THURSDAY, MAY 8, 1873

A VOICE FROM CAMBRIDGE

IT is known to all the world that science is all but dead in England. By science, of course, we mean that searching after new knowledge which is its own reward, a thing about as different as a thing can be from that other kind of science, which is now not only fashionable, but splendidly lucrative—that "science" which Mr. Gladstone and Mr. Lowe always appeal to with so much pride at the annual dinner of the Civil Engineers—and that other "science" prepared for Jury consumption and the like.

It is also known that science is perhaps deadest of all at our Universities. Let any one compare Cambridge, for instance, with any German university; nay, with even some provincial offshoots of the University in France. In the one case he will find a wealth of things that are not scientific, and not a laboratory to work in; in the other he will find science taking its proper place in the university teaching, and, in three cases out of four, men working in various properly appointed laboratories, which men are known by their works all over the world.

This, then, is the present position of Cambridge after a long self-administration of the enormous funds which have been so long accumulating there for the advancement of learning. Cambridge no longer holds the place which is hers by right in the van of English science, her workers are few, and to those few she is careful to afford no opportunity of work, such as it is the pride of scholastic bodies in other countries to provide for the men who bring the only lasting honour to a university.

We have in what has gone before instanced Cambridge specially, as we have to refer to a step which has been recently taken there; but if the state of things is to be condemned at Cambridge, it must be admitted that it is only too recently that an attempt has been made to correct, in one direction, a similar state of things at Oxford.

What then do the Universities do? They perform the functions, for too many of their students, of first-grade schools merely, and that in a manner about which opinions are divided; and superadded to these is an enormous examining engine, on the most approved Chinese model, always at work, and then there are fellowships.

Now the readers of NATURE do not need to be informed that at the present moment there are two Royal Commissions inquiring into matters connected with the Universities, and that not long ago, at a meeting at the Freemasons' Tavern, the actual absence of mature study and research at the Universities, the lack of opportunities and buildings for scientific puposes, the apotheosis of the examining system, and the wanton waste of funds in fellowships, were unhesitatingly condemned by some of the most distinguished men in the country, many of them residents in the Universities.

Within the last week a memorial has been presented to the Prime Minister by persons engaged in University education at Cambridge, which on one of the points above referred to contains a most important expression of opinion; but we had better give the memorial *in extenso*:—

[Memorial.]

"We, the undersigned, being resident Fellows of Colleges and other resident members of the University of Cambridge engaged in educational work or holding offices in the University or the Colleges, thinking it of the greatest importance that the Universities should retain the position which they occupy as the centres of the highest education, are of opinion that the following reforms would increase the educational efficiency of the University, and at the same time promote the advancement of science and learning.

"1. No Fellowship should be tenable for life, except only when the original tenure is extended in consideration of services rendered to education, learning, or science, actively and directly, in connection with the University or the Colleges.

"2. A permanent professional career should be as far as possible secured to resident educators and students, whether married or not.

"3. Provision should be made for the association of the Colleges, or of some of them, for educational purposes, so as to secure more efficient teaching, and to allow to the teachers more leisure for private study.

"5. The pecuniary and other relations existing between the University and Colleges should be revised, and, if necessary, a representative Board of University Finance should be organised.

"We are of opinion that a scheme may be framed which shall deal with these questions in such a manner as to promote simultaneously the interests of education and of learning, and that any scheme by which those interests should be dissociated would be injurious to both."

This memorial reflects great credit upon the two out of seventeen heads of Colleges, and the majority of Professors, Tutors, Assistant-Tutors, and Scholars who have signed it. The only wonder is that some action to remedy a state of things which has been considered a scandal by many, both in and out of the University, who have had the best opportunity of studying it, should not have been taken before. But we think the memorial fails in one point, and we believe that Mr. Gladstone has hit the blot, for his carefully worded reply reads to us most ominous. "The time has scarcely arrived for bringing into a working shape proposals for extending and invigorating the action of the Universities and Colleges in connection with the more effective application of their great endowments." We see in the memorial too much reference to teaching, and too little to the advancement of learning.

Surely if the funds accumulated at our great Universities are to be merely applied to teaching purposes, the Government has the best possible argument for instantly requiring a very large proportion of the "great endowments" to be handed over, in order to endow other teaching bodies at present crippled for want of funds, and to create other teaching centres where now no teaching exists.

Might not the memorialists have taken a higher line, in which they would have been supported by all the culture of the country? Might they not have pointed out that the universities were once the seats of learning, and that the fact that they are now merely seats of teaching has arisen from a misapplication of the "great endowments" to which Mr. Gladstone refers? Why should not the men of Cambridge say boldly that they wish their University to become again in the present what it was in the past? No government would dare to cripple such a noble work. As representing the then range of knowledge, and as seats of research centuries ago, our universities were unequalled; at present in both these respects they are ridiculous.

COUES' AMERICAN BIRDS

Key to North American Birds. By Elliott Coues, M.D. (Salem, U.S.)

THIS by no means small volume is intended to give a concise account of every species of living and fossil bird at present known from the continent north of the Mexican and United States boundary. The reputation of the author, who is so well known by his works on the sea-birds, and for the anatomy of the loon, cannot but be increased by this production, which illustrates on every page the extent of his general information, and the soundness of his judgment. The subject is treated in a manner rather different from that usually adopted by systematic ornithologists; less stress is laid on specific peculiarities, and more on the elucidation of the characteristics of the genera, families, and orders. There is a freshness and boldness in the manner in which the facts are handled, which will be extremely acceptable to those who look upon ornithology as a branch of natural history rather than an all-absorbing study of itself. We know of no work of the size which gives such a fair and reliable description of the reasons that have led to the limitation of the ranges of the larger divisions which now obtain, and their inefficiency is in many cases rendered but too evident. The introduction, occupying nearly seventy pages, incorporates much of the work of the illustrious Nitzsch, which is daily becoming more fully appreciated, though neglected so long. We are surprised to find that the labours of Mr. Macgillivray have not been here done equal justice to, for there cannot be a doubt that the peculiarities of the viscera are of as great importance in the classification of birds, and yet they are scarcely mentioned; in one instance we find it incorrectly stated that the cæca of the *Cathartidæ* are very small, the term must be here understood in its extreme sense, as they are absent altogether.

The descriptions of the genera are clear and concise; many of the peculiarities of the beak and primaries especially, are made more evident by the liberal introduction of excellent line drawings, as in the account of the genus *Vireo*, which is discussed much in detail; and in most cases a picture of the whole bird, or the head, is given. A key is appended for discovering the genera with facility, constructed on the same principle as those employed by botanists. The paucity of the avian fauna in the region discussed, in comparison to that of the Southern Continent, is made most manifest, and the few stragglers which have thence made their way north, serve well as illustrations of the classes which, were it not for them, would not find a place in a work on North American Birds.

FLAMMARION'S ATMOSPHERE

The Atmosphere. Translated from the French of Camille Flammarion, edited by James Glaisher, F.R.S., &c. (London: Sampson Low and Co., 1873.)

IN some respects the volume before us may be considered as the sequel to its equally sumptuous companion "The Forces of Nature." For the ordinary reader must have some acquaintance with physics intelligently to follow the disentanglement of the various forms of energy —the mingled play of which give rise to the phenomena of meteorology. Nevertheless, M. Flammarion writes so lucidly and pleasantly, that a totally unscientific person can read this work with enjoyment and instruction. On the other hand it contains much that will be of interest to the man of science, as well as to the mere *dilettante*.

The scope of the work is stated in the editor's preface. It treats of the form, dimensions, and movements of the earth, and of the influence exerted on meteorology by the physical conformation of our globe; of the figure, height, colour, weight, and chemical components of the atmosphere; of the meteorological phenomena induced by the action of light, and the optical appearances which objects present as seen through different atmospheric strata; of

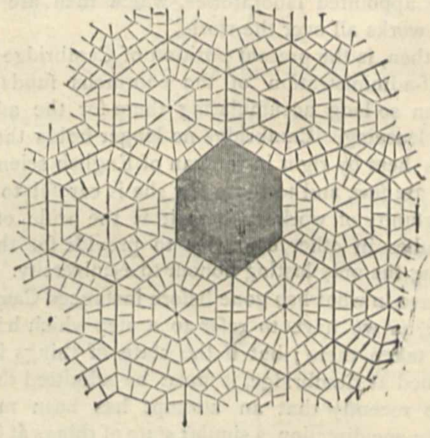


FIG. 1.—Section of a hailstone enlarged.

the phenomena connected with heat, wind, clouds, rain, electricity; and also of the laws of climate. These subjects are illustrated by ten admirable chromo-lithographs, and upwards of eighty woodcuts, but many of these latter we observe have already done duty in other French treatises. The coloured illustrations are quite works of art; especially noteworthy are the representations of a sunset, of sunrise as seen from the Righi, and of a solar and a lunar rainbow. Science has more often given than received aid from art, but the pages of this book show how much service art can render to science. The printing is remarkably well executed.

The translation has been done by Mr. E. B. Pitman, and the task has been well discharged. The value of the original work is considerably increased by the careful revision it has received from Mr. Glaisher, and the additions by him of many useful foot-notes. The tendency of M. Flammarion, like other popular French writers, to run into grandiloquent language, has been in general suppressed; though still a few cases remain that might well have been pruned.

One of the important features in this book is the frequent graphic delineation of meteorological data. Take for example the representation of the decreasing rainfall in passing from tropical to polar regions.

In a similar manner is shown the increase of rain, according to altitude, but in this there is evidently a mistake in one of the figures. Following this woodcut is the representation of the comparative depths of rainfall at noticeable spots. Towering over the whole is the rainfall at the mountain station of Cherra-Poejen in India, where upwards of 50 *feet* of rain annually descend during the seven months of the rainy season.

The engravings of different forms of hailstones are interesting. Here are some that fell on different occasions At the four corners are represented hailstones that fel at Auxerre, on July 29, 1871. The small drawings are o the more usual form of hailstones. The two stones in the centre are taken from drawings exhibited to the Academy of Sciences at St. Petersburgh, in September 1863. These stones were ellipsoidal in shape; their surface when examined through a lens "had the aspect of six-fronted pyramids, and a section of the interior revealed the existence of a hexagonal network of meshes," which is here represented on an enlarged scale. The fact of the crystalline structure of ice palpably occurring in hailstones, is a most interesting observation. Mere pressure

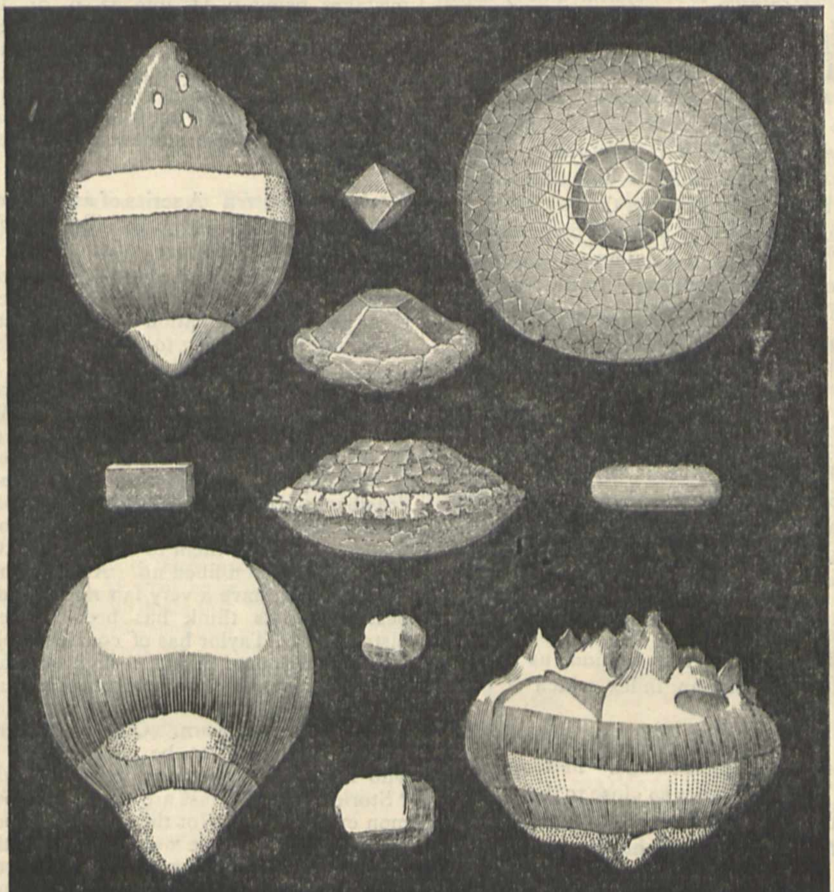


FIG. 2.—Different forms of hail.

of adjacent hailstones, like the pressure of soap-bubbles in a dish, would hardly produce such definite and regular hexagons.

As indicative of the labour Mr. Glaisher has bestowed on this work, we notice that all measurements are given n English equivalents, centigrade degrees are converted to Fahrenheit, Paris observations are replaced by data from Greenwich, and appropriate condensation and excision has reduced by one-half the unwieldy size of the original work.

Notwithstanding this evident care, several blemishes have escaped editorial revision. For example, the *ascent* of sound is given as the explanation of the ease with which sounds are heard in a balloon.

On p. 195 it is stated that "The sun's rays, after having traversed either the air, a pane of glass, or *any* transparent body, lose the faculty of retreating through the same transparent body to return towards celestial space." No reference is here made to diathermic bodies, such as rock-salt, concerning which this statement is wholly incorrect; and even as regards the most athermic substances, such as alum or water, a considerable percentage of the sun's rays (its luminous portion, for example) would be re-transmitted. To explain electrical phenomena, M. Flammarion remarks, "It is admitted, first, that electricity is a subtle fluid capable of being amassed, condensed, and rarefied, &c.," and on p. 493, "The Saint Elmo fires are a slow manifestation of electricity, a quiet outflow, like that of the hydrogen in a gas-burner." At the present day we hardly expected to find so material a conception of electricity put forth, unguarded by a restriction of the fluid theory being merely a convenient hypothesis whereby electrical effects can be represented to the mind. And what evidence has M. Flammarion for his unqualified assertion on p. 427, that "the globe is one vast reservoir for this subtle fluid [electricity], *which exists in all the worlds appertaining to our system, and of which the radiating focus is in the sun itself. . . . Its palpitations sustain the life of the universe!*"

We have noticed a few other passages that have escaped the editor's attention in the present edition. The author speaks of a mist in the Grotto del Cane as "composed of carbonic acid gas, which is *coloured by a small quantity of aqueous vapour.*" This is difficult to understand, the vapour being as invisible as the gas itself. We did not know it was necessary to use a "preparation of 'Joseph's paper,'" steeped in a solution of starch and potassic iodide, in order to detect ozone. In describing the discovery of oxygen and the chemical composition of the air, Lavoisier is the only name mentioned. It is not unlikely that a French writer should forget Priestley and Scheele, but the English editor ought hardly to have overlooked their names. We think also that a table of the analysis of air obtained from different parts of the globe should have been supplied. All that is given is one comparatively rough determination, namely, that 100 parts of air contain 23 of oxygen and 77 of nitrogen by weight. This is termed "an analysis made with every conceivable precaution." A large part of this same chapter is devoted to impurities present in the atmosphere, but Dr. Angus Smith's classical researches are not referred to, nor even is his name mentioned. And this reminds us that the volume is incomplete without an index, which it ought to possess.

We should like also to have seen some attempt at a collation of meteorological phenomena. Meteorologists in general seem to have their eyes so close to their special observations, that they accumulate a vast mass of figures without "hunting for a cycle," which has been asserted to be their first duty. There certainly appears to be some traces of an eleven-yearly cycle in the recurring period of extremely hot summers and cold winters from 1793 to the present time, cited by M. Flammarion. By collecting and tabulating these figures (given in chapters 4 and 5 of the third book), it becomes evident that extreme winters have immediately preceded or followed very hot summers. As the dates stand, they go alternately before and after, but this, no doubt, is but an accidental coincidence.

