arctic sun. This is supported by some direct observations; but the further suggestion that the white colour of so many arctic birds and mammals has also a physiological use in checking the loss of heat through radiation is less satisfactory. Not only is there no evidence to show that the loss of animal heat is at all influenced by the colour of the fur or feathers, but it is evident that the same result could be brought about by a very slight increase in the texture or thickness of the covering, such as actually occurs in all arctic animals. In the seventh chapter there is a very interesting discussion on the way in which the white winter coat of arctic animals is produced, and it is shown that in the American arctic hare the brown hairs of the summer coat turn white at the tips, while a quantity of new white hairs grow among them, producing at once the thickening of the coat for warmth and the change of colour for protection. That this last is the only function of the colour is well indicated by the case of the raven, which is found in the extreme north of the polar regions, even during the most intense colds of winter, wherever the reindeer and musk-sheep range. Yet it is here as black as elsewhere, although the occasional occurrence of pied and even of white ravens in various parts of Europe and America shows that a white race could be produced if that colour was of any advantage to the bird in its arctic habitat.

Two chapters are devoted to a subject which Mr. Poulton has made especially his own, the variable protective colouring of insects. This was first noticed by the late Mr. T. W. Wood, the well-known natural history artist who furnished many of the best illustrations for Darwin's "Expression of the Emotions in Man and Animals," and the result of his experiments were brought before the Entomological Society of London in 1867. Since then a few other observations have been made by several naturalists, but little was known of the extent or of the exact causes of the adaptation till Mr. Poulton carried out his experiments for several years in succession, and on so extensive a scale that in one year over 700 larvæ of the small tortoiseshell butterfly (*Vanessa urticæ*) were observed under various surroundings, and the colours of the resulting chrysalides recorded. In this way pupæ were obtained varying from black to nearly white or metallic golden colours, in each case corresponding more or less closely to the coloured surfaces on which they were suspended. By changing the coloured surroundings at different stages of the process, and by blinding some of the larvæ, it was ascertained that the period of susceptibility is the quiescent stage just before the change to the pupa state, and that in this case vision has nothing to do with the change of colour. By a number of ingenious experiments, it was ascertained that the whole surface of the skin is sensitive to the action of variously-coloured light, and the effect on the pupa-skin is produced, not directly, as by some photographic action, but by a physiological process acting through the nervous system. In some cases even the cocoons spun by the larvæ are modified by the surrounding colours; and still more curious changes are effected in the larva itself when, as in so many cases, the same species feeds on several plants having differently-coloured leaves. Even the presence of numerous dark twigs has been shown to cause a corresponding change of colour in the larva of the peppered moth (*Amphidasis betularia*). These two chapters afford a beautiful example of a very difficult and interesting inquiry leading to an explanation of some of the most curious colour-phenomena in the animal kingdom. Mr. Poulton points out the essential difference between this mode of colour-adjustment and that of the chameleon, and of some crustacea, frogs, and fishes, which can rapidly adjust their colours to new surroundings, in the following passage:—

"The essential difference between the two kinds of adjustment is that, in the one case, the pigmented part of certain cells contracts in obedience to nervous stimuli, and thus alters the general appearance; while in the other case the coloured part is actually built up of the appropriate tint, or loses its colour altogether and becomes transparent in obedience to the same stimuli. The frog or fish has a series of ready-made screens which can be shifted to suit the environment; the insect has the power of building up an appropriate screen. In many cases, however, the green colour of caterpillars is due to the ready-made colour of the blood, which becomes effective when pigment is removed from the superficial cells, but which disappears when the latter are rendered opaque. Here, however, the superficial cells form the screen which has to be built up, or from which the colour must be dismissed; and in certain species even the colour of the blood is entirely changed in the passage from a green to a dark variety, or *vice versâ*. Hence it is to be expected that the changes occurring in an insect will occupy a considerable time as compared with those which take place in a frog. Another difference between the two processes is that the stimulus from the environment falls upon the eye in the one case, and probably upon the surface of the skin in the other."

Mr. Poulton's work is of special importance for the numerous experimental proofs he gives of the protective value of many of the peculiarities in the colour markings or attitudes of insects. Thus the green lizard (*Lacerta viridis*) generally failed to detect a "stick caterpillar" in its position of rest, although the insect is seized and greedily devoured directly it moves. The value of the tufts of hair, called "tussocks," on many caterpillars was also proved experimentally.

"A caterpillar of the common vapourer moth (*Orgyia antiqua*) was introduced into a lizards' cage, and when attacked, instantly assumed the defensive attitude, with the head tucked in and the 'tussocks' separated and rendered as prominent as possible. An unwary lizard seized the apparently convenient projection; most of the 'tussock' came out in its mouth, and the caterpillar was not troubled further. The lizard spent a long and evidently most uncomfortable time in trying to get rid of its mouthful of hairs."

There is a most excellent account of the larva of the lobster moth (*Stauropus fagi*) which is protected by its marvellous resemblance to a withered beech-leaf and its stipules, and is also able to assume a terrifying attitude, when it resembles some large and strangely formed spider. When one of these larvæ had assumed the terrifying attitude, a marmoset monkey was much impressed by the alarming sight, and only ventured to attack after the most careful examination, and even then in the most cautious manner. A lizard exhibited the same caution before the larva was attacked. The same insect is also to some extent protected from ichneumons by two black marks, exhibited only when attacked, which resemble those produced by the stings of ichneumons, and thus prevent an attack, since these parasites always avoid larvæ which are already occupied.

Two chapters are devoted to an excellent account of the various forms of mimicry, a subject which, however interesting, has been so often treated that there is comparatively little new to be said upon it; and then we have two chapters on sexual colours, which will offer material for a few remarks, as the whole subject is full of difficulties, and requires much more observation and experiment before the problems it presents can be satisfactorily settled.

Mr. Poulton fully accepts Darwin's theory of female choice as the source of the greater part of the brilliant colour, delicate patterns, and ornamental appendages that exist among animals, and especially among birds and insects. Much stress is laid on the observations of two American writers on the courtship of spiders. These show that spiders resemble birds in the strange postures and long-continued antics of the male during courtship, and that he always exhibits whatever portion of his body is most conspicuously coloured.

"The female always watches the antics of the male intently, but often refuses him in the end, 'even after dancing before her for a long time.' Such observations strongly point towards the existence of female preference based on æsthetic considerations."

To the last four words we demur, as being altogether unproved. Why *æsthetic* considerations? Why not a deficiency in activity, or in size, or in some exciting odour, or in the excitability of the female at the moment? Any of these causes, or others unknown to us, may determine the acceptance or rejection of a male spider; and it is to be noted that the long-continued and careful observations of these American authors have not enabled them to adduce a single case in which any deficiency of colour was observed in a rejected male. There is, indeed, one case in which two well-marked male varieties of a species exist—one red, the other black; and these assume different attitudes in courtship. Messrs. Peckham say: "the *niger* form, evidently a later development, is much the more lively of the two, and whenever the two varieties were seen to compete for a female, the black one was successful." On this Mr. Poulton remarks: "It must be admitted that these facts afford the *strongest support* to the theory of sexual selection"; but there is not a particle of proof that the black colour was the cause of the selection rather than the "superior liveliness" which all breeders of animals believe to be the most attractive characteristic a male can possess.

Mr. Poulton speaks continually of the possession of an "æsthetic sense by those creatures in which sexual ornament occurs, but no proof whatever of this is given, other than the fact that insects do recognize diversities of colour, and that a few birds collect bright objects, as in the case of the bower-birds. This habit, existing in a few species only of one of the highest groups of birds, can hardly be held to be a proof that in all birds, even in such comparatively low types as ducks and Gallinaceæ, slight variations of colour in the male determine the choice of the female.

This æsthetic sense is supposed to exist even in insects, and some very doubtful facts are alleged in support of this view. It is stated that if all the brightly-coloured butterflies and moths in England were arranged in two divisions, the one containing all the beautiful patterns and combinations of colours, the other including the staring, strongly-contrasted colours and crude patterns, we should find that the latter would contain, with hardly an exception, the species in which independent evidence has shown, or is likely to show, the existence of some unpleasant quality. The former division would contain the colours displayed in courtship and when the insect is on the alert. And it is added that there is an immense difference between the two divisions—the one most pleasing, the other highly repugnant, to our æsthetic sensibilities, because the pleasing colours have been determined by the insect's sense of what is *beautiful*, the displeasing colours by the need for what is *conspicuous* to a vertebrate enemy. If there is, indeed, any such great and constant difference due to these causes, it must exist in all countries, and in all groups where these causes have come into play; but it is very doubtful whether any such difference does exist. In looking over a general collection of butterflies few would decide that the Danaidæ, Acræidæ, and Heliconidæ showed any deficiency in beauty and harmony of colour; yet they are preeminently the groups in which warning colours are predominant. So, also, the American and Eastern sections of the genus Papilio which are both subjects of mimicry and have all the other characteristics of protected groups with warning colours, are all exquisitely beautiful, with their rich green or crimson spots on a velvety black ground. And if we turn to birds, in which, as there are no known warning colours, all that are not protective are supposed to be due to sexual selection, we find, among much that is beautiful, great numbers of the harshest contrasts and most inharmonious combinations of colour that it is possible to conceive. Such are the blues and yellows and reds of the macaws and of a great number of other parrots; the equally harsh colours of the barbets and the toucans; the contrasted blue and purple or magenta and black of many of the chatterers. In many of these, no doubt, the texture of the surface is so delicate and the colours so bright and pure that we cannot but admire the tints themselves, although it is impossible to claim for the mode in which they are combined even the rudiments of æsthetic beauty. On the other hand, we find really beautiful combinations of colour and marking where sexual selection has certainly not come into play. Such are the exquisite tints and patterns of the cones, cowries, olives, harps, volutes, pectens, and innumerable other molluscan shells; while many of the sea-anemones, and considerable numbers of the caterpillars with warning colours, are equally beautiful.

Still more doubtful and more opposed to reasonable probability is the statement that "our standards of beauty are largely derived from the contemplation of the numerous examples around us, which, strange as it may seem, have been created by the æsthetic preferences of the insect world"—alluding, of course, to the colours and structures of flowers as being due to the need of attracting insects to fertilize them. Here objection may be taken, first, to the term *preferences* as applying to mere beauty in the flower, and still more emphatically to the term *æsthetic*, which there is not a particle of evidence for believing to enter at all into an insect's very limited mentality. Insects visit flowers wholly and solely, so far as we know, to obtain food or other necessaries of their existence, and every fact connected with the colours of flowers can be explained as due to the advantage of conspicuousness amid surrounding foliage, and distinctness from other flowers which are especially suited to different species of insects. When cows and horses refuse to eat the acrid buttercup, we do not say that the glaring yellow colour is repugnant to their æsthetic sensibilities, and that their dislike to the plant as food is the result; yet this would be less improbable than that bees and butterflies have any admiration of or liking for flowers independent of the supply of their physical wants. Moreover, a large part of the beauty *we* see in flowers is independent of colour, and is due to the graceful forms of individual flowers, their elegant groupings, and their charming contrast to the foliage which surrounds them. We now know that much of the variety in the form and position of flowers is dependent on their own physical needs, the protection of the pollen and the germ from rain, wind, or insect enemies, and that it has been produced by natural selection acting under the limitations due to the fundamental laws of vegetable growth. The purity and intensity of the colours are due to the fact that such colours offer a greater contrast to the ever-varying tints of foliage, twig, and bark, seen under constant modifications of light and shade, than would be offered by more sober hues; and thus it is that flowers usually exhibit the purest and brightest colours, which, combined with their elegant or curious forms, and the exquisite setting of green foliage which surrounds them, produce a general effect which is to us inexpressibly charming. But we have no reason to believe that any of the lower animals are affected in the smallest degree by these truly æsthetic feelings, and the use of the term as applied to them is simply begging the question, and is, therefore, not scientific.

It is because Mr. Poulton himself admits that the theory of sexual selection is still to some extent *sub judice* that the preceding remarks have been made in the way of protest against the use of terms which themselves tend to prejudge the case. In his chapters on this subject he has brought many arguments in its favour, some of which are ingenious and novel; but they all appear to rest on very slender evidence or to admit of another interpretation. They will, however, be useful as an incitement to further observation on this most interesting question, which, in all probability, will not be finally settled by the present generation of naturalists.

The book is well illustrated by numerous excellent woodcuts and a coloured plate, and there appear to be few if any misprints, the only one calling for remark being the placing of the cut at p. 34 upside down, so that the resemblance to a catkin is lost. Mr. Poulton is to be congratulated on having produced so readable and suggestive a volume on one of the most attractive departments of natural history, and on having by his own researches contributed so largely to the solution of some of the more interesting problems which it presents.

ALFRED R. WALLACE.

A HAND-BOOK OF ASTRONOMY.

Hand-book of Astronomy. Parts II. and III. By George F. Chambers, F.R.A.S. (Oxford: Clarendon Press, 1890.)

IN commenting upon the first part of this revised edition of Mr. Chambers's "Descriptive and Practical Astronomy," we pointed out the utter insufficiency of the portion devoted to the study of the sun, inasmuch as it left solar spectroscopy altogether out of consideration. Such an arrangement is a breach in the continuity of scientific inquiry, and a grievous fault in a hand-book that makes some pretence to give facts in historical sequence.

The second volume deals with instrumental and practical astronomy, and in it we find spectroscopical astronomy interpolated; the work that has been done in this direction following the description of the instruments employed. This circumstance, however, at once exhibits an inconsistency, for, if spectroscopy properly follows a description of the spectroscope, then telescopy should follow a description of the telescope; whereas in the former volume the aspects of the heavenly bodies were described, and in this the instruments by means of which they are observed.

A cause for the omission of all spectroscopic information from the sections to which it respectively and properly belongs, and its relegation to a couple of chapters in another volume, would be difficult to find. To these chapters, however, for which Mr. Maunder, of Greenwich Observatory, is made responsible, all matters spectroscopical have been referred, and so far as space permitted, Mr. Maunder has furnished a very comprehensive summary of the subject he had in hand; hence it may be that Mr. Chambers has acted wisely in intrusting the discussion of spectroscopic labours to a practical man. But the first duty of the compiler of such a volume as the one before us is to chronicle facts without comment or bias, and to lay before his readers the conclusions that have been drawn from them, leaving them to stand or fall on their own merits. This, however, has not been done; many observations are introduced with disparaging remarks, and conclusions deduced from them are said to be "most ingenious, but far from satisfying," without any evidence being adduced of their fallacy.

We also note that the sequence of spectra observed in comets as they approach to or recede from the sun, and supporting the meteoritic origin of these bodies, is mildly objected to. The shift in the position of the citron comet band, which admits of a ready explanation when the masking effect of the first flutings of manganese and lead is considered, is questioned, and the sequence is said to be

"partly founded on discrepancies as to the positions of some of the bands, which may prove to be significant but which, more probably, are simply due to the difficulties of observation, and partly to the fact that the yellow band of the carbon series in cometary spectra does not always show the same exact correspondence with the carbon band as do those in the green and blue. In particular, it shows at times two or more maxima within its borders, and its redward edge is rather diffused. The positions of these maxima are variously given, but appear to be about 5570 and 5450. There are not a few instances, also, in which this yellow, or, rather, citron, band has been recorded as having its sole maximum at one or other of these wave-lengths. Lockyer ascribes these divergences to the influence of the flutings of manganese and lead, but, bearing in mind the great difficulty of many of these observations, and that the citron band is much the faintest of the three, it seems scarcely safe at present to draw such an inference."

It is here acknowledged that the citron comet band has not a fixed position in the spectrum, and that its appearance is not always the same. Whether it is safe to conclude that the two maxima at λ 557 and λ 545 are due respectively to the flutings of manganese (558) and lead (546), it is not now our place to discuss. Since, however, the shift is real, it is hardly scientific to assert that the measures of its wave-length given by various observers are discrepancies of observation. Again, it is to be regretted that in the survey of cometary spectra no mention is made of Dr. Huggins's important observations in 1866-67 of "a bright line between *b* and F, about the position of the double line of the spectrum of nitrogen," in the spectrum of each of two small comets that appeared in those years. This is also the position of the chief line in the spectrum of the nebulæ, and suggests the connection that exists between the two bodies.

The standard of excellence deemed necessary to establish a sequence in the spectra of comets, as they approach to or recede from the sun, has not been applied all through the work. We find a table showing in parallel columns the general agreement between the motions of stars in line of sight as measured by Dr. Huggins, Mr. Maunder, and at Rugby. To one unacquainted with instrumental difficulties, the motion of stars in line of sight would appear to be a quantity that may be determined with some accuracy; but to those who know the pitfalls, by far the greater number of such observations appear worthless, for the accuracy attained in the majority of measurements is not sufficiently fine to allow any reliance to be placed upon them. In many cases a star, according to observation, has been moving towards the earth at the rate of about 50 miles a second, whilst another observation, made, perhaps, two minutes afterwards, indicated that it was receding from the earth with the same velocity. It is hardly just, therefore, to select certain determinations and arrange them in parallel columns to demonstrate the efficiency of the method adopted. At the end of the discussion of these motions, a note occurs on Algol. It is shown that the satellite theory of this star's variability, propounded by Goodricke and developed by Pickering, is supported by the fact that observations of its motion in line of sight, may be divided into groups, which indicate that at one time it is approaching our system, and at another receding from it owing to its orbital velocity. With these results we have nothing to do; but, if we remember rightly, Prof. Vogel was the first to demonstrate the periodic shift of the F line towards the red and the violet end of the spectrum, and in a communication to the Berlin Academy he gave the elements of the orbit traversed. This being so, it is curious to find that Prof. Vogel's discussion of his photographs has been omitted, although some months intervened between the communication and the publication of this volume, whilst Mr. Maunder's later division of his grievously discrepant observations into groups has been included.

There are a few other points to which we would call the author's attention. In the portion devoted to chronological astronomy, the dates of the commencement of the seasons and their consequent lengths, are given for 1860, the corresponding dates for 1890 being inserted in a footnote. It would have cost but little trouble to substitute the latter times when bringing the book up to date, and no purpose is served by the present arrangement.

A new feature, and one to be commended, is the insertion of plans and specifications for small observatories; this will doubtless be appreciated by amateur astronomers, since the directions and measurements which accompany them are supposed to be such that any builder of ordinary intelligence will be enabled to undertake the construction. It was hardly necessary, however, to give the description and sketch of an observatory on the tower of a dwelling-house and surrounded by chimneys, such as that possessed by the author. The position is certainly not conducive to accurate observations, and the dome described appears to offer every opportunity for being lifted off by a high wind and deposited in the garden.

