THURSDAY, JULY 12, 1877

THE "INFLEXIBLE"

THE question which has been raised respecting the stability of the *Inflexible*, important as it is with reference to that ship, leads to very much wider and more general considerations. It is already known that the same principle, or want of principle, which has brought doubt upon the one ship appears also in the *Ajax* and the *Agamemnon*, and is to be reproduced in the only ship of much size or importance which the Government purpose commencing during the present year. But even in this succession of large and costly ships we see probably but the beginning of a system which, having thus received countenance and sanction in the highest quarters in this country, may not improbably become extended over the navies of the world. We propose, therefore, to explain to our readers the nature of the question itself and the manner in which it has arisen.

And as an essential preliminary we will first explain what is meant by the terms "stability" and "curve of stability." For the purpose of this elementary explanation it will be sufficient to take the case of a ship floating in still water. In Fig. 1, which represents the transverse section of a ship taken through the centre of gravity, M represents the metacentre, G the centre of gravity, and B the centre of buoyancy, W L being the water-line when the ship is in an upright position. Supposing the ship to be inclined through an angle of θ degrees from that position by an external force, and W_1L_1 to become the new water-line; she will now tend to return to the upright position with a righting force equal to her total weight or displacement, acting with the leverage of G Z, and therefore equal to W × G Z. This is obviously the case, because while the ship is held in the inclined position her weight will be acting downwards through G in the direction of G H, which is perpendicular to the water's surface, $W_1 L_1$, and her buoyancy, which may be supposed to act collectively through its centre of buoyancy, B_1, will be pushing upwards through the line $B_1 M$, and therefore the righting effect will be that of the two forces (weight and buoyancy, which are alike) acting at the opposite ends of the lever, G Z, as previously stated. It is equally certain that in all ordinary forms of ship G Z will be changed in length as the ship's angle of inclination is changed, and if we calculate its lengths for a series of angles, and set up the lengths so obtained as ordinates along a base line on which abscissæ are measured off to represent the angles of inclination, we can draw a curve line through the points so obtained, and thus form what is called a "curve of stability." The first instance on record of this being done for an actual ship or design is that given in a paper "On the Stability of Monitors under Canvas," read in 1868 at the Institution of Naval Architects, and published in their *Transactions*, and in several other places. After stating the amount of stability which certain rigged monitors would have under given conditions, and showing that the maximum stability, and even the vanishing stability was reached in them at moderate angles of inclination, Mr. Reed said: "It must be obvious that the danger to be apprehended by these monitors when under canvas is very great; and when we think that they are liable at any moment to be overtaken by sudden gusts of wind, and that if they are heeled over beyond 8 deg. or 10 deg., the further they go the less resistance they offer to being capsised, their unfitness to carry sail must be quite evident."

The curve of stability was next constructed in the case of the *Captain*, immediately before her loss, and from a report by Mr. Barnes, one of the present Admiralty constructors, we take the following:—"We assume that the side plating on the poop and forecastle has been so damaged that the ship may be considered a rigged monitor with a free-board of about 6 ft. At that draught (25 ft. and ½ an inch) with an inclination of 14 deg., the gunwale on the immersed side is level with the water, but the stability of the ship notwithstanding goes on increasing until an inclination of 21 deg. is reached. As Mr. Reed has pointed out in his paper (quoted above) on rigged monitors, with a pressure of canvas which would incline the ship to say 8 deg., the inclination of the ship to the surface of the wave may reach about 34 deg. (in this case) before the ship would upset. As this angle is large we do not consider that even with the sides of the poop and forecastle destroyed, the *Captain* would be unsafe."

The above cases are both those of rigged ships, which the *Inflexible* can scarcely be considered, although it must be acknowledged that, as designed, she carried a considerable spread of canvas on two masts, and the present proposals—which we understand have been made—to diminish the spread of sail at all times, and to do away with it altogether in war time, are no doubt consequences of recent discoveries respecting the stability, or want of stability, of the ship with the unarmoured ends badly injured. After what has passed, however, we must accept the *Inflexible* as a mastless ship in time of war, and therefore a ship which can do with less stability than rigged ships require. In order to illustrate the nature and character of these curves we copy, in Fig. 2, a figure from Mr. Thearle's valuable work on "Theoretical Naval Architecture,"[1] in which he has grouped half-a-dozen curves which may be regarded as types of various kinds of curves of statical stability which occur in practice, viz.:—

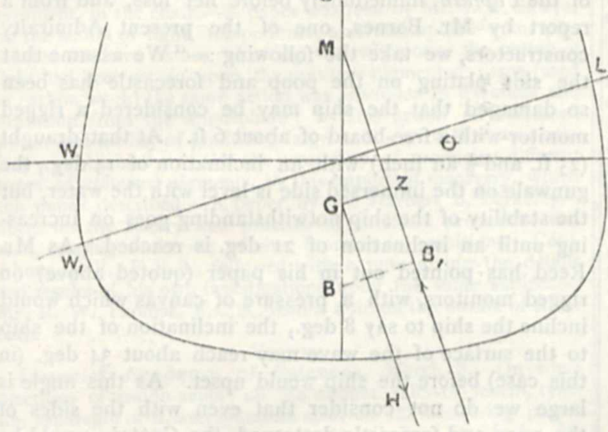
A. A lofty-sided troop-ship, carrying sail.
B. Do. Do.
C. A broadside iron-clad frigate, Do.
D. A turret-ship with high freeboard, Do.
E. A low freeboard iron-clad gun-vessel, not carrying sail.
F. A breastwork monitor, Do.

To facilitate comparison, we have added to Fig. 2 dotted lines showing the stability of the *Captain* as ascertained at the Admiralty just before her loss. The curve marked *a* shows the stability when the ship is fully stored and provisioned, and with the proper complement of coals on board with the poop and forecastle water-tight and assisting stability. The curve *b* refers to the ship under the same conditions, except that the poop and forecastle are supposed to be so damaged as not to assist stability. It will be observed that although Mr. Barnes considered

[1] Published by Collins, Sons, and Co., in the "Advanced Science Series."

the ship safe even when she had only the stability shown by *b*, the ship actually capsised when she had the larger amount shown by curve *a*, the two curves being the same up to about 20 deg. of inclination, but the latter showing much greater stability both in amount and in range after that amount of inclination was passed. Mr. Barnes no doubt expected that the ship would never be pressed under canvas enough to endanger her, but the event

Fig. 1.



showed that in matters of this kind the measure of safety must be ample, and that we must not trust to the chapter of accidents for the security of our men-of-war against capsising.

We are now in a position to explain the case of the *Inflexible* up to the point at present attained in the discussion, but in order to understand it the reader must take clearly into his mind certain differences between her

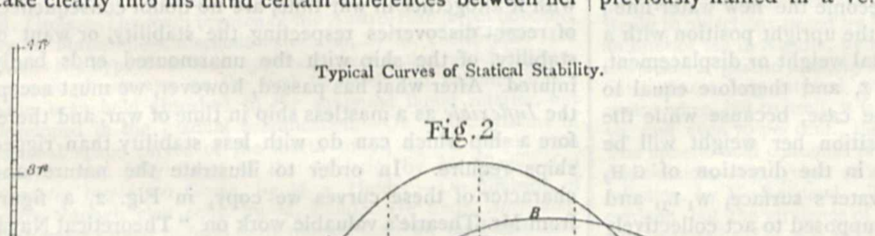

Typical Curves of Statical Stability.

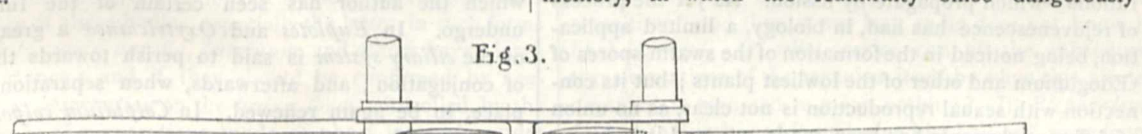
Fig. 2

and all previous ships as regards the relations of the armoured and unarmoured parts. In the case of the *Captain* we had a ship with armour rising to a uniform height of six feet above the water from stem to stern, and above this armour at one end a forecastle and at the other end a poop, both of these being of thin iron and unarmoured. It was in view, no doubt, of these unarmoured ends being liable to be so injured in action as to contribute nothing to the ship's stability that the Admiralty officers calculated and stated (as above quoted from Mr. Barnes' report) the ship's stability with the poop and forecastle destroyed. But the reader should carefully observe that as these unarmoured ends were wholly situated in the *Captain* at a height of six feet above the water, their destruction to any extent whatever could not affect the ship's stability at small angles of inclination; and in point of fact by looking at the dotted curves in Fig. 2 we see that the stability is the same whether these ends exist intact or not up to an angle of about 22 deg., for up to that point the two curves are identical. At that angle of inclination the poop and forecastle enter the water, and the curve of stability declines much more rapidly when they are injured than when they are uninjured. In the cases of the *Devastation*, *Thunderer*, and some other ships, there was a different arrangement, and one less favourable to stability, for in them the forecastle (not the poop) was sunk, so to speak, down into the armour, so as to reach to within a foot or two of the water's surface. In such cases, of course, the curve of stability, with the unarmoured ends injured, begins to decline earlier than if the forecastle stood wholly above the armoured side as in the *Captain's* case; but the *Devastation* class are all unmasted ships, and therefore subject to no pressure of canvas, so that much less stability was required in them than in the *Captain* and other rigged ships.

The *Inflexible* class of vessels differ from all the ships previously named in a very marked manner, for in her the ends are entirely unarmoured (excepting as regards a horizontal deck lying seven feet below water), and while the forecastle, and poop, where it exists, in the other ships named are comparatively short, in her they occupy two-thirds the length of the ship—one-third at each end. The central part of the ship, one-third in length, is alone armoured with side-armour, and therefore in considering the stability during an action, we may suppose that two-thirds of the ship's length, viz., the two wholly unarmoured ends, are destroyed, destroyed that is in the sense in which Mr. Barnes obviously used the phrase in the case of the *Captain*; or, in other words, so broken and damaged by shot or shell as to let the sea flow freely in and out of them, and therefore to possess no stability to help in keeping the ship upright. In Figs. 3 and 4 we have, illustrated, the *Inflexible* injured in this manner. One of the contentions of the Admiralty is that these ends cannot be injured during an action to this extent; but whatever the Admiralty officers may now assert in this respect, it is clear that in the case of the *Captain*, they thought this amount of injury possible, and it is equally clear from the quotations given by Mr. Goschen in Parliament, that they thought the same of the *Inflexible*, when they proposed that she should be built, and thought this, notwithstanding the introduction of certain cork-filled chambers and other sub-divisions upon which they now seem disposed to rely for the ship's safety. We may add that even during the present controversy, Mr. Barnaby has published figures which assume the total annihilation of the ends, and if they can be totally annihilated it is clear they may be so far injured as to lose all buoyancy and stability. We may confidently assume, therefore, that the ends can be so far wounded and damaged as to cease to help the ship's stability, and therefore to leave her wholly dependent upon the citadel for the power of keeping from capsizing. In Fig. 3 we have shown several large injuries, such as we may assume modern shells are fully capable of inflicting, merely to help the reader to get clear ideas on the subject.

The question now at issue really is, therefore, what amount of stability has the ship (by virtue of the citadel) with the ends thus injured? The *Times* and Mr. Reed say that careful calculations which have been made show that she has none, or next to none. Hitherto the Admiralty have refrained from saying how much they claim for her. They say that the *Times* and Mr. Reed are entirely wrong in their calculations, and that the ship really has abundant stability for all purposes of safety, and they appeal to a model which is at the Admiralty to prove this. Let us say at once no model can possibly prove anything of the kind; the model must be weighted and arranged entirely to represent the results of calculations, and it is these results which should be clearly, and fully, and authoritatively stated. The Government have laid certain papers on the table of the House of Commons, but they are not yet published, and until they are in our hands it is impossible to pursue the subject further. We shall hereafter give due consideration to them. All that we can now say is that with the *Captain* case fresh in our memory, in which the Admiralty office dangerously

Fig. 3.



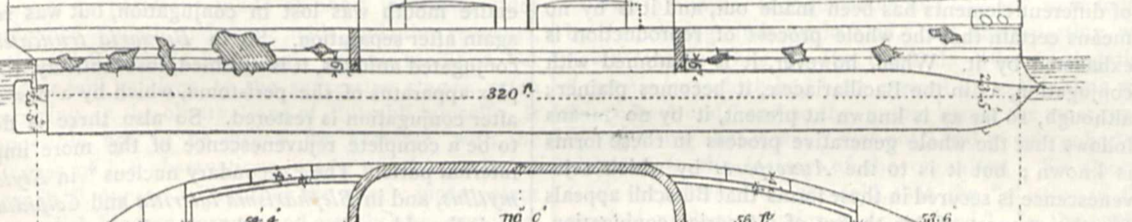


Fig. 4.

overrated the safety of the ship in this very respect, and, remembering as we do that for a ship to be safe at sea, she should have a very large margin of stability over and above that which mere statical and smooth water conditions point to, we shall not ourselves be satisfied with less than the Committee on Designs laid down, viz., "that the angle of vanishing stability should not be fixed at less than 50 deg." Nor shall we be content with this if this range is obtained only in conjunction with a small amount of stability from point to point. Mr. Reed has pointed out, in his letters to the *Times*, the great danger of considering range only, and has attacked the dictum of the Committee on this ground. Dr. Woolley, one of ts scientific members, has replied, admitting the accuracy of Mr. Reed's view, but explaining that the truth he enunciates is so elementary and obvious that the Committee thought it unnecessary to mention it, and would indeed have considered it "impertinent" (in the proper sense of the word) to state it. It is difficult to take this view of the matter, however, when we remember that the highest cientific officer of the Admiralty, in a matter affecting the safety of four of H.M. ships of the largest and newest type, has seized this dictum of the Committee as a sufficient and satisfactory guarantee of their security. We fear we must conclude that the Committee either neglected a very serious element in the calculations, or else greatly overrated the skill and discernment with which their words would be interpreted.

THE DEVELOPMENT OF THE OVUM[1]

Bütschli on the Earliest Developmental Processes of the Ovum, and on the Conjugation of Infusoria.

Studien über die ersten Entwicklungsvorgänge der Eizelle, die Zelltheilung und die Conjugation der Infusorien. Von O. Bütschli. (Frankfurt, 1876.)

II.

COMING now to the large and important question of the *Conjugation of Infusoria*, its nature and bearing upon the life-history of the forms, we are bound to state at once our conviction of the inefficiency of the observa-

[1] Continued from p. 180.

tions recorded on account of their discontinuity. Nothing but a close and continuous observation of the same forms extending over an entire life cycle, repeated again and again, can lead to absolute results. Errors fatal to the interests of truth inevitably arise, when minute organic forms are studied, not by continuous watching, but from inferences made from the phenomena manifest at different periods, the intervals between which are blank. Further, whilst the use of reagents on the dead forms taken at various stages is of the utmost value, when they are examined side by side with continuous observation on the living form, these may be not only not instructive but misleading when taken by themselves.