In spite of the slight defects we have pointed out, almost inseparable from a work dealing with such a variety of subjects, we can nevertheless endorse the opinion of the editor that the volume "will be found to be readable, popular, and accurate, and it covers ground not occupied by any one work in our language."

W. F. BARRETT

OUR BOOK SHELF

Mensuration of Lines, Surfaces, and Volumes. By D. Munn, F.R.S.E. (132 pp. "Chambers's Educational Course.")

THIS little work presupposes that the student has some knowledge of algebra and geometry, and we agree with the author that "it is not until a pupil has acquired this knowledge that he can take up the subject with any degree of intelligence or derive any educational advantage from its study." The number of propositions (59) is not too great; great judgment is displayed in the selection of the properties elucidated; the proofs are concise and clear, and are followed up by more than 350 examples, which appear to be clearly drawn up and to be well suited to test the student's acquaintance with the text. The book-work is accurately printed, the most important mistakes being p. 41, line 23, p. 91, lines 23, 24, and p. 110, line 22, but these are easily corrected. The work is one of a series, and the references throughout are to the edition of Euclid brought out by the same publishers; this reference to Euclid may appear objectionable in the eyes of some readers, but it is an objection easily got over in the case of those students for whom the work is intended.

Geological Stories. A series of autobiographies in chronological order. By J. E. Taylor, F.G.S. (London: Hardwicke, 1873.)

THE mere form into which Mr. Taylor has thrown his work—that of making a characteristic specimen from each geological formation tell its own story—has not, we think, added anything to its attractiveness: on the contrary, it will be apt to give many readers an uncomfortable feeling of unreality, and seems to us to have often cramped the author's freedom of description. We do not object to the autobiographical form in the abstract, but we think the direct form would have been more suited to Mr. Taylor's mental make. Notwithstanding this little drawback, Mr. Taylor tells the "old, old story," on the whole, in a manner well calculated to interest general readers, and send them to works where they may get the outline here given filled up. Anyone who reads this book carefully, will have a very fair notion indeed of what the best geologists think has been the earth's geological history. Mr. Taylor has of course wisely avoided entering upon disputed points, though one cannot but see that he has a comprehensive and very thorough knowledge of his subject. The illustrations are plentiful, though many of them seem well worn. On the whole the work is one we would recommend to be put into the hands of anyone who needs to be enticed into a knowledge of geology. "Stories" of this class are becoming more and more common every year. Not that we think or desire that they should ever supersede "stories" of another kind; but we take it as one of the most significant signs of the permeation of culture through society, that books of this class find a remunerative public.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Originators of Glacial Theories

THE writer of a notice of Tyndall's "Forms of Water" (NATURE, vol. vii. p. 400) blames Tyndall for having revived in a popular work the Forbes-Rendu controversy, and for calling attention to the claims of Agassiz and Guyot.

It seems rather curious that the attempt to give credit to scientific investigators for the share they may have had in the development of a great theory should be the occasion of fault-finding. No property is as subtle as scientific property, and the care Tyndall has bestowed upon the historical facts bearing on the glacial theory in his various writings on glaciers, is in marked contrast to the ignorance of the true state of the case usually displayed by English authors, who ascribe to Forbes the sole credit of all recent progress in the glacial theory.

Forbes's work commenced in 1841; it was in that year that he made his memorable visit to the Glacier of the Aar, and there found Agassiz, who had at that time already spent five summers in the study of glaciers, and published in 1840 the preliminary part of the investigations carried on by himself and his companions ("Études sur les Glaciers").

Agassiz with his usual freedom in dealing with his associates, which has so often made him appear as following the lead of his pupils, freely imparted to Forbes all he had seen, and certainly had no idea that the hospitality so freely proffered would be returned by the proceedings of Forbes, who appropriated what he could, and misrepresented the nature of his intercourse with Agassiz while his guest on the Glacier of the Aar.

To Tyndall we owe a thorough sifting of the claims of each investigator on the subject, and however unpalatable it may be to national prejudices that the name of Forbes should play a secondary part in these investigations by the side of those of Venetz and Charpentier, Rendu and Agassiz, the fact remains the same, and every fair-minded investigator will thank Tyndall for what he has done. ALEX. AGASSIZ

Cambridge, Mass., April 15

Scientific Endowments and Bequests

IN the article on scientific endowments and bequests in NATURE for April 24, there is a statement, in reference to the Trinity Natural Science Fellowship, which perhaps requires a little correction.

Although there can be no doubt that the proposed new scheme for the selection of a fellow is in every way better than the old system of selection by routine examination, it is hardly right to speak of the election of a Natural Science Fellow, which took place in October 1870, as an "unsuccessful experiment."

It is certainly much to be regretted that circumstances have prevented the gentleman then chosen from strengthening the staff of scientific workers and teachers at Cambridge; but it is equally certain, that no system of selection that could possibly be desired, would have resulted in the election of a man possessed at once of more promising scientific abilities, and of a more genuine love for science.

The writer of the article seems to think that the examiners on that occasion were in search of what he is pleased to call a "genuine zoologist;" there is no doubt that there was then as there is now, a striking absence of young men of ability, devoting themselves to zoology; but though the college had announced a preference for a physiologist, yet the examiners were empowered to recommend either a zoologist, or one following any other branch of natural science. F. M. BALFOUR

Trinity College, Cambridge, April 20

Permanent and Temporary Variation of Colour in Fish

ONE or two episodes in the annals of the Brighton Aquarium for the week just ended deserve a passing note.

Among the Plaice, *Pleuronectes platessa*, added to the general collection, is one remarkable example, having the posterior half of its under surface, usually white, coloured and spotted as brilliantly as the upper one; the line of demarcation between these two colours again, though sinuous, is most abrupt, there being no shading through from one to the other as might have been anticipated. This specimen may be turned to good account by advocates of the Darwinian theory, as affording a remarkable instance of the occasional tendency of a specially modified type to revert to its primæval state—the Pleuronectidæ being derived from ancestors originally possessing bilateral symmetry, and an equal degree of coloration on each side.

As the spawning season advances, many of the fish, and more especially certain of the Acanthopterygian order, undergo various important modifications in both their habits and appearance. During the last week or so, many of the larger examples of the Black Bream, or Old Wife (*Cantharus lineatus*), exhibited in tank 4 on the north side of the Western corridor, have afforded a striking illustration of these phenomena. Hitherto their prevailing tint has been a delicate silvery blue, varied by irregular longitudinal lines of pale yellow, a hue scarcely in harmony with the name by which they are most popularly known. These light colours have now disappeared, or rather become absorbed, in a prevailing shade of deep leaden black, which, while deepest on the back, spreads itself over the whole surface of the fish with the exception of a few transverse lighter bands in the region of the abdomen. The males in particular are most conspicuous for this change, and these retiring from the remainder of the shoal, select certain separate and prescribed areas at the bottom of the tank, where they commence excavating considerable hollows in the sand or shingle, by the rapid and powerful action of the tail and lower portion of their body. A depression of suitable size having been produced, each male now mounts vigilant guard over his respective hollow, and vigorously attacks and drives away any other fish of the same sex that ventures to trespass within the magic circle he has appropriated to himself. Towards his companions of the opposite sex his conduct is far different; many of the latter are now distended with spawn, and these he endeavours by all the means in his power to lure singly to his prepared hollow, now discovered to be a true nest or spawning bed, and there to deposit the myriad ova with which they are laden, which he then protects and guards with the greatest care. Whether the aggregated produce of a large number of females is thus consigned to one bed, and whether the ova are guarded by the male until the young fish make their appearance, are points which, while awaiting confirmation, may be almost confidently inferred, reasoning from the very analogous nest-forming habits of the *Gasterosteidæ* or Stickleback family, already so familiar to every naturalist. The male of the Lump fish (*Cyclopterus lumpus*) is said to watch over the spawn of the female in a very similar manner, and at the particular time of the year, early spring, when it is deposited, assumes the most lively tints of red and blue, which disappear again after his paternal duties have been discharged, and are not retained through life as has been formerly supposed. On this point we have direct evidence from specimens confined within the aquarium walls. For yet another instance of change of colour in the male fish, associated with its nest-forming habits in the same Acanthopterygian order, I am indebted to a recent visit to the aquarium at the Crystal Palace, where Mr. Loyd directed my attention to a male example of the Cuckoo Wrasse (*Labrus mixtus*), which had formed a deep hollow in the sand of its tank, and was endeavouring in the most persuasive manner to induce a female of the same species to share it with him, swimming backwards and forwards between her and the completed nest, and plainly exhibiting the greatest anxiety for her to follow. The normal brilliancy of this fish was supplemented by a light opaque patch that extended over a considerable portion of the back of his head and shoulders, while the tints of the remaining portion of the body were more than ordinarily deepened.

W. SAVILLE KENT

On Approach caused by Velocity and Resulting in Vibration

PROF. J. CLERK-MAXWELL, in his recent paper on "Action at a Distance," has brought under notice again the experiments of Prof. Guthrie "On Approach caused by Vibration," and has so well summarised in popular language the facts investigated and the conclusions arrived at, that fitting opportunity appears to present itself to me for calling the attention of the scientific world to phenomena closely allied to those under review although more complex in their manifestation, since in these velocity is independent of, yet initiates vibration. That they have not been referred to in the experiments either by Prof. Guthrie, Challis, and others who have taken part in the discussion is probably to be accounted for in the unfortunate although convenient habit indulged in by experimentalists of using the tuning fork as the agent for demonstration.

The following passage from Prof. J. Clerk-Maxwell's paper alluded to will best introduce my own observations—"Here is a kind of attraction with which Prof. Guthrie made us familiar. A disc is set in vibration and is then brought near a light suspended body which immediately begins to move towards the disc as if drawn towards it by an invisible cord. What is this cord? Sir W. Thomson has pointed out, that in a moving fluid the pressure is least where the velocity is greatest. The velocity of the vibratory motion of the air is greatest near the disc. Hence the pressure of the air on the suspended body is less on the side nearest the disc than on the opposite side; the body yields to the greater pressure and moves towards the disc. The disc therefore does not act where it is not. It sets the air next it in motion by pushing it, this motion is communicated to more and more distant portions of the air in turn and thus the pressures on opposite sides of the suspended body are rendered unequal, and it moves toward the disc in consequence of the excess of pressure. The force is therefore a force of the old school, a case of *vis a tergo*, a *shove* from behind."

It has been customary with me for several years, when occasion invited it, to demonstrate to my musical friends the physical action existing in the sounding organ-pipe, to show them (taking up a chance wood-shaving lying on the floor of the workshop or a strip of tissue paper) that, heterodox though the teaching be, the stream of air at the mouth of the organ-pipe constitutes a free-reed—visibly before them the film-like wood-shaving is drawn into the motion of the air, and the beautiful curve of the reed's swing displays itself beyond dispute; then to show them that the air-moulded tongue obeys every law of the free-reed, has its own definite rate of vibration, that the current is so directed that it shall *pass* not *strike* the lip, that it is an air-moulded or aëroplastic reed as definitely fashioned in substance, strength, proportion, and form, as metal reeds are to produce a required and determinate rate of vibration. First, the velocity of current, a constant upward force; then, the periodicity of vibration as a *secondary* mode of its activity. The aëroplastic reed forming with the pipe a *system* of transverse vibration associated with longitudinal vibration, and possibly another phase of vibration across the width of the reed enabling it to synchronise with the harmonic range of the pipe; the principle of action of the whole being termed, in my non-academic phraseology, suction by velocity; but if a more exact expression is found its explanation should imply, or better still, include the axiomatic phrase of Sir W. Thomson, "in a moving fluid the pressure is least where the velocity is greatest." To state the existence of an air-moulded free-reed is to give the key to its nature. Flutes, flageolets, whistle-pipes, disc-whistles, form one group with organ-pipes; all are of one type. Then there is another group of free-reeded instruments including the vocal organs, the trumpet, bassoon, oboe, harmonium, and the like, the only distinction between the two groups being that the one possesses reeds of air of definite pitch; and the other possesses reeds of grosser substance, whether it be membrane wood or metal, alike of definite pitch, but in every one the degree of elasticity or pliancy in the substance determines how much of that pitch shall be maintained as the work is done. Velocity is power, and in every conjunction of reed and pipe the reed is the dominant. Most distinctly it should be recognised that the air-reed does *work* and expends power in doing it. A rod or a string delivers up under a single blow the whole vibrating energy it is capable of—not so the air-column in the organ-pipe, which needs to be beaten the precise number of blows requisite for the pitch of tone elicited.

Reeds of the oboe are as truly free-reeds as are the vocal cords. The stream of air does not necessarily pass down the organ-pipe, but in the oboe it is essential it should pass down the pipe. The action of this orchestral instrument is best explained under the law of "least pressure," showing an identity in principle but with difference of mode; instead of the stream with a lapping action as an air-tongue at the mouth of the organ-pipe, we have an air-current passing between two sensitive reeds down a narrow straw-like tube into the main body of the pipe. The velocity in the little tube immediately causes "least pressure" in the interior, effecting approach and closure of the pair of lip-like reeds, and so on, a perpetual renewing and breaking of contacts, the periodicity of such movement being determined by the sensitiveness of the reed in relation to the air-tube through which the impulses must move before the "dispersion of the vibrations" into the air *relieves* the reed and fixes the *period* of its stroke. In further proof that the flue organ-pipe is a free-reed instrument, compare the flute, its representative, with the oboe and clarionet. So little is understood concerning the nature of these wind instruments, that, whenever in the science of acoustics they are referred to, it is stated that the clarionet is a closed pipe, and the oboe an open pipe; that the former produces the series of uneven harmonics and the latter the even series, and the explanation given is that the tube of the one is cylindrical, and the tube of the other is conical. The explanation does not really explain. It is true that the clarionet gives in relation to its length the pitch corresponding to that of a closed pipe, whilst the oboe, though of similar length (scale of key allowed for), is of the pitch of an open pipe, with relative harmonics; yet this difference arises not in any degree from the shape of bore cylindrical or conical. As well denominate the oboe "a closed pipe" if structure is compared; the one is not more a closed pipe than the other, the true cause of the diversity is in the rate of *reed-vibration* of the clarionet being only half the rate of that natural to the oboe. The proof is clear and open to anyone intent to observe. Place the oboe head on the clarionet-tube, and you will get from this same tube only the two-feet tone instead of the four-feet tone, and with this transformation of pitch the series of harmonics previously wanting. Place the flute-head on the clarionet-tube and the same results follow; showing that the velocity of vibration originates with the reed, and that the flute rightly considered is a free-reeded instrument.

The experience of years justifies me in presenting these conclusions, and should they not be disproved, questions will suggest themselves whether physicists should not look to the disturbance of the equilibrium of air-pressure as the chief element in determining the pitch of sounds produced in organ pipes; whether the long conserved doctrine of "the column of air within being alone the cause of sound" has not been detrimental to investigation as was in older times the doctrine that "nature abhors a vacuum," which, as Whewell points out, retarded science a century by pre-occupying men's minds against observation; and whether it is not through the presence of the law of "least pressure" that vibration of any kind becomes possible.

HERMANN SMITH

The Hegelian Calculus

YESTERDAY evening a copy of NATURE for the 10th instant, sent to my late address at Piershill, reached me here. The sender annexes the initials W. R. S.—those, presumably, of Mr. W. R. Smith. It was only thus that I became aware of that gentleman's letter on "The Hegelian Calculus," in said issue; and, as I am called upon by name therein, I should be obliged if, in an early number of the valuable publication referred to, you would kindly allow me insertion of this explanatory word in return.

In my rejoinder, mentioned by Mr. Smith as appearing in the current number of the *Fortnightly*, and which (rejoinder) treats, as Mr. Smith truly says himself, his own paper in the same pages "as a virtual concession of the entire case," I speak thus:—

"He that, with whatever tincture of mathematics, will but cast a single glance into the situation as it veritably is, will perceive at once that Mr. Smith's present paper is of such a character as not to demand any further answer from me. It is of such a character, however, that it may be put on the level of a business transaction, and if Mr. Smith can persuade any competent mathematician—say the greatest alive, Sylvester, he being at once mathematician, metaphysician, and German scholar, and at the same time wholly unknown to myself—if, I say, Mr. Smith can persuade any such competent expert to see in this matter with Mr. Smith's eyes, I shall consent to be mulcted in what pecuniary penalty this expert may please."

