THURSDAY, AUGUST 12, 1886

CENTRAL AMERICAN ENTOMOLOGY

Biologia Centrali-Americana. Insecta: Coleoptera. Vol. III. Part 2, "Malacodermata," by the Rev. Henry Stephen Gorham, F.Z.S., &c. (1880–86.) Vol. V. "Longicornia," by Henry Walter Bates, F.R.S. "Bruchides," by David Sharp, M.B. (London: R. H. Porter, 1879–86.)

TWO more instalments of the entomological portion of this great work show how earnestly it is being pushed on; and if it can be completed on the same lavish scale of illustration, and with the same thoroughness of execution, it will afford materials for a true conception of the richness of insect life in the tropical regions far beyond anything that has been hitherto attempted. Not only will it be superior to any other work of a similar character, but it will probably surpass in magnitude all the other works dealing with tropical insect-faunas combined.

The plan and method of treatment being exactly the same as that of Mr. Bates's volume on the Cicindelidæ and Carabidæ, already reviewed in NATURE (vol. xxxiii. p. 77), it will only be needful here to make a few remarks on points of general interest. Taking first the Malacodermata—a group represented in Britain by our Telephori, "soldiers and sailors," our glow-worm, and other allied forms—Mr. Gorham informs us that nearly one-fourth of all the known species of the world are here described from Central America, a preponderance in this district which is due no doubt to the fact that the group has never been a favourite one among coleopterists, and has thus been comparatively little attended to by collectors in the tropics. The large number of 813 species here enumerated as against 1272 of the favourite Longicornes, shows that it is not impossible that this tribe may one day rank among the richest groups of beetles. From a comparison of certain of the best known families in different parts of the world Mr. Gorham is of opinion that the total number of species in the tribe is not less than 12,000. He also states that the tropical American forms are as a whole very distinct from those of Africa and the Eastern tropics, and that they rank as "persistent forms of an earlier stage of development." This is specially interesting, because it agrees so well with the fact that nowhere else in the world do low forms of mammalia and birds constitute so large a proportion of a wonderfully rich fauna as in tropical America. Another suggestive remark is, that whenever "a genus is common to Central or South America and other distant parts of the world, it is also the case that it is represented by a species also identical or nearly so in both districts." Many examples are given of this interesting fact, and the no doubt correct solution is suggested, that in these cases there must have been a comparatively recent transmissal, either from one country to another, or from some common centre to both. The Miocene beetles of Switzerland exhibit so close a resemblance to living forms that we may well suppose these identical species to have been common to Europe and North America in Miocene times, and to have passed southward to the Old and New World tropics respectively when the temperate zones became unsuitable to them.

Of Longicornia about 9000 species are known, so that those from Central America alone are nearly one-seventh of the whole; but in this tribe more perhaps than any other is our knowledge imperfect, owing to the bulk of the species being restricted to the virgin forests, where they are very local and marvellously specialised; while though exceedingly abundant under favourable conditions—that is, when extensive clearances in the forest have been *recently* made—yet at other times they are so scarce that it is impossible to obtain even a moderate collection of them.

Mr. Bates remarks on the wonderful "endemicity" of the tropical American Longicorn fauna, 304 genera out of 330 being exclusively American; while both he and Mr. Gorham insist on the whole of the Central American fauna, including that of the highlands of Mexico, having tropical rather than north-temperate affinities. As regards the Malacodermata, however, the northern parts of Mexico are said to be "totally unexplored," while Mr. Bates states that there are 30 northern generic forms which reach Mexico but rarely go further south.

The Bruchides form a small tribe of usually minute beetles which have been so imperfectly collected in the tropics that no comparisons of any value can be made. No less than 150 species are here enumerated, forming nearly one-fourth of all that are yet known, and nearly 120 of these are new species, 25 of which are figured.

On looking over the beautifully executed coloured plates, on which nearly 500 new species of Longicornes are figured, we are struck by the great preponderance of protective tints in these insects, whole plates being filled with species of delicately mottled brown or grey colours evidently harmonising with the varying hues and rugosities of the tree trunks on which they rest; while those of more elegant forms and brilliant tints are usually of smaller size, except when they gain protection by their resemblance to other inedible insects. It fortunately happens that the other group treated in these volumes—the Malacodermata—are very largely, if not wholly, such a protected group, it having been found by experiment that birds will not eat our gay-coloured Telephori, and Mr. Belt found the same to be the case with the fire-flies of Nicaragua and their allies. In all parts of the world these insects are mimicked by others which have no such protection, and it is interesting to compare the plates in these two volumes and to see how many of the Longicornes have taken on the form and colouring of the Malacoderms. Whenever I noticed a pair which undoubtedly resembled each other, I turned to the descriptions, and in every case found that they inhabited the very same locality. Thus the Longicorn *Otheotethus melanurus* imitates the Malacoderm *Lucidota discolor*, both found at Chontales, the species mimicked having however, as is usual, a wider range. *Tethlimmena aliena* and *Lygistopterus amabilis*, another mimicking pair, are both recorded from Chontales only. *Callia albicornis*, from Panama, resembles two species of Malacoderms, *Silis chalybeipennis* and *Colyphus signaticollis*, both from Panama, and both taken on the Volcano de Chiriqui. If these last two are both inedible, it is a case among the Coleoptera similar to the numerous interesting cases of protected genera of Heliconoid butterflies resembling each other, the theory of which has been so lucidly explained by Dr. Fritz Müller (see NATURE, vol. xxvi. p. 87, and vol. xxvii. p. 481). A genus of Longicornes has been named *Lycidola*, and its eight known species are all said to resemble species of *Lycus*. Besides these there are at least a score of Longicornes which are evidently mimickers, though the exact species imitated does not happen to be represented on the plates. There are also many of the smaller species which evidently mimic ants or wingless Mutillidæ. Three such species are named by Mr. Belt, and two of these are figured, but they do not appear to resemble ants half so much as at least a score of other species; showing how difficult it is to determine whether a species is protectively coloured by means of figures, however carefully drawn and coloured. The extensive collections on which these volumes are founded would, I feel sure, afford a mass of interesting cases of mimicry if search were made for them, since, besides those already mentioned, there seems to be a considerable number of Longicornes which resemble some of the Cleridæ figured among the Malacodermata, and these also are probably cases of mimicry, although I am not aware that the Cleridæ have been proved to be an uneatable group.

Looking at the copious series of figures here given there does not seem to be any superiority of colouring over the corresponding Eastern groups. The much larger proportion of Cerambycidæ to Lamiidæ in tropical America gives it an advantage over the Eastern tropics, because the former family comprises most of the elegant forms and gay colours of the tribe; but notwithstanding their inferiority in this respect the Longicornes of Penang, of Java, and of New Guinea appear to be quite equal in their development of colour to those of Central America.

The present work has been got up at so great an expense both of time, labour, and money to its originators, Messrs. Godman and Salvin, that it must be considered one of the noblest individual contributions to the study of natural history that has ever been made. Its great bulk and cost must, however, render it inaccessible to many students who would wish to possess it, while its value to them would have been considerably increased if descriptions of all the recorded species had been given as well as of those which are new, rendering it a complete book of reference to the Insecta of Central America.

I would therefore suggest to Messrs. Godman and Salvin that they would confer a still greater boon on entomological students if they could make arrangements for the preparation of a series of compact octavo volumes giving the letterpress only of the present work, together with either the original descriptions or sufficient diagnoses of all the species enumerated which are not here described. These volumes could be issued after the completion of the great work, all brought up to one uniform date; and if published at a moderate price they would be sure to command a very large sale. Complete faunal hand-books of the kind suggested are among the most generally useful works that can be published, because they obviate the enormous waste of time and labour involved in consulting scores of expensive volumes in order to determine the name and history of perhaps half the insects which a student may possess.

It is quite unsafe to venture on any detailed criticism of the work of one so thoroughly acquainted with Longicorn Coleoptera as Mr. Bates, but my attention was attracted to Table II. by the figures of two alleged female Prionidæ, which are represented of a rich green colour, while the respective males are bronzy olive. If this is the fact, it is a curious case of reversed sexual coloration, though by no means unprecedented. In one of these species, *Mallaspi belti*, however, two varieties are figured, one green, the other olive brown, both said to be females; but the green specimen (as figured) differs greatly from the brown specimen, in having the femora of the second pair of legs much longer and more slender, in the somewhat different dentation of the thorax, and especially in the very different form of the scutellum, important differences which seem inconsistent with identity of species. Should any error have crept into the plates, the author will no doubt be glad to have his attention called to it.

ALFRED R. WALLACE

GEOMETRICAL OPTICS

An Elementary Treatise on Geometrical Optics. By W. Steadman Aldis, M.A. (London: Deighton, Bell, and Co., 1886.)

THIS is a second edition of a work which appeared first in 1872, and which was designed to meet the requirements of students reading for the first three days of the Mathematical Tripos. The new edition does not differ greatly from the old, except in form. The type is larger and clearer, and in this respect the book is considerably improved.

The laws of reflection and refraction, and the reflection and refraction of direct pencils at plane and spherical surfaces, are treated in a clear and comprehensive manner. In Article 36 reference is made to a useful method of illustrating from co-ordinate geometry the relations between a point and its image. If ϕ, ϕ' be the principal focal lengths of an optical system, u and u' the distances of an object and its image from the principal points, we have $\frac{\phi}{u} + \frac{\phi'}{u'} = 1$. Thus taking rectangular axes, and measuring along them distances ϕ and ϕ', we see that u and u' are the intercepts on the axes made by a straight line passing through the point ϕ, ϕ'. This has been worked out in an interesting paper in the *Philosophical Magazine* for December 1884, by Prof. J. Loudon, of Toronto.

The next chapter deals with the oblique reflection and refraction of small pencils. The general explanation is extremely lucid, but it surely is a mistake not to have introduced the notation of the differential calculus. Of course this is excluded from the first three days of the Tripos, but so too are oblique reflection and refraction, and the work is rendered unnecessarily cumbersome by the omission. A similar remark may apply to some of the sections of the next chapter on refraction through prisms and plates.

Chapter VI. treats of lenses, which are dealt with in the ordinary manner. This part of the book would have been improved by the introduction of some of the geometrical results in which the main consequences of Gauss's work have been expressed by various writers. It is really a misfortune that the theory of principal and nodal points is so little known to English authors. It is clearly explained in Mr. Pendlebury's book on lenses, but that does not include other parts of the subject, and is somewhat needlessly long.

The book concludes with an account of some simple optical instruments, dispersion and achromatism, and the geometrical theory of the rainbow.

OUR BOOK SHELF

New Commercial Plants and Drugs. By T. Christy, F.L.S., &c. No. 9. (London: Christy and Co., 1886.)

THIS pamphlet of 73 pages treats for the most part of medicinal products, though some consideration is also given to fodder and food-plants, essential oils, india-rubber, and various others. The first article is devoted to the Doundake (*Sarcocephalus esculentus*), a West African Rubiaceous plant, which has attracted some attention of late in cases of nervous paralysis. The root has been analysed by Messrs. Heckel and Schlagdenhauffen, and their analysis is given together with a reproduction of the two plates which accompanied their paper. Two new perfume oils come under consideration, namely, from *Eucalyptus staigeriana* and *Backhousia citriodora*. The first is a Queensland tree, and is known as the lemon-scented iron bark. The odour of the leaves is said to be exactly like that of the lemon-scented verbena, and the oil yielded by them is identical in fragrance with that from *Andropogon citratus*, or lemon-grass oil, which is imported into this country both from Ceylon and Singapore, where the plants are very extensively cultivated. Mr. Christy says that "the odour of the oil of this tree is quite different from that of *Eucalyptus citriodora*, which resembles, and might be substituted for, citronella oil, so extensively used for perfuming soap." The *Backhousia* oil is described as being like that of *Eucalyptus staigeriana*, and upon being tested for scenting soaps it was found to answer well, and would probably find a ready market in this country if it could be imported at a price to compete with ordinary verbena oil. It might realise 1*s*. 4*d*. to 2*s*. per pound.

The Kava root (*Piper methysticum*) of the Fiji Islands, which is so well known for the disgusting ceremonies which, in former times perhaps more than the present, accompanied its preparation, has of late years been introduced amongst us for its medicinal properties. The active principle of the Kava root appears to reside in a resinous substance extracted with alcohol. From a series of experiments it seems that this principle is a substance of very great importance as a local anæsthetic, but that in larger doses it produces a scaly affection of the skin. From the Kava root a spirit or liqueur has been distilled, and this under the name of Yagona is on sale at the refreshment bars of the present Colonial and Indian Exhibition.

Another new drug which probably has a future before it is the Kombe of Central Africa (*Strophanthus hispida* or *S. Kombe*) which has been proved to be of considerable value in affections of the heart. The first communication relating to the physiological action of this drug was made by Prof. Fraser to the Royal Society of Edinburgh in 1870, which was followed in 1885 by a more elaborate paper at the Cardiff Meeting of the British Medical Association. There seems, however, even after this lapse of time to be a difficulty in obtaining the seeds in quantity, or even the right species, several forms having been introduced from the Gold Coast, Sierra Leone, and other parts of Africa; the chief difference lies in the seed, some forms of which are covered with long, fine silky hairs.

Mr. Christy's pamphlet, like its predecessors, is a useful record of newly introduced and useful plants.

Heidelberg gefeirt von Dichtern und Denkern seit fünf Jahrhundesten. Herausgegeben von Albert Mays. (Heidelberg, 1886.)

IT was a happy thought of the compiler of this volume to collect and publish on the five hundredth anniversary of the foundation of the University of Heidelberg a selection of what has been written about the city and the University by eminent men of various nations at different periods of time. A collection of all that has been written about the ancient city and its lovely situation would, Herr Mays says, fill a respectable library, for besides histories in verse of the Palatinate and its capital there are innumerable tales, novels, and the like based on incidents in its history, and lyrical and historical poems on Heidelberg by the hundred. In making a selection from this vast mass of matter, the compiler has only retained poems or descriptions which are of special poetical or literary value, or those which are of special interest on account of the author, or, finally, those which exhibit some special originality or peculiarity. But even when thus winnowed a handy volume is left. Needless to say, the vast majority of the writers are German; there are a few English, and one American (Longfellow). The list commences with an extract from the Bull of Pope Urban VI. of October 23, 1385, authorising Prince Rupert to found the University. This is followed by extracts from over sixty authors arranged chronologically. Herr Mays notices as a curiosity that not one of these is French. The English authors naturally dwell on the castle, "next to the Alhambra of Granada the most magnificent ruin of the Middle Ages," rather more than on the University; but indeed the German writers do the same. The book will show the good people of Heidelberg, if they lack such knowledge at this festive season, that they are citizens of no mean city. It should also prove an interesting memento to many in Europe and America who have passed a few years at the most impressionable period of their lives at the old University, which, with its sister at Bonn, has of late years drawn the British student away from Göttingen.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Organic Evolution

FOR some time I have much desired to direct the attention of your readers all over the world to the two very remarkable articles on Organic Evolution, by Mr. Herbert Spencer, which appeared in the April and May numbers of the *Nineteenth Century*. I hope they will be separately published. They mark in my opinion a new departure in the Philosophy which has been built up by a certain school of writers on the Darwinian Theory. Let me explain what I mean.

From the first discussions which arose on this subject I have ventured to maintain that the successors of Darwin have run quite wild from the teaching of their master—that his Hypothesis, even if completely true so far as it went, offered no adequate explanation whatever of the multiform and complicated facts of Organic Evolution—that the phrase "natural selection" represented no true physical cause, still less the complete set of causes requisite to account for the orderly procession of organic forms in Nature; that in so far as it assumed variations to arise by accident it was not only essentially faulty and incomplete, but fundamentally erroneous; in short, that its only value lay in the convenience with which it groups under one form of words, highly charged with metaphor, an immense variety of causes, some purely mental, some purely vital, and others purely physical or mechanical.

The violence with which false interpretations were put upon this Theory and a function was assigned to it which it could never fulfil, will some day be recognised as one of the least creditable episodes in the history of science. With a curious perversity it was the weakest elements in the Theory which were seized upon as the most valuable, particularly the part assigned to blind chance in the occurrence of variations. This was valued not for its scientific truth,—for it could pretend to none,—but because of its assumed bearing upon another field of thought and the weapon it afforded for expelling Mind from among the causes of Evolution.

There have been many symptoms that this Philosophy is breaking down. Mr. Herbert Spencer, although he has worked out the consequences of Evolution with enthusiasm, has never been blind to some of its defects. His mind is too closely analytical not to be brought into contact at many points, with its manifest inapplicability and its wordy hollowness.

But in these two articles we have for the first time an avowed and definite declaration against some of the leading ideas on which the Mechanical Philosophy depends; and yet the caution, and almost the timidity, with which a man so eminent approaches the announcement of conclusions of the most self-evident truth—is a most curious proof of the Reign of Terror which had come to be established.

I cannot in this letter indicate the breadth and sweep of the admissions now made by Mr. Herbert Spencer in the two articles referred to,—fatal to the adequacy of the Mechanical Philosophy as any explanation of organic evolution. They cluster round, and follow from the central admission that "the words 'natural selection' do not express a cause in the physical sense." Another great admission is that the "co-operation" which is required in the growth and development of useful parts, cannot be accidental.

Of course, now that so eminent a man as Mr. Herbert Spencer has opened his eyes and his mouth to these—and many other—admissions, we shall have all the *Dii Minores* following suit.

I have read with great pleasure an article in your last number (p. 314) on "Physiological Selection," with an "additional suggestion on the origin of species." I rejoice that the author has at last discovered that "natural selection has been made to pose as a theory of the origin of species, whereas in point of fact it is nothing of the kind." This has been my contention for many years. ARGYLL

Aurora

WITH reference to the aurora of July 27, accounts of which appear in NATURE, vol. xxxiv. pp. 311 and 312, the following particulars of the accompanying magnetic disturbance recorded here may be of interest. The disturbance commenced about 3 p.m. on July 27 with small fluctuations in declination and horizontal force, followed by larger movements which commenced sharply at 10.20 p.m. in all three elements, and continued to about 7 a.m. on July 28. The greatest movement was between 10.20 and 11.30 p.m., amounting to 45′ in declination, ·011 of the horizontal force, and ·005 of the vertical force. Corresponding earth-currents were recorded as usual.

W. H. M. CHRISTIE

Royal Observatory, Greenwich, August 10

Mock Suns

KINDLY add the following, to make up for omission of my figure in your issue of July 29 (p. 289):—

The "arched eyebrows," as I called them, can best be described thus—

Resting on the top of the halo circle, where the third mock light stood, was a bow of peculiar curve. It was like two well-arched eyebrows flowing together by a curve of gentle dip at the point where it touched the halo. Each arch was about equal to one-eighth part of the halo circle in every respect except that its centre lay about the middle of the chord joining the upper mock light with the mock light on that side of the sun. The contrariflexure, and the anomalous positions of the two centres of the two arches, strike me as very noteworthy. I cannot presume to guess at an explanation.

