THURSDAY, MARCH 28, 1878

SCIENTIFIC WORTHIES

XII.—William Harvey,[1] Born April 1, 1578, Died June 3, 1658

WILLIAM HARVEY was born three hundred years ago, on the first of April, 1578, at Folkestone, in Kent. He was the eldest son of his father; who seems to have been a substantial farmer, wealthy enough to send his eldest son to the university and to embark his five other male children in the mercantile pursuits in which they all acquired riches. At sixteen, Harvey was sent to Caius College, Cambridge, and graduated B.A. at nineteen. But, desiring to become a physician, Harvey wisely determined to proceed with his medical studies at one of the great continental seats of learning; and, by good hap, chose the University of Padua, which had been famous for a long succession of admirable anatomists, among them Vesalius and Fabricius of Aquapendente, who was the incumbent of the anatomical chair in Harvey's time.

After five years' study at Padua, Harvey took his doctor's degree in 1602, returned to England, and obtained the doctorate of his own university. In 1604, he married, began practice in London, and five years afterwards became physician to St. Bartholomew's Hospital. In 1615, Harvey was elected "Professor of Anatomy and Surgery" by the College of Physicians, and his first course of lectures was delivered in 1616. It is possible that he expounded his ideas respecting the circulation of the blood on this occasion; but, in this case, it is not obvious why he himself, in the dedication of the "Exercitatio Anatomica de Motu Cordis et Sanguinis," published in 1628, should not have said so. On the contrary he writes:—

"Meam *de motu et usu cordis et circuitu sanguinis* sententiam E.D.D. antea sæpius in prælectionibus meis anatomicis aperui novam; sed jam per novem et amplius annos multis ocularibus demonstrationibus in conspectu vestro confirmatam, rationibus et argumentis illustratam, et ab objectionibus doctissimorum et peritissimorum anatomicorum liberatam, toties ab omnibus desideratam, à quibusdam efflagitatam, in lucem et conspectum omnium hoc libello produximus."

Why "jam per novem et amplius annos," if he had really taught the circulation "per duodecim annos?" Harvey is so careful a writer that I cannot doubt he had a meaning in the use of the particular words he has adopted, and that he did not wish to lay claim to having enunciated his complete views before 1618 or 1619.

However this may be, the famous treatise itself was not given to the public until 1628, and its appearance conferred upon its author a fame which rapidly extended over the civilised world. James the First died in 1625, and it is, on the whole, pleasant to reflect that Harvey owed nothing to that foul pedant. But his son was a man of a different stamp, and whatever the verdict on his political deeds may be, shines as one of the few English sovereigns who have shown an enlightened sympathy with letters, with science, and with art. Harvey became Charles the First's physician about 1632, and the monarch repaid the real respect and affection with which his eminent subject evidently regarded him, in the only way for which Harvey was likely to care; namely, by doing his best to aid him in his investigations, and taking a cordial and intelligent interest in them.

Between 1630 and 1632, Harvey travelled on the Continent with the young Duke of Lennox; and, in 1636, he was physician to the Earl of Arundel's embassy to the Emperor. During this visit, he is said to have tried to convince Caspar Hofmann, of Nuremberg, of the circulation of the blood, experimentally, but in vain. When the troubles between the King and the Parliament broke out, Harvey accompanied his master in his campaigns He was at the battle of Edgehill, in charge of the Prince of Wales and the Duke of York; and he told Aubrey that "he withdrew with them under a hedge, and tooke out of his pockett a booke and read. But he had not read very long before a bullet of a great gun grazed on the ground neare him, which made him remove his station."

By the King's order, Harvey was elected Warden of Merton College, Oxford, in 1645; and to the same efficient cause, or to the fact that he was the King's physician, we must probably look for the conference of an honorary degree by the University of that day on a mere scientific discoverer. But, after the surrender of Oxford in the following year, Harvey retired from public life altogether, and spent the remainder of his days at the homes of one or other of his brothers, in the neighbourhood of London.

In 1649 Harvey, published his two letters to Riolan, which form a supplement to the "Exercitatio Anatomica;" and, in 1651, when he had reached the ripe age of seventy-three, the "Exercitationes de Generatione" appeared. "The rest is silence," save a few letters. In the last of them we have, dated April 24, 1657, he writes to Vlackveld:—

"Frustra autem calcar mihi addis, ut in ætate hac, non solum matura, sed etiam fessa, ad aliquid noviter moliendum me accingam. Videor enim jam mihi, meo jure, rudem deposcere."

No man had a better right to claim an honourable discharge from duty. Six weeks later the wished-for release arrived, and on June 3,

Spectatum satis et donatum jam rude,

Harvey died in the eightieth year of his age, full of honours as of years, more than sufficiently wealthy, and able long before his death, to say that the great truth he had discovered and taught was accepted by all whose opinion was worth having.[1]

The only works which Harvey published are the famous treatise on the Circulation (1628), with the two letters to Riolan (1649), and the "Exercises on Generation (1651)." But he was a most diligent observer and writer, and he incidentally refers to a "Disquisition on the Causes and the Organs of Respiration," to "Medical Observations," to a treatise "On the Generation of Insects," and to many observations on Comparative

[1] The portrait of Harvey will be presented to our readers in one of the May numbers of NATURE. Though every facility has been afforded by the College of Physicians, there has been unavoidable delay in its preparation. ED.

[1] "Circuitum sanguinis admirabilem, a me jampridem inventum, video propemodum omnibus placuisse: nec ab aliquo quippiam hactenus objectum esse, quod responsum magnopere mereatur.'—*Exercitationes de Generatione*, Ex. lii.

Anatomy, the whole of which appear to have been destroyed when his house was plundered with the connivance, if not by order, of the Parliament, during his absence from London with the King.

Of the "Exercitatio de Motu Cordis et Sanguinis," I have treated so fully elsewhere [1] on a recent occasion, that I will again not touch upon the subject except so far as to repeat that, in my judgment, Harvey is entitled, beyond dispute, to be regarded as the sole discoverer of the circulation of the blood, and of the method of its propulsion by the heart.

The story of the extraction of the manuscript of the "Exercitationes de Generatione" from Harvey is well told by Ent, who undertook the charge of seeing the work through the press; a task of no small magnitude if we consider the superlative badness of the extant specimens of Harvey's handwriting.

The preface contains a singularly interesting disquisition on scientific method; and, among other observations the following, which is, perhaps, the weightiest in small compass ever laid before the student of physical science.

"For those who read the words of authors, and to whom impressions of their own senses do not represent the things signified by those words, conceive, not true ideas, but falsæ eidola and inane phantoms; whence they fill their minds with shadows and chimæras, and their whole theory (which they think to be science) represents but a waking dream or a sick man's delirium."

As in the case of the circulation of the blood, the scientific opinions of the day respecting the conditions of generation and the embryogenic process had descended from the Greeks. No one doubted that a large proportion of the lower forms of life owed their origin to equivocal or spontaneous generation, or, as it is now termed, abiogenesis; and, with respect to sexual generation, it was believed that the embryo originated at the time of sexual union, by the combination of two substances poured out *ad hoc*, the one being derived from the female, the other from the male parent. In this opinion both Aristotle and the Medici, following Galen, agreed; but they differed in the view which they took as to the nature and function of the two sexual elements. According to Aristotle, the female supplied merely the material of the embryo, by the excretion of a substance which he regarded as the purest part of the catamenial blood; this was coagulated, and endowed with the faculty of developing into an organism, by the spermatic fluid, of the male. The Medici, on the other hand, considered that the female produced a true spermatic fluid, analogous to that of the male, and having an equal formative energy; and indeed, that the sex of the embryo was determined by the predominance of the one or the other spermatic fluid.

As regards the embryogenic process itself, the Greeks had studied the development of the chick, and had learned somewhat respecting the fœtal state of viviparous animals; while, since the revival of learning, several important embryological investigations had been undertaken. Of these the most notable were those of Aldrovandus, of Coiter, of Harvey's master, Fabricius of Aquapendente, of Vesling, and of Parisanus, on the development of the chick. Fabricius' treatise, "De Ovo et Pullo," was accompanied by figures of the stages of development, which, for the time, must be termed very good; and it served Harvey as a sort of text-book, to which he constantly refers.

The "Exercitationes" show no advance on the knowledge of the ancients respecting the conditions of generation. Innumerable passages show that Harvey believed, as firmly as his predecessors and contemporaries did, in equivocal generation.[1] The persistent ascription to Harvey of the contrary opinion is simply astounding, and can only be explained on the supposition that those who quote what they are pleased to call "Harvey's aphorism," "Omne Vivum ex Ovo," against the holders of the doctrine of spontaneous generation, have never read the works of their authority.

I cannot discover the exact phrase "omne vivum ex ovo" anywhere in Harvey's works, though it is true that the sense of the words is expressed by him over and over again. But the context shows his meaning to be, not the assertion of the doctrine of biogenesis; but simply a declaration that, in whatever way a living being is generated, the nature which it at first possesses is that of an egg. And what Harvey wants to impress, by the frequent iteration of his opinion on this subject, is the difference between his view, that a germ is something which comes into existence more or less as a unit and has an individuality of its own, and that of his predecessors, who held that it is formed by the coalescence of separate entities. Nevertheless, there is an indication that Harvey was on the right track in respect of the question of spontaneous generation; and that, if his papers on the generation of insects had not been destroyed, he might have anticipated Redi; for the forty-first exercise contains the following remarkable passage:—

"But on these matters generally we shall have much to say, when we shall show that many animals, especially insects, take their origin and are generated from elements and seeds so small as to escape observation (like atoms floating in the air), which are scattered and dispersed hither and thither by the winds; yet these animals are supposed to arise spontaneously, or from putrefaction, because their germs are nowhere to be found."

It was exactly this thesis that Redi adopted and proved to demonstration, seventeen years afterwards, and therefore long before Harvey's death; and it is by following up the same line of argument that modern investigators have deprived abiogenesis of its last supposed experimental evidence. In whatever way, however, the germ of a plant or of an animal is produced it is the equivalent of an egg, and what Harvey means by an egg is clearly shown, in the following as in many other passages:—

"In the generation of all living things (as we have said) this is established, that they arise from some primordium (primordio aliquo) which contains not only the matter but the power of generation; and is, therefore, that out of which and from which the thing generated takes its origin. Such a primordium in animals (whether they proceed from parents, or arise spontaneously or out of putrefaction) is a humour contained in a membrane of some kind, or shell; in fact, a homogeneous body (corpus nempe similare) possessing life, either actually or poten-

[1] "William Harvey," *Fortnightly Review*, February 1, 1878.

[1] I pointed this out twenty years ago in my "Lectures on General Natural History," published in the *Medical Times and Gazette*. Take one passage out of fifty that might be cited: "Atque etiam terra suâ sponte plurima generat sine semine" (Exercit. xxix.). M. Pouchet might have taken this sentence for a motto.

tially. This primordium, if it is generated within an animal and remains there, until a like animal (univocum) is produced, is vulgarly called a *conception;* if, however, it is thrust out by parturition, or if it has originated elsewhere by chance, it is termed an *ovum* or *vermis.* I think, however, that, in either case, that from which an animal arises should be called primordium; just as plants produce their young from seeds; and that all these primordia are of one kind, namely, living things.

"I find a primordium of this sort in the uterus of all viviparous animals, before any fœtus can be discerned. In fact, there is a clear, viscid, white [colourless] fluid, like the white of an egg, inclosed in a membrane, which I term the egg of these animals; and, in red-deer and fallow deer, in sheep and other cloven-footed animals, it fills the whole uterus and both its cornua."[1]

It will be observed that, in the foregoing passage, Harvey insists upon one main quality of the primordium, namely, that it is a *corpus similare;* or, in other words, that it is relatively homogeneous; and, in the seventy-second exercise, "De humido primogenio," he insists strongly on what he believes to be the fact that the embryo takes its rise in a certain "humidum radicale et primigenium," "simplicissimum, purissimum et sincerissimum corpus," in which all the parts of the embryo are present potentially, but not actually, and out of which they arise by a gradual process of differentiation.

"The first rudiment of the body is a mere homogeneous and soft jelly, not unlike a spermatic coagulum, which, becoming changed (in accordance with the law of generation) and at the same time split or divided into many parts, as by a divine command, as we have said (let bone arise here, muscle or nerve there, here viscera, there receptacles of excretion, &c.) out of the inorganic arises the organic, out of the similar the dissimilar; out of the one and the same nature, many things of diverse and of contrary natures; not, indeed, by any transposition or local motion (as when by the power of heat homogeneous things unite, or heterogeneous things are separated), but rather by the disaggregation of homogeneous things, than by the aggregation of heterogeneous things."[2]

In this passage, as in those in which he advocates *epigenesis*, Harvey shows a complete grasp of the great truth that development is a gradual process of change from relative homogeneity to heterogeneity, put into such clear light in our own time by Meckel and von Baer.

Again, when Harvey dwells upon the close resemblance of the early conditions of the higher animals, and accounts for harelip as a retention of an embryonic condition, we see him hovering on the brink of some of the most important embryological generalisations of a century and a half after his time.

After Harvey, embryological theory distinctly retrograded for a full century, until, in fact, a hundred and eight years had elapsed, and, in 1759, Caspar Friedrich Wolff published his "Theoria Generationis." In the interval, the great truths laid down by Harvey, that all germs are homogeneous relatively to the forms to which they give rise, and that all those of the higher animals, at any rate, pass by *epigenesis* into the perfect living thing—"Fabrica a parte aliqua tanquam ab origine incipit: ejusque ope reliqua membra adsciscuntur: atque hæc per *epigenesin* fieri dicimus: sensim nempe partem post partem: estque isthæe, præaltera, proprie dicta generatio" (Exercitatio xlv.); these verities, justified by all our present knowledge, were ignored, and the doctrine of the "pre-existence of germs" and of "evolution" took their place. And so strong was the hold of the latter, that even Wolff's conclusive investigations produced little effect, and the full acceptance of Harvey's generalisations dates from the last half-century.

But while Harvey's views respecting the general nature of the embryogenic process were as much in advance of his time as were his doctrines respecting the motion of the heart and the circulation of the blood, his demonstration of them is a failure, the phenomena being too subtle and recondite for the means of investigation which he possessed.

So far as the process of fecundation is concerned, he is further from the truth than were the Greeks; for he steadily denies that the male element enters into the substance of the egg, or even comes into physical contact with it; and he ascribes the efficacy of the male to a sort of contagion, by which the female organism is infected, and in consequence of which, the ova, which he justly declares to be formed like any other growth, acquire the property of developing into embryos.

Again, though Harvey's discovery, that the region of the cicatricula in the hen's egg is the seat of the changes which give rise to the embryo, was of primary importance, he has not the least notion of the real nature of the cicatricula or of its relations to the yolk. The "primigenial radical humour," which he supposes to be the first commencement of the embryo, is nothing but the amniotic fluid, which is really formed long after the rudimentary body of the chick has appeared. And Harvey's supposition that the blood is that which is first formed and that the substance of the body grows round the vessels "like a mucor or fungus," is an error, which is, of course, enormous, and may seem unpardonable to any one who has not tried to make out the early stages of the development of the egg with the naked eye, or even aided by a hand-glass. It was the discovery that the rudiment of the body of the chick exists in the egg, long before Harvey supposed, that was one of the chief causes of the adoption of the notion of the pre-existence of germs which led to the "evolution" and "*emboitement*" hypotheses. Buffon, in fact, went so far as to say that the chick "exists fully formed (*en entier*) in the middle of the cicatricula when the egg leaves the body of the fowl,"[1] thereby erring as far as Harvey did, but in the opposite direction.

After due deduction is made for these errors and shortcomings, however, the great merit of having been the first to grasp the true principle of interpretation of the process of development, must, I think, be accorded to Harvey; and if we consider the part which the study o development has played, and must henceforward continue

[1] "De Uteri Membranis et Humoribus." Elsewhere (Exercitatio xxvi.) Harvey says:—

"Ovum itaque est corpus naturale, virtute animali præditum: principio nempe motûs, transmutationis, quietis, et conservationis. Est denique ejusmodi, ut, ablato omni impedimento, in formam animalis abiturum sit; nec magis naturaliter gravia omnia, remotis obstaculis, deorsum tendunt; aut lævia sursum moventur: quàm semen et ovum in plantam aut animal, insita a naturâ propensione, feruntur. Estque semen (atque etiam ovum) ejusdem fructus et finis, cujus est principium atque efficiens."

[2] Ex. lxxii. "De humido primogenio."

[1] Buffon, "Histoire Naturelle," t. ii., ed. 2, 1750, p. 351.

to play in biology, the "Exercitationes de Generatione," though second to the "Exercitatio Anatomica," can hardly be said to have another rival in the contemporary literature of biological science.

Modern morphology, no less than physiology, has its root in the work of William Harvey. T. H. HUXLEY

ZÖLLNER'S SCIENTIFIC PAPERS

Wissenschaftliche Abhandlungen (Erster Band). Von F. Zöllner. (Leipzig: L. Staackmann, 1878.)

IF we take a somewhat different course in reviewing this work from that which we should naturally adopt with works professedly scientific, we hope at least to justify our conduct to the reader before we finish. For, alas, all is not scientific that professes to be science, and even celestial minds can harbour very curious feelings and express them with most unmistakeable vigour, while not always striking above the belt.

The key-note of this work, as well as of a great deal of the other somewhat voluminous writings of Prof. Zöllner, is struck by himself in a foot-note to p. 129, where he tells us that "the aim of all his scientific efforts has been to contribute, as far as the ability given him permits, to the realisation" of a certain "hopeful project":—viz., the explanation of *all* molecular actions by means of that Law of Electric Attraction (due to W. Weber) which "has already been so fruitful in cöordinating under one principle all electric and magnetic phenomena."

Very good and laudable:—though we may permit ourselves to say, in passing, probably very unpromising. But it is quite impossible to say what hints a competent mathematician may not obtain while he is attempting to prosecute the applications of any theory—however remote its principles may be from those which the experimental facts themselves suggest to the physical investigator in his laboratory. Unfortunately even this concession is thrown away upon Prof. Zöllner:—for he not only does not claim to be considered as a mathematician, but has on a former occasion (in his work on *Comets*) expressly denounced those who attempt "by differentiating and integrating" to get at natural laws. He is, as Helmholtz long ago said, a *genuine* Metaphysician, and (as such) is a curiosity really worthy of study:—not of course merely because he is a Metaphysician, but because in this nineteenth century he attempts to bring his metaphysics into pure physical science.