Bütschli's observations are numerous and interesting, but their value will be best estimated, by understanding briefly the nature of the hypothesis they are declared by their author to indicate. Put in its shortest form, it is that conjugation amongst the Infusoria is simply a *rejuvenescence* of the creatures which undergo it, enabling them to become "the stem ancestors of a series of generations" which propagate by fission. As yet the process of rejuvenescence has had, in biology, a limited application, being noticed in the formation of the swarm-spores of Œdogonium and other of the lowliest plants; but its connection with sexual reproduction is not clear, as no union of different elements has been made out, and it is by no means certain that the whole process of reproduction is exhausted by it. When, however, it is combined with conjugation, as in the Bacillariaceæ, it becomes plainer; although, so far as is known at present, it by no means follows that the whole generative process in these forms is known; but it is to the *Auxospores* by which rejuvenescence is secured in these forms that Bütschli appeals for the support of his theory of infusorial conjugation. Pfitzer and Schmitz have made what are at present the most complete observations of the phenomena in question; from which we learn that the customary mode of reproduction is by fission, but at each repetition the individuals dwindle in size, until they can apparently go no farther,[1] then the conjugation of two individuals takes place, the formation of auxospores being the result, that is to say rejuvenated individuals; and from these a new departure of fissiparous generations takes place, well observed by Schmitz in the case of *cocconema cistula*. There is no coalescence; the frustules simply lay themselves parallel to one another, they become surrounded by a common envelope of mucus; the protoplasm of the cells comes into contact, each frustule grows larger and becomes an auxospore. What the influence is which these frustules exert upon each other is wholly unknown; but that it has a real existence is shown in the result; each auxospore forming a stem ancestor of a new series.

This is what Bütschli extends to the infusoria, and contrary to the interpretations of Balbiani, Stein, and others, maintains that the act of conjugation so well known amongst the Paramecia, Vorticellæ, &c., is not a precursor of sexual products, but simply a means by which these forms, exhausted by continued fission, become more highly vitalised and rejuvenated, and again enter upon the process of fissiparous multiplication, which indeed becomes thus their only method of increase.

It should be noted that on the whole the facts adduced by Balbiani and Stein are admitted, but they are submitted to a wholly different interpretation; and it is specially insisted on that the forms that go into the conjugation state are of a minimum size; which fact Balbiani explains as the result of a special development for sexual purposes, but this is disallowed by Bütschli, who insists that it results from exhaustion of vitality at the terminus of a series of fissiparous multiplications. Indeed these weakened and minimised forms unite in conjugation and are neither absorbed into each other nor produce embryos, but increase in size and vitality, separate, and commence again the fission by which alone increase is effected.

The truth of this is insisted on as deriving strong support from some of the very remarkable external changes which the author has seen certain of the Infusoria undergo. In *Euplotes* and *Oxytrichineæ* a great part of the *ciliary system* is said to perish towards the end of conjugation; and afterwards, when separation takes place, to be again renewed. In *Colpidium colpoda* the entire mouth was lost in conjugation, but was renewed again after separation. So in *Bursaria truncatella*, the conjugated animals, it is affirmed, lose entirely the complex apparatus of the peristoma, which by a new growth after conjugation is restored. So also there is declared to be a complete rejuvenescence of the more important internal parts. The "secondary nucleus" in *Stylonichia mytilus*, and in *Blepharisma lateritia* and *Colpidium colpoda* the old nucleus is said to be eliminated and a new one formed. In others, part of the nucleus is thrown off, and part renewed; in others a new nucleus formed and coalesced with the old one. From these and similar observations it is inferred that the "essence of conjugation consists in the rejuvenescence of both the individuals;" and that this is chiefly centred in the "secondary nucleus" which is declared to be of the utmost importance in the life of the creature.

During the process of conjugation, also, the plasma-contents of the individuals have been seen to interchange; this especially in *Oxytrichineæ*, but also in other infusoria.

Against Balbiani's hypothesis—that the nucleus is the ovarium and the nucleolus the testis, containing spermatic elements—Bütschli affirms that in *P. aurelia* and *P. colpoda* the supposed spermatic capsule in some cases wholly disappeared without any following change in the nucleus that could be discovered, and that consequently it did not effect fertilisation. In short, he believes that the observations he has made are quite competent to overturn the sexual hypothesis in these organisms, and to establish that of *rejuvenescence* in its place.

That there is extreme ingenuity in this hypothesis we readily admit; that there is also the utmost conflict of interpretation amongst the best observers of these organisms, we admit with equal readiness. But that the author's observations give *scientific* sanction to his theory on the one hand, or either explain away or harmonise the labours of his predecessors or *collaborateurs* on the other, we are fain to dispute. The exhaustive and continuous

[1] It is impossible not to notice here the extremely interesting and certainly somewhat remarkable paper of Dr. Wallich in the February number of the *Monthly Microscopical Journal* for 1877, "On the Relation between the Development, Reproduction, and Markings of the Diatomaceæ;" for in this paper what is apparently the *auxospore* of Pfitzer and Schmitz is called the *sporangial frustule*. But this, instead of having dwindled in size before conjugation appears to have become enormous in proportion, and within this the "new parents of the race arise," and from the conjugation of *these* the new forms spring as daughter frustules.

method of observation—following a single form through all the phases of its life—has never been thoroughly adopted; and conflict of interpretation inevitably arises. Bütschli has fallen into the same groove, and his results, although valuable and full of suggestion, have no irresistible meaning. They present points of new departure for hypothesis, and nothing more.

Nor can we be quite certain, from the evidence afforded, of the correctness of the larger and more important of the facts stated. We want, for example, more than a mere statement that the "ciliary apparatus" and the important organs of the *peristoma* were actually destroyed by conjugation. That they are suppressed—flattened—deranged by prolonged contact, we have observed again and again in several forms, especially *Stylonichia*, *Pustulata*, and *Mytilus;* but they rapidly regained their *normal condition*, and certainly did not *grow afresh* by "rejuvenescence" as in the cases stated by our author. And this is certainly of moment. In some important sense also this will apply to the nucleus and nucleolus themselves. Doubtless the investigations of Bütschli on the metamorphoses of these bodies, especially the latter, in such forms as *P. bursaria*, *aurelia*, *putrinum*, and others have a large importance; and if they should be confirmed by *continuous observation* on the *living form*, controlled by the evidence of preparations, made at short intervals, under the influence of acetic and osmic acids, and other reagents, not only will Balbiani's hypothesis become modified, but a sequence will be given to the successive stages, often now wanting, in the observations of Bütschli himself. It is impossible not to be struck, for example, with the minuteness of his observations, made on the nucleolus changes in *P. bursaria;* but they are utterly incompetent to accomplish his own purpose and establish his own idea. He declares that both Balbiani and Stein utterly mistook the destiny of the nucleus and nucleolus; and quite repudiates the changes said to come upon the nucleus during conjugation. But to establish his own hypothesis the whole process of morphological change in the nucleus at least should have been followed, and not once but many times. Yet the very first complete change effected in this organ could not be explained; and after following it into fission as the result of conjugation, he observed four "nucleolus capsules" as the issue, in each paramæcium. Two of these became light and clear; the other two diminished in size, and became fibrous, but on the second day they lost their fibres and became homogeneous and dark; and on the third day—*vanished!* that is to say, by the method pursued by the observer, they were lost, and "no trace of them was to be found." From this Bütschli concludes that they were "cast out," and no further concern in relation to them is evinced! Yet it must be remembered that Balbiani describes a similar condition of the same forms, and considers the granules germs or ova. To deal thus lightly with the ejection of apparently organised bodies in a set of observations designed to *prove* that what have been considered ovarian, or at least sexual, products, was erroneous, is certainly remarkable. Clearly no result can be arrived at until the manner of the vanishing of these bodies be understood; and if they were ejected, until their future destiny became known. This is all the more imperative from the fact that *after* the ejection of the "bodies," the paramæcium resumes its normal condition in size and appearance, although the method by which this conclusion is reached is by saltative inferences, and not by continuous proofs.

Again,—in *B. bursaria* and *aurelia*, two "light bodies"—definite products of the nucleolus—are repeatedly seen in successive stages after conjugation, but having been followed to a certain point we are told that "the further destiny of these two light bodies escaped me!" and yet it is assumed that the life history of the creatures is known.

Again,—in these same forms the *nucleus* broke up into a hundred spherules; and yet our author frankly declares "I am not quite certain of the destiny of the . . . fragments of the old nucleus!" This is the more important since Schaafhausen affirms that he has seen *P. aurelia* lay or deposit ova; "the organisms crammed full of egg-spheres, surrounded with clear fluid, extrudes in an hour several times one such egg."

Again,—in *Colpidium colpoda*, after conjugation, two small light spheres appear, these the author "thinks most probably" grow out of the nucleus capsules, while the *nucleus* itself is *cast out;* Bütschli followed it "for some time" and then it was lost, so he does not know its final destiny! Of what service can all the subsequent transformations of the organism itself be when this ejected organism is assumed to mean nothing? In *Blepharisma laterita* a number of "nucleolus-like bodies" were found by "squeezing and acetic acid," but their destiny was never found; while on the third day after conjugation "the *nucleus* which had been present up to this time was not to be found," and so the author meets the emergency by supposing that it was "cast out," and of course had no meaning in the history of the organism. So also in *Chilodon cucullus*, we are told that the "destiny of the original nucleus remains undetermined." In the conjugation phenomena of *Stylonichi mytilus* there is an equal or even more grave defect.

In precisely the same way in the attempt made by Bütschli to establish the position he occupies that the embryonal regions of Balbiani and others as existing in these lowly forms are to be entirely explained by the presence of swarm spores of internal parasites, there is the same want of perfect sequence, and the unscientific "no doubt" which is made to supply the place of facts.

But our space is exhausted. We have not referred to the above defects with any attempt to depreciate a valuable book. It is because it is strong enough in important facts to be a help in the unravelling of biological difficulties that we have not hesitated to point out the difference between the *theories* and the *facts* which it contains. To have attempted exhaustive criticism of such a work would have involved four or five times the space occupied by this article; but after a careful perusal and reperusal of its contents, we are obliged to admit the ingenuity of the author both in the work he has done and the method he has employed for interpreting it. But it is to the former that we attach by far the most importance; for whilst there are many missing links in evidence which make conclusions from the whole unwise, there are facts given us which must help future observers and land us nearer to the desired truth.

It may be finally observed—1. That if the theory of rejuvenescence, as put and insisted on by Bütschli, be established for any one form, conjugation should have no other meaning or place in any part of its history than rejuvenescence can explain. Now *Stylonichia pustulata* is amongst the forms the author has seen to conjugate, and as he believes, as a consequence, to become simply more vital and larger for renewed fissipartition. But Engelmann is undoubtedly right in his affirmation, that there is a conjugate state in which these organisms do *not* again separate, but the pair simply fuse together. One of the writers of this paper has observed it repeatedly under conditions which render error impossible; this is not the place to consider to what this fusion leads, but it is important as a fact, inasmuch as it throws doubt upon the *completeness* of the theory of rejuvenescence, even supposing the facts given us by Bütschli led without exception up to it. Bütschli even admits that this process of fusion may happen, but he simply dismisses it as a "very unusual one"—surely all the more important on this account, inasmuch as we know that in more highly organised creatures not only a long time, but generations may intervene between distinct acts of fertilisation.

2. It does not follow that if rejuvenescence be rejected to the extent and with the meaning Bütschli gives it, that it must be rejected altogether. He gives us many remarkable facts that deserve further experiment and research; and it may result, that what he calls rejuvenescence, is one of the many modes by which rapidity of fissiparous multiplication is in some organisms aided, and the necessity for the true act of fertilisation is made less frequent; and

3. It is clear that there are points in the theory of Balbiani which the facts given by Bütschli overturn; while there are others that certainly remain unshaken, if they be not strengthened. But it is needful to remember that if the facts given by Bütschli wholly invalidated the interpretations of Balbiani the theory advanced by Bütschli by no means follows as a consequence. In the present state of this inquiry we must seek facts industriously, and with persistent honesty, and be assured that their accumulation will lead to important issues; but we shall do well to place theory, however fascinating, in an extremely subordinate place.

W. H. DALLINGER
J. DRYSDALE

VON RICHTHOFEN'S "CHINA"

China. Ergebnisse eigener Reisen, und darauf gegründeter Studien, Von Ferdinand Freiherrn von Richthofen. Band I. (Berlin: D. Reimer, 1877.)

WE are glad to welcome the appearance of the first volume of this long-promised work from the pen of the well-known geologist and geographer, Baron v. Richthofen. We content ourselves at present with a general account of the work, hoping in an early number to be able to examine it in detail. The author has enjoyed rare facilities for the accumulation of material, and has improved them so thoroughly that the published results of his researches will assume a leading position among the late additions to scientific literature. In 1860 he accompanied Count Eulenberg on his mission to China and Japan for the purpose of closing commercial treaties between these lands and the German states. On the return of the expedition Baron v. Richthofen lingered behind, attracted by the many unsolved problems of the Celestial Empire. Up to 1872 he devoted himself to a systematic, thorough investigation of the geography and geology of China, traversing in the course of seven different journeys the whole eastern part of the empire from Canton to Corea, and penetrating westward to the sources of the Yang-tze-Kiang and the frontiers of Thibet. The essential aims of the traveller were to place on a scientific basis the geography of the land, determining the hypsometric relations, and the laws governing the conformation of the mountain-chains, to examine the general geological structure, especially in its relations to the great basins of Central Asia, and to study the laws of climatic changes. Other scientific questions received a minor consideration, and the intellectual life of the people was left entirely out of view. The present volume forms little more than an introduction to the elaboration of the immense number of observations made during the long series of years, which will form the body of the work. It is mainly occupied with an extensive and complete description of the growth of our knowledge with regard to China, forming a valuable index to the literature on this country. No small amount of space is devoted to the book, "Yü-Kung," or imperial geography, forming the sixth in the series of historical works attributed to Confucius, and covering the period 2357–720 B C. The remaining portion of the volume is occupied with the geographical relations of China to Central Asia, and contains a most important study of the loess regions of Northern China. They are not only considered in their relations to the saline steppes of Central Asia, but are compared with all the great loess formations known, and supply the basis for an interesting theory with regard to the formation in the one case of fertile valleys, as those of the Nile and Mississippi, and in the other of sandy wastes. Scarcely less valuable is the clear and distinct picture afforded of the whole mountain system of this portion of Asia. The author finds the laws governing the conformations so simple, that less time was required to determine the system than would have been necessary for a tenth of the area in Europe. In a closing chapter on the problems of modern scientific geography, the author sharply defines the province of his science, drawing clearly the limits between it and political geography, ethnography, and kindred sciences. The method to be used in the solution of these problems he defines as "the uninterrupted consideration of the causal, mutual relations between the earth's surface from its various points of view, terrestrial physics, and the atmosphere on the one side, and between these elements and the organic world in its broadest sense on the other side." Of the three volumes yet to appear, one will be devoted to palæontology, in which the author will be assisted by Dr. Kayser, Dr. Schwager, Prof. Schenk, and other able geologists The remaining two will contain the author's extended researches into the coal-fields of China, regarded by him as more valuable than the deposits in the United States of America—the geological structure of the land, the climatic phenomena, the population as affected by these two agencies, the river system, means of transport by land and water, chief productions, mercantile possibilities, &c. A generous grant from the Emperor of Germany has permitted the publication of the work in a most sumptuous style, and the introduction of numerous carefully executed maps and illustrations wherever opportunity is offered by the text.