May I add that a correspondent of the *Standard* states that he too saw the white ray on the *left* side; and that it stretched, to use his expression, "round the sky almost to the east, and at the end of it was another mock sun much less brilliant," where it "seemed about to begin a fresh series of mock suns and circles." This too seems to me too striking a feature to be lost to record in NATURE. W. J. HERSCHEL

Littlemore, August 2

Meteors

ON August 4, 10h. 40m., a beautiful slow meteor was seen here threading its way from about 2° S. of o Ursæ Majoris to very slightly below β Aurigæ. Its light fluctuated greatly, but at its best it must have been brighter than Jupiter, though the effect was much marred by mist. The most noteworthy feature was its extreme slowness of movement; a careful determination gave 8 seconds as the time it remained in sight. There was no train of any sort; the meteor rolled along with a star-like aspect, and its velocity near the end point became so much impeded that it seemed almost stationary. I observed fifty-seven other meteors during the same night, but none of these could be associated in appearance and direction with the one specially described. Its radiant-point was probably in Ursa Major, close to β, at about 162° + 59°.

On August 6, 10h. 3m., a meteor equal to Jupiter was seen pursuing a long path just south of and nearly parallel to α and ϵ Pegasi. It left a bright streak, and was a conspicuous object, notwithstanding the moonlight. The radiant-point was at about 32° + 17°, nearly 6° S.S.E. of α Arietis, or possibly in the extreme east boundaries of Aries.

It would be important to hear of duplicate observations of these large meteors. In the eastern parts of England they must have appeared very bright, and being visible at a convenient hour in the evening many persons will have noticed them.

Bristol, August 9 W. F. DENNING

LAST night at about eleven o'clock a fine meteor was visible here through an opening in clouds. Its path was in Aquarius, commenced a little to the east of η, and seemed to be in the direction of a line joining η and δ. In three or four seconds the meteor passed over about 20°, and it left momentarily a trail over the last 10°. This was slightly curved, the convex side being to the east, and the colour varying from yellow for a quarter of the curve to red during the remainder. At first the meteor resembled Saturn in size and colour, then became larger, whiter, and afterwards pale blue, and when it finally disappeared behind the clouds it considerably exceeded Venus at her brightest, both in size and brilliance. L. J. H.

Ramsey, Isle of Man, August 5

PHYSIOLOGICAL SELECTION: AN ADDITIONAL SUGGESTION ON THE ORIGIN OF SPECIES[1]

II.

NEXT, let it be observed that we cannot expect to meet with much direct evidence of physiological selection from our domesticated varieties. For, first, breeders and horticulturists keep their strains separate artificially, and preserve many kinds of variation other than those of the reproductive system with which alone we are concerned; and, secondly, it is never the aim of these men to preserve this particular kind of variation. Therefore, all that we can here learn from our domesticated productions is the paramount importance of preventing intercrossing with parent forms, if a new varietal form is ever to gain a footing. No one of these domesticated varieties could have been what it now is unless such intercrossing had been systematically prevented by man; and this gives us good reason to infer that no natural species could have been what it now is unless every variety in which every species originated had been prevented from intercrossing with its parent form by nature. For the cases are extremely rare in which one species differs from another (living or extinct) in respect of any feature so highly utilitarian in character as to justify belief that the newer species owed its differentiation to natural selection having been able to overcome the swamping effects of free intercrossing.

[1] Abstract of a Paper read before the Linnean Society on May 6, by George J. Romanes, M.A., LL.D., F.R.S. &c. Continued from p. 316.

Again, as to plants and animals in a state of nature, the particular variation with which we are concerned would scarcely be noticed until it had given rise to a new species. In this respect, therefore, the theory of physiological selection is in the same predicament as that of natural selection: in neither case are we able directly to observe the formation of one species out of another by the agency supposed; and, therefore, in both cases our belief in the agency supposed must to a large extent depend on the probability established by general considerations. Nevertheless, although our sources of direct evidence are thus seen to be necessarily limited, I shall now hope to show that they are sufficient to prove the only fact which they are required to prove—namely, that the particular kind of variation, on the occurrence of which my theory depends, does occur both in nature and under domestication.

One very obvious example of the particular variation which is required by the theory of physiological selection has already been given in the season of flowering or of pairing being either advanced or retarded. This I take to be a most important case for us, inasmuch as it is one that must frequently arise in nature. Depending as it chiefly does on external causes, numberless species both of plants and animals must, I believe, have been segregated by its influence. For in every case where a change of food, temperature, humidity, altitude, or of any of the other many and complex conditions which go to constitute environment—whether the change be due to migration of the species or to alterations going on in an area occupied by a stationary species—in every case where such a change either retards or promotes the season of propagation, there we have the kind of variation which is required for physiological selection. And it is needless to give detailed instances of such variation where this is due to so well known and so frequently observed a cause.

But it is on what may be called the spontaneous variability of the reproductive system itself that I mainly rely for evidence of physiological selection. The causes of variability are here much more numerous, subtle, and complex than are such extrinsic causes as those just mentioned; and they are always at work in the reproductive systems of all organisms. The consequence is, as Mr. Darwin has shown by abundant evidence, that variations in the direction of sterility depend more on what he calls the nature of the organism than on the influence of external conditions. Of this fact we have direct evidence, firstly in individuals, secondly in varieties, and thirdly in species.

(1) *Individuals.*—Mr. Darwin observes, "it is by no means rare to find certain males and females which will not breed together, though both are known to be perfectly fertile with other males and females. We have no reason to suppose that this is caused by these animals having been subjected to any change in their habits of life; therefore such cases are hardly related to our present subject. The cause apparently lies in an innate sexual incompatibility of the pair when matched." He then proceeds to give examples from horses, cattle, pigs, dogs, and pigeons, concluding with the remark that "these facts are worth recording, as they show, like so many previous facts, on what slight constitutional differences the fertility of an animal often depends." Elsewhere he gives references to similar facts in the case of plants; and instances of this individual incompatibility, both in plants and animals, might easily be multiplied.

Now, if even as between two individuals there may thus arise absolute sterility without there being in either of them the least impairment of fertility towards other individuals, much more may such incompatibility extend towards a number of individuals. For certainly the most remarkable feature about this individual incompatibility is the fact of its being only individual: it would not be nearly so remarkable, or antecedently improbable, if the incompatibility were to run through a whole race or strain. In the fact of individual incompatibility, therefore, we have the kind of variation which my theory requires, and this as arising spontaneously in the highest degree of efficiency.

(2) *Races.*—But of even more importance for us is the direct evidence of such a state of matters in the case of varieties, breeds, or strains. In the ninth chapter of the "Origin of Species," and in the nineteenth chapter of the "Variation of Plants and Animals under Domestication," Mr. Darwin adduces miscellaneous instances of varieties of the same species which exhibit a higher degree of fertility within themselves than they do with one another. In this respect, therefore, they resemble natural species; but as they are only domesticated varieties known to belong to the same species, they are here available as evidence of what may be termed racial incompatibility, or of the particular kind of variation which my theory requires. To quote only two instances: "The yellow and white varieties (of Verbascum) when crossed produce less seed than the similarly coloured varieties"; and the blue and red varieties of the pimpernel are absolutely sterile together, while each is perfectly fertile within itself. Such instances are the more suggestive on account of their arising under domestication, because, as a rule, domestication increases fertility, and is thus inimical to sterility—sometimes even breaking down the physiological barriers between natural species. Therefore, if in some cases even under domestication the reproductive system may vary in this manner, so as to erect physiological barriers between artificial varieties, much more are such barriers likely to be erected between varieties when these arise in a state of nature.

But as regards varieties in a state of nature, I have not been able to meet with any evidence of racial incompatibility. Nor is this to be wondered at: for, unless the degree of such incompatibility were well pronounced, it would not be noticed; while, if it were well pronounced, the two varieties would for this very reason be classified as species. Therefore, the fact of racial incompatibility within the limits of wild species could only be proved by experiments undertaken expressly for the purpose, in the way which I shall afterwards explain.

(3) *Species.*—According to the general theory of evolution, which in this paper is taken for granted, the distinction between varieties and species is only a distinction of degree; and the distinction is mainly, as well as most generally, that of mutual sterility. Therefore my theory of physiological selection is here furnished with an incalculable number of instances of the particular kind of variation which is required; for in so many instances as variation has led to any degree of sterility between parent and varietal forms—or between the varying descendants of the same form—in so many instances it is merely a statement of fact to say that physiological selection must have taken place. There remains, however, the question whether the particular change in the reproductive system which led to all these cases of mutual sterility was anterior or posterior to changes in other parts of the organism. For, if it was anterior, these other changes—even though they be adaptive changes—were presumably due to the sexual change having interposed its barrier to crossing with parent forms; while, if the sexual change were posterior to the others, the presumption would be that it was the latter which, by their reaction on the sexual system, induced the former. I shall have to consider this alternative later on. Here, therefore, it is enough to point out that under either possibility the principles of physiological selection must have been at work; only these principles are accredited with so much the more causal influence in the production of species in the proportion that we find reason to suppose the sexual change to have been, as a rule, the prior change. But under either alternative, and on the doctrine that species are extreme

varieties, we have many hundreds of thousands of instances of fertility within the varietal forms with sterility towards allied forms.

Probably enough has now been said to show that, as a matter of fact, the particular kind of variation in the reproductive system which is required by the theory of physiological selection does occur, firstly, in individuals; secondly, in races; and thirdly, in species. But the evidence of physiological selection as an agency in the evolution of species is so far only *primâ facie*. That is to say, although we have evidence to prove the occurrence of this particular kind of variation, and although we can see that whenever it does occur it must be preserved, as yet we have seen no evidence to show how far this kind of variation has been at work in the formation of species. I will, therefore, next proceed to give an outline sketch of the evidence which I have been able to find, tending to show that the facts of organic nature are such as they ought to be, if it is true that physiological selection has played any considerable part in their causation. And to do this I will begin by taking the three cardinal objections to the theory of natural selection with which I set out—namely, sterility, intercrossing, and inutility. For, as we shall see—and this in itself is a suggestive consideration—all the facts which here present formidable obstacles to the theory of natural selection, when this is regarded only as a theory of the origin of species, are not only explained by the theory of physiological selection, but furnish to that theory some of the best evidence which I have been able to find.

Argument from Sterility.—In what respects do species differ from one another? They differ firstly, chiefly, and most generally in respect of their reproductive systems: this, therefore, I will call the primary difference. Next, they differ in an endless variety of more or less minute details of structure, which are sometimes adaptive and sometimes not. These, therefore, I will call the secondary differences. Now, the secondary differences are never numerous as between any two allied species: in almost all cases they admit of being represented by units. Yet, if it were possible to enumerate all the specific differences throughout both the vegetable and animal kingdoms, there would be required a row of figures expressive of many millions. In other words, the secondary specific distinctions may occur in any parts of organisms, but never occur in many parts of the same organism. So that, if we have regard to the whole range of species, the secondary distinctions are seen to be, in the highest imaginable degree, variable or inconstant: the only distinction which is at all constant or general is the primary distinction, or the one which belongs exclusively to the reproductive system. Surely, therefore, what we primarily require in any theory of the origin of *species*, is an explanation of this relatively constant or general distinction. But this is just what all previous theories fail to supply. Natural selection accounts for some among the many secondary distinctions, but is confessedly unable to explain the primary distinction. The same remark applies to sexual selection, use and disuse, economy of growth, correlated variability, and so forth. Even the prevention of intercrossing by geographical barriers or by migration is unable to explain the very general occurrence of some degree of sterility between two allied varieties which have diverged sufficiently to take rank as different species. All these theories, therefore, are here in the same predicament: they profess to be theories of the origin of species, and yet none of them is able to explain the one fact which more than any other goes to constitute the distinction between species and species. The consequence is that most evolutionists here fall back upon a great assumption: they say it must be the change of organisation which causes the sterility—it must be the secondary distinctions which determine the primary. But the contrary proposition is surely at least as probable, namely, that it is the sterility which, by preventing intercrossing with parent forms, has determined the secondary distinctions—or, rather, that it has been the original condition to the operation of the modifying causes in all cases where free intercrossing has not been otherwise prevented. For, obviously, it is a pure assumption to say that the secondary differences have always been historically prior to the primary difference, and that they stand to it in the relation of cause to effect. Moreover, the assumption does not stand the test of examination, as I will now proceed to show.

(1) On merely *a priori* grounds it scarcely seems probable that whenever any part of any organism is slightly changed in any way by natural selection, or by any other cause, the reproductive system should forthwith respond to that change by becoming sterile with allied forms. Yet this is really what the assumption in question requires, seeing that *all* parts of organisms are subject to the secondary specific distinctions. What we find in nature is a more or less constant association between the one primary distinction and an endless profusion of secondary distinctions. Now, if this association had been between the primary distinction and some one—or even some few—secondary distinctions, constantly the same in kind; in this case I could have seen that the question would have been an open one as to which was the conditional and which the conditioned. But as the case actually stands, on merely antecedent grounds, it does not appear to me that the question is an open one. Here we have a constant peculiarity of the reproductive system, repeated over and over again—millions of times—throughout organic nature; and we perpetually find that when this peculiar condition of the reproductive system is present, it is associated with structural changes elsewhere, which, however, may affect any part of any organism, and this in any degree. Now, I ask, is it a reasonable view that the one constant peculiarity is always the result, and never the condition, of any among these millions of inconstant and organically minute changes with which it is found associated?

(2) But, quitting *a priori* grounds, it is a matter of notorious fact that in the case of nearly all our innumerable artificial productions, organisms do admit of being profoundly changed in a great variety of ways, without any reaction on the reproductive system following as a consequence.

(3) Again, as regards wild species, Mr. Darwin proves that "the correspondence between systematic affinity and the facility of crossing is by no means strict. A multitude of cases could be given of very closely allied species which will not unite, or only with extreme difficulty; and, on the other hand, of very distinct species which unite with the utmost facility." And he goes on to say that "within the limits of the same family, or even of the same genus, these opposite cases may occur"; so that "the capacity of the species to cross is often completely independent of this systematic affinity, that is, of any difference in their structure or constitution, excepting in their reproductive systems." Now, on the supposition that sterility between species is always, or generally, caused by the indirect influence on the reproductive system of changes taking place in other parts of the organism, these facts are unintelligible—being, indeed, as a mere matter of logic, contradictory of the supposition.

(4) Mr. Darwin further shows that, "independently of the question of fertility, in all other respects there is the closest general resemblance between hybrids and mongrels." Clearly, this fact implies that natural selection and artificial selection run perfectly parallel in all other respects, save in the one respect of reacting on the reproductive system, where, according to the views against which I am arguing, they must be regarded as differing, not only constantly, but also profoundly.

(5) Lastly, Mr. Darwin concedes—or rather insists—

that "the primary cause of the sterility of crossed species is confined to differences in their sexual elements." A general fact which assuredly proves that the primary specific distinction is one with which the organism as a whole is not concerned: it is merely a local variation which is concerned only with the sexual system. Why, then, should we suppose that it differs from a local variation taking place in any other part of the organism? Why should we suppose that, unlike all other such variations, it can never be independent, but must always be superinduced as a secondary result of changes taking place elsewhere? It appears to me that the only reason why evolutionists suppose this is because the particular variation in question happens to have as its result the origination of species; and that, being already committed to a belief in natural selection or other agencies as the causes of such origination, they are led to regard this particular kind of local variation as not independent, but superinduced as a secondary result of these other agencies operating on other parts of the organism. But once let evolutionists clearly perceive that natural selection is concerned with the origin of species only in so far as it is concerned with the origin of adaptive structures—or of some among the secondary distinctions—and they will perceive that the primary specific distinction takes its place beside all other variations as a variation of a local character, which may, indeed, at times be due to the indirect influence of natural selection, use, disuse, and so forth; but which may also be due to any of the numberless and hidden causes that are concerned with variation in general.[1]

I trust, then, that reasons enough have now been given to justify my view that, if we take a broad survey of all the facts bearing on the question, it becomes almost impossible to doubt that the primary specific distinction is, as a general rule, the primordial distinction. I say "as a general rule," because the next point which I wish to present is that it constitutes no part of my argument to deny that in some—and possibly in many—cases the primary distinction may have been superinduced by the secondary distinctions. Indeed, looking to the occasional appearance of partial sterility between our domesticated productions, as well as to the universally high degree of it between genera, and its universally absolute degree between families, orders, and classes, I see the best of reasons to conclude that in *some* cases the sterility between *species* may have been originally caused, *and in a much greater number of cases subsequently intensified*, by changes going on in other parts of the organism. Moreover, I doubt not that of the agencies determining such changes natural selection is probably one of the most important. But what does this amount to? It amounts to nothing more than a re-statement of the theory of physiological selection. It merely suggests hypothetically the cause, or causes, of that particular variation in the reproductive system with which alone the theory of physiological selection is concerned, and which, as a matter of fact, *howsoever caused*, is found to constitute the one cardinal distinction between species and species. Therefore I am really not concerned with what I deem the impossible task of showing how far, or how often, natural selection—or any other cause—may have induced this particular kind of variation in the reproductive system by its operations on other parts of an organism. Even if I were to go the full length that other evolutionists have gone, and regard this primary specific distinction as in all cases due to the secondary specific distinctions, still I should not be vacating my theory of physiological selection: I should merely be limiting the possibilities of variation within the reproductive system in what I now consider a wholly unjustifiable manner. For, as previously stated, it appears to me much the more rational view that the primary specific distinction is likewise, as a rule, the primordial distinction; and that the cases where it has been superinduced by the secondary distinctions are comparatively few in number.[1]

If we thus regard sterility between species as the result of what I have called a local variation, or a variation arising only in the reproductive system—whether this be induced by changes taking place in other parts of the organism, to changes in the conditions of life, or to changes inherent in the reproductive system itself—we can understand why such sterility rarely, though sometimes, occurs in our domesticated productions; why it so generally occurs in some degree between species; and why as between species it occurs in all degrees.

It rarely occurs in our domesticated productions because it has never been the object of breeders or horticulturists to preserve this kind of variation. Yet it sometimes does occur in some degree among our domesticated productions, because the changes produced on other parts of the organism by artificial selection do, in a small percentage of cases, react upon the reproductive system in the way of tending to induce sterility with the parent form, while not lessening fertility with the varietal form. Again, this particular condition of the reproductive system is so generally characteristic of species simply because in as many cases as it occurs it has constituted the reason why species exist as species. And, lastly, this particular variation in the reproductive system has taken place under nature in such a variety of degrees—from absolute sterility between species up to complete, or even to more than complete, fertility—because natural species, while being records of this particular *kind* of variation are likewise the records of all *degrees* of such variation which have proved sufficient to prevent overwhelming intercrossing with parent forms. Sometimes this degree has been less than at other times, because other conditions—climatic, geographical, habitatorial, physiological, and even psychological[2]—have co-operated to prevent intercrossing, with the result of a correspondingly less degree of sterility being required to secure a differentiation of specific type. Lastly, where species have been evolved on different geographical areas, or by use, disuse, and other causes of a similarly "direct" kind, there has been no need to prevent intercrossing in any degree; so that allied species formed under any of these conditions may still remain perfectly fertile, or even more than naturally fertile, with one another.