To a man whose whole object in scientific life is the establishment of Weber's Law as the fundamental fact of the Kosmos, of course all works are an Abomination in which even an attempt is made to show that *action at a distance* can be (and therefore *ought* to be) dispensed with. Hence Clerk-Maxwell's Theory, which, even its opponents must allow, has succeeded at least as well as Weber's in connecting and explaining the phenomena of electricity, magnetism, and light, must be demolished at all hazards. But the reader of Maxwell's great work on *Electricity*, who has seen in its very *Preface* that the main object of that work was to carry out to their legitimate mathematical developments the physical ideas of Faraday, will scarcely be prepared to find that Prof. Zöllner accepts Faraday and denounces Maxwell!

This *tour de force* is worthy of so accomplished a metaphysician. It is absolutely refreshing in its coolness! According to Prof. Zöllner, both Clerk-Maxwell and Sir W. Thomson (to whose advice the former owns his indebtedness) quote Faraday correctly, and yet altogether misapprehend his meaning! In fact we are now told, though not in so many words, that Faraday, whom we had all looked on as an opponent of action at a distance, was really a firm believer in it, and a strenuous advocate of it! Not only Faraday, but even Newton himself:—in spite of the celebrated *Letters to Bentley*, in which all of us have hitherto read the inconceivability of distance-action to any mind which "has in philosophic matters a competent faculty of thinking"—even Newton himself, it seems, believed in action at a distance!

On this no farther comment is necessary than one I made some time ago, when Prof. Zöllner, to his own satisfaction at least, proved me to be ignorant alike of Latin and of the very *First Law of Motion*;—viz, that "Prof. Zöllner should not attempt to criticise . . . until he acquires sufficient knowledge of British technical terms . . ."

That a good deal of Prof Zöllner's censure is due to his imperfect apprehension of English, will, I think, be allowed by every candid reader. I say nothing of numerous misspellings—sometimes ludicrous, such as "*in his sobber* (*sic*) *senses*"—which occurs twice at least (pp. 142, 711), because there are quite as many misspellings in the German, and all are, therefore, probably due to the printer. But it is a wonderful piece of information for us benighted islanders to be told that our foremost scientific men, while quoting Newton accurately, entirely miss, or rather misrepresent, his meaning. So wonderful that I certainly shall not be believed, unless I refer definitely to some of the inculpatory passages:—

[The passage (pp. 141–152) is too long for translation, so I give a small part only; restricting myself to the *tone* in which British authors are spoken of, for the *substance* of the accusation, such as it is, has been already indicated.]

"One's impaired power of discovering contradictions prevents his recognising them as such even when the effect of the contrast is heightened by juxtaposition. Hence we must ascribe the non-retractation of such by their authors not to moral weakness but to incapacity. Hence also the surprising *naïveté* with which such men (*i.e.*, Sir W. Thomson, Clerk-Maxwell, *et hoc genus omne*) hand over to their critic the weapons with which to exterminate them, &c., &c. He who thinks it superfluous to bother himself with the thoughts of his predecessors and contemporaries loses *ipso facto* all right to consideration for himself and his writings. Such an author will in after time be forgotten, just as he has forgotten his predecessors, and this in the name of Eternal Right. For, only in the continuity of the mental work of successive generations is there security for the progress of Humanity!"

The reader of this will perhaps think that he has seen enough of Prof. Zöllner and his work:—enough at least to enable him to form a pretty shrewd guess as to the scientific value of the whole. But I must be excused if I trouble him with a few additional remarks on another aspect of the book.

Some years ago Prof. Helmholtz kindly undertook to revise the German translation of *Thomson and Tait's Natural Philosophy*, and was in consequence somewhat wildly attacked by Prof. Zöllner in the *Preface* to his book on *Comets*. To that attack Prof. Helmholtz replied in a very admirable article, of which a translation has already appeared in NATURE (vol. xi. pp. 149, 211).

The great crime which according to Prof. Zöllner was committed, was a double one. Sir W. Thomson and I ventured to express an opinion (to which we still adhere) unfavourable to theories such as that of Weber:—and Prof. Helmholtz so far forgot his duty as a German as to be responsible for the reproduction of our work in his native tongue! As we now know that the promulgation and extension of Weber's Theory has been the object of Prof. Zöllner's life-work, perhaps it was not unnatural that he should complain of such conduct. But it is quite another thing when, after being completely demolished from the *scientific* point of view, he returns to the attack in another style—bringing against the various persons named charges of a totally different character—though all equally groundless.

A great many of these arise undoubtedly from imperfect acquaintance with the English language. Thus, to take a ludicrous one, Prof. Zöllner evidently imagines that "smoke-rings" *must* be formed with tobacco-smoke? And he fancies that it was in a smoking party that Sir W. Thomson hit upon his hypothesis of vortex atoms. For, after translating part of Thomson's own account of his theory, he says that a "skilled and powerful tobacco-smoker was necessary to the experimental verification of it."

Smokers, to whose charmed circle Prof. Zöllner evidently does not belong, can alone judge how skilled and powerful they would have to become before they could produce from their own lips the vortex rings, *full of sal-ammoniac crystals* and somewhere about six or eight inches in diameter, which Sir W. Thomson describes in the paper referred to. But Prof. Zöllner comes back to this notion, as he does to others, with absolutely "damnable iteration." Here is an instance (p. 103) which we paraphrase as follows:—

"The reader will note that 'Tobacco-smoke' and a 'creative act' are the inseparable companions of Thomson's Vortex-atoms:—although in the whole of Helmholtz's paper, on which Sir W. Thomson has erected the airy structure of his hypotheses, there is not a single passage in which such things are alluded to.

"Since Sir W. Thomson and the mathematical supporters of his hypotheses continually employ tobacco-smoke for the explanation of their views, I also may be permitted to employ the same medium to make clear my notions. Were I to describe the feelings with which I crossed the threshhold of the Vortex-world of Thomson after leaving the clear and bright Thought-world of Newton, Kant, and Faraday, I could not succeed better than by comparing them to those of the Alpine traveller who leaves the enlivening freshness of the clear mountain air to enter the tobacco-laden atmosphere of a muggy beerhouse!"

We next have Thomson's (and Helmholtz's) speculations as to the origin of life on the earth:—once more overhauled and torn to shreds. Then the unfortunate "luminous corpuscle" of Thomson and Tait has again to perform its antics—but in a somewhat new phase. For it is now shown to be due to the same inaccuracy of thought (Denkfehler) as the "moss-grown fragments."

"Only the yet undeveloped understanding of a child can content itself with such hypotheses, as it does with the answer to the child's question, 'Where did the new-born little brother or sister come from?' The mother soothes the childish causation-excitement with the answer, 'The Stork brought it':—on the correct presumption that the child will not farther inquire whence or from whom the Stork received the infant."

So far as I can judge without an attentive perusal of the whole 732 pages of the work (*Erster Band*), such as, amusing though it is throughout, I cannot spare time to bestow, Prof. Zöllner seems to think that Clerk-Maxwell, Thomson, and myself *believe in the existence* of those imaginary beings (invented by Maxwell, and called *Demons* by Thomson) who were introduced for the purpose solely of showing the true basis on which the Second Law of Thermodynamics has to be received as a fact in physical science! Hence we are treated to a whole Chapter called "*Thomson's Dämonen und die Schatten Plato's*."[1]

But it was well that this Chapter should be written. For Prof. Zöllner has recorded in it a discovery *of the very first order*:—if it be correct. He has held the two ends of a cord (sealed together) in his hand, while trefoil knots, *genuine* IRREDUCIBLE TREFOIL KNOTS, of which he gives us a picture, were developed upon it! He shows us the reasoning by which he was led to predict the possibility of this very wonderful achievement—absolutely unique in character, so far as I know, throughout the whole range of science. Prof. Klein, of Munich, some time ago showed, as is well known, that knots cannot exist in space of four dimensions. Hence Prof. Zöllner was led to conclude that beings (not, of course, *Thomson's Dämonen* nor *die Schatten Plato's*, for these are unscientific, and therefore impossible) in space of four dimensions could put an irreducible knot on an earthly string of which the ends were fastened together! It is some time since the Astronomer-Royal for Ireland told me *his* jocular mode of arguing from Klein's discovery:—viz., that all the secrets of the spiritualistic "rope-trick" could be at once explained by supposing that *inside* the mysterious cabinet (in which the tambourines and the musical boxes fly about) space was of four dimensions—so that the well-corded performers were at once loosed from their bonds on entering it! But Prof. Zöllner (with the assistance of the spiritualists) has tied knots by means of beings who exist in four dimensional space!!! Those who tied can of course loose, so that there is now (thanks to Prof. Zöllner and the spirits) no such thing as an irreducible knot!

I need say nothing of the treatment which Prof. Zöllner bestows on other scientific men with whom he has the misfortune to disagree: such as the imaginary *execution-scene* (pp. 377–416) of a distinguished Physiologist! Plain men in this country, and in Germany also I doubt not, have uncomfortably plain terms for such outbursts. But such things are not for a scientific journal. I can hardly divest myself of the impression that Prof. Zöllner, in spite of his oft-expressed utter detestation of "Jokelets" of all kinds (Witze, Scherze, &c.) has been led by his feelings of "sittlicher Entrüstung" to attempt the perpe-

[1] This is not the place to continue discussions with Prof. Clausius, but the reader of Prof. Zöllner's book should be warned that, extensive as is his reading, it does not always seem to include the most cogent arguments which have been presented on one or other side in several controversies of which he undertakes to give an account.

tration of a gigantic joke upon his readers. For I have looked in vain through this large volume for anything that can well be called *Science;* with the one exception of some remarkable experiments due to Fresnel, to which it is well that attention has been called.

In conclusion, though I cannot make pretensions to any minute acquaintance with the German language, I think I may venture to suggest to Prof. Zöllner, for his next edition, a title which shall at least more accurately describe the contents of his work than does his present one. I cannot allow that the title "Scientific Papers" is at all correctly descriptive. But I think that something like the following would suit his book well:—

Patriotische
METAPHYSIK DER PHYSIK,
für moderne deutsche Verhältnisse.

Mit speciellem Bezug auf die vierte Dimension und den Socialdemokratismus bearbeitet.

With this little hint, which I hope will be taken, as it is meant, in good part, I heartily wish him and his work farewell.

P. G. TAIT

A DICTIONARY OF MUSIC

A Dictionary of Music and Musicians. By eminent writers, English and Foreign. With Illustrations and Woodcuts. Edited by George Grove, D.C.L. (London: Macmillan and Co., 1878.)

NO better proof of the spreading interest in musical subjects which is now taking place in England could be found than the publication of this important work. Although similar "Lexicons," some of them extending to the portentous dimensions which German monographs are apt to assume, are not uncommon in that country, there have, as far as the writer knows, been hitherto none in our language which exactly occupy the position aimed at by this. Those which most nearly approach it, are either somewhat antiquated, or, like the excellent little work of Dr. Stainer, propose to themselves a far more restricted object. Nor indeed is the reason of the difference in this respect between the two countries difficult to assign. In Germany the whole population is more or less musical; every little town or village has abundance of practical musicians, mostly playing stringed instruments, among its inhabitants, who not only can take their part efficiently in a quartette, or in a local orchestra, but who are sufficiently informed in musical theory and literature to furnish an intelligent public which can support and encourage extensive undertakings of a scientific and historical character.

In England, on the other hand, unlike Germany, there has been, until quite lately, as little of representative musical culture as there has been of really national soldiering. We had been content to leave the defence of our country, no less than the executive realisation of great artistic master-pieces, to a separate and stipendiary class; while the bulk of the nation had merely "assisted," according to the French sense of the word, by listening and applauding. In both instances we, to a considerable degree, realised the dreams of Plato's Utopia; and though in the one case our φύλακες, the army, in spite of its small size and its professional leaders, for education and gallantry are probably unparalleled, it is, perhaps, to be feared that the artistic class, the μουσικοί, have somewhat suffered from isolation and lack of responsibility.

To this cause, and to unthinking prejudice, must be referred the tone of depreciation if not of contempt, which in the last century attached to the name "fiddler." It is conspicuous in the "Tweedledum and tweedledee" epigram of Handel's day, and frequently crops out in the Johnsonian, and even in later periods. The altered feeling of the present day cannot be better illustrated, than by the public estimation of Rubinstein or Joachim, or the genuine national grief at the early death of Titiens.

But the reform in the republic of sweet sounds must come, and is coming, *ab extra.* Audiences themselves must be fairly proficient in an art to esteem its higher developments and manifestations. The supply, according to the laws of political economy, must precede the demand; nor can true æstheticism of any kind fully prosper until the bulk of the population have been educated up to its intelligent and critical comprehension. For the moment it may be that in this particular branch the outsiders have distanced the regular executants. It would be a severe, but not altogether false statement to make, that in modern England—which has really become a musical nation—all classes are musical except the musicians. It is certain that our grandest celebrations, such as those of Handel and that at Leeds, are festivals where the latter are only secondary to the hearty and enthusiastic willingness of a voluntary but well-disciplined non-professional choir. Indeed it might, *à priori,* be anticipated that such would be the case, since the fondness for music, although it may be materially developed by circumstances and education, still remains very much of a gift; and this gift, which forms the strongest motive to exertion in acquiring it, is far more likely to exist in one who turns to the subject from love than in those who have simply adopted its study by chance, or as a means of earning a livelihood.

That such is to a certain extent the fact, receives ample illustration from the very first page of Mr. Grove's initial number, in which are recorded the names of the contributors to the work. Including the editor himself, who, though not a professional musician, has earned, under the familiar initial which he here again adopts, a full title to speak with knowledge and authority on musical subjects, a large proportion of the writers are not dependent on the art or practice of music for their social status. Among them will be found clergymen, a consul, a colonel, a doctor, an engineer, a Queen's counsel, a schoolmaster, and many others, whose devotion to the cause of music must be purely voluntary and a labour of love. As it cannot be doubted that all alike have given proofs of their competence to undertake the task entrusted to them, it is surely no forced conclusion to regard their co-operation as evidence of the depth to which educated English society is now penetrated by this subtle and once neglected branch of æsthetic culture. To the same class, moreover, the work appeals for support, a support which is more than justified by the laborious care, the painstaking and punctilious accuracy displayed by the editor in its compilation.

The present instalment of the work is the first of a series of quarterly parts, and only contains the letter A, with part of letter B. On turning over the pages the articles which attract the eye are one on ABBREVIATIONS in music and one on ARPEGGIO, by Mr. Franklin Taylor; an interesting account of the ACADÉMIE DE MUSIQUE, by Mr. John Hullah; an excellent little treatise on ACCENT in music, with abundant musical examples, by Mr. Ebenezer Prout; another on ACCENTS in plain song, by the Rev. Thomas Helmore; instructions as to ACCOMPANIMENT, by Mr. Hopkins, of the Temple, supplemented by another article on ADDITIONAL ACCOMPANIMENTS, by Mr. Prout; ÆOLIAN HARP is from the pen of Mr. Hipkins; ANTHEM is given by Dr. Monk, of York; ARRANGEMENT, by Mr. Hubert Parry; BAGPIPE, by the writer of this notice. In the biographical department, which is especially full, a long and exhaustive account of the BACH family, by Herr Maczewski of Kaiserslautern, stands foremost. There are also interesting notices of ADOLPHE ADAM and of AUBER, by Mr. Franz Hueffer; of many Italian composers, by Mr. Edward H. Pember, Q.C., of DR. ARNE, and of ATTWOOD, by Mr. Husk, Librarian of the Sacred Harmonic Society; of DR. ARNOLD, and a sympathetic biography of MICHAEL BALFE, by the late Dr. Rimbault. Sir Frederic Ouseley and the Editor contribute several smaller notices. The names of English musicians appear to have received especial attention.

There can be no hesitation in saying that the work just commenced promises to fill a gap in English bibliography, and that it furnishes excellent material for reference. Besides this, it presents the collateral advantage of offering a charming combination of amusement and instruction for desultory reading in the many *horæ subsecivæ* which occur even in the lives of the most busy.

W. H. STONE

OUR BOOK SHELF

Pioneering in South Brazil. Three Years of Forest and Prairie Life in the Province of Paraná. By Thomas P. Biggs-Wither. Two vols. With Map and Illustrations. (London: John Murray, 1878.)

MR. BIGGS-WITHER has written two volumes of genuine and varied interest and much instruction, as a result of his three years' work in a little-known region of South Brazil. He went out as one of an engineering party to open up a road between the Atlantic and Pacific, and he traversed much of the country on the banks of the rivers Ivahy and Tibagy, tributaries of the Paraná. Much of his time was spent in the forests of this region, virtually unexplored, and presenting a splendid field for any enterprising naturalist. Mr. Wither is an excellent observer, and his book abounds with information on the natives, the natural history, and physical geography of the region. He met with many adventures, and suffered much from heat and insects, but altogether he seems to have had a thoroughly enjoyable time of it. He writes throughout in an attractive and simple style, and his work must be regarded as an important contribution to a knowledge of the luxuriant region with which it deals.

LETTERS TO THE EDITOR

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

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

The Phonograph

WE shall be much obliged if you will allow us to draw the attention of your readers to a curious fact which the phonograph has allowed us to prove, and which we announced last Monday at a meeting of the Royal Society of Edinburgh. We have seen no mention of the fact elsewhere.

Not only are vowels unaltered by being spoken backwards, but the same fact is true of consonants. Whether the pulsations of air be made in a given order or in the reverse order the ear accepts the sound as indicating the same letter. This is true of all the simple vowel sounds and of all the simple consonant sounds, including of course several combinations which in English are spelt with two letters, as *th* or *ng*, but which are really simple consonants.

We tried the experiment on single pairs of syllables separated by a single consonant, as *ada*, *aba*, *aja*, *etc.* A person coming from outside and ignorant of what consonant had been spoken was able to identify the consonants quite as well backwards as forwards. The chief difficulty was found in distinguishing *affa* from *assa*.

We find that this peculiarity is not limited to consonants between vowels, but that *ab* said backwards becomes *ba*. We have here a standard as to what does really constitute a single letter or element of articulate speech; it is any one reversible part. Your readers who possess a phonograph may most easily verify this observation by saying a word backwards, and hearing the phonograph say it intelligibly forwards; for instance, *noshäeesossa* produces *association* beautifully.

We shall be glad to learn whether this fact has been already published, and also whether it was foreseen as a possibility by any writer.