But although the first and second volumes of this work possess a few commendable features, the third volume has none. It bears the mark of hurried revision, and stands condemned as one of the most incomplete and incorrect productions of its kind. The title of the volume is "The Starry Heavens," and had it been written a quarter of a century ago might have contained most of the matter that is now given. In the face of this fact, which can be well substantiated, Mr. Chambers remarks, "The contents of the volume have been thoroughly revised and brought up to date, and when necessary extended and re-arranged;" yet the only reference to the important and increasing application of photography to the delineation of nebulæ is that in the case of the nebula in Andromeda: "Mr. I. Roberts has recently obtained photographs of this object which seem to combine the features exhibited by Sir J. Herschel in the engraving appended to his 'Outlines of Astronomy,' with the rifts recorded by Bond."

The curtness with which Mr. Chambers disposes of the long-exposure photographs which mark an era in the progress of astronomy is lamentable, and the comparison of them with previous observations is misleading, for the features shown in the engraving at the end of Sir J. Herschel's "Outlines" were never observed; and if Mr. Chambers has seen the photograph he must have noticed that Bond's rifts are considerably extended, and appear as divisions between masses of nebulous matter sweeping round the nucleus. At any rate a person who had not seen the photograph would scarcely be able to appreciate its beauty from the description.

We do not, of course, wish to say that, since photography has so considerably extended our knowledge of the structure of celestial species, all drawings of them should be discarded. The photographic plate only adds to their value because, by a cumulative effect, it grasps and renders manifest faint light which the eye alone can never appreciate; but this is such an important development that the hand-book in which nebulæ are described and their forms dilated upon without giving it full consideration must be stigmatized as terribly incomplete.

Again, the selection of drawings of nebulæ which Mr. Chambers made for the first edition of this work in 1867, and which is still retained, is not a happy one by the common consent of all observers; and we should have supposed that, since many elementary text-books contain reproductions of some of the photographs of nebulæ, a work of such pretensions as this, in which drawings of nebulæ may be counted by the score, would have had at least one photographic representation of their form to enrich its pages.

Also, with respect to the nebula in Andromeda, Mr. Chambers records: "Huggins has noticed the spectrum to be continuous (though cut off at the red end), and therefore, whatever it is seemingly, it is *not gaseous*." That the spectrum was observed by Dr. Huggins in 1864 to be crossed "evidently either by lines of absorption or by bright lines," and that it has been shown to have the same spectrum as that of a comet at a mean distance from the sun, are matters with which Mr. Chambers is apparently not acquainted. It is good to see it asserted, in an italicized expression however, that the nebula does not consist of gaseous matter.

Following the chapters devoted to star clusters, nebulæ, and the Milky Way, and making up the greater portion of the work, we find catalogues of naked-eye, red, variable, and binary stars, which may be found useful. The indexes to both volumes leave much to be desired; indeed, the author notes that they are not complete by themselves, and are designed for use in connection with the table of contents. The disadvantages of this division are obvious, since reference is rendered unnecessarily difficult, a circumstance which, in the eyes of those accustomed to use works of this character, detracts considerably from its merit. At the end of the third volume a general index to the whole work is inserted which is said to be comprehensive. In this we find the names given of all the minor planets, although in the vast majority of cases the cognomen of these unimportant bodies is only known to the discoverer, and to index them is an utter waste of space. The principle, however, of including what might have been omitted and of omitting what should have been included, seems to have been followed by Mr. Chambers through each of the three volumes. We should advise, therefore, that in the case of a future edition a more careful consideration of what constitutes astronomical progress should be made. If this were done, and the facts were arranged in a rather better order, the compilation would be more useful as a hand-book of astronomy.

ANNALS OF THE MUSEUM OF BUENOS AYRES.

Annales del Museo Nacional de Buenos Aires para dar a conocer los objectos de historia natural nuivos ó poco conocidos conservados en este establecimento. Por German Burmeister, Med. Dr., Phil. Dr., Director del Museo Nacional de Buenos Aires. Entrega decimasexta. (Buenos Aires, 1890.)

THE veteran man of science, Dr. H. Burmeister, of Buenos Ayres, continues to issue the "Annals" of the Museum under his charge with unfailing regularity, and now sends us a copy of the 16th part of this excellent serial. Upon the present occasion he deserts for a while his favourite subject of the fossil animals, which the Argentine Tertiaries produce in such countless abundance and of so strange a character, and gives us an account of a scientific expedition into Patagonia, recently carried out by his son, Sr. Carlos V. Burmeister, one of the assistant naturalists of the Museum.

The scientific staff of the expedition to Patagonia left Buenos Ayres in November 1888, and proceeded by railway to Bahia Blanca, and thence by diligence to Carmen on the Rio Negro, where the rest of the party was assembled. The next point attained was Trelew, the chief town of the Welsh settlement on the Rio Chubut, which is now connected by a railway, 70 kilometres in length, with Port Madryn on the Atlantic. By this route, various additional stores, forwarded direct from Buenos Ayres by steamer, were received, and the Expedition, being fully equipped, finally started for the interior of Patagonia on January 9, 1889. The route taken was up the valley of the Chubut until its junction with its tributary, the Rio Chico, whence the latter was followed to its source in the great Lake Colhue. Although the country surrounding this sheet of water is now utterly devoid of trees of any sort, this was certainly not the case in past times, as enormous trunks of fossil trees were observed on the shores of the lake. From Lake Colhue the Rio Singuer which flows into it was ascended, until a point was reached where this stream takes an abrupt bend to the north-west. Thence the route lay for many days through the unknown uplands of the interior, until the upper waters of the Rio Chico de Santa Cruz were struck in lat. 48° 55′ 15″ S., on the last day of February. Descending the Rio Chico de Santa Cruz, the Expedition reached Beagle Bluff at the mouth of the great Santa Cruz, on March 9. Beagle Bluff, we may remind our readers, was so named from H.M.S. *Beagle*, which visited the spot in 1834, and first explored the River Santa Cruz. Darwin, who accompanied the boats of the *Beagle* in their survey of this stream, came to the conclusion that the river-valley of the Santa Cruz was formerly a strait dividing South America right across at this point, like the Straits of Magellan do now further south (see Darwin's "Naturalist's Voyage," chap. ix.).

The interior of Patagonia traversed by Sr. Burmeister's Expedition appears to be almost deserted at the present time. No natives seem to have been met with between the Chubut and the Rio Chico de Santa Cruz until the lower part of that river was reached.

From Port Santa Cruz the Expedition returned northwards along the Atlantic coast to Port Deseado in lat. 47° 56′, and thence, ascending the river of the same name, rejoined their former route on the Rio Singuer.

Besides the accurate survey made during the expedition, a large number of photographic views were taken, a selection of which will be published subsequently. These will be of interest in connection with the question of the origin of the singular "basaltic terraces" of this country, of which Darwin gave us the first indication, and which are frequently referred to by Señor Burmeister. Large collections were also made in natural history, most of which await further examination. But articles on the mammals and birds obtained during the expedition are appended to the present Report. Most of these are referred to species already fairly well known, although an exception must be made in favour of *Canis griseus*—the smaller of the two native foxes of Patagonia, of which little, if anything, has been recorded since its accurate description by Dr. H. Burmeister was published some years ago. The remaining collections still to be worked out will probably be found to contain objects of greater rarity; but there can be no doubt that the Patagonian fauna, though of great interest, is rather meagre.

OUR BOOK SHELF.

The Triumph of Philosophy. By James Gillespie (Ealing: West Middlesex Printing and Publishing Co. 1890.)

THE author has endeavoured to correct the Copernican theory of astronomy, and propounds instead the Gillespian or true system of the universe, which asserts that the earth, as well as the sun, is fixed in space and all the stars revolve round it in a year.

One of the objections to the present arrangement reads as follows:—

"Can any man in his sober senses believe that the earth could fly through space at the rate of 1000 miles a minute. Would it not drive all the atmosphere either away from the earth or like the tail of a comet? Could the moon keep her constant path round the earth at 273,000 miles distant, if she (the earth) was flying at this terrific speed?"

To understand this argument, it is necessary to believe with Mr. Gillespie that gravitation has nothing to do with the motions of any of the heavenly bodies. In his words: "I admit gravitation on the earth, but it only extends a certain distance from the earth, and it is quite powerless at the moon's distance, otherwise the moon—if she has weight at all—would fall crash on to the earth."

The greater portion of the work is taken up with observations of Mr. J. B. Dimbleby, of the British Astronomical Society (*sic*). This gentleman, whose genius seems shrouded in obscurity, is styled "Transit Medallist, Professor of Chronology, first calculator of all eclipses and transits from Adam, and the discoverer of five lines of astronomical time." We give a short extract, in which some of his researches are referred to:—

"He has proved, by a long and by a true calculation, that the earth, the sun, the moon, Mercury, and Venus were all in one direct line at creation, and it is almost likely that the other planets were in the same position, and there they would stand like a team of racehorses till the Divine signal was given, and off they went each on his own course; and it has been proved by eclipses and transits, ancient and modern, that they have not varied a single minute since that great day."

It will be readily understood that to try to convince Mr. Gillespie of the unsoundness of his arguments would be the height of absurdity, since he has not even an elementary knowledge of physical laws. As in all similar productions, strong words and hearty abuse are indulged in to patch up weakness of argument; no one is disturbed by the tirade, however, and the Gillespian doctrine of the universe will doubtless pass away with Mr. Dimbleby and its originator.

Watch and Clock Making in 1889. By J. Trippling, F.R.A.S., &c. (London: Crosby Lockwood and Son, 1890.)

THIS little book consists of an account and comparison of the exhibits in the horological section of the French International Exhibition.

In England there is very little literature on this subject, but on the Continent, and in France especially, a great many works on it have been published. The chief textbook is that by M. Saunier, who has done much towards the elevation of the social position of watchmakers, and whose books are the standard works of reference on the Continent.

Twelve technical schools competed against one another at the Exhibition; great importance being attached to the technical teaching of this class of subject abroad. An excellent programme of the work which is done during the student's course is given by the author, and shows the method of teaching that is adopted.

Chronograph makers are next dealt with; of these there were twenty representatives, four being English. For performance, finish, and the number of instruments produced, England was awarded the palm. The tests which instruments of this kind have to undergo are more severe in England than in Switzerland, owing to the greater variation in temperature. For instance, one English chronometer went for twenty-eight weeks with a variation never exceeding 1·4 seconds; while a Swiss chronometer, cited as being an exceptionally good one, varied as much as 2·2 seconds in two weeks.

The next section treats of the manufacture of watches, and in this one hundred and fifty firms exhibited. This number was divided into two classes—"factory system" and "garret system"; the former consisting of those who manufactured them by using steam and hydraulic power for the output of the whole or part of the watch on the interchangeable system, the latter of those who still kept to the old mode of making them "under a system of subletting to small makers who work at their own homes."

Messrs. Rotheram and Sons, of Coventry, about the oldest and the largest firm of watch manufactures in England, headed the list, and seem to have had a fine display, theirs being one of the most striking exhibits in the Exhibition.

In the remaining pages the author gives an account of the merits and exhibits in the manufacture of clocks, turret clocks, tools, watch-cases, &c., concluding with a short summary.

On the whole, the British section seems to have fared very well, and to have held its own against foreign competition, and to those interested in the subject this work will afford a good insight into the present condition of watch and clock making.

The Harpur Euclid. Books V., VI., and XI. By E. M. Langley, M.A., and W. Seys-Phillips, M.A. (London: Rivingtons, 1890.)

THIS is an edition of Euclid's Elements revised in accordance with the reports of the Cambridge Board of Mathematical Studies and the Oxford Board of the Faculty of Natural Science.

The books dealt with are V., VI., and XI.

In most of the works on this subject Book V. is generally omitted, and only the definitions are learnt; but the authors have thought it advisable for the reader to acquaint himself with the terms used and with some of the theorems which are established in it. Although he is allowed to use these theorems as axioms, proofs are given depending on the definitions, the notation used being that recommended by De Morgan and adopted by the Association for the Improvement of Geometrical Teaching in its Syllabus and Elements.

Preceding Book XI. is a good and well worked out series of propositions on loci, harmonic division, similarity, maxima and minima; and a few miscellaneous problems, such as the nine-point circle, &c.

The proofs in Book XI. differ slightly from those ordinarily given in text-books, but are made shorter and perhaps clearer by the adoption of symbols.

The method throughout of dotting all construction lines is a great help to the reader, and is to be heartily recommended, the figures in Book XI. showing this off to advantage.

A large number of exercises are given here and there for the student to practise his ingenuity on.

The International Annual of Anthony's Photographic Bulletin, 1890-91. Edited by W. Jerome-Harrison and A. H. Elliott. (London: Iliffe and Son, 1890.)

THIS is the third volume that has been published of this most interesting Bulletin, and, glancing through its pages, we conclude that it is one of the best publications of its kind that we have come across. The articles, written in great part by men of acknowledged ability, contain a large amount of useful knowledge, forming a store of information from which workers in every rank of the art may obtain something that will interest them.

One of the chief features of the volume is the great increase in number of illustrations, which are printed by the various kinds of processes now available, and which show the advancement made in the application of photography for purposes of illustration.

The usual collection of tables is presented at the end. Among them may be mentioned Dr. Woodman's table of view angles, tables for the simplification of emulsion calculations, and tables of comparative exposures. The work concludes with a revised list of the Photographic Societies of the British Isles, British Colonies, America, and most of those on the Continent.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Discharge of Electricity through Gases.

IN the Bakerian lecture on "The Discharge of Electricity through Gases," in the last number of the Proceedings of the Royal Society, Prof. Schuster says:—"I do not see how the insulating power of air at the ordinary temperature is consistent with the presence of ions, however few in nnmber, for ultimately a diffusion to the electrodes and a discharge would necessarily take place. This seems to me to be fatal to J. J. Thomson's view of the disruptive discharge."

This statement implies a misconception of the theory of the electric discharge advanced by me in the *Philosophical Magazine*, June 1883, for there is nothing in the theory of the discharge there given which makes the presence of free ions in air at ordinary temperatures and pressures essential. I will quote two sentences from the paper to show what the theory is:—"In order to make the spark pass through an elementary gas, we have to decompose the molecules into atoms. Thus the stronger the connection between the atoms in the molecules, the greater the electric strength." "Chemical decomposition is not to be considered merely as an accidental attendant on the electrical discharge, but as an essential feature of the discharge, without which it could not occur."

The misconception has, no doubt, arisen from my using in the same paper the Clausius-Williamson hypothesis of the interchange of atoms among the molecules to account for the difference of pressure in different directions in the electric field. But this hypothesis is not essential to the theory of the *discharge* given in the paper, for on that theory the discharge does not take place until *ordinary* dissociation of the molecules is produced by the electric field. The existence or non-existence of the quasi-dissociation of the Clausius-Williamson hypothesis which does not produce any chemical effects, does not affect the theory of the discharge, though it does that of the inequality of pressure.

J. J. THOMSON.

Cambridge, July 19.

Birds and Flowers.

IN your note on Mr. G. F. Scott-Elliot's paper on this subject (NATURE, July 17, p. 279) you remark: "In accordance with the view of Darwin, but opposed to that of Wallace, Mr. Scott-Elliot believes that the identity of colour (an unusual shade of red) in the majority of ornithophilous flowers and on the breasts of species of *Cinnyris* is an important element in pollination by birds." There must be, I think, some misapprehension here. I am not aware that Darwin has anywhere referred to the colours of birds as being generally similar to those of the flowers they frequent. Mr. Grant Allen has done so in his work on "The Colour-Sense," and I have opposed his views in NATURE (vol. xix. p. 501), because he founds the resemblance on the theory of sexual selection, and because the facts do not support any such general relation. That such a relation does sometimes occur I have shown, by quoting Mrs. Barber in my "Darwinism" (p. 201) as to the scarlet and purple colours of a sun-bird being highly protective when feeding among the similarly coloured blossoms of the *Erythrina caffra*, which, at the time, has no foliage. I have also called attention (in the same work, p. 319) to the numerous flowers now known to be fertilized by birds, and to the numerous large tubular flowers of a red and orange colour in Chile and the Andes, which are apparently adapted to be fertilized by humming-birds. The general uniformity of colour would be advantageous as an indication of bird-flowers as distinguished from insect-flowers; but there is no similarity to the colours of the birds. Curiously enough, the common Chilian Eustephanus is green-coloured in both sexes, while its close ally in Juan Fernandez is red in the male. Yet the flowers it frequents in the island are not red, but mostly white and yellow (see "Tropical Nature," p. 272). It is evident, therefore, that the prevalent colours of the flowers do not determine the colours of the birds which frequent them, unless those colours are so predominant that a similar colour becomes protective, as is more generally the case in the scantily-wooded plains of South Africa than anywhere else.

ALFRED R. WALLACE.

Reduplication of Seasonal Growth.

FROM time to time instances of this in the case of foliage have been recorded by correspondents in the pages of NATURE. This year I have noticed not only an unusually early appearance of this in the development of new foliage-laden twigs, as in former years in the oaks, the hornbeams, the elms, and other forest trees; but, what is more rare with this somewhat exceptional summer, the fruit-trees seem to be expending their reserve energy in a second season of *flowering*. At this moment an apple-tree in my garden presents the curious sight of apple-blossoms side by side with apples more than half-grown, and a rowan-tree laden with nearly ripe fruit has a corymb of flowers on one of its higher boughs. The plum-trees have presented similar abnormal phenomena within the last week or two. The facts are of interest as pointing to considerable interference with the normal cycle of functional change by variations in environment.

Wellington College, Berks, July 18. A. IRVING.

Chimpanzees and Dwarfs in Central Africa.

PERHAPS Mr. Stanley or Surgeon Parke, if applied to, could throw some more light on the extraordinary statement made by Emin Pasha, recently referred to, which, if it be true, is the most important statement in the whole book.

It is probable that when Emin Pasha witnessed the torch-bearers, whether chimpanzees or young negroes or dwarfs, he was not alone, and, even though very short-sighted, he would have been able to verify his observation of the torch-bearing animals by reference to those near him. An experienced naturalist like Emin Pasha is not likely to have made the mistake Prof. Romanes thinks he did make—but it is possible.

Bearing in mind that a large ape is now undoubtedly acting as a signalman (under direction) on a railway at Natal, who can say what the limits of intelligence are in the tribes of Simians?

J. F.

The Perseid Meteors.

ACCORDING to Mr. Denning, the radiant of the famous Perseid meteor-shower (which, in his opinion, commences early in July) shifts night after night until about August 20, the principal change being an increasing R.A. The declination also increases, but more slowly.

I have some reason to think that the true explanation of the phenomena is that there are several radiants almost simultaneously in action, but which do not attain their maxima at the same data. For this reason I would ask those of your readers who are interested in the subject to watch these meteors carefully on the present occasion. W. H. S. MONCK.

Dublin, July 15.

P.S.—Mr. Denning's Catalogue in *Monthly Notices* for May suggests to me the existence of four radiants (each of some continuance) whose approximate positions are $6^\circ + 52^\circ$, $20^\circ + 57^\circ$, $32^\circ + 53^\circ$, and $44^\circ + 56^\circ$.

"Wind Avalanches."