In view of these considerations, I should regard it as a serious objection to my theory if it could be shown that sterility between allied species is invariably absolute, or even if it could be shown that there are no cases of unimpaired fertility. What my theory would expect to find is exactly what we do find—namely, an enormous majority

[1] Mr. Darwin himself does not appear to have held the view against which I am now arguing—viz. that the primary distinction is always, or usually, superinduced by the secondary. Not even here, therefore, is his authority opposed to my views: upon this question his voice is merely silent.

[1] The paper here develops another line of argument which it is difficult to render in abstract. Its object, however, is to show that, even in the cases where the primary distinction is superinduced by the secondary—whether these cases are, as I believe, "comparatively few" or comparatively numerous—my theory is available to explain why the primary distinction is so habitual an accompaniment of the secondary distinctions, of whatever kinds or degrees the latter may happen to be. For, according to my theory, the reason of this association in such cases is that it can only be those kinds and degrees of secondary distinction which are able so to react on the reproductive system as to induce the primary distinction that are, *for this reason*, preserved. Or, otherwise expressed, in cases where the secondary distinctions induce the primary, the former owe their existence to the fact that they happened to be of a kind capable of producing this particular effect. Under this view, even in these cases it is the principles of physiological selection that have determined the kinds of secondary distinction which are allowed to survive. For these principles have, in all such cases, *selected* the particular kinds of secondary distinction which have proved themselves capable of so reacting on the reproductive system as to bring about the primary distinction—a general view of the subject which appears to be justified by the very general association between the two.

[2] See "Origin of Species," p. 81, where it is shown that among vertebrated animals different varieties of the same species, even when living on the same area, frequently exhibit a marked repugnance to pairing with one another. In the same passage, it is remarked the different varieties sometimes occupy different stations.

of instances where sterility occurs in all degrees, with a few exceptional instances where secondary distinctions have been able to develop without being associated with the primary distinction. So that, on the whole, I cannot but candidly consider that all the facts relating to the sterility of natural species are just what they ought to be, if they have been in chief part due to the principle which I am advocating. Mr. Darwin appears to have clearly perceived that there must be some one principle serving to explain all these facts—so curiously related, and yet so curiously diverse. For he says, and he says most truly, "We have conclusive evidence that the sterility of species must be due to some principle quite independent of natural selection." I trust I have now said enough to show that, in all probability, this hitherto undetected principle is the principle of physiological selection.

(*To be continued.*)

RED SUNSETS AND VOLCANIC ERUPTIONS

THE great volcanic eruption in New Zealand raises anew the question of the connection between volcanic eruptions and sunset phenomena arising from attenuated matter in the upper regions of the atmosphere. The theory that the noteworthy sunsets about the end of 1883 were due to the Krakatão eruption has been questioned on the ground that, in many parts of the world, these red sunsets have continued until the present time, though not with the same intensity as in 1883. Beautifully variegated sunsets have always been very common in this country. The result was that the sunset phenomena of 1883 did not appear to us as anything new in kind, but only as an intensification of something with which we were already familiar. In order to reach a decisive conclusion we must have observations made in regions where the upper atmosphere is exceptionally free from vapours or other attenuated matter. The advent of such matter can then be detected when it could not be detected at other places. Among such regions I would suggest South Africa, especially the Cape of Good Hope. During my brief residence there in November and December of 1882, nothing was more striking than the extreme whiteness and purity of the western twilight. If such a twilight is there the rule during the whole year, then any diffusion of volcanic vapour in the upper atmosphere must produce a very striking effect. I would therefore suggest to observers in that region the value of precise information on this point, especially with a view of learning to what extent, and within what time, the red sunsets of 1883 disappeared, and whether any such phenomena now reappear as the result of the volcanic eruption in New Zealand. S. NEWCOMB

MR. FORBES'S EXPEDITION TO NEW GUINEA

NATURALISTS will be glad to learn that a collection of natural history objects has been sent to England by our countryman Mr. H. O. Forbes, who has been doing good work on the Astrolabe Mountains in south-eastern New Guinea. Unfortunately a lack of proper support appears to have greatly crippled the efforts of this energetic traveller, who fears that he may be compelled to abandon his proposed expedition to Mount Owen Stanley, the ascent of which was the primary object of his explorations on leaving England. The disaster which befel Mr. Forbes at Batavia, where the boat with all his equipment for the expedition was capsized and everything lost, will be fresh in the recollection of our readers (see NATURE, vol. xxxii. p. 552), and it is only by the utmost display of courage and energy, and by a large pecuniary sacrifice on his own part, that Mr. Forbes has been able to fit out an expedition to New Guinea from Brisbane. It is to be hoped that the great Societies of this country and Australia will not allow this expedition to come to an end for lack of funds. Mr. Forbes has shown what he can do in the cause of science, and a little timely help would now enable him to conduct the work of exploration on which his soul is bent and bring it to a successful issue. It is not generally known in this country that during his last expedition to the Malay Archipelago he expended more than 600*l*. of his own money in endeavouring to render his expedition more complete, and nothing but a little generous encouragement is needed to enable him to sustain the serious pecuniary loss which has befallen him in his attempt to reach Mount Owen Stanley. At the time of writing, we hear that there is a prospect of Australia coming to the rescue and aiding Mr. Forbes towards the attainment of his object, and we trust that England will also do something for a man who, as an explorer and a naturalist, has reflected credit on his country.

The district recently explored by Mr. Forbes has been visited before by Mr. Goldie and Mr. Hunstein, the latter of whom has procured some remarkable novelties among the Birds of Paradise, which have been recently described by Dr. Finsch and Dr. Meyer (*Zeitsch. Ges. Orn.* ii. pp. 369-391). Hunstein has indeed penetrated further than Mr. Forbes was able to do on the present occasion, as the latter has as yet only worked the Sogeri district from a height of 1000 to 5000 feet, and this only in the rainy season.

Among the many interesting species found by Mr. Forbes in the Sogeri district may be mentioned *Harpyopsis novæ-guineæ*, Salvad, *Charmosyna stellæ*, Meyer, *Psittacella pallida*, Meyer (scarcely to be distinguished from *P. brehmi* of Mount Arfak), *P. madaraszi*, Meyer, *Eos incondita*, Meyer, *Parotia lawesi*, Ramsay, *Lophorina minor*, Ramsay, *Paradisornis rudolphi*, Meyer, *Amblyornis subalaris*, Sharpe, *Paradisea raggiana*, Sclater, *Microdynamis parra*, Salvad (*Rhamphomantis rollesi*, Ramsay), *Melidectes emilii*, Meyer, *Rallicula rubra*, Schlegel, and many other notable species, amongst which are two which appear to be undescribed, viz.,

Melirrhophetes batesi, sp. n.

M. similis *M. ochromelani*, Meyer, sed fasciâ supra-oculari cervina distinguendus. Long. tot. 9·3, culm. 1·35, alæ 4·8, caudæ 4·2, tarsi 1·15.

Pseudogerygone cinereiceps, sp: n.

P. similis *P. flavilaterali*, Gray, ex Novâ Caledoniâ, sed minor, et rectricibus haud subterminaliter albo-fasciatis distinguenda. Long. tot. 3·4, culm. 0·4, alæ 1·9, caudæ 1·2, tarsi 0·65.

It was a little unfortunate for Mr. Forbes that Mr. Hunstein should have visited the Horse-shoe Range so shortly before the arrival of the former in New Guinea, but it says much for the complete way in which Mr. Forbes does his work of exploration, that he should have obtained specimens of nearly every one of the new species discovered by Mr. Hunstein. Unfortunately the Birds of Paradise were out of colour at the time of his visit, but the specimens sent are of great interest, as showing the moults and changes of plumage in these birds. Of the extraordinary species known as Prince Rudolph's Bird of Paradise (*Paradisornis rudolphi*) with blue wings and blue flank-plumes, Mr. Forbes secured only one, apparently a female. As these surprising novelties have been discovered in the Astrolabe Range, which has an elevation of less than 5000 feet, what prizes and discoveries may not be awaiting the explorer if he reaches Mount Owen Stanley with an altitude of 13,000 feet? May he succeed!

R. BOWDLER SHARPE

THE PERSISTENT LOW TEMPERATURE

IT is seldom that the weather maintains such a decided persistency for temperatures below the average conditions. Week after week passes, and the thermometrical records are monotonously alike in chronicling low temperatures over the whole country.

The Weekly Weather Reports issued by the Meteorological Office are compiled from observations at stations fairly representative of the whole of the British Islands, and the results are grouped into twelve districts. These returns show that the low temperature is not limited to any special area of the United Kingdom, but is common to every part. From the middle of May to the beginning of August there was only one week, ending July 5, in which the temperature was above the average in the western districts of England, Ireland, or the Channel Islands, whilst in the period of seven months from January 4 to August 2 the temperature in the north-west and south-west of England and in the Channel Islands has only been above the average in three weeks—March 29, May 10, and July 5; and averaging the results for the whole of the British Islands, these are the only weeks in which the resultant temperature was above the average, and may fairly be considered the only warm periods during the seven months.

This persistency of low temperature is to be traced over the whole of the past twelve months, commencing with the beginning of August 1885. To the three warm weeks already mentioned there must be added those of November 9 and 30, December 21, and January 4, making seven in all, and these represent the only warm weeks throughout the entire period, and are the only weeks in which the mean temperature for the whole of the British Islands was above the average.

The following table, which is compiled from the Weekly Weather Reports for the fifty-two weeks ending August 2, 1886, shows the number of weeks with the temperature in excess or defect of the average, and the extent of the deficiency for the several districts. The averages used for the comparison are for the twenty years 1861–1880.

	Weeks above the average	Weeks in agreement with average	Weeks below the average				
			1°-2°	3°-4°	5°-6°	7°-8°	9°-10°
Scotland, N. ...	7	6	15	16	6	2	—
Scotland, E. ...	11	4	17	10	7	3	—
England, N.E. ...	12	2	14	13	8	3	—
England, E. ...	9	3	13	11	12	1	3
Midland Counties ...	11	2	12	13	9	2	3
England, S. ...	10	7	14	10	6	2	3
Scotland, W. ...	10	1	23	9	5	4	—
England, N.W. ...	7	—	17	12	11	2	3
England, S.W. ...	7	6	14	13	7	2	3
Ireland, N. ...	9	1	18	15	5	4	—
Ireland, S. ...	8	5	19	10	7	2	1
Channel Islands ...	6	9	20	11	5	—	1

From this it is seen that the highest number of weeks during the year with the temperature above the average was twelve in the north-east of England, whilst the lowest was six in the Channel Islands.

Throwing the weekly values together so as to form a monthly result, it is seen that November 1885 is the only month of the last twelve in which the resultant temperature for the whole of the British Islands was above the average, and then the excess only amounted to 1°; of the remaining eleven months, one was in agreement with the average, one had a defect of 1°, four had a defect of 2°, three a defect of 3°, and two a defect of 4°. The three consecutive months having the greatest deficiency of temperature were January to March, the defect averaging fully 3° for the entire period.

The rainfall for the same twelve months was above the average during the six months September, October, and November 1885, and January, May, and July 1886, the excess being larger in England than in Scotland or Ireland. It was in fair agreement with the average in March and April, and in defect in the four months August and December 1885, and February and June 1886.

CHAS. HARDING

THE PLIOCENE DEPOSITS OF NORTH-WESTERN EUROPE

IN the series of stratigraphical monographs on which the Geological Survey is engaged, the preparation of the volume treating of the Pliocene deposits has been assigned to Mr. Clement Reid. In pursuance of the plan on which these works are being written, I requested him to visit some of the Continental regions where deposits of corresponding age are best developed, and a personal acquaintance with which would extend his knowledge of their English equivalents. He has accordingly spent some time recently in Belgium and Holland, and among other localities visited the well-known exposures of the Diestian beds around Diest and Antwerp. The sections there laid open, the remarkable assemblage of organic remains contained in them, and the peculiar condition in which the shells at Diest have been preserved led him on his return to this country to re-examine the curious deposit of ironstone at Lenham, on the North Downs, in which, so far back as 1857, the occurrence of Pliocene shells was announced by Prof. Prestwich. Doubt was cast upon this identification of the age of these shells: by many geologists they were looked upon as Lower Eocene, though their original discoverer has consistently maintained his opinion. Mr. Reid has now been fortunate enough to obtain a considerable number of additional species that settle beyond doubt the Pliocene age of the Lenham beds, and thus confirm the view of the veteran Oxford Professor. The establishment of this point raises questions of such wide interest in geology that I feel justified in anticipating the appearance of the memoir in which the facts will be detailed. At my request Mr. Reid has drawn up the following report, which briefly embodies the facts he has brought to notice, and touches upon some of the problems which they suggest.

ARCH. GEIKIE

Some years ago Prof. Prestwich announced the discovery of beds of Pliocene age at a height of over 600 feet on the North Downs (*Quart. Journ. Geol. Soc.*, vol. xiv. p. 322). The bad preservation of the fossils, however, led Mr. S. V. Wood, who examined them, to mark all the species as doubtful, though he was inclined to agree that they were probably Pliocene. Owing to the unsatisfactory nature of the palæontological evidence, and apparently also to an accidental mixture of Eocene fossils from other localities, this discovery has been discredited or ignored, though Prof. Prestwich himself has always maintained its accuracy.

Recently, while preparing an account of the British Pliocene beds for the Geological Survey, it has been necessary for me to examine any outlying deposits which have been considered to belong to that period. For this purpose I paid a second visit to Lenham, near Maidstone, having several years ago examined that locality with no satisfactory result, owing to the obscurity of the sections. A number of blocks of fossiliferous ironstone were obtained from pipes in the Chalk—just as the original specimens were found. These were brought to London, carefully broken up, and impressions taken from the moulds of fossils with which the ironstone was filled. By this means a series of casts was obtained very much better than the obscure impressions so doubtfully determined by Mr. S. V. Wood. The result of the examination of these fossils has thoroughly corroborated Prof. Prestwich's view, for there is not a single Eocene species among them. With two or three exceptions they are all known Pliocene forms; some are new to England, though occurring in France and Italy.

The species obtained were the following, my determinations in every case being indorsed by Messrs. Sharman and Newton :—

Pyrula reticulata, Lam.
Nassa prismatica, Broc.
Ringicula ventricosa, J. Sow.
Pleurotoma turrifera (?), *Nyst.*
,, *consobrina* (?), Bellardi (Upper Miocene)
,, *Jouanneti* (?), Des M. (Upper Miocene)
Trophon muricatus, Mont.
Cerithium tricinctum, Broc.
Turritella incrassata, J. Sow.
Fusus, sp. (= an undetermined Red Crag species)
Scalaria clathratula, Turt.
Margarita trochoidea (?), S. V. Wood, var.
Trochus millegranus, Phil.
Natica, 2 sp.
Bulla lignaria, Linn.
Ostrea, sp. (young)
Pecten, 2 sp.
Pectunculus glycimeris, Linn.
Arca lactea, Linn.
,, *diluvii*, Lam. (new to England)
Leda, sp. (not *L. myalis*)
Nucula, sp.
Diplodonta rotundata, Mont., oval var.
Cardium, 3 sp.
Cardita senilis, Lam.
Astarte Basteroti, Laj.
,, *gracilis*, Munster
Tapes, sp.
Gastrana fragilis, Linn.
Tellina donacina, Linn.
Mactra, sp.
Lutraria elliptica, Lam.
Teredo (?)
Terebratula grandis, Blum.
Lunulites (?)
Balanus, sp.
Diadema (?)

The first thing that strikes one in this list is that the whole of the living species are southern forms, and the nearest allies of the extinct species belong to much warmer seas than ours. This, and the general character of the fauna, and proportion of extinct species, lead me to refer the beds to the Older Pliocene period, and to correlate the deposit with our Coralline Crag and with the Lower Crag or Diestian of Belgium. The fossiliferous clay of St. Erth, in Cornwall, I also think is of about the same age, and not newer.

Some curious questions are raised by these recent discoveries, and by others equally remarkable in Belgium and Holland. We now find that, instead of the Older Pliocene period being one of elevation, there must have been wide-spread submergence over great part of Western Europe. A few years since the Coralline Crag was generally considered to be our only representative of the period, and as it did not rise much above the sea-level, it was often assumed that much of the rest of England was dry land. Now it is known that Pliocene beds cap the highest parts of the North Downs, and from the undisturbed position of the shells, unworn, and generally with the valves united, it is evident that the depth of water must have been sufficient to prevent the deposits at the bottom being affected by storms. A subsidence sufficient to allow only 20 or 30 fathoms of water over the highest parts of the North Downs (and the depth in which the Lenham shells lived could hardly have been less) would submerge the whole of the east and south of England, except a few hills.

In Cornwall also there appears to have been a submergence to a considerable depth, for the St. Erth clay was evidently laid down in still water, which would not be found at a less depth than 40 or 50 fathoms in a district exposed like this to the Atlantic swells. The fossils also in that clay point to some considerable depth of water, while the general flattened contour of the country suggests that this district has nearly all been submerged within a comparatively recent period. The lower parts of Cornwall form a smooth, undulating country, out of which rise abruptly the higher hills. Round one of these hills—St. Agnes Beacon—coarse sand is found at a high level. This is probably a beach deposit of the same age as the clay at St. Erth, though all fossils have now disappeared from it. Cornwall seems at that period to have formed a scattered archipelago like the Scilly Islands.

Among the hard rocks of Cornwall denudation does not appear much to have changed the general configuration of the country since the Older Pliocene period. Moreover the Pliocene deposits were probably never continuous or thick, but merely formed patches in sheltered places and round the shores, the rest of the sea-bottom being rocky. In the south-east and east of England, however, the case was different, for the rocks of that region are soft and much more easily denuded. The position of the Lenham beds, at the very edge of an escarpment, over 600 feet above the sea, indicates that the great valleys of the Thames and Weald have to a large extent been excavated since Pliocene times.

On the other hand, the question arises whether the elevation of the Wealden axis was still in progress during the Pliocene period. That the greater part of this enormous disturbance had been completed before that period seems proved by the absence of any Pliocene beds in the Hampshire or London basins in the synclinal folds parallel with the Weald. But there is possibly evidence of less violent movements of upheaval in the different levels at which Older Pliocene beds now occur. We find the Coralline Crag slightly above the present sea-level, the Lenham beds 610 feet above, while at Utrecht deposits of about the same age are found at a depth of at least 1140 feet below the sea, and their bottom has not yet been reached.[1] If the movements in North-Western Europe have been regular and of equal amount everywhere, then, taking the Downs near Lenham as the starting-point, with a depth of 20 fathoms, we should expect to find in the Coralline Crag the deposits and fauna of 120 fathoms, and at the bottom of the well at Utrecht those of 310 fathoms.