FLEEMING JENKIN
J. A. EWING

Edinburgh, March 25

The Age of the Sun's Heat in Relation to Geological Evidence

1. IT is an admitted fact that the age of the sun's heat will not harmonise with the evidence of geology, on the supposition that this heat was *solely* derived from the approach of matter under the action of gravity. Dr. James Croll, in dealing with this question in a recent number of NATURE,[1] has suggested the existence of a previous proper motion in the colliding matter that formed the sun, whereby, in accordance with accepted physical principles, a store of heat adequate for any period might have been provided. However a difficulty is raised here by Dr. Croll, in the *Philosophical Magazine* (May, 1868), where this question is first dealt with, and as this difficulty would seem on examination not to be insurmountable, I venture to call attention to the subject here, more especially as attendant questions of interest would seem to attach to it.

2. Of course it is admitted that the age of the sun's heat is the limit to conditions of life on the earth, and the point in question is that if the sun had acquired such a store of heat as geological time would appear to demand, then the sun must have been (owing to the excessive heat) a very extensive nebula, probably extending far beyond the limits of the present solar system, and consequently, that even if such a store of heat had existed in the sun, it would not be available for geological time, since the earth could not then have existed as a separate planet, from the fact that the solar nebula would then have extended beyond the limits of the earth's present orbit. Dr. Croll says (p. 372): "But if the sun had originally possessed the amount of energy supposed, then his volume would have extended beyond our earth's orbit, and of course our earth could not at that time have existed as a separate planet." This, therefore, puts a difficulty in the way of the sun having possessed such a store of heat as would be available for geological time. The accepted principles of Laplace are, of course, admitted here, according to which the earth originally formed part of the nebulous mass of the sun, and became naturally detached through the rotation of the nebula at its contraction.

3. Here it seems to have been tacitly assumed (according to the quotations above given) that the present orbit of the earth was its *original* orbit. Is there, however, any necessity for assuming this? For in this lies all the difficulty. Are we not rather warranted in inferring from accepted principles that the present orbit of the earth was *not* its original orbit. For it is an admitted fact that resisting media (the ether, &c.) exist in space, by which, through friction, the orbits of the planets are gradually becoming contracted, so that they slowly approach the sun. It is a mere question of *time*, therefore, for the earth to have come in towards the sun from any distance, or its original

[1] NATURE, vol. xvii. p. 206; also *Quarterly Journal of Science*, July, 1877

orbit might (for anything we can say to the contrary) have been beyond the present orbit of Jupiter. However slowly we may suppose the earth to be approaching the sun, yet in the vast epoch of time (which is precisely what is *necessary* in order to harmonise with geological evidence) it may have approached millions of miles towards the sun. There is one point of peculiar harmony here which is worth noticing in connection with this, viz., as the sun cools down or gives out less heat to the planets, so the planets reduce their distance from the sun; thus tending to equalise the heat conditions suitable for life. Thus, although the heat of the sun when first formed may have been enormously greater than it is at present, yet on account of the distance of the planets (including the earth) from it at that remote time, the conditions for life may have been as favourable as now, and thus the first geological changes may have commenced on the earth at that remote epoch when the sun was an incandescent nebula occupying a vastly greater volume than now (perhaps even the volume of the earth's present orbit), or under these conditions any interval of time for life on the earth that geological evidence may require is afforded.

4. There is another point that would appear to be of interest in connection with this subject. The *rate* at which a planet approaches the sun through friction in the media in space would depend (admittedly) on its mass, or would be greater when its mass is less. It follows evidently from this therefore that the great planets, Jupiter, Saturn, &c., must have approached the sun at a slower rate than the earth (or the smaller planets generally). It would follow therefore (more particularly in view of the vast epoch of time demanded by geology) that the *relative* position of the planets must have changed from this cause, that the earth, for example, must at one time have been nearer Jupiter than at present; more especially as the greater velocity of the earth in its present contracted orbit causes greater friction (and thereby brings the earth more rapidly towards the sun). Indeed it is an evident consequence of this principle that it would require only a certain relative *difference* in mass of the planets (or in the length of the elapsed time) to have made the small planets occupy positions *beyond* the larger planets originally, and so the positions of the planets to have been reversed, *i.e.*, the smaller planets *furthest* from the sun, and the larger planets nearest. The tendency of the friction evidently is to arrange the positions of the planets, so that the larger are furthest from the sun.[1] This it may be noted is the position at the present time. We do not of course mean to assume necessarily that there has been an actual reversal in the positions of the planets; all we adduce is that friction must inevitably tend to *change* relative position, when the masses of the bodies are different, and whether the positions are reversed depends therefore on the *time* during which this cause was in operation (and here we are considering especially the vast interval of time required by geology)—the change of relative position being more rapid the greater the relative differences of the masses. Thus it is a known fact that a meteorite approaches the sun or contracts its orbit at an enormously more rapid rate than a planet. It is so far certain that through friction in the medium known to exist in space, the planets (whose masses are different) must have changed to some degree their relative positions, or that the earth (for example) must have been nearer Jupiter at one time than it is now. These it should be observed cannot be regarded as speculations, but rather as deductions dependent on accepted principles.

5. Time may evidently have as great significance in physical as in geological changes, or in giving time its full import great results may follow; and it will be admitted that it is of interest to trace the slow operation of causes into their legitimate results through lengthened time epochs, not confining the attention to the infinitesimally narrow range of human experience.

London, March 21 S. TOLVER PRESTON

[1] It would seem a rather curious fact to note that those planets which contain within themselves the greatest store of heat (*i.e.*, the large planets), and which therefore would probably be the longest time before they were adapted to the conditions of life, are those which approach the sun the slowest. It is also evident that the fact of the earth being a *small* planet, would tend to augment the difference between the range of its present, and that of its original, orbit.

English Lake-dwellings and Pile-structures

GENERAL LANE FOX has described the old, and, in some cases, successive pile-works in the peat of Finsbury and Southwark, outside Roman London (*Anthropological Review*, vol. iv. No. 17, April, 1867, pp. lxxi. *et seq.*). Another very interesting case was evidently under Sir C. Bunbury's observation in 1856, near Wretham Hall, six miles north of Thetford, where, in a drained mere, "numerous posts of oak-wood, shaped and pointed by human art, were found standing erect, entirely buried in the peat." Red-deer antlers, both shed and broken from the skull, and also *sawn* off, were found in this peat. (See *Quart. Journ. Geol. Soc.*, vol. xii., p. 356.)

Since writing the above, I have been informed that Mr. W. M. Wylie, F.S.A., referred to this fact in "Archæologia," vol. xxxviii., in a note to his excellent memoir on lake-dwellings. I can add, however, that remains of *Cervus elaphus* (red deer), *C. dama ?* (fallow deer), *Ovis* (sheep), *Bos longifrons* (small ox), *Sus scrofa* (hog), and *Canis* (dog), were found here, according to information given me by the late C. B. Rose, F.G.S., of Swaffham; who also stated, in a letter dated August 11, 1856, that in adjoining meres or sites of ancient meres, as at Saham, Towey, Carbrook, Old Buckenham, and Hargham, cervine remains have been met with: thus at Saham and Towey, *Cervus elaphus* (red deer); at Buckenham, *Bos* (ox) and *Cervus capreolus* (roebuck); at Hargham, *Cervus tarandus* (reindeer).

The occurrence of flint implements and flakes in great numbers in the site of a drained lake between Sandhurst and Frimley, described by Capt. C. Cooper King, in the *Journal* of the Anthropological Institute, January, 1873, p. 365, &c., points also in all probability to some kind of lake-dwelling, though timbers were not discovered.

Lastly, the late Dr. S. Palmer, F.S.A., of Newbury, reported to the "Wiltshire Archæological Society" in 1869, that oaken piles and planks had been dug out of boggy ground on Cold Ash Common, near Faircross Pond, not far from Hermitage, Berks.

T. RUPERT JONES

Selective Discrimination of Insects

AS bearing on the question discussed by "S. B.," and by Mr. Bridgman and others, at p. 163 *ante*, and in previous numbers of NATURE, the following observations may have some interest. One day in the latter part of July, 1877, I took on a flower of red clover (*T. pratense*) an humble-bee (*Bombus Carolina ?*), having the hairs of its body and legs densely dusted with pollen-grains of an *Althæa*, which was in full blossom in the same enclosure, about one hundred feet from the spot where I took the bee.

On the same day and at the same place I attempted to take another *Bombus*, which was ravishing a flower of the same species of clover. It escaped me, and, flying to a distance of about twenty feet, alighted on a flower of a Canada thistle (*Cirsium arvense*), into which it immediately plunged its tongue. After watching it feed for a moment or two, I again attempted to capture it, when it again escaped, and, flying to about the same distance as before, alighted on a flower of a larkspur (*Delphinium Consolida*), and upon my third attempt to take it, it flew away and disappeared.

As to whether insects are attracted by odour or colour, I wish to call attention to an observation of Mr. Crouch, as detailed by Mr. Gosse in "A Year at the Shore." "*Tealia crassicornis* is as good a mimicry of the great dahlias as the *Sagartiæ* are of the daisies." "Even bees are occasionally deceived. Mr. Crouch, when once looking at a fine specimen which was expanded so close to the surface that only a thin film of water covered the disc and tentacles, saw a roving bee alight on the tempting surface, evidently mistaking the anemone for a veritable blossom."

Covington, Ky., U.S.A. V. T. C.

The Telephone as a Means of Measuring the Speed of High Breaks

IN some experiments with an induction coil and wheel break which I have lately been engaged on I have found the telephone useful in determining the number of times per second in which the current is broken.

For this purpose it may be attached to the secondary terminals, or the whole or part of the primary current may be passed through it.

The telephone may also be used generally for determining the speed of electro-magnetic motors by taking advantage of the fact that the current driving them is either short-circuited or broken a definite number of times in each revolution. The telephone wires may in this case be attached at two points some distance apart on one of the battery wires. The note of the telephone gives the number of breaks per second.

Pixholme, Dorking, March 17 J. E. H. GORDON

Meteor

As meteors are rarely seen by day, I write to inform you that I observed one this morning, at exactly 10.20 A.M., not only in broad daylight, but in bright sunshine. I only caught a hasty glance of it as it was disappearing. It was in the eastern side of the sky, descending towards a point in the horizon nearly due north from us, at an angle of about 40°. As we are quite in the country, it could not have been anything else than a meteor. I found that two of our servants had seen it also, and described it as having a tail, which I did not see. JAMES ELLIOT

Goldielands, near Hawick, March 25

The Bermuda Lizard

IN his "Geographical Distribution of Animals" (Am. ed. ii. p. 135), Mr. Wallace states, speaking of the Bermudas, that "a common American lizard, *Plestiodon longirostris*, is the only land reptile found on the islands."

Plestiodon longirostris is not a common American species. It is peculiar to the larger islands of the Bermuda Archipelago. It was described by Prof. E. D. Cope (*Proceedings* of the Academy of Natural Sciences, Philadelphia, 1861, p. 313) from Bermuda specimens. It has never been found elsewhere. Its closest affinities are with a West African species.

G. BROWN GOODE

U.S. National Museum, Washington, January 21

Landslip near Cork

THE village of Coachford, on the River Lee, sixteen miles from Cork, has been the scene of a curious landslip, or subsidence of soil.

On Wednesday, the 13th inst., a man on his way to work, at about eight o'clock A.M., on going along a path beside a dyke or bank which separates two fields close to the village, noticed a breach in the dyke which had not existed before; and on going to examine, found a deep hole in the earth about a yard in diameter, the depth of which appeared to him to be about a hundred feet, and at the bottom of which he heard the sound of running water. From that time till six o'clock P.M. the hole gradually increased in diameter by the falling in of the sides, until it appeared as I saw it on Sunday, the 17th inst., a conical cavity fifty to sixty feet in diameter and thirty to forty in depth. The soil is composed of gravel and sand, with a substratum of limestone.

The same thing has evidently taken place several times before in the immediate vicinity of the above-mentioned cavity, as there are no less than seven other similar depressions of various sizes in the same piece of ground, but the formation of none of these is remembered by even the oldest inhabitants of the place.

I should mention that the fields between which the landslip has taken place lie pretty high, and that the River Lee is about half a mile distant. A belief has long existed in the village that a stream, which is supposed to flow into the Lee, runs beneath the place, at some depth underground.

Cork, March 20 C. J. COOKE

JOACHIM JOHN MONTEIRO

A FEW days ago (NATURE, vol. xvii. p. 391) we recorded the melancholy fact of the death of this enterprising African traveller. We have since been favoured with a few particulars of his life and labours, which appear to us to demand more than a passing word of recognition. His work on "Angola and the River Congo" (Macmillan, 1875) is still fresh in the mind of the public, and has been made doubly interesting through the recent travels of Mr. Stanley. Mr. Monteiro commenced his scientific education at the Royal School of Mines, under the late Sir H. De la Beche, and at the College of Chemistry under Dr. Hoffmann, at both of which places he obtained first-class honours. His first visit to Angola was in the year 1858, when he went to work the Malachite deposits at Bembe, in that province, and also the blue carbonate of copper. This obtained honourable mention in the International Exhibition of 1862. It was while working these deposits at Bembe that the King of Congo came down to pay a visit, and was received with all honours. A very curious letter from this king, asking for a "piece of soap to wash his clothes with," is now in the possession of the British Museum.

It was during his stay at Bembe, and while exploring the country round, that he discovered that the fibre of the *Adansonia digitata* was so valuable for the purposes of making paper, but it was not until 1865 that he returned to the coast for the purpose of developing this extraordinary discovery. He continued to work this enterprise for many years, so as to fully establish the claim of this fibre to being the most valuable natural product for paper-making. Paper made exclusively of this fibre is scarcely to be distinguished from parchment, and it is owing to this remarkable quality that a small percentage of the fibre enables the manufacturer to utilise substances which would be otherwise useless. While at Bembe Mr. Monteiro procured some of the most interesting birds, and although the results of his first collecting were perhaps not so important in regard to novelties as those made later on, the value of this, our first contribution to the avifauna of Inner Angola, will never be underrated by ornithologists. In September, 1866, he accompanied Mr. A. A. Silva, the United States Consul, on an ascent of the River Quanza for the purpose of opening up the country to trade, and the natives were greatly astonished at their first experience of a "smoke-vessel." In April, 1873, he had the brothers Grandy as his guests at Ambriz, and supplied them with beads and goods for the arduous undertaking assigned to them by the Royal Geographical Society, of endeavouring to discover the sources of the River Congo, and of aiding Livingstone should he cross the continent and make for the West Coast. Mr. Monteiro accompanied the brothers Grandy five days inland. He explored the Congo as far as Porto da Lenho, in a steamer belonging to a Dutch house at the mouth of the river; and it was while on this expedition that he met by appointment, and at their desire, nine kings of Boma, whose curiosity he greatly excited by being the owner, as they said, of the first white woman, his wife, they had ever seen, and from her hand the kings were greatly pleased to receive a "dash" or present.

Mr. Monteiro was honoured with the friendship of Dr. Livingstone, who strongly desired him to accompany his expedition as mineralogist, but this wish he could not accede to, owing to his engagements in working out the fibre-scheme on the West Coast. His researches in the natural history of Angola have been of great importance to science. Among the many botanical specimens which he forwarded to England may be mentioned the plant and flowers of *Welwitschia mirabilis*, from which Sir Joseph Hooker was enabled to compile his splendid monograph of this extraordinary plant; besides many parasites, orchids, &c., which have been named after him. Perhaps the most interesting animal discovered by him was the beautiful little lemur (*Galago monteiri*), and the well-known chimpanzee, "Joe," which lived so long in the Zoological Gardens, was also brought to England by him. His second collection of birds was described by Dr. Hartlaub in 1865, and contained many new species, the most interesting of which were a Hornbill (*Tockus monteiri*) and a Bustard (*Otis picturata*), while he also procured a living specimen of the splendid Plantain-eater (*Corythaix livingstonii*) discovered by Dr. Livingstone in the Zambesi country.

Mr. Monteiro's eighth, and, as it has unfortunately proved, his last, visit to Africa, was one to Delagoa Bay, and here he expired, after a severe illness, on the 6th of January last. In company with his wife, who contributed so largely to his natural history collections, at which she worked with equal courage and zeal, he had set himself to develop the mineral and natural products of that Portuguese possession, and had already sent to England many valuable specimens, when his untimely death put an end to all his projects. There can be no doubt that Angola, to the elucidation of the natural history of which Mr. Monteiro contributed so largely, still presents a fine field for the collector, and it is to be hoped that some one will be found who will continue the researches so well instituted by the deceased traveller.

SOUND COLOUR-FIGURES

THE great interest excited by Prof. Bell's telephone and Mr. Eddison's phonograph, in which an elastic disc or membrane faithfully takes up the highly complex vibrations due to sounds of the human voice, has directed renewed attention to the optical methods hitherto employed in studying the motion of resonant media. These have, in important instances, been based on observations of the secondary effects produced by sonorously vibrating bodies. Thus Chladni watched the behaviour of sand strewn upon sounding plates and membranes; König that of gas flames acted on by aërial vibrations. The present article describes an analogous method depending on the colours reflected from slightly viscous liquid films when thrown into sonorous vibration.

The ordinary phenomena called the "colours of thin plates" are sufficiently well known, but a short description of them, taken from a standard work on Physical Optics, may still not be out of place here as a reminder.

"If the mouth of a wine-glass be dipped in water, which has been rendered somewhat viscid by the mixture of soap, the aqueous film which remains in contact with it after emersion will display the whole succession of these phenomena. When held in a vertical plane, it will at first appear uniformly white over its entire surface; but, as it grows thinner by the descent of the fluid particles, colours begin to be exhibited at the top, where it is thinnest. These colours arrange themselves in horizontal bands, and become more and more brilliant as the thickness diminishes; until finally, when the thickness is reduced to a certain limit, the upper part of the film becomes completely black. When the bubble has arrived at this stage of tenuity, cohesion is no longer able to resist the other forces which are acting on its particles, and it bursts."—(Lloyd's "Wave-Theory of Light," p. 100.)

If the film, instead of remaining at rest, is thrown into sonorous vibration, totally distinct colour-phenomena instantly present themselves. A rough idea of their general character may be obtained without the aid of any apparatus as follows. While washing the hands, after getting a good lather, a film can easily be formed between the thumb and forefinger of one hand held in a horizontal plane; the other hand supplies an extemporised tube through which a note can be sung, and so vibrations caused to impinge on the *lower surface* of the film.