SOME of the readers of Dr. Pernter's paper, "A Winter Expedition to the Sonnblick," may perhaps be interested by the following extracts from the *Alpine Journal* of June 1864. They are taken from a painfully interesting paper by Mr. Gosset, describing a fatal accident on the Haut-de-Cry in February of that year.

A party of six were crossing a wide *couloir*, "about 150 feet broad at the top and 400 or 500 at the bottom." The actual fall of the avalanche is thus described:—"Bennen advanced; he had made but a few steps when we heard a deep, cutting sound. The snow-field split in two about 14 or 15 feet above us. The cleft was at first quite narrow—not more than an inch broad. An awful silence ensued . . . broken by Bennen's voice: 'Wir sind alle verloren.' . . They were his last words. I drove my alpenstock into the snow, and brought the weight of my body to bear on it. . . . I turned my head to see whether Bennen had done the same thing. To my astonishment, I saw him turn round, face the valley, and stretch out both arms. (So in Dr. Pernter's paper, "Their advice is to throw oneself prostrate, with hands outstretched.") The ground on which we stood began to move slowly, and I felt the utter uselessness of any alpenstock. I soon sank up to my shoulders, and began descending backwards. . . . The speed of the avalanche increased rapidly, and before long I was covered up with snow. I was suffocating when I suddenly came to the surface again. I was on a wave of the avalanche, and saw it before me as I was carried down. . . . The head alone was preceded by a thick cloud of snow-dust; the rest of the avalanche was clear. Around me I heard the horrid hissing of the snow, and far before me the thundering of the foremost part of the avalanche. . . . At last I noticed that I was moving slower; then I saw the pieces of snow in front of me stop at some yards' distance; then the snow straight before me stopped. . . . I felt that I also had stopped, . . . but the snow behind me was still in motion; its pressure on my body was so strong, that I thought I should be crushed to death."

Mr. Gosset further remarks:—"The upper stratum of snow was eleven days old. . . . The snow was thawing, and the whole snow-field in a state of uncertain equilibrium. By cutting through the snow at the top of the *couloir* we cut one of the main points by which the snow of the two different layers held together. . . . The avalanche may have taken a minute to descend; I can give no correct estimation on this point."

The vividness of the above description, and its complete accord with Herr Rojacher's account given in Dr. Pernter's paper, will, I hope, excuse the length of the extracts.

Otham, Maidstone. F. M. MILLARD.

ON THE METEOROLOGICAL CONDITIONS OF DESERT REGIONS, WITH SPECIAL REFERENCE TO THE SAHARA.[1]

THE arid regions of the world are, speaking roughly, distributed in two bands north and south of the equator. They comprehend all inland drainage areas, or areas where the streams have no connection with the sea, which are also regions where evaporation is in excess of precipitation, for if the latter were in excess the water would rise till it could flow into the sea, as in the case of the great lake region of North America, and the area would no longer be one of inland drainage. The largest of the deserts, the Sahara, is about 3½ million square miles in area, and the area of all the deserts of the world together about 11,500,000 square miles. In other words, over one-fifth of the land of the world has no outlet for drainage to the sea, and in all that area evaporation is greater than precipitation. These areas correspond very closely with the regions of the world where the rainfall is less than 10 inches annually.

In no place in the world can there be found such enormous ranges of temperature as in these deserts. In the Sahara the temperature sometimes falls from 100° during the day to the freezing-point during the night, due to the great dryness of the atmosphere and to the radiation that takes place from the soil after the sun has set. These inland drainage areas correspond very much in their barometric phenomena. In all desert regions during summer all the winds blow in upon them. In winter the reverse takes place—the winds flow out of them, and that holds good both for the northern and the southern hemispheres. This occasions the low rainfall, for the great majority of these regions are more or less bounded by high hills. The winds arrive at the deserts over these hills, and the vapour is precipitated from the atmosphere by the hills, with the result that when the winds reach the interior regions there is nothing left to be deposited. If there are not hills all round any desert area, then, as in the case of Northern Asia, the winds pass from a colder to a warmer climate, and as they get to warmer regions they are able to contain more vapour, and, consequently, no rain is precipitated.

The author then gave an account of his own views and impressions as to the Sahara. When staying in May last in Algeria, he was anxious to make a trip to the desert, principally with the object of examining the sand and other deposits. During the *Challenger* expedition they had found in the bed of the Atlantic for a long distance

[1] Abstract of a Paper read by Dr. John Murray at the meeting of the Scottish Meteorological Society held in Edinburgh on July 14.

west of the African coast opposite the Sahara, and in the bed of the Indian Ocean to the south of Australia, small grains of red quartz sand, and they had found scarcely a trace of such in the sea-bed in any other part of the world. He suspected this quartz sand had been blown out from the Sahara in the one case, and from the Australian desert in the other.

In the south of Algeria he got a light carriage which could traverse the desert, such as was now in use for the post just established by the French to Tougourt, in the Sahara. Taking bedding and food with him, he first skirted a large area covered with salt, and then passed on through the long belt of oases which the French have planted on the way to Tougourt. Along this route numerous artesian wells had been sunk, and an abundant supply of water thereby obtained for the palm-trees which had been planted. There were now three companies in existence, who had dug artesian wells, and were planting thousands of palm-trees, with the view of getting a valuable return in a few years.

At Tougourt the real sandy part of the desert began, and he made excursions into it, with that town as his head-quarters. He exhibited to the meeting a specimen of the sand, of a light yellowish-brown colour, and exceedingly fine in the grains. There were a good many clay particles in it, and the quartz particles, which were also numerous, were identical with those they had got in the bottom of the Atlantic. There was no doubt that the winds from the desert carried the sand a long way out to sea. He had also examined the region geologically, and the formation of the rocks was entirely that of fresh water, and of Quaternary date.

The great majority of geographers and geologists had expressed the belief that the Sahara was an old sea-bed, but he was of opinion that it had never as a whole been covered by the sea since Cretaceous or Devonian times, and no part of it had been covered by the ocean since Tertiary times. All the assertions as to the discovery of shells rested upon one common species being found very rarely in one region of the desert. He thought that, owing to recent researches, the opinion as to the Sahara being an old sea-bottom was likely soon to disappear from our text-books. He considered that the features of the region had been produced by atmospheric conditions. The sand was the product of the disintegration of the rocks *in situ*, which engirdle the Sahara. The existing rock was not far below the surface, and, by digging down to it, the hard sandy particles were found embedded in the stone. The sun shone on the rocks, and they expanded. The sudden cooling at night broke them up, the wind carried away the smaller particles, and so continually the rocks were being disintegrated by means of changes other than water, although water perhaps had in times past played a greater *rôle* there than it did now.

There was a range of hills in the desert to the south 7000 feet high, and for three months in the year their summits were covered with snow. Descending the hills were river-courses, some of great length. Much of the region, he considered, had once been a large fresh-water lake. Speaking of the commercial aspect of the Sahara, he said it was difficult to go there without becoming enthusiastic about it. There seemed to be no limit to the amount of water that was to be got by sinking artesian wells. The head of the water must be a long distance away in the higher lands surrounding the desert.

The cultivation of palms was extending to an enormous extent, and the French expected to carry on their railway to Tougourt (at present nearly a week's journey from Algeria) in the next few years. The French were also hopeful that France would tap all the trade of the North Soudan across the Sahara, by making a railway across the desert. He did not think it was at all impossible to build and keep open such a railway. There was plenty of water to be had, and the sand never drifted to such an extent as to bury a railway. The climate, though very warm, was at the same time very healthy. If the French built the railway, they would then have no cause to complain about Britain remaining in Egypt.

WILLIAM KITCHEN PARKER, F.R.S.

WILLIAM KITCHEN PARKER was born at Dogsthorpe, near Peterborough, June 23, 1823, and died suddenly, of syncope of the heart, July 3, 1890. He was visiting his second son, Prof. W. N. Parker, at Cardiff, and, whilst cheerfully talking of late discoveries and future work in his favourite biological pursuits, he ceased to breathe. Accustomed to outdoor life, he was a true lover of Nature from the first; the forms, habits, and songs of birds, especially, he knew at an early age. Village schooling at Dogsthorpe and Werrington, and a short period at Peterborough Grammar School, prepared him for an apprenticeship, at 15 years of age, to Mr. Woodroffe, chemist and druggist at Stamford; and three years afterwards he was apprenticed to Mr. Costal, medical practitioner, at Market-Overton. At Stamford he studied botany earnestly, and used to persuade a fellow-apprentice to leave his bed in early mornings to go afield in search of plants. Both when living at his father's farm, and in his holidays afterwards, he kept many pet animals, and dissected whatever he could get, including a donkey and many birds. Of the latter he prepared skeletons; and of these he made many large drawings, at Market-Overton, which of late years he had some thought of publishing as an atlas of the osteology of birds. In 1844–46 he studied at King's College, London; and became student-demonstrator to Dr. Todd and Mr. (now Sir William) Bowman there. He also attended at Charing Cross Hospital in 1846 and 1847, and, having qualified as L.S.A., he commenced practice, in 1849, at Tachbrook Street, Pimlico; and soon afterwards married Miss Elizabeth Jeffery. His wife's patient calmness under all difficulties and trials was a true blessing to a man of Mr. Parker's excitable temperament; and her unselfish life and widespread influence for good are well known in and beyond the family circle. Unfortunately he was left a widower about four months ago. His family consists of three daughters and four sons. Of the latter, one is Professor of Zoology and Comparative Anatomy in the University of Otago, New Zealand; the second is Professor of Biology in the University College at Cardiff, South Wales; the third is an able draughtsman and lithographer; and the fourth has lately taken his diplomas of L.R.C.P. and M.R.C.S.

Mr. Parker had a good father, courteous and gentle by nature, conscientious, and earnest in business, who had worked hard to be able to give even his youngest son, Mr. W. K. Parker, "a start in life." From his placid and thoughtful mother he probably inherited much of his love of reading and his talent for learning.

Always energetic, in spite of constant ill-health, Mr. Parker enthusiastically carried on his medical work and his natural-history studies, especially in the microscopic structure of animal and vegetable tissues. Polyzoa and Foraminifera, collected on a visit to Bognor, and from among sponge-sand and Indian sea-shells, especially attracted his attention. Having sorted, mounted, and drawn numbers of these microzoa, he was induced, about 1856, by his friends W. Crawford Williamson and T. Rupert Jones, to work at the Foraminifera systematically. His paper on the *Miliolitidæ* of the Indian Seas (Trans. Micros. Soc., 1858), and a joint paper (with T. R. Jones) on the Foraminifera of the Norwegian coast (*Annals N. H.*, 1857) resulted; and the latter formed the basis of a memoir on the Arctic and North-Atlantic Foraminifera (Phil. Trans., 1865). With T. Rupert Jones, and afterwards with W. B. Carpenter and H. B. Brady, Mr. Parker, down to 1873, described and illustrated many groups and species of Foraminifera, recent and fossil (see C. D. Sherborn's "Bibliography of Foraminifera" for these papers and memoirs), thereby establishing more accurately a natural classification of these microzoa, determining their bathymetrical conditions, and therefore their value in geology. That he did not neglect anatomical research is shown by memoirs in the Proceedings and Transactions of the Zoological Society on the osteology (chiefly cranial) and systematic position of Balæniceps (1860), Pterocles (1862), Palamedea (1863), Gallinaceous Birds and Tinamous (1862 and 1866), Kagu (1864 and 1869), Ostriches (1886), Microglossa (1865), Common Fowl (1869), Eel (NATURE, 1871), skull of Frog (1871), of Crow (1872), Salmon, Tit, Sparrow-hawk, Thrushes, Sturgeon, and Pig (1873). In the meantime the Ray Society had brought out his valuable "Monograph on the structure and development of the Shoulder-girdle and Sternum in the Vertebrata" (1868); and his Presidential addresses to the Royal Microscopical Society (1872, 1873), and notes on the Archæopteryx (1864), and the fossil Bird bones from the Zebbug Cave, Malta (1865 and 1869), had been published. Subsequently the Royal Society's Transactions contained his abundantly illustrated memoirs on the skull of the Batrachia (1878 and 1880), of the Urodelous Amphibia (1877), the Common Snake (1878), Sturgeon (1882), Lepidosteus (1882), Edentata (1886), Insectivora (1886), and his elaborate memoir on the development of the wing of the Common Fowl (1888). In the "Reports of the *Challenger*" is his memoir on the Green Turtle (1880); and those on Tarsipes (Dundee, 1889), and the Duck and the Auk (Dublin, 1890), are his last works.

In former times a skull was taken as little more than a dry, symmetrical, bony structure; or, if it were the cartilaginous brain-case of a shark, it was to most a mere dried museum specimen. When, however, the gradations of the elements of the skull, from embryonic beginnings, were traced until their mutual relations and their homologues in other Vertebrates were established, light was thrown on the wonderful completeness of organic uniformity and singleness of design. How such studies can be carried on both by minute dissection and the modern art of parallel slicing, and not by one method alone, is to be gathered from his teaching.

Mr. Parker was elected a Fellow of the Royal Society in 1865, and in the year following he received a Royal Medal for his comprehensive, exact, and useful researches in the developmental osteology, or embryonal morphology, of Vertebrates. Some few years afterwards the Royal Society gave him an annual grant to aid in the prosecution of his studies; and, when that was discontinued, a pension from the Crown was graciously and appropriately awarded to him. A generous friend, belonging to a well-known Wesleyan family, more than once presented £100 towards the cost of some of the numerous plates illustrating his grand memoirs in the Philosophical Transactions.

In 1873 he received the diploma as Member of the Royal College of Surgeons, and was appointed Hunterian Professor, Prof. Flower being invalided for a time; and afterwards both held the Professorship conjointly. His earnestness and wide views were well appreciated, opening up the modern aspect of comparative anatomy, and showing that both in Man and the lower Vertebrates the wonderful structural development of their bony framework should be studied in a strictly morphological rather than a teleological method, and that its stages and resultant forms could be regarded only in the Darwinian aspect.

These lectures, given in abstract in the medical journals, became the basis of his "Morphology of the Skull," in writing which, from his dictation and notes, Mr. G. T. Bettany kindly assisted him; and again, in a semi-popular book, "On Mammalian Descent," another friend (Miss Arabella Buckley, now Mrs. Fisher) similarly helped him. In the latter work, his own usual style frequently predominates, full of metaphor and quaint allusions, originating in his imaginative and indeed poetic mind, fully impregnated with ideas and expressions frequent in his favourite and much-read books—Shakespeare, Bacon, Milton, some of the old divines, and, above all, the old English Bible.

Separating himself from the trammels of foregone conclusions, and from the formulated, but imperfect, misleading conceptions of some of his predecessors in Biology, whom he left for the teaching of Rathke, Gegenbaur, and Huxley, Prof. W. K. Parker earnestly inculcated the necessity of single-sighted research, and the following up of any unbiassed elucidations, to whatever natural conclusion they may lead. Simple and firm in Christian faith, resolute in scientific research, he felt free from dread of any real collision between science and religion. He insisted that "our proper work is not that of straining our too feeble faculties at system-building, but humble and patient attention to what Nature herself teaches, comparing actual things with actual" (Proc. Zool. Soc., 1864); and in his "Shoulder-girdle, &c.," p. 2, he writes: "Then, in the times to come, when we have 'prepared our work without, and made it fit for ourselves in the field,' we shall be able to build a 'system of anatomy' which shall truly represent Nature, and not be a mere reflection of the mind of one of her talented observers."

Again, at p. 225, in illustration of some results of his work, he says:—"The first instance I have given of the Shoulder-girdle (in the Skate) may be compared to a clay model in its first stage, or to the heavy oaken furniture of our forefathers, that 'stood pond'rous and fixed by its own massy weight.' As we ascend the vertebrate scale, the mass becomes more elegant, more subdivided, and more metamorphosed, until, in the Bird Class and among the Mammals, these parts form the framework of limbs than which nothing can be imagined more agile or more apt. So also, as it regards the Sternum; at first a mere outcropping of the feebly developed costal arches in the Amphibia, it becomes the keystone of perfect arches in the true Reptile; then the fulcrum of the exquisitely constructed organs of flight in the Bird; and, lastly, forms the mobile front-wall of the heaving chest of the highest Vertebrate."

Prof. W. K. Parker was a Fellow of the Royal, Linnean, Zoological, and Royal Microscopical Societies; Honorary Member of King's College, London, the Philosophical Society of Cambridge, and the Medical Chirurgical Society. He was also a Member of the Imperial Society of Naturalists of Moscow, and Corresponding Member of the Imperial Geological Institute of Vienna, and the Academy of Natural Sciences of Philadelphia. In 1885 he received from the Royal College of Physicians the Bayly Medal, "Ob physiologiam feliciter excultam."

In conversations shortly before his death, he often spoke of looking forward throughout his life-time (alas! how quickly shortened!) to continued application of all the energy he could devote to his useful work—at once a consolation to him and a duty.

He has well expressed his own view of biological pursuits, at p. 363 of the "Morphology of the Skull":—"The study of animal morphology leads to continually grander and more reverend views of creation and of a Creator. Each fresh advance shows us further fields for conquest, and at the same time deepens the conviction that, while results and secondary operations may be discovered by human intelligence, 'no man can find out the work that God maketh from the beginning to the end.' We live as in a twilight of knowledge, charged with revelations of order and beauty; we steadfastly look for a perfect light, which shall reveal perfect order and beauty."

An unworldly seeker after truth, and loved by all who knew him for his uprightness, modesty, unselfishness, and generosity to fellow-workers, always helping young inquirers with specimens and information, he was suddenly lost to sight as a friend and father, but remains in the minds of fellow-workers, of those whom he so freely taught, and of his stricken relatives, as a great and good man, whose beneficent influence will ever be felt in a wide-spreading and advancing science, and among thoughtful and appreciative men in all time.

ALPHONSE FAVRE.

BY the death of Prof. A. Favre, Switzerland has been deprived of one of her foremost men of science, and geology has lost a very assiduous and successful cultivator. His death appears to sever the last remaining link between the present generation of Swiss geologists and that older and famous one which included Bernhard Studer, Arnold Escher von der Linth, Peter Merian, and Oswald Heer. The late Prof. Favre, who had reached the age of seventy-seven at the time of his death, was the author of numerous papers, the earliest of which, "On the Anthracites of the Alps," was published as long ago as 1841. He will perhaps be best remembered by the part he took in the famous controversy concerning the supposed admixture of fossils, belonging to different geological horizons, which were said to occur in the same beds in the Alps. In opposition to M. Scipion Gras and others who asserted that such intermixture of fossils did actually occur, Favre was able to show, by a series of patient investigations, that the apparent reversals of succession, and intimate union of Carboniferous, Jurassic, and Tertiary strata, could all be accounted for by repeated interfoldings and complicated overthrust faults. It is interesting to note that at the time when Favre was thus successfully contending for such an interpretation of supposed anomalies in the Alpine rocks, James Nicol in this country was engaged in a precisely similar controversy with Murchison and his followers, concerning the rocks of our own Highlands. But whereas the triumph of Favre's views was immediate and complete, and their author lived to see the justice of his interpretation universally admitted, Nicol was fated to witness the influence of great authority exerted for a long time in preventing the truth of his conclusions from being accepted; and only after his death was the retraction made which showed how much Scotland owes to this able interpreter of the geological structure of his native land. History may be relied upon, however, to do equal justice to the successful Swiss geologist and the disappointed Scotch one. Prof. Favre, besides papers on a great variety of geological questions, wrote several works dealing with the geology of the parts of Savoy, Piedmont, and Switzerland of which Mont Blanc forms the centre. During the later years of his life he had retired from his Professorship of Geology at Geneva, but up to the time of his death Favre held the post of President of the Federal Commission having charge of the geological map of Switzerland. As long ago as 1874 he was elected a foreign member of the Geological Society, and he was also a correspondent of the Institute of France.