Of course with reciprocity in the other event. I hope Mr. Sylvester will kindly pardon me for having thus, almost involuntarily, made free with his name; but, if I could say the above then, certainly not less can I say the above now—after this letter of Mr. Smith's. The "character" in allusion is one, I believe, hitherto unexampled in literary controversy, and such that, as I also believe, the most important interests call forth thorough understanding of it. It is in consequence of this "character" that, as I have intimated, I cannot, with any respect to myself, enter into further direct relations with Mr. Smith, and that I must confine myself to what has been said above. All, for that part, may be confidently left to time. Napoleon snipped off, and put in his pocket the alleged gold tassel, assured that use would disclose the tinsel in suspicion. So, as regards the—to me—extraordinary operations of Mr. Smith—not but every *Kenner* must see what is concerned at a glance—I can leave them fearlessly to the intromissions of the public.

Further proceeding, let me intimate in conclusion, however formidable it may look, must, so far as I am concerned, be arranged by a friend on the one part, and a friend on the other. Longer to trouble the public with these altercations can only seem to it impertinent. I, at least, shall be satisfied if it will but consider the result in the end.

Edinburgh, April 18 J. HUTCHISON STIRLING

Moving in a Circle

I HAD to cross a very large flat field in Lincolnshire one evening; the ground covered with snow, and there being a dense fog. I knew my way perfectly; but on coming to the hedge found that I had deviated *to the right*. Next day I had occasion to re-visit my track and found that I had described about one quarter of a circle. T. M. W.

JUSTUS LIEBIG

JUSTUS LIEBIG was born at Darmstadt, the native place of many eminent chemists, May 13, 1803; died at Munich, April 18, 1873.

As generations pass away, and the deeds and capacities of great men come to be truly estimated, it will be found that the name of Liebig claims a position very close to those of Lavoisier and Dalton, the greatest leaders in our science. It is not as the author of the 317 investigations the titles of which fill the pages of the Royal Society catalogue, nor even as the father of organic chemistry, nor as the great originator of a scientific physiology and agriculture, nor again as the writer of numerous handbooks, that Liebig has done most for science; his greatest influence has been a personal one, for it is to him that most chemists now living either directly or indirectly owe their scientific existence. The Giessen Laboratory was the first one in which our science was truly taught, and from this centre the flame of original research was carried throughout all lands by ardent disciples who more or less successfully continued, both as regards tuition and investigation, their master's work.

Liebig early showed his love for experimental inquiry, and his father apprenticed him—as was then usual in the case of boys who exhibit such tastes—to an apothecary. Ten months of the shop drudgery was sufficient to convince the boy that this sort of life was not what he required, and it is said that he ran away from his pill-making; at any rate, he returned to his home in Darmstadt, and soon entered the University of Bonn, and afterwards that of Erlangen, where he met with congenial spirits, and continued his scientific education. At that time (1822), however, the German universities were almost destitute of means of stimulating research, or even of imparting a knowledge of existing science in its higher and more modern forms; and for this reason the steps of all young German chemists were naturally turned towards Paris, where Gay Lussac, Thenard, Dulong, and other well-known masters were working and teaching. In 1822, being nineteen years of age, Liebig had already made himself known in his native town and to its paternal government by the investigation of the action of alkalies on fulminating silver, as well as by other publications on the composition of certain colouring materials; and the Grand Duke, anxious to promote the glory of his capital, gave his promising young townsman the means of studying in Paris. There Liebig, thanks to the friendly introduction of Alexander von Humboldt, was allowed to work in Gay Lussac's private laboratory, where he completed his investigation on fulminic acid, and became acquainted with Gay Lussac's methods of exact investigation. In Paris, too, he met Mitscherlich and Gustav Rose, and the intercourse with them and other men of science which he there enjoyed confirmed him in the choice of his profession, and in 1824 he returned home and was appointed, when twenty-one years of age, Extraordinary, and two years afterwards the Ordinary Professor of Chemistry at Giessen, the University of his country, and the scene of the great labours and triumphs of his life.

The influence which Liebig has exerted on the progress of discovery in our science is due to his possession of that peculiar gift essential to all great investigators of nature, which unites to indomitable perseverance in following out experimental details, the higher power of generalisation. His indefatigable energy in experimental investigation must be known to all who have even turned over the pages of his Annalen; there is scarcely a volume in the thirty years dating from the commencement of the journal in 1832 to 1862, which does not contain some important record of his labours, and in the height of his power the number of independent researches which he was able to carry out at once is certainly marvellous. A mere list of even the most important of his investigations in the one branch of organic chemistry would be far too long for a brief notice such as this; it may, however, be well to call to mind his productivity during the first few years of the Giessen career. In the first rank amongst his earlier researches, and serving as a necessary basis for the whole, come those in which he placed the analysis of organic substances upon a firm and simple basis. His final description of the apparatus is worth remembering—"There is nothing new in this arrangement but its simplicity and perfect reliability." The attack on this subject, commenced in conjunction with Gay Lussac in 1823, was not completed by himself till 1830; but then he furnished chemists with the simple and effectual methods which, with slight modifications, we still employ. Thus armed, the secrets of the composition of the organic acids and alkaloids were soon revealed, and among the most important discoveries we have first amongst the acids, fulminic (1822), cyanic (1827), hippuric (1829), malic, quinic, rocellic and camphoric (1830), lactic (1832), aspartic (1833), uric (1834), then we find chloral and chloroform (1831), acetal (1832), aldehyde (1835).

In 1837 he published, in conjunction with Dumas, a paper, "Note sur la constitution de quelques acides," in which for the first time the theory of polybasic organic acids was put forward, Graham's researches on the phosphates proving the polybasic character of phosphoric acid having been published in 1833. In a research on the constitution of these bodies published in 1838 this was more fully worked out, and Davy's previously expressed views as to the part played by hydrogen confirmed and supported. His researches on the cyanogen derivatives (1834), on the chlorine substitution-products of alcohol (1832), and those carried on for so many years in conjunction with his life-long friend Wöhler, as on the composition of sulphovinic acid (1832), and especially that on the derivatives of benzoic acid (1832) sufficed to place the theory of organic radicals on a firm basis. Then too we must not forget their conjoint researches, chiefly carried on by correspondence between Giessen and Göttingen on the oxiacids of cyanogen (1830), a most difficult subject worked out in a masterly way, or that on the formation of benzoyl hydride from amygdalin in the bitter almond (1837), or again the memorable investigations on the nature of uric acid and the products of oxidation of this substance by nitric acid (1838), in which not only a large number of new bodies are described and allantoin artificially prepared, but system and order introduced among the whole.

One of his favourite subjects was that of Fermentation, and his explanation of the phenomena as being due to the action of a substance whose molecules are in a state of motion upon the fermentable body is yet well known, though now in the minds of most supplanted by the germ theory of Pasteur.

As a critic Liebig was sharp, satirical, and sometimes even unsparing and bitter, especially when his own views were assailed; his anonymous critiques are brimfull of good-humoured satire, whilst in others to which he gives his name, he lashes his victim most unmercifully. Who can read his "Das enträthselte Geheimniss der geistigen Gahrung" "Vorläufig briefliche Mittheilung," 1839, without amusement? His description of the minute organisms having the form of a Beindorfschen Destillirblase (ohne den Kühlapparat) feeding on sugar and excreting alcohol (aus ein rosenroth gefärbten punkt), and carbonic acid (aus dem Harnorganen) will be long remembered, and even at the present day the satire has not lost its applicability. Then again in a letter purporting to be written from Paris and signed S. C. H. Windler, though doubtless written by Liebig, he laughs to scorn the idea that the theory of substitution, which he himself upheld, could be so far extended as was by some chemists believed possible. In this letter he states, as the last great discovery of the French capital, that it had been found possible to replace in acetate of manganese, first the atoms of hydrogen by chlorine, then the atoms of oxygen, then those of manganese, and lastly that even the atoms of carbon had been replaced by this gas. So that a body was in the end obtained, which, although it contained nothing but chlorine, still possessed the essential properties of the original acetate of manganese. He adds in a note : "Je viens d'apprendre qu'il y a déjà dans les magasins à Londres des étoffes en chlor filé, très recherchés, dans les hôpitaux, et preférés à tout autres pour bonnets de nuits, calecons, etc.!"

Those who wish to read an unsparing critique, may turn to Liebig's remarks on Gerhardt (1846), to those on Mulder as regards his protein theory, or again on Gruber and Sprengel respecting a review of his own book on Organic Chemistry (1841). It was not in Liebig's nature to spare either private persons or Governments when he thought that science would be advanced by plain speaking. In his two papers on "Der Zustand der Chemie in Oestreich" *(*1838*)*, and in "Preussen" *(*1840*)*, whilst he points out the shortcomings of both countries, bravely asserts, in the strongest terms, the dependence of national prosperity upon original research, a subject concerning which in England, *most people, thirty years later* (*to our shame be it said*) *are altogether in the dark !*

Other and wider questions, to the solution of which Liebig in later life turned his energies, were those respecting the establishment of a Scientific Agriculture, and the foundation of a new science of Physiological Chemistry. It is in this direction that his labours are best known to the general public in England ; and there is no doubt, although in many details his views have since proved erroneous, that he was correct in the main issues, and that the stimulus given to British agriculture through Liebig's writing and investigations, has been of the most important kind. Agriculturists have thus been made aware that a scientific basis for their practice exists which, if not as yet complete, can still explain much in their art of what had previously depended on mere empiricism. Then, again, the interest and attention which were thus brought to bear on these subjects, has led to the establishment of Agricultural Colleges and "Versuchs-Stationen," and to the carrying out of researches like those magnificent ones of Lawes and Gilbert, from which we are receiving information concerning the various questions relating to plant life such as long-continued investigation and observation alone can yield.

In the year 1852, having lectured for sixty semestres in Giessen, he left the university to which he had given a world-wide fame, to become the centre of a galaxy of men of science whom Maximilian II. of Bavaria had called to Munich. There, having built himself a good laboratory and a spacious house adjoining, he spent the remainder of his days in quiet labour and well-earned and honoured repose. The active period of his life having passed, he entirely withdrew from discussions on purely theoretical questions, and occupied himself with investigations chiefly of a practical character, such as those on the extract of meat, and on infants' food. He continued to re-edit his various books, indulging occasionally in his old habit of a sharp hit at the views of some scientific brother. His last investigation and critical discussion of the labours of other chemists was published in 1870, "On Fermentation and the Origin of Muscular Force." In this he strenuously upholds his old theory of fermentation against Pasteur's explanation of the phenomena, and his views and arguments are as forcibly and clearly expressed as we find them in his early publications. The last of his hundreds of communications to the Annalen is a notice on the discovery of chloroform, published in March of last year, in which he calls attention to the fact that the discovery of this important substance is due to himself in 1831, and not to Soubeiran, as is generally supposed, although Liebig overlooked the small quantity of hydrogen (0·8 per cent.) which chloroform contains, and termed it a chloride of carbon.

As an author, Liebig is remarkable for the lucidity and grace of his style. The best examples of this are to be found in his "Familiar Letters on Chemistry." His mode of popular treatment of a somewhat obscure subject is seen in the well-known chapter (xxiv.) in his "Familiar Letters," on "Spontaneous Combustion of the Human Body." He there goes step by step through all the better authenticated cases, shows the want of sufficient evidence in each case, points out the fallacies of the theories proposed to explain them, and concludes with proving, by the application of known physical and chemical laws, that the supposed phenomena cannot possibly occur.

Looking once more back upon the labours of Liebig, we again come to the conclusion that the chief and characteristic glory of his life is the impulse which he gave to the study of our science and the personal influence which he exerted among his numerous and distinguished pupils.

The present short and imperfect sketch of the scientific bearings of a great life is not one in which personal qualities can be discussed ; suffice it to say that though Liebig was an awkward adversary, he was a faithful friend, and always ready and anxious to assist deserving merit.

H. E. ROSCOE

Number 2

NOTES FROM THE "CHALLENGER"

WE left Santa Cruz on the evening of Friday, the 14th of February. The weather was bright and pleasant with a light breeze—force equal to about 5—from the north-east. Our course during the night lay nearly westward, and on the morning of the 17th we sounded, about 75 miles from Teneriffe, and 2,620 miles from Sombrero Island, the nearest point in the Virgin group, in 1,891 fathoms, with a bottom of grey globigerina ooze, mixed with a little volcanic detritus. The average of two Miller-Casella thermometers gave a bottom temperature of 2° C.

The slip water-bottle which was used by Dr. Meyer and Dr. Jacobsen in the German North-Sea Expedition of last summer was sent down to the bottom, and Mr. Buchanan determined the specific gravity of the bottom water to be 1·02584 at a temperature of $17^{\circ}\cdot9$ C., the specific gravity of surface water being 1·02648 at a temperature of $18^{\circ}\cdot5$ C.

All Sunday, the 16th, we spent sailing with a light air from the northward, and by Monday morning we had made about 130 miles from our previous sounding. The dredge was put over at 5.15 A.M. with 2,700 fathoms rope, and a weight of 2 cwt. 300 fathoms before the dredge.

After steaming up to the dredge once or twice, hauling-in was commenced at 1.30 P.M., and the dredge came up at 3.30 half full of compact yellowish ooze. The ooze was carefully sifted, but nothing was found in it with the exception of foraminifera, some otolites of fishes, some dead shells of pteropods, and one mutilated specimen of what appears to be a new Gephyrean. This animal has been examined by Dr. von Willemœs-Suhm, who finds that it shows a combination of the character of the Sipunculacea and the Priapulacea. As in the former group, the excretory orifice is near the mouth, in the anterior part of the body, while, as in the latter, there is no proboscis and there are no tentacles. The pharynx is very short, and is attached to the walls of the body by four retractor muscles. The pharynx shows six to seven folds ending in a chitinous border. The mouth is a round aperture, beset with small cuticular papillæ. The perisom is divided into four muscular bands, the surface large, showing a tissue of square meshes, in each of which there are four to five sense-bodies. For the reception of this singular species Dr. von Willemœs-Suhm proposes to establish the genus *Leioderma*, which will represent a family intermediate between the Sipunculids and the Priapulids.

On the 18th we sounded at 9 A.M. in 1,525 fathoms, lat. 25° 45′ N., long. 20° 12′ W., 160 miles S.W. of the Island of Ferro, and 50 miles to the west of the station of the day before, in 1,525 fathoms. The "Hydra" tube brought up no bottom, and we sounded again with a depth of 1,520 fathoms, and again no bottom. It thus seemed that we had got upon hard ground, and as the sounding of the following day gave 2,220 at a distance of only 19 miles, we had evidently struck the top of a steep rise. The dredge was lowered at 10 A.M. with 2,220 fathoms of line and 2 cwt. leads 300 fathoms before the dredge. At 5.30 P.M the dredge was hauled up, and contained a few small pieces of stone resembling the volcanic rocks of the Canary Islands, and some large bases of attachment and some branches of the calcareous axis of an Alcyonarian polyp allied to *Corallium*. Some of the larger stumps were nearly an inch in diameter; the central portion very compact, and of a pure white colour: the surface longitudinally grooved, and of a glossy black. The pieces of the base of the coral which had been torn off by the dredge were in one or two cases several inches across and upwards of an inch thick, forming a thick crust from which the branches of the coral sprang. The crust was of a glossy black on the surface, showing a fine regular granulation, and a fracture through the crust was of a uniform dark brown colour and semi-crystallised. The whole of the coral was dead, and appeared to have been so for a long time. It was so fresh in its texture, however, that it was scarcely possible to suppose that it was sub-fossil, although from the comparatively great depth at which it was found, and the many evidences of volcanic action over the whole of this region, one could scarcely avoid speculating whether it might not have lived at a higher level and been carried into its present position by a subsidence of the sea-bottom. I hope we may have an opportunity of determining this question in returning over the same ground later in the season.