If this is done the reflected colours will be seen to be in regular motion, and, in particular, a number of small eddies of colour will be observed whirling about fixed centres of rotation. Steady coloured bands may also be sometimes recognised, but with much greater difficulty.

Fixed bands and stationary vortices form, in fact, the constituent elements of all the sound colour-figures obtainable by film-reflection.

In order to study these in detail a specially arranged apparatus is, of course, requisite. I have found the following give excellent results.

An L-shaped cylindrical brass tube is permanently fixed upon a wooden stand, with its two limbs vertical and horizontal. The vertical limb terminates in a narrow flat circular ring. The open orifice of the horizontal limb is fitted into a caoutchouc tube of equal bore, ending in a trumpet-shaped mouth-piece. For the purpose of supporting the films operated on, I use a series of metallic discs pierced with apertures of various shapes and sizes. On covering one of these, by means of a camel-hair brush, with some weak solution of soap,[1] a film of considerable durability will be formed upon it. The disc should first be held in a vertical plane until the coloured bands have begun to show themselves, and then laid gently upon the horizontal ring prepared for its reception. The observer places himself so as to get a good view of the assemblage of colours reflected by the film, and the instrument[2] is ready for use. Sounds of tuning-forks, whistles, organ-pipes, &c., or notes of the human voice have only to be produced near its mouthpiece, in order that their vibrations may be conducted to the film, and the resulting phenomena observed.

The forms thus presented are of endless variety and great beauty. They almost invariably include both motionless curvilinear bands of colour very regularly disposed, and also a system of colour-vortices revolving about fixed nuclei. The contrast between the steady and moving portions of the figures is always very striking, and the effects of changing tint which accompany the progressive thinning of the film gorgeous in the extreme. When the moment of its dissolution is close at hand, patches of inky blackness invade the field, until at last there is sometimes nothing left but an ebony background, with here and there a few scraps of light, either at rest or still flying round their former orbits, the remnants of fixed bands and whirling vortices.

That the results obtainable by the mode of experimenting above described are likely to present a practically endless variety of form, will be at once obvious from an enumeration of the several causes which may influence the assemblage of colours reflected at a given instant from a given film acted on by the vibrations of a given sound. These are:—1. The shape of the film; 2. Its size; 3. Its consistency; 4. The intensity of the sound; 5. Its pitch; 6. Its quality; 7. The direction in which the sound-vibrations take place with reference to the plane of the film.

It thus appears that each colour-figure observed *may* be a function of not less than seven[3] independent variables; and on experiment this proves to be the fact. An alteration made in any one of these elements, while all the rest are kept constant, produces a corresponding change in the appearances observed. The intensity of the sound does not, it is true, affect the form of the figure, but controls the rate of its vortical motion; the louder the sound the more rapid the rotation of the colour-whirls. All the other elements act directly on form.

It is evident from what has preceded that an attempt at anything like a general classification of sound colour-figures would afford materials for a considerable volume. All that can be done within the present narrow limits is to draw attention to a few points of special interest.

Dependence of Form on Pitch.—This is perhaps most distinctly shown by alternately stroking with a resined bow two mounted tuning-forks of different pitch, the open ends of whose resonance-boxes are placed close to the mouthpiece of the Phoneidoscope. As long as the same aperture is used, and the film kept at one degree of consistency by frequent renewal, each note will instantly call forth its own colour-figure for any number of alternations. This mode of experimenting has the advantage of giving perfectly steady and sharply defined figures. But the successive alterations of form due to changing pitch are more interestingly shown by singing[4] the diatonic or chromatic scale, on some single vowel, into the Phoneidoscope. The complete change of figure consequent on

[1] Castile soap, I find, answers extremely well.

[2] It is manufactured and sold under the title of the "Phoneidoscope," by S. C. Tisley and Co., Philosophical Instrument Makers, 172, Brompton Road, S.W.

[3] A reader of Helmholtz will see that I might have added an eighth element by taking into account differences of phase among partial tones, which, though inoperative on quality, directly affect mode of resultant vibration.

[4] A pitch-pipe with a sliding piston may be substituted for the voice in this experiment.

perhaps but a semitone's alteration of pitch, is often most surprising. It was these sudden kaleidoscopic bounds from one form to another which suggested the name given to the observing instrument. In general the complexity of the figure increases with the acuteness of the exciting sound. With low notes a comparatively simple arrangement of a few rings and pairs of vortices occupies the film. As the pitch rises, the separate parts of the figure diminish in size and increase in number, so that the whole field is covered with a regular pattern which is constantly growing more and more minute. With very shrill sounds the pattern can only be made out by using a magnifying-glass.

Effects of Quality.—These are easily observed by employing unison organ-pipes of different *timbres, e.g.*, treble C's belonging to stopped and open diapasons, claribella, and hautbois, respectively. By sounding them consecutively in the above order, figures rapidly increasing in complexity are obtained.

Prominent among differences of quality are those which distinguish vowel-sounds of the human voice sung successively on one and the same note. Marked corresponding differences of colour-figure are recognisable in many instances, but I have not at present succeeded in extending the observation to *all* the European vowel-sounds.

Effects due to Direction of Vibration.—The best mode of observing these is to strike a tuning-fork, and hold it with one of its prongs *close* to the surface of the film.

By moving the fork it is easy to show that both the axis of symmetry, and to some extent also the form, of the colour-figure thus produced, are dependent on the position of the fork with respect to the film, and therefore on the direction in which the exciting vibrations impinge upon it. The steady bands of a figure obtained by this method shift to and fro upon the film in obedience to the fork's movements, almost as though under a magnetic influence resident in its prongs.

Resultant Figures due to Combined Sounds.—If the sounds of two tuning-forks are separated by a considerable interval of pitch, say an octave, they will generate, when alternately applied to the same film, very different figures. When both are applied together there results a figure different from either of those due to each fork by itself. It is in fact a compromise between the two. In order to convince himself of this the experimentor should first get the forms of the component figures well into his memory by repeatedly producing them, and then watch the effect, *on some one band in either figure*, of mixing the two sounds in various degrees of relative intensity. Let us suppose that fork 1 produces figure 1, and fork 2 figure 2, respectively, and that a band in figure 1 is selected for observation. Then if fork 1 be struck sharply, and fork 2 weakly, the band will alter its form so as to exhibit a slight approach to the arrangement in the corresponding part of figure 2. As the note of fork 2 is more loudly sounded this approach will be more decided. If fork 2 is made preponderant the result will be the arrangement of Fig. 2 with some modification towards that of figure 1. The same thing holds good for the rotating portions of the figures. Complex colour-flows are seen to result from a compromise between simpler component vortices.

Effect of Beats.—When two sounds of very nearly the same pitch coexist, slow fluctuations of intensity called "beats" are known to be produced. If a film is exposed to the simultaneous action of two sounds so related, the fixed parts of the resulting figure take up a swaying motion about their mean position, each complete oscillation synchronising exactly with one entire beat. The vortices show, in general, an increased speed of rotation during one half of each beat, and a diminished speed during the other half. But in particular cases a bolt forward every alternate half-beat seems to be followed by intermediate quiescence, or the direction of motion may be actually reversed, so that a vortex rotates positively during one half-beat and negatively during the next.

Representation of Dissonance.—When the beats become too rapid for separate recognition, and coalesce into the effect which we call discord, the colour-figure presents a tremulous appearance, like that shown by the tip of a singing gas flame. Prof. Helmholtz has remarked how unpleasant is the impression which a flickering light makes upon the eye, and pointed out its analogy to the effect of rapidly intermittent sounds on the ear. In the present experiment, acoustical and optical dissonance are exhibited in a direct and interesting connection.

As the phenomena described in the above article admit of such facile reproduction in all their beauty of form and splendour of hue, I have thought it needless to attempt illustration by diagrams, which could convey but an inadequate notion of the former, and none at all of the latter.

SEDLEY TAYLOR

Trinity College, Cambridge, March 6

REFLECTION OF LIGHT[1]

PLACE the heliostat in position, and bring a slender beam of light into the darkened room. Then get a small looking-glass, or hand-mirror, and a carpenter's steel square, or a sheet of stiff paper, having perfectly square corners. Hold the mirror in the beam of light. At once you see there are two beams of sunlight, one from the heliostat and another from the mirror. Hold the glass toward the heliostat, and you will see this second beam going back toward the window.

This is certainly a curious matter. Our beam of light enters the room, strikes the mirror, and then we appear to have another. It is the same beam, thrown back from

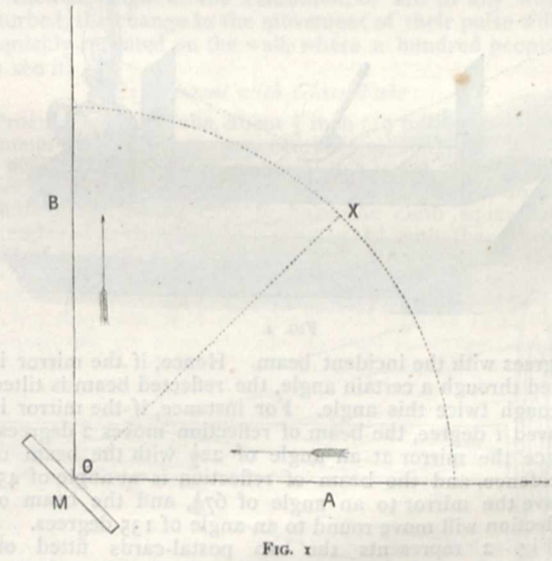

FIG. 1

the glass. This turning back of a beam of light we call the reflection of light.

Place a table opposite the heliostat, and place the mirror upon it, against some books. Turn the mirror to the right, and the second or reflected beam of light moves round to the right. Turn the glass still more, and the beam of light will turn off at a right angle, and there will be a spot of light on the wall at that side of the room. Now bring the carpenter's square or the piece of square paper close to the mirror, so that the point or corner will touch the glass just where the sunlight falls upon it. Now

[1] From a forthcoming volume of the "Nature Series"—"Light: a Series of Simple, Entertaining, and Inexpensive Experiments in the Phenomena of Light, for the Use of Students of Every Age," by Alfred M. Mayer and Charles Barnard.

one edge of the square is brightly lighted by the sunbeam, and if the mirror is placed at an angle of forty-five degrees with the sunbeam, the other edge of the square is lighted up by the second beam.

In Fig. 1, A is the beam of light from the heliostat, and B is the beam reflected from the mirror, that is marked M. To make this more simple, we call the first beam the beam of incidence, and we say that it travels in the direction of incidence, as shown by the arrow. The second beam, marked A, we call the beam of reflection, and the course it takes we call the direction of reflection. The point marked O, where the light strikes the mirror, is called the point of incidence.

In the diagram is a dotted line representing a quarter of a circle reaching from the beam of incidence to the beam of reflection. A quarter of a circle, as you know, is divided into ninety degrees. Another dotted line extends from O at the mirror to X on the quarter-circle, and divides it into two parts. Half of ninety is forty-five, and hence the mirror stands at an angle of forty-five degrees with both beams of light. Now the line A and the dotted line reaching from O to X make the angle of incidence, and the angle between B and the line from O to X is the angle of reflection; and the curious part of this matter is, that these two angles are always equal. Here they are both angles of forty-five degrees.

Move the mirror about in any direction, and measure the angles of incidence and the angles of reflection, and these angles will always be exactly equal.

If you look at the diagram you will see that the mirror is at an angle of 45 degrees with the beam of incidence, and that the beam of reflection is at an angle of ninety

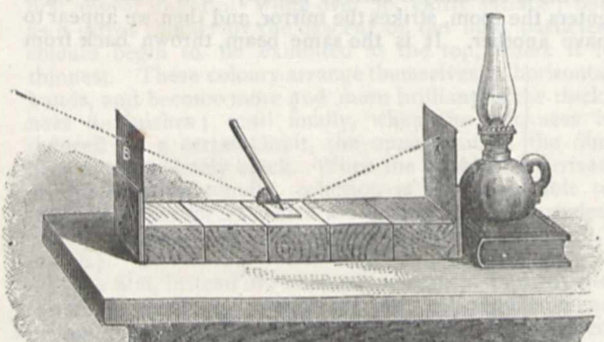

FIG. 2.

degrees with the incident beam. Hence, if the mirror is tilted through a certain angle, the reflected beam is tilted through twice this angle. For instance, if the mirror is moved 1 degree, the beam of reflection moves 2 degrees. Place the mirror at an angle of 22½ with the beam of incidence, and the beam of reflection is at angle of 45. Move the mirror to an angle of 67½, and the beam of reflection will move round to an angle of 135 degrees.

Fig. 2 represents the two postal-cards fitted on blocks of wood that we used in a former experiment, and the three blocks of wood we cut out at that time. The five blocks are placed close together in a line, and with the postal-cards at the ends. A lighted lamp is placed near one of the cards, and on the middle block is a small piece of window-glass that has been painted with black varnish. A single coat of black varnish on one side of the glass is all that is required to give us the black mirror needed in this experiment. Place the lamp close to the card in such a position that the flame will be just on a level with the hole in the card. If the lamp is not convenient the blocks and cards may be placed upon a table facing a north window in full daylight.

When everything is ready look through in the postal-card marked B, down upon the black mirror, and on it you will see a single spot of light, the reflection from the lamplight or the light from the window shining through the hole marked A in the drawing. Get the needle-pointed awl and place it so that the point will just touch the spot of light in the black mirror, and then fasten the awl in this position with a piece of wax, as represented in the picture.

You will readily see that this experiment is the same as the last. Again we have a beam of light reflected from a mirror. The beam of incidence passes through the postal-card at A and finds its point of incidence on the mirror, and the beam of reflection extends from the point of incidence to the second card at B.

Take a sheet of stiff paper 10 inches (25·4 centimetres) long, and about 4 inches (10 centimetres) wide, and hold it upright between the two cards, with the bottom resting on the mirror. With a pencil make a mark on the edge of this at the point of incidence marked by the awl, and at the hole in the card where the beam of incidence enters, and marked A in the drawing. Draw a line between these two points and you have an angle formed by this line and the base of the paper. This angle marks the angle of incidence. Put the paper on the blocks with the ruled line toward the card B, and you will find that the line fits here equally well. It now extends from the point of incidence to B, and proves that this angle is the same as the other, that both sides are alike, and that the angle of incidence and the angle of reflection are equal.

Take out the block in the middle and move the others nearer together till they touch. Repeat the experiment: make a measurement with a piece of paper as before, and draw a line on it from the point of incidence to either of the holes on the cards, and then compare the angles thus found, and in each case they will be exactly alike. Take out another block and try it again, and you will reach the same result.

These experiments show us that there is a fixed law in this matter, and the more we study it the more we are convinced that it has no exceptions.

Experiment in Multiple Reflection

Choose a south room on a sunny day and close the blinds and shutters at all the windows save one, and at this window draw down the curtain until only a narrow space is left at the bottom. Close this space with a strip of thick wrapping-paper, and then cover the rest of the window with a blanket or shawl so as to make the room perfectly dark. Then cut a round hole the size of a five-cent piece in this paper, and through this hole a slender beam of sunlight will fall into the darkened room.

Bring a hand-mirror into this beam of light and the beam of reflection will make a round spot of sunlight on the wall above the window. This spot of light is a picture of the sun thrown by the mirror upon the wall. Hold the mirror at an oblique angle in the sunbeam and direct the beam of reflection upon the opposite wall. Now there are several reflections, brilliant spots of light. If the spots of light do not stand out sharp and clear, turn the mirror slowly round and you will soon find a position for the glass that will give six or more reflections.

How does it happen that a common looking-glass can thus split a single sunbeam into several beams? If you touch a pencil to a mirror you will notice that while the point of the pencil touches the glass the point of the reflected pencil seen in the mirror does not meet the point of the real pencil, and that there is a little space between them. The reflection we see in the glass is from the smooth surface of the quicksilver at the back of the glass, and the space between the reflection and the pencil is filled by the glass.

Hold a sheet of common window-glass before a lighted lamp or candle, and you will see a faint reflection of the flame in the glass, and at the same time you can readily see through the glass. This shows us that the outside of any piece of smooth glass will reflect light, and our experiment is designed to show a still more curious matter.

Fig. 3 represents the single beam reaching the point of incidence on the outside of the mirror at O, and reflected to the wall at 1. Part of the light goes through the glass to B, and here is another point of incidence, and a new beam of reflection is thrown through the glass to the wall at 2. If you look at the reflections on the wall, you will see that the second spot of light is the brightest. This comes from the quicksilver, for, as this is a better reflector than the glass, it sends out a brighter beam of reflection. When this second beam of reflection passes through the glass, a part of its light is reflected from the under side of the surface, and is turned back

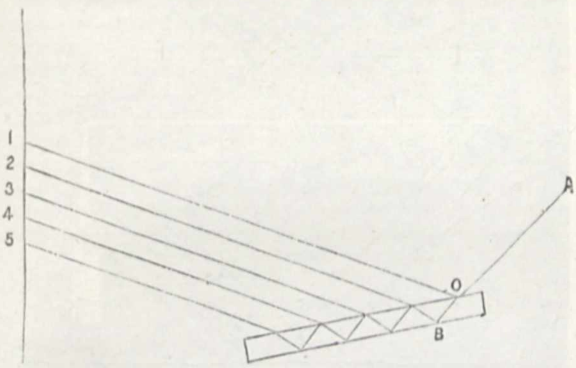

FIG. 3.

against the quicksilver again. Once more it is reflected, and a new beam of reflection makes number 3. The drawing shows the path these beams of light take in the glass, and the quivering spots of light on the wall show how one beam of light may be reflected again and again in different directions. If the reflector was perfect and returned all the light, these multiple reflections might be repeated many times over; but every time light is reflected from any bright surface a part of the light is lost, and thus each reflection grows fainter and fainter till the light is spent. Look at the multiplied reflections on the wall, and you will see that the first reflection from the glass is bright, and that the second, from the quicksilver at the back of the glass, is brighter still; and that the others grow fainter and fainter till all the light is spent, and the reflections disappear.