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.]

Soldiers' Rations

IN your issue for June 28 (p. 158) Mr. H. Baden Pritchard states in his article on "Soldiers' Rations," "And yet, as we have said, with this apparently liberal feeding, our men do not receive so much actual nourishment, or nitrogenous matter, as the German soldier."

My calculations, based on Prof. Parkes' table of soldiers' rations, and Prof. Frankland's experiments on food and urea, give the following values of the several soldiers' rations:—

			Foot tons.
1.	English Military Prison	...	4,509
2.	English Soldier (Home)	...	3,964
3.	Prussian ,, (War)	...	3,812
4.	French ,, (Crimea)	...	3,683
5.	French ,, (Home)	...	3,580
6.	French ,, (War)	...	3,538
7.	Austrian ,, (Home)	...	3,242
8.	Prussian ,, (on the march)	...	3,223
	Mean	...	3,694

As the average daily external work of a man is 353·75[1] foot tons, the efficiency of man regarded as a heat engine is 9·6 per cent. of the internal work.

An efficiency of 8·2 per cent. can be obtained by engines working at 40 lbs. pressure and steam cut off at half stroke; so that man regarded as a machine, does not occupy a very high position. The explanation of this is, that man is not a *machine*; he is a *machine maker*. The mechanism of a cat or beetle is vastly higher than that of man, and yet they are immeasurably his inferiors. SAML. HAUGHTON

Trinity College, Dublin, July 7

Printing and Calico Printing

IN your article on the Caxton Exhibition last week, there is the remark that the beauty of execution in the specimens preserved to us of the work of the earliest known printers suggests a doubt whether the date of the actual invention must not be pushed back farther than the accepted one. But does that follow? Is not the beauty of the first printing simply the beauty of the wood engraving of the time? an art which had attained an exquisite perfection before its application to movable type.

That there should be doubt and obscurity as to the date, name, and claim of the first inventor can surprise no one who will ask himself who, for instance, was the inventor of our present mode of calico printing by roller; and, if he cannot answer, shall turn, as he has every right to do, to the current issue, ninth edition, of the "Encyclopædia Britannica" for the satisfaction of his doubt. He will find there, in that long, elaborate, and amply-illustrated article, not the bare mention of the name, even (unless I have strangely missed what I expressly looked for) of the otherwise remarkable man who conceived the idea, mechanically wrought it out for his own immediate purpose, and himself elaborated its application to the printing of calicoes—revolutionising that important branch of our industry—all well within the lifetime of men not half a century old among us! The Rev. Isaac Taylor—turning a moment from his own researches into the Etruscan mystery—should be able to tell us in what precise year it was, after 1840, that his father, Isaac Taylor, the author of the "Natural History of Enthusiasm," and a long series of subsequent works, sufficient alone for a reputation of a high and lasting order—a teacher of teachers, the depth and extent of whose influence and the fulness of whose intellectual stature have not yet been adequately recognised—engraved on the roller illustrations for his new translation of Josephus, undertaken in connection with Dr. Traill. The death of his fellow-worker cut short that enterprise, but a portion of the work appeared; and I myself, as a boy, was often in the little private workshop at Stanford Rives while this idea was struggling on the turning-lathe, through the patient genius of its author, for mechanical existence. In 1855 or 1856 I found him superintending its actual application to the printing of calicoes at Manchester. The discovery received the immediate and inevitable compliment of piracy, and brought to him and his loss instead of gain. But that within five-and-twenty years his very *name* should seem to have wholly dropped away from what was undoubtedly his own unaided invention, and one withal of so much national importance, and in an age of lime-light publicity like ours, is almost a curiosity of injustice, and throws, as I have said, a flood of light on a crowd of similar miscarriages in the indifferent past. As a hundred years hence this also may be beyond remedy, kindly assist me to arrest a moment the remorseless tooth of All-Father Time by the insertion of this contemporary note. HENRY CECIL

Breigner, Bournemouth, July 9

Stamping out Noxious Insect Life

THE subject of insect and germ life in its relation to putrefaction and infectious disease is now assuming such importance from the investigations and demonstrations of Dr. Tyndall, Mr. Murray, and other scientific inquirers, that I think you may consider the following curious facts not unworthy of space in your journal.

I observe in a report of Dr. Tyndall's lecture on Germs, in NATURE, he refers particularly to the varying tenacity of life which germs under certain conditions exhibit, and which he refers to the period of incubation or stage of development up to the state of emergence as complete organisms, when they are readily destroyed. He says: "We now turn to another aspect of the question; following the plain indications of the germ theory of putrefaction, we sterilise in five minutes the very infusions which, a moment ago, were described as resisting five hours' boiling. The germs are indurated and resistant, the adult organisms which spring from them are plastic and sensitive in the extreme. The gravest error ever committed by biological writers on this question consists in the confounding of the germ and its offspring. The active bacteria developed from those obstinate germs are destroyed at a temperature of 140° Fahr. Let us reflect upon these facts. For all known germs there exists a period of incubation, during which they prepare themselves for emergence as the finished organisms, which have been proved so sensitive to heat. If, during this period, and well within it, the infusion be boiled for the fraction of a minute, even before the boiling point is reached at all, the softened germs which are then approaching their phase of final development will be destroyed. Repeating the process of heating every ten or twelve hours, each successive heating will destroy the germs then softened, until after a sufficient number of heatings the last living germ will disappear. If properly followed out the method of sterilisation here described is infallible; a temperature, moreover, far below the boiling-point suffices for sterilisation."

Now as the laws of nature apply to all magnitudes alike, whether it be a grain of sand or the planet Jupiter, to the various stages of incubation of the germs of bacteria or of noxious insect life, I think I may claim some credit for having *stumbled* upon, and for having applied on a practical and large scale, a system for eradicating insect life in animals based on this law of varying tenacity of life in germs and insects. More than two years ago I advocated this system, and in September last issued a circular, in which I stated that "a short time after clip-day I dipped, by immersion, the young lambs, and I repeated the same before harvest; at the same time I made a long narrow pen alongside the stackyard fencing, into which I crammed all my old sheep as close together as possible. I then, with an ordinary watering-pan, watered them all over with diluted fluid; the latter operation was completed in half an hour, and the cost in material was less than one halfpenny per head, the proportions in both cases being 1 to 100. Now for results! I lately minutely examined the whole of my sheep, for the purpose of deciding if it was necessary to give them a final dressing before October, and I can now frankly, and without

[1] "Animal Mechanics," p. 62.

hesitation, state that in the whole flock, old and young, I could not find a single living insect, or the germ of one."

In the month of March last, agreeably to my promise, I issued a faithful report of the results of this system of stamping out insect life. The sheep cleansed on this principle were absolutely clear of insect pests, whilst others not so treated were never free. I shall send with pleasure this report to any of your readers who may desire to have it.

I believe I may say there is exact analogy between this system for exterminating insect life in animals and that adopted by Dr. Tyndall to show that the earliest eggs or germs of bacteria are extremely obstinate to kill, whilst the more fully developed are destroyed without difficulty, clearly showing that more than one treatment is necessary for the complete destruction of germ life as well as for a higher form of insect life, and that the same law applies to both alike.

I am fully convinced of the possibility of stamping out noxious insects that affect sheep and other animals, and sincerely hope Mr. Murray's suggestion at the Society of Arts of united action to effect this purpose under the direction of science and experience may be acted upon with little delay. W. LITTLE

The Hall, Heckington, Lincolnshire

Complementary Colours

IN NATURE (vol. xvi. p. 150) you give a most interesting, though very brief, account of Prof. Rood's researches on colour, the result of which you sum up in these words :—

"The mixture with white is the same as if the colours were moved towards the violet end of the spectrum."

I know of Prof. Rood's results only from your abstract, but your summary is not a perfectly accurate account of the facts which you state immediately before, unless the expression "violet end" is to be used in a new sense, or, what would be better, replaced by the expression, "violet *pole*."

The following will be found a correct summary of Prof. Rood's results :—

Let the colours of the spectrum be arranged, not in a line but in a circle, and the gap between red and violet be filled up with purple. Each colour will then be opposite to its complementary colour. Greenish yellow and violet, which are mutually complementary, are the opposite poles, and the succession will be as follows :—

Greenish yellow.	
Yellow.	Yellowish green.
Orange.	Green.
Vermilion.	Cyanogen blue.
Purple.	Cobalt blue.
	Ultramarine.
Violet.	

The addition of violet to any one of the colours except those at the two poles will bring that colour nearer to the violet pole ; the same addition to either of the polar colours will leave them unchanged as to their position in the circle. *The addition of white will have the same effect.*

As regards the effect of the addition of violet, this is what we might expect. Violet added to violet will only make violet. Violet added in small quantities to greenish yellow, which is its complementary, will only make it whiter without changing the colour. Violet added to any other colour will bring it nearer to violet. We might select any pair of complementaries as poles, and obtain a parallel result. But what is new, and if confirmed, most important, is that white has the same effect as violet. I can suggest no explanation of this.

For the fact that every colour in the spectrum has its complementary, see Prof. Grassmann in the *Philosophical Magazine* of April, 1854. His paper appears to be less known than it deserves. The pairs of complementaries according to him are as follows :—

Red.	Bluish green.
Orange.	Azure.
Yellow.	Indigo.
Yellowish green.	Violet.
Green.	Purple.

Most authorities say that purple is not to be found in the spectrum, but Grassman says that under favourable conditions of light it may be. I think that in any observations on the subject where great accuracy is desired, the use of sunlight is to some extent misleading, and that the true white is that of an incandescent solid or liquid at a very high temperature—that is to say the electric light. The sun's light is such a light where it leaves the body of the sun, but part of its rays are absorbed in the sun's atmosphere, and the blue in greater proportion than the red and yellow ; and a further loss of blue rays takes place in the earth's atmosphere by scattering, forming the blue of the sky. The blue light of the sky is taken out of the white light of the sun. For these two reasons the sun's light at the surface of the earth is not truly white but yellowish.

I can scarcely doubt that when the spectrum of the electric light is carefully examined, it will be found to contain purple ; and also that some simple mathematical relation will be discovered between the wave-lengths of every colour and its complementary. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, co. Antrim, June 24

Phyllotaxis

THE theory which regards the alternate arrangement of leaves as the normal mode receives some support from the arrangement of the inflorescence of opposite leaved plants. In *Lysimachia nemorum* the leaves are opposite, inflorescence indefinite, solitary, and axillary, but it will be observed that the flowers springing from the axils of opposite leaves are never both equally developed at the same time, one will be fully expanded while the other is yet in bud, or one will be found in seed and the other in flower ; it will be further observed that the oldest or most fully developed flower appears alternately on opposite sides of the stem ; if all the leaves on this plant were separated by internodes, the arrangement would be *tetrastichous*, but owing to the suppression of the internodes between the first and second and the third and fourth leaves, the arrangement becomes opposite. The oldest of the two opposite flowers of each pair of leaves will be found to spring from the axil of the first, third, and fifth leaf, and plants with this alternate disposition of flowers may sometimes be met with ; but usually a flower originates in the axil of each leaf, and then the youngest or latest flowers spring from the second and fourth leaves of the verticil ; these latter may be looked upon as originating from arrested branches. This view is supported by the fact that plants may be sometimes found which, in place of producing the late flowers in the axils of the third and fourth leaves, produce branches from these points instead. In *Caryophyllaceæ* the opposite sides of the cymose inflorescence never exhibit an equal amount of development at the same time, proving that one of the sides is older than the other, although, owing to non-development of an internode, it is at the same level. A similar arrangement occurs in *Labiatæ* plants, but owing to the crowded inflorescence, it is not so evident, but it is very marked where branches spring from opposite leaves ; one is generally two or three times as long as the other, and by tracing the arrangement of these long branches along the stem, the normal alternate arrangement may be determined. In *Scrophulariaceæ*, where both opposite and alternate leaves are met with, all the above-mentioned modifications may be seen. *Veronica chamædrys* has opposite leaves, and when the axillary racemes are opposite, one is invariably more developed than the other ; this can be best seen by examining the inflorescence in the young state, as the dissimilarity in size disappears in the pairs of old racemes owing to the younger of the two continuing to grow until it has acquired the size of the other ; sometimes this plant may be met with bearing in the axil of one of its opposite leaves a branch, and a raceme of flowers in the other, and in such instances the branches and flowers are produced on alternate sides ; in *V. officinalis* this is the usual arrangement. The suppression of the alternate nodes of an alternate-leaved plant with axillary inflorescence would produce the arrangement seen in *Lysimachia*, inasmuch as it would bring together flowers of different ages and in different stages of expansion ; but in this instance all the flowers would belong to the same generation or be the product of the same stem, whereas in *Lysimachia* the earliest developed of each pair of opposite flowers alone belong to the stem, while the later flower of each pair belong to another generation, and spring from a branch originating in the axil of the leaf opposite (owing to non-development of an internode) to the early flower ; the branch, however, is generally arrested, and the flower alone appears, although sometimes the branch is more or less developed.

G. E. MASSEE

GEOGRAPHICAL WORK IN RUSSIA DURING 1876[1]

THE most important journeys by Russian geographers during 1876 were those of MM. Prshevalsky and Potanin in Central Asia, of Dr. Mikluho-Maclay in Polynesia, and the meteorological journey of M. Wojeikoff round the world. We have from time to time given notes of the progress made by M. Prshevalsky, and of the journeys of Mikluho-Maclay.

M. Potanin left Bulun Tokhoi (NATURE, vol. xv., p. 461) on August 20, and after having followed the eastern shore of the lake Ulungur, and crossed the deep and rapid Black Irtysh at Durbeldjin, he reached the river Kran, at Fulta, close by the Lamaïte convent, Shara Suma. The fertile valley of the Kran is the storehouse for the Southern Altai region; the Kirghises come here to purchase grain from the eastern slopes of the Altai and from the valley of Kobdo. The crossing of the Altai by the Djamaty pass, at the sources of the Black Irtysh, having been reported as very difficult, M. Potanin crossed the ridge by a more southern pass, Urmogaity, at the sources of the Kran river (9,000 feet above the sea), and entered on a wide hilly plateau covered with numerous lakes, and gently sloping to the east by a series of terraces, divided by border ridges. The easternmost of these ridges runs north and south, reaches 10,000 feet at the Terekty-asoo pass, and separates the high terrace of the Deloon river from the low tract on which the town Kobdo is built. This place was reached by M. Potanin on October 16. Rich collections of plants, insects, and birds were made during the journey, as well as a survey and a geological sketch of the route, together with determinations of latitudes and barometrical measurements of heights.