Attached to the branches of the coral there were several specimens of a magnificent sponge belonging to the Hexactinellidæ. One specimen, consisting of two individuals united together by their bases, is about 60 centimetres across, and has very much the appearance of the large example of the tinder-fungus attached to the trunk of a tree (Fig. 1). Both surfaces of the sponge are covered with a delicate network of square meshes closely resembling that of *Hyalonema*, and formed by spicules of almost the same patterns. The sponge is bordered by a fringe of fine spicules, and from the base a large brush of strong, glassy, anchoring spicules project, fixing it to its place of attachment. The form of the barbed end of the anchoring spicules is as yet unique among sponges. Two wide, compressed flukes form an anchor very much like that of one of the skin-spicules of *Synapta*. The sponge when brought up was of a delicate cream colour. It was necessary to steep it in fresh water to free it from salt, and the colour changed to a leaden grey. A number of small examples of the sponge, some of them not much beyond the condition of gemmules, were found attached to the larger specimens and to branches of the coral, so that we have an opportunity of studying the earlier stages of its development.

For this sponge, which forms the type of a new genus, I propose the name *Poliopogon*[1] *amadou*.

Attached to the sponge were two examples of a fine Annelid which Dr. v. Willemœs-Suhm refers to the family Amphinomidæ, sub-family Euphrosyninæ, with many of the characters of the genus *Euphrosyne*. The body is 12 mm. long and 5 mm. broad, and consists of fifteen segments. The surface of the head is covered with a caruncle extending over the anterior segments, and the whole surface is clothed with milk-white two-branched setæ, which radiate over each segment like a fan.

On the following day a series of temperatures were taken from the surface to 1,500 fathoms at intervals of 100 fathoms.

Depth.	Temp.	Depth.	Temp.
Surface	19°·5C.	800 fathoms . .	5°·6C.
100 fathoms . . .	17·2	900 " . . .	4·7
200 "	13·7	1000 " . . .	4·6
300 "	11·0	1100 " . . .	3·8
400 "	9·5	1200 " . . .	3·5
500 "	7·6	1300 " . . .	3·1
600 "	6·5	1400 " . . .	2·8
700 "	6·2	1500 " . . .	2·6

The dredge was not used, but, as is our custom whenever the rate of the ship is such as to make it practicable, a large towing-net was put out astern.

In hot, calm weather the towing-net is usually unsuccessful. It seems that the greater number of pelagic forms retire during the heat of the day to the depths of a few fathoms, and come up in the cool of the evening and in the morning, and in some cases in the night. The larger phosphorescent animals are frequently abundant during the night round the ship and in its wake, while none are taken in the net during the day. Mr. Moseley has been specially engaged in working up the developmental stages of *Pyrosoma*, and the intricate structure of the tissues and organs of some of the surface groups, whose extreme transparency renders them particularly suitable for such researches.

Feb. 21.—Up to 2.15 P.M. sailing under all plain sail at the rate of six knots an hour before the N.E. trades, force 3 to 4.

The dredge was put over at 5 P.M. with 3,400 fathoms of line, and was kept down till one o'clock A.M. on the following morning, the ship drifting slowly. Our position at noon on the 21st was about 500 miles S.W. of Teneriffe, lat. 24° 22′ N., long. 24° 11′ W., Sombrero Island S. 58° W. 2,220 miles. Work began early on the 22nd, and the dredge, which had begun its ascent at 1.15 A.M., came up at 5.45 half full of a yellowish ooze, which was not so tenacious as usual, and on the whole singularly poor in higher living things. A careful and laborious sifting of the whole mass gave us three small living mollusca, referred to the genera *Arca*, *Limopsis*, and *Leda*; and two Bryozoa apparently undescribed. Foraminifera were abundant, many examples of miliolines being of unusually large size. Some beautiful radiolarians were sifted out of the mud. These may have been taken into the dredge on its way up, or more probably they may have lived on the surface or in intermediate water and have sunk to the bottom after death, since they consist of continuous fenestrated shells of silica.

On Tuesday the 25th a small dredge was lowered at 6.30 A.M. with 3,500 fathoms of line (2,500 fathoms of 2½-in. rope and 1,000 of 2-in.), and 2 cwt. leads attached 300 fathoms in advance. At 7.30 we sounded in 2,800 fathoms, with a bottom of the same reddish ooze, and a temperature of 2° C. A series of temperatures were taken at intervals of 100 fathoms down to 1,000, the result agreeing closely with those of the previous series. At 5.15 P.M. the dredge came up clean and empty. It had either never reached the bottom, owing to some local current or the drift of the ship, or else everything had

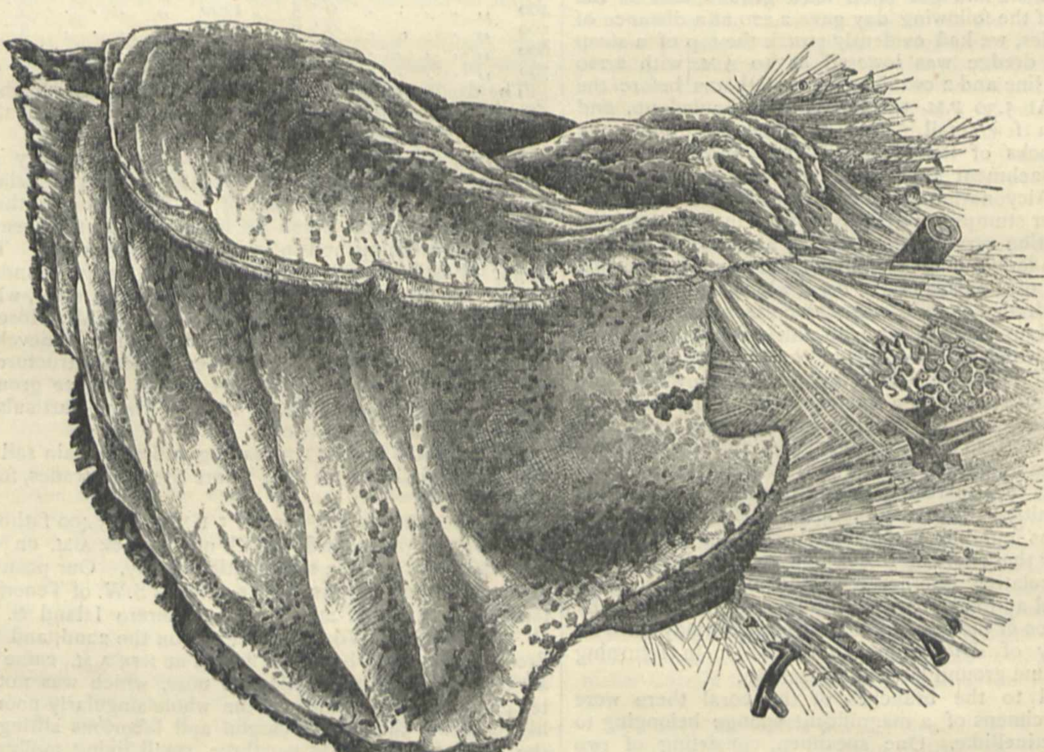
[1] Πολιὸς, white, and πώγων, a beard.

been completely washed out of it on its way to the surface. The bottom water gave a specific gravity of 1·02504 at 19°·6 C., that of the surface being 1·02617 at 21°·3 C. While sounding, the current-drag was tried, and indicated a slight north-westerly current.

As the attempt to dredge on the previous day had been unsuccessful, it was determined to repeat the operation with every possible precaution on the 26th. The morning was bright and clear, and the swell, which had been rather heavy the day before, had gone down considerably. A sounding was taken about 10 o'clock A.M. with the "Hydra" machine and 4 cwt. The sounding was thoroughly satisfactory, a sudden change of rate in the running out of the line indicating in the most marked way when the weight had reached the bottom. During the sounding a current-drag was put down to the depth of 200 fathoms, and it was then ascertained that, by means of management and by meeting the current by an occasional turn of the screw, the ship scarcely moved from her position during the whole time the lead was running out. The depth was 3,150 fathoms; the bottom a perfectly smooth red clay, containing scarcely a trace of organic matter—merely a few coccoliths, and one or two minute granular masses. The thermometer indicated a bottom temperature of 1°·9 C.

The small dredge was sent down at 2.15 P.M. with two hempen tangles; and, in order to ensure its reaching the bottom, attached to the iron bar below the dredge which is used for suspending the tangles, a "Hydra" instrument with detaching weight of 3 cwt. Two additional weights of 1 cwt. each were fixed to the rope 200 fathoms before the dredge. 3,600 fathoms of rope were payed out—1,000 fathoms 2 in. in circumference, and the remainder (2,600 fathoms) 2½ in. The dredge came up at 10.15 P.M. with about 1 cwt. of red clay.

This haul interested us greatly. It was the deepest by several hundred fathoms which had ever been taken, and, at all events coincidentally with this great increase in



Base

FIG. 1.—POLYOPOGON AMADOU Wy. T.

depth, totally different from what we had been in the habit of meeting with in the depths of the Atlantic. For a few soundings part of the ooze had been assuming a darker tint, and showed on analysis a continually lessening amount of calcareous matter, and, under the microscope, a smaller number of foraminifera. Now calcareous shells of foraminifera were entirely wanting, and the only organisms which could be detected after washing over and sifting the whole of the mud with the greatest care, were three or four foraminifera of the Cristellarian series, with their tests made up of particles of the same red mud. The shells and spines of surface animals were entirely wanting; and this is the more remarkable as the clay-mud was excessively fine, remaining for days suspended in the water, looking in colour and consistence exactly like chocolate, indicating therefore an almost total absence of movement in the water where it is being deposited. When at length it settles, it forms a perfectly smooth red-brown paste, without the least feeling of grittiness between the fingers, as if it had been levigated with extreme care for a process in some refined art. On analysis it is almost pure clay, a silicate of alumina and the sesquioxide of iron, with a small quantity of manganese.

It is of course a most interesting question whether the peculiar nature of this deposit is connected in any way with the extreme depth. I am certainly inclined at present to believe that it is not. The depth at Station 5 was 2,740 fathoms, and on that occasion foraminifera were abundant, and several bivalve mollusca were taken living. I cannot believe there can be any difference between a depth of 2,740 fathoms and one of 3,150 so essential as to arrest the life of the organisms to the secretions of whose tests the grey Atlantic ooze is due. I am rather inclined in the meantime to attribute this peculiar deposit to the movement of water from some special locality—very possibly the mouths of the great South American rivers—the movement possibly directed in some measure by the form of the bottom. This, however, is a question for the solution of which we may hope to procure sufficient data. WYVILLE THOMSON

ON THE ORIGIN AND METAMORPHOSES OF INSECTS*

III.

THE INFLUENCE OF EXTERNAL CONDITIONS ON THE FORM AND STRUCTURE OF LARVÆ

THE facts recapitulated very briefly in the preceding chapters show, that the forms of insect larvæ depend greatly on the group to which they belong. Thus the same tree may harbour larvæ of Diptera, Hymenoptera, Coleoptera, and Lepidoptera; each presenting the form typical of the group to which it belongs.

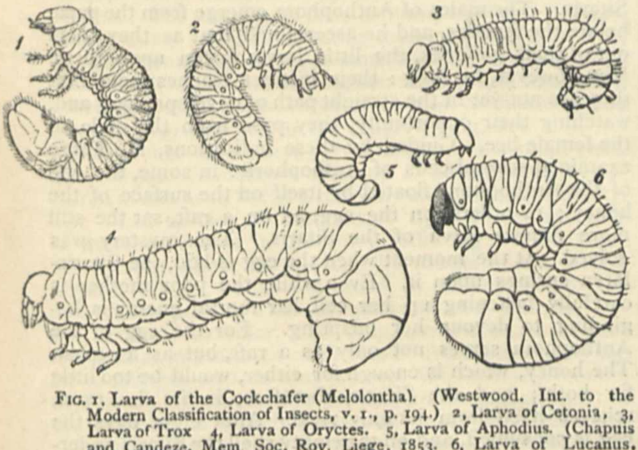


FIG. 1, Larva of the Cockchafer (Melolontha). (Westwood. Int. to the Modern Classification of Insects, v. 1., p. 194.) 2, Larva of Cetonia, 3, Larva of Trox 4, Larva of Oryctes. 5, Larva of Aphodius. (Chapuis and Candeze, Mem Soc. Roy. Liege, 1853. 6, Larva of Lucanus. (Packard, "Guide to the Study of Insects," Fig. 403).

If, again, we take a group, such, for instance, as the Lamellicorn beetles, we shall find larvæ extremely similar in form, yet very different in habits. Those for instance of the common cockchafer (Fig. 1) feed on the roots of grass, those of *Cetonia aurata* (Fig. 2) are found in ants' nests; the larvæ of the genus Trox (Fig. 3) on dry animal substances; of Oryctes (Fig. 4) in tan-pits: of Aphodius (Fig. 5) in dung; of Lucanus (the stag-beetle, Fig. 6) in wood.

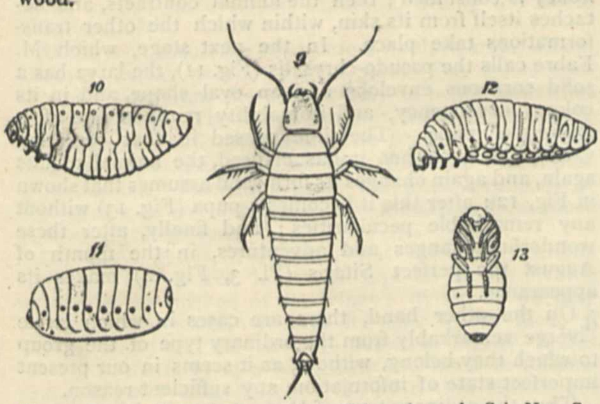


FIG. 9, Larva of Sitaris humeralis. (Fabre, Ann. d. Sci. Nat. Ser. 4, vol. vii.) 10, Larva of Sitaris humeralis, in the second stage. 11, Larva of Sitaris humeralis, in the third stage. 12, Larva of Sitaris humeralis, in the fourth stage. 13, Pupa of Sitaris.

In the present chapter it will be my object to show that the form of the larva depends also very much on its mode of life. Thus, those larvæ which are internal parasites, whether in animals or plants, belong to the vermiform state; and the same is the case with those which live in cells, and depend on their parents for food. On the other hand, larvæ which burrow in wood have strong jaws and generally somewhat weak thoracic legs; those which feed on leaves have the thoracic legs more developed, but less so than the carnivorous species. Now, the Hymenoptera, as a general rule, belong to the first category: the larvæ of the Ichneumons, &c., which live in animals,—those of the Cynipidæ, which inhabit galls,—and those of ants, bees, wasps, &c., which are fed by their parents, are all fleshy, apodal grubs. On the other hand, the larvæ of *Sirex*, which are wood-burrowers, quit the type which is common to the majority of the order, and remain in the egg until they have developed small thoracic legs. Again, the larvæ of the Tenthredinidæ, which feed upon leaves, closely

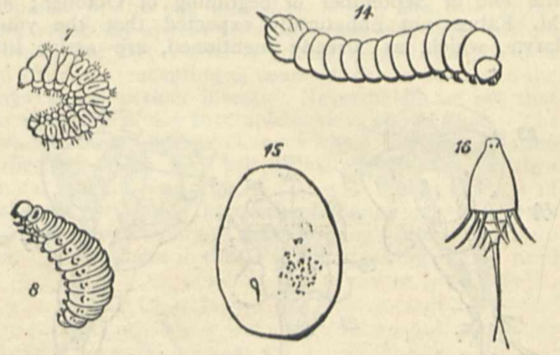


FIG. 7, Larva of Brachytarsus (Ratzeburg, Forst. Insecten). 8, Larva of Crioceris (Westwood, l.c.) 14, Larva of Sirex (Westwood l.c.) 15, Egg of Rhynchites, showing the parasitic larva in the interior. 16, the parasitic larva more magnified.

resemble the caterpillars of Lepidoptera, even to the presence of abdominal prolegs. There is, however, some little variety in this respect, some species having eleven pairs, some ten, some nine, while the genus *Lyda* has only the three thoracic pairs.