A Pliocene fauna of over 300 fathoms would be most interesting to examine, but of such a fauna no trace has yet been detected anywhere in North-Western Europe. The Pliocene deposits, though now at such different levels, are shown by their included fossils to have been laid down in about the same depth of water. Though differing much in mineral composition at the various localities, they nevertheless agree as closely in regard to their shells as the very different nature of the sea-bottoms would lead us to expect. The whole 1143 feet of Pliocene and Pleistocene beds at Utrecht consists of essentially shallow-water deposits, pointing to a continuous depression.

Were we to assume that the present positions of the Pliocene deposits of the north-west of Europe represent the relative depths at which the beds were originally laid down, a curious difficulty would present itself in any attempt to compare the Pliocene and recent sea-bottoms. Any deep depressions in the seas around England are now filled with cold water and contain an Arctic fauna. In similar depths during the Pliocene period one would expect to find a similar fauna, unless there existed, as in the Mediterranean, a barrier to cut off the Polar currents, or unless there was at that time no cold area at the Pole. Neither of these explanations seems sufficient, and it is more probable that those geologists are right who maintain that the direction of the movements in areas of subsidence or elevation remains the same during long periods. Holland may thus have undergone continued, though probably intermittent, depression since the early part of the Pliocene period ; thus allowing the accumulation of a great thickness of shallow-water Newer Tertiary beds. The axis of the Weald, including the Downs near Lenham, has been correspondingly elevated. Suffolk was little affected, and the deposits were therefore, in that district, thin and largely of organic origin.

I do not bring forward these conclusions as to elevation and submergence as indisputable facts, but merely as the results of my recent studies in the Pliocene beds at home and on the Continent. Any day new discoveries may profoundly modify our views, but the curious facts will remain, that Northern Europe has yielded only a shallow-water Pliocene fauna, and no trace of boreal outliers such

[1] See Dr. J. Lorié, "Contributions à la Géologie des Pays-Bas," *Archives du Musée Teyler*, ser. ii. vol. ii. part 3.

as occur in our existing seas—and this notwithstanding the very different levels at which Pliocene beds now occur

CLEMENT REID

EARTHQUAKE-RECORDERS FOR USE IN OBSERVATORIES

TWO years ago the writer described in NATURE (vol. xxx. pp. 149 and 174) some of the instruments which he had designed and used in Japan for the registration and analysis of earthquake movements. In response to applications from the directors of several observatories, who wished to add seismometric apparatus to their other equipment, arrangements were some time ago made with the Cambridge Scientific Instrument Company for the manufacture of instruments by aid of which the observation of earthquakes might become part of the ordinary work of any meteorological or astronomical station where such movements occasionally occur. In the design of these seismographs the object has been kept in view of

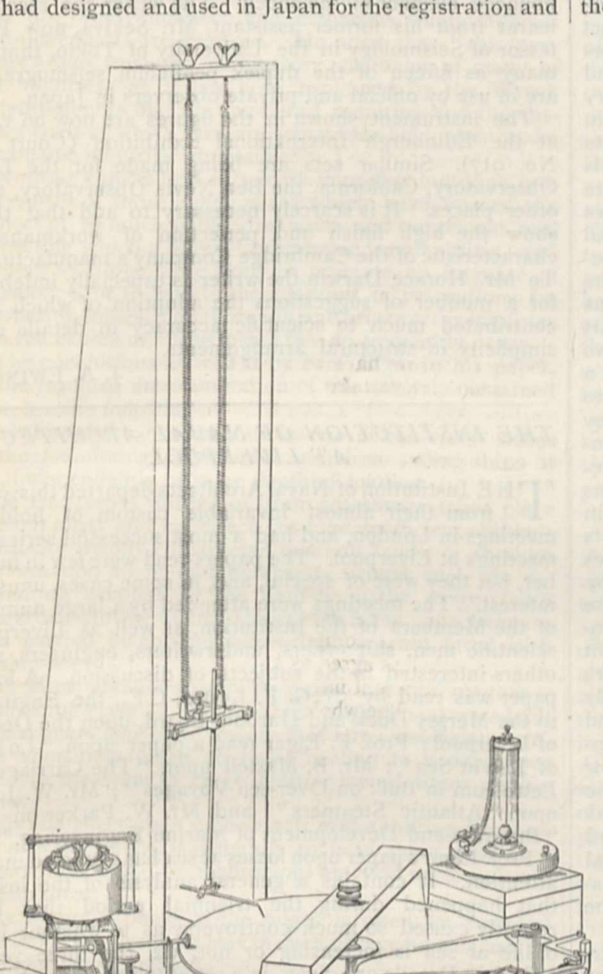

FIG. 1.—Complete three-component seismograph, for motions in all direction .

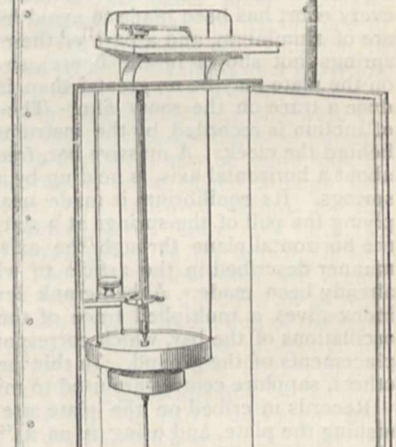

FIG. 2.—Duplex pendulum seismograph, for horizontal motion.

making them easily capable of use by observers who have not made seismometry a special study. They are entirely self-recording, and require little attention during the long intervals which must, in most situations, be expected to elapse between one period of activity and the next.

One group of instruments is arranged to give a complete record of every particular of the movement by resolving it into three rectangular components—one vertical and two horizontal—and registering these by three distinct pointers on a sheet of smoked glass which is made to revolve uniformly by clockwork. A single earthquake always consists of many successive displacements of the ground; hence the record traced by each pointer on the moving plate is a line comprising many undulations, generally very irregular in character. The amplitude, period, and form of each of these are easily measured, and by compounding the three we obtain full information regarding the direction, extent, velocity, and rate of acceleration of the movement at any epoch in the disturbance.

This group of instruments is shown in Fig. 1. In the centre is the plate of smoked glass, which gets its motion through a friction-roller from a clock furnished with a centrifugal governor, acting by fluid-friction, and balanced so that its speed is not sensibly affected by the shaking of the ground. The clock is started into motion by means of a Palmieri seismoscope, which appears in the figure behind the plate, on the right. This is a small common pendulum whose bob carries at the bottom a piece of stiff platinum wire that projects into a recess in a cup of mercury below—the recess being formed by an iron pin standing lower than the surface of the surrounding mercury. On the slightest shaking of the ground, contact with the edge of the mercury takes place, and this closes a circuit which releases an electro-magnetic detent and starts the clock. This occurs during the preliminary tremors which are usually found in advance of the main movements of an earthquake. The same circuit starts another clock (of the escapement type) which fulfils two functions. It marks time on the revolving plate during a part of the first revolution, and then continues to go as an ordinary clock, so that, by inspecting its dial afterwards, the interval which has elapsed from the occurrence of the earthquake is known, and the date of the shock in hours and minutes is thus determined with as much precision as the phenomenon admits of. This part of the apparatus is omitted from the figure. The two horizontal components of motion are recorded by a pair of horizontal pendulums, set at right angles to each other, but with their indices inclined so that they write side by side on one radius of the plate. The pendulums are supported on a single stand, but with independent adjustments for position and stability. Each has two pivots, consisting of hard steel points, which turn in sapphire centres. At the pivots and at the tracing-points every effort has been made to avoid friction. The indices are of aluminium, and a part of their weight is taken by springs (not shown in the figure), so that their pressure on the plate may be no greater than is necessary to produce a trace on the sooty film. The vertical component of motion is recorded by the instrument which appears behind the clock. A massive bar, free to move vertically about a horizontal axis, is held up by a pair of long spiral springs. Its equilibrium is made nearly neutral by applying the pull of the springs at a suitable distance below the horizontal plane through the axis of support, in the manner described in the article to which reference has already been made. A bell-crank lever with a jointed index gives a multiplied trace of the apparent vertical oscillations of the bar, which correspond to vertical displacements of the ground. In this instrument, as in the others, sapphire centres are used to minimise friction.

Records inscribed on the plate are preserved by varnishing the plate, and using it as a "negative" to print photographs. The motion, as recorded, is magnified to an extent which experience of Japanese earthquakes has shown to be desirable in dealing with disturbances ranging from those which are just recognisable as earthquakes up to those which are to some extent destructive. For great earthquakes, separate apparatus of the same type is designed, in which the multiplying indices are dispensed with, and the scale and style of the other parts are considerably modified.

Another and distinct instrument, also manufactured by the Cambridge Company, is the duplex pendulum seismograph, shown in Fig. 2. A massive bob is hung by three parallel wires from the top of a three-cornered box, and is reduced to nearly neutral equilibrium by being coupled by a ball-and-tube joint to the bob of an inverted pendulum below it. The two form a system which can be made as nearly astatic as is desirable, and so furnish a suitable steady-point for the horizontal part of earthquake movement in any azimuth. The motion is magnified and recorded by a vertical lever geared to the upper bob by a ball-and-tube joint, supported on gimbals from a bracket fixed to the box, and furnished with a jointed index which writes on a fixed plate of smoked glass. Records of the kind which the duplex pendulum gives are of course incomplete in two important particulars: they show nothing of the vertical motion (which, however, is usually a comparatively small part of the whole), and they show nothing of the relation of *time* to displacement throughout the disturbance. But they exhibit very clearly the change of direction which the movements undergo, and the actual direction taken by any pronounced element of the shock. The writer has recently learnt from his former assistant, Mr. Sekiya, now Professor of Seismology in the University of Tokio, that as many as fifteen of the duplex pendulum seismographs are in use by official and private observers in Japan.

The instrument shown in the figures are now on view at the Edinburgh International Exhibition (Court 21, No. 917). Similar sets are being made for the Lick Observatory, California, the Ben Nevis Observatory, and other places. It is scarcely necessary to add that they show the high finish and perfection of workmanship characteristic of the Cambridge Company's manufactures. To Mr. Horace Darwin the writer is especially indebted for a number of suggestions the adoption of which has contributed much to scientific accuracy in details and simplicity in structural arrangements.

J. A. EWING

THE INSTITUTION OF NAVAL ARCHITECTS AT LIVERPOOL

THE Institution of Naval Architects departed this year from their almost invariable custom of holding meetings in London, and had a most successful series of meetings at Liverpool. The papers read were few in number, but they were of special, and, in some cases, unusual interest. The meetings were attended by a large number of the Members of the Institution, as well as Liverpool scientific men, shipowners, underwriters, engineers, and others interested in the subjects of discussion. A local paper was read by Mr. G. F. Lyster, C.E., the Engineer to the Mersey Dock and Harbour Board, upon the Docks of Liverpool; Prof. F. Elgar read a paper upon "Losses of Life at Sea"; Mr. B. Martell upon "The Carriage of Petroleum in Bulk on Over-sea Voyages"; Mr. W. John upon "Atlantic Steamers"; and Mr. W. Parker on the "Progress and Development of Marine Engineering."

Prof. Elgar's paper upon losses at sea has attracted much attention. It contains a general analysis of the losses that happened during the triennial period that has recently caused so much controversy as to whether loss of life at sea is increasing or not, viz. the three years 1881-83. Details are given, in a set of tables appended to the paper, of the steamers and iron sailing ships belonging to the United Kingdom, of and above 300 tons gross register, that were reported to the Board of Trade as foundered or missing during the five calendar years 1881-85. The facts contained in these tables show clearly the great advantage it would be to the shipping community if such information were published periodically in a clear and convenient form. Probably no documents that emanate from any Government Department are more bewildering, or more difficult to extract any tangible information from, than the voluminous and complicated returns of wrecks and casualties, and of lives lost at sea, that are published annually by the Board of Trade. We hope that the attention of the Royal Commission now sitting upon Loss of Life at Sea, has been forcibly directed to the many imperfections and the comparative uselessness of the present published returns that profess to deal with these matters; and that one of the Committee's recommendations will be that something should be done to make them clear and instructive.

There is another cognate matter which we hope will also be dealt with satisfactorily by the Royal Commission, viz.

the manner in which wreck inquiries are now conducted. As matters stand, the evidence obtained at those inquiries, and the rulings that are given by the Courts, have no scientific or practical value. There is no class of quasi-scientific literature that we know of which contains more bad science than is to be found in the rulings of the Wreck Inquiry Courts. Prof. Elgar puts the case very mildly when he says that the returns of the Wreck Inquiry Courts are not all that might be wished as regards the publication of facts connected with losses, and that they are often imperfect and erroneous where difficult technical points are involved. He adds that "this probably arises from the perfunctory character of many of the inquiries; as it has been explained by the Wreck Commissioners that the number of inquiries, and the distant places at which they are sometimes held, often make exhaustive inquiries impossible."

Nothing can be held to excuse imperfect inquiries into the causes of those losses at sea which have formed the subject of so much public discussion and excitement, and respecting which a Royal Commission is now sitting; and nothing would be more likely to promote an increase of knowledge, or to lead to the adoption of precautions for preventing losses, than thorough and trustworthy inquiries into the causes of those losses that so frequently occur.

The conclusions arrived at by Prof. Elgar in his paper, as the result of an examination of the analysis contained in it, are the following:—

(1) The shifting of cargoes is one of the chief causes of the foundering of steamers and iron sailing ships at sea, independently of mere depth of loading.

(2) Dangerous shifting of grain sometimes takes place through hasty and imperfect stowage, inefficient shifting-boards, or weakly-constructed end bulkheads, or through the omission to fit end bulkheads, where such are required on account of the density of the cargo; and dangerous shifting of coal sometimes takes place, because it is carried in compartments that are not fitted with shifting-boards.

(3) Many steamers carrying grain and coal cargoes—notably the class of narrow three-decked steamers built several years ago—are vessels that have insufficient stiffness when fully laden, to resist heeling to a dangerous angle, in the event of cargo shifting or of water getting below.

(4) The effect upon such vessels of the shifting of cargo, and of water below, is generally to hold them over at a considerable angle of inclination, but not to completely capsize them.

(5) Pumping power at the bilges is often an essential condition of preventing loss in such circumstances, and of getting a vessel righted.

(6) The stability of these vessels when laden with the various cargoes they are likely to carry, should be completely determined by calculation before they are sent to sea; and clear instructions, based upon the information so obtained, should be framed for the guidance of those who are responsible for their loading. Such instructions should include particulars of the empty spaces to be left in the 'tween decks, or of the weight of ballast to be carried, or both, for each class of cargo.

(7) All the authentic particulars procurable of ships that have foundered and are missing, and of the circumstances and the manner in which the foundered ships were lost, should be collected and published periodically for the information of the shipping community.

(8) The losses of steamers through the shifting of cargoes seem to be chiefly among the narrow steamers of the three-decked type that were built several years ago. The steamers of that type that have recently been built have more beam and much greater stability than those formerly built, and it may be confidently hoped that the attention which has been given to this matter of late, and the improvements that have consequently been introduced into this type of vessels, will lead to a diminution of losses among them.

Mr. Martell's paper upon "The Carriage of Petroleum in Bulk on Over-sea Voyages" deals very fully with the history of the carriage of petroleum by sea, and the special precautions that are necessary to enable it to be carried safely and economically in ships. Besides those points, however, that are special to the treatment of petroleum as a cargo, there are others which naturally grow out of a consideration of the subject. There is, for instance, the important question of the use of liquid fuel for marine propulsion. The mechanical difficulties involved by this have now been overcome, so that *astatki*, the residuum of crude oil, might be profitably used as fuel for steamers employed upon comparatively short voyages. It is largely and successfully used for marine propulsion on the Caspian Sea, where oil is very cheap and coal is very expensive. The chief obstacle at present to extending the use of this fuel is its cost. The price of *astatki* at Baku varies from 4*d.* to 1*s.* 3*d.* per ton; the carriage by rail to Batoum raises the cost at that port to about 1*l.*; and after adding freight charges for bringing it to this country, its total cost on delivery would, according to Mr. Martell, be not less than 2*l.* 2*s.* From these figures it must be evident that while the best steam coal can be shipped at Cardiff for about 9*s.* per ton, liquid fuel cannot be economically used in competition with it. As the cost of transport of liquid fuel from Baku to Batoum becomes reduced—and this can only be a question of time—there is no doubt that liquid fuel will come into general use for local steamers, and most likely for many steamers trading in the Mediterranean.

Mr. W. John refers, in his paper upon "Atlantic Steamers," to several matters that are of importance to the travelling public. He advocates the adoption of twin-screws in first-class Atlantic steamers as a provision against total breakdown in the event of a shaft, or of any other vital part of the propelling machinery, giving way. He also advocates a middle-line bulkhead, and greater internal subdivision generally, so that ships may be more safe in the event of a compartment being bilged through collision. Mr. John states that improved designs for the Atlantic passenger steamers of the future now form the subject of work and investigation in the drawing-offices of several shipyards. The developments that are taking place are, doubtless, generally in the direction of providing greater safety against accidents to the hull of the ship, or to the propelling machinery, by means of greater internal subdivision and twin-screw engines. Higher speeds than any yet realised are being contemplated by building purely passenger vessels that will carry no cargo; and many improvements of details, which are in the direction of making the accommodation for passengers more like that furnished by a first-class hotel, are also being devised.

Mr. Parker's paper upon "The Progress and Development of Marine Engineering" forms a supplement to one read by Mr. F. Marshall before the Institution of Mechanical Engineers at Newcastle-on-Tyne, in 1881. Mr. Parker traces the progress that has been made in economy of steam propulsion since the introduction of the triple expansion-engine by Mr. A. C. Kirk in 1874. Mr. Kirk fitted triple expansion-engines to the *Propontis* for Mr. W. H. Dixon, in that year, with boilers designed for a working pressure of 150 lbs. per square inch; but the boilers did not prove satisfactory, and were ultimately removed. The next triple expansion-engines were those of the yacht *Isa*, designed by Mr. A. Taylor, of Newcastle-on-Tyne, in 1877; and those of Messrs. G. Thompson and Sons' steamer, *Aberdeen*, which were constructed by Mr. A. C. Kirk, in 1881, for a steam pressure of 125 lbs. per square inch. The *Aberdeen* was the real pioneer vessel of the triple expansion type of engine; as it was proved in her that triple expansion-engines could be made not only to fulfil all the ordinary conditions of working at sea, but to effect a great economy in coal-consumption. Since then the new system has come rapidly into use, and shipbuilders and marine engineers are now looking in the direction of triple and quadruple expansion-engines for the economical advantages of high-pressure steam in future ships.