AID TO ASTRONOMICAL RESEARCH.

PROF. PICKERING, of the Harvard College Observatory, has issued the following notice:—

"Miss C. W. Bruce offers the sum of six thousand dollars ($6000) during the present year in aiding astronomical research. No restriction will be made likely to limit the usefulness of this gift. In the hope of making it of the greatest benefit to science, the entire sum will be divided, and in general the amount devoted to a single object will not exceed five hundred dollars ($500). Precedence will be given to institutions and individuals whose work is already known through their publications, also to those cases which cannot otherwise be provided for, or where additional sums can be secured if a part of the cost is furnished. Applications are invited from astronomers of all countries, and should be made to the undersigned before October 1, 1890, giving complete information regarding the desired objects. Applications not acted on favourably will be regarded as confidential. The unrestricted character of this gift should insure many important results to science, if judiciously expended. In that case it is hoped that others will be encouraged to follow this example, and that eventually it may lead to securing the needed means for any astronomer who could so use it as to make a real advance in astronomical science. Any suggestions regarding the best way of fulfilling the objects of this circular will be gratefully received. "EDWARD C. PICKERING.

"Harvard College Observatory, Cambridge, Mass., U.S.A., July 15, 1890."

NOTES.

THE American Association for the Advancement of Science will meet this year at Indianapolis, under the presidency of Prof. Goodale. The first meeting will be held on August 19. The subject selected in advance for special discussion is "The Geographical Distribution of North American Plants," and papers upon it will be presented by Messrs. Watson, Macoun (of Ottawa), Sargent, Britton, Underwood, Halsted, and Coulter.

A ROYAL COMMISSION has been appointed to inquire and report "what is the effect, if any, of food derived from tuberculous animals on human health, and, if predjudicial, what are the circumstances and conditions with regard to the tuberculosis in the animal which produce that effect upon man." Lord Basing is chairman. The other Commissioners are Prof. G. T. Brown, Dr. George Buchanan, Mr. Frank Payne, and Prof. Burdon Sanderson.

THE Turin Academy of Medicine has proposed the following theme for the Riberi Prize of about £750: "Researches on the nature and the prophylaxis of one or several infectious diseases of man." Works may be sent printed or in manuscript; they may be in Italian, French, or Latin; and printed works must have appeared since 1886. The date limit is December 31, 1891.

THE failure of the Government to carry its scheme for the extinction of some public-house licences is likely to result in an important advantage to education. In his statement on Monday with respect to the money which was to have been applied to this object, Mr. Goschen said:—"As regards England we propose to add the amount set free by the abandoned licensing clauses to the residue which, under the Bill as it stands, goes to the county councils, accompanying this inclusion by an intimation that possibly new charges may, by and by, be put upon them, with reference to intermediate, technical, or agricultural education. It seems very desirable, if more is to be done in this respect, that the localities, and especially county councils, should be interested in the work. In England there is at present little machinery available for carrying out such an object, and it would be impossible to create such a machinery at this period of the session. But in Wales and in Monmouthshire the machinery does exist. County councils may supply funds to the joint committee for intermediate education under the Act of last year out of the county rate, but to the extent of a halfpenny of such rates only. We shall propose that the county councils in Wales should have authority to increase the sum out of the additional funds now placed at their disposal. . . . As regards Ireland we shall propose that the £40,000 which falls to her share should be utilized for the further promotion of intermediate education, and for this purpose should be placed at the disposal of the Intermediate Education Board for Ireland, a body which, I believe, commands the confidence of the Irish public generally, irrespective of political and religious differences." The Government propose that the £50,000 which falls to the share of Scotland shall be handed over unconditionally to the county councils; but Mr. Campbell-Bannerman has given notice that he will move an amendment to the effect that the money be devoted directly to the completion of a scheme of free primary education.

The Drapers' Company, London, has contributed £3000 towards the cost of the new buildings for technical instruction in connection with Nottingham University College. This branch of the College will be under the care of the recently-appointed Professor of Mechanical Engineering and Technology, Mr. William Robinson, late chief assistant at the City and Guilds Technical College, Finsbury.

A public meeting was held at the Town Hall, Kensington, yesterday, under the presidency of the Hon. and Rev. E. Carr Glynn, to consider measures whereby the technical and scientific education of apprentice and other plumbers may be ensured.

Last week the Institute of Electrical Engineers held a series of meetings at Edinburgh in connection with the International Exhibition. The series began on Tuesday, when Dr. Hopkinson occupied the chair. Dr. Walmsley read a paper on some of the principal features of the Exhibition, in which he referred particularly to the telegraph and electric light apparatus and gas-engines. Mr. A. R. Bennett read a paper on "Foreign Currents in Telegraph and Telephone Lines." He described experiments he had carried out with overhead wires, and pointed out their effect in wet weather. Mr. W. H. Preece said that the foreign currents found in electric wires were far more readily perceptible in telephone than in telegraph wires. The currents were due often to the swing of the wires, and greatly to the alternating system of generating electric light recently introduced. Mr. Bennett said that disturbances might be caused by the introduction of electric tramways. In the evening the members of the Society attended a *conversazione* given in their honour in the grand hall of the Exhibition. On Wednesday, when the chair was taken by Mr. W. H. Preece, a paper on "The Working Efficiency of Secondary Cells" was read. This paper, of which we hope to give some account, was the joint work of Messrs. W. E. Ayrton, C. G. Lamb, E. W. Smith, and M. W. Woods. On Thursday, Mr. Spagnoletti was in the chair, and Mr. A. R. Bennett read a paper on "Experiments on Radiometry." Some discussion followed, in which Dr. Walmsley, Mr. Stroh, Mr. Fairfax, and others took part.

At the instance of a number of Magdeburg manufacturers, an electro-technical experimental station is about to be founded in that town, to afford to companies or private persons opportunity of experimenting as to the practicability and cost of various electrical arrangements, and of testing machines, apparatus, &c. The station will be arranged on the pattern of one already in existence at Munich, but expanded in several directions. Dr. M. Krieg, editor of the *Electrotechnical Echo*, will be at its head. Among other matters which will come under consideration, are the examination of arrangements for illumination, transmission of force, and metallurgical purposes, determination of the luminous power of arc and glow lamps, and of constants, such as intensity and tension of current, testing of carbon rods, of measuring-instruments, accumulators, primary batteries, &c., examination of conducting and insulating materials, lightning conductors, private telephone arrangements, and so on. Youths devoting themselves to electro-technical work will have opportunities of gaining thorough practical knowledge in the place.

The death of Mr. John Ralfs, at Penzance, on the 14th inst., at the age of 83, removes one of the last survivors of a past generation of botanists. His "British Desmidieæ," published in 1848, remains to the present time unsurpassed in botanical literature for the beauty and accuracy of its coloured plates. As it was the first British work (except Hassall's "British Fresh-water Algæ," published three years earlier) which did any justice to this beautiful class of fresh-water organisms, so it remained the only one until the appearance of Dr. Cooke's "British Desmids" in 1887. Mr. Ralfs also contributed several papers on the Mosses, Fungi, and Algæ of his native county to the Transactions of local scientific Societies. Of a retiring disposition, and practising as a surgeon in Penzance, he was but little known personally to his fellow-workers. Within the last two years he was elected an Honorary Fellow of the Royal Microscopical Society.

Mr. G. W. Rafter has contributed to the Transactions of the American Society of Civil Engineers an interesting paper on freshwater Algæ, and their relation to the purity of public water-supplies. He finds that a number of Algæ may assist in rendering drinking-water unpotable, producing a nauseous or "fishy" smell, generally due to the decomposition of their mucilaginous envelope, or of the starch or oil contained in their cells. In addition to the well-known Fungus or Schizomycete *Beggiatoa*, which has the remarkable property of withdrawing sulphur from sulphates in solution, the following freshwater Algæ are especially deleterious when occurring in large masses:—*Cladophora*, *Vaucheria*, *Batrachospermum*, *Draparnaldia*, *Chætophora*, *Volvox*, *Eudorina*, *Pandorina*, *Hydrodictyon*, *Palmella*, *Crenothrix*, *Oscillaria*, and diatoms generally, especially *Meridion circulare*. Desmids appear to be usually innocuous.

The British Vice-Consul at Los Angeles, in California, in his last Report, has some observations on the vine and orange pests in that region. The vine-disease now seriously menaces the existence of the viticultural industry in the vicinity of Los Angeles. At first it attacked chiefly the "mission" vines; now, other varieties of red vines are dying, and the white varieties are also suffering. The disease first appeared in its present dangerous form in the southern part of California, and destroyed many vineyards. Prof. Dowlen, an expert employed by the Viticultural Commission to ascertain its cause, and, if possible, discover a remedy, inclines to the opinion that it is due to a fungus. On the other hand, Mr. Wheeler, Chief Executive Officer of the Viticultural Commission, reports that he is fully convinced that the fungus found on the dead vines is not the prime cause of their decadence, and that it attacks them only when they have been weakened by other causes. As to the Icerya, or "white scale," which has ravaged the orange-groves, the Vice-Consul says that a year ago many of the principal orange-growers in the vicinity of Los Angeles had abandoned their efforts to exterminate this pest, concluding that their trees must die. Fortunately, it was learned that an Australian parasite, the *Vedolia cardinalis*, had exterminated the white scale in Australia. A colony of the bugs was imported, and placed on the trees in an orchard in Los Angeles; they multiplied so rapidly that in a few months the scale was entirely exterminated in the district; many trees, which a year ago were nearly dead, have revived and borne half a crop this season.

Artificial musk is a recent chemical achievement. A process for its production has been patented in Germany, the inventor being Herr A. Bauer, of Gisparsleben, in the Erfurt district. It is a familiar experience in organic chemistry, that on introduction of nitro groups (NO_2) into organic bodies, by action of nitric acid, a smell like that of musk is often noticed. In the present case, pure butyl-toluol is treated with a mixture of sulphuric and nitric acid, and the nitro-compound is purified by crystallization from alcohol, the yellowish-white crystals smelling strongly like musk. According to Dr. Paul (*Humboldt*), the smell is not perfectly pure, and it can be distinguished from that of musk by the perfumer, but not by the general public. Curiously, a 1 per cent. alcoholic solution has not the smell of musk; only after dilution with water does this come out, and the dilution may be carried far before the smell is lost; with 1 in 5000 it is still quite distinct. Certain properties of the new product seem to render it very useful in the perfuming of soap.

THE small toe in man has recently (we learn from *Humboldt*) been made a subject of study by Herr Pfitzner. It is well known that thumbs and great toes are two-jointed, and the other fingers and toes generally three-jointed. In many human skeletons, however, the small toe is found to be two-jointed, the middle and end phalanges being fused into one piece, though still distinguishable. This variety occurs in about 36 per cent. of cases, and, as a rule, in both toes simultaneously; and there are more instances among women (41·5 per cent.) than among men (31·0 per cent.). One naturally thinks here of shoe-pressure causing union of two bones originally separate. But it appears that in children, from birth to the seventh year, and in embryos from the fifth month, the fusion occurs about as often as in adults. Further, the material of examination was not from a class of people who wear tight shoes. Herr Pfitzner concludes that the small toe in man is in course of degeneration (*Rückbildung*), and that without apparent adaptation to external mechanical influences. Processes of reduction are also observed in the connected muscular system. The question arises, Has the tendency reached its limit, or have we merely the first act of a total degeneration of the fifth toe? The author inclines to the latter view, but desires an extension of these researches among peoples who do not wear shoes or sandals, or have only of late begun to wear them. In living persons, it is not difficult to determine, by stretching and bending, whether the small toe is two- or three-jointed; and in this way adequate data might be had for determining any percentage differences in occurrence of the old and the new form in different races; also for investigating the inheritance of acquired characters, members of several successive generations being examined.

DEFECTIVE sight is becoming more general in the United States, and blindness, particularly among the poor, shows a steady growth. So says the British Consul at Philadelphia, whose statements are advanced on the authority of oculists. Purulent ophthalmia of infancy is prevalent in charitable institutions, poor-houses, &c. The disease shows itself within a fortnight after birth. A recent investigation of the blind in the country almshouses and asylums of an adjoining State showed that one out of every five cases of blindness was due to ophthalmia, and that the cases could have been cured if they had been properly treated in time. The disease is said to be contagious, and few or no special precautions have been taken in any of the institutions to prevent its spreading. The increase of the blindness throughout the country has been so marked of late years—four times as great as the increase of population—that it has been made the subject of special investigation by the American Ophthalmological Society, the investigation including a study of the ophthalmia so prevalent in Egypt, to which the ophthalmia of infancy is closely akin.

A VERY odd result of rivalry between two tiger-snakes is recorded by Mr. D. Le Souef, Assistant Director of the Melbourne Zoological Gardens, in the May number of the *Victorian Naturalist*. One of the snakes was large, the other small. Not long ago both happened to fasten on the same mouse, one at each end. Neither would give way, and the larger snake not only swallowed the mouse, but also the smaller snake. In about ten minutes nothing was seen of the smaller snake but about two inches of its tail, and that disappeared next day.

IN the new quarterly statement of the Palestine Exploration Fund, Mr. Flinders Petrie gives a short report of his recent excavations at Tell Hesy, in Palestine. These have proved to be remarkably interesting. The remains of Tell Hesy consist of a mound which is formed of successive towns, one on the ruins of another, and an enclosure taking in an area to the south and west of it. The lowest wall of all—28 feet 8 inches thick, and formed of clay bricks, unburnt—is believed to be that of Lachish, the ancient Amorite city, erected probably 1500 years B.C. Phœnician pottery of about 1100 B.C. is found above its level. Later constructions are the supposed wall of Rehoboam, and remains of the fortifications made in the reigns of Asa, Jehoshaphat, Uzziah, Jotham, and Manasseh. The pottery discovered on the spot is very valuable. "We now know for certain,' says Mr. Petrie, "the characteristics of Amorite pottery, of earlier Jewish and of later Jewish influenced by Greek trade, and we can trace the importation and the influence of Phœnician pottery. In future all the tells and ruins of the country will at once reveal their age by the potsherds which cover them."

M. P. MÉGNIN is engaged in an elaborate study of the varieties of dogs. He has published two volumes on the subject, and a third is to appear shortly. The author tries to give an account of the origin of the varieties at present known.

HERR A. HARTLEBEN, of Vienna, Pest, and Leipzig, has begun the publication, in "Lieferungen," of two works which promise to be very good and useful. They are "Das Luftmeer," by Prof. F. Umlauft, and "Physik und Chemie," by Dr. von Urbanitzky and Dr. S. Zeisel. Both works are illustrated. The former will present an exposition of the principles of meteorology and climatology; the latter is to contain a general account of physical and chemical phenomena in their relation to practical life.

DURING the last few months a fortnightly *Meteorological Bulletin* has been published at Madrid, by a person under the *nom de plume* "Noherlesoom," professing to give the principal features of the weather for the coming fortnight, illustrated by isobaric charts for special days. Some pages of text contain extracts from various orthodox works bearing upon weather prediction. The present state of the science does not warrant predictions of this nature, nor is it stated upon what principles they are made; yet the weather predicted for the first half of July corresponded in some respects to the very unseasonable conditions experienced during that period in this country.

THE new meteorological observatory of San José de Costarica is to be considered a welcome gain to science, seeing that (as Dr. Hann points out) between Mexico in 19° N. lat. and Rio de Janeiro and Cordoba in 22° and 35° S. lat., there has been no observatory of the first rank, either in Central or South America. Recent data from Prof. Pittier there, reveal a remarkable daily period of rainfall. Thus in the five months August to December, while only 1·5 inch of rain fell between midnight and midday, 35 inches, or more than twenty times as much, fell between midday and midnight. Comparing the hours, 6 to 11 a.m., with 2 to 7 p.m., the quantities are 0·3 in. and 27·6 in. Nearly the whole of the rainfall occurs within six hours (75½ per cent.). And the largest amount is towards sunset, not (as commonly supposed about the tropics) in the early hours of the afternoon.

Writing on the subject of medicine in China, the *North China Herald* of Shanghai observes that medicine in China is very old. In the year 579 B.C. the moxa and acupunture were already practised by Chinese physicians, for it is in that year that this treatmeat is first mentioned in any book, Chinese or foreign. In addition to this there was the celebrated Pien-tsio, who some time during the period from the eighth century before Christ to the sixth performed remarkable cures by feeling the pulse first and basing his treatment upon the indications. On one occasion he was in attendance upon a prince who was in a state of unconsciousness for five days, and he depended on pulse-feeling for his knowledge of the patient's condition. The great books of Chinese medicine belonged to the age of the sages. They are the classics of Chinese medicine, and in them its theories and principles are enshrined. In these books we find such statements as that metal and water combine, in accord with the influence of Venus and Mars. The soul is spoken of as something distinct from though included in the body. Madness, fever, apoplexy, paralysis, cholera, are all described. The five elements are represented as revolving powers, and they correspond to the five planets in the heavens. The earth moves westward through space which surrounds it below as well as above and around. Ignorance of astrology is stated to be a cause of disease and death. Interlaced with the doctrine of the five elements is found the doctrine of the dual principles of darkness and light, each divided into greater and lesser. The veins and arteries are here described as canals originating in the skin, which, consequently, is that part at which all disease commences its invasion of the human frame. The possibility of the human subject securing immortality by Taoist methods is discussed, and the affirmative is believed. The "Soo wên," having in it these and other curious things, such as the rotundity of the earth and the doctrine of a universal and primæval vapour, and having a distinct tincture of the Mesopotamian astrology, constitutes in itself a convincing proof that China was receptive of Western knowledge to a large extent in the fifth, fourth, and third centuries before Christ. From that time during more than two thousand years China has been under the dominion of the philosophy of this book. The writer predicts that a history of Chinese medicine, being the result of the uninterrupted experience of two thousand five hundred years, in spite of its Babylonian theory, now exploded by modern discoveries, would prove deserving of high respect for its practical utility in many important ways.