Again, the larvæ of beetles are generally active, hexapod, and more or less flattened: but on the other hand with those species which live inside vegetable tissues, such as the weevils, they are apod fleshy grubs, like those of Hymenoptera. Pl. 2, Fig. 6, represents the larva of

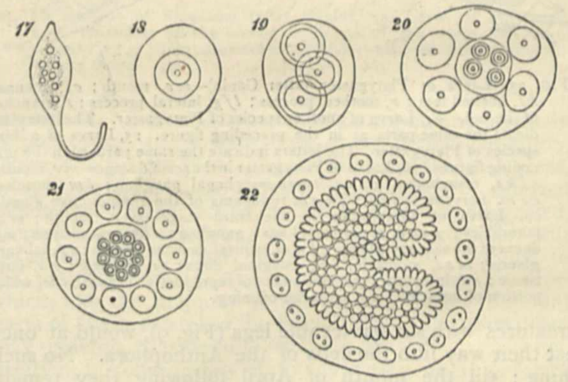


FIG. 17, Egg of Platygaster (after Ganin). 18, Egg of Platygaster showing the central cell. 19, Egg of Platygaster after the division of the central wall 20, Egg of Platygaster more advanced. 21, Egg of Platygaster more advanced. 22, Egg of Platygaster showing the rudiment of the embryo.

the nut-weevil, Balaninus (Pl. 1, Fig. 6), and it will be seen that it closely resembles Pl. 2, Fig. 5, which represents that of a fly (Anthrax), Pl. 1, Fig. 5, and Pl. 2, Figs. 7, 8, and 9, which represent respectively those of a Cynips or gall-fly (Pl. 1, Fig. 7), an ant (Pl. 1, Fig. 8), and wasp (Pl. 1, Fig. 9). Nor is this the only group of Coleoptera which affords us examples of this fact. Thus in the genus Scolytus (Pl. 1, Fig. 4), the larvæ (Pl. 2, Fig. 4),

* Continued from vol. vii. p. 489.

which, as already mentioned, feed on the bark of the elm, closely resemble those just described, as also do those of Brachytarsus (Fig. 7). On the other hand the larvæ of certain beetles feed on leaves, like the caterpillars of Lepidoptera; thus the larva of *Crioceris Asparagi* (Fig. 8), which, as its name denotes, feeds on the asparagus, closely resembles that of certain Lepidoptera, as for instance of *Thecla spini*. A striking illustration of this is afforded by the genus Sitaris (Pl. 3, Fig. 4), a small beetle allied to Cantharis, the blister-fly, and Meloe, the oil-beetle. The habits of this species have been very carefully investigated by M. Fabre.*

The genus Sitaris is parasitic on Anthophora, in the galleries in which it lays its eggs. These are hatched at the end of September or beginning of October; and M. Fabre not unnaturally expected that the young larvæ, which, as already mentioned, are active little

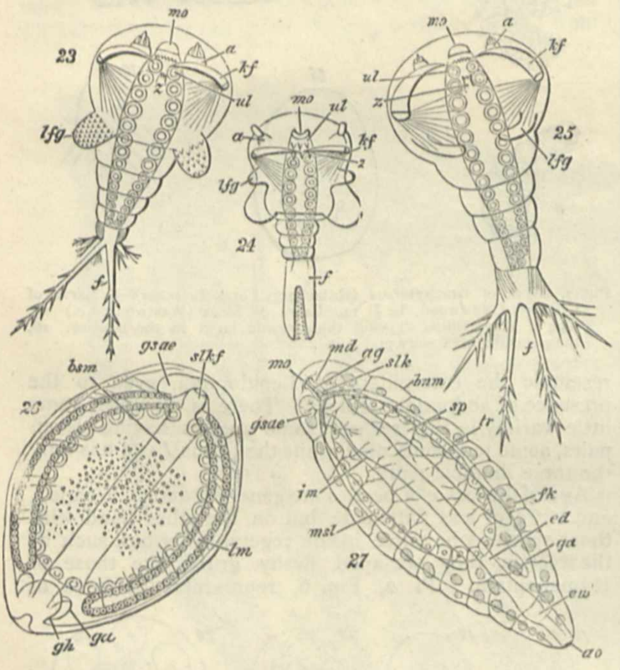


FIG. 23, Larva of Platygaster (after Ganin)—*mo*, mouth; *a*, antenna; *kf*, hooked feet; *r*, toothed process; *lfg*, lateral process; *f*, branches of the tail. 24, Larva of another species of Platygaster. The letters indicate the same parts as in the preceding figure. 25, Larva of a third species of Platygaster. The letters indicate the same parts as in the preceding figures. 26, Larva of Platygaster in the second stage—*mo*, mouth; *slkf*, œsophagus; *gsae*, supra-œsophagal ganglion; *lm*, muscles; *bsm*, nervous system; *gagh*, rudiments of the reproductive glands. 27, Larva of Platygaster in the third stage—*mo*, mouth; *md*, mandibles; *gsae*, supra-œsophagal ganglion; *slk*, œsophagus; *ag*, ducts of the salivary glands; *bnm*, ventral nervous system; *sp*, salivary glands; *msl*, stomach; *im*, imaginal discs; *tr*, tracheæ; *fk*, fatty tissue; *ed*, intestine; *ga*, rudiments of reproductive organs; *ew*, wider portion of intestine; *ao*, posterior opening.

creatures with six serviceable legs (Fig. 9), would at once eat their way into the cells of the Anthophora. No such thing: till the month of April following they remain without leaving their birth-place, and consequently without food; nor do they in this long time change either in form or size. M. Fabre ascertained this, not only by examining the burrows of the Anthophoras, but also by direct observation of some young larvæ kept in captivity. In April, however, his specimens at last threw off their long lethargy, and hurried anxiously about their prisons. Naturally inferring that they were in search of food, M. Fabre supposed that this would consist either of the larvæ or pupæ of the Anthophora, or of the honey with which it stores its cell. All three were tried without success. The two first were neglected, and when placed on the latter the larvæ hurried away, or perished in the attempt, being evidently unable to deal with the sticky substance. M. Fabre was in despair: "Jamais experience," he says, "n'a éprouvé pareille déconfiture. Larves, nymphes, cellules, miel, je vous ai tous offert; que voulez-vous donc, bestioles maudites?" The first ray of light came to him from our countryman, Newport, who ascertained that a small parasite found by Léon Dufour on one of the wild bees, and named by him Triungulinus, was, in fact, the larva of the Meloe. The larvæ of Sitaris much resembled Dufour's Triungulinus; and acting on this hint, M. Fabre examined many specimens of Anthophora, and at last found on them the larvæ of his Sitaris. The males of Anthophora emerge from the pupæ before the females, and he ascertained that as they come out of their galleries, the little larvæ fasten upon them. Not, however, for long: their instinct teaches them that they are not yet in the straight path of development; and, watching their opportunity, they pass from the male to the female bee. Guided by these indications, M. Fabre examined several cells of Anthophora: in some, the egg of the Anthophora floated by itself on the surface of the honey; in others, on the egg, as on a raft, sat the still more minute larva of the Sitaris. The mystery was solved. At the moment when the egg is laid, the Sitaris-larva springs upon it. Even while the poor mother is carefully fastening up her cell, her mortal enemy is beginning to devour her offspring. For the egg of the Anthophora serves not only as a raft, but as a repast. The honey, which is enough for either, would be too little for both; and the Sitaris, therefore, in its first meal, relieves itself from its only rival. After eight days the egg is consumed, and on the empty shell the Sitaris undergoes its first transformation, and makes its appearance in a very different form as shown in Fig. 10.

The honey which was fatal before is now necessary; the activity which before was necessary, is now useless; consequently, with the change of skin the active, slim larva changes into a white, fleshy grub, so organised as to float on the surface of the honey, with the mouth below, and the spiracles above the surface; "grâce à l'embonpoint du ventre," says M. Fabre, "la larve est à l'abri de l'asphyxie." In this state it remains till the honey is consumed; then the animal contracts, and detaches itself from its skin, within which the other transformations take place. In the next stage, which M. Fabre calls the pseudo-chrysalis (Fig. 11), the larva has a solid corneous envelope and an oval shape, and in its colour, consistency, and immobility reminds one of a Dipterous pupa. The time passed in that condition varies much. When it has elapsed, the animal moults again, and again changes its form, and assumes that shown in Fig. 12; after this it becomes a pupa (Fig. 13) without any remarkable peculiarities; and finally, after these wonderful changes and adventures, in the month of August the perfect Sitaris (Pl. 3, Fig. 4) makes its appearance.

On the other hand, there are cases in which larvæ diverge remarkably from the ordinary type of the group to which they belong, without, as it seems in our present imperfect state of information, any sufficient reason.

Thus the ordinary type of Hymenopterous larvæ, as we have already seen, is a fleshy apod grub; replaced however in the leaf-eating and wood-boring groups, Tenthredinidæ and Sirecidæ (Fig. 14) by caterpillars, more or less closely resembling those of Lepidoptera. There is, however, a group of minute Hymenoptera, the larvæ of which reside within the eggs or larvæ of other insects. It is difficult to understand why these larvæ should differ from those of Ichneumons, but as will be seen by the accompanying figures, they assume very remarkable and grotesque forms. The first of these curious larvæ was observed by De Filippi,*

* Ann. das. Sc. Nat. V. vii. T. 4. See also Natural History Review, April 1862.

* Ann. and Mag. of Nat. His., 1852.

who had collected some of the transparent ova of *Rhynchites betuleti* and to his great surprise found more than half of them attacked by a small parasite, which proved to be the larva of a minute Hymenopterous insect belonging to the Pteromalidæ. Fig. 15 shows the egg of Rhynchites, with the parasitic larva, which is represented on a larger scale in Fig. 16. Recently, however, this group has been more completely studied by M. Ganin,* who thus describes the development of Platygaster. The egg, as in other allied hymenopterous families, for instance in Cynips, is elongated and club-shaped (Fig. 17). After a while a large nucleated cell appears in the centre (Fig. 18); this is a new formation not derived from the germinal vesicle. This nucleated cell divides (Fig. 19) and subdivides. The outermost cells continue the same process, thus forming an outer investing layer. The central one, on the contrary, enlarges considerably, and develops within itself a number of daughter cells (Figs. 20 and 21), which gradually form themselves into a mulberry-like mass, thus giving rise to the embryo (Fig. 22).

Ganin met with these larvæ in those of a small gnat, Cecidomyia. Sometimes as many as fifteen parasites occurred in one host, but as a rule only one attained maturity. The three species of Platygaster differed considerably in form, as shown in the three following Figs. (23-25). They creep about in the egg by means of the strong hooked feet, *kf*, somewhat aided by movements of the tail. They possess a mouth, stomach, and muscles, but the nervous, vascular, and respiratory systems do not make their appearance until later. After some time the larva changes its skin and assumes the form represented in Fig. 26. In this moult the last abdominal segment of the first larva is entirely thrown off: not merely the outer skin as in the case of the other segments, but also the hypodermis and the muscles. This larva, as will be seen by the figure, is in the form of a barrel or egg, and ·870 mm. in length, the external appendages having disappeared, and the segments being indicated only by the arrangement of the muscles; *slkf* is the œsophagus leading into a wide stomach which occupies nearly the whole body, *sgsae* is the rudiment of the supraœsophagal ganglia, *bsn* the ventra nervous cords. The ventral nervous mass has the form of a broad band, with straight sides; it consists of embryonal cells, and remains in this undeveloped condition, during the whole larval state.

At the next moult the larva enters its third state, which, however, as far as the external form (Fig. 27) is concerned, differs from the second only in being somewhat more elongated. The internal organs, however, are much more complex and complete. The tracheæ have made their appearance, and the mouth is provided with a pair of mandibles. From this point the metamorphoses of Platygaster do not appear to differ materially from those of other Hymenoptera.

An allied genus, Polynema, has also very curious larvæ. The perfect insect is aquatic in its habits, swimming by means of its wings; flying, if we may say so, under water. It lays its eggs inside those of Dragon flies; and the larva, as shown in Fig. 28, leaves the egg in the form of a bottled-shaped mass of undifferentiated embryonal cells, covered by a thin cuticle, but without any trace of further organisation. Protected by the egg shell of the Dragon fly, the young Polynema is early able to dispense with its own; and bathed in the nourishing fluid of the Dragon fly's egg, it imbibes nourishment through its whole surface, and increases rapidly in size. The digestive canal gradually makes its appearance, the cellular mass forms beneath the original cuticle a new skin, distinctly divided into segments, and provided with certain appendages. After a while the old cuticle is thrown off, and the larva gradually assumes the form shown in Fig. 29. *asch* are the antennal discs, or rudiments of the antennæ, *flsch* of the wings, *bsch* of the legs, *vfg* are lateral projections, *gsch* of the ovipositor, &c., *fk* is the fatty tissue. The subsequent metamorphoses of Polynema offer no special peculiarities.

* Zeits. f. Wiss. Zool., 1869.

From these facts—and, if necessary, many more of the same nature might have been brought forward—it seems to me evident that while the form of any given larva depends to a certain extent on the group of insects to which it belongs, it is also greatly influenced by the external conditions to which the animal is subjected; that it is a function of the life which the larva leads and of the group to which it belongs.

The larvæ of insects are generally regarded as being nothing more than immature states—as stages in the development of the egg into the imago; and this might more especially appear to be the case with those insects in which the larvæ offer a general resemblance in form and structure (excepting of course so far as relates to the wings) to the perfect insects. Nevertheless we see that this would be a very incomplete view of the case The larva and pupa undergo changes which have no relation to the form which they will ultimately assume. With a general tendency, as regards size and the production of wings, to this goal, there are combined other changes bearing reference only to their existing wants and condition. Nor is there in this, I think, anything which need

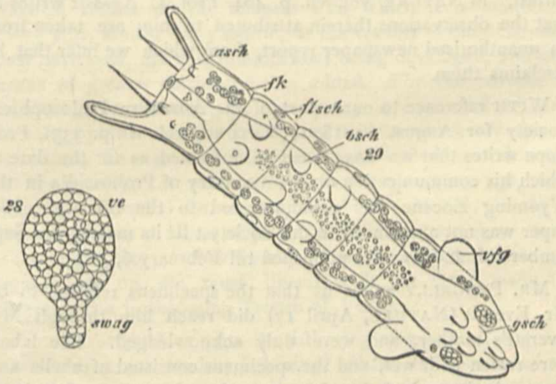


FIG. 28, Embryo of Polynema (after Ganin). 29, Larva of Polynema, *asch*, rudiments of the antennæ; *flsch* of the wings; *bsch* of the eggs; *vfg*, lateral projections; *gsch*, rudiments of the ovipositor; *fk*, fatty tissue.

surprise us. External circumstances act on the insect in its preparatory states, as well as in its perfect condition. Those who believe that animals are susceptible of great, though gradual, change through the influence of external conditions, whether acting, as Mr. Darwin has suggested, through natural selection, or in any other manner, will see no reason why these changes should be confined to the mature animal. And it is evident that creatures which, like the majority of insects, live during different parts of their existence in very different circumstances, may undergo considerable changes in their larval organisation, in consequence of forces acting on their larval condition; not, indeed, without affecting, but certainly without affecting to any corresponding extent, their ultimate form.

I conclude, therefore, that the form of the larva in insects, whenever it departs from the original vermiform—or the later Campodea—type, depends in great measure on the conditions in which it lives. The external forces acting upon it are different from those which affect the mature form; and thus changes are produced in the young, which have reference to its immediate wants, rather than to its final form.

And, lastly, as a consequence, that metamorphoses may be divided into two kinds, developmental and adaptional.