It is estimated that the present triple-expansion marine engine, with 150 lbs. of steam-pressure, has an advantage of from 20 to 25 per cent. in economy of coal consumption, over the ordinary compound engine with 90 lbs. pressure, which it is rapidly supplanting. These results have been achieved through a clear appreciation of the waste of energy which is caused by the alternate heating and cooling of a steam cylinder that takes place in consequence of the difference of temperature at which the steam enters and leaves it. The steam-jackets introduced by James Watt as a cure for this were imperfect and wasteful in their action. An effectual remedy has been found as the result of many years of study and experiment by men of science and engineers, by expanding the steam successively in several cylinders, so as to make the variation of the temperature of the steam in each cylinder as small as possible.

NOTES

We greatly regret to announce the death of Mr. George Busk, F.R.S., the well-known surgeon and naturalist, in the seventy-eighth year of his age. We must reserve a detailed notice of Mr. Busk's life and work.

Geologists will be sorry to hear of the death of Mr. Gerrard Kinahan, son of the well-known geologist of the Geological Survey of Ireland. Last October he accepted an appointment in the service of the National African Trading Company. The last letter received from hi n gave an interesting account of his explorations up the southern tributaries of the Niger. He died on May 23 from a wound with a poisoned arrow in a fight with the native tribes at a place called Anyappa. His training as a chemist and geologist at the College of Science in Dublin and also at the School of Mines in London had thoroughly qualified him for original research, and his quietly enduring temperament and kindliness of nature augured a most successful scientific future, whether at home or abroad. But he has been cut down on the very threshold of his career—another young victim to the dangers of African explorati on.

The death is announced of Dr. R. J. Mann, F.R.C.S., aged sixty-nine. Dr. Mann was for three years President of the Meteorological Society, and was a Member of the Astronomical, Geographical, Photographic, and other Societies. He gave up his medical practice to take a Government appointment in Natal, where he served as head of the Education Department and Medical Officer for many years. On his return, about 1864, he became Emigration Agent for the Colony, and when, some ten years later, he resigned that post, he devoted himself to his favourite scientific pursuits. He was a popular and prolific writer. The protection of buildings from lightning was a subject on which he wrote a goo l deal, and for which he did much valuable work.

M. Chevreul, the illustrious French chemist, will complete his hundredth year on Monday next. A grand *fête* at the Museum in honour of the occasion is being organised. Delegations from foreign countries as well as from the provinces are expected. In one of the *salles* at the Museum there is to be an exhibition presenting a *résumé* of the scientific labours and discoveries of M. Chevreul. The banquet will be at noon, in order that the famous centenarian may himself be present.

Our Vienna correspondent writes:—"Dr. von Frisch, having recently experimented on preventive inoculations for hydrophobia, has made a preliminary communication to the Vienna Academy of Sciences, in which he states that it was impossible for him to prevent the breaking out of rabies by means of Pasteur's method if the infecting virus (of at least fourteen days' incubation) were administered to previously healthy animals by trepanning. This latter method of artificial infection of animals Dr. von Frisch suggests to be the only safe one. He made his experiments on rabbits and on dogs. At first sixteen healthy rabbits were trephined, and the virus (of sixteen days' incubation) was injected under the dura mater. Fifteen of these rabbits were then subjected at intervals to the usual preventive inoculations, the remaining one not being inoculated. All these animals except one, which, as Frisch believes, was not sufficiently infected, died between the fourteenth and thirty-third day after infection, with symptoms of rabies, and if particles of their spinal cord were injected into healthy rabbits, the latter also became rabid. Similar experiments were then made on dog , and with the same results. But a series of rabbits infected by subcutaneous injection of the virus, and then treated by Pasteur's method, continue healthy up to the present time."

The Grosvenor Museum for Chester and North Wales was opened at Chester on Monday by the Duke of Westminster. The new museum is intended as the home of four influential local societies—namely, the Chester Society of Natural Science, founded by Charles Kingsley; the Chester Archæological Society, which is closely associated with the name of the late Dean Howson; the Chester Schools of Art; and the Chester Science Classes. The first floor is devoted entirely to science, except one room to be used as a laboratory, a committee-room, and a model-room for the school of art. The upper floor is entirely devoted to the school of art. In the several rooms there are exhibited specimens illustrative of the natural history of the district, water-colour drawings, collections of antiquities, oil paintings, wood carvings, a collection of pictures by members of the Art Club, appliances for science teaching, memorials of Canon Kingsley and Dean Howson, a collection of objects illustrative of Oriental art, a magnificent collection of tapestry, choice embroidery, lace, porcelain, textile fabrics, &c.

The autumn congress of the Sanitary Institute of Great Britain will be held in the city of York on September 21 and following days, under the Presidentship of Sir T. Spencer Wells, Bart.

The summer meeting of the Institution of Mechanical Engineers will be held on Tuesday morning, August 17, and Wednesday morning, August 18, at 25, Great George Street, Westminster. The following papers have been offered for reading and discussion after the address by the Pre ident:—Experiments on the steam-jacketing and compounding of locomotives in Russia, by M. Alexander Borodin, of Kieff; on the working of compound locomotives in India, by Mr. Charles Sandiford, of Lahore; description of a portable hydraulic drilling-machine, by M. Marc Berrier-Fontaine, of Toulon; description of the Blackpool electric tramway, by Mr. M. Holroyd Smith, of Halifax; on triple-expansion marine engines, by Mr. Robert Wyllie, of Hartlepool.

The French Association for the Advancement of Science begins its annual meeting to-day at Nancy.

The lectures recently delivered at Oxford by Prof. Sylvester on his "New Theory of Reciprocants," will appear in the coming numbers of the *American Journal of Mathematics*. The lectures are presented in quite simple style, and will be exceedingly interesting to all students of the modern algebra, or, more accurately, of the theory of invariants. The first eight or nine lectures will appear in the forthcoming number of the *Journal*, vol. viii. No. 3.

A Society for the study of anthropology has been founded in Bombay. Before the departure of the East Indian mail the second ordinary meeting of the Society had been held, and Mr. E. Tyrrel-Leith, the President, was able to give a very satisfactory account of its prospects.

THE report of the Directors and Secretary of the City and Guilds of London Institute on the technological examinations of the present year has just been issued. It states that there is a large increase in the number of candidates who presented themselves, and a satisfactory increase in the number of those who have passed. In 1885, 3968 candidates were examined, of whom 2168 passed. In 1886, 4764 candidates were examined, of whom 2627 have passed. Examinations were held this year in 48 subjects. Applications for examination were received in all the 49 subjects, but, as only one candidate presented himself in sugar manufacture, in accordance with the regulations of the Institute no examination was held in this subject. Last year examinations were held in 42 subjects. The subjects in which there has been the greatest increase in the number of candidates are mechanical engineering, plumbers' work, electric lighting, and gas manufacture. One new subject was this year added to the list—namely, brickwork and masonry, in which 99 candidates came up, and of these 57 satisfied the examiners. In addition to the practical examinations in weaving and pattern designing, in metal-plate work, in carpentry and joinery, and in mine-surveying, which had been previously held, a practical examination was held this year for the first time in typography. Seventy-seven candidates presented themselves for this examination, of whom 32 have succeeded in obtaining a certificate. From the returns furnished in November last, it appears that 7660 persons were receiving instruction in the registered classes of the Institute, as compared with 6396 in the previous year. This increase is due partly to increased attendance at some of the classes, and partly to the formation of new classes, the number of classes in connection with the Institute having increased from 263 in the Session 1884–85 to 329 during the past year. These classes were held in 116 different towns of the United Kingdom. 203 prizes have this year been awarded, being an increase of 26 on those granted last year. These awards include 180 money prizes, 65 silver and 138 bronze medals, of which 62 are in the honours grade and 141 in the ordinary grade. Last year there were 177 money prizes, 51 silver and 126 bronze medals.

THE Norwegian Meteorological Institute of Christiania has adopted an ingenious plan for disseminating its weather reports among the farmers, fishermen, &c. Thus, on the brake of every train departing from the capital to any part of the country after 3 p.m. a signal is exhibited indicating the weather to be expected for the ensuing twenty-four hours. These signals are very simple, consisting of red and white triangles, squares, and balls, each of which, or several combined, have their meaning; a white ball, for instance, "fine weather," &c. These signals will also be displayed from the masts of several coasting steamers. The arrangement is in force from July 1 to October 1.

ACCORDING to the official returns of the Minister of Education in Prussia the number of students in philology and the kindred subjects of philosophy and history in that kingdom—now for a considerable time known to be sensibly on the decrease in the field of the ancient classics—has altogether steadily declined from Michaelmas 1881 to Easter 1885. The number of students of philosophy, philology, and history at the Universities of Prussia amounted in the winter session of 1881–82 to 2522, in the summer session of 1882 to 2535, in the winter session of 1882–83 to 2504, in the summer session of 1883 to 2398, in the winter session of 1883–84 to 2311, in the summer session of 1884 to 2258, and in the winter session of 1884–85 to 2181. Within a period of 3½ years, therefore, the decline in the number of students of philosophy, philology, and history has been about 14 per cent.

A LARGE specimen of the lizard tribe imported from Japan into the Colonial and Indian tropical aquarium lately died in the act of extruding her eggs, numbering eight. One of her feet that had become broken during her existence was found to have grown again. A further consignment of turtles has arrived at the aquarium together with a number of eggs, which have been placed in the Chelonian hatchery for incubation. Some fine specimens of foreign oysters have also arrived.

THAT kingfishers possess a remarkable instinct to avoid those fish proving harmful to them is exemplified by the following incident. A correspondent informs us that being infested with these birds he set traps for them in two of his ponds, one containing minnows and the other perch. A capture was effected daily where the minnows were located, but on no occasion was a kingfisher caught near the perch pond. The latter fish are injurious to birds.

M. GASTON TISSANDIER in a recent number of *La Nature* describes the efforts made by himself and his brother to pursue the subject of aërial photography. For this purpose they sought the assistance of M. Paul Nadar, whose father made the first attempts twenty-eight years ago, to take photographs from balloons. An ascent was made on July 2 from Auteuil, the descent taking place after a voyage of about six hours at Ségrie in La Sarthe, the length of the journey being about 180 kilometres. The maximum altitude exceeded 1700 metres. During the voyage M. Nadar succeeded in executing thirty instantaneous photographs, a dozen of which are, M. Tissandier says, unquestionably the most perfect yet obtained from a balloon. These were taken at various altitudes, ranging from 800 to 1200 metres. They were perfect in all details, but lose by reproduction by heliogravure. Those taken at 1200 metres it has been found impossible to reproduce at all, as they lose all their fineness in the process. The apparatus was placed in different positions on the edge of the car, sometimes being almost vertical, sometimes inclined so as to form with the horizon an angle varying from 25° to 45°. The time in each case was 1/250th part of a second. M. Nadar has enlarged some of the photographs with the new Eastmann paper with remarkable success. It is obvious from the illustrations given in *La Nature* that the photographs have suffered in the reproduction, the details being slightly blurred and indistinct, but the streets, principal houses, gardens, &c., are perfectly clear in the two pictures which were taken at altitudes of 800 and 1100 metres respectively.

A RECENT number of the *British North Borneo Herald* contains a report on the climate of North Borneo, by Dr. Walker, the principal medical officer, which is interesting as being the first scientific account of the meteorology of this recent addition to the British Empire. The climate, Dr. Walker says, is noticeable for nothing more than for its equability and the absence of extremes. The temperature, rainfall, winds, natural phenomena generally, and the diseases are, for a tropical country, of the most mild and temperate types. The country is visited by the regular monsoons at the ordinary times; the rainfall near the coast, according to records kept for seven years past, ranged from 156·9 to 101·26, and averaged 124·34. The temperature recorded at the coast has ranged between the extremes of 67°·5 and 94°·5; better arrangements are now being made for observing temperatures. The absence of tornadoes and earthquakes is to be noticed. The only indication at the present day of the existence of volcanic action is a hot spring, which is reported to exist on an island near the coast. The bulk of the report is occupied with information of a more medical kind, such as the chief diseases, and their respective effects on the various races, native and immigrant, in North Borneo; sanitaria, and the like.

AT a recent meeting of the Anthropological Institute at the Colonial Exhibition, Mr. Swettenham, of the Straits Civil

Service, read a paper on the races of the Straits Settlements. Of the Malays he said it was unlikely that they could be indigenous to the peninsula, but where they came from, whether Java, Sumatra, or elsewhere in the Archipelago, is a question which has never yet met with a satisfactory answer. Their own tradition is that they had a supernatural origin, and that they crossed from Sumatra. Up to about 1250 they were pagans, or followed some form of Hindoo worship, but about that time their conversion to Mohammedanism began. Up to this time, Malay, of all the Sumatran languages, had no written character of its own, but then Perso-Arabic characters were introduced, and many Arabic words found their way into the Malay language. Relics of Hindoo superstitions are still found amongst the Malays and Negritos of the peninsula, and the customs even now observed, especially in Perak, on certain occasions savour strongly of devil-worship. As to the Negritos, Mr. Swettenham remarked that the most complete collection of the clothing, weapons, and ornaments of these people ever yet brought together will be found in the Straits Settlements Court of the Exhibition. His own observation led him to divide the Negritos into two widely different sections—the Sakai and the Semang—the former a people of moderate stature and large bones, rather fairer in complexion than Malays, with long unkempt wavy hair standing straight out from their heads; the latter small and dark, with black frizzy hair close to their heads, like that of the Negro races. Some writers have found in the comparison of languages a connecting link between the Negritos of various tribes and Malays, and believe the former to show traces of Melanesian blood. The paper contains many interesting observations on the manufactures of the Malays, and on the customs of these and the Negritos.

WE have received two excellent memoirs of American men of science, recently read before the National Academy. The first is by Mr. J. D. Dana, and deals with the life and work of Arnold Guyot; the second, the life of Jeffries Wyman, by Mr. A. S. Packard. In each case the work appears to be done admirably, and a list of the writings of the subject of the memoir is appended. At the beginning of his account of Guyot, Mr. Dana notices as a remarkable fact in the history of American science, that, forty years since, the same Republic of Switzerland lost, and America gained, three men of science who became leading men of the country in their several departments—Agassiz in zoology, Guyot in physical geography, and Lesquereux in palæontological botany. A fourth—De Pourtalès, who accompanied Agassiz—also deserves prominent mention, for he was the pioneer of deep-sea dredging in America. The Society of Natural Sciences of Neuchâtel lost all four to the United States between 1846 and 1848. The memoir of Wyman (the list of whose papers, &c., reaches the number of 175) concludes with a very touching portrait from the pen of Dr. Oliver Wendell Homes, and an ode by Mr. Russell Lowell.

NOS. 25 and 26 of *Excursions et Reconnaissances*, which have just reached this country from Saigon, do not contain so much matter of general interest as usual. In both M. Landes continues his collection of the folk-lore of Annam, under the title "Contes et Légendes Annamites." In No. 26 M. Silvestre, an official connected with the administration of native affairs, has a short paper on the Chao tribe of the Hung-hoa province of Tonquin, which is interesting as showing incidentally the vast number of various tribes, or tribes under various names, which exist in French Indo-China. How far they are related to each other and to some earlier race of which they are the fragments is one of the ethnological problems of the future. Lieut. Campion describes a voyage made in a despatch-vessel to various islands lying off the coast of Cochin-China, which have hitherto been unvisited by Europeans; and the indefatigable M. Aymonier continues the publication of an encyclopædic work on Annam.

A RECENT number of the *American Meteorological Journal* contains an article on the notorious dust-storms of Pekin. These occur in the dry season, especially in winter and early spring. They come on at irregular intervals, perhaps six or eight times in the season, and last about three days. The wind is westerly, most often north-west, and blows fresh or high. The condition of the streets of Pekin, evil as that is, would not account for the heavy clouds of dust that come down with the storm. The mouth and eyes have to be protected from the fine dust, which penetrates the closest room, and makes food to taste gritty. This abundant dust is spread over a large area. It extends eastward from Pekin to the sea, and south-eastward it regularly descends as far south as the Yellow River, and sometimes Shanghai, 10° of latitude away. The writer of the paper says this vast quantity of dust must come from the great deserts of Mongolia. A series of observations during one of these storms showed a fall in the thermometer when it came on, and a rapid change in the barometer, which rose from 786 mm. to 797 mm. making several rises and falls of less magnitude in the meantime. The clouds, which the day before had been unbroken, rapidly cleared away; the sun was so obscured that it could be inspected by the naked eye; it was also set in a ring. The wind showed diurnal variations, the air was dry, and one had a feeling of malaise and nervousness. After the wind went down, the barometer remained high for a day or two, and on its descent there was another, but much less marked, dust-storm. The storm thus appears to have been a gale accompanying an area of high pressure, which came from the Desert of Gobi and travelled eastward. The dryness of the wind and its abundant dust were in part due to this desert, which lies west and north-west of Pekin, and is not far away. In his great work on China, Richthofen discusses the geological effects of these storms, which are observed throughout the south and west of the Desert of Gobi, and further west are much worse than at Pekin.

A LATE number of the *Journal* of the Asiatic Society of Bengal contains a short memorandum by Prof. Pedler, of the Presidency College, Calcutta, on certain experiments which he has made on the corrosion of the lead linings of Indian tea-chests—a subject of considerable importance in more senses than one. His conclusions are that tea properly manufactured in the ordinary way has no power to corrode lead; but if unseasoned and damp wood is used for the boxes, corrosion of the lead is almost certain, some varieties of wood acting more violently than others. Even with seasoned wood, if it becomes saturated with water, and be then placed in favourable circumstances of heat and moisture, corrosion takes place. The active agent, he thinks, does not exist ready formed in unseasoned wood, but is produced by a secondary action from the constituents of the wood. The corrosion is not due usually to contact action between the lead and the wood, but a volatile substance is gradually produced from the unseasoned wood. The corroding agent is usually acetic acid in the presence of moist air and carbonic acid, but other acids of the same series are sometimes produced and also act on the lead, and in the case of butyric and valeric acids the incrustation is of a greenish yellow, while that from acetic acid is whitish or yellowish. The lead being corroded by these acids, which are produced by the decomposition of substances known to be present in the woods, the tea takes up the disagreeable odour of the latter after they have undergone the change in which acetic, butyric, and the other acids are formed, and will thus become deteriorated.