Second Experiment in Multiple Reflection

Light a lamp and place it on a table, and get the two postal-cards and the blocks that we used in the experiment in reflection. With a sharp knife cut a slit in one card, just at the pin-hole, about $\frac{3}{4}$ inch (19 millimetres) long and $\frac{1}{25}$ inch (1 millimetre) wide. Then place this card close to the lamp, as in the other experiment, and set up the other card about fifteen inches away from it. Then lay a looking-glass on the table between the two. Look at Fig. 2, and arrange the cards as there represented, and put the mirror in place of the blackened glass on the blocks. On looking through the small hole in the postal card (marked B in the drawing), you will see in the mirror several bars of yellow light, placed one over the other. Again we have an instance of multiplied reflection. Instead of seeing the reflections thrown upon the wall, we can look down upon them and see them, just us they stand, each at its point of incidence on the glass and the quicksilver. Study these brilliant bars of light, examine the diagram carefully, and you will readily see that this experiment simply exhibits in a different manner the same thing that we saw in the last experiment.

Experiment with Mirror on Pulse

Get a small bit of looking-glass, about an inch (25 millimetres) square, and some wax. Warm the wax in the hand till it is soft, and then make three small pellets about the size of a pea. Put one of these on the back of the little mirror, near the edge and half-way between two corners. Place one at each of the opposite corners, so that the mirror will have three legs or supports placed in a triangle. Put the heliostat in place, and bring a small beam of sunlight into the dark room. If this is not convenient any beam of sunlight in a dark room (as in former experiments) will answer.

Turn back your coat-sleeve, and, while standing near the beam of light, place the little mirror on the wrist, with one of the wax legs resting on the pulse. Then bring the arm into the beam, so that the light will fall on the mirror. Hold the arm steady, and watch the spot of reflected light thrown upon the wall. See! It moves backward and forward with a curious, jerking motion. It is like the ticking of a clock, or like the bending of one's pulse. It is the motion of your pulse. The mirror moves with the pulse, and the beam of reflection thrown on the wall moves with it, and, though this movement is very slight, the reflection on the wall moves over a space of several inches, and we can see it plainly. In our first experiment in reflection we learned that when a mirror was moved to the right or left, the beam of light reflected from it moved also to the right or left, and each time through twice as great an angle as the mirror.

This experiment is a wonderfully interesting one, and may be tried with a number of boys or girls, and each may see the peculiar beating of his or her pulse pictured on the wall in the most singular and startling manner. If any of the persons whose pulse-beats are thus exhibited get excited, laugh at the exhibition, or are in any way disturbed, the change in the movement of their pulse will be quickly repeated on the wall, where a hundred people can see it.

Experiment with Glass Tube

Procure a glass tube, about $\frac{3}{4}$ inch (19 millimetres) in diameter and 12 inches (30·5 centimetres) long, and paint the outside with black varnish. If this is not convenient, cover the tube with thick black cloth, and fasten it down with mucilage, taking care to have the cloth square at the ends. Punch a hole in a postal-card with the sharp point of a pair of scissors, and with a knife make the

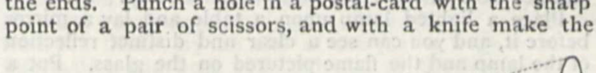

FIG 4.

ragged edges of the hole smooth. Hold the card at one end of the tube, so that the hole will come just at the centre of the opening, and then, while facing a window or a bright lamp, look through the tube with one eye, and you will see a spot of light surrounded by a number of beautiful rings.

Here we have another example of multiplied reflection. The light entering the tube through the hole in the card falls on the smooth surface of the interior of the tube, and appears to the eye in the form of rings.

Fig. 4 represents a section of the tube, and shows the paths the different rays of light take, and shows how each is reflected from side to side till they all meet in the eye. The dotted lines and the rings projected beyond the tube show how they appear to the eye. By studying this drawing carefully, and trying cross cuts and slits in the card in place of the single hole, you will get a very correct idea of repeated reflection, and find the tube a source of considerable amusement.

Experiments in Dispersed Reflection

Get a small piece of black velvet or cloth and take it to a dark room where the heliostat will give us a slender beam of sunlight. If this is not convenient use a common beam of sunlight in a dark room, as in some of our former experiments. Hold the velvet in the hand between the fingers, and so as to leave the palm of the hand clear. Turn back the coat-sleeve so as to expose part of the white cuff, and then bring the velvet into the beam of sunlight. You will observe nothing in particular, for the black rough cloth does not reflect the light at all. Now move the hand so that the spot of light will fall on the palm. See what a pretty rosy glow of light falls on the wall! This is the reflected light from the hand. The skin is rough, and the light is diffused and scattered about, and instead of a bright spot of reflected light, as with a mirror, we have this glow spread all about on the wall and furniture. Now move your hand so that the sunlight falls on your cuff. Immediately there is a bright light shining on the wall and lighting the room with a pale bluish-white glare. Move the hand quickly so that the black cloth, the hand, and the white cuff will pass in succession the beam of light. Observe how the different things reflect the light in different degrees. The cuff is the smoothest and whitest, and gives the brightest reflection; the hand gives less light because it is less smooth; and the cloth, that has a very dark and rough surface, gives no reflection at all, and the spot of sunlight falling upon it seems dull and faint.

This experiment shows us something more in the reflection of light. A piece of glass, the surface of water, polished metals, ice, and all substances having very smooth surfaces, reflect light in one direction. The linen cuff also reflected light, but apparently in a very different manner from the mirrors we have been using.

Place a lighted lamp upon a table and lay a mirror before it, and you can see a clear and distinct reflection of the lamp and the flame pictured on the glass. Put a sheet of white paper before the lamp, and you can see only a confused spot of reflected light on the brightly-lighted paper. Lay a freshly-ironed napkin or handkerchief before the lamp, and even the indistinct spot of light has disappeared, and the white cloth reflects light equally from every part.

These drawings are intended to show how light is reflected from different surfaces. The first represents a smooth surface, like glass, that sends all the beams in one direction, because the points of reflection for the beam are in the same plane. (See 1, 2, 3, Fig. 5.)

The second drawing represents a slightly-roughened surface, like paper. Some of the points of reflection turn the light one way, some another, and the beam of reflection is no longer formed of parallel rays. They are scattered about, and the image they form is confused and indistinct. In the third drawing we have a rough surface, like cloth, and here the rays of the beam of reflection are scattered in every direction, and we can see no image.

It is in this manner that we are enabled to see the people and things about us. The light of the sun or a lamp falls upon them, and is reflected into our eyes, and we say we see the objects. Very few things reflect light so brightly that we obtain from them a reflected image of the source of the light, and we generally see only dispersed and scattered light, that does not blind or dazzle the eye, and enables us to look upon these objects with ease, and to readily see all their parts.

The clouds, the water, the grass, rocks, the ground, buildings, the walls inside, clothing and furniture, and everything we can see, reflect light in every direction again and again, and thus it is that all spaces, without and within, are filled with light so long as the sun shines. At night the sun sinks out of sight, and still it is light for

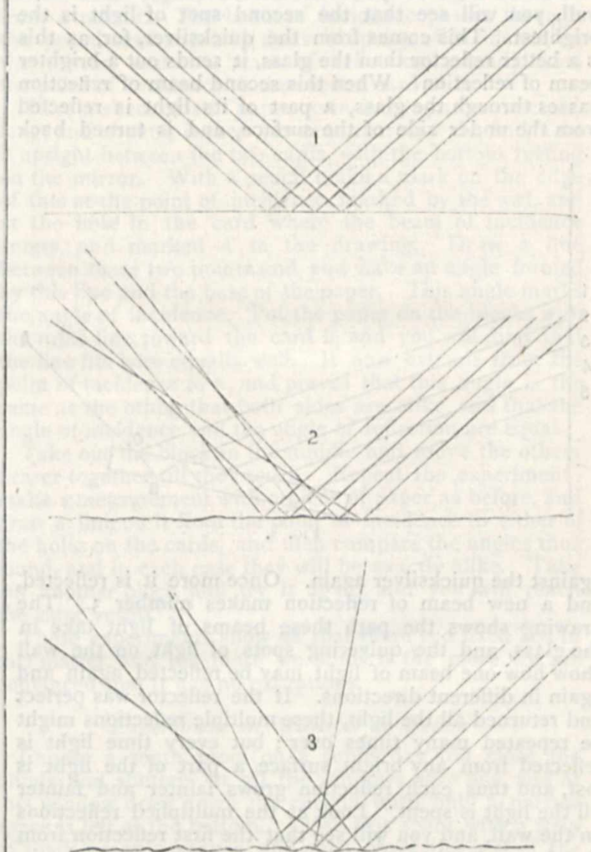

FIG. 5.

some time after, for the sunlight is reflected from the sunset-clouds and the sky.

Sometimes, upon a summer's day, when broken clouds partly hide the sun, you will see long bars of dusky light streaming from openings in the clouds. These long bars are beams of sunlight shining upon dust and fine mist floating in the air, and we see them because each speck and particle reflects light in every direction.

Experiment with Jar of Smoke

Fig. 6 represents a large, clean glass jar, such as one sees at the confectioner's. It is standing upon a black cloth laid upon a table in a dark room, and on top of the mouth is laid a postal-card, having a slit, one inch (25 millimetres) long, and $\frac{1}{25}$ inch (1 millimetre) wide, cut in it. Above the jar is a hand-mirror, so placed that the beam of sunlight from the heliostat (or from a hole in the curtain) will be reflected downward upon the postal-card on top of the jar.

This simple apparatus is designed to show how light is reflected from small particles floating in the air. Set fire to a small bit of paper and drop it into the jar. Place your hand over the mouth of the jar, and in a moment it will be filled with smoke. When the paper has burned out, put the postal-card in place, so that the slit will be in the centre of the mouth of the jar. Let the beam of reflected light from the mirror fall on this slit.

Look in the jar and you will see a slender ribbon of light extending downward through the jar. Elsewhere it is quite dark and black. Here we see the light streaming through the opening in the card, and lighting up the particles of smoke in its path.

Take off the card, and let the reflected beam fall freely into the jar. The smoke is now wholly illuminated, and the jar appears to be full of light, and every part of the bottle shines with a pale-white glow.

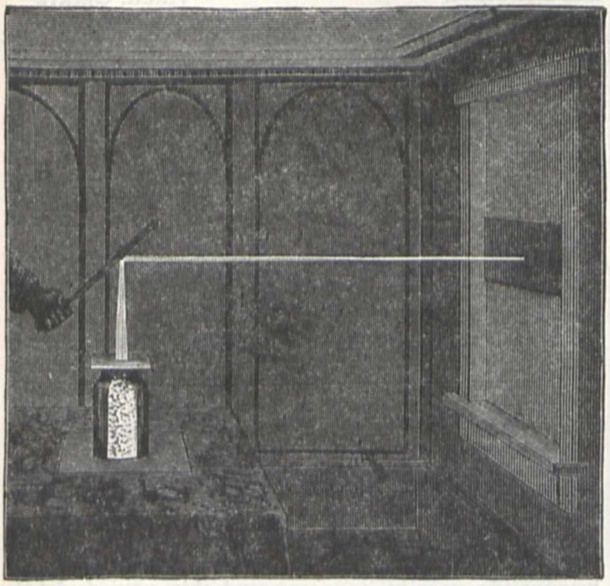

FIG. 6.

Put the postal-card on again and let the light fall through the slit. The smoke has nearly all disappeared, and the ribbon of light in the jar is quite dim. Curious streaks and patches of inky blackness run through it. What is this? Nothing—simply nothing. The smoke is melting away, and the beam of light disappears because there is nothing to reflect it and make it visible.

This part of the experiment appears quite magical in its effects, and is exceedingly interesting.

The Milk-and-Water Lamp

Take away the jar and put a clear glass tumbler in its place. Fill this with water and throw the beam of reflected light down upon it, and the water will be lighted up so that we can easily see the tumbler in the dark. Now add a teaspoonful of milk to the water and stir them together. Throw the beam of light down once more. This is indeed remarkable. The tumbler of milk-and-water shines like a lamp, and lights up the room so that we can easily see to read by its strange white light. Move the mirror and turn aside the beam of light, and instantly the room becomes dark. Turn the light back again, and once more the glass is full of light.

Here the minute particles of milk floating in the water catch and reflect the light in every direction, so that the entire goblet seems filled with it, and the room is lighted up by the strange reflections that shine through the glass.

AMERICAN GEOLOGICAL SURVEYS

MISSOURI

THE State of Missouri boasts of abundant mineral wealth. Its seams of coal and its stores of iron and lead mark it out as one of the great centres of the future industry of the United States. Such a country might have been supposed only too anxious to have its mineral formations accurately mapped, so as to know exactly where and how its subterranean resources lie. Yet the history of its official action in this matter is by no means a gratifying one. As far back as the year 1849 a memorial was presented to the General Assembly of the State, praying for the formation of a Geological Survey, with liberal appropriations for constructing maps and publishing reports; for investigating causes affecting health, the agricultural capacities of different soils, the water system, and the rocks and minerals of the country. It was not until the early summer of 1852 that the State geologist, who, in response to this memorial, was appointed, began operations. Five annual reports, consisting for the most part of only a few leaves, appeared up to the year 1861, and, with one exception, contained mere statements of progress. Perhaps the Legislature began to think that the results obtained were not worth the expenditure to secure them. At all events, in 1861 the Survey was disbanded. The authorities, however, seem to have been unwilling that the fruits of the long years of work of their geological staff should be lost; they accordingly arranged to have them published, but finally abandoned this idea on account of the expense. For nine years nothing further appears to have been done in the matter. At last, in 1870, the Legislature once more roused itself to consider the expediency of having the country properly explored and mapped. A "Mining, Metallurgical, and Geological Bureau" was now created, and a new State geologist was appointed. This arrangement, however, not proving satisfactory, the act was amended next year, but soon thereafter the State geologist resigned, and Mr. R. Pumpelly took his place. The body by which the geological work of the State was controlled, now called the "Bureau of Geology and Mines," consisted of a board of five managers, with a staff formed of a State geologist, an assistant palæontologist and geologist, an assistant chemist, and such additional assistance as might be possible within the limits of an annual appropriation of 10,000 dollars.

By the spring of 1872 a more liberal spirit had appeared in the assembly. An additional chemical assistant was allowed, and the annual vote was raised to 20,000 dollars. The Survey now set to work with prodigious vigour. Mr. Pumpelly and his associates undertook an extensive exploration of the iron and coal districts, while the chemists were busy analysing the minerals sent into them from the field. By the end of the year a large mass of information had been collected, and as the liberality of the Legislature had shown no sign of waning, a large appropriation was asked for the publication of the results obtained in 1872, and another grant for the issue of the still unprinted reports of previous years. Both these appropriations, amounting to 9,000 dollars in the one case, and 3,000 dollars in the second, were voted. Accordingly two volumes duly appeared next year. The Report for 1872 was sumptuously printed and illustrated. Moreover, it was accompanied by a monstrous atlas of chromo-lithograph maps and sections. Some parts of the coal-fields were carefully illustrated by sections to show the structure of the areas and the relative positions of the seams in different districts. Perhaps some of these sections were on a needlessly large scale. Certainly the whole atlas was issued in a style so luxurious as to suggest that the Legislature must not only have become more liberal, but must be anxious to atone for former delinquencies by an almost extravagant expenditure in print and paper.

But this golden age was not destined to last. Mr. Pumpelly resigned, very shortly after the appearance of his meritorious though costly volumes. His successor, Mr. G. C. Broadhead, who had previously acted as chief assistant-geologist, found the fund at his disposal so depleted by the heavy expenses of the winter and spring of 1873, that he had to reduce his field-staff. The Board of

Management likewise determined that the cost of the Annual Reports should in future be paid out of the yearly appropriation, thereby of course, considerably narrowing the possible amount of work to be done in the field. In spite of these drawbacks, however, the State-geologist succeeded, during his first year of office, in doing some useful work, and yet kept a sufficient balance to publish a bulky report with a quarto atlas of plates. His plan was to attack first of all those branches of inquiry which presented the greatest interest or had the closest bearing upon the industrial resources of the State. The ground was surveyed by counties, Mr. Broadhead himself taking a lion's share of the hard work. The two lead regions of South-west and Central Missouri were likewise examined. Many analyses were also made of the ores, slags, coals, and other mineral substances sent up to the office. The Report which gave an account of these labours cannot fail to be of great service in the development of the mineral resources of the State. Mr. Broadhead is evidently exactly the kind of director needed to keep the Missouri Geological Survey in full activity and to satisfy the demands of a utilitarian legislature.

The oldest rocks in Missouri appear to be certain granites and other crystalline masses, on which lie somewhere about 3,000 feet of Lower Silurian strata, including representatives of the Potsdam, Black River, Birdseye, Trenton, and Cincinnati groups of other parts of the United States. Upper Silurian rocks are much more feebly represented, but Dr. Shumard has recognised beds probably equivalent to the lower Helderberg and Niagara groups. The Devonian groups of Hamilton and Onondago are still more sparingly developed, only about 100 feet of strata being referable to those horizons. The Carboniferous system, however, is well displayed, and contains the following groups :—

LOWER.	Upper coal-measures (poor in coal)	1,307 feet.
	Middle ,, (with 7 ft. of coal)	324 ,,
	Lower ,, (with 13 ft. 6 in. of coal) ...	250-300 ,,
UPPER.	Chester group (sandstone) from a few feet to ...	100 ,,
	St. Louis ,, (limestone), maximum	250 ,,
	Keokuk ,, (shale and chert), perhaps exceeding	200 ,,
	Encrinital or Burlington group	60 ,,
	Chouteau limestone	100 ,,
	Vermicular sandstone and shales	75 ,,
	Lithographic limestone	55 ,,

No later formations occur until we reach the "Drift. This consists of two divisions ; the lower, formed of dark blue clay, overlaid and interstratified with beds and pockets of sand sometimes inclosing remains of terrestrial vegetation ; the upper composed of stiff, tenacious, brown, drab, and blue clays, often mottled, and containing rounded granitic pebbles. Large boulders of crystalline rocks from a northern source occur in the lower division, up even to a height of 1,050 feet above the level of the Gulf of Mexico. Most of the observed boulders occur in the valleys. They diminish in numbers and size as they are traced southwards, the Missouri River seeming to limit their extension in that direction. Above these clays lies the "bluff," or loess, a very fine light brown siliceous marl, with occasional concretions of limestone. With sufficient consistency to weather out into perpendicular escarpments, this deposit forms a belt of hilly country receding ten miles from the river, and then changing into a stiff clay which may be part of the "drift." The low alluvial lands lie on what is termed the "bottom prairie," generally a dark tenacious clay, often containing concretions of bog-iron, and rarely beds of sand.