A most important work accomplished by the Russian Geographical Society during 1875 and 1876 is the geometrical levelling made along the Siberian highway, from Ekaterinburg to Irkutsk, on a distance of 2,236 miles. All meteorologists are well aware what a gap in our knowledge as to the distribution of pressure of the air upon the surfaces of large continents, arises from a want of geodetically-measured heights of meteorological stations. All attempts to trace isobars upon the Asiatic continent (one of which was made in the standard work of Mr. Buchan) have failed until now, the heights of the meteorological stations at Omsk, Tonesk, Krasnoyarsk, Irkutsk, and Nerchinsk having only now been directly measured. The Geographical Society has undertaken a geometrical levelling along the whole line, Ekaterinburg to Irkutsk, which levelling will afterwards be continued to Nerchinsk and Tashkend. This difficult enterprise, carried on with all possible accuracy, is now completed with full success, and the superintendent of the levelling, M. Moshkoff, is now busily engaged in computing the definitive results.

A yet more important undertaking, accomplished by the Russian geodesists, Col. Sharnhorst and Capt. Kulberg, during the years 1873-1876, is the precise determination of longitudes, by means of telegraphic signals, carried out along an arc of 103°, between Moscow and Vladivostok, on the Pacific. But this work is so important that we hope to be able to give a special report upon it.

We may also mention the work of Capt. Onatsévich on the shores of Russian Manchooria (NATURE, vol. xv. p. 417), and the important cartographical work of M. Sidensner between the Obi and Jenissei rivers.

Most valuable work was done also during 1876 by the Siberian branch of the Geographical Society. The measurements of depth of the Baikal were continued by MM. Dybovsky and Godlevsky, and showed that the greatest depth of the lake is to be found in its southern part and close to its north-western shore. M. Grebnitsky explored the region of the Southern Usuri and returned with valuable geological and botanical collections. M. Chersky explored the valley of the Irkut river and arrived at very important results, the chief of which are:—(1) that this valley is geologically a very old westerly extension of the Baikal trough; (2) that it contains immense glacial deposits; and (3) that the outflows of basaltic lava in the valley are, with one exception, pre-glacial. We notice also the entomological excursions and the exploration of the Kasbek (Devdorak) glacier, made by members of the Caucasian branch of the Society.

[1] "Report of the Russian Geographical Society for 1876," by the secretary, V. I. Sreznevsky.

Besides these explorations, the Society has also issued some valuable publications. The most important of them are—(1) the fourth volume of supplements to Ritter's "Asia," being a description, by MM. Semenof and Potanin, of the Altai and Sayan highlands, according to works which appeared from 1836 to 1872; the names of the two authors sufficiently recommend the work; and (2) the second volume of M. Prshevalsky's "Travels in Mongolia," which contains—the Climatology and Ornithology, by the traveller himself; the Herpetology, by Prof. Strauch; and the Ichthyology, by Prof. Kessler. The seventh volume of the *Memoirs* of the Society contains the first part of the work of Prince Kropotkin, "On the Glacial Period in Finland and on the Bases of the Glacial Theory," with numerous maps and engravings. The *Isvestia* (Bulletin) of the Society contains, besides valuable small contributions, two very valuable maps of the Hissar and Koolab beckdoms, by M. Mayeff, and of the Lower Tunguska River, by M. Chekanofsky.

The scientific results of the expedition made to the Amu-daria in 1875 and 1876, will appear very soon. They contain the astronomical, magnetical, and meteorological observations made by M. Dorandt, and a thorough and elaborate hydrographical description of the Amu-daria, by M. Zuloff, with the collaboration of Col. Makshéeff. The first of these works is already printing, and contains abundance of most valuable meteorological data (pressure, temperature of air and of the soil, evaporation, level of water, variations of magnetical elements, &c.). The Meteorological Committee of the Society is engaged in preparing complete tables of the amount of snow and rain during 1872-1876, measured at the numerous stations organised by the Society. Finally, we can only mention some of the various works issued by the Society in the departments of Ethnography, Statistics, and Historical Geography; as, for instance, those on the trade in grain in Western Russia, by M. Rayevsky; the ethnographical description, with maps of South-Western Russia, by M. Gildebrand; the text to the ethnographical map of Russia, published by M. Rittich, being now at press; and many other valuable works of less importance.

A POCKET HAMMOCK

IN these days, when exploring tours and extended scientific excursions are so universal, it is a great advantage to be able to take up one's bed and walk, to be in short entirely independent of sleeping accommodation. Even in our own country it is often an advantage to the working geologist, or botanist, or zoologist, to be independent in this respect, and while it is sometimes no great hardship to make one's bed on the heather or grass under the lea of a broom-bush or dyke, still it is seldom advisable to do so if it can be avoided. Many of our readers will therefore be glad to know that Seydel and Co. of Birmingham have devised a handy hammock, which bears the name of the "Ashantee Hammock," from its having been found of great service during the Ashantee campaign, Sir Garnett Wolseley testifying strongly to its manifold utility. It is made of light but strong netting, and can be so folded up as to be slung over the shoulder like a bag, or even carried in a fair-sized coat-pocket. From the arrangement of the ropes, hooks, and screws, it can be used under almost any circumstances, and, as we ourselves can testify, forms a thoroughly comfortable and secure bed or lounge. Mr. Stanley, we believe, was so favourably impressed with the hammock, that he has taken a supply with him in his present exploration; and for explorers in tropical countries, we should think it would prove useful in many ways, as it can not only be used as a bed, but, mounted on a pole, as a travelling litter or palanquin. For those of our readers engaged in explorations of any kind, geological, geographical, botanical, zoological, or even in doing an ordinary tour, in remote districts, we

ASHANTEE HAMMOCK ON SLINGING APPARATUS.

believe the hammock would be found of real service, as it would make them quite independent of sleeping accommodation, and would not increase the weight of their *impedimenta* by very many ounces. An idea of its construction and its adaptability to almost any circumstances may be obtained from the illustrations we give. We can honestly recommend the hammock as likely to answer all the purposes for which it has been designed.

THE SANITARY INSTITUTE

THE lecture by Dr. Richardson, published in our issue of last week, has called public attention to the Sanitary Institute of Great Britain, before which the lecture was delivered. The Institute was founded in July, 1876, at a public meeting held at St. James's Hall, and presided over by his Grace the Duke of Northumberland. The Institute has for its work a wide range of subjects. It has sprung, we may say, out of the necessities of the time, and in the first instance may be considered as a nucleus round which will cluster the many men of science who are now employed in carrying out the executive sanitary or health work of the kingdom. The various medical officers of health, the certifying surgeons under the Factory Acts, the engineers and sanitary surveyors of different localities, the mayors of municipalities, and the chairmen and presidents of local boards, all of these must needs take an interest in and in time form the body corporate of an institution framed for the purpose of becoming as it were a voluntary health parliament. In addition to these sections of the Institute there are many other sections of the community which will, we should think, earnestly join in the work. For reasons plainly stated by Dr. Richardson ladies are invited to take part in the proceedings and to help forward sanitary progress. We feel sure there will be a large class of active men also who will be ambitious to take a part in the great practical scientific labour of the time, the only labour we may say in which science lends herself immediately to the aid and comfort of domestic life and felicity.

The detailed work of the Sanitary Institute has been in some measure projected by its founders; but it is more than probable that in the course of its natural development it will grow into something different from that which is now supposed. At the same time we are bound to say that the plan is sufficiently simple and practical to warrant the hopes of those who have mapped it out. The objects we have seen proposed are all directed to some useful and very desirable end. To obtain a registration of the diseases of the kingdom, to establish communications with medical officers of health, to form local branches of the Institute throughout the kingdom; to examine and grant certificates of qualification to local surveyors and inspectors of nuisances, and to form a register of such certificated officers; to investigate the chemical aspects of the sewage question; to establish a sanitary exhibition, and to form a library of books on health subjects—these objects, some of which must needs become a part of such an organisation, are sufficiently comprehensive to cover any amount of work, and to tax any amount of industry that may be found in the best organised public body. So far the prospects of the Institute are brought beyond what is common to such undertakings in their earliest days. Members are daily being added, and an effective Council has been elected. Already one of the provincial towns, Scarborough, has invited the Institute to hold the first provincial Congress there, and in France a kindred society has been formed in sequence, and, it may be said without offence, in imitation of the one already founded in London. The visit of Dr. Pietra Santa, of Marié Davy, and other savants from Paris to the meeting on Thursday last, is a significant sign of the good feeling with which the two rival societies have commenced their labours.

For our parts we welcome heartily both institutes, and shall enjoy the privilege of watching their onward progress and recording their success.

ON THE SOURCE OF THE CARBON OF PLANTS

NEARLY half the dry substance of plants is carbon; and it is conclusively established that they derive, at any rate, the greater part of it, directly from the carbon-dioxide of the atmosphere, which the chlorophyll cells have the power of decomposing in sunlight, at the same time evolving oxygen. But this function of vegetation, which is so essential a complement to the processes of animal life, gives rise to many problems hitherto unsolved; and an important one is whether or not plants avail themselves of other obviously possible sources of carbon than that existing in such very small proportion, although in large actual amount, in the ambiant air.

Our knowledge bearing upon the subject as it exists in the present day, is the resultant of careful investigations by many observers. In the last century Bonnet discovered the gaseous exhalation; Priestley that the gas is oxygen; Ingenhouz that the oxygen is only evolved in sunlight; Sennebier that it is due to the decomposition of carbon-dioxide, but he believed that the carbon-dioxide is taken up in solution in water. Early in this century de Saussure carried out a long series of experiments on the relations between the carbon-dioxide decomposed, and the oxygen evolved, and on the amount of carbon-dioxide in the air compatible with the healthy development of plants. Since his time many eminent names have been added to the list of patient labourers in this field of inquiry.

Boussingault worked on the question whether the carbon-dioxide is absorbed by the leaves, or taken up by water through the roots; and by direct experiments proved that the leaves of plants do take up the carbon-dioxide, which is so sparingly, though so uniformly, diffused in the atmosphere. His researches led him to conclude that, by far the greater part, if not the whole, of the carbon which enters into the constitution of the organs of plants is derived from atmospheric carbon-dioxide; and while drawing attention to the fact that, for healthy and vigorous action, plants require large volumes of air to pass over them, and to the surprising rapidity with which they absorb the carbon-dioxide from it, he makes calculations as to the surface presented to the air by the leaves of different crops. Taking the average number of plants growing per hectare (about $2\frac{1}{2}$ English acres), he estimates that:—

Artichoke	gives a surface of	142,410 square metres.
Beetroot	,, ,,	49,921 ,, ,,
Potato	,, ,,	39,641 ,, ,,
Wheat	,, ,,	35,490 ,, ,,

Boussingault also made experiments in regard to the absorption of carbon-dioxide by plants growing under different conditions as to soil and manures. He found that a Helianthus which in twenty-four hours would, without any manure, only decompose 2 c.c. of carbon-dioxide, decomposed 182 c.c. in the same time when supplied with manure containing nitrates and phosphates, 11 c.c. when with nitrates without phosphates, and only from 3 to 6 c.c. when manured with phosphates without nitrates.

That the carbon-dioxide contained in the atmosphere is sufficient for normal vegetation is proved by the abundant growth of heath and other wild plants on sandy hills; and the numerous experiments on water-culture conclusively show that a plant may grow luxuriantly, and store up an abundance of carbon, when supplied only with mineral salts, in a solution which contains little or no carbon-dioxide.

Sachs speaks of it as an unquestionable fact, "that most plants which contain chlorophyll (for instance, our cereal crops, beans, tobacco, sun-flower, &c.) obtain the entire quantity of their carbon by the decomposition of atmospheric carbon-dioxide, and require for their nutrition no other carbon-compound from without." He goes on to say: "The compound of carbon originally present on the earth is the dioxide, and the only abundantly active cause of its decomposition and of the combination of carbon with the elements of water is the cell containing chlorophyll. Hence all compounds of carbon of this kind, whether found in animals or in plants or in the products of their decomposition, are derived indirectly from the organs of plants which contain chlorophyll."

Dr. J. Boehm made direct experiments with seedlings of scarlet-runner, growing them under glass shades, luted with potass lye, in pots containing in some cases quartz sand moistened with a nutritive solution, and in others garden-soil rich in humus. The two sets were quite equal in development and duration of life; those in the garden soil formed quite as little starch as those in the sand; and from this he concluded that the carbon dioxide yielded by the garden soil had taken no share in the growth of the plants.

Liebig had, however, supposed that plants might owe some part of their carbon to the carbon-compounds in the soil, which were absorbed by their roots, and that young plants especially drew their supply from this source. He speaks of the effect of drought as checking the supply of carbon-dioxide by the roots, and throwing the plant exclusively upon that in the air.

But the tendency of more recent investigations points to the conclusion that the atmosphere and the parts of plants living in it are solely concerned in the storing up of the carbon of vegetation.

We may pause for a moment to consider the amount of the carbon so stored up.

Liebig estimated that more than 1,000 lbs. of carbon may be harvested annually from a Morgen of surface—somewhat less than two-thirds of an English acre.

According to the estimates of Lawes and Gilbert, with wheat for twenty years in succession on the same land there was an actual yield of 2,500 lbs. of carbon, per acre, per annum, where no organic carbon compounds were added to the soil, and where these were added (in the form of farm-yard manure) the actual yield in carbon was less. With barley, for twenty years in succession, the average annual yield was 2,088 lbs. of carbon per acre; and the indication is that some other crops, under similar conditions, acquire even more.

Estimates recently made of the forest growth in Germany give as much as 2,700 lbs. In tropical climates where vegetable growth is more luxuriant the amounts are far greater; and in the West India Islands as much as from $2\frac{1}{2}$ to 5 tons of carbon may be harvested per acre in the crop of sugar-cane.

With these large amounts of accumulation on the one hand, we have, on the other, an atmosphere containing carbon-dioxide in so small a proportion as 0·04 per cent.

Then we have to bear in mind the large supplies of carbon-dioxide within the pores especially of manured soils, as determined by Boussingault, and at the disposal of the roots of plants. Also the enormous quantity of water taken up from the soil and passing through plants during growth, probably at any rate more than 200 parts for every part of dry substance fixed, and the fact that carbon-dioxide is present in all natural waters would lead to the supposition that the roots would scarcely either take it up to no purpose, or act as a filter to that which constitutes so important a requirement of the plant.