THE additions to the Zoological Society's Gardens during the past week include a Common Fox (*Canis vulpes* ♂), British, presented by Mr. J. W. Morgan; a Spotted Ichneumon (*Herpestes nepalensis*) from Nepal, presented by Mr. Herbert W. Brown; a Common Polecat (*Mustela putorius*), British, presented by Mr. William Buckley; a Red-crested Cardinal (*Paro-

aria cucullata) from South America, presented by Mr. W. E. Ayerst; four Florida Tortoises (*Testudo polyphemus*) from Florida, presented by Mr. Hugh Bellas; a Common Viper (*Vipera berus*) from Hampshire, presented by Mr. Gerald Waller, F.Z.S.; a Brown-throated Conure (*Conurus æruginosus*) from South America, a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, a Macaque Monkey *Macacus cynomolgus*) from India, deposited; a Bandicoot Rat (*Mus bandicoota*), a Bronze-spotted Dove (*Chalcopelia chalcopilos*), bred in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *AUGUST* 15–21

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on August 15

Sun rises, 4h. 47m.; souths, 12h. 4m. 16·6s.; sets, 19h. 21m.; decl. on meridian, 14° 1′ N.: Sidereal Time at Sunset, 16h. 57m.

Moon (one day after Full) rises, 19h. 12m.*; souths, 0h. 13m.; sets, 5h. 19m.; decl. on meridian, 12° 13′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	5 13	12 4	18 55	9 7 N.
Venus	2 10	10 11	18 12	21 9 N.
Mars	10 48	15 59	21 10	10 23 S.
Jupiter	8 45	14 44	20 43	0 55 S.
Saturn	1 34	9 40	17 46	21 59 N.

* Indicates that the rising is that of the preceding evening.

Occultations of Stars by the Moon (visible at Greenwich)

Aug.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
17	4 Ceti	6	21 58	near approach	345 —
17	5 Ceti	6	22 3	22 32	10 323
17	B.A.C. 5	6	22 11	23 21	62 278
19	ν Piscium	4½	22 42	23 47	68 261

Aug.	h.	
16	8	Mercury in inferior conjunction with the Sun.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	Aug. 17,	21 28	*m*
Algol	3 0·8	40 31 N.	,, 20,	0 18	*m*
R Comæ	11 58·4	19 25 N.	,, 17,		*M*
W Virginis	13 20·2	2 47 S.	,, 17,	0 0	*M*
δ Libræ	14 54·9	8 4 S.	,, 21,	20 4	*m*
U Coronæ	15 13·6	32 4 N.	,, 15,	2 21	*m*
W Herculis	16 31·2	37 34 N.	,, 18,		*M*
U Ophiuchi	17 10·8	1 20 N.	,, 17,	2 56	*m*
			,, 17,	23 4	*m*
W Sagittarii	17 57·8	29 35 S.	,, 21,	0 0	*M*
U Sagittarii	18 25·2	19 12 S.	,, 15,	0 0	*M*
β Lyræ	18 45·9	33 14 N.	,, 20,	21 0	m_2
S Vulpeculæ	19 43·7	27 0 N.	,, 21,		*M*
R Sagittæ	20 8·9	16 23 N.	,, 19,		*m*
δ Cephei	22 24·9	57 50 N.	,, 20,	2 0	*m*

M signifies maximum; *m* minimum; m_2 secondary minimum.

TENTH ANNIVERSARY OF THE JOHNS HOPKINS UNIVERSITY

THE tenth anniversary of the Johns Hopkins University at Baltimore was celebrated on April 26 last. Of the addresses delivered on that occasion we reprint two, the second of which reviews the work of this distinguished institution since its foundation. The work of the University in every department of human knowledge is well-known and appreciated in this country, and it is unnecessary to add a word to the address of Dr. Thomas, beyond expressing a cordial hope that the future may, in the words of the very appropriate ode read on the occasion, be

"Smooth course and splendour of the sunset-smiles."

The following is the address delivered by Prof. Henry A. Rowland, Ph.D., who took for his subject "The Physical Laboratory in Modern Education."

"From the moment we are born into this world down to the day when we leave it, we are called upon every moment to exercise our judgment with respect to matters pertaining to our welfare. While nature has supplied us with instincts which take the place of reason in our infancy, and which form the basis of action in very many persons through life, yet, more and more as the world progresses and as we depart from the age of childhood we are forced to discriminate between right and wrong, between truth and falsehood. No longer can we shelter ourselves behind those in authority over us, but we must come to the front and each one decide for himself what to believe and how to act in the daily routine and the emergencies of life. This is not given to us as a duty which we can neglect if we please, but it is that which every man or woman, consciously or unconsciously, must go through with.

"Most persons cut this Gordian knot, which they cannot untangle, by accepting the opinions which have been taught them and which appear correct to their particular circle of friends and associates: others take the opposite extreme, and, with intellectual arrogance, seek to build up their opinions and beliefs from the very foundation, individually and alone, without help from others. Intermediate between these two extremes comes the man with full respect for the opinions of those around him, and yet with such discrimination that he sees a chance of error in all, and most of all in himself. He has a longing for the truth, and is willing to test himself, to test others, and to test nature until he finds it. He has the courage of his opinions when thus carefully formed, and is then, but not till then, willing to stand before the world and proclaim what he considers the truth. Like Galileo and Copernicus he inaugurates a new era in science, or, like Luther, in the religious belief of mankind. He neither shrinks within himself at the thought of having an opinion of his own, nor yet believes it to be the only one worth considering in the world; he is neither crushed with intellectual humility, nor yet exalted with intellectual pride; he sees that the problems of nature and society can be solved, and yet he knows that this can only come about by the combined intellect of the world acting through ages of time, and that he, though his intellect were that of Newton, can, at best, do very little toward it. Knowing this he seeks all the aids in his power to ascertain the truth, and if he, through either ambition or love of truth, wishes to impress his opinions on the world, he first takes care to have them correct. Above all, he is willing to abstain from having opinions on subjects of which he knows nothing.

"It is the province of modern education to form such a mind, while at the same time giving to it enough knowledge to have a broad outlook over the world of science, art, and letters. Time will not permit me to discuss the subject of education in general, and, indeed, I would be transgressing the principles above laid down if I should attempt it. I shall only call attention at this present time to the place of the laboratory in modern education. I have often had a great desire to know the state of mind of the more eminent of mankind before modern science changed the world to its present condition and exercised its influence on all departments of knowledge and speculation. But I have failed to picture to myself clearly such a mind, while, at the same time, the study of human nature, as it exists at present, shows me much that I suppose to be in common with it. As far as I can see, the unscientific mind differs from the scientific in this, that it is willing to accept and make statements of which it has no clear conception to begin with, and of whose truth it is not assured. It is an irresponsible state of mind without clearness of conception, where the connection between the thought and its object is of the vaguest description. It is the state of mind where opinions are given and accepted without ever being subjected to rigid tests, and it may have some connection with that state of mind where everything has a personal aspect and we are guided by feelings rather than reason.

"When, by education, we attempt to correct these faults, it is necessary that we have some standard of absolute truth: that we bring the mind in direct contact with it, and let it be convinced of its errors again and again. We may state, like the philosophers who lived before Galileo, that large bodies fall faster than small ones, but when we see them strike the ground together, we know that our previous opinion was false, and we learn that even the intellect of an Aristotle may be mistaken. Thus we are taught care in the formation of our opinions, and find that the unguided human mind goes astray almost without fail. We must correct it constantly and convince it of error over and over again until it discovers the proper method of reasoning, which will surely accord with the truth in whatever conclusions it may reach. There is, however, danger in this process that the mind may become over-cautious, and thus present a weakness when brought in contact with an unscrupulous person who cares little for truth and a great deal for effect. But if we believe in the maxim that truth will prevail, and consider it the duty of all educated men to aid its progress, the kind of mind which I describe is the proper one to foster by education. Let the student be brought face to face with nature: let him exercise his reason with respect to the simplest physical phenomenon, and then, in the laboratory, put his opinions to the test; the result is invariably humility, for he finds that nature has laws which must be discovered by labour and toil, and not by wild flights of the imagination and scintillations of so-called genius.

"Those who have studied the present state of education in the schools and colleges tell us that most subjects, including the sciences, are taught as an exercise to the memory. I myself have witnessed the melancholy sight in a fashionable school for young ladies of those who were born to be intellectual beings reciting page after page from memory, without any effort being made to discover whether they understood the subject or not. There are even many schools, so-called, where the subject of physics or natural philosophy itself is taught, without even a class experiment to illustrate the subject and connect the words with ideas. Words, mere words, are taught, and a state of mind far different from that above described is produced. If one were required to find a system of education which would the most surely and certainly disgust the student with any subject, I can conceive of none which would do this more quickly than this method, where he is forced to learn what he does not understand. It is said of the great Faraday that he never could understand any scientific experiment thoroughly until he had not only seen it performed by others, but had performed it himself. Shall we then expect children and youth to do what Faraday could not do? A thousand times better never teach the subject at all.

"Tastes differ, but we may safely say that every subject of study which is thoroughly understood is a pleasure to the student. The healthy mind as well as the healthy body craves exercise, and the school-room or the lecture-room should be a source of positive enjoyment to those who enter it. Above all, the study of nature, from the magnificent universe, across which light itself, at the rate of 186,000 miles per second, cannot go in less than hundreds of years, down to the atom of which millions are required to build up the smallest microscopic object, should be the most interesting subject brought to the notice of the student.

"Some are born blind to the beauties of the world around them, some have their tastes better developed in other directions, and some have minds incapable of ever understanding the simplest natural phenomenon; but there is also a large class of students who have at least ordinary powers and ordinary tastes for scientific pursuits: to train the powers of observation and classification let them study natural history, not only from books, but from prepared specimens, or directly from nature; to give care in experiment and convince them that nature forgives no error, let them enter the chemical laboratory; to train them in exact and logical powers of reasoning, let them study mathematics; but to combine all this training in one and exhibit to their minds the most perfect and systematic method of discovering the exact laws of nature, let them study physics and astronomy, where observation, common-sense, and mathematics go hand in hand. The object of education is not only to produce a man who *knows*, but one who *does*; who makes his mark in the struggle of life and succeeds well in whatever he undertakes; who can solve the problems of nature and of humanity as they arise; and who, when he knows he is right, can boldly convince the world of the fact. Men of action are needed as well as men of thought.

"There is no doubt in my mind that this is the point in which much of our modern education fails. Why is it? I answer that the memory alone is trained, and the reason and judgment are used merely to refer matters to some authority who is considered final, and worse than all they are not trained to apply their knowledge constantly. To produce men of action they must be trained in action. If the languages be studied, they must be made to translate from one language to the other until they have perfect facility in the process. If mathematics be studied, they must work problems, more problems, and problems again, until they have the use of what they know. If they study the sciences, they must enter the laboratory, and stand face to face with nature; they must learn to test their knowledge constantly, and thus see for themselves the sad results of vague speculation; they must learn by direct experiment that there is such a thing in the world as truth, and that their own mind is most liable to error. They must try experiment after experiment and work problem after problem until they become men of action, and not of theory.

"This, then, is the use of the laboratory in general education—to train the mind in right modes of thought by constantly bringing it in contact with absolute truth, and to give it a pleasant and profitable method of exercise which will call all its powers of reason and imagination into play. Its use in the special training of scientific men needs no remark, for it is well known that it is absolutely essential. The only question is whether the education of specialists in science is worth undertaking at all, and of these I have only to consider natural philosophers or physicists. I might point to the world around me, to the steam-engine, to labour-saving machinery, to the telegraph, to all those inventions which make the present age the 'Age of Electricity,' and let that be my answer. Nobody could gainsay that the answer would be complete, for all are benefited by these applications of science, and he would be considered absurd who did not recognise their value. These follow in the train of physics, but they are not physics; the cultivation of physics brings them and always will bring them, for the selfishness of mankind can always be relied upon to turn all things to profit. But in the education pertaining to a University we look for other results. The special physicist trained there must be taught to cultivate his science for its own sake. He must go forth into the world with enthusiasm for it, and try to draw others into an appreciation of it, doing his part to convince the world that the study of nature is one of the most noble of pursuits, that there are other things worthy of the attention of mankind besides the pursuit of wealth. He must push forward and do what he c. . according to his ability, to further the progress of his science.

"Thus does the University, from its physical laboratory, send forth into the world the trained physicist to advance his science and to carry to other colleges and technical schools his enthusiasm and knowledge. Thus the whole country is educated in the subject, and others are taught to devote their lives to its pursuit, while some make the applications to the ordinary pursuits of life that are appreciated by all.

"But for myself I value in a scientific mind most of all that love of truth, that care in its pursuit, and that humility of mind which makes the possibility of error always present more than any other quality. This is the mind which has built up modern science to its present perfection, which has laid one stone upon the other with such care that it to-day offers to the world the most complete monument to human reason. This is the mind which is destined to govern the world in the future and to solve problems pertaining to politics and humanity as well as to inanimate nature.

"It is the only mind which appreciates the imperfections of the human reason, and is thus careful to guard against them. It is the only mind that values the truth as it should be valued, and ignores all personal feeling in its pursuit. And this is the mind the physical laboratory is built to cultivate."

Dr. Thomas's address was as follows:—

"The foundation and growth of a University is an event of the greatest interest.

"Its functions and use have been elaborately discussed by many modern thinkers and scholars. I shall call your attention to three statements of men of differing schools of thought.

"Goldwin Smith, discussing Oxford University organisation, says:—

"'Experience seems to show that the best way in which the University can promote learning and advance science is—

"'(1) By allowing its teachers, and especially the holders of its great professorial chairs, a liberal margin for private study;

"'(2) By keeping its libraries and scientific apparatus in full efficiency and opening them as liberally as possible;

"'(3) By assisting, through its press, in the publication of learned works which an ordinary publisher would not undertake;

"'(4) By making the best use of its power of conferring literary and scientific honours.'

"Matthew Arnold says, the University 'ought to provide facilities, after the general education is finished, for the young man to go on in the line where his special aptitudes lead him, be it that of languages and literature, of mathematics, of the natural sciences, of the application of these sciences, or any other line, and follow the studies of this line systematically, under first-rate teaching.'

"Again, 'The idea of a University is, as I have already said, that of an institution not only offering to young men facilities for graduating in that line of study to which their aptitudes direct them, but offering to them also facilities for following that line of study systematically under first-rate instruction. This second function is of incalculable importance, of far greater importance even than the first. It is impossible to over-value the importance to a young man of being brought in contact with a first-rate teacher of his matter of study, and of getting from him a clear notion of what the systematic study of it means."

"John Henry Newman says:—'It is a great point, then, to enlarge the range of studies which a University professes, even for the sake of the students; and though they cannot pursue every study which is open to them, they will be gainers by living among those and under those who represent the whole circle. This I conceive to be the advantage of a seat of universal learning, considered as a place of education. An assemblage of learned men, zealous for their own sciences and rivals of each other, are brought by familiar intercourse and for the sake of intellectual peace to adjust together the claims and relations of their respective subjects of investigation. They learn to respect, to consult, to aid each other. Thus is created a pure and clear atmosphere of thought, which the student also breathes, though in his own case he only pursues a few sciences out of the multitude. He apprehends the great outlines of knowledge, the principles on which it rests, the scale of its parts, its lights and its shades, its great and its little, as he otherwise cannot apprehend them.

"'Hence it is that his education is called "Liberal." A habit of mind is formed which lasts through life, of which the attributes are freedom, equitableness, calmness, moderation, and wisdom. This, then, I would assign as the special fruit of the education furnished at a University. . . . This is the main purpose of a University in the treatment of its students.'

"And a great thinker of another generation, George Fox, advised the setting up of schools for instructing 'in whatsoever things were civil and useful in the creation.'

"We may then conclude that a University, wisely planned and faithfully administered, should be able to gather together a company of teachers, distinguished in character and learning; to present courses of study, important and thorough; and to attract scholars mature in age and competent by reason of previous training to pursue special lines of study, in order to fit themselves in a worthy manner for their chosen vocation. It should be wide in its scope and able to supplement the College, and aid students to perfect themselves in many departments of learning. It should provide liberally all the apparatus for this study. It should be rich in laboratories, in books, in instruments. It should endow research and stimulate investigation and discovery. It should be prepared to give results of work done within its halls speedy and wide publicity amongst scholars engaged in kindred pursuits. It should give its contribution to society by training men who are fitted to help in the solution of the problems of the age—scientific, social, political, moral, and religious, both by stimulating the production of books and by contributions to the journals and literature of the day. It should encourage all noble aspirations, conserve all good inheritances of the past, and create an atmosphere of enthusiasm for hard work. It should be able to bestow honours worthy of the name in reward for faithful devotion and for the successful fulfilment of its courses of study. Its work should be known and recognised where learning is known and recognised, and its name should carry weight in other Universities and centres of research in the world of letters.

"Such thoughts as these, I am sure, Judge Dobbin, were in your mind and in the minds of the other trustees to whom was intrusted by our late townsman, Johns Hopkins, the foundation and guidance of this University which was to bear his name. On the completion of the first decade of its existence, in the presence of the trustees and the President and Faculty of the University, before the graduates, the present Fellows, and students of the University, and in the presence of this company of our friends and fellow-citizens, it has seemed fitting to allude to these sentiments as we proceed to consider the progress of this University.

"I am glad to take this opportunity of replying in public to questions such as were asked me by a young Baltimorean, who the other day said: 'Why do Baltimoreans have to go to New Haven or somewhere abroad to learn about the Johns Hopkins? Why do you not tell us what is being done?' In order to do this before a Baltimore audience, I have supposed my friend to have asked the following questions, to which I shall briefly reply:—

"(1) Have great teachers been attracted to the University?

"(2) Have important courses of study been instituted?

"(3) Have students come, and from whence?

"(4) Have patient and successful researches been carried on?

"(5) Has the University gathered together suitable apparatus, &c., for study?

"(6) Have the results of these researches been given by the University to the world?

"(7) Has the work done here been recognised elsewhere?

"(8) Has the training given proved valuable to those who have received it?

"(9) What has the University done for this community?

"The Board of Trustees was incorporated in August 1869, at the instance of Johns Hopkins and during his lifetime. About a year after the death of the founder, in December 1873, the Board was put in possession of the endowment provided by his beneficence, and organised for work. The President of the Board, the late Galloway Cheston, took an active part in the enterprise, and by his advice greatly aided in laying the foundation of the University, and his name will always be honourably associated with its history. The other members of the Board, all of whom had been named by Johns Hopkins, were Reverdy Johnson, Jun., the first Chairman of the Executive Committee, Francis T. King, Lewis N. Hopkins, Thomas M. Smith, William Hopkins, John W. Garrett, Francis White, Charles J. M. Gwinn, George W. Dobbin, George William Brown, and James Carey Thomas.

"*What Great Teachers have been attracted?*—It was soon apparent that the wise and untrammelled directions of Johns Hopkins to his trustees to found a University would attract the attention of those interested in the cause of education, especially in the United States.