From the early part of last century lead and iron have been worked in Missouri. The mining industry of the State has gradually developed, and is now making rapid progress. In the year 1872, 13,550,135 pounds of lead were produced in the State. During the first six months of 1874, 5,050 tons of pig-lead were sent by railway into St. Louis. The yield of iron and zinc is likewise steadily increasing. Vast quantities of sulphate of baryta are said to be raised, and to be used in the improvement (that is, the adulteration) of white lead. A territory so richly stored with mineral wealth ought to be able to equip and maintain a sufficient staff for the thorough exploration of the geological and mineralogical structure of the ground, and for the formation of a museum where the rocks, minerals, fossils, and manufactured mineral products may be displayed, and made practically useful and instructive.

ARCH. GEIKIE

OUR ASTRONOMICAL COLUMN

DUN ECHT OBSERVATORY PUBLICATIONS, VOL. II.—In this handsomely-printed volume of two hundred pages we have the first portion of results of observations made during Lord Lindsay's expedition to the Mauritius on the occasion of the late transit of Venus, an expedition which for the care and forethought bestowed upon the arrangements and the excellence and completeness of the equipment, compares favourably with any of those fitted out by the various Governments which took part in the observation of this rare phenomenon.

It was upon the strong recommendation of the eminent Secretary of the German Transit of Venus Commission, Prof. Auwers, that Lord Lindsay was induced to take out a heliometer, and an instrument of this class, similar to those intended to be used in the Russian expeditions, was ordered in the spring of 1872 and completed in due time by the joint exertions of Messrs. Repsold, of Hamburg, and Messrs. Cooke and Sons of York. In the investigation of the constants of the instrument previous to the expedition, experience was obtained of the great precision to be attained in the measurement of angular distance between two stars by its means, and this experience led to a determination to take advantage of a near opposition of the minor planet Juno, occurring during the anticipated period of residence at the Mauritius, to investigate the solar parallax, from the diurnal parallax of the planet, by measuring its distance and angle of position with respect to a star, both morning and evening. On November 4 Juno in perigee was distant 1·029, and though the parallactic displacement in such case is considerably less than in a transit of Venus, or an opposition of Mars, it was believed that the great accuracy attained in measures with the heliometer would more than compensate for this disadvantage.

Vol. ii. of the publications of Lord Lindsay's Observatory is devoted to the discussion of the observations of Juno, preceded by a very detailed account of the instrument and its adjustments and of the methods adopted in determining its instrumental errors, as errors of scale divisions and errors of screw and of the method of observation and calculation of instrumental results. And in the event of criticism of any of the processes it must be stated that the whole of the work is so presented as to admit of future discussion, with any modification of plan that may be deemed advisable. It was originally intended that the observations should commence on October 10 and continue to the end of November. Circumstances, however, prevented so long a series of measures ; Lord Lindsay's yacht with the instruments did not arrive at the Mauritius until November 2, and it was not till November 10 that the first heliometric observations could be made. The first reliable series was obtained two evenings later, and from this time to November 30, observations were secured on twelve evenings and eleven mornings, some of them not being so complete as was desirable. It will thus be seen that Juno was past opposition before work could be commenced, and this first attempt to determine the solar parallax, through measuring the diurnal parallax of a minor planet with the aid of the heliometer, was consequently made under less favourable conditions than may be secured in future investigations of the same kind; nevertheless, it is certain that Lord Lindsay and Mr. Gill have been amply justified by the result in the confidence they placed upon the proposed methods of observation, and have proved that one means of determining the solar parallax, admitting comparatively of very frequent repetition, is comparable in point of accuracy with methods involving far greater difficulty and expense and chance of failure. In the correction of the equations of condition for errors in the tabular places of Juno, derived from observations at Greenwich, Washington, and Cambridge, U.S., it was found desirable to work upon two systems, the probabilities being rather in favour of the second. The definitive result for the mean solar parallax is 8″·77, according to the first system, and 8″·76 according to the second. To these values and their probable errors (± 0″·04) the authors do not attach high importance, indeed, a discordant value from observations on November 15 being included, they say, "if we were asked what we believe to be the most probable value resulting from the determination, we should reject this result; the values then become 8″·82 – first system; and 8″·81 – second system. At the same time we are aware that the rejection of any observation is quite unsound." In a longer series, however, it is probable, as they observe, that the single discordant value would have been counterbalanced by another.

So far as we know, this is the first application of the heliometer to observation in the southern hemisphere. We think it must be generally conceded by astronomers that Lord Lindsay and Mr. Gill have rendered an important scientific service in this introduction of the most accurate of measuring instruments in the investigation of the sun's distance, by a method admitting of such repeated confirmation. Three of the minor planets approach the earth in the present year within the distance at which Juno was observed at the Mauritius in 1874.

THE SATELLITES OF MARS.—Prof. Asaph Hall, to whom, as the discoverer of these bodies, the right of selection of names appertains has definitively decided for *Deimus* for the outer moon and *Phobus* for the inner one, agreeably as he mentions to the suggestion of Mr. Madan in these columns, founded on the lines in the "Iliad," which Pope thus renders:—

"With that he gives command to *Fear* and *Flight*,
To join his rapid coursers for the fight;
Then grim in arms, with hasty vengeance flies,
Arms that reflect a radiance through the skies."

THE DATE OF EASTER.—Easter Sunday falling on April 21, is considered late this year, and it is thirteen days after the mean date, but it is to be remarked that in no year since the introduction of the Gregorian calendar into England has the festival occurred on the latest possible date, April 25, though in two years, 1761 and 1818, it fell on March 22, which is the other limit. In 1886, Easter Sunday will fall on April 25, in the new or Gregorian style, for the first time since the year 1734, or eighteen years before this style was accepted in England. The only other occasion since the reformation of the Calendar by Pope Gregory XIII., upon which Easter has fallen on the latest possible date was in 1666, and after 1886 this will not again occur till 1943.

BIOLOGICAL NOTES

THE AGRICULTURAL ANTS OF TEXAS.—Mr. H. C. McCook has presented to the Academy of Natural Sciences of Philadelphia a memoir on the habits of these most curious and interesting ants (*Myrmica molefaciens*, Buckley = *M. barbata*, Smith). An abstract of the memoir will be found in Sheet 20 of the *Proceedings* of the above Academy (p. 299). The author encamped in the midst of a large number of the ant hills during the summer of 1877, and carefully studied the habits of the inmates; the spot selected was in the neighbourhood of Austin, Texas, upon the tableland to the south-west of the Colorado River and its affluent, Barton Creek. The limestone rock here and there cropped up, the soil was black and tenacious, varying in depth from a few inches to three feet. The formicaries were very numerous, and were to be found along roads, in open fields, and in the very streets, paths, gardens, and yards of Austin; indeed, one was even seen in the stone-paved courtyard of an hotel. They are commonly flat circular clearings, hard and smooth; a few have low mounds in the centre, composed of bits of gravel of one or two grains' weight; the clearings vary in width from twelve to two or three feet. From each, roads three to seven in number, diverge into the surrounding herbage. These are often of great length, and during the working hours are thronged by the ants going and returning. The ants take their siesta during the meridian heat of the sun, generally stopping work about twelve, and not returning to it until two or three o'clock. The seeds collected were always taken from off the ground, they were chiefly seeds of small Euphorbiaceous and Rubiaceous plants, and of grasses. The ants proved to be true harvesters. The seeds were carried into the granaries through the central gates. They were shelled, and the hulls were carried out and deposited in refuse heaps, which, when carefully searched, yielded no perfect fruits. They seemed to be most fond of the grass called *Aristida stricta*, and it even seems possible that they sow this for themselves, though the author does not commit himself to this as a fact. The interior economy of the ant-hill is fully described. Here it may be noted that the ants are clever in attack, that their "sting" is as bad as a wasp's, and that they are so well versed in the science of war, that they would have been more than a match for Mr. McCook, had he not himself employed a small army (of two men) to fight with those ants that would fight with him while he was pulling their granaries, their nurseries, and their queen's palace to pieces, in order to let us know all about them. Prof. Leidy made some remarks on this paper, adding that he had studied the habits of an allied species (*M. occidentalis*) which he had met with during a summer in the Rocky Mountains. The habits of this species were very like those of the species described by Mr. McCook, but in addition Prof. Leidy mentioned that his species fostered a fine large Coccus for its saccharine production.

THE FIRST STAGES OF DEVELOPMENT IN PLANTS.—Great interest attaches to the earliest changes occurring after the fertilisation of the germinal cell or oösphere in plants; and the difficulty of the subject has taxed the ability of the best histological botanists. To satisfy the doctrine of evolution many students think it necessary to be able to trace homologies in the development of all stem-bearing plants. The latest investigation, which appears to carry the comparison further than has yet been attempted, is that of Mr. S. H. Vines, of Cambridge, who has diligently sought out and compared all the embryological evidence, derived from the writings of Hofmeister, Hanstein, Fleischer, Mettenius, Pringsheim, and many others. He shows that in all stem-bearing plants the germinal cell (that which is fertilised) divides into two portions, one of which gives rise to an embryonic tissue called suspensor, in higher forms, while the remainder alone produces the true embryo. This comparison is of especial interest in relation to mosses. In these plants it is the spore-capsule which is the product of the fertilisation of the germ-cell, and it is this capsule which corresponds to the whole leafy plant of a fern. Following out the analogy, the seta or stalk of the capsule in a moss corresponds with the part called "foot" in an embryo fern, and with the suspensor in flowering plants. Mr. Vines's paper is contained in the

January number of the *Quarterly Journal of Microscopical Science*.

RHIZOPODS IN AN APPLE TREE.—Freshwater rhizopods are beginning to be well known, but Prof. Leidy has lately discovered a number in an apple-tree. While waiting for a railway train, last December, his attention was attracted to a large-apple tree which had then quite recently been thrown down by a storm, and from the fork of its trunk he collected a small bunch of moss, which, on examining it carefully, he found to contain a number of rhizopods. Of these one was *Difflugia cassis*; it was abundant. Another, which occurred in smaller number, was *D. globularis*, and in addition, some specimens of *Trinema acinus*, *Euglypha alveolata*, and *E. brunnea*, were met with. The moss from which they were washed with filtered water was found at a distance of about eight feet from the ground (*Proceedings*, Acad. Nat. Scien. Philadelphia, 1877, p. 321). We hope this hint will not be lost by the investigators of our British or Irish rhizopods.

THE AERONAUTIC FLIGHT OF SPIDERS.—Many observations have been made on this singular phenomenon, but the Rev. H. C. McCook is pursuing his inquiries with a perseverance that succeeds in detecting many new details in the performance. Recently (October, 1877) he paid attention to groups of young wolf-spiders (Lycosidæ), which crowded the tops of railings in a meadow. Their faces were turned in the direction from which the wind was blowing; the abdomen in each was elevated at an angle of 45°, the claws brought in, and the legs stiffened, thus raising the body. From the spinnerets at the apex of the abdomen a single thread was exuded, and rapidly drawn out to several feet by the breeze. Gradually the foremost pair of legs sank to the level of the post, and the entire attitude became that of intense resistance. Then suddenly and simultaneously the eight claws were unloosed, and the spider mounted with a sharp bound into the air, and went careering across the meadow. As far as could be observed, it appeared that the spider took a voluntary leap at the moment of loosing its hold. One spider, by good hap, was followed through its flight. The position of the body was soon reversed, the head being turned in the same direction as the wind. The legs were spread out, and were united at the claws by delicate filaments of silk. After flying a distance of about eighty feet, the spider gradually settled down upon the meadow. The difficulty of this observation will be understood by entomologists, for it required exact suitability of position as to light, the limitation of the flight to a moderate height, and a comparative moderation of its speed. (*Proc.*, Acad. Nat. Sci. Philadelphia, 1877, p. 308.)

TURKOMAN GREYHOUNDS.—The Jardin d'Acclimatation has lately been enriched (we learn from *La Nature*) with three Turkoman greyhounds of great beauty, the first specimens imported into Europe. The animals are known in the country under the name of Tazi, and are employed in catching hares, like the Sloughi in Algeria and the greyhounds in Persia. They are of noble aspect, and have great strength of muscle; their head is remarkably long and delicate in form. The hair on the body is short; but the ears (which are very large) are covered with long silken hair. Their legs are also covered with well-developed hair, and the contrast of this with the upper smooth part of the body is surprising at first sight; the dogs appearing as if they had large waving pantaloons, or reminding one of some kinds of fowl. One of the three dogs was obtained from the Kirghises of Emba, the two others at Samarkand (and by M. de Ujfalvy). We believe that it is among this breed that, as mentioned by Hamilton Smith, the *stop* greyhound is found so trained, that when a whole pack of them is in pursuit of a doubling hare, a stick thrown before it instantly produces a general halt, and one only is then signalled out to pursue the game.

GEOGRAPHICAL NOTES

CHINA.—Mr. E. C. Baber's long-deferred Report on the journey of the Grosvenor Mission through Western Yünnan, from Tali-fu to Têng-yüeh, contains much matter which is of interest from more than one point of view. The most important of his surveys is that of the route from Tali-fu to Têng-yüeh, as it connects Garnier's explorations with the work of Sladen's expedition, and thus puts Bhamo in topographical communication with Shanghai and Saigon. The survey next, but not much inferior, in importance, is the route from Yünnan-fu to Tali-fu, in which the track followed was different to Garnier's. Mr. Baber has also prepared a running survey of his route across China from Hankow to Têng-yüeh. His remarks on the native races are interesting, especially in regard to the Kutung people. What or where Kutung is he was unable to ascertain; he describes the men as of a dark reddish complexion, with rather prominent features, above the average height and well-proportioned, dressed in close-fitting woollen garments, which in some cases were neatly cut and handsomely embroidered. The women seen would have been considered handsome anywhere; paler in colour than the men, their oval intelligent faces reminded the observer of the so-called Caucasian type, and in every step and movement there was a decision and exactness very different from the motion of a Chinese. One of the women, too, was particularly remarkable for a peculiarity of her long hair, which was naturally wavy, a feature never met with among the Chinese. Mr. Baber was fortunate in seeing the quarterly fair at Tali-fu, at which some 5,000 people were present, many of them being Lolos, Shans, Thibetans, &c. At this stage of his journey he propounds a not improbable explanation of the term "golden teeth," as applied to the inhabitants, viz., that it arose from the discoloration of the teeth produced by chewing betel with lime. Mr. Baber's observations on the extent of the poppy cultivation will hardly be found encouraging by those who desire to see the consumption of opium put an end to, for he says that his party walked some hundreds of miles through poppies; and a similar remark applies to his account of the trade-route into Yünnan from Burmah. The valleys, or rather abysses, he says, of the Salwen and Mekong must long remain insuperable difficulties, not to mention other obstacles between Yünnan-fu and Têng-yüeh. The members of Col. Sladen's expedition appear to have assumed that, when the latter place is reached, the obstacles to a highway into Yünnan have been surmounted, whereas the fact is that the difficulties begin at that place. Loth as most Englishmen are to admit it, Mr. Baber adds, the simple and evident approach to Eastern Yünnan is from the Gulf of Tonquin, but it by no means follows that the same holds true of the western part of the province. In conclusion we may mention that an interesting feature in Mr. Baber's report is his comparison of Marco Polo's narrative with his own experiences, and his verification in many respects of the Venetian's information respecting a country almost entirely unknown to Europeans.

PRJWALSKY'S JOURNEY TO LOB-NOR.—In the *Isvestia* of the Russian Geographical Society, and as Supplement 53 to Petermann's *Mittheilungen*, the narrative of Prjwalsky's journey from Kuldja to Lob-Nor and the Altyn-Dagh, is now published, with maps showing the route and the discoveries made. We have already referred to the results of this important journey between August, 1876, and July, 1877, a journey which the enthusiastic Dr. Petermann regards as the crown of Central Asiatic exploration, and as equal in importance to Stanley's journey down the Congo, or even the attainment of the Pole. Prjwalsky gives ample details as to what he saw along the route, and his observations will be of special value to the ethnologist as containing important details concerning the various peoples he met with. The zoologist and botanist will also find much to interest them. Not only does he bring certain information on the Lob-Nor, which is little better than a marsh, apparently drying up, but also makes an important contribution to our knowledge of the great mountain plateau which separates India from Central Asia. The Lob-Nor basin forms the foot of the Kuen-luen and of the great plateau which stretches from the plains of India over the Himalayas, the Karakorum, the highlands of Khor, in an unbroken sweep to the basin mentioned. Close by the Lob-Nor this mountain rises like a wall out of the low plain, some of the lowest valleys having a height of 10,000 feet above the sea. From this northern slope on the Lob-Nor, at about 60° W. long., the plateau stretches away south, for 13° (850 miles) to its southern slope on the Indian plain. At the meeting, on February 20, of the Russian Geographical Society the Secretary read a letter from Col. Prjwalsky, dated Fort Zaisan, January 11. The traveller said that, after having seen the impossibility of penetrating into Tibet *viâ* Lob-Nor, he was compelled to try the indirect route *viâ* Guchen and Hami, whence he proposed to go south to Tsandam and to Hlassa, crossing the sources of the Blue River. Thus, he left Kuldja on September 9, and reached Guchen. As along the whole of the route to Guchen, which passes through the towns Shikho and Manas, there were Chinese troops, as also many *champans* (convicts condemned to hard labour), Col. Prjwalsky followed another route, viz., to Lake Ebi-nor, thence north to the Saur Mountains, and thence to Guchen, along the route followed in 1875 by Col. Sosnovsky. Thus, he reached Guchen about the beginning of November, but here a serious illness compelled him to return to Zaisan, which he reached on January 13. A later telegram announced that the indefatigable traveller had recovered and that he was again on his way to Tibet.

MONGOLIA AND SIBERIA.—At the same meeting a letter from the traveller Potanin dated Bjisk, January 14, stating that he had arrived at the end of his Mongolian journey, after obtaining many hypsometrical and topographical data, as well as making rich botanical, zoological, and mineralogical collections. The Secretary of the Society gave a review of the activity of the Siberian department. Two expeditions were sent out by this department during the past year, one, which will be absent for several years, under the leadership of M. Czerski to investigate the shores of Lake Baikal geologically, the other conducted by M. Agapidin, to examine the flora of the district of Balagansk in the government of Irkutsk.