NOTES

THE following are the names of the fifteen candidates who have been selected by the Council of the Royal Society, for election this year into that body:—William Aitken, M.D., Sir Alexander Armstrong, M.D., K.C.B., Robert Stawell Ball, LL.D., John Beddoe, M.D., Frederick Joseph Bramwell, C.E., Staff-Captain Edward Kilwick Calver, R.N., Robert Lewis John Ellery, F.R.A.S., Lieut.-Col. J. Augustus Grant, C.B., C.S.I., Clements Robert Markham, C.B., George Edward Paget, M.D., George West Royston-Pigott, M.D., Osbert Salvin, M.A., The Hon. John William Strutt, M.A., Henry Woodward, F.G.S., James Young, F.C.S.

THE University of Cambridge has accepted the offer made by Dr. Anton Dohrn of the Zoological Station at Naples, through Dr. Michael Foster and Prof. Newton, of a working table in the laboratory of the station; and last week, on the recommendation of the Board of Natural Sciences, a grace passed the senate without opposition to the effect that from the Worts Travelling Bachelors' Fund the sum of 100*l*. per annum be granted for three years, for the purpose of securing to such members of the University, as the Board shall from time to time nominate, facilities of studying in the station.

WITH reference to a short article entitled "Survival of the Fittest," in NATURE, vol. vii. p. 404, Prof. L. Agassiz writes us that the observations therein attributed to him are taken from an unauthorised newspaper report, from which we infer that he disclaims them.

WITH reference to our report of the American Philosophical Society for August 16, 1872 (NATURE, vol. vii. p. 335), Prof. Cope writes that we have been misinformed as to the date at which his communication on the discovery of Proboscidia in the Wyoming Eocene was communicated to the Society. The paper was not announced to the Society till its meeting on September 20, and was not published till February 6, 1873.

MR. PENGELLY writes us that the specimens referred to by Mr. Everett (NATURE, April 17) did reach him through Mr. Everett's mother, and were duly acknowledged. The labels were rotten with wet, and the specimens consisted of shells and bones, the latter including human teeth and portions of a skull, incisors of some rodent, and a large hog-like molar.

PENIKESE ISLAND, the gift of which for the study of natural history to Prof. Agassiz by Mr. Anderson we have already more than once spoken of, was handed over by the donor on Monday, April 21, in a very simple way, accompanied by some speech-making. Prof. Agassiz and his generous admirer then met for the first time, and for the first time Agassiz set foot on the future sphere of his labours. The short deed of conveyance was read and handed over, and Prof. Agassiz briefly returned thanks, announcing that he intended to christen the institution to be founded on the island, "The Anderson School of Natural History." Preparations for the school, which will open this summer, will be immediately commenced. Plans have already been drawn for a two-story wooden building 100 ft. long and 25 ft. wide. The lower floor is intended for laboratories and working-rooms, of which there will be eight, with a large hall. The second story will contain twenty-six sleeping-rooms, two bath-rooms, and a large room for the Superintendent of the Institution. Several friends of Mr. Anderson in New York have become interested in the school, and will probably give liberally towards its endowment. The island of Penikese, Penekese, or Penequese, and often called Pune by the pilots, is one of a group of the Elizabethan Isles, lying between Buzzard's Bay and Vineyard Sound, and stretching southward from Cape Cod to a point nearly opposite the coast of Rhode Island. Penikese is just inside and on starboard hand of the entrance to Buzzard's Bay. It is twelve miles from New Bedford. The island is three-fourths of a mile long and half a mile wide, and contains ninety-seven acres of land, some of which is of good quality. A young tree was pointed out that had grown in one season higher than anybody in the party could reach. The surface is hilly, the highest point being about a hundred feet above the water. Mr. Anderson reserves a peninsula of some fifteen acres on the east end of the island, and here he proposes to build a house next year. Prof. Agassiz states that Penikese is a much better location for the school than the one originally contemplated at Nantucket. The school is to be devoted mainly to the study of fish and marine objects in the summer season, and a much larger variety is found in Penikese. The Sound and waters in the vicinity of Nantucket have almost invariably a sandy bottom, while the diversity in marine topography in Buzzard's Bay invites and fosters a corresponding variety of animal and vegetable life.

AT the meeting of the Iron and Steel Institute recently held in London, Mr. Lowthian Bell was elected president, and delivered a very interesting address. He pointed out the great success which had attended the organisation of the society, which although only in the fifth year of its existence, now numbered on its rolls 522 members. He expressed his opinion that the Institute had far from reached its limits. Referring then to the instances which still exist here and there, of a disregard for scientific inquiry, the result, perhaps, of considerable success effected independently of philosophical research, in which cases practical experience, as it is called, is the only rule admitted, Mr. Bell remarked, that on the other hand, abstract science, correct as it may be in every step employed in its elaboration, when introduced into the workshop may be found unable to stand the rude but inevitable test of commercial practicability; hence the necessity of a convenient method of effecting a sound union between these two great principles, and to obtain this was the object of the organisation of the Iron and Steel Institute, where are brought face to face men, some distinguished for their practical knowledge, and others equally eminent for their attachments to scientific observation. He then proceeded to consider the present aspect of foreign competition, and thought the progress in other countries in iron manufacture had arisen from an adaptation of our own appliances, and not from any important discoveries abroad. In speaking of the recent scarcity of coal, although it was his impression that an important addition can and will be made to their present output, he yet contemplated the possibility of a time being now approaching when "any extension of manufacturing operation in this country would have to be regulated, not by the requirements of society for their produce, but by the means our coal mines might possess of furnishing the fuel required. Mr. Bell, after referring to several improvements in the plant and processes for manufacturing iron, looking forward to the future, expressed his opinion that, unless new discoveries of coal be made in Europe, the great rival we have to fear in the iron manufacture is the United States, which possesses unlimited quantities of ores of the finest quality, and such enormous deposits of coal, that our own wealth in that mineral is but comparative poverty. At the proceedings on April 30, a paper by Dr. C. William Siemens, "On the Manufacture of Iron and Steel by Direct Process," was read. Dr. Siemens described his rotative regenerative gas furnace.

A SPECIAL meeting of the Council and Natural History Committee of the Asiatic Society was held at Calcutta a few weeks since, for the purpose of considering Mr. Schwendler's scheme for the establishment of a Zoological Garden in Calcutta. After considerable discussion it was resolved that the Council of the Society should once more record their opinion as to the great advantage to Natural History Science, as well as to the public which would result from the successful establishment of a Zoological Garden. In addition a Committee was appointed to report on the scheme. Few places are more suitable for the establishment of such gardens than Calcutta—climate, facilities for procuring animals, and an enormous floating population are all in their power. We are glad to learn that several of the native princes have already promised large donations, and that the local and Imperial Governments will give the scheme their support.

DR. SCHOMBURGK'S Report on the Botanic Garden at Adelaide, South Australia, gives an interesting view of the usefulness of such an institution in a new country. Although, according to the director, young Australia has very little taste for the science of botany, yet the number of persons who frequent the gardens for the purpose of getting various kinds of information increases yearly. Part of the report deals with the subject of state conservation of forests. In many districts of the colony the supply of wood for timber and fuel appears to be altogether exhausted, or is soon about to become so. The effect of the *déboisement* on the climate is much dreaded by Dr. Schomburgk, and no doubt, even if the belief in a diminution of the rainfall be not well founded, clearing certainly promotes evaporation, and sooner or later brings about the drying up of springs. Various economic plants have been introduced, including esparto (*Macrochloa tenacissima*). The climate allows of the planting out of many palms in the open air, such as *Latania borbonica*, *Rhapis flabelliformis*, *Sabal Blackburniana*, several species of *Chamærops* and others. There are grand possibilities for a well-managed botanic garden in such a climate.

THE third part of Mr. D. G. Elliott's superb "Monograph of the Paradiseidæ or Birds of Paradise," has just been published, it contains six plates beautifully executed by Mr. Wolf and Mr. Smit.

THE first part of a new biological work has recently been published at Moscow, entitled "Pripoda"—popularnoi estestvenno—istoricheski saornik. It contains a paper by M. Severtzoff on the sheep of Asia, but from being written in Russian, it is beyond the reach of most English readers, and would probably be worthy of translation.

LETTERS received from Mr. R. Swinhoe announce his removal from the Consulship of Ning-po to the more northern Chinese port of Che-fow, on the south shore of the Gulf of Petchelee. M. Swinhoe also announces the despatch of a living specimen of the very interesting hornless deer, *Hydropotes inermes*, first described by him in 1870, for the Zoological Society's Menagerie.

WE understand that Dr. John Anderson, F.Z.S., director of the Indian Museum at Calcutta, will return to England in the autumn for a leave of two years.

WE learn from *Sirius* that the Russian Government has devoted 70,000 roubles to the observation of the Transit of Venus, and is to send out twenty-four expeditions to various parts of the world.

FROM *Sirius* we learn that recently 84 pages of a manuscript of Copernicus have been discovered.

THE Archæological Institute of Great Britain and Ireland will hold its annual meeting at Exeter on July 29 and following days. Lord Devon has consented to fill the office of President.

THE Royal Microscopical Society hold a conversazione in the Large Hall, King's College, on Wednesday evening, May 14.

IN reference to the Natural Science Scholarship at Trinity College, Cambridge, to which, as mentioned last week, Mr. Bridge has just been elected, we are informed that Mr. Alfred Milnes Marshall, of St. John's College, was also highly recommended by the examiners for a second scholarship, but the master and seniors decided that only one should be given. Mr. Bridge, we may add, has for some time past, been a non-collegiate member of the University.

A VERY interesting publication is the "Memoir of the Founding and Progress of the U.S. Naval Observatory," at Washington, prepared by Prof. J. E. Nourse, by order of Rear-Admiral B. F. Sands, the present Superintendent of the observatory. The large pamphlet gives details of the history of the observatory from the first attempt in 1810 to move the American Government to take steps to establish a meridian for America, so as to make that country independent of the meridians of Greenwich and Paris, down to the present time, when by the liberality of the Government and the zeal and knowledge of American astronomers and meteorologists, it has become one of the most efficient observatories in the world. The present observatory was founded in 1842, and the first superintendent was the late Commander M. F. Maury, whose successors have been Capt. J. M. Gilliss, Rear-Admiral C. H. Davis, and Rear-Admiral B. F. Sands. In their attempts to render their observations, astronomical, meteorological, and magnetic, as thorough and wide as possible, the officials have been well backed by the American Government, the result being, as we have said, that the observatory is perhaps the most efficient institution of the kind in the world, both with regard to the higher aims and the practical results of the sciences with which it is connected. Every year, almost every month, as the readers of our "Notes" must have seen, are new ramifications being developed, and new means of greater efficiency being added. For the purpose of circulating accurate time, the observatory is connected with all the telegraphic offices in the United States, and every day at 12 o'clock, the exact time is by this means made known throughout the country. At present, as we noted some time ago, there is being constructed for the observatory by Messrs. Clark, of Cambridgeport, at a cost of 50,000 dollars, a refracting telescope of the largest size; and as we also noted several months since, preparations on the most liberal scale are being made for observing the forthcoming Transit of Venus.

A CORRESPONDENT puts the following case:—A strong man is suddenly struck dead by lightning. What has become of the potential energy he possessed the instant before he was struck? To this we have received the following reply:—His potential energy would be where it was before, viz., within the space bounded by his external surface. What the lightning has done has been to destroy the mechanism for realising that potential energy. A small portion of the man's potential energy might have been converted into actual energy by the lightning, as, for instance, in the shape of heat; but the great bulk would be got by anybody who chose to eat his body.

AN International Monument to the late Commodore Maury has been proposed, and there is no doubt his memory well deserves such a tribute. It has been mooted that an appropriate form in which to embody the monument would be a lighthouse on Rocos, which is sighted by all vessels on the route t Rio de Janeiro.

AT a meeting held in Edinburgh last week, it was resolved to appeal to the public for subscriptions in order to procure the erection in Edinburgh of Mrs. D. O. Hill's statue of Dr. Livingstone. The sum proposed to be raised is 3,500*l*.

THE U.S. signal office has begun the publication of a brief monthly review of the weather, in which special attention is, of course, given to the storms that visit the United States. It appears from these that there were enumerated during the month of January twelve storms, during February ten, and during March eleven. The paths pursued by the centres of these storms are classified as follows:—Twenty-one passed from the Upper Missouri Valley, and possibly from Oregon and British Columbia, eastward, over the lakes to Canada or New England; nine passed from the south-west, north and eastward, to the Middle or Eastern States; three passed from the south-west, eastward, to the South Atlantic States, and thence north-eastward; and two passed up north-eastward some distance off the Atlantic coast. Several of these storms divided into two portions, pursuing separate routes; and, with but one or two exceptions, they all increased in severity as they advanced eastward. The rainfall returns show a general deficiency on the Pacific coast; that, however, which was reported in the States east of the Rocky Mountains in March is probably compensated by the excess during January and February. During the entire three months the temperature has been colder than usual—at least for the country east of the Rocky Mountains.

WE have received the programme of the Leeds Naturalist's Field Club for the quarter April to June, from which we see that alternately with "exhibition of specimens and conversation," which takes place once a fortnight, papers on subjects of scientific interest are to be read. Excursions also take place on an average once a fortnight, the first object of the Club being "the minute investigation of the natural history, in all its branches, of the immediate neighbourhood of Leeds, and a more general investigation of the whole of the West Riding." This Society was founded in 1870, and was reorganised on a broader basis in March 1872, and seems to be doing good work.

A CORRESPONDENT writes, asking information with reference to the etymology of the word *aphis*.

THE following additions to the Brighton Aquarium have been made during the past week:—Picked Dogfish (*Acanthias vulgaris*), Larger Spotted Dog-fish (*Scyllium stellare*), Lesser do. (*Scyllium canicula*), Monkfish (*Rhina squatina*), Spotted Rays (*Raja maculata*), Sharp-nosed do. (*Raja lintea*), Streaked Gurnards (*Trigla lineata*), Grey Gurnards (*Triglia gurnardus*), Greater Weevers (*Trachinus draco*), Lesser do. (*Trachinus vipera*), Gemmeous Dragonets (*Callionymus lyra*), Lump Fish (*Cyclopterus lumpus*), Sea Snail (*Liparis vulgaris*), Yarrell's Blenny (*Blenniops ascani*), Sand Smelts (*Atherina presbyter*), Turbot (*Rhombus maximus*), Brill (*Rhombus lævis*), Sail Fluke (*Rhombus punctatus*), Plaice (*Pleuronectes platissa*), Flounders (*Pleuronectes flesus*), Soles (*Solea vulgaris*), Minnows (*Leuciscus phoxinus*), Tench (*Tinca vulgaris*), Masked Crab (*Corystes cassivelanus*), Tube Worms (*Serpula contortuplicata*), Sea Mice (*Aphrodite aculeata*), Sun Starfish (*Solaster papposa*), Mediterranean Corals (*Balanophyllia verrucari*), Golden Cup Coral (*Balanophyllia regia*), Devonshire Cup Coral (*Caryophyllia smithii*), Sea-fingers (*Alcyonium digitatum*), Sea-anemones (various).

THE additions to the Zoological Society's Gardens during the past week include an Indian leopard (*Felis pardus*), two Indian jackals (*Canis aureus*), presented by Capt. Henry; a Malabar Squirrel (*Sciurus maximus*), presented by Mr. Whiteside; three Egyptian cats *Felis chaus* (?) from Cashmere, presented by Capt. J. J. Bradshaw; two Egyptian geese (*Chenalopex ægyptiaca*), presented by Mr. H. W. Thornton; a hawfinch (*Coccothraustes vulgaris*), from the British Isles, presented by the Viscountess Downe; four European Terrapins (*Emys lutaria*) and a green lizard (*Lacerta viridis*, var. *chloronotus*), presented by Lord A. Russell; two black-handed spider monkeys *Ateles melanochir*); a white-throated Capuchin (*Cebus hypoleucus*); a blue-fronted Amazon (*Chrysotis æstiva*); a yellow-fronted Amazon (*C. ochrocephala*), and an orange-winged Amazon (*C. amazonica*), from Cartagena; a crested agouti (*Dasyprocta cristata*) from Colon; an alligator, and a red and yellow macaw (*Ara chloroptera*), from Barauquilla; a golden eagle (*Aquila chrysaëtus*), purchased; a bladder-nosed seal (*Cystophora cristata*), from the North Atlantic, deposited.