Dr. Moll[1] has recently, by some interesting experiments, made a contribution to the evidence which is required to answer the question—Can leaves decompose the carbon-dioxide which is at the disposition of the roots? and argues that the proof that one part of the plant—the leaf—takes up and decomposes carbon-dioxide, is no proof that it is not taken up in another part—the root.

He quotes the experiments of Sennebier and de Saussure, but considers that they were not made quantitatively, or with sufficient exactness to solve this problem. For its elucidation he rests his methods upon Sach's theory, that the starch in the chlorophyll grains must be considered as the first visible product of the decomposition of carbon-dioxide, and that therefore, according to him, the presence or absence of starch in the leaves is the crucial test of the decomposition or non-decomposition of carbon-dioxide. In Dr. Moll's investigation of the starch contents he used Sach's modification of Boehm's method.

Five sets of experiments were made to meet the different aspects of the question.

In the first set glass shades were used, in one of which the air was kept free from carbon-dioxide by being luted with potass lye, while the other contained ordinary air, or air with an excess of carbon-dioxide, and was luted with water. The liquid lute was in porcelain dishes, made with a round hole in the middle; the central hole and outer edge being deeply rimmed. The shades, of less circumference than the dishes, were set in them, and were furnished with tubular necks, into which smaller tubes were fixed for the current of air to pass through, and for other requirements of the experiments. The exit tube of the shade in which the atmosphere was kept free from carbon-dioxide was conducted through a test-tube filled with pieces of pumice saturated with potass lye. Preliminary experiments with etiolated plants, with a watch glass containing baryta-water within the shade, satisfied the author that he secured having air absolutely free from carbon-dioxide under that luted with potass lye; and some early failures taught him how to regulate the supply of carbon-dioxide and air in the other shade, so as to grow plants as well-developed and healthy as those in the open air. With thick-leaved plants he found that it was necessary to add as much as 2 per cent. of carbon-dioxide to a volume of air supplied to them of about 2,500 c.c. daily, in order to satisfy their requirements for free growth.

Experiments were made with plants of French bean, nasturtium, gourd, and sugar-beet, growing in the open air in pots in good garden soil. From these was selected a leaf, or the upper part of a stem with several leaves, still organically united with the parent plant, which was passed through the hole in the porcelain dish, under the glass shade, and carefully secured air-tight, and from injury to itself, by cork and wadding. The plants for comparison were as nearly alike as possible in every respect, and a control plant grew in the open air between the shades. Both etiolated seedlings, which became green as quickly without carbon-

[1] "Ueber den Ursprung des Kohlenstoffs der Pflanzen." Von Dr. J. W. Moll (Utrecht).—*Landwirthschaftliche Jahrbücher*, Band vi. Heft 2.

dioxide as in common air, and well developed green gourd leaves, were tried. The gourd leaves, which contained starch at the beginning, entirely lost it within a day or two in the atmosphere deprived of carbon-dioxide, while those in the other shade remained still full of it. The shades, and the contents of the dishes, were then changed, so as to bring the starchless leaves into the shade containing carbon-dioxide. During the day these became again full of starch; while within twenty-four hours it had quite disappeared from the leaves in the other shade. In a similar experiment with sugar-beet the control plant in the open air was covered with a black paste-board box, and it was found that the leaves in the shade deprived of carbon-dioxide lost their starch at about the same rate as those in the dark. In no case was starch found in the leaves while they remained in an atmosphere without carbon-dioxide.

The second set of experiments was made with long leaves of bulrush and bur-reeds, which were etiolated, and then separated from the plants. With the same general precautions as before, the upper end of the leaf was inserted in the shade without carbon-dioxide, the lower in an atmosphere containing five per cent. of carbon dioxide, whilst the space between was left free to the open air. This intermediate part was obscured by tin-foil, so that no starch could be formed in it at the expense of any carbon-dioxide passing through the tissues from the lower shade; and it was supposed that if such a phenomenon were possible, the spacious longitudinal air channels of these plants might be especially favourable to the transmission of the gas. These experiments usually lasted one day, and uniformly gave the same result; starch was formed abundantly where carbon-dioxide was at disposal in the air, while the excess of it in the lower shade had no effect upon the portion of leaf in the upper shade, which remained entirely free from starch.

The apparatus when arranged was always placed in a light window, shaded by gauze blinds if the sun were too hot; and in these latter experiments it was an interesting circumstance that, in the lower portions of these rather thick leaves, more starch was formed on the side next to the window; therefore, in two cases a piece of looking-glass was placed behind the shade, when, being equally illuminated, starch was formed in equal abundance on both sides of the leaf. This variation in the starch-formation, according to the amount of light, showed that that portion of leaf had not always used all the carbon-dioxide at its disposal, and that consequently there was an excess which might have passed upwards through the tissues.

The third set varied from these in having no part of the leaf exposed to free air, thus obviating the possibility of the carbon-dioxide being diffused into it in passing upwards through the plant. A glass vessel containing air without carbon-dioxide was placed within a large shade containing air with 5 per cent. of this gas; and a previously etiolated leaf, with its stem in water, was so fixed as to be partly in the one and partly in the other. After six or eight hours it was examined for starch. Without exception starch was formed abundantly in the parts in the large shade, whilst no trace of it was found in those in the inner vessel even quite close to the junction between the two.

The remaining two sets of experiments were made to ascertain whether starch formation in leaves, in the open air, is accelerated by giving an excess of carbon-dioxide, either to adjoining parts of the leaves themselves, or to the roots. In the first case leaves separated from the plant were divided lengthways. One half, with the stalk in water, was in a shade with air containing 5 per cent. of carbon-dioxide, its upper part projecting under the glass lid of the shade, which was luted with grease, into the open air. The other half of the same leaf was laid on the lid, on filter paper soaked with boiled water to keep it moist, and put as near as possible to the projecting piece of leaf. In the other cases etiolated leaves, organically united with plants whose roots were in rich humus soil, were divided lengthways; one half, quite cut off, was laid near to the other, and the two were examined and compared after some hours' exposure in sunlight. The results of both these sets of experiments were uniformly the same; careful examination showed that starch was formed as readily and plentifully in those portions of leaves excluded from any other source of carbon-dioxide than that in the air surrounding them, as in those having an excess of it at command.

From these experiments Dr. Moll concludes that starch is never formed in leaves in an atmosphere deprived of carbon-dioxide, however much of it may be at the disposa of the other, under- or above-ground, parts of the plant; nor can starch-formation be accelerated in one part of a leaf by an excess of carbon-dioxide being at the disposal of another part of it, either in the air, or through the roots.

The results of these elaborate experiments are doubtless in accordance with the direction of those of other modern inquirers on this subject. At the same time it will probably be felt, that, when long-accepted opinions, which many well-known facts seem to favour, are held to be called in question, we may still ask for further confirmation, before accepting as decisive, conclusions depending on the exact interpretation of experiments made with living organisms exposed to somewhat artificial conditions. It may be hoped, however, that this further instalment of evidence in a given sense will incite to further research.

OUR ASTRONOMICAL COLUMN

DE VICO'S COMET OF SHORT PERIOD.—It has been already remarked in this column that, according to Prof. Brünnow's last investigations relative to this comet, it appears necessary to admit a very material degree of uncertainty in the value of the mean motion determined from the observations of the year 1844, notwithstanding the comet was discovered on August 22, and followed till December 31, or for a period of more than four months, and, moreover, was observed with a degree of precision which has seldom been attained with these bodies. In Prof. Brünnow's masterly and elaborate discussion, "Mémoire sur la Comète elliptique de De Vico," which gained the prize offered by the Royal Institute of the Netherlands, in June, 1848, the planetary perturbations were calculated to the epoch of next return to perihelion in February, 1850, but in consequence of the computed positions showing that observation in that year would be quite hopeless, the calculation was continued with all possible precision to the ensuing perihelion passage early in August, 1855. The computed track in the heavens for this appearance was by no means an unfavourable one for observation; the comet would remain for a considerable period near the earth, being at its least distance on August 2, just before the perihelion passage, when it should have approached our globe, according to Prof. Brünnow's calculation, within 0·58 of the earth's mean distance from the sun. Nevertheless, it was not detected in this year—an object observed by M. Goldschmidt, not far from its track, in May, being certainly a distinct body, if the star of comparison was correctly identified. It was looked for repeatedly with the large refractors at Cambridge and Berlin. In 1860 again, ephemerides were prepared and a search was made, at least at the observatory of Harvard College, U.S., but ineffectually, indeed the chance of observing this comet when the perihelion passage falls in the winter must be but small.

The later results obtained by Prof. Brünnow, to which allusion is made above, will be found in No. 3 of his Ann Arbor *Astronomical Notices:* he there gives his reasons for concluding that he had placed too great reliance upon the value of the mean motion determined in his memoir, and while obtaining a new value (about 650″) which would assign for the period of revolution in 1844 about 1994·0 days, he intimates the necessity of searching for the comet in future on the supposition that this period may be in error ± 30 days. At this distance of time or at the end of the sixth revolution since 1844, so great an amount of uncertainty of course renders the preparation of limited ephemerides useless, but it may be observed that the period finally deduced by Prof. Brünnow would bring the comet to perihelion again in the present summer, and it will certainly be worth while to keep a close watch upon those regions of the heavens which its path must traverse on this hypothesis; we might indeed expect, if the comet continues in the same condition as in 1844, that it would not escape detection, should the perihelion passage fall between the beginning of the present month and the middle or end of October. On July 14 its orbit is thus projected on the sky, the positions consequently indicating the line in which it should then be found according to the different suppositions as to the date of perihelion passage:—

Time from Perihelion.	Right Ascension.	Declination.	Distance from Earth.	Intensity of Light.
+ 40 days	60·3	+ 19·3	1·89	0·17
+ 10 ,,	43·0	+ 13·4	1·12	0·56
− 20 ,,	21·2	+ 3·0	0·64	1·68
− 40 ,,	350·1	− 13·6	0·39	4·02
− 50 ,,	321·6	− 24·8	0·34	4·78
− 60 ,,	289·3	− 30·1	0·38	3·60

While it is of importance that an effort should be made to recover the comet, now to all intents *lost*, in the present year, no surprise need be occasioned if the endeavour should prove fruitless. It is quite possible that the mean motion in 1844 was of such amount as would bring the comet, with the influence of planetary perturbation into so close a proximity to Mars at the end of August, 1866, as to occasion very material changes in the elements of its orbit; and again there is the possibility that, as Dr. von Asten suspects has been the case with Encke's comet, it may have encountered one of the minor planets, and with the result of a sensible change in its motion.

And it is to be borne in mind to whatever cause or causes the circumstance may be due, that De Vico's comet has been shown by M. Le Verrier and Prof. Brünnow to be with great probability identical with the comet of 1678 observed by Lahire at Paris; yet in the long interval from 1678 to 1844 there is no record of a comet which can be identified with it, and in the early part of its appearance in the latter year it was visible to the unassisted eye. It does appear strange that in the days of Messier and Pons the comet should have escaped detection at one or other of its returns.

While writing on De Vico's comet we may mention that in heliocentric longitude 339°·6 this body approaches very near to the orbit of the periodical comet of D'Arrest, of which observations may be expected in the present year. The distance is within 0·0055 of the earth's mean distance from the sun, or about 507,000 miles, rather more than twice the moon's distance from the earth, but it does not appear likely that there has been any actual close approach of the two comets during the last fifty or sixty years.

THE LATE PROFESSOR HEIS.—We regret to record the sudden death of Prof. Edward Heis, the well-known German astronomer, which occurred on June 30 from an attack of apoplexy. Prof. Heis was born in 1806, completed his studies at Bonn in 1827, and received in 1852 a call to the ordinary professorship of mathematics and astronomy at the Royal Academy of Münster, Westphalia, which he filled until the time of his death. He was a most diligent and accurate observer in the particular branches of astronomical research to which he devoted himself. His "Atlas Cœlestis Novus" may be considered the standard work for magnitudes of the stars visible in central Europe, his acute vision enabling him to add a large number of stars of what he calls 6·7m. not included in Argelander's "Uranometria." While resident at Aix-la-Chapelle previous to his appointment to Münster he published the results of ten-years' observations upon shooting-stars which were carefully discussed. In 1875 appeared his observations on the zodiacal light, extending over the twenty-nine years, 1847-1875, and forming No. I. of *Publications of the Royal Observatory at Münster*; it is a most important addition to our collection of observations of this as yet little understood phenomenon. From 1858 to 1875 he edited the *Wochenschrift für Astronomie*, a periodical better known on the Continent than in this country. Prof. Heis was also the author of a collection of examples and problems in general arithmetic and algebra, which, we believe, has reached the forty-fifth edition in Germany. His observations of variable stars were conducted upon a system of extreme care, his researches in this direction being encouraged and guided by Argelander; he first established the variability of that irregular star ε Aurigæ, not without a long course of assiduous observation. He was an excellent draughtsman, and produced many fine pictures of nebulæ, though, unfortunately, supplied with very limited optical means.

THE CAXTON EXHIBITION

IT is not too much to say that Science has been advanced by the art of printing more than by any other of the world's inventions, for by it not only has the knowledge of scientific truth been spread throughout the world, but it has been perpetuated to all time, and the names of great heroes in science have been rendered immortal. Long after sculptured monuments, commemorative of the lives and work of great men have crumbled away, their written works remain, and the art of printing has contributed more than anything else to the bringing about of that result. The names of some of the greatest philosophers the world has ever seen would have had but a narrow and comparatively ephemeral celebrity, were it not for the record of their lives and writings which the productions of the printing press have preserved to them.

But great as have been the advantages which Science has derived from the printer's art, she has, in return, conferred as many and as important benefits upon the development of that art; and this is recorded in unmistakable language in the Caxton Collection, which, though (probably for want of space) very deficient as far as modern printing machines are concerned, constitutes a most interesting and instructive series of historical and typical forms, in which the rise and development of printing machinery may be traced from the early screw presses of wood used by Caxton and the early printers, through the Stanhope and lever presses of the last century, to the powerful steam machinery of the present day.

The principal aim of the designers of printing machinery has always been to obtain increased rapidity of working; and during the last fifty years this has been brought to an extraordinary degree of perfection. It was considered a wonderful feat when, in the year 1814, the celebrated König machine was started, throwing off 1,100 sheets of the *Times* newspaper per hour; but this number was doubled by König's second machine, which he brought out ten years after. In the year 1827, by means of Applegarth and Cowper's four-cylinder machine, the yield was raised to 5,000 per hour, and in 1848 the celebrated "Times" vertical machine was erected, which produced 12,000 single impressions per hour. The next advance was made by Richard Hoe, who, in 1857, introduced his cylinder machine into this country, where it was first employed by the proprietors of *Lloyd's Weekly Newspaper*. Shortly afterwards the proprietors of the *Times* adopted it, and by means of a ten-cylinder machine, 16,000 single impressions of the *Times* were thrown off per hour. This was till lately the most rapid printing machine ever invented, but having to be supplied with separate sheets of paper from ten different feeding-boards, it required some twenty men and boys to work it. Since that time a still further advance in the art of printing has been made by the invention of the now celebrated Walter machine, by which the bulk of the *Times* is now produced. This machine works from a continuous roll of paper, printing it on both sides and—requiring the attendance of only a man and two boys—throws off 25,000 single impressions, or 12,500 complete newspapers, per hour.