The Cambridge Local Lectures Syndicate held a Conference of Local Lecturers and Committees in the Senate House on July 9 and 10, the Vice-Chancellor, Dr. Butler, Master of Trinity College, presiding. The subjects discussed were: (1) the affiliation of lecture centres to the University; (2) the relations with the Education Department; (3) State aid for local lectures, a subject started at Oxford last year, and introduced on this occasion by the request of some of the centres, not as part of the programme of the Syndicate; (4) local finance; (5) work in rural districts; (6) district associations. The subjects were all of them actively discussed, "State aid" being referred back to the Committee which is working in the matter. The whole party, numbering about 180, lunched in the Hall of King's and dined in the Hall of Trinity, as guests of the Syndicate, and visited the Library, the Museums of Science, and the Fitzwilliam Museum, at each of which an expository address was delivered.

The Syndicate have invited a limited number of their students in various parts of the Kingdom to spend the month of August in Cambridge, for the purpose of quiet and serious study. For some years, individual invitations of this kind have been given by persons interested in the work. The Syndicate have received favourable accounts of the work done and of the effect produced, and they are now making it part of their official business. They had contemplated from 30 to 40 students, but the number of those desirous of coming considerably exceeds that. The principle of the Syndicate is to give to the students opportunities which they could not have in the lecture centres, and on this account the ordinary subjects of local lectures are not included in the curriculum. The work is to last from August 5 to 30 inclusive. Newnham College will give a collegiate home to the women students, and Selwyn to the men, on very moderate terms. The mornings will be given to the science students, whose work will consist of courses of experimental demonstrations in the laboratories of chemistry, physics, geology, &c. The afternoons will be given to the art students, whose work will consist of series of lectures on Greek art, early English sculpture and inscriptions, early engraving, and architecture, all illustrated from the art collections and the buildings in Cambridge. Single lectures will be given, by leading residents in Cambridge, on subjects of which they have special knowledge, and this, no doubt, will be a feature of unusual interest and profit. The University Library, the Philosophical Library, and the Library of Art and Archæology, will all be open to the students by special arrangement for reading and study. Special lectures will be given on King's Chapel and Ely Cathedral, and the manuscript and other treasures of some of the College libraries will be shown and described in detail. Visits will be paid to the Observatory by day, for the inspection of the astronomical instruments, and Prof. Adams or his representative will receive small parties of the students at night. It is proposed to give to those who go satisfactorily through the regular course of study some record of what they have done. Several of the lecture centres have given scholarships of £10 to their best students to enable them to go to Cambridge, and the Syndicate are meeting all prizes of this kind by a remission of the small lecture fee. The advantage of working in small parties of 10 or 12 at such subjects as those indicated, and under such circumstances, can scarcely be exaggerated. The determination of the Syndicate is that the whole course of study shall be serious and quiet, but social amenities will not be disregarded.

The Report of the Cambridge Local Lectures Syndicate, recently issued, is unusually encouraging. The number of students and of courses of lectures is larger than ever, and the proportion of serious students to the whole number attending the lectures shows a remarkable increase. It is easy to get a large number of people to come to popular lectures, but to make people who come to lectures into serious students is a different matter. Nearly half of the whole number of 11,500 students have attended not the lecture only, but also the "class" for more detailed work by question and answer which always precedes or follows the lecture in the Cambridge system. More than a fifth part of the whole have written papers weekly for the lecturer, and the examinations at the end of the respective courses have been attended by nearly one in six. This is an interesting record of solid work done. A specially satisfactory feature of the year's work has been the manner in which the centres have supported the Syndicate in keeping up the lectures in each course to the full number of twelve, which is an integral part of the Cambridge system. Of 125 courses only five have been "half-courses" of six lectures, given under special circumstances and without the privilege of an examination. Thus the total number of lectures given has been about 1470, and the number of attendances at lectures not far off 140,000.

The additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus* ♀ ♀) from India, presented by Captain C. Taylor; a Hawfinch (*Coccothraustes vulgaris*), British, presented by Mr. L. C.

Wharton; a Snow Bunting (*Plectrophanes nivalis*), European, presented by Mr. J. Young, F.Z.S.; a Common Boa (*Boa constrictor*) from Venezuela, presented by Mr. R. J. Money; a White-thighed Colobus (*Colobus vellerosus* ♂) from West Africa, a Cape Ratel (*Mellivora capensis* ♂) from South Africa, an Arctic Fox (*Canis lagopus* ♀) from the Arctic Regions; four Spoonbills (*Platalea leucorodia*), European, a Short-toed Lark (*Calendrella brachydactyla* ♂) from Algeria, purchased; four Australian Wild Ducks (*Anas superciliosa*), two Slender Ducks (*Anas gibberifrons*), eight Chilian Pintails (*Dafila spinicauda*), six Summer Ducks (*Æx sponsa*), four Mandarin Ducks (*Æx galericulata*), two Red-crested Pochards (*Fuligula rufina*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

OBJECTS FOR THE SPECTROSCOPE.

Sidereal Time at Greenwich at 10 p.m. on July 24 = 18h. 10m. 17s.

Name.	Mag.	Colour.	R.A. 1890.	Decl. 1890.
			h. m. s.	° ′
(1) G.C. 4390	—	—	18 6 45	+ 6 49
(2) G.C. 4403	—	—	18 14 17	−16 13
(3) D.M. + 43° 2890 ...	8	Reddish-yellow.	18 3 29	+43 26
(4) η Serpentis	3	Yellow.	18 15 36	− 2 56
(5) γ Ophiuchi	3	White.	17 42 16	+ 2 45
(6) D.M. + 36° 3243 ...	8	Red.	18 39 0	+36 50

Remarks.

(1) This small bright nebula was thought by W. Struve to be one of the most curious objects in the heavens. The G.C. description is: "A planetary nebula; very bright; very small; round; a little hazy." According to D'Arrest, its diameter is about 7″. The observations of Dr. Huggins and Captain Herschel show that the spectrum consists of the three chief nebula lines, and a faint continuous spectrum. Dr. Huggins also notes that "the lines are exceedingly sharp and well-defined." This latter observation requires confirmation, and the spectrum should also be examined for other lines, as we know that a greater number of lines are seen in other nebulæ of the same class.

(2) This is the so-called "Horse-shoe Nebula," which is thus described by Herschel: "A very remarkable object; bright; extremely large; extremely irregular figure; 2-hooked." The spectrum has been observed both by Dr. Huggins and Captain Herschel. The former noted in 1866 that the line near λ 500 was visible, in addition to a faint continuous spectrum, and added: "When the slit was made as narrow as the intensity of the light would permit, this bright line was not so well defined as the corresponding line in some of the other nebulæ under similar conditions of slit, but remained nebulous at the edges." It will be seen that this observation gives the chief line a very different character to the preceding one (4390), and it is very desirable that the discrepancy should be cleared up, especially as Dr. Huggins has recently stated that the line is always seen sharp and well defined, although there is no evidence to show that he has reobserved the nebulæ in which he formerly recorded it as ill defined. It is important that both nebulæ should be examined as nearly as possible at the same time with the same instrumental conditions. Captain Herschel simply writes: "Bright object; bright lines."

(3) The spectrum of this star is one of great interest in connection with the view that stars of Group II. are similar in constitution to comets. Dunér states that, notwithstanding the small magnitude of the star the bands are very well seen even in the ultra blue, and that they are so wide and dark that the spectrum is totally discontinuous, especially in the blue-green and the blue. Now it seems pretty evident that all the light referred to in the blue in a faint star like this cannot be due simply to continuous spectrum, and it is therefore probably due to the radiation of some substance. This substance is probably carbon, giving a series of bright flutings in the blue-green and blue, and giving rise to apparent dark bands, which are in all probability simply the dark spaces between the bright flutings. The measurements made by Dunér and Vogel of the bands in other stars show close coincidences with the carbon flutings, but the question can only be finally decided by direct comparisons. If the existence of the carbon flutings be confirmed, then we must conclude that stars of Group II. and comets showing the same series of flutings are identical in constitution.

(4 and 5) These are stars of the solar type and of Group IV. respectively, and the usual more detailed observations are required in each case.

(6) The observations of Secchi and Dunér show that the spectrum of this star is a well-marked one of Group VI.; but the only details observed were three "zones" separated by two strong dark bands. Further details and deviations from the regular type should be looked for. A. FOWLER.

NICE OBSERVATORY.—The third volume of the "Annales de l'Observatoire de Nice" contains a new map of the solar spectrum by the late M. L. Thollon, the whole of the theory of the minor planet Vesta by M. Perrotin, the Director of the Observatory, and numerous observations of comets and planets made by M. Charlois.

The part of the spectrum mapped by M. Thollon extends from A to *b*, and is contained on seventeen beautifully engraved plates, each having two horizons 32 cm. long. The whole length is thus a little over ten metres, and the number of lines contained in it is about 3200, of which 2090 are said to have a solar origin, 866 are purely telluric, and 246 have a mixed origin—that is to say, they result from the superposition of solar and telluric lines.

Each of the 33 horizons is divided into millimetres, from 0 to 320, hence the lines can easily be read off to $\frac{1}{10}$ of a division. Thollon intended at the beginning of his work to express the position of the lines on a scale of wave-lengths, and this would doubtless have facilitated their identification to a considerable extent; but the method of relative measurement which he adopted was more accurate than the absolute measures made by Ångström, and he found that to use a wave-length scale it would be necessary to alter a number of accepted places of lines or to alter his measured intervals. It is rather unfortunate that such should be the case, for ready reference to the lines and comparisons of them with those mapped by other observers are rendered somewhat difficult. Beneath each scale are four horizons on which are respectively represented: (1) the appearance of the lines when the sun is 80° from the zenith and the air is dry; (2) the appearance of the lines when the sun is 60° from the zenith and the air is very moist; (3) the appearance of the lines when the sun is 60° from the zenith and the air is very dry; (4) the lines of solar origin—that is, those that would be observed from outside our atmosphere. The width of the lines was determined for each of the four horizons, and intensities are expressed from 1 to 10, 1 indicating the weakest and 10 the strongest lines. The values for each line are given in the text relating to the maps. Another horizon gives the position of iron lines, but this is incomplete in some of the maps owing to M. Thollon's death.

The theory of Vesta, by M. Perrotin, is in continuation of that published in the first volume of "Annales de l'Observatoire de Toulouse, 1880," and deals with the algebraical expressions of the perturbations produced on its elements by different planets.

ENLARGEMENT OF PHOTOGRAPHS OF STELLAR SPECTRA.—The enlargement of all the photographs of stellar spectra taken under Prof. Pickering's direction at the Henry Draper Memorial observatories is made by means of a cylindrical lens, and the result of the adoption of this method is well known. Dr. Scheiner, of Potsdam Observatory (*Astronomische Nachrichten*, No. 2969), has obtained even better results by fixing the negative lengthways in a frame which has a to-and-fro movement. The motion causes the width of the lines to be increased on the plate being exposed, in a manner similar to the increase that takes place when a cylindrical lens is inserted between it and the negative. The advantage of the arrangement over that of Prof. Pickering lies in the fact that the diminution of the intensity of the lines in the process of enlargement is much less.

The method now described by Dr. Scheiner has been used successfully at South Kensington for some time.

THE SCIENTIFIC PRINCIPLES INVOLVED IN MAKING BIG GUNS.

I.

STEAMSHIPS are now called *boats*, and the largest cannon are called *guns*, according to a process in language which philologists have explained; but while steamships have increased in size and complication, the gun, however big, satisfies the Hibernian definition of a cylindrical hole with metal placed round it; and the most difficult problem of the gun-maker is to dispose the metal in the most efficient manner, hampered as he is by the limitations of the metallurgical art.

The difficulties increase with the size of the gun, according to the well-known law of Mechanical Similitude.

Geometrical Similitude is independent of scale; a geometrical theorem is true, however large the figure may be drawn; but the laws of Mechanical Similitude are complicated, when we notice the differences between a simple girder and the Forth Bridge, or between the anatomy of large and small animals.

As an example of mechanical similitude, consider what sort of a steamship would be required to reduce the voyage to America from six to five days. The present steamers crossing in six days have a speed of 20 knots, and displacement of 10,000 tons, and the indicated horse-power is close on 20,000. To cross in five days the speed would have to be increased 20 per cent., to 24 knots; and now if we apply Froude's law that, at corresponding speeds as the sixth root of the displacements, the resistances are as the displacements, we shall find that the steamer would have to be of 30,000 tons, and of 65,000 horse-power, thus exceeding even the *Great Eastern's* dimensions.

With given material, say steel, the strongest with which we are familiar, a limit of size is soon reached at which the structure falls to pieces almost of its own weight; and recent experience with the heaviest artillery seems to show that we are nearing this limit.

The larger the gun or structure, then, the greater the necessity for careful and scientific design and proportion. It is proposed to give here a sketch of the fundamental principles which guide the gun-maker, and which he applies to secure the safety of the gun under the greatest pressure it can ever be called upon to sustain.

While reaping almost all the glory of success, the gun-maker cannot risk the disgrace of a failure; on the other hand, the carriage-maker can work with a small margin of safety, as ample warning would be given of any failure, and breakage is easily repaired; but the failure of a gun may be so disastrous that it must be avoided at all cost, so that the gun-maker never allows himself to work very close to the limits which his theory allows.

At the present time the design and employment at sea or in forts of such monsters as our 110-ton or Krupp's 135-ton guns is severely criticized and condemned in certain circles; but it is a maxim in artillery that one big gun is worth much more than its equivalent weight in smaller guns; and for naval engagements a few line-of-battle ships armed with the heaviest artillery are invincible, if properly flanked and protected by the light cavalry of frigates.

So, too, with steamships; the largest and fastest always fill with passengers, and by making rapid passages, and therefore more in a given time, are found to be more profitable in spite of their great initial cost and expense of working.

The size of the gun is settled by the thickness of armour it is required to attack; the calibre increasing practically as the thickness to be pierced, but the weight of the gun mounting up as the cube of the calibre. Thus if an 8-inch gun weighing 13 tons can pierce 12 inches of armour, a 16-inch gun is required to pierce 24 inches, and the 16-inch gun will weigh 104 tons.

PART I.—THE STRESSES IN A GUN.

(1) The theory of gun-making begins with the investigation of the stresses set up in a thick metal cylinder, due to steady pressures, applied either at the interior, or exterior, or at both cylindrical surfaces.

So far, the dynamical phenomena which arise from the propagation and reflexion of radial vibrations are beyond our powers of useful analysis; so that we restrict ourselves to the investigation of the elastical problem of the thick cylinder of elastic material, subject to given internal and external pressures, applied steadily, as in the case of a tube tested under hydraulic pressure.

Fig. 1 is drawn representing the stresses set up in a cylinder or tube B, by an internal pressure p_i; we denote by r_i and r_o the inner and outer radii, the suffixes i and o denoting *inside* and *outside*; and then r can be used to denote any intermediate radius.

The stress at any point at a distance r from the axis will consist of a radial pressure, p, and a circumferential tension, t; the radial pressure p decreasing from p_i at the inner radius r_i to zero at the outer radius r_o, the atmospheric pressure not being taken into account; while the circumferential tension t at the same time diminishes from t_i to t_o.

The British units employed in practical measurements with guns are the inch and the ton; so that r being measured in inches, p and t are measured in tons per square inch.

(2) To determine the state of stress at any point of the cylinder, we suppose it divided by a diametral plane $r_o r_i \mathrm{O} r_i r_o$; and the equilibrium of an inch length of either half is considered.

The stresses p and t being represented graphically by the ordinates of the curves $p_i p p_o$, $t_i t t_o$, the equilibrium of either half of the cylinder requires that the area of the circumferential tension-curve $r_i t_i t_o r_o$ and its counterpart should be equal to the area of the rectangle $\mathrm{O}p_i$, and its counterpart, these latter representing the thrust due to the pressure p_i on the half cylinder.

Then, denoting the area $r_i t_i t_o r_o$ by Q, and calling it the resistance of the section $r_i r_o$,

$$Q = p_i r_i \quad . \; . \; . \; . \; . \; . \; . \; . \; . \quad (1).$$

If we divide the resistance Q by the thickness of the cylinder $r_o - r_i$, we obtain the *average* circumferential tension in the material; and when the cylinder is thin, the maximum circumferential tension t_i and the average tension $Q/(r_o - r_i)$ will not be appreciably different; so that a knowledge of the average circumferential tension will be sufficient for practical purposes in such cases as, for instance, of the cylindrical shell of a boiler; and we have thus the elementary formula ordinarily employed in the design of boilers.

But when, as in a gun or hydraulic press, the thickness has to be made considerable, we must have the means of determining the *maximum* tension t_i, and of contriving that t_i shall not exceed a certain proof limit suitable for the material.

(3) Now, just as the equilibrum of either half of the cylinder requires that the area $r_i t_i t_o r_o = p_i r_i$, so the equilibrium of either half of a part of the cylinder bounded internally by the radius r_i, and externally by any radius r, requires that the area $r_i t_i t r$ should equal the rectangle $\mathrm{O}p_i$ minus the rectangle $\mathrm{O}p$; or, in the notation of the Integral Calculus—

$$\int_{r_i}^{r} t\,dr = p_i r_i - pr \quad . \; . \; . \; . \; . \; . \; . \quad (2).$$

The first attempt at a solution of these equations (1) and (2) is due to Peter Barlow, when called upon to calculate the strength of the cylinder of the Bramah hydraulic press, in a paper read before the Society of Civil Engineers in February 1825, and published in the *Edinburgh Journal of Science*, and in the Trans. I.C.E., vol. i. 1836.

(4) Barlow assumed that under an internal pressure the metal is compressed radially as much as it is stretched circumferentially, so that the cubical compression of the metal is zero, and he is justified therefore in putting $p = t$ in the material of the cylinder.

Then equation (2) becomes

$$\int_{r_i}^{r} p\,dr = p_i r_i - pr;$$

so that, differentiating with respect to r,

$$p = -\,d(pr)/dr, \text{ or } dp/p + 2dr/r = 0;$$

and integrating again with respect to r,

$$\log p + \log r^2 = \text{constant},$$

or

$$pr^2 = a, \text{ a constant}; \; p = t = ar^{-2} \quad . \; . \; . \; . \quad (3);$$

so that p and t, if equal, vary inversely as the square of the distance from the axis.

Thus, a cylindrical tube under internal and external pressures which are inversely as the squares of the internal and external radii respectively, will, according to Barlow's law, have at any point a radial pressure and an equal circumferential tension, also inversely as the square of the distance from the axis.

When the thickness of the cylinder is considerable, compared with the bore, this solution of Barlow will give a very fair indication of the true result.

(5) But Rankine showed ("Applied Mechanics," § 273) that, by superposing the state of hydrostatic stress produced by equal internal and external pressures, we obtain the algebraical solution of the most general case where the internal and external applied pressures are arbitrary.