NEW GUINEA.—The Rev. S. Macfarlane has just sent home a report of a voyage which he made towards the close of last year from Murray Island to the east end of New Guinea, and in the course of which he visited several places previously unknown. He mentions having gone on shore near Killerton Point, not far from East Cape, where he found himself unable to communicate with the people except by signs, for they could not understand any of the dialects spoken at Teste Island, Port Moresby, and Murray Island, nor the Eastern and Western Polynesian languages, though upon inquiring the names of things, Mr. Macfarlane's companion thought he detected a resemblance to the Raratongan. The locality visited not suiting their purposes, the party went six or seven miles further to the eastward, and landed at the mouth of a river or mountain stream, where the hills slope down to within a short distance of the beach, and behind the village there is a well-wooded, fertile, and lovely valley. Mr. Macfarlane describes the neighbourhood as thickly populated, though the people are scattered in small villages within hailing distance of each other. Speaking generally, he says that the country about the east-end of New Guinea has a totally different appearance from that in the vicinity of Port Moresby, and the contrast was very striking. The former looked lovely and luxuriant, like the South Sea Islands, whilst the latter had a barren, brown, parched appearance, as if two days' sail had brought the party into a new country in quite a different latitude. We hear that Mr. Andrew Goldie, to whose gold discoveries in New Guinea we have before alluded, has sent home to the Earl of Glasgow an account of his recent explorations, accompanied by a sketch map and several drawings. At Mr. Goldie's request, his Lordship has handed the papers to the Geographical Society, and they will probably be read at one of the meetings during the present session.

LAKE NYASSA REGION.—A paper was read at Monday' meeting of the Royal Geographical Society, by Mr. H. B. Cotterill, "On the Nyassa, and a Journey from the North-East to Zanzibar." In August last he met Capt. Elton and some friends at the south end of the lake, and ran up the west coast. They were detained some days under Mount Chombi, which he ascended, and found to be about 4,000 feet above the lake. The high land on the west of the lake was found to trend off in a north-westerly direction. They at last made a start with about fifty men. Their route crossed the Chombaka River. The whole of the country was covered with groves of banana They procured other carriers and crossed the Chombaka Valley, crossing the river several times and passing two very beautiful little lakes. In crossing the Chombaka for the third time at a point where it flowed through a very deep ravine, they struck more towards the north. They found stretching away to the east and south-east a great plain bounded in the far distance by a towering range of mountains that evidently ran up from the eastern side of the Nyassa towards the north-west. The native name for these mountains and the surrounding country is Kondi. They had been gradually ascending since they left Nyassa, and when they reached Mazote's, they were at an elevation of about 6,000 feet above the sea. It was decided that some of them should push on to Mereri's Town. So Capt Elton and he and another started off, and having crossed the Kondi Range, they found themselves on a great plateau, 7,000 feet high, called Uwanji, a splendid cattle country, watered by many streams. Crossing the Makesumbi River, they found themselves in an undulating country, covered with thick bush. There Capt. Elton began to break down, and at South Ushekhe breathed his last. They then had to traverse some 350 miles of the Ujiji caravan route, and on the last day of February reached Zanzibar.

INDO-CHINA.—Dr. G. Barrion, a French naval surgeon is about to undertake an exploring journey to the Indo-Chinese peninsula.

MR. STANLEY has announced to the Paris Geographical Society that he will visit Paris in June, before his departure for America, to receive the medal the Society has awarded him.

NOTES

ROBERT JULIUS V. MAYER, whose name is so intimately associated with the mechanical theory of heat, died at his native town, Heilbronn, on the 21st inst., in his sixty-fourth year. We can only intimate the event this week, but hope next week to be able to speak in detail of Mayer's life and work.

IN connection with our article on Harvey in this number, we may remind our readers that for some time a movement has been on foot for the erection of a statue to Harvey in his native town, Folkestone. Only 800*l.*, half the sum requisite, has been obtained, and we are sure many of our readers, on being made aware of the deficiency, will be glad to help to fill it up. Donations may be sent to the hon. treasurers of the fund, Sir George Burrows and Mr. Prescott Hewett, or to the hon. secretary, Mr. George Eastes, M.B., 69, Connaught Street, Hyde Park Square, W.

A great banquet, under the auspices of the College of Physicians, to be held on the day of the Harveian oration, is also talked of, but judging by the apathy shown generally on the subject of Harvey's tercentenary, it is not very probable it will come off. How is it that we take so little trouble here to keep alive the memory of our great dead?

WE notice the death of Prof. A. Lamy at Paris on the 20th inst. For a number of years he has occupied the Chair of Industrial Chemistry at the École Centrale. As an investigator his name is chiefly known in connection with the metal thallium. Very shortly after the detection of its spectrum by Mr. Crookes in 1861, he observed the same phenomenon in the lead works at Lille; and his isolation of the metal and descriptions of its properties followed so closely on the announcements of the English chemist that the question of priority was vigorously discussed for some time, until finally decided against him. Contemporaneously with Mr. Crookes he submitted the new element to a careful examination, and it is to him we owe the first determination of the atomic weight 204, the discoveries of the poisonous properties, of the close relations with the alkaline group, of the remarkable thallium alcohols, and the preparation of thallium glass. In 1869 Lamy invented the two valuable pyrometers associated with his name, the one based on the dissociation-tension of calcium-carbonate for temperatures above 800°, and the second containing instead of carbonate the compound $CaCl_2,8NH_3$ for temperatures below 42°. In physics he studied the electric properties of sodium and potassium, and was the first to produce induction currents by means of terrestrial magnetism.

THE death is announced of Michel-Charles Durieu de Maissonneuve, on February 20, aged eighty-two. He was honorary director of the Gardens of Bordeaux. As member of the Scientific Commission of Algeria he was known to botanists for his researches in the flora of that country.

WE regret to announce the death of Prof. Gustav Willmanns of Strassburg University, well known through his African explorations and discoveries. Prof. Willmanns was only thirty-two years of age.

IN the course of a few weeks a festival will be held in the city of Liége, to celebrate the fortieth year of the professorship of Theodore Schwann, the author of the cell-theory. To some of our readers it will be a startling piece of intelligence that the founder of modern histology is actually at this moment alive, and teaching as Professor of Physiology in the Belgian University. The committee charged with the management of the celebration desire the co-operation of scientific bodies and of individuals in this country. We are authorised to draw the attention of officials of the learned societies and other corporations to the approaching event, and to beg them to obtain some expression of sympathy with the object of the celebration—viz., the doing homage to the genius of Theodore Schwann. It is requested that letters intended to be read at the celebration may be forwarded either direct to the secretary, Prof. Edouard van Beneden, Liége, or to Mr. Ray Lankester, Exeter College, Oxford. All Englishmen of science who have specially occupied themselves in the field of work opened up by Schwann, are begged to communicate individually with either of the above-named gentlemen, and to forward their photographs for insertion in an album which is to be presented to the founder of the cell-theory.

M. RAOUL PICTET, at Geneva, in consideration of the importance of his discoveries with regard to the liquefaction of gases, has had the honorary title of Doctor of Medicine conferred upon him by the University of Jena.

IT was stated at the last meeting of the Royal Dublin Society that a new explosive agent has been discovered by Prof. Emerson Reynolds, in the Laboratory of Trinity College, Dublin. It is a mixture of 75 per cent. of chlorate of potassium with 25 per cent. of a body called sulphurea. It is a white powder, which is very easily prepared by the mixture of the materials in the above-named proportions. The new powder can be ignited at a rather lower temperature than ordinary gunpowder, while the effects it produces are even more remarkable than those caused by the usual mixture. Dr. Reynolds states that his powder leaves only 45 per cent. of solid residue, whereas common gunpowder leaves about 57 per cent. It had been used with success in small cannon, but its discoverer considered that its chief use would be for blasting, for shells, for torpedoes and for similar purposes. Dr. Reynolds pointed out that one of the advantages this powder possesses is that it can be produced at a moment's notice by a comparatively rough mixture of the materials, which can be stored and carried without risk so long as they are separate. The sulphurea, the chief component of the new explosive, was discovered by Dr. Reynolds about ten years ago, and could be easily procured in large quantities from a product of gas manufacture which is at present wasted.

THE annual meeting in London of the Iron and Steel Institute commenced yesterday, and will be continued to-day and to-morrow. Discussions will take place on papers read at the Newcastle meeting, and several papers will be read on subjects of technical interest.

THE great forge of Creusot has just despatched for an Italian ironclad two steel plates, weighing respectively 23,000 and 31,000 kilogrammes. They required a special railway train constructed for the purpose. The recent experiments at Spezia show that vessels protected by these plates are absolutely imperforable by any missiles so far known.

THE rare phenomenon of St. Elmo's fire was observed at several localities in the Harz Mountains during the past month. At Blankenburg it occurred at a temperature of + 0°·5 C. and pressure of 721·5 mm., after a series of storms. The air was so laden with electricity, that canes held aloft emitted from their points light blue flames five inches in length and three in breadth. In Döblitz the phenomenon occurred in the midst of a storm, half snow and half rain, when the ends of the branches in an entire grove were surmounted by flames from four to five inches in length.

A THEORY of the chemical action of light recently propounded by M. Chastaing is controverted by M. Vogel (in the reports of the German Chemical Society), who cites various facts to show that rays of any kind are capable of producing either an oxidising or a reducing action on inorganic substances, according to the nature of the substance by which they are absorbed; there is no ground for attributing to the less refrangible rays in all cases an oxidising, and to the more refrangible a reducing, power. M. Chastaing's second proposition, that light has an oxidising action on organic substances, which is strongest in the violet and weakest in the red, is also opposed by M. Vogel.

CAPE COLONY, New Guinea, the Australian Colonies, the South Seas, and, it would appear, almost every known portion of the southern hemisphere, have been suffering from a severe and protracted drought. Shade temperatures of 124° and 127° are reported from the interior of Australia, the heat being much less intense near the coast, owing to the strong sea-breezes which prevail in connection with the great heat of the interior. Sheep, cattle, horses, and the wild animals of these regions are dying off in thousands. In Cape Colony, in particular, complete ruin has overtaken large numbers of the settlers, many of the homes of hitherto well-to-do colonists having been broken up, and the several members gone into menial service in exchange for the barest necessaries of life. We have received several letters on this subject already, and shall be glad if our readers in the regions named will favour us with any information of which they may be in possession, suggesting or disproving the cyclical character of these droughts.

A PARIS correspondent sends us the following:—On March 15 a parricide was guillotined at Evreux (Eure), and a fraternity for burying the dead existing in the place, the body was not, as usual, thrown into a large basket and sent hurriedly to its grave. An ordinary coffin was prepared, and as soon as the execution was completed the corpse was laid in it. To the horror of the spectators the body was seen to be agitated by spasms so powerful that it almost jumped twice out of the coffin, and it was necessary to use force in order to control its motions. These contractions were, of course, unaccompanied by consciousness.

IN connection with the lamentable catastrophe to the *Eurydice* Sir George Airy sends to the *Daily News* some valuable information as to the meteorological condition on Sunday:—On Sunday, March 24, between 1h. 30m. and 3h. 0m., the wind, which had previously been almost imperceptible, had four times risen to a pressure of 1½ lb. per square foot; but from 3h. 0m. to about 3h. 55m. it was nearly calm, the pressure scarcely exceeding ¼ lb. per square foot. During the former of these two periods the direction of the wind had been fluctuating on both sides of west, but during the latter it was for the most part west-south-west. At 3h. 56m. nearly the direction changed very suddenly to north-north-west, and the force changed with most unusual suddenness to 4 lb., from which it rose at 4h. 3m. to 9 lb. per square foot. It declined for a time, but rose at 4h. 40m. to 10 lb. It fell and rose once more, and finally sank at 5h. 30m. to almost perfect calm. The fluctuations of the barometer were very inconsiderable. At 2h. 30m. it stood at 29·35 inches; at 3h. 56m. it was 29·28; and at 5h. 30m. was again 29·33. The temperature about 2h. 0m. had been as high as 49°, diminishing with fluctuations (probably produced by clouds) to 45° just before the squall. With the squall it sank most rapidly to 38°, and continued to fall, till at 5h. 0m. it was about 32°."

FROM an inquiry on the electromotive force and internal resistance of some thermopiles, those of Noë, and of Clamond, modified by Koch, M. Beetz concludes (*Ann. der Phys.*, No. 1) that the latter, from its great solidity, is preferable for technical purposes. That it requires to be heated long before use is of little consequence, and once in action, it works on with great constancy, both as regards electromotive force and resistance. Though, with an equal number of elements, the electromotive force is under that of the Noë pile, its utility is not less, as the elements can be easily increased. Only the burner must be improved in construction. On the other hand, the Noë pile offers the great advantage for laboratory purposes, that (by coupling several cylindrical piles) a productive current-source is readily obtained, with very constant electromotive force; the duration has been considerably improved in the new construction.

ACCORDING to *La Nature* the telephone is finding great favour in Spain; a goodly number are being produced in Barcelona, and numerous applications made of them. Telephonic chambers are being constructed designed to isolate the hearer from external noises and render communication more easy and sure. These chambers are of small size and have glass windows for light; the doors are closed with pads of caoutchouc. Telephony was lately tried between Barcelona and Saragossa, which are about 364 kilometres apart. The communication was satisfactory at the former place (notwithstanding bad weather); at Saragossa it was somewhat imperfect, which is accounted for by the telephonic chamber having been used at one place but not at the other.

As the latest instance of collections of personal contributions to scientific literature, we notice the appearance in Paris of a handsome volume containing Prof. Kuhlmann's various researches during the past half-century. The work affords not only an interesting glimpse into the lines of investigation followed out by a single mind, but also into the general progress of applied chemistry since 1830; for there is probably no chemist alive who has done more for the practical application of his science than this Lille professor. The present volume contains detailed accounts of the baryta industry, which he created, of the general introduction of crystallisation into technical operations, of the phenomena accompanying the use of cements and the formation of stone, as well as the minute studies on the formation of nitrates and artificial manures, on the crystallisation of insoluble bodies, on the madder dyes, as well as a great variety of other technical and purely scientific subjects. Prof. Kuhlmann is now in his seventy-fifth year, but is still able to contribute occasionally the results of new investigations.

UNDER the editorship of Heinrich and Gerhard Rohlfs, assisted by a numerous staff, Hirschfeld, of Leipzig, is publishing a new quarterly journal under the title *Deutches Archiv für Geschichte der Medizin und medizinische Geographie.*

THE French Academy has published the seventh edition of its "Dictionnaire de la Langue Française." Scientific terms have not been admitted into the general vocabulary except such as are now in common use and cannot be ignored even by unscientific persons.

MR. STAB, corresponding member of the Society of Arts, at Smyrna, reports that the plague of field-mice, or rats, has again broken loose, and that they are wasting the fields far and wide, digging up the seed-corn, and devouring all they can. This is the plague from which Homer records that Apollo Smynthius delivered the Greeks. As the Smynthian Apollo no longer has believers, Mr. Stab wishes to know what remedy can be recommended. The western states of America suffer much from this pest.

DR. A. B. MEYER, of the Royal Zoological Museum, Dresden, writes, in answer to Mr. Boulger's inquiry (vol. xvii. p. 392), that the reason why Mr. W. W. Wood did not send specimens of Navicula (NATURE, vol. xii. p. 514) is, that he died a short time after he wrote that letter. Dr. Meyer heard this from a Manila friend.

A BOTANICAL Exchange Society has been established at Buda-Pesth for the purpose of exchanging specimens of the native plants of Hungary, Transylvania, Croatia, Sclavonia, and, as far as possible, of Turkey and Russia, for those of other parts of the world. During the last two years upwards of 300 botanists have joined the Association, and more than 120,000 specimens have been distributed. All communications and applications for further information should be addressed to Herr Richter Lajos, Erzherzogin Marie Valerie Gasse, Nro. 1, Buda-Pesth, Hungary, accompanied by a subscription of 4 marks, or 5 francs, for which sum an exchange of 100 specimens will be effected.

A LECTURE will be delivered in the Theatre of the Royal Engineer Institute, Chatham, at five P.M., on April 3, by Prof. Huxley, F.R.S., on "The Geographical Distribution of Animals; and on Collecting and Observing in Aid of the Investigation of the Problems connected therewith."

ELECTRIC lights are becoming very common in Paris. The Lontain system is now working daily at the Lyons railway terminus at the expense of the Company. M. Jamin has published an elaborate article on the subject in the last number of the *Revue des Deux Mondes*.

THE telephonic signal invented by MM. Henry Brothers was exhibited at a lecture delivered at Montrouge under the auspices of the Paris municipal authorities. One apparatus was placed at the Mansion House and another at the Public School, at a distance of 500 metres. When each apparatus was used as a signal giver and connected with an ordinary telephone as receiver an air played at one end of the line could be heard by the whole audience at the other end. The Henry signal is constructed to work with a dry element, and requires no other wires than those of the telephone.

THE *Midland Naturalist* continues to keep up the promise of its first number. No. 3, for March, has the first part of a lecture by Dr. Cobbold on the Parasites of Man, and among other interesting papers we may note those of Mr. Robert Garner on Edward Forbes and his Country, and the Ray and Palæontographical Societies: An Appeal, by Mr. W. R. Hughes.

Photographic Rays of Light is the somewhat unhandy title of a new photographic quarterly published in Baltimore, U.S.A. The contents are varied, and the journal seems likely to prove useful to photographers. The first number contains a photographic plate, "A Study in Artistic Photography."

IN the February session of the Berlin Anthropologische Gesellschaft, Dr. Rahl-Rückhard delivered an elaborate address on the anthropology and ethnology of South Tyrol, a subject which has hitherto been untouched. This region has been swept over by so many tidal waves of invasion that the character of the original inhabitants has hitherto been entirely unknown. In order to solve the problem a large collection of skulls was obtained from an ancient charnel-house at Meran, and submitted to careful measurements. The results showed that they belonged to two sharply-defined classes. The first, a brachycephalic type, was evidently identical with that of the ancient Rhætians who formed the aboriginal population at the advent of the Teutonic tribes. The second variety, an orthocephalic type with dolichocephalic tendencies, cannot easily be classified. It is, however, certain that it does not coincide with the cranial type of the ancient Helvetians in the neighbouring parts of Switzerland.