In all these rapid machines the type *formes* are cast in cylindrically-curved stereotype plates, which are produced by first setting up the matter in type by the ordinary process and then pressing the *formes* so produced into *papier maché* moulds into which the stereotype metal is cast. By this means several plates from the same mould can be produced and therefore the same number of identical sheets may be printed at the same time.

With regard to the actual operation of printing the aid that Science has given has been almost exclusively in the direction of mechanical improvement and perfection. The art of stereotyping or the reproduction of plates and blocks for illustrations has, however, been developed by discoveries in many branches of Philosophy. Electricity has long been employed in the production of copies of wood engravings by the electrotype process, which copies are now almost universally used for rapid work where fine finish is not necessary, and the many processes in which photography is combined with engraving are every day becoming more generally employed for improving and facilitating the art of printing.

It will readily be understood that notwithstanding all the improvements in printing machinery by which such rapidity as we have referred to is insured, the art of rapid printing will be most materially hampered unless the operation of type-setting or composing can be carried on with corresponding rapidity. The importance of this is shown by the attention it has received and by the many systems that have been devised for mechanical and automatic type-setting. A special feature of the Caxton exhibition is the collection of machines for that purpose. Here again Science has lent her aid, and to any one interested in the applications of Science for the assistance of personal dexterity a careful study of the various machines exhibited will be found most interesting and instructive.

One of the most beautiful of these machines is the automatic type-setter of Dr. Mackie, which we illustrate in Fig. 1, and which is a most ingenious application of the well-known principle first invented by M. Jacquard, and applied by him to the operation of weaving, and which has since been employed for telegraphic and other purposes. In this machine a horizontal wheel, carrying a number of little platforms, revolves on a vertical axis beneath a set of upright boxes arranged in a circle round it. Each of these boxes is divided vertically into eight compartments containing the types; and the platforms, during the revolution of the horizontal wheel, pass in succession below, but without touching them. Each platform is furnished with eight adjustable projecting pins, that is to say, as many as there are compartments in the boxes. The use of these pins, or "pick-pockets" as they are called, is to remove the types contained in the corresponding compartments of the boxes at the moment of passing below them; and the types so removed, resting on the platforms, are carried round with them until pushed off at another point in their revolution, where they are collected and delivered in long lines in their proper order, and evenly spaced. The pins are automatically set up or left alone by the Jacquard mechanism to be referred to presently.

Calling the compartments containing the types and the corresponding pins on the platforms by the figures 1, 2, 3, 4, &c., it might at first be supposed that if, for instance, the pins 1 and 3 were set up, they would remove types from the first and third compartments of all the boxes as they passed beneath them, but this is provided against by the platforms being hinged at one end, so as to be capable of rising and falling through a small vertical arc, and by another portion of the Jacquard mechanism each platform is raised only when it is approaching that particular box which contains the compartments to which its projected pins correspond.

The regulation of the movements of both platforms and pins is effected by a set of levers, whose movements are determined by the positions of the perforations on a continuous ribbon of Jacquard paper, which positions correspond to the letters, spaces, &c., required to be set up. This ribbon is fed into the machine at a uniform speed by a

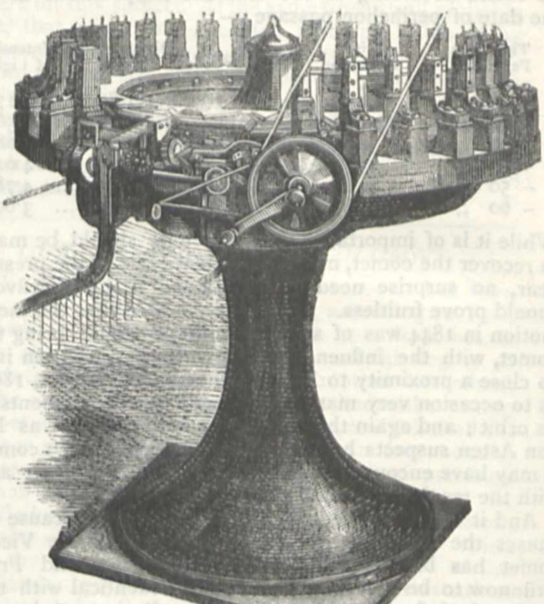


FIG. 1.

revolving spur-wheel armed with pins, which gear into a longitudinal row of holes punched along the centre of the strip of paper, and which is shown in Fig. 2, which represents a piece of the paper ribbon perforated for setting up the name of this journal, "Nature." The four lower rows, which are marked in the figure with Roman numerals, are those by which the rising and falling of the platforms are regulated, and the other eight rows, indicated by ordinary figures, correspond to the eight compartments of the boxes and control the protrusion of the pins or "*pick-pockets*." On reference to the figure it will be seen that the capital letter N is drawn from the fifth compartment of that box, under which a platform is raised by the dropping of the levers, which are controlled by the combination of the two lines of perforations marked I. and IV.; and again the small letter r is contained in the third compartment of a box whose platform is raised by the single lever corresponding to the row marked I.

The perforation of the paper is done at a separate instrument, which, at the Caxton Exhibition, is, in external appearance, exactly like an ordinary cottage pianoforte, the keys of which are marked with the letters, figures, spaces,

&c., and which, by simple mechanism, punch corresponding holes in the paper when pressed down by the fingers. This operation being quite independent of the machine last described, can be carried on at any slack time, or when the type-setter is in use, and the prepared paper can be put away until the machine is ready to work from it. This is a special advantage of the system which printers will readily appreciate; and it possesses another of great value, and that is that parts of words of two to eight letters, and several short words, can be set up simultaneously, as the compartments are so filled that letters likely to come together are in contiguous divisions and may be released by the mechanism at the same moment. As an instance of this the eight compartments of one of the boxes are filled with types in the following order:— **w i t h a t s** and spaces, so that the ten words wit, with, it, that, hat, hats, at, as, is, and has, may be drawn by one operation, and the preparation of the paper for such combinations is no less simple, for it is performed by depressing several keys at once, as in playing chords in music.

By this system of type-setting, using one, two, or three perforators respectively, as many as eight, twelve, and twenty-four thousand types may be set up per hour.

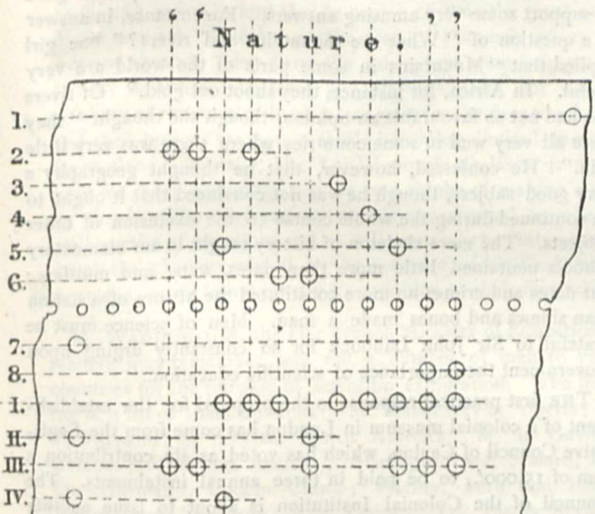


FIG. 2.

We have described Dr. Mackie's machine at some length, because it is a very beautiful application of the mathematical laws of permutations and combinations, and of mechanics to the saving of skilled labour, and is itself an interesting example of some of the services rendered by Science to the printer's art.

Another very ingenious application of Science to type-setting is the "Clowes" electrical compositor, invented by Mr. John Hooker. In this machine the types are contained in forty-eight nearly vertical troughs or reservoirs, and are pushed out through a lateral opening at the lower end by a *striker* under each trough actuated by an electro-magnet, so arranged that, when a current of electricity is sent through its coils, one type is released from its reservoir and drops out. Below the openings of the reservoirs are as many flat running tapes, and when a letter is released it drops on to the tape which is running below it, and is carried by it at the speed of seven inches per second to the edge of the table of the machine, where it is thrown on to another tape running at a quicker speed (about twenty-one and a half inches per second), and making an angle of about 150° with the set of parallel tapes before mentioned. This angle determines the relative distances of the reservoirs from the quick-running tape, and the speeds are so adjusted to these distances that the time occupied by a type in travelling from the reservoirs to collecting apparatus is exactly the same in all cases so that the types are delivered into the composing-*stick* exactly in their order of release from the reservoirs. This part of the apparatus may in telegraphic language be called the "receiving instrument."

The "transmitting instrument" consists of a series of rectangular plates of copper insulated from one another and arranged on a sloping board representing exactly the compartments in the ordinary compositor's "*Lower Case.*" Each of these plates is in metallic communication with one end of the coil of one of the discharging magnets, the other end being in connection with one pole of a voltaic battery consisting of two small Grove elements. The compositor sits in front of this set of plates, having the copy before him, and holding in his hand a copper stile or contact piece which is in connection with the other pole of the battery. Every time he touches with the stile one of the rectangular plates of copper a voltaic current is sent through the coils of its corresponding magnet and a letter corresponding to the plate touched is liberated on to the tapes and is instantly carried to the composing-stick. The collecting apparatus is extremely ingenious and is worked by a quick running cam by simple mechanism, which is a beautiful specimen of workmanship.

By this machine as many as 15,000 letters per hour may be set up; and it possesses the advantage over other systems that it can be worked by any ordinary compositor *at case*, and requires no special training for its manipulation.

Of other type-setting machines there are exhibited in the collection examples of Kastenbein's system, which is adopted in the *Times* office; the Hattersley compositor, in which the types are, by the depression of keys, shot down vertical grooves, by which they are guided to the composing frame, and by which it is said that types may be set at the rate of 8,000 per hour. Muller's machine, which is represented in the collection by a model, is a well-made apparatus, intended to set type at a speed of 5,000 letters per hour. Both this and the Hattersley machine set up the type in columns, ringing a bell at the end of each line.

Heinemann's apparatus is an exceedingly simple machine, depending upon quickness of hand and eye in aiming a pointer at the particular divisions of a comb-shaped series of guides, by which the types are withdrawn from the reservoirs corresponding to those divisions. It is a well-made machine, and its simplicity is a safeguard against its becoming deranged.

The operations of type-founding, of paper-making and folding, of lithography, and steel engraving, which are all more or less dependent upon scientific aid, are all represented at South Kensington, but we must reserve their consideration for a future notice, as well as a description of an interesting gas-engine, exhibited by Messrs. Crossley Brothers, which is admirably adapted for laboratory purposes.

From what has been said it will be seen that the Caxton Exhibition is an exceedingly interesting and instructive one, and will well repay several visits. C. W. C.

NOTES

WE are glad to see that the first grants from the Research Fund of the Chemical Society have just been made. They are as follows: to Dr. C. R. A. Wright 50*l.* for the investigation of certain problems in chemical dynamics; to Mr. G. S. Johnson 25*l.* for a research on double salts with potassium tri-iodide; to Mr. E. Neison 25*l.* for a research on octyl compounds; to Mr. Carleton Williams 25*l.* for a research on hydrocarbons containing the group isopropyl twice; and to Mr. George Harrow 10*l.* for a research on derivatives of aceto-acetic ether.

The German Astronomical Society, as it is generally called, but really the International Astronomical Society, meets this year at Stockholm, from August 30 to September 1.

Now that the British Association meeting is again at hand, perhaps we may be permitted to urge upon the authorities the necessity for introducing some improvement in the daily programme published during the session. Last year (vol. xiv., p. 463) we noticed the handsome, full, carefully-arranged programme daily published by the American Association, and we have before us the *Tageblatt* of last year's meeting at Hamburg of the German Naturalists and Physicians. This is a quarto publication, each day's issue averaging twenty pages, and containing such important and detailed information that it is well worth binding and preserving. The rules of the Association are given in the first issue, a list of members with their addresses is given daily until complete, the arrangements for the meetings of sections and general meetings are clearly tabulated, a well-arranged general programme and list of all papers to be read each day are given, all information as to excursions, places to be visited, entertainments (including theatres), advertisements likely to appeal to members, summaries of each day's proceedings in the various sections, general meetings, dinners, &c. ; in short every kind of information likely to make the proceedings be carried on with perfect smoothness and give the members the minimum of trouble and worry. Appended is a supplement of 180 pages containing reports of lectures given at general meetings and in connection with the various sections. All this contrasts strongly with the shabby tract-like programme issued during the meetings of the British Association; if the expense is an obstacle we are quite sure no member would object to a small charge if he could only be assured of obtaining each morning a well-printed journal on a scale similar to that of either the American or the German Association.

At the Congress on Domestic Economy to be held at Birmingham on the 17th, 18th, and 19th instant, under the presidency of Lord Leigh, Prof. Huxley will read a paper on Elementary Instruction to Children in Physiology, Mr. W. S. Mitchell one on the Practical Use of the Food Collection of the Science and Art Department, and Captain Galton on Warming and Ventilation. Many other papers bearing on the subject of the Congress will be read, and an exhibition will be organised.

Many of our biological readers will be glad to know that Dr. George Bennett, F.Z.S., of Sydney, has arrived in this country, and that any communications directed to the office of the Zoological Society, 11, Hanover Square, will be forwarded to him.

The Portuguese African Exploring Expedition left Lisbon for Loanda on the 7th inst.

Mr. Richard S. Floyd, one of the trustees of the Lick Californian estate, has been for a year past in Europe, investigating the comparative merits of reflectors and refracting lenses, for the great telescope. We are told by the *New York Tribune*, for various reasons, which he gives in detail, he decides against a large reflector, one point being that even if the extreme nicety of adjustment which the reflector requires could be attained in the new observatory, it would be liable to derangement in the high winds of a mountainous position. If a refractor is decided upon, estimates should be asked, Mr. Floyd says, from Cooke and Sons, of York, from Alvan Clark and Sons, and from Howard Grubb. He reports that the reputation of Clark's refractors and Grubb's, from all he can learn abroad, is about equal. The story of Mr. Lick's millions had preceded Mr. Floyd, and he has found it difficult to bring down the estimates of European opticians to the basis of ordinary business profit.