For if we suppose the state of stress in the cylinder is a hydrostatic stress, composed of a radial pressure p, and an equal circumferential pressure $-t$, then equation (2) becomes—

$$\int_{r_i}^{r} p\,dr = pr - p_i r_i ;$$

and differentiating with respect to r,

$$p = d(pr)/dr, \text{ or } dp/dr = 0 ;$$

so that

$$p = b, \text{ a constant ; and then } t = -b \quad . \; . \; . \; (4).$$

(6) The superposition of this state of stress on Barlow's state of stress gives—

$$p = ar^{-2} + b, \qquad t = ar^{-2} - b \quad . \; . \; . \; . \; (5),$$

or

$$(p + t)r^2 = 2a, \qquad p - t = 2b ;$$

values which will be found to verify equation (2); and now the constants a and b are determined for arbitrarily applied internal and external pressures p_i and p_o by the equations

$$p_i = ar_i^{-2} + b, \qquad p_o = ar_o^{-2} + b ;$$

so that

$$a = \frac{p_i - p_o}{r_i^{-2} - r_o^{-2}} = \frac{(p_i - p_o)r_i^2 r_o^2}{r_o^2 - r_i^2} ;$$

$$b = \frac{p_o r_o^2 - p_i r_i^2}{r_o^2 - r_i^2} = \frac{p_o r_i^{-2} - p_i r_o^{-2}}{r_i^{-2} - r_o^{-2}} .$$

These results were first obtained by Lamé and Hart (the late Sir Andrew Searle Hart, of Dublin), but in a much more complicated manner. Lamé's solution was given in his "Leçons sur la théorie mathématique de l'élasticité des corps solides"; while Hart's treatment of the question will be found in Note W to Robert Mallet's "Physical Conditions involved in the Construction of Artillery" (1856). An investigation of the same problem by Maxwell, when about eighteen years old, in the Trans. R. S. Edin., vol. xx. 1850, has been generally overlooked.

Rankine's treatment analyzes the mechanical signification of the separate terms of the solution, and obtains them by simple reasoning from the state of stress, without an appeal to the laws of elasticity and the consequent state of strain.

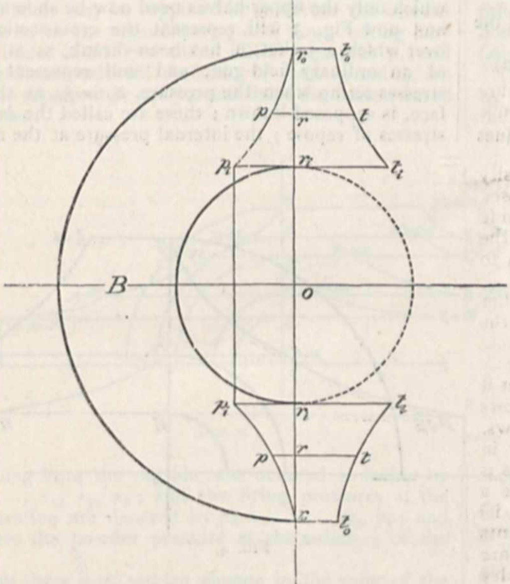

FIG. 1.

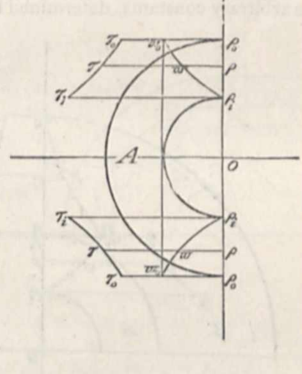

FIG. 2.

(7) Putting $p_i r_i^2 = p_o r_o^2$ makes $b = 0$, and gives the particular case considered first by Barlow; and putting $p_i = p_o$ makes $a = 0$, and gives the additional particular case of uniform hydrostatic stress invented by Rankine.

But, in the general case, a and b may have any values, positive or negative, according to the relations between p_i and p_o, r_i and r_o.

Thus, as in Fig. 1, with $p_o = 0$, we find—

$$a = \frac{p_i}{r_i^{-2} - r_o^{-2}}, \quad b = \frac{-p_i r_o^{-2}}{r_i^{-2} - r_o^{-2}} ;$$

and then

$$p = ar^{-2} + b = p_i \frac{r^{-2} - r_o^{-2}}{r_i^{-2} - r_o^{-2}} ; \quad . \; . \; . \; . \; . \; (6)$$

$$t = ar^{-2} - b = p_i \frac{r^{-2} + r_o^{-2}}{r_i^{-2} - r_o^{-2}} ; \quad . \; . \; . \; . \; . \; (7)$$

$$t = p_i \frac{r_i^{-2} + r_o^{-2}}{r_i^{-2} - r_o^{-2}} = p_i \frac{r_o^2 + r_i^2}{r_o^2 - r_i^2} ; \quad . \; . \; . \; . \; (8)$$

$$t_o = p_i \frac{2r_o^{-2}}{r_i^{-2} - r_o^{-2}} = p_i \frac{2r_i^2}{r_o^2 - r_i^2} \quad . \; . \; . \; . \; (9)$$

(8) Now using t to denote the *average* value of the circumferential tension, so that

$$t = p_i r_i/(r_o - r_i),$$

then

$$\frac{t_i}{t} = \frac{r_o^2 + r_i^2}{r_i(r_o + r_i)}, \quad \frac{t_i - t}{t} = \frac{r_o}{r_i}\,\frac{r_o - r_i}{r_o + r_i} \quad . \; . \; (10)$$

thus showing that the maximum tension t_i may exceed the average tension t by a considerable amount; and it is this *maximum* tension t_i which must be carefully watched and kept down below a certain working value; so that, with given t_i, the maximum allowable pressure in the tube is given by

$$p_i = t_i \frac{r_o^2 - r_i^2}{r_o^2 + r_i^2} .$$

This is the formula now used in the design of a hydraulic press, or of a thick tube, of bore $2r_i$, to stand an internal pressure p_i; t_i being fixed by the strength of the material, and then r_o being calculated.

We notice that p_i is always less than t_i, so that a tube, however thick, cannot stand, if unsupported, an internal pressure greater than the working tenacity of the material.

But, as the pressures in gunnery often exceed the tenacity of any known material, the requisite strength must be provided by an initial compression of the tube due to shrinking on one or more cylindrical jackets.

(9) Fig. 2 is drawn representing graphically the state of stress set up in a tube A by an external applied pressure ϖ_o, as in the tube or flue of a boiler by the external pressure of the water, or in the internal tube of a gun by the shrinkage pressure of the outside jacket.

Denote by ρ_i and ρ_o the inner and outer radii of the tube A, and by ρ any intermediate radius.

The stress at any point of the tube will now consist of a radial pressure ϖ, and of a circumferential *pressure* τ, represented by the ordinates of the curves $\varpi_o\varpi\varpi_i$, $\tau_o\tau\tau_i$; and dividing the tube by a diametral plane $\rho_o\rho_i O\rho_i\rho_o$, and considering the equilibrium of inch length of either half, we shall find as before that the area $\rho_i\tau_i\tau_o\rho_o$ = the rectangle $O\varpi_o = \varpi_o\rho_o$; while considering the equilibrium of any coaxial cylindrical portion, bounded by the radii ρ_o and ρ, then the area $\rho\tau\tau_o\rho_o$ = rectangle $O\varpi_o$ − rectangle $O\varpi$; or, in the notation of the Integral Calculus—

$$\int_\rho^{\rho_o} \tau d\rho = \varpi_o\rho_o - \varpi\rho \; ; \quad \ldots \ldots \quad (11)$$

leading, by differentiation with respect to ρ, to

$$\tau = - d(\varpi\rho)/d\rho \; ; \quad \ldots \ldots \ldots \quad (11^*)$$

the general solution of which can, as before, be exhibited in the form—

$$\varpi = \beta + \alpha\rho^{-2}, \; \tau = \beta - \alpha\rho^{-2}, \quad \ldots \ldots \quad (12)$$

or

$$(\varpi - \tau)\rho^2 = 2\alpha, \; \varpi + \tau = 2\beta,$$

where α and β are arbitrary constants, determined from the values of the arbitrary pressures applied to the interior and exterior surfaces.

(10) Now with $\varpi_i = 0$,

$$0 = \beta + \alpha\rho_i^{-2}, \; \varpi_o = \beta + \alpha\rho_o^{-2} \; ;$$

so that

$$\alpha = \frac{-\varpi_o}{\rho_i^{-2} - \rho_o^{-2}}, \; \beta = \frac{\varpi_o\rho_i^{-2}}{\rho_i^{-2} - \rho_o^{-2}} \; ;$$

and then

$$\varpi = \beta + \alpha\rho^{-2} = \varpi_o \frac{\rho_i^{-2} - \rho^{-2}}{\rho_i^{-2} - \rho_o^{-2}}, \quad \ldots \quad (13)$$

$$\tau = \beta - \alpha\rho^{-2} = \varpi_o \frac{\rho_i^{-2} + \rho^{-2}}{\rho_i^{-2} - \rho_o^{-2}}, \quad \ldots \quad (14)$$

$$\tau_o = \varpi_o \frac{\rho_i^{-2} + \rho_o^{-2}}{\rho_i^{-2} - \rho_o^{-2}} = \varpi_o \frac{\rho_o^2 + \rho_i^2}{\rho_o^2 - \rho_i^2}, \quad \ldots \quad (15)$$

$$\tau_i = \varpi_o \frac{2\rho_i^{-2}}{\rho_i^{-2} - \rho_o^{-2}} = \varpi_o \frac{2\rho_o^2}{\rho_o^2 - \rho_i^2}. \quad \ldots \quad (16)$$

Given, then, τ_i the maximum allowable crushing pressure of the material, then

$$\varpi_o = \tau_o(\rho_o^2 - \rho_i^2)/2\rho_o^2 = \tfrac{1}{2}\tau_o(1 - \rho_i^2/\rho_o^2) \quad \ldots \quad (17)$$

is the maximum allowable external pressure on the tube.

(11) If we make $\rho_o = r_i$ and $\varpi_o = p_i$, the tube A of Fig. 2 may be supposed to be gripped by the cylinder B of Fig. 1, of which only the upper halves need now be shown, as in Fig. 3; and now Fig. 3 will represent the cross-section of a tube, A, over which a jacket, B, has been shrunk, as at the breech end of an ordinary field-gun, and will represent graphically the stresses set up when the pressure, $\varpi_o = p_i$, at the common surface, is supposed known; these are called the *initial stresses*, or stresses of repose; the internal pressure at the radius ρ_i and the external pressure at the radius r_o being zero, as the atmospheric pressure is insensible in our calculations.

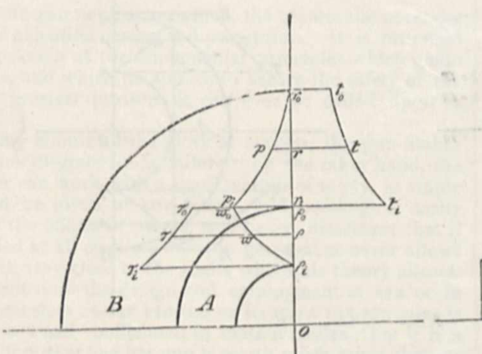

FIG. 3.

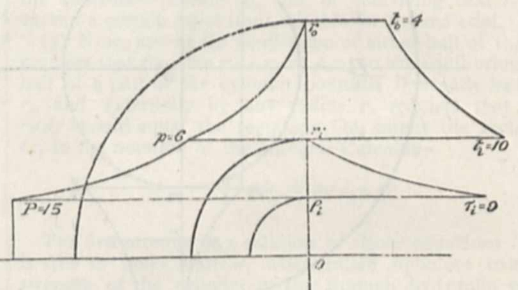

FIG. 4.

In Fig. 3 we notice that the total pull resistance across the section r_or_i, represented by the area $r_ot_ot_ir_i$, is equal to the total thrust resistance of the section $\rho_o\rho_i$, represented by the area $\rho_o\tau_o\tau_i\rho_i$, and each of these is equal to the resultant pressure thrust represented by the area of the rectangle Op_i.

(12) Now, suppose a pressure P (say 15 tons on the square inch) is applied at the interior of the tube, either by the steady pressure of water, as in a hydraulic press, or by the momentary pressure of gunpowder, as in the bore of a gun.

We suppose that the additional stresses due to this pressure, P, which we shall call the *powder stresses*, are the same as those which would be set up in a homogeneous cylinder of internal radius ρ_i, and external radius r_o, by a steady pressure, P; and these powder stresses will therefore, by what precedes, in equations (6), (7), (8) (Fig. 1), at a distance r from the axis, consist of a radial pressure—

$$P \frac{r^{-2} - r_o^{-2}}{\rho_i^{-2} - r_o^{-2}}, \quad \ldots \ldots \quad (18)$$

and a circumferential tension—

$$P \frac{r^{-2} + r_o^{-2}}{\rho_i^{-2} - r_o^{-2}}, \quad \ldots \ldots \quad (19)$$

having a maximum value at the bore of

$$T = P \frac{\rho_i^{-2} + r_o^{-2}}{\rho_i^{-2} - r_o^{-2}}.$$

We must superpose these powder stresses on the initial stresses of the compound cylinder to obtain the stresses when the cylinder is used as a gun (or hydraulic press); these are called the *firing stresses*, and they are exhibited graphically in Fig. 4.

(13) We now see the reason for setting up initial stresses in the gun by shrinking a jacket over the interior tube.

For the maximum circumferential tension at the bore on firing is reduced by the initial stresses from

$$T = P\frac{\rho_i^{-2} + r_o^{-2}}{\rho_i^{-2} - r_o^{-2}} \text{ to } P\frac{\rho_i^{-2} + r_o^{-2}}{\rho_i^{-2} - r_o^{-2}} - \varpi_o \frac{2\rho_i^{-2}}{\rho_i^{-2} - \rho_o^{-2}}, \quad . \; (20)$$

while at the interior of the jacket the circumferential tension is altered from

$$P\frac{r_i^{-2} + r_o^{-2}}{\rho_i^{-2} - r_o^{-2}} \text{ to } P\frac{r_i^{-2} + r_o^{-2}}{\rho_i^{-2} - r_o^{-2}} + p_i \frac{r_i^{-2} + r_o^{-2}}{r_i^{-2} - r_o^{-2}}. \quad . \; . \; (21)$$

The maximum stresses in the gun are thereby equalized to a great extent, and material can be economized.

(14) Thus, with $\rho_i/\rho_o = r_i/r_o = \frac{1}{2}$, and $P = 15$, the powder stresses are given by circumferential tensions—

$$T = \tau_i = 17, \qquad t_i = 5 ;$$

so that, with a shrinkage pressure $\omega_o = p_i = 3$, the principal firing stresses are given by circumferential tensions—

$$\tau_i = 17 - 8 = 9, \text{ a great reduction on } 17,$$
$$t_i = 5 + 5 = 10,$$

while

$$\tau_o = 5 - 5 = 0,$$
$$t_o = 2 + 2 = 4.$$

We need not consider the radial pressures for practical purposes.

To equalize these maximum tensions, $\tau_i = 9$ and $t_i = 10$, the tube might be made slightly thicker and the jacket thinner, or else the shrinkage pressure ω_o or p_i slightly diminished, keeping to the same bore and external diameter.

(15) We have thus shown how the initial stress, the powder stress, and the firing stress at any point of a gun composed of a tube and a single jacket is found, and exhibited graphically in Figs. 3 and 4.

The curves in the figure are seen to be all similar to a curve whose equation is of the form $y = ax^{-2}$, now called the Barlow curve.

When the gun is built up of three or more concentric cylinders, the method of procedure is the same; the initial pressure between the cylinders may be supposed known from the amount of shrinkage given in the manufacture; and now, taking any intermediate cylinder of the gun under initial pressures p_i and p_o at the internal and external surfaces, of radii r_i and r_o, we erect ordinates to represent p_i and p_o, and draw the Barlow curve joining their ends.

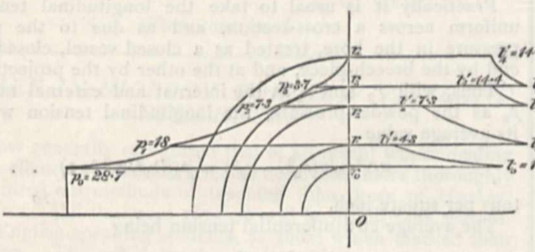

FIG. 5.

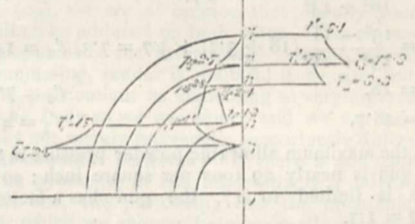

FIG. 6.

The Barlow curve representing the circumferential tension or pressure will always appear as an equal reflection of the pressure curve, the position being assigned so as to make the area of the circumferential *tension* curve equal to $p_i r_i - p_o r_o$; and it may happen that this area may vanish or become negative, showing that some or all of the initial circumferential tensions are really pressures.

(16) But practically the gun-maker reverses this procedure; with him it is the maximum circumferential firing tension t_i of a tube or hoop which is limited by the strength of the metal; so that, starting with these t_i's, as given, he calculates the pressures between the successive coils of the gun, proceeding inwards, and finally determines the maximum allowable powder pressure in the interior of the bore.

Afterwards he subtracts the powder stresses from these firing stresses, and thus obtains the initial stresses in the gun; and then from these initial stresses he calculates the amount of shrinkage to be given to the coils or hoops to obtain the requisite state of initial stress. But we shall show subsequently that the requisite amount of shrinkage is given just as simply from the firing stresses as from the initial stresses; so that henceforth we need only determine the firing stresses.

(17) Then Fig. 5 represents the maximum allowable firing stress over the powder-chamber of the American 8-inch gun, shown in cross-section, as composed of an inner tube, A, over which a jacket, B, and two hoops, C and D, have been shrunk on.

In practice, the maximum allowable tension in the jacket and hoops is restricted to 18 tons per square inch, but in the inner tube to 15 tons per square inch, so as to allow for erosion of the bore, the weakening due to the rifling grooves, and the possible failure of the tube.

(18) In the notation of the "Text-book of Gunnery," 1887, by Major Mackinlay, R.A., supposing there are n cylinders in the cross-section of the gun, the successive radii of the cylindrical surfaces, beginning from the outside, are denoted in inches by $r_n, r_{n-1}, \ldots, r_2, r_1, r_0$; and the firing pressures at the surfaces of separation are denoted by $p_{n-1}, \ldots, p_2, p_1$; and p_0 finally denotes the powder pressure at the radius r_0 of the bore.

We notice that there is no sudden change in the value of the radial pressure; but that the circumferential tension, t, changes suddenly from one cylinder to the next.

As we are concerned principally with the *maximum* tensions, which occur practically at the inner surface of a cylinder, we denote them, proceeding inwards, by $t_{n-1}, t_{n-2}, \ldots t_2, t_1, t_0$; and we shall suppose them to change suddenly to $t'_{n-1}, t'_{n-2}, \ldots t'_2, t'_1$, in proceeding inwards to the next cylinder.