ON THE HYPOTHESES WHICH LIE AT THE BASES OF GEOMETRY*

III.—*Application to Space.*

§ 1.—BY means of these inquiries into the determination of the measure relations of an n-fold extent the conditions may be declared which are necessary and sufficient to determine the metric properties of space, if we assume the independence of line-length from position and expressibility of the line-element as the square root of a quadric differential, that is to say, flatness in the smallest parts.

First, they may be expressed thus: that the curvature at each point is zero in three surface-directions; and thence the metric properties of space are determined if the sum of the angles of a triangle is always equal to two right angles.

Secondly, if we assume with Euclid not merely an existence of lines independent of position, but of bodies also, it follows that the curvature is everywhere constant; and then the sum of the angles is determined in all triangles when it is known in one.

Thirdly, one might, instead of taking the length of lines to be independent of position and direction, assume also an independience of their length and direction from position. According to this conception changes or differences of position are complex magnitudes expressible in three independent units.

§ 2.—In the course of our previous inquiries, we first distinguished between the relations of extension or partition and the relations of measure, and found that with the same extensive properties, different measure-relations were conceivable; we then investigated the system of sinple size-fixings by which the measure-relations of space are completely determined, and of which all propositions about them are a necessary consequence; it remains to discuss the question how, in what degree, and to what extent these assumptions are borne out by experience. In this respect there is a real distinction between mere extensive relations, and measure relations; in so far as in the former, where the possible cases form a discrete manifoldness, the declarations of experience are indeed not quite certain, but still not inaccurate; while in the latter, where the possible cases form a continuous manifoldness, every determination from experience remains always inaccurate: be the probability ever so great that it is nearly exact. This consideration becomes important in the extensions of these empirical determinations beyond the limits of observation to the infinitely great and infinitely small; since the latter may clearly become more inaccurate beyond the limits of observation, but not the former.

In the extension of space-construction to the infinitely great, we must distinguish between *unboundedness* and *infinite extent*, the former belongs to the extent relations, the latter to the measure-relations. That space is an unbounded three-fold manifoldness, is an assumption which is developed by every conception of the outer world; according to which every instant the region of real perception is completed and the possible positions of a sought object are constructed, and which by these applications is for ever confirming itself. The unboundedness of space possesses in this way a greater empirical certainty than any external experience. But its infinite extent by no means follows from this; on the other hand if we assume independence of bodies from position, and therefore ascribe to space constant curvature, it must necessarily be finite provided this curvature has ever so small a positive value. If we prolong all the geodesics starting in a given surface-element, we should obtain an unbounded surface of constant curvature, *i.e.*, a surface which in a *flat* manifoldness of three dimensions would take the form of a sphere, and consequently be finite.

§ 3. The questions about the infinitely great are for the interpretation of nature useless questions. But this is not the case with the questions about the infinitely small. It is upon the exactness with which we follow phenomena into the infinitely small that our knowledge of their causal relations essentially depends. The progress of recent centuries in the knowledge of mechanics depends almost entirely on the exactness of the construction which has become possible through the invention of the infinitesimal calculus, and through the simple principles discovered by Archimedes, Galileo, and Newton, and used by modern physic. But in the natural sciences which are still in want of simple principles for such constructions, we seek to discover the causal relations by following the phenomena into great minuteness, so far as the microscope permits. Questions

(Continued from page 17.)

about the measure-relations of space in the infinitely small are not therefore superfluous questions.

If we suppose that bodies exist independently of position, the curvature is everywhere constant, and it then results from astronomical measurements that it cannot be different from zero; or at any rate its reciprocal must be an area in comparison with which the range of our telescopes may be neglected. But if this independence of bodies from position does not exist, we cannot draw conclusions from metric relations of the great, to those of the infinitely small; in that case the curvature at each point may have an arbitrary value in three directions, provided that the total curvature of every measurable portion of space does not differ sensibly from zero. Still more complicated relations may exist if we no longer suppose the linear element expressible as the square root of a quadric differential. Now it seems that the empirical notions on which the metrical determinations of space are founded, the notion of a solid body and of a ray of light, cease to be valid for the infinitely small. We are therefore quite at liberty to suppose that the metric relations of space in the infinitely small do not conform to the hypotheses of geometry; and we ought in fact to suppose it, if we can thereby obtain a simpler explanation of phenomena.

The question of the validity of the hypotheses of geometry in the infinitely small is bound up with the question of the ground of the metric relations of space. In this last question, which we may still regard as belonging to the doctrine of space, is found the application of the remark made above; that in a discrete manifoldness, the ground of its metric relations is given in the notion of it, while in a continuous manifoldness, this ground must come from outside. Either therefore the reality which underlies space must form a discrete manifoldness, or we must seek the ground of its metric relations outside it, in binding forces which act upon it.

The answer to these questions can only be got by starting from the conception of phenomena which has hitherto been justified by experience, and which Newton assumed as a foundation, and by making in this conception the successive changes required by facts which it cannot explain. Researches starting from general notions, like the investigation we have just made, can only be useful in preventing this work from being hampered by too narrow views, and progress in knowledge of the interdependence of things from being checked by traditional prejudices.

This leads us into the domain of another science, of physic, into which the object of this work does not allow us to go to-day.

Synopsis

PLAN of the Inquiry:

I. Notion of an n-ply extended magnitude.

§ 1. Continuous and discrete manifoldnesses. Defined parts of a manifoldness are called Quanta. Division of the theory of continuous magnitude into the theories

(1) Of mere region-relations, in which an independence of magnitudes from position is not assumed;

(2) Of size-relations, in which such an independence must be assumed.

§ 2. Construction of the notion of a one-fold, two-fold, n-fold extended magnitude.

§ 3. Reduction of place-fixing in a given manifoldness to quantity-fixings. True character of an n-fold extended magnitude.

II. Measure-relations of which a manifoldness of n dimensions is capable on the assumption that lines have a length independent of position, and consequently that every line may be measured by every other.

§ 1. Expression for the line-element. Manifoldnesses to be called Flat in which the line-element is expressible as the square-root of a sum of squares of complete differentials.

§ 2. Investigation of the manifoldness of n-dimensions in which the line-element may be represented as the square root of a quadric differential. Measure of its deviation from flatness (curvature) at a given point in a given surface-direction. For the determination of its measure-relations it is allowable and sufficient that the curvature be arbitrarily given at every point in $n\frac{n-1}{2}$ surface directions.

§ 3. Geometric illustration.

§ 4. Flat manifoldnesses (in which the curvature is everywhere $= 0$) may be treated as a special case of manifoldnesses with constant curvature. These can also be defined as admitting an independence of n-fold extents in them from position (possibility of motion without stretching).

§ 5. Surfaces with constant curvature.

III. Application to Space.

§ 1. System of facts which suffice to determine the measure-relations of space assumed in geometry.

§ 2. How far is the validity of these empirical determinations probable beyond the limits of observation towards the infinitely great?

§ 3. How far towards the infinitely small? Connection of this question with the interpretation of nature.

THE DEVELOPMENT THEORY IN GERMANY*

III.

Chorology: or, the Geographical Distribution of Living Beings

THE importance of the theory of Evolution does not consist in its accounting for this or that particular fact, but in its explaining all biological facts collectively. It is found to be confirmed in every detail by the mode of distribution of the various organisms on the surface of the earth. This distribution had already been studied by Alexander von Humboldt and Fr. Schouw for plants, by Berghaus and Schmarda for animals. But previous to Darwin and Wallace, this study had produced only a collection of unsystematised facts; Haeckel has attempted to create out of it a special science under the name of *Chorology*.

With the exception of the monocellular protozoa, which, on account of their simplicity, have been able to appear at the same time or at several times in different places; with the exception also of species which owe their origin to a hybrid or bastard generation, and which it has been possible to reproduce in different circumstances wherever the parent species have previously spread, it must be admitted that each of the other species has only been originated a single time and in a single place. But, once produced, they must, as a consequence of the struggle for existence, and in virtue of the laws of population, or rather of excess of population, tend to spread to the widest possible extent. Animals and plants migrate as well as man, both actively and passively.

In the case of animals, which have, more than plants, freedom of movement, active migration plays the principal part. The more easy locomotion is in the case of any species, the more rapidly is the species bound to spread. This is why birds and insects, furnished with wings, although referable to a less number of orders or natural groups than other animals, yet present a very great diversity of species slightly distinguishable from one another; this is to be ascribed to the fact that the facility with which they can move from place to place has subjected them to the modifying influences of the most varied localities. After birds and insects the swiftest runners among the denizens of the land, the best swimmers among the inhabitants of the water have been subject to the widest extension. With regard to animals which are fixed or immovable while being developed, corals, tubicolæ, tunicata, crinoids, &c., they usually enjoy during their youth so much of the power of movement as admits of their displacement. A great number of floating plants are also transported to great distances by water.

But the spread of a large number of plants and of certain animals can be explained only by a passive migration. The wind sweeps to great distances, sometimes over seas, eggs of small animals, seeds, and sometimes even minute organisms; this explains the well-known phenomena of showers of frogs. These eggs, these seeds, these small organisms, sometimes fall into the water, which transports them to still greater distances. Trunks of trees, which traverse the ocean under the direction of the currents, and those which the tempest hurls from the mountain tops, can carry with them, hidden in their interstices, in the moss or the parasitical plants with which they are covered, in the earth which adheres to their roots, innumerable germs to be developed in new regions. The icebergs of the polar sea have landed foxes and bears even on the shores of Iceland and Britain. Birds, insects, mammals which are removed, carry with them thousands of parasites, microscopic beings, eggs or germs. Man himself carries them about more abundantly still along with the varied materials he employs for his works and his industry.

The fact of the distribution of certain species which cannot be explained by migration, either active or passive, may be accounted for by geological facts. In consequence of the im-

* Continued from vol. vii. p. 434.

perceptible but unceasing change of the level of the seas, in consequence of the phenomena of subsidence and elevation of the land, lands at one time united have been divided, watercourses which communicated have been separated, thus accounting for the fact that fishes of the same species are found in different rivers, that islands are tenanted by the same mammals as the continents. England has been united to Europe at two different times; at a certain epoch our continent must have been united by land to N. America. The South-sea Islands are the remains of what was at one time a single land; so in the Indian Ocean land has at one time stretched along the South of Asia from Sunda to Africa; this great continent which Sclater has called *Lemuria*, on account of the apes which were peculiar to it, is probably the cradle where the human race was developed from the anthropoid apes. Mr. Wallace has proved that the Malay Archipelago consisted of two entirely different parts: one, comprehending Borneo, Java, and Sumatra, was united to Asia by the peninsula of Malacca, while the other, comprehending the Celebes, the Moluccas, New Guinea, the Salomon Isles, &c., was immediately attached to Australia.

Another cause which has favoured the dispersion of species all over the globe, was the uniformity of temperature which prevailed up to the tertiary geological period. Previous to the freezing of the polar regions, species found everywhere a climate equally warm and agreeable, favourable to migrations in all directions; since that period, on the contrary, a new difficulty of existence has arisen,—organisms have to undergo acclimatisation; those which have the power of adapting themselves to the lower temperature of regions at a distance from the equator, have been transformed by selection into new species; while those which have found such adaptation impossible, have been compelled, under pain of extinction, to remove to more favourable climates. When, at a later period, occurred that strange phenomenon—of which, as yet, no satisfactory explanation has been given—known as the Glacial Period, animals and plants were compelled to migrate anew; the living population of the earth, condensing itself between the tropics, a terrible struggle for existence took place between the old inhabitants of these regions and those that fled thither for refuge; many species were bound to disappear, while many new ones were originated. There is still another chorological phenomenon which is to be accounted for by the glacial period, viz., the resemblance of many of the inhabitants of mountains to those of the Polar regions; as those animals and those plants are not found in the intermediate countries, it is absolutely necessary to suppose a migration which, considering the habits of these creatures, could only have taken place at the glacial epoch. It is probable that at this period the gentians, the saxifrages, the Polar hare and fox, inhabited the central part of Europe; but as the temperature rose, some of these creatures retired towards the north, while the remainder found a refuge upon the summits of the European mountains.

When plants or animals migrate to new regions, they are subjected to new conditions of existence to which they must adapt themselves. The new climate, new food, relations with new organisms, all this obliges the emigrants to submit to modifications under pain of annihilation, and, as a consequence, to form new varieties or new species; it is in these circumstances, in fact, that natural selection acts with the greatest intensity. In ordinary circumstances, individuals which have changed breed with individuals who have not changed, and the products of such crossings have a tendency to revert to the primitive type; but when a migration has taken place, when modified individuals are separated from the others by mountains or by seas, they can no longer interbreed, and this isolation insures the preservation of the newly acquired forms. It is of course evident that these considerations apply only to species in which the sexes are separate.

There still remain three other chorological phenomena which furnish an important proof of the truth of the evolution theory. There is first the likeness of form, the family resemblance which exists among the local species characteristic of each region, and the extinct and fossil species of the same region; in the second the no less striking family resemblance which exists among the inhabitants of certain groups of those of the neighbouring continents, whence the population of these islands must have come; and lastly, the special character presented by the collective fauna and flora of the islands. All the facts adduced by Darwin, Wallace,* and Moritz Wagner,† as well as all those other facts which geographical and topographical dispersion of organisms present to us are simply and completely explained by the theory of selection and migration, while it would be impossible to explain them without it.

* "Malay Archipelago."
† The "Darwinian Theory and the Law of Migration of Organisms" Leipzig, 1868).

Palæontology

Thanks to the theory of evolution, the natural classification of animals and plants, which was previously only a record of names for arranging the different forms in an artificial order, or a record of facts expressing summarily the degree of resemblance among them, tends to become the genealogical tree of organisms. In order to construct it the student has only to combine the data furnished by the three parallel developments referred to above—the palæontological development, the embryological development, and the systematic development in the order of perfection or of comparative anatomy. The writer in the *Révue Scientifique* here gives a table presenting a view of the geological and palæontological doctrines of Haeckel. Between the stages generally admitted by geologists, Haeckel intercalates others which he calls inferior or intermediate stages in relation to the superior stages. Haeckel accepts completely the system of gradual and continuous evolution as propounded by Lyell, and rejects the system of sudden catastrophes which has been advocated by Cuvier and his disciples. He places the probable appearance of man in the Miocene, and his certain existence in the Pliocene. Many attempts have been made to determine approximately how many thousand years each geological period has lasted; these conjectures are principally framed on the relative thickness of the different beds. The total thickness of the Archæolithic or Primordial beds, in which Haeckel includes the Laurentian, Cambrian, and Silurian, is 70,000 ft.; that of the Primary, from the Devonian to the Permian, 42,000 ft.; that of the Secondary, 15,000 ft.; that of the Tertiary, 3,000 ft.; while the thickness of the beds of the "Anthropolithic" or Quaternary age is only from 500 to 700 ft. From these figures, the following relative duration of the successive ages may be deduced:—

Primordial Age . . .	53·6
Primary ,, . . .	32·1
Secondary ,, . . .	11·5
Tertiary ,, . . .	2·3
Quaternary ,, . . .	0·5

Thus the Primordial age has existed longer than the other four put together. As to the number of centuries or of millenniums necessary for the deposition of one bed only one foot thick, that depends on circumstances so variable that it is impossible to give any measure: it is longer in the depths of mid-ocean, in the beds of very long rivers, in lakes which receive no affluents; it is shorter on the sea-margins, at the mouths of great rivers whose course is long and straight, in lakes which receive many tributary streams. It results from such considerations that every estimate of the duration of a geological epoch must be relative.

It will be necessary, moreover, to take into consideration, elevations and depressions of the ground, which, according to Haeckel, will be alternative, and will correspond to the mineralogical and palæontological differences which exist between two systems of beds and between two formations of these systems. When a certain region, after having remained for many thousand centuries beneath the water, emerges for a certain time, and is again submerged, it will be readily admitted that the bed which is deposited after such an interval ought to present characteristics different from those of the lower bed: for time is bound to accomplish change of all organic and inorganic conditions. This theory has been disputed by Huxley, who finds it inconsistent with the existence of a large number of beds, in which are found united organic forms, holding a middle place between those of adjacent formations; the English naturalist adduces, for example, the beds of Saint Cassian, in which are found mingled the forms of the primary and secondary formations.