In the debate on the education estimates, on Tuesday night, Sir John Lubbock, speaking on the extra subjects which had been made compulsory, said he doubted whether under any circumstances it would be desirable thus to stereotype one form of education for the whole of England; but surely we ought not to do so unless we were very clear as to what is the best system. There was, however, very great difference of opinion on this head. The first authority to which he would refer was that of a committee of that House. It was presided over by his hon. friend the member for Banbury, and after careful inquiry they reported that in their opinion "elementary instruction in the phenomena of nature should be given in elementary schools." The next authority which he would quote was the Royal Commission, presided over by the Duke of Devonshire, which unanimously recommended that more substantial encouragement should be given to the teaching of the rudiments of science in our elementary schools. In Scotland, too, great dissatisfaction was felt with the present system. At the last conference of elementary teachers, held in London, which was very numerously attended, it was resolved that the system of payment "embodied in the Code is unsound in principle and injurious to the progress of true education." The inspectors of schools differed greatly as to the most suitable subjects. Even in regard to geography they were not unanimous. It was said as a subject to lend itself very much to "cram." One of the inspectors gave in support some very amusing answers. For instance, in answer to a question of "What are mountains and rivers?" one girl replied that "Mountains in some parts of the world are very useful. In Africa, for instance, they shoot out gold." Of rivers she had not so favourable an opinion, though she thought "they were all very well in some countries where there was very little rain." He confessed, however, that he thought geography a very good subject, though he was not convinced that it ought to be continued during the whole course to the exclusion of other subjects. The mere skeleton of history taught in our elementary schools contained little more than dates, wars, and murders; but dates and crimes no more constituted the history of a nation than sinews and bones made a man. Men of science must be grateful to Sir John Lubbock for so constantly urging upon Government the importance of scientific education.

The first practical response to the proposal for the establishment of a colonial museum in London has come from the Legislative Council of Ceylon, which has voted as its contribution a sum of 15,000*l*., to be paid in three annual instalments. The Council of the Colonial Institution is about to issue another circular on the subject to the colonial Governments.

At the last sitting of the French Geographical Society, excellent news was received from M. de Brazza, the French explorer of the Ogové. He reached a distance of 250 miles beyond the place where M. de Compiègne was obliged to retreat hastily to save his life. He finds that Ogové does not bend towards the Zaire. If its course does not change further up, both streams may belong to a single system. It was reported, also, that M. Say, a French officer in the National Marine, had reached the Hoggar, in Central Africa, but the news requires confirmation.

The *Bulletin* of the Paris Geographical Society for April (just issued) is mainly occupied with a long and elaborate review of the geographical work of the year 1876, by M. Ch. Maunoir. M. de Bizemont discusses some of the observations for latitude obtained by M. de Brazza during his exploration of the Ogové. In connection therewith M. de Bizemont gives a list of the instruments which he considers most useful to explorers in new countries.

Among the papers in this month's part of *Petermann's Mittheilungen* is one on the Cartography of the Philadelphia Exhibition; Dr. Güssfeldt contributes an important paper on the exploration, by himself and Dr. Schweinfurth, of that part of the Arabian desert between the Nile and the Gulf of Suez; and Dr. Radde a paper on the plain of the Upper Euphrates. Dr.

C. E. Jung has the first part of an important contribution on the Geographical Outlines of South Australia.

THE *Geographical Magazine* for July contains a masterly paper, with an elaborate and carefully-constructed map by Mr. Trelawny Saunders on the Himalayan system. Both article and map are evidently the result of thorough study and extensive knowledge.

FROM a Report of the Board of Commissioners of the New York State Survey, which is under the charge of Mr. J. T. Gardner, formerly of the United States Geological Survey, we learn that, although the Survey was decided on only in 1876, much has already been done in the way of commencement, and that it is likely to be carried out with a thoroughness quite equal to any of the trigonometrical surveys of Europe.

MR. LANDSBOROUGH, the well-known Australian explorer, recently read a paper at Oxley, Queensland, in which he adduces a variety of interesting facts to prove that dense forests are on the increase in Australia, that the climate is becoming moister, and therefore improving, that the country is gradually ceasing to be favourable to sheep-rearing, and becoming agricultural, and seems to hint that in course of time the great central desert may yet "blossom as the rose." Formerly when there were no sheep to keep down the grass, fires were frequent and terribly destructive to trees and all vegetation, but since the stocking of the country there is less grass for the fires to consume, and their ravages are consequently becoming limited in extent. Queensland, especially, Mr. Landsborough declares, is now so unfit for sheep-pasturing, that no one thinks of making a living by them. The observations of this experienced traveller are well worthy of attention, and it will certainly be interesting to watch the changes caused by the presence of civilised men in Australia, as we know exactly its condition at their first advent.

M. WADDINGTON, the late French Minister of Education, our readers may remember, sent out a number of men to various countries for the purpose of scientific exploration. The following is a list of these missions:—M. Masqueray in Algeria; MM. Pinard and de Cessac, North America; M. la Gaviniere, Celebes; Marignac, Antilles; Armingaud and Malard, Italy; Dr. Harmand, Cochin China; Wiener, Peru and Bolivia; Raffray and Maindron, New Guinea; Ed. Blanc, Maritime-Alps; Ratte, New Caledonia; Ujfalvy, Central Asia; Serre, Say, Sahara; Rochemonteix, Egypt; du Chatelier, Finistere (France); Abbé Ansault, Italy; Mangeot et Bersot, Japan; Mouchez, Algeria; Guizet, Japan and China.

WE have received the *Bulletin*, for 1876, of the Essex Institute (Salem, U.S.), one of the best of the many local societies of the United States. A large portion of the *Bulletin* is occupied with a valuable paper by Mr. E. W. Nelson, on the birds of North-East Illinois. We may state that this Institute is issuing a series of "Historical Collections," which are likely to be of service to those who are interested in the political history and social progress of the United States.

THE *Kansas Collegiate* is the title of a small sheet conducted by the students of Kansas State University, and contains various notes and news likely to interest those for whom it is intended. The number for May 23 contains a Scientific Supplement devoted to subjects of more or less scientific importance. The longest of these is an address by Prof. F. H. Snow, on "The Relation of Birds to Horticulture," and which contains some interesting information on the habits of many of the Kansas birds. Another paper, by Prof. G. E. Patrick, gives the results of an examination of a meteorite found at Wacender, Mitchell Co., Kansas. Prof. Snow, we notice, has formed a fine and constantly-increasing collection of the birds of Kansas.

THE *Commission Supérieure*, or governing body of the French International Exhibition of 1878, has been completed by the appointment of some influential members, among whom are the Duc d'Audifret-Pasquier, president of the French Senate, M. Andral, the vice-president of the Council of State, M. Alphaud, the chief engineer of the Paris works. Amongst the ordinary members are M. Brunet, Minister of Public Instruction, M. St. Claire-Deville, member of the Institute, and M. Rothschild the banker. M. Krantz has given a detailed report on the state of the works, which are much in advance of the specified time. The unexpected success of the exhibition in foreign countries and especially in Great Britain and the British Colonies will fill up the vacuum created by the abstention of Germany. Many nations have asked for an enlargement of the space allotted which it has been impossible to grant. The public will be admitted by tickets and not by turnstiles. The coffee-houses, balls, concerts, theatres, so numerous in the 1867 exhibition, have been abolished, but great experiments for testing the apparatus exhibited, and promoting human knowledge will be tried. China will be represented by an official commission, and Siam will make a magnificent display. Liberia, the negro republic on the Gold Coast, will exhibit for the first time in France.

THAT science in certain of its applications does pay is evident from the fact that a M. Delille, a "professor" of legerdemain, who has practised at fairs in France, and who has died at the age of eighty-eight, gained by his trade a fortune valued at several millions of francs. He began to practice at the early age of sixteen, and was seen operating at the last fair of St. Germain. He dealt largely with electricity. Here is another argument agains the Endowment of Research very similar to one which has been urged before.

FROM the prospectus of St. Thomas's Hospital Medical School, we notice that two scholarships of the value of 60*l.* and 40*l.* respectively will be awarded during the first week in October, after an examination in physics, chemistry, botany, and zoology.

THE King of the Belgians, who has been appointed a second time president of the International Association for Exploring and Civilising Central Africa, has declared that next year he will decline to continue the office. The Society is possessed of an annual revenue of 73,000 francs, principally from subscriptions obtained in Belgium, where the scheme is very popular. It has been decided by the executive committee that a station should be founded in the Trans-Tanganyika region. The head of the station and the explorer have been appointed. A depot will be formed at Zanzibar, and three others in intermediate countries; one is to be placed under a Catholic mission, and two under two Protestants, who have volunteered to help the Association. The works are to be begun without further delay.

A COMPANY is now being formed, we learn from the *Engineer*, to construct a pneumatic railway between the South Kensington Station of the District Railway and the Albert Hall. The line will rise the whole way to the Albert Hall, the ruling gradient being 1 in 48. The train will be blown through the tube by an ejector, in other words, a great centrifugal pump, two feet in diameter, fixed close to the District station, and worked by a pair of condensing engines exerting about 170 indicated horse-power. The tunnel will be of brick, and the floor will be paved. Its cross-sectional area will be 105·5 square feet; at the end of the train is fixed a screen or piston, with an area of 104 square feet, the difference being allowed for windage. The train will consist of six carriages, of very light build, the rail gauge being four feet. This train will hold 200 passengers, and the total load will be thirty-two tons, or ten tons less than the weight of a single engine on the Metropolitan Railway. The maximum resistance at twenty miles an hour will be about 2,420 lbs., requiring to overcome it a pneumatic pressure of 2·6 ounces per square inch, and 162-horse-power, assuming the useful effect to be sixty per cent.

A VERY severe thunderstorm passed over London on the evening of July 5. Between eight and nine there came a very brilliant flash of lightning, followed by a deafening peal of thunder. Many people were stunned and in several cases were found quite insensible. Immediately after it was found at Kilburn that the telegraph wires, running from the top of the Queen's Arms to a house about 300 yards higher up the Edgeware Road, were struck by the lightning, and fell in red-hot fragments, varying in length from six inches to an inch, all along the road, a great deal of yellow smoke attending the fall of the wire. In one or two houses windows were broken, and a little girl who was passing through the street had her hair singed and her jacket burnt. The instruments at the office with which the destroyed wires were connected were much agitated, and the telegraph clerk, a young lady, was much stunned.

THE fourth edition of the "Lists of Elevations principally in that portion of the United States West of the Mississippi," edited by Mr. Henry Gannett, and published in connection with Mr. Hayden's Survey, must prove of great value to the geographer and meteorologist. The first edition, published in 1872, contained only thirty-one pages, the present edition contains 164 pages. It contains, among a variety of other matter, profiles of nearly all the railroads in the part of the United States above mentioned. The results given by these profiles have been made to accord, and the heights of several thousands of points on them have been determined with an approach to accuracy. This edition contains also the heights of many thousands of points determined approximately by means of the barometer. Elevations of many thousands of mountain-peaks are given, from which very correct ideas of the ruling heights of the principal ranges may be derived. It contains also tables of the slopes of the principal streams of the west, which are of value in studying the important question of irrigation. With these various lists of elevations there is given with this edition a map of the United States, in approximate contours of 1,000 feet of vertical intervals, which, in a measure, embodies all the results of this department. Toward the improvement and ultimate perfection of this map this work is to be mainly directed in future. To express still more clearly the facts brought out by the map, it is the intention of the Survey to make shortly a relief model of the United States, on the basis of this map.

WE have on several occasions referred to the association known as the Yorkshire Naturalists' Union, composed of a large number of local scientific societies in Yorkshire. This association publishes a useful monthly journal, *The Naturalist*, intended as a general field club record. We have received the twenty-fourth number of this journal, which, besides several papers on natural history, contains reports of several of the associated societies. From a report of the third meeting of the Union held recently at Wakefield, we notice that the Bradford Scientific Association was admitted to the Union, and that a testimonial, in the shape of a microscope, was presented to Mr. J. M. Barker, late secretary of the West Riding Consolidated Naturalists' Society.

THE additions to the Zoological Society's Gardens during the past week include four Common Kingfishers (*Alcedo ispida*) European, presented by Mr. J. Lyford; two Horned Lizards (*Phrynosoma cornutum*) from Texas, presented by Mr. W. A. Bowie; a Sun Bittern (*Eurypyga helias*), a Sacred Ibis (*Geronticus æthiopicus*), bred in the Gardens; eight speckled Terrapins (*Clemmys guttata*), three Red-vented Terrapins (*Clemmys rubriventris*), two American Box Tortoises (*Terrapene carinata*) from North America, purchased.

THE INFLUENCE OF LIGHT UPON THE DEVELOPMENT OF BACTERIA[1]

WE have been engaged during the last few months on an investigation into the effect of light upon the development of bacteria in certain of those solutions in which they are usually produced.

We reserve the details for a paper which we hope to submit to the Royal Society in the course of their next session, but wish to state, in the meanwhile, that the first portion of our inquiry has led us to the following conclusions:—

1. That light is inimical to the development of bacteria.
2. That under favourable conditions it may prevent their development.
3. That under less favourable it may not prevent but only retard.
4. That for the full effect of light to be produced direct insolation is necessary.
5. That those conditions which tend to neutralise the action of light are the same which are known to favour processes of fermentation and putrefaction.
6. That the fitness of the solution to serve as a nidus is not destroyed by insolation.
7. That, so far as our investigation has yet gone, it would appear that the germs originally present in the solution are destroyed by direct insolation.

We are still pursuing the inquiry, and have devoted much time to investigating the influence of the refrangibility of the ray, but regret that at present we are not in a position to give any definite conclusions on this point.

We are endeavouring also to trace an analogy between facts which we have observed and certain vital and chemical processes, in which light is known to play a part, and are extending our observations to other phenomena of fermentation and to microscopic fungi.

That light is not essential for the development of bacteria has been long known, but that it is absolutely inimical to their production has not, so far as we are able to ascertain, been previously shown, and we are encouraged, therefore, to lay before the readers of NATURE this statement of our results.

ARTHUR DOWNES; T. P. BLUNT

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

LONDON.—The following is the list of the new associates of the Royal School of Mines:—Associates in Mining and Metallurgy—C. W. Folkard, A. K. Huntington, E. W. Voelcker; Associates in Mining—E. H. Liveing, W. H. Merritt; Associates in Metallurgy—A. C. Copeland, J. F. Hogan, C. H. Lemann, W. Leyson, E. T. McCarthy; Associate in Geology—A. R. Sawyer. The Edward Forbes Medal and prize of books was awarded to A. Heilprin; the De la Beche Medal and prize of books to E. W. Voelcker; the Murchison Medal and prize of books to F. G. Mills.

SCIENTIFIC SERIALS

Journal de Physique, June.—On the theory of electrometers, by M. Mascart.—On the dynamical theory of gases (continued), by M. Violle.—Process for measuring the index of refraction of liquids, by M. De Waha.—Application of the electric current to the study of the spheroidal state of liquids, by M. Hesehus.—Temperature and humidity of the air at different heights observed at Upsala during 1875, by M. Hamberg.—Proceedings of the Physical Society of St. Petersburg.

Archives des Sciences Physiques et Naturelles, June 15.—Study on the variations of transparence of the waters of Lake Leman, by M. Forel.—On the different modes of crystallisation of water, and the causes of the varied appearances of ice, by M. Pictet.—Researches on some niobiferous and tantaliferous minerals, by M. Delafontaine.