(19) Starting from the outside cylinder, the stress formulas give, since $p_n = 0$,

$$p_{n-1} = ar_{n-1}^{-2} + b, \qquad 0 = ar_n^{-2} + b,$$

while

$$t_{n-1} = ar_{n-1}^{-2} - b, \qquad t'_n = ar_n^{-2} - b;$$

so that

$$p_{n-1} = a\left(r_{n-1}^{-2} - r_n^{-2}\right),$$
$$t_{n-1} = a\left(r_{n-1}^{-2} + r_n^{-2}\right),$$

or

$$p_{n-1} = \frac{r_{n-1}^{-2} - r_n^{-2}}{r_{n-1}^{-2} + r_n^{-2}} t_{n-1}, \quad \ldots \ldots (22)$$

giving p_{n-1} when t_{n-1} is assigned by its maximum allowable value.

Also

$$t_{n-1} - t'_n = p_{n-1}, \quad \ldots \ldots (23)$$

giving t'_n, if required for the diagram.

Proceeding inwards to the next cylinder, we have (with different values of a and b)—

$$p_{n-2} = ar_{n-2}^{-2} + b, \qquad p_{n-1} = ar_{n-1}^{-2} + b,$$
$$t_{n-2} = ar_{n-2}^{-2} - b, \qquad t'_{n-1} = ar_{n-1}^{-2} - b;$$

so that, eliminating the a and b, first b and then a,

$$p_{n-2} - p_{n-1} = a\left(r_{n-2}^{-2} - r_{n-1}^{-2}\right),$$
$$t_{n-2} + p_{n-1} = a\left(r_{n-2}^{-2} + r_{n-1}^{-2}\right),$$

and therefore, by division,

$$p_{n-2} - p_{n-1} = \frac{r_{n-2}^{-2} - r_{n-1}^{-2}}{r_{n-2}^{-2} + r_{n-1}^{-2}} (t_{n-2} + p_{n-1}),$$

or

$$p_{n-2} = \frac{r_{n-1}^{2} - r_{n-2}^{2}}{r_{n-1}^{2} + r_{n-2}^{2}} (t_{n-2} + p_{n-1}) + p_{n-1}, \quad (24)$$

giving p_{n-2} when p_{n-1} is known, and when t_{n-2} is assigned by its maximum allowable value in practice.

Also

$$t_{n-2} - t'_{n-1} = p_{n-2} - p_{n-1} \quad \ldots \quad (25)$$

thus determining t'_{n-1}; a knowledge of t'_{n-1} is required when we come to the determination of the amount of shrinkage necessary to produce p_{n-1}.

Proceeding successively in this manner, we finally obtain—

. . . .

$$p_2 = \frac{r_3^2 - r_2^2}{r_3^2 + r_2^2}(t_2 + p_3) + p_3 \quad . \quad . \quad . \quad . \quad \text{(iii.)}$$

$$p_1 = \frac{r_2^2 - r_1^2}{r_2^2 + r_1^2}(t_1 + p_2) + p_2 \quad . \quad . \quad . \quad . \quad \text{(ii.)}$$

$$p_0 = \frac{r_1^2 - r_0^2}{r_1^2 + r_0^2}(t_0 + p_1) + p_1 \quad . \quad . \quad . \quad . \quad \text{(i.)}$$

thus determining p_0, the maximum allowable powder pressure in the gun, for maximum working values of $t_0, t_1, t_2 \ldots t_{n-1}$; and these are the fundamental equations employed in gun-making.

(20) With no shrinkage, or a homogeneous gun, the maximum allowable powder pressure would be reduced to

$$t_0 \frac{r_n^2 - r_0^2}{r_n^2 + r_0^2},$$

so that we perceive the advantage of the shrinkage in strengthening the gun.

(21) In Fig. 5 the dimensions are taken from the American "Notes on the Construction of Ordnance," No. 31, by Lieut. Rogers Birnie, slightly altered to round numbers; the diameter of the powder-chamber of the 8-inch gun is supposed to be 10 inches; so that $r_0 = 5$; and we put $r_1 = 7$, $r_2 = 11$, $r_3 = 13$, $r_4 = 16$; instead of 4·75, 7, 11, 13·15, and 15·75, as given in the Note 31.

Now, solving equations (25), (iv.), (iii.), (ii.), (i.) with $p_4 = 0$, $t_3 = t_2 = t_1 = 18$, $t_0 = 15$, we shall find—

$$p_3 = \frac{16^2 - 13^2}{16^2 + 13^2} \times 18 = 3{\cdot}7, \qquad t'_4 = 14{\cdot}3;$$

$$p_2 = \frac{13^2 - 11^2}{13^2 + 11^2}(18 + 3{\cdot}7) + 3{\cdot}7 = 7{\cdot}3, \quad t'_3 = 14{\cdot}4;$$

$$p_1 = 18, \qquad t'_2 = 7{\cdot}3;$$

$$p_0 = 28{\cdot}7, \qquad t'_1 = 4{\cdot}3.$$

Thus, the maximum allowable powder pressure in the chamber of this gun is nearly 29 tons per square inch; so that if the pressure is limited to 17, the gun has a factor of safety $29 \div 17 = 1{\cdot}7$.

Joining the tops of the ordinates for p_0 and p_1, t_0 and t'_1, &c., by Barlow's curves, we have the graphical representation of the maximum allowable firing stresses of this gun; in which it must be noticed that the area of the rectangle, $p_0 r_0 = 143{\cdot}5$, is equal to the area of all the circumferential tension curves bounded by the jagged edge $t_0 t'_1 t_1 t'_2 \ldots$

(22) With a powder pressure $p_0 = 28{\cdot}7$ (tons on the square inch) the powder stresses will be given by

$$t_0 = \frac{16^2 + 5^2}{16^2 - 5^2} \times 28{\cdot}7 = 34{\cdot}9,$$

$$p_1 = p_0 \frac{7^{-2} - 16^{-2}}{5^{-2} - 16^{-2}} = 13{\cdot}1,$$

$$t_1 = t_0 - p_0 + p_1 = 19{\cdot}3 = t'_1;$$

$$p_2 = 3{\cdot}5, \quad t_2 = 9{\cdot}7 = t'_2;$$

$$p_3 = 1{\cdot}0, \quad t_3 = 7{\cdot}2 = t'_3;$$

and

$$p_4 = 0, \quad t_4 = 6{\cdot}2.$$

Subtracting these powder stresses from the firing stresses, we are left with the initial stresses in the gun in a state of repose, represented in Fig. 6, and given by

$p_0 = 0$,	$t_0 = -19{\cdot}9$,	
$p_1 = 4{\cdot}9$,	$t'_1 = -15$,	$t_1 = -1{\cdot}3$;
$p_2 = 3{\cdot}8$,	$t'_2 = -2{\cdot}4$,	$t_2 = -8{\cdot}3$;
$p_3 = 2{\cdot}7$,	$t'_3 = 7{\cdot}2$,	$t_3 = 10{\cdot}8$.
$p_4 = 0$,	$t'_4 = 8{\cdot}1$,	

(23) The data to which the gun-maker works are, first, the calibre of the gun; and secondly, the maximum powder pressure to be expected at any point of the bore; from these data, and the quality of the steel at his command, and also from the capacity of his machinery in producing and shaping the various pieces, the gun-maker proceeds to calculate the requisite thickness and number of the coils, arranged so that the maximum working tension shall not exceed certain practical limits laid down (18 tons per square inch in the coils, and 15 in the tube).

Thus, suppose he is called upon to design the cross-section of a gun over the powder-chamber, 10 inches in diameter, to stand a pressure of 20 tons per square inch.

He will generally take a factor of safety, say 2, and allow for double the pressure, so that he puts $p_0 = 40$, and then $t_0 = 15$.

He has r_0 given as 5 inches, and now r_1 is settled by the manufacture of the solid steel block or log, which is bored out to form the inner tube A; and now he can calculate p_1 and t'_1.

Practical considerations of manufacture decide the thickness and external radius r_2 to be given to the jacket B; and now, knowing r_1, r_2, p_1, and $t_1 = 18$, he can calculate p_2 and t'_2.

Similar practical metallurgical and manufacturing considerations decide the most suitable thickness for the hoops C, D, . . . ; and when he finds the radial pressure has become zero (or negative) the gun-maker knows that he has given his gun sufficient thickness and strength.

(24) A rule, suggested by Colonel Gadolin, was originally found convenient, by which the radii of the coils were made to increase in geometrical progression; this rule, though useful when guns were formed of a steel tube strengthened with wrought-iron hoops, is obsolete now that steel is used throughout; it was, however, formerly employed as a first approximation in the tentative solution of the problem.

The Longitudinal Stress in the Gun.

(25) So far we have not yet taken into account the distribution of longitudinal tension in the gun; and it must be confessed that no satisfactory rigorous theory exists at present for the determination.

Practically it is usual to take the longitudinal tension as uniform across a cross-section, and as due to the powder-pressure in the bore, treated as a closed vessel, closed at one end by the breech-piece, and at the other by the projectile.

Thus, with r_0 and r_2 as the internal and external radii, and p_0 as the powder-pressure, the longitudinal tension will have its average value

$$\pi r_0^2 p_0 / \pi(r_2^2 - r_0^2) = p_0/(r_2^2/r_0^2 - 1) \quad . \quad . \quad . \quad (26)$$

tons per square inch.

The average circumferential tension being

$$p_0 r_0/(r_2 - r_0),$$

this longitudinal tension will be

$$\frac{r_0^2}{r_2^2 - r_0^2} \cdot \frac{r_2 - r_0}{r_0} = \frac{r_0}{r_2 + r_0}$$

of the average circumferential tension, reducing to one-half in a thin cylinder, in which we may put $r_2 = r_0$.

For this reason it was formerly considered safe to leave the longitudinal strength to take care of itself; but some alarming failures, in which the gun on firing drew out like a telescope, have shown the necessity of carefully hooking the coils together, to provide the requisite longitudinal strength.

The larger the gun, the greater the number of separate parts requisite in its construction, and the greater the difficulty of providing for longitudinal strength.

(26) By taking a simple cylindrical tube under given internal and external pressures, and supposing it closed by hemispherical ends, a certain theory of distribution of longitudinal tension can be constructed.

For while the cylindrical part has the same transverse stresses as previously investigated, the stresses in the hemispherical ends may be considered the same as would be produced if they were joined up into a complete spherical vessel, under the same applied pressures.

A similar procedure to that already given for the cylinder is shown by Rankine ("Applied Mechanics," § 275) to lead to radial pressure $p = ar^{-3} + b$, and tension $t = \frac{1}{2}ar^{-3} - b$, in all directions perpendicular to the radius r.

For equation (2) for the cylinder becomes modified in the sphere to

$$\int_{r_i}^{r} 2\pi r t dr = \pi r_i^2 p_i - \pi r^2 p \; ; \quad . \quad . \quad . \quad . \quad . \quad (27)$$

or, differentiating with respect to r,

$$2rt = -d(r^2p)/dr$$
$$= -2rp - r^2dp/dr,$$

or

$$t = -p - \tfrac{1}{2}rdp/dr. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (28)$$

(27) The first assumption of Barlow, that there is no cubical compression, gives $t = \frac{1}{2}p$; and therefore

$$dp/p + 3dr/r = 0,$$

or

$$pr^3 = a, \text{ a constant,}$$
$$p = 2t = ar^{-3}.$$

Rankine's second assumption of uniform hydrostatic stress gives $t = -p$; and therefore

$$dp/dr = 0, \; p = b, \text{ a constant.}$$

Hence, in the general case,

$$p = ar^{-3} + b, \; t = \tfrac{1}{2}ar^{-3} - b; \quad . \quad . \quad . \quad . \quad (29)$$

where a and b are determined from the given values p_i and p_o of the internal and external applied pressures; so that

$$p_i = ar_i^{-3} + b, \quad p_o = ar_o^{-3} + b,$$

$$a = \frac{p_i - p_o}{r_i^{-3} - r_o^{-3}}, \quad b = \frac{p_o r_o^3 - p_i r_i^3}{r_o^3 - r_i^3} \quad . \quad . \quad (30)$$

(28) We may now take $\frac{1}{2}ar^{-3} - b$ to represent the longitudinal tension at radius r in the cylindrical part of the closed vessel.

Unfortunately for the strict mathematical accuracy of this method, we must suppose the circumferential tension to change suddenly from its value given from the formula $ar^{-2} - b$ to one given by a formula of the form $\frac{1}{2}a'r^{-3} - b'$, in passing from the cylindrical part to the hemispherical end.

A. G. GREENHILL.

(*To be continued.*)

STUDIES IN BIOLOGY FOR NEW ZEALAND STUDENTS.[1]

IT is now generally recognized that of all recent works dealing with elementary natural science, none have more thoroughly revolutionized our methods of teaching than those of Huxley, well known; and the years 1875–77 will be for all time memorable to English-speaking students, as those which marked their publication. The principles therein laid down are now so well known and generally adopted, that explanation of them would be here superfluous. In his work on "Physiography" the author points out (preface, p. viii.) that any intelligent teacher will have no difficulty in making use of the resources of his surroundings, in the manner and to the end laid down by himself; and this, in the long run, is the refrain of the method by which he has effected the revolution alluded to. So far as external evidences go, this wise counsel appears to have been nowhere more readily acted upon than in New Zealand.

Prof. Hutton, now of Christchurch, New Zealand, early took the hint; and, in so doing, produced the first of the series of pamphlets now under consideration. He chose for his purpose the Shepherd's Purse (cf. NATURE, vol. xxiv. p. 188), and Prof. Parker, who succeeded him, has, in turn, prepared notes serial with those of his predecessor—upon "The Bean Plant" (1881), and now upon "The Skeleton of the New Zealand Crayfishes." During the interval between the publication of Prof. Parker's pamphlets there appeared the third of the series, entitled "The Anatomy of the Common Mussels (*Mytilus latus*, *edulis*, and *magellanicus*)." This, the work of Alex. Purdie, and the least didactic of the series, was originally presented as a thesis for the degree of M.A. in the University of New Zealand.

The pamphlets alluded to are illustrated—in the case of that before us, by six clear woodcuts; and those of Parker, with which we need now alone be concerned, chiefly depart from the precedent laid down by Huxley in their less rigid adherence to the single type organism chosen for study. Wherever parts of this are, by adaptive change, so modified as to be non-typical in structure, Parker has introduced supplementary descriptions of corresponding parts of less modified allies. The necessity for this mode of procedure is now generally recognized; and the only danger to be averted in the future is that of unconscious reversion to the old condition of the "*omnium gatherum* of scraps." Let the type organism be always adhered to as closely as possible. Prof. Parker has exercised, in the matter, a wise discretion; and, having availed himself of the researches of Boas, has given to the world of carcinologists a laboratory guide which cannot fail to be of great service to them. The arthropods of the genus *Palinurus* happen to have furnished him, a few years ago, with material for original observation; the results of his inquiry are brought to bear upon the needs of the beginner in the pamphlet before us, and the value of the latter is thereby enhanced.

In dealing with the morphology of the eye-stalk (and of the pre-oral region generally), Prof. Parker states the alternative views, and gives the names of their leading upholders. Although he adopts the belief that the ophthalmic and antennulary regions of the arthropod body do not form the first and second metameres, and introduces, in accordance therewith, a revised nomenclature, his remarks, when dealing with the real point at issue, are so framed as to leave the mind of the student unbiassed. And moreover, he has so arranged his book that consideration of this vexed question in morphology is deferred until the concluding paragraph. This is as it should be. He naïvely summarizes the position in the words:—

"The fact of the eye-stalk bearing a flagellum seems to prove conclusively that it and the antennule are homologous. The question then resolves itself into this: Are the eye-stalks and antennules appendages in the ordinary sense, *i.e.* lateral offshoots of the first two metameres, or are they to be looked upon as prostomial appendages comparable with the tentacles of Chætopods and the antennæ of insects?"

Mindful of comments upon the general question raised in the above, which have already appeared in this journal (NATURE, vol. xxxv. p. 506), we are of opinion that equally good arguments are still to be adduced on both sides. The extraordinary facts of development of the invertebrate nervous system which are now accumulating, render it doubtful if we are justified in regarding the prostomium as something so very different from the rest of the body as we are wont; and we are led to ask whether it may not merely represent a precociously differentiated portion of the common perisoma? If there is any truth in the belief that the symmetry of the bilateralia is a laterally compressed radial one, the probability that the prostomium may represent that which we suggest becomes vastly increased; and it is worthy of remark that that lobe in some Chætopods (*Nemodrilus*, *Phreoryctes*) so far conforms to the characters of a body segment as to become externally subdivided. Nor must it be forgotten that the *Catometopa* bear (especially the *Ocypodidæ*), an optic style which would appear to present us, in its variations, with a series of conditions transitional between that of the eye-stalk of Milne-Edwards's *Palinurus* (to which Parker appeals in seeking to show that that appendage and the antennules are homologous) and that of the ordinary podophthalmatous forms.

We congratulate the students of the University of Otago upon the good use which, in their interests, their Professor has made of the advice of his distinguished master. We cannot, however, allow to pass unnoticed the statement (p. 7) that the seventh abdominal somite (by which term Prof. Parker designates the telson) bears appendages only in Scyllarus. This is not the case, as has been previously pointed out in these pages (NATURE, vol. xxxii. p. 570). The supposed appendages, did they exist, would be at least peri-proctous in position; and, as there is reason to believe the antennules (which Parker, be it remembered, admits to be serially homologous with the ophthalmites) to have been originally peri-stomial, if not meta-stomial, the supposed peri-proctous appendages might, with equal reason, be denied homology with the other abdominal members.

Finally: the altered position of the sterna in the anterior cephalic region and the consequent displacement of their appendages is said to be "a result of the *cephalic flexure*, by which, in the embryo, the anterior cephalic sterna become bent strongly upwards." Allowance has not yet been made, in dealing with this question, for the fact that, in the Decapods, these changes are greatly exaggerated by the general enlargement of the cephalo-thoracic region, consequent upon the aggregation therein of the more important and specialized viscera, and upon specialization of the thoracic appendages for ambulation.

G. B. H.

[1] "Studies in Biology for New Zealand Students." No. 4. "The Skeleton of the New Zealand Crayfishes (*Palinurus* and *Paranephrops*)." By T. J. Parker, B.Sc., F.R.S., of the University of Otago. (Wellington: Colonial Museum and Geological Survey Department. London: Trübner and Co.)

THE MANCHESTER WHITWORTH INSTITUTE.

THE inaugural proceedings in connection with the formal organization and constitution of the Manchester Whitworth Institute took place on Thursday last, July 17. Among those present were Lord Hartington, Sir F. Leighton, Sir Joseph C. Lee, Sir J. J. Harwood, Mr. W. Mather, M.P., Sir Henry Roscoe, M.P., Mr. O. Heywood, and many representatives of educational institutions in the city.