AT the workshops of the Michigan Central Railway at Jackson, Michigan, an interesting experiment was recently made, in order to ascertain the very shortest time in which a locomotive engine could be mounted ready for use from the finished component parts. Up to the present this work had been generally done by about five or six workmen in the space of from nine to fourteen days. When the fact became known that a Mr. Stewart of Jackson had done the work with fourteen workmen in twenty-five hours, and a Mr. Edington, with the same number of workmen, in 16½ hours, a bet between these two gentlemen was the result; and before a number of spectators they eventually both proceeded to mount a locomotive engine, each being assisted by fourteen workmen, and having all the parts of which the engine consists ready at hand. They accomplished the task in the remarkably short period of two hours and fifty-five minutes. The bet was won by Mr. Edington, who finished one minute sooner than his antagonist.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mrs. Baxter; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. Jas. Bennett; a Malayan Bear (*Ursus malayanus*) from Malacca, presented by Mr. S. Palmer; a Short-toed Eagle (*Circaetus gallicus*), South European, presented by Mr. H. M. Upcher; a Savigny's Eagle Owl (*Bubo escalaphus*) from Persia, presented by Dr. J. Huntly; two Reindeer (*Rangifer tarandus*) from Lapland, deposited; a Beccari's Cassowary (*Casuarius beccarii*) from South-East New Guinea, a Plantain Squirrel (*Sciurus plantani*) from Java, a Spotted Eagle Owl (*Bubo maculosus*) from South Africa, a One-streaked Hawk (*Melierax monogrammicus*) from West Africa, two Matamata Terrapins (*Chelys matamata*) from the Upper Amazons, an Anaconda (*Eunectes murinus*) from South America, received in exchange.

MIMICRY IN BIRDS

WE have received two interesting contributions to this subject. One is contained in *The New Moon*, or Crichton Royal Institution Literary Register for November, 1873, being the observation on a starling by Dr. Crichton, the Medical Superintendent.

"Two or three years ago," he states, "in accordance with our principle of encouraging birds to become denizens of the grounds, we put up a few boxes for starlings. One of these was placed on the window sill of the writer's bedroom. Two years ago one of these birds took possession of the aforesaid box. Every morning, for two or three hours, he perched himself on an iron railing, erected to protect flowers, within two feet of the window, and there executed a comic medley with all the precision and effect of a finished *artiste*. The attention of the writer was first called to this extraordinary performance by having his window every morning surrounded by what appeared to be a general assembly of the whole tribe of *Aves*, wild and tame. The quacking of the duck, the screech of the lapwing, the eerie notes of the moorland plover, and many others, were imitated with a precision worthy of Mimos himself. He failed, however, to secure a mate for that year. Last year he was more successful. He revisited in spring his former cottage, and brought a mate with him. The usual family arrangements were made with the greatest care and despatch, when, in due time, a brood of young linguists made their appearance. During the hatching season our linguistic friend, every morning at dawn, resumed his perch within three feet of my bed, and for two or three hours, he repeated his extraordinary performance. The birds imitated always with the greatest precision are the hen, duck, goose, lapwing, plover, heron, and gull. The song or whistle of many small birds are also imitated. The only human note imitated is the whistle of the boy. This is frequently heard. It always begins on the same pitch, and passes downward through a major third, forming a beautiful musical curve. He is gradually adding to his vocabulary. During twelve months he has certainly added the cry of the heron, the gabble of the goose, and the cackle of the hen.

Mr. H. O. Forbes sends us the following instance:—

In the grounds of a friend in the neighbourhood of London, a colony of starlings had for many years built their nests in the trees in boxes placed here and there for their accommodation. The children of the house—all quite young then—a few years ago—at whose presence the birds showed not the slightest alarm, were constantly playing about close to the nests, and of course constantly calling each other by name. There was only one girl in the family, called *Maggie*, and as she was a great pet, perhaps her name was oftener mentioned than those of the others. Be that as it may, her father was one day greatly astonished by hearing his daughter's name pronounced in exact imitation of the voice of one of her brothers, whom he knew could not be near. For a moment he was puzzled, but close at hand, on the bough of an acacia tree, he detected the mocking-bird—a common starling—in the act of deception, which he continued to practice often afterwards.

AMERICAN SCIENCE

THE comparison of the intensities of light of different colours has long been considered one of the most difficult of photometric problems. In the February number of the *American Journal of Science and Arts* Mr. Rood describes a simple method of making this comparison. The luminosity of cardboard painted with vermilion, *e.g.*, was determined thus:—A disc of the cardboard is attached to the axis of a rotation apparatus, and smaller discs of black and white (in sectors) are fixed on the same axis, so that by varying the relative proportions of black and white a series of grays can be produced at will. The compound black and white disc is first arranged to give a gray decidedly darker than the vermilion; this tint is now gradually lightened till the observer becomes doubtful as to the relative luminosities of the red and gray discs; the angle of the white sector is then measured. Next a gray decidedly *more* luminous than the vermilion is compared with it, and diminished in brightness till the observer again becomes doubtful, when a second measurement is taken. (The manipulation is done by an assistant without the experimenter knowing the exact black and white discs chosen.) From a number of such experiments a mean is obtained, which (it is proved) expresses the luminosity very correctly.

In an interesting paper on the glycogenic function of the liver Mr. Leconte, after stating that "the sole object of this function is to prepare food and waste tissue for final elimination by lungs and kidneys; to prepare an easily combustible fuel, liver-sugar, for the generation of vital force and vital heat by combustion, and at the same time a residuum suitable for elimination as urea," points out that the function is not *sugar-making*, as usually supposed, and which is a pure *chemical process* and *descensive* metamorphosis, but *glycogen-making*, *a vital function*, and *ascensive* metamorphosis. In diabetes the true organ *directly* in fault is not the kidneys nor the lungs, but the liver, which fails to arrest the sugar as glycogen. The starch-making function in plants offers a striking analogy to the function under consideration; for plants change soluble forms of amyloids (dextrin and sugar), into the insoluble form of starch (corresponding to glycogen, which is animal starch), and store it away for future use. This analogy is more remarkable in the lower animals and in embryonic conditions; the function often residing *in all parts* in such cases (as plants), while in higher animals it is confined to the liver. And it is sluggish animals that accumulate most glycogen in their tissues. Plants, however, store away the starch as building materials; animals, as fuel for force-making. Further attention is called to the close relation between the functions of the liver and kidneys. As we descend the animal scale, we find cases (*e.g.* insects) in which the same organ performs both functions. The fact of a large percentage of glycogen being found in the tissues of entozoa, which do not need any internal source of heat, is regarded by Mr. Leconte as a striking proof (if any were still needed) that the prime object of respiration is not *heat-making*, but *force-making*. Heat is only a concomitant, often useful, but sometimes useless, and even distressing.

Mr. Trouvelot, of Cambridge, furnishes accounts of three celestial phenomena observed by him, viz., undulations in the train of Coggia's comet, sudden extinction of the light of a solar protuberance, and the zodiacal light of the moon.

The atomic weight of antimony having been variously given by MM. Schneider, Dexter, and Dumas (using different methods), as 120·3, 122·3, and 122 severally, Mr. Josiah P. Cooke, jun., was led to a fresh study of the subject. The general conclusion which he reaches, after a very patient and laborious investigation (which the chemist will find highly instructive) is that the most probable value is $Sb = 120$ when $S = 32$.

SOCIETIES AND ACADEMIES

London

Linnean Society, March 7.—Dr. Gwyn Jeffreys, F.R.S., vice-president, in the chair.—Mr. Thos. Christy exhibited a series of fruits, among which were Chinese quinces, chayottes, and a remarkable citron known in China as the "claw of Buddha."—Prof. Ray Lankester also brought forward and made remarks on a collection of fossil walrus tusks (*Trichecodon Huxleyi* [?]) from the Suffolk crag, and sent him for examination by Mr. J. E. Taylor, of the Ipswich Museum.—Examples of a variety of *Helix virgata* were likewise shown by Mr. Rich.—On nudibranchiate mollusca from the eastern seas, by Dr. C. Collingwood, was the first paper read. He remarks that residents searching carefully within limited areas have more chance of obtaining new and interesting forms than have zoologists or extensively equipped expeditions who but pay hurried visits to tropical coasts. Season and other influences have much to do with abundance or paucity of species in given localities. He gives curious instances of specimens of nudibranchs, isolated in a dish of sea-water spontaneously and uncommonly neatly amputating the region of their own mouth. With other information the author further describes sixteen new species, illustrating the same with coloured drawings from nature. Mr. Thos. Meehan's paper, on the laws governing the production of seed in *Wistaria sinensis*, was communicated by the Rev. G. Henslow in the absence of the author. The latter alludes to the fact that the Wistaria, when supported, grows amazingly, but is seedless; on the contrary, the self-supporting so-called "tree-wistarias" produce seeds abundantly. These cases illustrate the difference between vegetative and reproductive force; they are not antagonistic, but supplement each other. While Wistaria flowers freely without seeding, it has been supposed this arises from the bees not cross-fertilising. Mr. Meehan submits data, however, in which he thinks the question lies rather in the harmonious relation between the two above nutritive powers than with insect pollenisation.—The Rev. M. J. Berkeley in an examination of the fungi collected during the Arctic Expedition 1875–76, mentions twenty-six species were obtained, all determined save two. Seven are new species, and seventeen already known widely distributed forms. The *Agaricus Feildeni* and *Urnula Hartii* are unusually interesting.—A paper on the development of *Filaria sanguinis hominis*, and on the mosquito considered as a nurse, by Dr. P. Manson, was read by Dr. Cobbold. Discussing general questions, he proceeds to show that the female mosquito, after gorging with human blood, repairs to stagnant water and semi-torpidly digests the blood. Eggs are deposited which float on the water and become the familiar "jumpers" of pools. The filariæ thus enter the human system along with the drinking water. Dr. Manson got a Chinaman whose blood was previously ascertained to abound with filariæ to sleep in a "mosquito house." In the morning the gorged insects were captured and duly examined under the microscope. A drop of blood from the mosquito was thus found to contain 120 filariæ, though a drop from a prick of the man's finger yielded only some thirty. The embryo once taken into the human body by fluid medium pierces the tissues of the alimentary canal. Development and fecundation proceed apace, and finally the filariæ met with in the human blood are discharged in successive and countless swarms, the genetic cycle being thus completed.—Dr. Cobbold, on his own behalf, further contributed a paper on the life history of *Filariæ bancrofti*, as explained by the discoveries of Wucherer, Lewis, Bancroft, Manson, Sonsino, and others.—Mr. Charles C. B. Hobkirk, of Huddersfield, was duly elected a Fellow of the Society.

Chemical Society, March 7.—Dr. Gilbert, vice-president, in the chair.—The following papers were read:—On some new derivatives of anisoïl, by W. H. Perkin. The author has obtained orthovinylanisoïl boiling 195°–200° C., sp. gr. at 15, 1·0095; orthoallylanisoïl, boiling 222°–223° C. sp. gr. at 15, ·9972; and orthobutenylanisoïl, boiling 232°–234° C. sp. gr. at 15, ·9817. The author compares the physical properties of the ortho- and para- compounds; the former boil about 10° lower, have a slightly higher specific gravity, and crystallise with much greater difficulty.—Note on the action of ammonia on anthrapurpurin, by W. H. Perkin. The author has investigated the colouring matters produced by the action of heat on an ammoniacal solution of anthrapurpurin in sealed tubes at 100° and 180° C. At the former temperature an unstable substance was obtained dyeing alumina mordants purple and weak, iron mordants indigo blue. At 180° a new substance, anthrapurpuramide, was formed, which does not dye mordants.—On certain polyiodides, by G. S. Johnson. The author attempted without success to prepare a compound having the composition $AgRI_6$, or a similar substance having thallium in place of silver; various compounds of silver and potassium, thallium and potassium, and especially a very complicated substance containing lead, acetic acid, potassium, and iodine were formed and analysed. The latter substance crystallises in square prisms; of the six phases two have a dark purple and four a greenish golden reflection.—On an improved form of wash-bottle, by T. Bayley. The object of this contrivance is to prevent the reflux of steam or other gases, such as ammonia, into the mouth of the operator, without losing the advantages of the ordinary wash-bottle.—On the preparation of glycollic acid, by R. T. Plimpton. The author endeavoured to prepare this substance by the method recommended by Prof. Church, but only obtained quantities too small for analysi, using two ounces of oxalic acid.

Edinburgh

Royal Society, February 18.—Sir William Thomson in the chair.—Prof. Fleeming Jenkin read a paper on the application of the graphic method to the determination of the efficiency of a direct acting steam-engine. His results show that it is impossible to determine by empirical laws the efficiency of an engine as it varies with every change in the rate of action, the point at which the steam is cut off, &c.—Prof. Tait communicated a paper by Mr. Alexander Macfarlane, M.A., B.Sc., on the disruptive discharge of electricity. The difference of potential required to produce a spark between spheres for distances up to 15 centimetres is proportional to the square root of the distance between their centres and between parallel plates; it is a hyperbolic function of the distance between them; for a constant distance it is a similar function of the pressure of the gaseous medium for a range of pressures of from one atmosphere to 20 mm.—Mr. J. Y. Buchanan, of the *Challenger*, read a paper on the compressibilities of distilled water, sea-water, solution of chloride of sodium, and mercury. They were determined by instruments resembling piezometers immersed in the sea when free from currents, the approximate pressure being ascertained by the sounding-line. The compressibilities at various temperatures relative to that of distilled water were ascertained by compression in a powerful Bramah press. The compressibilities being found, these same instruments were used for measuring depths of the sea accurately when currents, &c., affected the indications of the sounding-line. A water piezometer was found to be much more sensitive to pressure than to temperature, a mercury one very sensitive to temperature and not so to pressure. The approximate depth was ascertained by the sounding-line, to which were attached the two piezometers. From the indications of the line and of the mercurial instrument the temperature of the bottom was approximately determined. This, applied to the indication of the water instrument, gave the depth accurately, and hence the true temperature was found from the mercurial. He described a new method of getting the compressibility of glass.—Prof. Crum Brown and Mr. A. Blaikie gave a paper on the decomposition of the salts of trimethyl sulphine by heat.—Sir Wm. Thomson communicated extracts from letters of Prof. Quincke, who has found that the surfaces of glass and quartz which have been for some time cut, change very much in their indices of refraction.—Prof. Jenkin mentioned some experiments by Mr. Gott on the telephone, which, he maintained, completely confirm Prof. Graham Bell's theory of the telephone.

Scottish Meteorological Society, February 1.—It was stated in the report from the Council that the Government had paid 1,000*l.* to the Society for past services rendered by it to a public department; that the Society has 102 regularly observing stations, in addition to the sixty lighthouse stations on the Scottish coast, and a large number of rain-observing stations; and that during the past four months seventy-five new members had been added to the Society.—Mr. Buchan read a paper on the weather of 1877, more special attention being given to the rainfall, the paper being illustrated by thirteen maps coloured according to the quantity of rain which fell in each month in different parts of the country. The maps represented in a strong light the influence of the physical configuration of the land on the rainfall in relation to different winds, both as regards their direction and their height in the atmosphere.

PARIS

Academy of Sciences, March 18.—M. Fizeau in the chair.—The following papers were read:—Motion of translation of cyclones; theory of a "rain motor," by M. Faye. He cites with satisfaction Prof. Loomis's recent conclusion from observations of the U.S. Signal Office, that "rainfall is not essential to the formation of areas of low barometer, and is not the principal cause of their formation or of their progressive motion"; and he regrets that the theory to which the "rain motor" belongs dies so hard.—On a trombe observed at sea, in December last, in the Straits of Malacca, by M. Faye. This was seen to descend from the clouds and penetrate the sea; the water rose round and exteriorly to the trombe.—M. Tisserand was elected member for the section of astronomy in place of the late M. Leverrier.—On the measurement of the mean density of the earth, by MM. Cornu and Baille. They have improved their apparatus by using four (instead of two) attracting spheres of mercury, and diminishing the distance of attraction. From an analysis of Baily's experiments, and with regard to resistance of the air, they show that the result was to assign too high a value for the mean density of the earth.—On the marine mollusca of Stewart Island (New Zealand), by M. Filhol. The number of these is 179.—Influence of rest and of motion on the phenomena of life, by M. Horvath. He placed in glass tubes a liquid favourable to multiplication of bacteria, and containing some alive. Some of the tubes were then continually agitated, while others, with the same quantity and at the same temperature, were left at rest. There was abundant multiplication in the latter, none in the former.—On interstitial fibromas of the uterus, by M. Abeille.—On improvements in the telephone, by M. Navez. He claims priority in use of the Ruhmkorff coil (which use, however, M. du Moncel carries back to Gray). For transmitter in Edison's system, he uses a battery of ten or twelve rundles of carbon. In the transmitter he uses a vibrating plate of copper covered with silver; in the receiver one of iron doubled on one of brass, and the two soldered together. Two magnets are employed in the receiver, with core and bobbin between, &c.—M. Vulpian presented M. Bernard's last volume, "Leçons sur les Phenomènes de la Vie commune aux Animaux et aux Végétaux, faites aux Muséum d'Histoire Naturelle."—Researches on absorption of ultra-violet rays by various substances, by M. Soret. *Inter alia*, distilled water, with a thickness of 10 mm., is considerably less transparent than quartz, and stops the last line of aluminium, but with greater thickness it takes the first rank, and it may be considered a solvent of almost perfect transparence. Absorption in the ultra-violet is subject to the same general laws as in the visible spectrum. Several substances are mentioned which give absorption bands in the ultra-violet.—On a new telephone called the mercury telephone, by M. Breguet. This is on the principle of a Lippmann electrometer. Suppose two vessels containing mercury with acidulated water above, and, dipping in the latter in each a tube partly filled with mercury and ending below in a capillary point. The mercury in the two vessels is connected by wire; likewise that in the two tubes. On speaking over one tube the air vibrations in it are communicated to the mercury, which translates them into variations of electromotive force, and these variations generate corresponding vibrations in the air-mass of the receiver. The practical form of the instrument is an improvement on this.—On the daily oscillation of the barometer, by M. Renon.—Investigation of oxide of lead in the hyponitrate of bismuth of druggists, by M. Carnot. The hyponitrate is sometimes given to the extent of 10 to 20 grammes per day, and this might include one or two decigrammes of oxide of lead.—Researches on gallium, by M. Dupré.—Action of ozone on iodine, by M. Ogier.—Researches on suspension of phenomena of life in the embryo of the hen, by M. Dareste. An egg taken from a hatching apparatus after two days and replaced after two days (the heart beats having quite stopped) develops a chick as usual.—Proofs of the parasitic nature of anthrax; identity of lesions in the rabbit, the guinea-pig, and the sheep, by M. Toussaint.—On a new bioxide of manganese couple, by M. Gaiffe. This consists of a carbon cylinder with holes parallel to its axis filled with grains of bioxide of manganese; it is placed in a glass containing water and about 20 per cent. of chloride of zinc.—On three bolides observed in January and February at Damblain (Vosges) and Chaumont (Haute Marne), by M. Guyot.

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