It is certain that even yet our knowledge of palæontology is very imperfect, and far from enabling us to write, with anything like exactness, the history of the production of organic species. We know with what difficulties this study is surrounded. The fossil remains of the most remote ages appear to have been destroyed by the great heat of the lower beds in which they were deposited. *Eozoon Canadense* is the only fossil which has hitherto been found in the formations of the Laurentian period; while the beds of carbon and of crystallised lime (graphite and marble) give us the assurance that in them have existed animal and vegetable petrifactions. Another difficulty lies in the fact that hitherto the field of geological exploration has been very restricted. Outside of England, Germany, and France, very few formations have been seriously studied; almost the only successful explorations have been in railway-cuttings. One indication of what may be discovered elsewhere is furnished by the remarkable petrifactions which have resulted from some researches prosecuted in Africa and Asia, in the neighbourhood of the Cape, and on the Himalayas: forms have been discovered which fill up important gaps in palæontological classification. It must be remembered also that only the hard and solid parts of organisms have been preserved, that entire forms, such as the Medusæ, shell-less molluscs, many articulata, nearly all worms, could leave no trace behind. The most important parts of plants, the flowers, have completely disappeared. Moreover, terrestrial organisms have been petrified only in accidental instances, where they have fallen into the water and been covered with mud; it is not to be wondered at then if the number of fossils of this kind is relatively much less considerable than that of those kinds which have inhabited the sea or fresh water. This explains also the apparently strange fact that of many fossil mammals, especially those of the secondary, we recognise only the lower jaw. This arises from the fact that that bone is easily separated from the dead body; while the rest swims on the surface of the water and is carried to the bank, the jaw falls to the bottom, and is buried in the mud, where it is petrified. The traces of those which have been found in different beds of sandstone, and especially in the red sandstone of Connecticut, belong to organisms whose bodies are entirely unknown to us, and prove that we are far from possessing remains of all actual forms. What gives us reason to think that an immense number must remain unknown is the fact that of those whose fossil remains we possess, only one or two examples have come to light. It is only ten years since a bird of the highest importance was discovered in the Jura; till then no intermediate form was known between the birds proper and reptiles, which are, nevertheless, the class most closely related to the former. Now this fossil bird, which possesses the tail, not of an ordinary bird, but of a lizard, confirms the hypothesis that birds are descended from the saurians. A couple of small teeth which have been found in the Keuper of the Trias are, up to the present, the only proof that mammals have existed from the Triassic period, and that they did not appear only in the Jurassic period, as was previously believed.

Fortunately we are able to supplement the insufficient data of palæontology by those of embryology, since individual development is, as it were, a reproduction or recapitulation brief and rapid, by means of heredity and adaptation of the development of species. Embryology is especially valuable for the light which it throws on the more ancient forms of the primordial period; by it alone do we learn that these primitive forms must have been simple cells, similar to eggs; that these cells, by their segmentation, their conformation, and their division of labour, have given birth to the infinite variety of the most complicated organisms.

To the valuable data respecting the relations of organisms furnished by palæontology and embryology must be added those derived from comparative anatomy. When organisms, whose exterior is very different, resemble each other in their interior construction, we may conclude with certainty that this resemblance is due to heredity, while the differences are a result of adaptation. If, for example, we compare the limbs or extremities of different mammifers, the arm of man, the wing of the bat, the anterior members of the mole adapted for digging, those of other mammifers made for leaping, climbing, or running; if we consider, besides, that in all these members variously formed, the same bones are found, equal in number, in the same place, disposed in the same manner, are we not forced to admit the close relationship of organisms? This homology can be explained only by heredity, by descent from common ancestors. And to go still further, if we find in the wing of the bird, in the anterior members of reptiles and amphibia, the same bones as in the arms of man, or in the anterior limbs of other mammifers, can we not affirm with certainty the common descent of all these vertebrate animals?

SCIENTIFIC SERIALS

Ocean Highways, May.—The first paper in this number is an article on Mexico, by Mr. Maurice Kingsley, accompanied by a map showing the course of the Vera Cruz and Mexico Railway. This is followed by a very interesting article on "Railway Communication between London and Calcutta," with a map showing the proposed line from Ostende, by Vienna, Constantinople, Diabeker, Herat, Cabul, Lahore, Delhi, Cawnpore, and Calcutta. By this route the land journey would amount to 6,336 miles, with only 73 miles of sea, which could be accomplished in 214 hours, or about 9 days; while by the present shortest route, the sea-journey amounts to 3,941 miles, and the time taken is 492 hours, or upwards of 20 days. Dr. Robert Brown contributes a paper entitled "A Cruise with the Whalers in Baffin's Bay," which is followed by "Notes on Mr. Stanley's Work," by Capt. R. F. Burton, in which that gentleman points out several things in Stanley's book that he thinks are capable of amendment. Burton thinks Stanley "wants only study and discipline, to make him a first-rate traveller." This is followed by a very valuable paper on "The Steppes to the North of Bokhara," by A. Vámbéry. Then follow the usual reviews, notes, reports of societies, &c.

SOCIETIES AND ACADEMIES

London

Chemical Society, May 1.—Dr. Odling, F.R.S., president, in the chair.—Dr. H. Sprengel, "On a new class of explosives," gave an account of some new explosives consisting of two liquids inexplosive by themselves, but which when mixed and fired with a detonating charge are as effective as nitroglycerine.—Prof. Abel of the Royal Arsenal, Woolwich, drew attention to the great difference produced by variations in the mechanical state of the explosive.—On Zirconia, by Mr. J. B. Hannay.—On Pyrogallate of lead and lead salts, by Mr. W. H. Deering.

Royal Horticultural Society, April 16.—General meeting, Sir Coutts Lindsay, Bart., in the chair. The Rev. M. J. Berkeley commented on the plants exhibited, and remarked that the unused archways of railways might be profitably employed for the production of mushrooms.—Mr. W. A. Lindsay (the secretary) enumerated the concessions which the Council had made for this year to Her Majesty's commissioners for the Exhibition, including a passage-way across the gardens: the society would receive in return the sum of 1000*l*.—Scientific committee—Prof. Westwood, F.L.S., in the chair. The Rev. M. J. Berkeley commented on an article in the recent number of the journal of the Royal Agricultural Society on the injury suffered by horses fed upon mouldy oats. There was an evident error with respect to the fungus figured as *Aspergillum* (sic) which was clearly the common bread-mould *Ascophora Mucedo*. With respect to the diseased coffee-plants from Natal brought forward at the last meeting he was disposed to think that climatic conditions were the cause, of their malady. The differences between the summer and winter temperatures had been too slight to check the growth of the coffee trees. There are often three flowerings instead of one, or at all events two. It seemed on the whole probable that growth was over-estimated, and that, consequently, when the drought came, the plants were unable to support it. There was a minute immature black fungus, which might be referred to *Depazea*, on the twigs. Prof. Thiselton Dyer read a letter addressed to Dr. Hooker from Dr. Henderson in charge of the Calcutta Botanic Garden, describing the disease of the opium poppy. This appeared to be favoured by moist weather, and the plants affected were infested with *Peronospora arborescens*, and also with a fungus (which Mr. Berkeley identified as *Macrosporium cheiranthi*, a peculiar form of *Cladosporium herbarum*.) The places attacked were black, and the disease progressed from below, upwards. If the plant has not flowered when attacked, it never does so; but if it is on the point of flowering, the sepals, petals, and stamens, do not drop off as they would do in healthy plants. The effect of guano, even in very small quantities, was remarkable in increasing the crop.

Institution of Civil Engineers, April 29.—Mr. T. Hawksley, president, in the chair.—"On the Rigi Railway," by Dr. William Pole, F.R.S., M. Inst. C.E. The object of this railway was to convey passengers to the top of the Rigi, a mountain near Lucerne, from which there was a view so celebrated as to attract large numbers of visitors in the summer months. The line commenced at Vitznau, on the Lake of Lucerne, and was about four miles long. The works are mostly formed by cutting and benching on the rocky slope of the mountain. There was but one short tunnel, and only one iron bridge over a ravine. The gauge was 4 feet 8½ inches.

Glasgow

Geological Society, April 10.—Mr. John Young, vice-president, in the chair.—The chairman exhibited a specimen of carboniferous limestone from Braidwood, near Carluke, containing in great abundance the tests or shells of a species of Foraminifer, *Saccimina carteri*. Similar organisms had been found in a limestone from the Elf Hills, Northumberland, and described by Dr. H. B. Brady in 1871. They had also been found once or twice in the limestones of the east of Scotland, but so far as he was aware, this was the first instance in which it had been recognised in the limestones of the Lanarkshire coal field.—Mr. J. Thompson, F.G.S., read a paper which he had prepared in conjunction with Mr. Henry Caunter, on the geology of the neighbourhood of Stornoway, island of Lewis. The authors briefly described the relations of the gneissic or Laurentian rocks to the Cambrian strata of the island. The junction of the two formations is seen in the bed of a small stream that flows into the sea in the harbour of Stornoway; also in Garabost Bay, about seven miles to the east. The Laurentians dip N.W., while the lower members of the Cambrian dip at an angle of 23° to the N.E. These beds have been termed by Sir R. Murchison, Upper Cambrian. The authors next described the more recent deposits of the island, beginning with the boulder drift, with its transported striated erratics, all of which belong to the Laurentian system, and are traceable to the west and north-west. They then referred to the gravels and drift-sand which overlie the remains of an extensive bed of peat seen in Stornoway Bay, where it attains a depth of 15 feet. At the lower extremity of this bed, and only seen at extreme low tides, are numerous stumps of trees of considerable dimensions, the roots of which rest upon and pass down through a bed of clay which forms the subsoil. From this it would seem that there has been an extensive subsidence of the island at a comparatively recent period, and that the climatal conditions must have been very different during the time when such trees grew from those which prevail at the present day.

PARIS

Academy of Sciences, April 28.—M. de Quatrefages, president, in the chair.—The following papers were read.—On the actions produced in capillary spaces by molecular attractions, by M. Becquerel. The author described the various results produced by inserting solutions contained in cracked vessels into other vessels containing solutions capable of producing precipitates in them, *e.g.* baric nitrate and potassic sulphate. After a few days the solutions communicate by the crack and electric currents are started.—On the heat disengaged by the reactions between the alkalis and water: potassic and sodic hydrates by M. Berthelot. The results obtained lead the author to suppose that there is a potassic hydrate intermediate between the ordinary fused and crystallised hydrates.—On the combinations produced by the electric discharge between marsh gas and carbonic anhydride, and between carbonic oxide and hydrogen, by MM. P. and A. Thenard.—On certain particular spectroscopic observations by Father A. Secchi.—On the application of the pandynamometer to the measurement of the work performed by a steam engine, by M. G. A. Hirn.—On the application of the mathematical theory of elasticity to the study of articulated systems formed by elastic rods, by M. Maurice Levy.—On the composition of the thermic mineral waters of Vichy, Bourbon l'Archambault, and Neris, as regards those substances which invariably exist in water in minute proportions, by M. de Gouvernain.—An examination of the difference produced in the spectrum of chlorophyll by different solvents, by M. J. Chautard.—On the unwholesome nature of the Versailles water supply, by M. E. Decaisne.—On the awakening of the Phylloxera in the month of April 1873, by M. Faucon.—On nebulæ discovered and observed at the Marseilles observatory, by M. E. Stephan.—On characteristics in the theory of conics, on planes, and in space, and on second order surfaces, by M. Halphen.—On the vapour emitted at the same temperature by the same body in two states, by M. J. Moutier.—On the spectrum of erbia, by M. Lecocq de Boisbaudran. The author has found that erbia and erbic phosphate give, when heated, different band spectra, of which the author exhibited plates and tables. These spectra he has carefully investigated, and finding it impossible to attribute either of them to another body, he concluded that they were both due to erbium in different states of combination.—Observations on M. du Moncel's late note on the history of the silent discharge, by M. Arn. Thenard.—On the Manufacture of ammonic sulphate from nitrogenous waste products, by M. L'Hote.—On the conditions of formation of extra silicious pig in blast furnaces, by M. S. Jordan. Experiments on the effects of dynamite, by MM. Roux and Jarrou.—On necrobiosis and gangrene, an experimental study on the phenomena of mortification and putrefaction as they occur in the living body, by M. Chauveau.—On the geology of Mount Léberon, by M. A. Gaudry.

DIARY

THURSDAY, May 8.

Royal Society, at 8.30.—Contributions to the Study of the Errant Annelides of the older Palæozoic Rocks: Prof. Alleyne Nicholson.—Researches in Spectrum Analysis in Connection with the Spectrum of the Sun: J. Norman Lockyer.—The Action of Light on the Electrical Resistance of Selenium: Lieut. Sale.

Mathematical Society, at 8.—On Bicursal Curves, and Plan of a Curve-tracing Apparatus: Prof. Cayley.—On an application of the Theory of Unicursal Curves: M. Hermite.

Society of Antiquaries, at 8.30.

Royal Institution, at 3.—Light: Prof. Tyndall.

FRIDAY, May 9.

Royal Institution, at 3.—A Fortnight in Asia Minor: Mr. Grant Duff, M.P.

Astronomical Society, at 8.

Quekett Club, at 8.

SATURDAY, May 10.

Royal Institution, at 3.—Ozone: Prof. Odling.

MONDAY, May 12.

Royal Geographical Society, at 8.30.

London Institution, at 4.—Elementary Botany: Prof. Bentley.

TUESDAY, May 13.

Royal Institution, at 3.—Roman History and Architecture: J. H. Parker.

Photographic Society, at 8.—On instantaneous Landscape Photography: F. R. Elwell.—Improvements in Carbon Printing: A. Marion.

WEDNESDAY, May 14.

Society of Arts, at 8.—Improvements in Rifles: Capt. O'Hea.

Geological Society, at 8.—Notes on Structure in the Chalk of the Yorkshire Wolds: J. R. Mortimer.—On the genus *Palæocoryne*, Duncan and Jenkins, and its affinities: Prof. P. Martin Duncan.—On *Platysiagum sclerocephalum* and *Palæospinax priscus*, Egerton: Sir Philip de M. Grey-Egerton.—On a new genus of Silurian Asteridæ: Dr. Thomas Wright.

Archæological Association, at 8.—Anniversary.

London Institution, at 7.—Paper and Discussion.

Society of Telegraph Engineers, at 7.30.—On the Block System of Working Railways: W. H. Preece and Capt. Mallock.

THURSDAY, May 15.

Royal Society, at 8.30.

Society of Antiquaries, at 8.30.

Chemical Society, at 8.—On Isomerism: Dr. H. E. Armstrong.

Numismatic Society, at 7.

Royal Institution, at 3.—Light: Prof. Tyndall.

BOOKS RECEIVED

English.—Comet's Tails no longer a Mystery: T. A. R. (Reeves and Son).—Manual for Medical Officers of Health: E. Smith (Knight & Co.).—Manchester Science Lectures, 1871–73. 3rd Series: J. Heywood & Co.—Tropical World. New Edition: Dr. G. Hartwig (Longmans).—The Life of von Humboldt, Vols. i. and ii.: Bruhns, translated by Lassell (Longmans).—Astronomical Plates from the Observatory of Harvard College (Trübner).—Text-books of Science; Electricity, and Magnetism: F. Jenkin (Longmans).—Critiques and Addresses: Thomas Huxley (Macmillan & Co.)—The Familiar History of British Fishes: Frank Buckland (published by the Society for promoting Christian Knowledge).—The Cruise of the *Curacoa* among the South Sea Islands, 1865: J. C. Brenchley (Longmans).

Foreign.—Zeitschrift fur Biologie, Part 1, Vol. ix.—Zoologische Botanische Gesellschaft in Wien, Vol. xxii., 1872.—Die Naturkräfte, Munich. Edited by Dr. K. A. Zittel.

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