The governors first held their inaugural gathering in the building which is to form part of the museum, and which stands in one corner of the park. Afterwards, a meeting was held in a tent in the park. At this meeting Lord Hartington said that, although he had not been aware that he would be called upon to address them before the evening proceedings, he was pleased to move a resolution which acknowledged the wise benevolence and generosity of the legatees of Sir Joseph Whitworth, and commended the Institute to the support of the public as subscribers and donors of works of art and books, and to the community of Manchester for a contribution from its municipal funds for maintenance. He described the new departure taken that day as of a very important and possibly momentous character—probably the most important and ambitious step which had been taken yet in the direction of the movement of technical and scientific instruction and art education. That undertaking was the embodiment of a great idea, and the charter of the institution appeared to have embodied the ancient idea of a University, under which various colleges independent of one another agreed to co-operate in a common management and government, while retaining a considerable independence for a common end and a common good. In one respect, however, the ancient course seemed to have been reversed, for the University was prepared to support the colleges, which were the technical and art schools, instead of the colleges supporting the University, as of old. In conclusion, he expressed a hope that the example of the Whitworth legatees would lead others, and especially the Corporation, to assist and promote the useful objects of the Institute.

The proceedings connected with the opening of the Institute were continued in the evening, when the Mayor entertained a distinguished company at a banquet in the Town Hall. The loyal toasts having been honoured,

The Mayor proposed the residuary legatees of the late Sir Joseph Whitworth.

Chancellor Christie, in responding, said it was the earnest desire of the late Sir Joseph Whitworth that his fortune should be employed in promoting the cause of education, and especially of science and art education. He desired that there should be a graduated system of schools and colleges, by which a deserving lad might rise from the lowest elementary school to the highest institutions for the teaching of science, literature, or art. How best to accomplish this exercised Sir Joseph Whitworth for many years, but he was never able to perfect a scheme. That work he left to his legatees, and they had already spent over £300,000 in carrying out what they believed to be his ideas, while other liabilities still remained.

Mr. Alderman Thompson proposed "Success to the Whitworth Institute."

The Marquis of Hartington, in responding, said that his connection with the question of technical education was an extremely slight and superficial one. He did not pretend to be be an expert on the matter, and he had only taken it up because he had been struck with the fact that every other country in Europe gave more time and money to the promotion of technical education in some form or another than did the English nation. This state of things was coincident with complaints of the great severity of the commercial and industrial competition to which we were exposed. He could not help asking himself whether there was any connection between our neglect of technical education and the increased severity of the competition to which we were exposed. Then there was another question. Suppose the severity of the commercial competition were due to other causes, were we giving ourselves every chance in neglecting the technical education of our industrial population? He thought it was scarcely possible to exaggerate the importance of this question. To us the maintenance of our place in the race of commercial and industrial competition was not a question of greater or less prosperity at any particular moment; it was not a question of being leader or follower in the world's civilization; it was for many millions of our population a question of actual existence. If, through any circumstances, we ceased to be the greatest producers of the necessaries the world required; if, through any circumstances, we ceased to be the greatest distributors of the wealth of the world, not only would these small islands cease to be the seat of a great empire, but their limited extent would fail to produce the materials of bare existence for millions of people whom our industrial supremacy alone had brought together and enabled to exist here. We had received from our predecessors a great inheritance—the commercial and industrial leadership of the world. Up to the present time that inheritance had not shrunk or dwindled. Our pre-eminence had been largely due to the natural advantages we had enjoyed, but we knew that the conditions of supremacy, such as we had hitherto enjoyed were not always permanent. History taught us that in ancient times Greece and her colonies, and in modern times Italy and Holland, enjoyed that commercial supremacy which had more lately been ours. That supremacy had passed away from those countries under the changing conditions of commercial and industrial enterprise in Europe, and it would be rash to predict that our natural advantages, to which we owed so much, were sure to continue. It would be impossible for human foresight to make adequate protection against what might happen, but it must be a great advantage to any nation when the leaders and captains of its industries and commercial pursuits were able to avail themselves of the most complete scientific education which it was possible to give. It was such considerations as these that had induced him upon more than one occasion to call the attention of his fellow-countrymen to the importance of this question. He could not pretend to do more. How these things were to be attained he left to experts to say. We might have long to wait before, by the action of the State, any measures would be taken which we might hope would place us on a footing as regarded technical and scientific education with other European nations, and it therefore gave him the greatest satisfaction to see that localities where the need was more especially felt had themselves taken the initiative, and had founded institutions for the purpose of making some advance in that which had been considered to be the business of the State in other countries. There was one feature of the present time which was calculated to give cause for just and legitimate satisfaction. He alluded to what he thought he saw in the growth of local public spirit. Such a spirit had never been altogether wanting among us. That it existed formerly among us was abundantly proved by the munificent foundations for religious, educational, and charitable purposes which our forefathers had handed down. There was a time when there was a tendency for even these ancient foundations to lapse into lethargy, and mismanagement began to prevail, but all that had begun to change, and now we had not only been occupied in reforming the abuses of those old foundations and institutions, so as to make them fully available for the new and growing wants of the people, but there had been shown to exist at the present time to as great an extent as formerly a disposition on the part of individuals who had acquired wealth in certain localities to use that wealth not for any selfish or personal purpose, but for the benefit and advantage of that population in the midst of which they had lived. He doubted not that the example which had been set by men like Sir Joseph Whitworth would be largely followed.

Sir Frederick Leighton also responded.

WEIGHTS, MEASURES, AND FORMULÆ USED IN PHOTOGRAPHY.

THE Photographic Convention of the United Kingdom, at a meeting held in the Town Hall, Chester, on June 26, considered the Report of a Committee which had been appointed to consider the weights, measures, and formulæ used in photography. The Committee consisted of W. Bedford, C. H Bothamley (Secretary), A. Cowan, A. Haddon, A. Levy, A Pringle, and G. Watmough Webster. The Report was drawn up by C. H. Bothamley. The following recommendations were unanimously adopted by the Convention:—

A. *Weights and Measures.*—(1) If the metric system be used, weights will naturally be expressed in grammes and measures in cubic centimetres.

(2) If the English units be used, the minim and the drachm should not be employed at all. All weights should be expressed either in grains or decimal parts of a grain, or in ounces and fractions of an ounce; all measures in fluid grains, or in fluid ounces and fractions of a fluid ounce.

B. *Formulæ.*—(3) Formulæ should give the number of *parts* of the constituents, by weight or measure, to be contained in some definite number of *parts, by measure,* of the solution. The mixture can then be made up with (*a*) grammes and cubic centimetres, or (*b*) grains and fluid grains, or (*c*) ounces and fluid ounces, according to the unit selected.

(4) The standard temperature for making up solutions should be 15° C. or 62° F. No appreciable error will be introduced by the fact that these two temperatures are not quite identical.

(5) Formulæ should give the quantities of the constituents to be contained in x parts of the finished solution, and not the quantities to be dissolved in x parts of the solvent. When a solid dissolves in a liquid, or when two liquids are mixed, the volume of the solution or mixture is, as a rule, not equal to the sum of the volumes of its constituents. The expansion or contraction varies with the nature of the solids and liquids and the proportions in which they are brought together. In making up a solution, therefore, the constituents should first be dissolved in a quantity of the solvent smaller than the required volume of the finished mixture, and after solution is complete, the liquid, cooled if necessary to the ordinary temperature, is made up to the specified volume by addition of a further quantity of the solvent.

(6) It is very important to specify, in the case of liquids, whether parts by weight or parts by measure are intended. The equivalence between weight and measure only holds good in the case of water and liquids of the same specific gravity: a fluid ounce of ammonia solution or of ether weighs less than an ounce; a fluid ounce of strong sulphuric acid weighs nearly two ounces.

(7) Whenever possible, formulæ should give the quantities of the constituents required to make up 10, 100, or 1000 parts of the solution.

(8) When a mixture (*e.g.* a developer) is to be prepared just before use from two or more separate solutions, it is desirable that the proportions in which the separate solutions have to be mixed should be as simple as possible—*e.g.* 1 to 1, 1 to 2, 1 to 3, 1 to 10.

(9) When metric units are employed, the original French spelling, "gramme," should be used in preference to the contracted spelling, "gram," in order to avoid misreading and misprinting as "grain."

SCIENTIFIC SERIALS.

In the *Journal of Botany* for June and July we find contributions to systematic and descriptive botany by Mr. E. G. Baker, on new plants from the Andes, and on the genera and species of Malveæ; by Mr. F. N. Williams, a synopsis of the genus *Tunica* of Caryophyllaceæ, and others.—Mr. A. Fryer records what he believes to be an example of hybridity in *Potamogeton.*—Mr. H. T. Soppitt describes a new parasitic fungus, *Puccinia digraphidis*, the teleutospore-form of which occurs on *Phalaris arundinacea*, while the æcidio-form is parasitic on *Convallaria majalis*.

The original papers in the *Nuovo Giornale Botanico Italiano* for July all refer to the geographical distribution of Italian plants, chiefly Hepaticæ and Fungi. Among the papers read at the meetings of the Italian Botanical Society the following are of special interest:—Signor O. Kruch contributes to our knowledge of the foliar fibrovascular bundles of *Isoetes.*—The exhaustive researches of Prof. Arcangeli on the structure of the various organs in the Nymphæaceæ are represented by an account of the leaves of *Nymphæa* and *Nuphar.*—Signor U. Martelli gives a very interesting account of the dissociation of a lichen (*Lecanora subfusca*) into its constituent algal and fungal elements, the complement of Stahl and Bonnier's observations on the synthesis of lichens.—Prof. Arcangeli describes the carnivorous habits of an Aroid, *Helicodiceros muscivorus*.

American Journal of Science, July, 1890.—The inconsistencies of utilitarianism as the exclusive theory of organic evolution, by Rev. John T. Gulick. The author criticizes various conclusions arrived at by Mr. Wallace in his volume on "Darwinism."—The southern extension of the Appomattox formation, by W. J. McGee. In a paper entitled "Three Formations of the Middle Atlantic Slope," published in this *Journal* in 1888, a distinctive late Tertiary formation well displayed on the Appomattox River in Eastern Virginia was defined and named after that river; and its principal characters, distribution, stratigraphical relations, and probable age were recorded. The present number contains the result of an extension of the research into the Carolinas, Georgia, Alabama, and Mississippi.—An experimental proof of Ohm's law, preceded by a short account of the discovery and subsequent verification of the law, by Alfred M. Mayer. The experiment described is very suitable for lecture demonstration, and all details are given. A low-resistance Thomson galvanometer is joined up to a box containing coils of 1, 2, and 3 ohms resistance, and to a coil of wire wound round a disk of wood which slides on an upright magnet 1·5 cm. in diameter. The quick movement of this coil causes the production of a magneto-electric current, and adopting the conception of the lines of magnetic force it may be said that a ring with one coil cuts a certain number of these lines, this cutting of the lines causes the current, and is the electromotive force. A ring with two, three, or four coils cuts two, three, or four times the number of lines, and increases the electromotive force in the same proportion. The resistance in the circuit can also be changed by means of the resistance coils, and hence it can be proved that the current is directly as the electromotive force and inversely as the resistance by observations of the galvanometer deflections.—Microscopic magnification, by W. Le Conte Stevens. If F be the equivalent focal length of the eye-piece of a microscope, f that of the objective, T the tube length, and D the distance of distinct vision, the magnification, M, is expressed by the formula $M = \frac{(D+F)(T-f)}{Ff}$.—Notes on the minerals occurring near Port Henry, N.Y., by J. F. Kemp.—Occurrence of goniolina in the Comanche series of the Texas Cretaceous, by Robert T. Hill.—A method for the reduction of arsenic acid in analysis, by F. A. Gooch and P. E. Browning.—On the development of the shell in the genus Tornoceras, Hyatt, by Dr. Charles E. Beecher.—Fayalite in the obsidian of Lipari, by Jos. P. Iddings and S. L. Penfield.—On some selenium and tellurium minerals from Honduras, by Edward S. Dana and Horace L. Wells. The locality from which the minerals were obtained is the El Plomo mine, Ojojoma District, Department of Tegucigalpa, Honduras. An analysis of one showed that it contained 29·31 per cent. of selenium and 70·69 per cent. of tellurium, the great proportion of selenium constituting it the nearest opproach to native selenium which has yet been found in nature. It is proposed to call this mineral selen-tellurium. Some tellurium-iron minerals are also described.—Some connellite from Cornwall, England, by S. L. Penfield.

American Journal of Mathematics, vol. xii., 4 (Baltimore, July 1890).—This number opens with a short note (pp. 323–336) on confocal bicircular quartics, by Prof. Franklin, and closes with a memoir on the theory of matrices, by H. Taber (pp. 337–396.) The memoir is a full investigation of the subject, touching upon the results already obtained by Cayley ("Theory of Matrices," *Phil. Mag.*, 1858), Hamilton ("Quaternions," 1852), the two Peirces, and Clifford. The writer was not aware of Buchheim's paper, with an identical title, in the London Mathematical Society's Proceedings (vol. xvi.) until after his own paper was written. There is much which is substantially the same in the two memoirs, but Mr. Taber claims to have "treated the whole subject more in detail and more systematically than Mr. Bucheim" (*sic*).

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, July 15.—M. Hermite in the chair. New studies on the rotation of the sun, by M. H. Faye. An account is given of Dr. Wilsing's observations of faculæ for the purpose of determining the time of rotation, and of the recent work done by M. Dunér, in which Fizeau's method was adopted.—On the photography of the polarization fringes of crystals, by MM. Mascart and Bouasse. A method of obtaining photographs of these fringes is described.—On the freezing of meat by cold liquids, by M. Th. Schlœsing. A new method for freezing and preserving large quantities of meat is described.—The active elasticity of muscle, and the energy used in its creation, in the case of dynamic contraction, by M. A. Chauveau.—On linear differential equations, by M. Cels.—Method of measuring the difference of phase of the rectangular components of a refracted light-ray, by M. Bouasse.—On the measurement of the vapour-tension of solutions, by M. Georges Charpy. The author uses the condensation hygrometer to determine indirectly the tension of the vapour above the solution employed.—On the laws of Berthollet, by M. Albert Colson.—Researches on the double nitrites of rhodium, by M. E. Leidié. Double nitrites of rhodium and potassium, sodium, ammonium, and barium respectively are described, methods of preparation and properties of each salt being given.—On some combinations of camphor with phenols and their derivatives, by M. E. Léger. Many of the compounds obtained yield crystals of definite form and constant composition, and are hence proved to be true compounds.—On mannite hexachlorhydrin, by M. Louis Mourgues. The method of preparation and properties of this body are given; its analysis indicates that it possesses the formula $C_6H_8Cl_6$. Raoult's method gives its molecular weight as 278; the writer is of opinion that its constitution corresponds to $CH_2Cl(CHCl)_4CH_2Cl$.—On some new derivatives of β-pyrazol; a contribution to the study of the nitric ethers, by M. Maquenne.—Researches on the division of the embryonic cellules among the Vertebrata, by M. L. F. Henneguy.—On the colouring reagents of the fundamental substances of membrane, by M. L. Mangin. The author compares the action of colouring matters of membrane with their chemical composition, and establishes the results furnished by the colouring reagents by chemical analyses of the tissues.—On the expansion of silica, by M. H. Le Chatelier. The experiments show that amorphous silica expands very little between 600° C. and 1000° C. Quartz expands regularly up to nearly 600°, and then reaches a point where increase of temperature causes contraction. Calcined chalcedony expands slowly up to 200°, then the coefficient of expansion is enormously increased for a time, but finally it returns to the original value. Tridymite behaves much like chalcedony, expanding slowly up to about 120°, when an abrupt change takes place; the slow expansion then returns again, and finally contraction takes place with increase of temperature. Thus the change in the coefficient takes place at a higher temperature in the minerals of high density (quartz, chalcedony) than for those of lower density (tridymite and calcined chalcedony).—Analysis of the menilite of Villejuif, by M. Auguste Terreil.—On the prediction of storms by the simultaneous observation of the barometer and the higher atmospheric currents, by M. G. Guilbert.

AMSTERDAM.

Royal Academy of Sciences, June 28.—Prof. van de Sande Bakhuyzen in the chair.—Dr. Beyerinck described experiments relating to the culture of Zoöchlorella, Lichen gonidia, and other lower Algæ in a pure state.—The same speaker treated of the artificial infection of *Vicia Faba* with *Bacillus radicicola*. Twelve pots filled with sterilized river-sand, which was rendered very poor in nitrogen by washing with distilled water, were divided into four sets, each of three. On April 25, a well-sterilized seed of *Vicia Faba* was planted in each pot. The pots were of such a construction that the dust of the air was wholly excluded from the sand, and the watering could also take place under perfect dust-exclusion. The first set was watered with a mixture of 0·1 monopotassium phosphate, 0·03 calcium chlorate, 0·06 magnesium sulphate, pro 1 litre distilled water; the second set with the same mixture; the third set with the same mixture, to which was added 0·2 gr. calcium nitrate; the fourth set with the same mixture, to which was added 0·2 gr. ammonium sulphate. When the plants had developed their second leaf, the three pots of the first set, and one single pot of each of the three latter sets, were infected with a gelatine culture of *Bacillus radicicola* var. *fabæ*, cultivated in 1889 from the tubercles of *Vicia Faba*, and since that time kept in successive cultures. The bacteria wherewith the infection took place were mixed with sterilized common water. On June 20 there was found on one old cotyledon a *Penicillium*, and therefore the experiment was not further continued. All the plants were taken from the pots, and their roots well washed and examined; every single one of the six infected plants bore many tubercles, whilst no single one of the six remaining not infected plants showed the least sign of tubercles. The presence or absence of nitrogen as nitrate or as ammonium is therefore indifferent with regard to the practicability of the infection. By another set of experiments it was shown that gelatine cultures of *Bacillus ornithopi*, cultivated in 1889 from the tubercles of *Ornithopus perpusillus*, had no power to infect *Vicia Faba*. But negative results are not equal to positive in value.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Evolution of Photography: J. Werge (Piper and Carter).—Higher Geometry, W. J. Macdonald (J. Thin).—Zoological Types and Classification: W. E. Fothergill (J. Thin).—Principles of General Organic Chemistry: Prof. E. Hjelt, translated by J. Bishop Tingle (Longmans).—Philosophy of Tumour Disease: C. Pitfield Mitchell (Williams and Norgate).—Diseases of Crops and their Remedies: A. B. Griffiths (G. Bell and Sons).—Principles of Economics, vol. i.: A. Marshall (Macmillan and Co.)—Elementary Text-Book of Heat and Light: R. Wallace Stewart (W. B. Clive and Co.).—Quarterly Review, July (Murray).—The Forum, July (New York).—Electrical Engineer's Pocket-Book: H. R. Kempe (Lockwood).—Monograph of the British Cicadæ, Part III.: G. B. Buckton (Macmillan and Co.).

CONTENTS.