"The opportunity of developing an institution suited to the needs of the country was sufficient to draw to Baltimore from across the Continent the then President of the University of California, Daniel C. Gilman, who was named to the trustees as the man best fitted by previous training and devotion to the study of educational methods, to advise and direct the establishment of the new foundation, by his former colleagues of Yale College—by President Eliot, of Harvard University, at once the most renowned and the most venerable institution of learning in the country—by President White, of Cornell University, then in the early days of its growing importance and usefulness—by President Angell, of the University of Michigan, the crowning institution of learning of the well-organised system of public instruction in that great and strong Western State—and by numerous other leading educators. At the request of the trustees Mr. Gilmun came to Baltimore, and after consultation with them accepted the Presidency of the Johns Hopkins University. Under his thoughtful care and constant and laborious effort the plan originally contemplated has been gradually and harmoniously developed.

"Besides President Gilman, the University also drew from across the ocean, from Woolwich, England, Prof. Sylvester, one of the two greatest English mathematicians, and indeed one of the greatest of the world; and from Virginia, in our own land, Prof. Gildersleeve, second to none in his attainments in and devotion to Greek and other classical study—besides younger men whose subsequent career has justified the bright promise of their early years. I shall not mention further by name the present distinguished staff of Professors and teachers, whose work I have alluded to, and who form the permanent renown and attraction of the University.

"I will give a list in chronological order of those gentlemen, not now connected with the University, who, for a longer or shorter period, have lectured here during the past ten years:—

"In Language and Literature, Profs. F. J. Child, James Russell Lowell, W. D. Whitney, C. R. Lanman, Thomas C.

Murray, H. C. G. Brandt, Sidney Lanier (too early lost), Profs. W. W. Goodwin, J. A. Harrison, J. Rendel Harris, Hiram Corson, A. S. Cook, Messrs. George W. Cable, Edmund Gosse, Justin Winsor, A. Melville Bell, Drs. Isaac H. Hall, and W. Hayes Ward; in History and Political Science, Profs. T. M. Cooley, F. A. Walker, W. F. Allen, the lamented J. L. Diman, H. von Holst, Austin Scott, James Bryce, E. A. Freeman (who gave six lectures and imparted a decided impulse to historical study here), R. M. Venable, Messrs. J. J. Knox and Eugene Schuyler; in Archæology and Art, Messrs. W. W. Story, F. Seymour Haden, J. Thacher Clarke, W. J. Stillman, Dr. Charles Waldstein, and Mr. Frederick Wedmore; in Philosophy and Logic, Profs. William James, G. S. Morris, Mr. C. S. Pierce, and Dr. Josiah Royce; in Physical and Mathematical Science, Profs. J. E. Hilgard, J. Willard Gibbs, John Trowbridge, A. Graham Bell, S. P. Langley, Arthur Cayley, C. S. Hastings, and Sir William Thomson; in Chemistry and Biology, Profs. J. W. Mallet, W. G. Farlow, J. McCrady, W. T. Sedgwick, H. Sewall, and W. Trelease.

"At our commencements, anniversaries, and other gatherings, we have heard from Presidents Eliot and White, from Dean Stanley, Dean Howson, Prof. Huxley, Archdeacon Farrar, Chief Justice Waite, Hon. W. M. Evarts, Dr. W. A. P. Martin, Dr. W. B. Carpenter, Hon. S. T. Wallis, J. B. Braithwaite, and others.

"Many of these have been listened to by those not members of the University who were specially interested in their subjects, and it may be fairly said that many eminent and great teachers have been both for long and short periods attracted to the University.

"*What University Courses are here offered, and what Graduate Students have been attracted?*—The courses of University studies that have been pursued have been so often and so fully referred to in the reports and circulars of the University, that I can only enumerate those in higher mathematics, in physics, in chemistry, in mineralogy and petrography, in biology; in Greek, in Latin, in Sanskrit, in Hebrew, in Aramæan, in Arabic, in Assyrian, and in Sumero-Akkadian; in English, in German, in the Romance group of languages, including French, old and modern, Wallachian, Italian, Spanish, Catalan, old Provençal, modern Provençal, and Portuguese; in history, ancient and modern, in political economy, physical and historical geography; in psychology, pedagogics and philosophy, in mental hygiene and ethics. In these studies advanced instruction has been given by all available means, such as lectures, laboratory practice, seminary work, books, models, and plates, in order to fit those who are preparing for teaching or special research.

"That these courses have succeeded in attracting students of mature age is evident from the fact that out of the total number of students (923) enrolled during the decade, 590 have pursued graduate courses, and these 590 came from more than 100 different Universities and Colleges as widely separated as Russia and Japan.

"*What Apparatus and Appliances have been gathered together?*—To aid in the instruction given, the trustees have from the first had in view securing the most convenient and free access to the most modern means of promoting research. They were greatly aided by the existence in Baltimore of a library of unusual value to students—the gift of the late George Peabody, and brought together with much care and diligence by the trustees, the provost, and the librarian of the Peabody Institute—and which has been liberally opened to members of the University. As a supplement to the Peabody collections the University has placed within its own walls 29,000 volumes—a portion of which are standard reference-books needed by all the teachers and students; the remainder are special and often costly books which have been called for by the specialists here engaged in work.

"The plans of the University being at first, from the nature of the case, tentative, the work was begun in two dwelling-houses purchased in 1875, on Howard Street, near Monument Street, and in a hall erected at the time, and named after the founder, which contained an assembly-room and accommodations for the library and for the biological laboratory, and in a chemical laboratory built at the same time, and this was for some time the modest seat of the University. The location was found more convenient than had been foreseen, both for students who lived in the city and for those that came from elsewhere, who readily found accommodation in lodgings suited to their taste and means. Easy access was had to the Peabody and other collections of books, as those of the Historical Society, and later of the Pratt Library, and there have gradually grown around the present site complete and well-equipped laboratories. The chemical laboratory has been greatly enlarged and perfected. The biological laboratory adjoining has been erected after plans suggested by years of work and by comparison with foreign institutions of a similar kind, and there is now building near by the physical laboratory, of which Prof. Rowland has been speaking to you to-day. Laboratory work in pathology has been begun in one of the buildings of the Johns Hopkins Hospital, and it is intended to erect the Medical School on a lot now owned by the University, adjacent to the hospital.

"Into these various buildings have been gathered, at the suggestion and under the careful personal supervision of various experts, about 70,000 dols. worth of apparatus of the most approved modern make, thus placing within the reach of investigators the means of pursuing advanced research, as well as enabling students to become familiar by personal use with the newest methods of study and experiment.

"*What Research is carried on, and what has been published?*—The researches which have been made have been many and varied. I cannot refer to the more technical, such as those in mathematics and inorganic chemistry, &c., but briefly to the more easily stated.

"Our knowledge of the nature of the sun, as perceived through the solar spectrum, has received accessions from the beautiful image thrown from the gratings first made here by the agency of a wonderful dividing-engine, the invention of the Professor of Physics. From this image a map of the spectrum has been published, very much more minute than any before made.

"Researches in electricity and magnetism have been made under the auspices of the United States Government, with the co-operation of other nations; the mechanical equivalent of heat has been redetermined; investigations have been conducted in physiology, especially of the heart's action; lower animal life has been studied, especially that of the oyster in connection with the State of Maryland; both here and in Boston the cause of water pollution in great reservoirs has been discovered; the curious geological formation of our own neighbourhood has been brought to notice and has attracted wide attention. The philologians and grammarians have been engaged in the investigation of Greek and Latin syntax; in editing ancient writings, such as Pindar, the newly discovered Greek MSS. of the Teaching of the Twelve Apostles, and part of an old Syriac MS. of the New Testament. Baltimore is now one of the centres for the interpretation of Sanskrit texts and of Assyrian inscriptions. A great contribution has been made to the study of American Institutions, and new methods of historical research and of publication have been initiated.

"It is with satisfaction that I state that these researches have been widely recognised at home and abroad, not as *promises* for the future, but as successful experiments recorded, and conclusions reached which have passed into the history of science. By means of them the fame of the University has been carried into every seat of learning in the world, from Oxford and Cambridge in England, to Tokio, Japan; from the northern and more modern Universities of Sweden and Russia to the ancient seats of learning in Italy and Southern Europe. The exchanges on the shelves of our library, received with almost every foreign mail in return for the six scientific journals published by the University,[1] attest both its importance and its estimation outside its own walls. Besides this, personal and unsolicited testimonials from eminent men are on file in the office which have been received from many quarters.

"These researches, delicate, prolonged, and important, and others not now mentioned, have been made by Professors, Fellows, and advanced students. Indeed the whole plan of Fellowships has in reality been a most practical and efficient endowment of research, and has richly repaid the University and the community in the importance and value of the results obtained.

"Twenty young men who have not quite completed their

[1] (1) The "American Journal of Mathematics," commenced in 1878, now in its eighth volume; (2) the "American Chemical Journal," commenced in 1879, now in its eighth volume; (3) the "American Journal of Philology," commenced in 1880, now in its seventh volume; (4) "Studies from the Biological Laboratory." commenced in 1879, now in its third volume; (5) "Studies in Historical and Political Science," begun in 1882, of which the fourth series is in progress; (6) the "Johns Hopkins University Circulars," begun in 1879, of which forty-nine numbers have been issued.

work as students following masters, but who have gone far enough to indicate that they are possessed of unusual ability, are annually chosen by the Academic Council, and are encouraged by a generous stipend to devote all their time to study which is not of a distinctively professional character. They are chosen because of the hope they give of future achievements, or are selected on the evidence they submit of their previous intellectual attainments. The system here adopted has elsewhere been followed.

"*What has been the Value of this Training?*—Has the training here been of value to the men that have submitted to the severe ordeal of discipline and who have often surrendered honourable and lucrative positions to avail themselves of the advantages offered for research and study? Or, in other words, are the diplomas to be given to-day as testimonials of the University to the attainments of those to whom they are so worthily awarded, of real value to their possessors?

"Of the 69 persons who in these ten years have been admitted to the degree of Doctor of Philosophy, denoting proficiency in various lines of special graduate study, either in letters or in science, 56 have obtained honourable positions as professors and teachers in 32 Universities and Colleges; and of the 90 to whom the degree of Bachelor of Arts has been given, 20 have engaged in teaching in 16 Colleges and high schools.

"I will conclude this part of my subject by quoting the reply made by a graduate student from North Carolina, when asked what he had found here of most use, he replied: 'The freedom of access to able teachers and the stimulant of studying in company with men of maturer minds than one meets elsewhere.'

"*But what has the University done for this community?*—Besides the incidental advantages which must accrue to any community from the presence of a great seat of learning, the trustees have had in mind from the first the special needs of this city and state. At the conclusion of the late war fewer boys were at college than at former periods. Many young men here and further south had foregone college training, and circumstances forbade the sending of others who were growing up. It was manifest that the need of our own people was first a college in order to train for life, or for further university instruction. So side by side with the University has developed the college department of the Johns Hopkins University. This was begun when the discussion of a fixed, a free, or wholly or partly elective college course had not been so warmly debated as at the present time, but it was evident that the wide range which the development of various branches of knowledge has taken since the old arrangement of college studies was effected, and the limited time which can ordinarily be devoted by students to preparation for their life-work, made a readjustment of the college course desirable. This was accomplished here by arranging, after a fixed matriculation, the studies in groups rather than years, and demanding in each group a certain required amount of training in other than the main study of the course. Thus classical students are required to study some science, scientific students some classics, and all to receive a fixed amount of general English training in literature, ethics, philosophy, and modern languages.

"The seven groups for which, in accordance with these principles, arrangements are now made, are these:—

"(1) Classical—corresponding closely with what has been hitherto known in this country as the usual college course.

"(2) Mathematical-Physical—which meets the wants of those who are expecting to enter upon the modern vocations in which rigid mathematical discipline is indispensable.

"(3) Chemical-Biological—which is adapted to those, among others, who expect to enter upon the subsequent study of medicine.

"(4) Physical-Chemical—which is most likely to be followed by students preparing for those scientific pursuits which are neither chiefly mathematical nor chiefly biological.

"(5) Latin-Mathematical—which affords a good fundamental training, without prolonged attention to the study of Greek.

"(6) Historical-Political—which furnishes a basis for the subsequent study of law.

"(7) Modern Language—where French, German, English, and in exceptional cases, other modern languages, take the place of Latin and Greek in the traditional classical course.

"It cannot be said that this arrangement is perfect, but it has worked well, and great effort is made to have it at once liberal and adapted to the exigencies of active life. I should like all the time at my disposal to expand more fully this slight sketch of the college course which lies near my own heart, but must content myself with stating that it has from the first attracted our own boys, to whom great inducement has been held out, and who have proved some of our most enthusiastic and successful students, have won for themselves many of our own Fellowships, and have gone out to positions of importance and emolument. Their number is rapidly increasing, and the University is constantly endeavouring to make closer the connection between the high schools, whether private or public, and the collegiate department of the Johns Hopkins University.

"Various free scholarships are annually offered to students coming from Maryland, Virginia, and North Carolina, and have been held by 150 students from these States. The existence in our midst of such advantages is stimulating our young men to avail themselve of them, and is increasing the number and efficiency of preliminary schools. We have now in the collegiate department 130 students.

"I have thus, in the briefest and most prosaic manner, endeavoured to summarise the work of ten years into the space of twice as many minutes. It has been impossible, although I have not even glanced at the various literary and scientific Societies formed for themselves by the members of the University, nor alluded to the common college life, nor spoken of the work of the Christian Association of the University, which has served an excellent purpose; but yet I think that I have shown that something has been done to bring together great teachers, to start liberal courses of study, to attract students, to collect libraries and apparatus, to stimulate research, to publish results, and have stated in what manner this work has been recognised, and how the needs of this community have been considered.

"But I am sure that in reaching these conclusions you must feel how little has been done in comparison with what is practicable with longer time and greater resources. The perpetuation and enlargement of the University on a broad and liberal foundation should be the pride of every citizen. It is a great trust to be handed down to those who shall succeed us. Let us be careful to see that no detriment happen to it.

"Amidst the jarring of contending factions and classes there needs must be thoughtful men trained to habits of patient investigation and quiet study—amidst the rush of business and competition, men who in secluded laboratories pass hours and days in subtile experiments—amidst the selfishness of politicians and placemen, historians and philosophers and teachers who can recall the lessons of past ages and vindicate the great moral principles which underlie all true progress.

"For these and other great purposes Universities should exist and be richly endowed. They should be few, but strong.

"A president of a growing Western College, last week in Baltimore, emphasised most strongly the importance of adding efficiency to existing Universities in order to make them great centres for training and research. The possessors of great wealth, most frequently in this country accumulated in the course of a single life, have often felt their responsibility in its ultimate destination. They have in many instances, amongst which the course of Johns Hopkins is conspicuous, returned their accumulated gains to the community in noble gifts, founding great institutions of learning and great charities for the training of the future citizen and for the alleviation of human suffering. These should be fostered and enlarged, as has been done at Harvard and at Cornell, in order that the greatest good may be accomplished.

"The training of *men* is after all the most important end of all educational effort. It is to you, young men, the sons of this new foundation, that your teachers and friends look as the best evidence of the success of their endeavour. Your learning, your usefulness, your accomplishments, your high aims and noble character, your achievements, whether in the pulpit or the forum, the college or the laboratory, at home and abroad will afford a continual and living reminder of this, the place of your training.

"To a State founded on the beneficent precepts of Christianity, the walls of its defence must be not the physical strength of its citizens but their moral character. In vain will science harness the powers of the universe unless they are yoked to the chariot of peace and goodwill. In vain will learning and training give efficiency to individual influence and native genius, unless the purposes of the man are noble and far-reaching. The truth which sets free is the truth which warms the heart and expands the sympathies, as well as enlightens the intellect, which is of

Him who is the truth Himself. Let us have confidence in the supremacy of truth. Such has hitherto been the guiding lamp of the Johns Hopkins University. May it ever be the beacon of the future."

SCIENTIFIC SERIALS

A LARGE space in the June number of the *Journal of Botany* is occupied by a long biographical notice, by the editor, of the late Rev. W. W. Newbould, of whom an excellent portrait is also provided. The other articles are almost entirely of local interest.

THE *Journal of the Franklin Institute*, vol. cxxi. No. 724, April 1886.—Lieut. J. P. Finley, tornado study: a useful summary of the principal facts scientifically known respecting tornadoes.—F. E. Galloupe, rapid transit and elevated railroads. This concludes the discussion on this topic.—G. E. Waring, Jun., mechanical appliances in town sewerage; discusses the systems employed in several American cities.—Prof. R. H. Thurston, construction of a large Prony brake. Gives an account of a brake capable of absorbing 540 horse-power.—Dr. W. H. Wahl, summary of engineering and industrial progress for 1885.—Report of Committee on Delany system of multiplex telegraphy.

No. 725, May.—J. M. Hartman, the blast-furnace: a very concise summary of present methods of construction and theories.—Lieut. A. B. Wyckoff, hydrographic work of the U.S. Navy. J. Shinn, the cultivation of flax in the United States.—L. D'Auria, the law of cylinder condensation of steam-engines. The new formulæ indicate that the proper way to decrease cylinder condensation is to increase piston speed.—C. J. Kintner, history of the electrical art in the U.S. Patent Office. An interesting account, in which two early forms of storage battery are described. The author, however, appears to think that nothing can be called an invention unless it has been patented in the United States. There were secondary batteries prior to Kintner's, electric motors prior to Davenport's, and telephones prior to Graham Bell's.—Report of examiners of electrical exhibition on applications of electricity to art productions.

No. 726, June.—Chief Engineer Isherwood, an account of experiments made by Chief Engineers Zeller and Hunt to ascertain the economic effect of using in a non-condensing engine saturated steam alone, and of using it mixed with compressed hot air. No economic saving was effected by this process, as there was not sufficient time for the steam and hot air, which were delivered into the cylinder in separate masses, to become mixed, and the air failed to prevent condensation.—S. L. W., on the Oram system of marine propulsion. This system has twin screws placed forward at about 1/5 of the vessel's length from the bow, in recesses in the sides.—G. W. Chance, the South Street Bridge.—W. Lewis, experiments on the transmission of power by gearing. Valuable researches on the causes of loss of power in worm-gearing and spur-gearing.

No. 727, July.—C. Sellers, Jun., Oliver Evans and his inventions. A biographical notice of this remarkable man, whose prediction of the future of the steam-engine is well known.—O. E. Michaelis, the applications of electricity to marksmanship. This is the first part of the paper, and treats rather of mechanical methods of measuring speed of projectiles, such as Robins's ballistic method.—H. M. Dubois, tests of vehicle wheels.—F. E. Ives, colour-sensitive photographic plates. A compound sensibilisator of fresh blue myrtle chlorophyll with a little eosin is found to be the most sensitive to yellow and green.—Report of Committee on the Phelps induction telegraph. The Committee praise highly this invention for telegraphing to and from a moving train.—Report of Committee on the process and furnace for the reduction of refractory ores and the production of metals, alloys, and compounds, invented by E. H. and A. H. Cowles. Cowles's electric furnace, for reducing ore by means of the voltaic arc between carbon poles, is merely a development of the electric furnace devised by the late Sir W. Siemens. It appears to be eminently suitable for the production of aluminium compounds.—Prof. E. J. Houston, some additional facts concerning the Reis articulating telephone. Gives an account of some recent experiments transmitting speech with the identical apparatus manufactured by Reis and used by him in his lecture before the Physical Society at Frankfort in 1861.

Annalen der Physik und Chemie, vol. xxviii. No. 5, May.—R. Colley, on some new methods for observing electric oscillations, and some applications of them. This paper gives certain relations between the time of oscillation of discharges through a shunt having a great coefficient of self-induction and the capacity of the conden er. Using a standard coil the coefficient of self-induction of which could be determined by its geometrical form, and a normal guard-ring condenser made of three sheets of silvered glass, the capacity of which could equally be determined, the author made experiments from which he deduces a new value of the ratio v, which he gives as $3{\cdot}015 \times 10^{10}$ centims. per second.—Hans Jahn, on the relation of the chemical energy and the current energy of galvanic elements. A discussion of Helmholtz's expression for the secondary heat, together with some determinations made on Daniell's and De La Rue's cells.—E. Riecke, on the pyro-electricity of tourmaline. The first part of this paper summarises the previous researches of Gaugain and others upon the electricity of the tourmaline in relation to its section, length, rate of cooling, &c., and gives an account of some new and careful observations made upon three tourmalines. The second part of the paper is devoted to the development of a mathematical theory of the electricity of the tourmaline, based on the physical hypotheses that the molecules possess an initial electric polarisation, measurable in terms of the electric moment per unit of volume, and dependent upon the temperature, and that there is a surface-conductivity of a certain value. The formulæ appear to agree very well with the observed facts.—T. Ihmori, on the absorption of mercury vapour by spongy platinum. A quantity of platinum, deposited from chloride by formic acid, was found to increase in weight in presence of mercury. The author uses this increase of weight to inve tigate the figures given by Hertz and by Hagen, for the pressure of mercury vapour at different temperatures. His results are considerably lower than those of Hagen, and a little higher than those of Hertz.—C. Pulfrich, on the elastic reaction of a caoutchouc tube.—A. König, on a new method of determining the modulus of elasticity. Errors of observation are avoided by using two mirrors, the inclination of which altered by the loading of the bar under examination.—Karl Exner, on sense-formulæ: lenticular action of non-homogeneous bodies. Discussion of lenticular action of cylindriform disks with parallel plane faces made of materials which, on being cast in moulds, cool non-homogeneously with refractive indices that increase or diminish from point to point below the surface. The formulæ deduced coincide with ordinary lens formulæ when the variation of refractive index is proportional to the square of the depth from the surface. This appears to be nearly the case in disks of cast glue.—W. Wien, researches on the absorption-phenomena occurring in the diffraction of light. This paper discusses diffraction in relation to the colours of metallic reflection. Incidentally it brings out an additional proof that the vibrations are perpendicular to the so-called plane of polarisation.—H. W. Vogel, on some colour-experiments, and on photography in natural colours. Two solutions, one of chrysanilin, the other of anilin blue, in alcohol, are respectively yellow and blue; but when superposed give red, not green. The violet of the spectrum appears to play a very unimportant part in colour-sensations; methyl-violet, and nearly all the so-called violet pigments and dyes owe their tint to mixtures of red and blue rays, not to rays of spectrum violet. For colour-printing at least six tints are found requisite, and in general sufficient. Hence the author thinks that all requirements of colour-photography would be met by six printings from six blocks produced by photography from plates of bromide emulsion, to which the following six substances have been used as "sensibilisators": *red*, naphthol blue; *orange*, cyanin; *yellow*, eosin; *green*, saffranin; *green-blue*, fluorescein; *blue*, chrysanilin or aurantin. The author further points out that as the actual tint of any colouring-matter is the complementary colour to that absorbed by the colouring-matter itself, it follows that each of the six plates ought to be printed off in the same dye-stuff that has served as photographic "sensibilisator."—P. Volkmann, note on Prof. Quincke's remarks on the determination of capillary constants of liquids.—R. Schultze, on a small improvement in Wiedemann's pyknometer.

No. 6, June.—A. Kundt and E. Blasius, remarks on some researches on the pyro-electricity of crystals. A convenient apparatus for heating crystals is described; also some observations on the amethyst. The effects of cracks in the crystals are also studied.—K. Mack, pyro-electric and optical observations on Brazilian topaz. The author refers the phenomena to the presence of a single electric axis, inclined to each of the three principal axes of the crystal. He also points out that the two optic axes do not make equal angles with the greatest of the three principal axes.—W. Stscheglajeff, on the electro-magnetic rotation of the plane of polarisation in chloride of iron. Curves given show that in this substance Verdet's rule that the rotation is proportional to the intensity of the field is not observed.—H. Haga, experimental researches on the convection of heat by the electric current. Careful experiments described in this paper show that the Thomson effect in mercury is negative.—Fr. Stenger, on phenomena of fluorescence Some doubt having been thrown upon the transmutation, by Magdala red and other bodies, of red rays into orange or yellow rays, the appearance of these higher rays being attributed to stray light, the whole matter has been repeated with the utmost precautions. It appears to be now established that eosin and fluorescein also have this property. All three bodies are exceptions to Stokes's rule that the transmutation in fluorescence is always a degradation in the spectrum scale. The author also discusses the matter in relation to Lommel's theory and to the influence of solvents. —E. Ketteler, a remarkable limiting case of crystalline reflection, and its investigation by the aid of the perfected total-reflectomer of Kohlrausch.—G. Hansemann, on a new method of determination of periods of oscillation of bar-magnets. A photographic camera and a mirror oscillating in conjunction with a seconds pendulum are applied to the ordinary apparatus for observing oscillations by reflection.—Werner Siemens, on the conservation of energy in the atmosphere of the earth. A discussion of atmospheric laws and of *vis viva* of the atmospheric masses, too involved for a brief abstract.—R. Gerhardt, on the tube-flute stop of the organ. An experimental and mathematical discussion of the effect of putting a small open tube into the closed top of the flute pipe.—W. Alexejew, on solutions. The author arrives at the following conclusions: solids dissolve better than liquids; at one given temperature a solid can give only one saturated solution, a liquid two; supersaturated solutions have two temperatures of decomposition, one at which decomposition may occur, another at which decomposition must occur. A large number of data of observation are plotted in curves.—E. Himstedt, reply to the observations of Lord Rayleigh upon my determination of the ohm.—L. Graetz, on the dependence of the elasticity of caoutchouc upon temperature, and its relation to coefficients of thermal expansion. From his observations the author predicts that a twisted rod of caoutchouc, when suddenly further twisted, will warm itself.—Fr. Stenger, simple demonstration of residual electric charges, by means of an exhausted tube used as a Leyden jar.—A. Oberbeck, remarks on my work on the resonance of electric oscillations. An acknowledgment of the priority of Dr. J. Hopkinson.—A. König, on an observation respecting the empirical basis of our perception of space. This basis is the apparent extent of the objects in the field of vision as distributed over the retina, and their relative apparent displacement when the eye is turned about.—Fr. Stenger, correction to the memoir on the properties of calc-spar in a homogeneous magnetic field.

Rivista Scientifico-Industriale, June 30.—On some new registering thermic instruments, by Prof. Filippo Artimini. A full description, with illustrations, is given of the author's registering thermo-pyrometer, in which the degrees of temperature are accurately recorded by an ingenious application of electricity.—Telephoning at great distances, by F. van Rysselberghe. The author gives a summary of his recent experiments in the United States, showing the possibility of telephoning at any distance and establishing a regular international telephonic service between all the great cities of the world. The telegraphic wires now in use may be utilised for the simultaneous transmission of telegraphic and telephonic messages.

SOCIETIES AND ACADEMIES

SYDNEY

Royal Society of New South Wales, June 2.—Chr. Rolleston, C.M.G., President, in the chair.—Papers read:—A new species of Ardisia from New Guinea, by Baron Ferd. von Mueller, K.C.M.G., F.R.S., descriptive of the only specimen as yet found so far north.—A comparison of the dialects of East and West Polynesia, Malay, Malagasy, and Australian, by the Rev. George Pratt, author of a dictionary of the Samoan language. This was a valuable contribution towards a polyglot of the languages of Polynesia, some of which have already passed away, and most of which are changing through the introduction of new words and the rapid intermingling of various races. The Royal Society of New South Wales was urged to take steps to preserve these records and customs not only of Polynesia, but of the fast-diminishing tribes of Australia.—The discovery of a poison in three species of Daphnandra, a genus of plants of the order Monimiaceæ, by T. L. Bancroft, M.B. (Edin.), F.L.S. (Brisbane).—On some new poisonous substances discovered on the Johnstone River, North Queensland, also by Dr. Bancroft. These papers were descriptive of experiments of the therapeutic action on the guinea-pig.—Prof. Liversidge, F.R.S., exhibited and described: (1) a meteorite, the third one known to be found in New South Wales, composed of iron principally, nickel, cobalt, sulphur, phosphorus, and carbon; (2) the matrix of the rock of the tin deposits of Tasmania, in which the cementing material is topaz; (3) a collection of New South Wales silver ores (38 specimens), collected by Mr. McGarvie Smith; (4) shale from the Hawkesbury sandstone showing worm tracks and perforations, the first time noticed in these rocks.—Mr. Lawrence Hargrave exhibited a model illustrating the undulatory motion of serpents, based upon the trichoidal plane, a continuation of similar studies by him on the motion of fishes and the flight of birds.

Microscopical Section.—The following papers were read during the year 1885:—The *Phylloxera vastatrix*, by Dr. Morris, illustrated with specimens of the diseased vine from the neighbourhood of Sydney; and by the same author, Notes on mounting diatoms in highly refractive media.—Specimens of *A. pellucida* were exhibited mounted in piperine, picric acid, chlorides of tin, and thallium, and sulphur in combination with disulphide of arsenic. These slides were exhaustively tested against the American methods, viz. Dr. Chase's metallic silver and realgar, also Prof. Smith's (Geneva, N.Y.) specimen slide. The microscopes and accessories were of the latest make, and the objectives used were homogeneous immersions by Tolles, 1/10, 1/25; Spencer, 1/12; Powell, 1/12, 1/20. The slides of Dr. Morris's sulphur and arsenic combination gave the best results. In addition to the above-mentioned objectives the following choice glasses were acquired by members of the section during the year:—Powell's, 1/6; Hom N.A., 1·5; Green (late Tolles), 1/2″ 30°; Bausch and Lomb's, 1/16 immersion; Wales, 1/12 immersion, 170°. A valuable Ross Zentmeyer binocular stand with apparatus was presented by H. G. Wright, M.R.C.S.E., whilst immersion and high-angled condensers were purchased. Amongst the numerous slides exhibited were some of new mosses found in the neighbourhood of Sydney by Mr. Whitelegge, and a bacillus found by Dr. Morris in the ulcerated intestine of a foal, the cause evidently of a widely spread epidemic prevalent throughout the colony amongst young foals only.

PARIS

Academy of Sciences, August 2.—M. Jurien de la Gravière, President, in the chair.—On the relations of geodesy to geology, by M. H. Faye. In this second communication it is shown that the harmony of the two sciences results in the remarkable law determining the constancy of the mathematical figure of the globe throughout the whole series of geological evolutions, a law which sooner or later will enable us to form a clear idea regarding the thickness of the present crust of the earth. At the same time the problem cannot be completely solved by the resources of geometry alone, and recourse must be had to the other sciences bearing on the subject.—On the displacement of ammonia by other bases, and on its quantitative analysis in the soil, by MM. Berthelot and André. From their further researches the authors conclude that magnesia cannot be safely employed for the quantitative analysis of ammonia in the analysis of the earths and other organic products containing insoluble double ammoniacal salts. Certain derivatives from the aldehydes are in the same position, as are also probably the ammoniacal salts formed by the humic and allied acids.—On the quantitative analysis of ammonia (continued), by M. Th. Schlœsing. Having previously shown (July 26) that by distillation on magnesia all the ammonia may be extracted from the solution of its hydrochlorate, or from that of the ammoniaco-magnesian phosphate, the author completes his demonstration by causing the magnesia to act on the double ammoniacal salts, and especially on the chlorides containing magnesium and zinc.—Observations on the oldest sedimentary groups in the north-west of France (continued), by M. Hébert. A careful study of the whole region leads to the conclusion that North Brittany, north of a line drawn from Quimper to Rennes, and West Normandy, north of a line drawn from Pontorson to Domfront and Falaise, are mainly constituted by the vertical clay-slates of Saint-Lô, overlain by the purple conglomerates, schists, and nearly horizontal red sandstones. Thus is confirmed the general conclusion announced by Dufrénoy in 1835.—On the presence of microscopic mineral crystals of the feldspar group in certain Jurassic limestones of the Alps, by M. Ch. Lory. The crystals here described yield on analysis about 47 per cent. of potassic and sodic feldspar mixed with a little albite; 45 of quartz in bipyramidal crystals and pulverised; 8 of argile, analogous in its composition to that of the carbonates of lime of the same horizon.—On the operations prosecuted in Tunisia by Commander Landas since the death of Col. Roudaire, by M. de Lesseps. The creation of an inland sea, the original object of these works, has been definitively abandoned, and attention is now devoted to the Wed Melah basin, which, by the sinking of Artesian wells, promises soon to recover its former productiveness.—Note on M. Marcel Deprez's experiments relating to the transmission of force between Creil and Paris, by M. Maurice Lévy. In this note is embodied the report of the sub-committee appointed to verify the results already obtained by M. Deprez during the course of the experiments carried out by him at Creil since November 1885. The main object of these experiments was to show the possibility of transmitting electrically to the Paris terminus, a distance of 56 kilometres, a force of 200 horse-power generated at Creil on the Great Northern line, with an effective yield of 50 per cent. The preliminary operations, concluded on May 24, show that the force consumed at Creil varied from 67 to 116 horse-power, that received at Paris from 27 to 52 horse-power, the yield being from about 41 to 45 per cent., and increasing with the transmitted force. The experiments, conducted at the expense of MM. Rothschild, show conclusively that with a single generator and a single receiver force may be profitably transmitted to a distance of over thirty miles with a loss of not more than 55 per cent. on 52 horse-power, without exceeding a current of 10 amperes, an angular velocity of 216 revolutions per minute, or a peripheric velocity of 7·50 m. per second. With improved appliances the loss, mainly due to absorption by the machines themselves, will probably be reduced to 50 per cent., and to still less in operations conducted on a larger scale.—Measurement of the intensity of sound by means of the manometric flames, by M. E. Doumer. It is shown that this apparatus, hitherto used mainly as a method of demonstration and summary study of the *timbre* of vocal sounds, is susceptible of far more varied applications, and especially may rival the graphic method in determining the height or intensity of sound.—On the separation of arsenic, antimony, and tin, by M. Ad. Carnot. By employing oxalic acid and the hyposulphite of soda or ammonia, sulphurous acid and sulphuretted hydrogen, the author has succeeded in effecting these separations rapidly and accurately, as he had already effected the separation of copper, cadmium, zinc, and nickel. His new methods enable him greatly to simplify the analysis of the complex alloys, of which these metals are constituents.—Heat of formation of the crystallised seleniures and of the amorphous seleniures, by M. Charles Fabre. Here are treated the seleniures of iron, manganese, cobalt, nickel, zinc, cadmium, copper, thallium, lead, mercury, and silver. In general the heat of formation of the seleniures prepared at high temperatures is shown to be equal or slightly inferior to that of the corresponding precipitated sulphides.—On the combinations of chloral and of resorcine, by M. H. Causse.—On the composition of the element in the grease of sheep's wool which is soluble in water, by M. E. Maumené.—On the indirect innervation of the skin, by M. C. Vanlair.—Note on the arterial system of the scorpion, by M. F. Houssay.—Fresh researches on the production of monstrosities in the hen's egg by a modification of the germ before incubation, by M. Dareste.—Observations on the pollinisation of orchids indigenous in France, by M. Paul Maury.—A first survey of the vegetation in the French territory of the Congo, by M. Ed. Bureau. The botanical collections formed by the Mission of West Africa, which have already reached Paris, comprise two herbariums, one collected by MM. Thollon and Schwébisch, the other by MM. J. de Brazza and Pecile. There are altogether 599 species, chiefly from the districts of Franceville, Brazzaville, Ossika, Diélé, Lékéti, and Nganshu, on the Ogoway, Alima, and Lower Congo.

BERLIN

Chemical Society, May 24.—Dr. W. Will reported on the utilisation of myristic acid for lauric acid. According to the investigations of C. Reimer and W. Will there was, in the nuts of *Myristica surinamensis*, an excellent material for obtaining large quantities of myristic acid. Herr Lutz, student, had obtained from it myristinamid, and in accordance with the method of Hofmann, had transferred that into myristintridecylurea, tridecylamin, tridecyl nitrite, tridecylamid, and the corresponding combinations of the twelfth series, inclusive of lauric acid.—Herr O. N. Witt reported on experiments for the local determination of the sulfo group in the naphthalic acids, which led him to the same results as those obtained by Clève.—Prof. C. Liebermann referred to a work undertaken but not yet completed, with a view to the elucidation of the constitution of opianic acid. He showed that there were reasons to support the assumption of an aldehyde group in this compound, as also for the opposite assumption, a fact which led to a discussion on the so-called atom migrations, in which Herren Hofmann, Klason, Liebermann, Krämer, Pinner, and Will took part. Prof. Hofmann then called attention to the fact that such molecular shiftings of place had been particularly in quite recent times observed by him whilst studying the ether of cyanuric acid. He described the formation of a 2/3 iso- and 1/3 ortho-ethyl ether of cyanuric acid which he had obtained from cyanurate of silver by means of ethyliodide. This ether transformed itself, even at the ordinary temperature, into isotriethyl-cyanurate.—In conclusion Prof. Tiemann communicated a work by N. Nagai, on an aromatic ketone isolated from the root of a Japanese peony, having the constitution—

$$C_6H_3(OCH_3)(OH)(COCH_3).$$

BOOKS AND PAMPHLETS RECEIVED

"Madagaskar," by Prof. R. Hartman (Freytag, Leipzig).—"Elements of the Comparative Anatomy of Vertebrates," by R. Wiedersheim; translated by W. N. Parker (Macmillan).—"Bulletin de la Société Impériale des Naturalistes de Moscou," No. 1, 1886 (Moscou).—"Publications of the Leander McCormick Observatory, Virginia," vol. i. part 2.—"Algebra," part 1, by G. Chrystal (Black, Edinburgh).—"The Gold Fields of Victoria: Reports of the Mining Registrars for the Quarter ended March 31, 1886" (Ferres, Melbourne).—"Science and Art Directory," revised to July 1886.

CONTENTS