Annalen der Physik und Chemie, No. 4, 1877.—Johann Christian Poggendorff (memoir).—New experiments on the expansion of bodies by heat, by M. Glatzel.—On the objections of Clausius to Weber's law, by M. Zöllner.—On normal magnetisation, by M. Petruscheffsky.—On stratification of the electric light in Geissler tubes after insertion of a flame and some other resistances, by M. Holtz.—On the cohesion of salt solutions, by M.

Quincke.—On the excitation of electricity through gliding friction, by M. Riess.—On unipolar induction of a solenoid, by M. Zöllner.—Remarks on Prof. Neumann's paper on the number of electric materials, by M. Edlund.

No. 5.—On the reflection of heat rays from metals, by M. Knoblauch.—On the treatment of ponderomotive and electromotive forces occurring between linear currents and conductors, according to the fundamental laws of electrodynamics, by M. Clausius.—On the tensions of vapour in dissociation of salts containing water of crystallisation, by M. Pareau.—On the coefficients of temperature of heat conduction of air and hydrogen, by M. Winkelmann.—On the phenomena of motion of electrified mercury in glass vessels, by M. Herwig.—On divergences from Ohm's law in metallically conducting bodies, by M. Braun.—On the theory of unipolar induction and Plücker's experiments, by M. Riecke.—On heat conduction in sulphate of copper, by M. Pape.—Remarks on the polarisation of the rainbow, by M. Lommel.—On the history of the invention of the areometer, by M. Gerland.—On the significance of the rhombohedric and prismatic surfaces in quartz, by M. Baumhauer.

SOCIETIES AND ACADEMIES

LONDON

Zoological Society, June 19.—E. W. H. Holdsworth, F.Z.S., vice-president, in the chair.—The secretary read a letter addressed to him by Mr. J. M. Cornély, announcing that his female *Hydropetes inermis* had just produced three young ones.—Mr. J. E. Harting, F.Z.S., exhibited and made remarks on a variety of the common Snipe, intermediate between the usual form of that species and the so-called Sabine's Snipe.—Mr. B. Tegetmeier, F.Z.S., exhibited a specimen of a curiously malformed sternum of the Tawny Owl.—Mr. John Murray, Naturalist to the *Challenger* Expedition, exhibited and made remarks on a series of sharks' teeth, whales' ear-bones, and other specimens dredged up at great depths during the *Challenger* Expedition.—Mr. P. L. Sclater, F.R.S., read the first of a series of reports on the collection of birds made during the voyage of H.M.S. *Challenger*, containing general remarks on the collection, which was stated to consist of about 679 skins of terrestrial and 198 of oceanic birds, besides a considerable series of specimens in salt and in spirit, and a collection of eggs, principally of the oceanic species.—A communication was read from the Marquis of Tweeddale, F.R.S., containing a report on the collection of birds made during the voyage of H.M.S. *Challenger* in the Philippine Islands. Amongst them were examples of seven species new to science.—Mr. P. L. Sclater read a paper giving a description of the birds collected at the Admiralty Islands during the visit of the *Challenger* expedition to that place. Amongst these were examples of six species hitherto unknown to naturalists.—A communication was read from the Rev. O. P. Cambridge, C.M.Z.S., on some new species of Araneidea, with characters of two new genera and some remarks on the families *Podopthalmides* and *Dinopides*.—A note was read by Mr. J. H. Gurney on the breeding of the Polish swan in captivity, and on the stages of plumage of the young birds.—A communication was read from Mr. F. Moore, in which he gave a complete description of the Lepidopterous fauna of the Andaman and Nicobar Islands, so far as is yet known.—A communication was read from Mr. Herbert Druce, F.Z.S., containing a revision of the Lepidopterous genus *Paphia*, with descriptions of twenty-one new species.—A communication was read from Mr. E. J. Miers, F.Z.S., containing the description of a collection of Crustacea (*Decapoda* and *Isopoda*), chiefly from South America, with descriptions of new genera and species.—Mr. A. H. Garrod read a description of the brain of the Sumatran Rhinoceros (*Ceratorhinus sumatrensis*).—A paper by Mr. A. D. Bartlett, contained the description of a new Guinea Fowl, from Mombassa, in Eastern Africa, based on a specimen brought home by Mr. Gerald Waller, for which the name *Numida ellioti* was proposed.

Entomological Society, July 4.—Prof. Westwood, president, in the chair.—Mr. J. W. Douglas exhibited a living specimen of *Cerambyx Heros* and a young larva of the same insect, bred from a log of wood imported from Bosnia.—The president exhibited some cases composed of small semi-transparent quartz-like particles and constructed by the larva of a Trichopterous insect inhabiting Southern Europe. They had been described by Swainson in 1840 as a shell belonging to the genus *Thelidomus*.—The president also exhibited a plant-bug (*Capsidæ*) found on the leaf of an orchis which had become covered with blisters from the attack of the insect.—Mr. Jenner Weir exhibited a female specimen of a *Cicada* taken in his presence in the New Forest by Mr. Auld, who stated that he had heard it stridulating. Mr. Douglas, however, suggested that the sound had been produced by a male concealed near.—Mr. S. Stevens exhibited two living specimens of *Tillus unifasciatus* taken on a fence near Norwood.—Mr. J. P. Mansell Weale, who had just returned from South Africa, exhibited a fine collection of insects from that country and read a paper containing the results of his observations and experiments upon the breeding of *Papilio merope* and other insects.—The secretary read a letter from Dumfries stating that *Colias edusa* had made its appearance in that district in the month of June.—The president brought before the Society the recent accounts of the appearance of the Colorado beetle in Canada and in Europe.

Physical Society, June 23.—Prof. G. C. Foster, president, in the chair.—Prof. W. Grylls Adams exhibited a very complete form of optical bench, which, in addition to being provided with all the improvements introduced by Prof. Clifton, carries an arm which can be set at any angle to it and is provided with appliances for studying a beam of light or radiant heat when it deviates from the main axis of the instrument. At the base of a pillar firmly clamped in any position in the manner adopted by Prof. Clifton, is fixed a horizontal graduated circle, and a vernier, attached to a counterpoised arm, which rotates round the axis of this pillar, renders it possible to determine the angle made by the arm with the bench to one minute. At the upper extremity of the pillar is a steel pivot to which various appendages may be clamped, and immediately below this is a second graduated circle by which to determine the angular position of whatever is supported by the pillar. Mirrors, metallic surfaces, prisms, &c., may be placed on this pillar for the reflection, refraction, diffusion, or polarisation of heat and light. For radiant heat the rotating arm carries a line thermo-electric pile and a table on which absorbing media may be placed. Prof. Adams illustrated the use of the instrument by projecting on to a screen the interference bands obtained when a beam of light, after reflection from the two surfaces of a thick plate of glass, is again reflected from the two surfaces of a similar plate placed very nearly parallel to the first. A compensator consisting of two plates of glass of equal thickness is also added between the two thick plates, and an ingenious arrangement renders it possible to incline the glasses at any angle to one another, and to move them either independently or together. He also showed the effect produced in the positions of the bands when the rays from the two surfaces of the first plate traverse [air of different densities before falling on the second. The adjustment of this latter was facilitated by fine screws supplemented by springs which rendered it possible to give a slight movement to the plate in any direction, by combining a motion of translation of the plate parallel to its reflecting faces with a motion of rotation about a vertical or horizontal axis.—Mr. F. D. Brown exhibited an apparatus he has arranged, in which to compare thermometers. From a brass hemispherical boiler rises a tube of the same metal two inches in diameter and about two feet long; the steam, after ascending through it, descends a metallic jacket surrounding it, whence it passes into a U-shaped condenser, and from this it is returned to the boiler. The upper end of the condenser is in connection with a large air-tight vessel forming the base of the apparatus, and in which any required degree of exhaustion can be maintained by the use of Lothar Meyer's form of pump. The thermometers are placed in tubes, which pass within the wide brass tube at its upper end, and by varying the nature of the liquid in the boiler, and the pressure to which it is subjected, the boiling point can be retained constant at any required temperature.—Dr. Guthrie and Mr. Akroyd communicated a paper on electrical selection. When a metal or other body is rubbed against some non-conducting substance like caoutchouc, electricity is developed, and the track of the metal may be readily made evident by sprinkling on the caoutchouc a mixture of red lead and sulphur. This sieving imparts negative electricity to the sulphur and positive to the red lead, hence that particular ingredient of the mixture is drawn to the metal track which possesses the opposite kind of electricity. Iron, for example, when rubbed against caoutchouc generates negative electricity, and, after sprinkling the powder, the iron track is revealed by the marked collection thereon of red-lead. A list of mixtures was given which may be used instead of the above, and it was shown that electrical selection may prove of use (1) in making an electrical diagnosis of the metals, (2) in certain experiments where the quadrant electrometer is objectionable, and (3) in teaching, where this instrument is often unavailable on account of its cost. An adjourned special general meeting of the society was then held, after which the meetings were adjourned until November next.

Anthropological Institute, June 26.—Mr. John Evans, F.R.S., president, in the chair.—Three new members, one honorary, and one corresponding member were elected.—Mr. Burt exhibited the prow of a New Zealand war canoe supposed to have been that which met Capt. Cook on his second visit to that country.—Mr. Atkinson exhibited a specimen of gold so-called Irish ring money.—A paper by Mr. Mortimer on an underground structure near Langtoft, Yorkshire, was read. Mr. Mortimer considers it is not a Botontinus; in this opinion he is opposed by Mr. J. E. Price, F.S.A.—Mr. C. H. E. Carmichael, M.A., read a paper on a Benedictine missionary's account of the natives of Australia and Oceania, in which he summarised the principal points of anthropological interest in the *Memoire Storiche dell' Australia*, by Mgr. Don Rudesindo Salvado, O.S.B., and illustrated the missionary's account by reference to the views expressed by Topinard, Virchow, and other foreign writers. Mgr. Salvado maintains the unity of the Australian race and language, and upholds the possibility of raising the aborigines to a fairly high pitch of civilisation, using their extreme quickness in learning to speak and write European languages. Two letters written in Italian by native boys brought to Europe at about eleven years of age, were commented upon by Mr. Carmichael, who laid copies on the table, and promised further investigation of the questions raised in the discussion.—The president, Mr. C. Walford, Sir John Lubbock, and others took part in the discussion.—H.I.M. the Emperor of Brazil was present at the meeting.

VIENNA

Imperial Academy of Sciences, April 12.—Senile changes of the joints and their connection with *Arthritis deformans*, by M. Weichselbaum.—On a new determination of a quantity having reference to the measurement of molecules from the theory of capillarity, by M. Boltzman.—On the orbit of Dione 106, by M. Seydler.—On the decomposition of hydroxylamin by alkaline copper solution, by M. Donath.—On a method of determining the resistance of bad conductors of electricity, by M. Domalip.—Influence of temperature on velocity of evaporation, by M. Baumgartner.—On diffusion of vapours through clay-cells, by M. Puluj. The velocity of diffusion depends on the temperature in the same way as the maximum of tension. There is not direct proportionality between velocity of diffusion and difference of tension. The logarithmic function represents the connection more accurately.—A contribution to the knowledge of viscous substances, by M. Obermayer. Experiment showed that the internal friction in brittle black pitch follows the same laws as fluid friction. That in soft bodies does not exactly follow those laws.—On the internal condition and the latent heat of vapours, by M. Puschl. Very rare aqueous vapour deviates from Mariotte's law in an opposite direction to that of gases and vapours generally, and in this it behaves like very greatly rarefied atmospheric air.

PARIS

Academy of Sciences, July 2.—M. Peligot in the chair.—The following papers were read:—On the generation of the meridian curve of a surface of revolution, of which the mean curvature varies according to a given law, by M. Resal.—Researches on anhydrous chloral and on its hydrate, by M. Berthelot. There is a liberation of heat in the reaction of gaseous chloral with gaseous water, with formation of a gaseous compound, gaseous hydrate of chloral therefore truly exists as a compound distinct from a simple mixture of the two vapours.—Remarks on the subject of M. Mouchez' letter of June 18, by M. Villarceau.—On the distribution of waters coming from natural slopes of the French territory, and on the amelioration of our interior navigation, by M. De Lesseps. M. Cotard has suggested the storing of water in the higher parts and distribution of it to navigation-canals giving cheap transport for materials of small value, and avoiding the formation of unwholesome marshes. M. Sibour advises the opening of a canal (seven kiloms.) between the lake of Berre and the harbour of Marseilles.—Reply to M. Roudaire's last communication on the formation of a Saharan sea, by M. Cosson. *Inter alia*, he urges that the change of the local climate would be fatal to the date, and that new plants introduced would not compensate the loss. The Artesian system is open to being greatly developed. The caravans of Central Africa would not diverge from their route to Morocco and Tripoli. The addition of so much saline matter would make the Artesian water undrinkable and unfit for irrigation. The climate would become very unhealthy from combination of moisture with great variations of temperature, &c.—M. Godron was elected correspondent for the section of botany, in room of the late M. Lestiboudois, obtaining thirty-three votes, against five for M. Duval Jouve.—Trepanation of the membrane of the tympanum, successfully performed in a case of long deafness which had resisted all treatment, by M. Bonnafont. Any deafness not accompanied by weakening of the sensibility of the acoustic nerves (ascertained by placing a watch on the cranial wall near the ear), may be cured or greatly improved (he thinks) by trepanation of the tympanic membrane. The tympanum should be anæsthetised, and the canula should be allowed to remain in the opening till it falls out naturally.—Argilo-calcareous land and phylloxera, by M. Joffroy. A vine-stock planted in such land resists the disease when the surface of the ground is sufficiently inclined from its base, and is preserved from contact with rain-water from higher ground.—Researches on the compressibility of liquids, by M. Amagat. He studied volatile liquids kept liquid by pressure at a temperature above that of their boiling-point (when, it is known, their coefficient of dilatation becomes very considerable). He gives numerical results for ordinary ether and chlorhydric ether, and will afterwards show that these numbers agree satisfactorily with deductions from the formulæ of the mechanical theory of heat.—On the state of the vines treated at Cognac with alkaline sulphocarbonates, by M. Mouillefert.—On the vapour of hydrate of chloral, by M. Troost. Fresh experiments by a method which he describes confirm his former results, which M. Wurtz had questioned.—Dissociation of gaseous iodhydric acid in presence of an excess of one of the elements, by M. Lemoine The most important result is the stability which this excess gives to the combination; in mixing iodhydric acid with increasing quantities of hydrogen the quantity of iodhydric acid dissociated diminishes about half. Still the character of the dissociation seems always to subsist, whatever the inequality in the atomic proportions. This influence of *mass* in dissociation is in accord with several other known facts.—On the dissociation of ammoniacal salts in presence of metallic sulphides, by MM. De Clermont and Guiot.—On the employment of fluoride of bromine as a dehydrating agent, by M. Landolph. He gives several examples of its action (with camphor, &c.).—On the ordinary presence of copper and zinc in the human body, by MM. Raoult and Breton. They give the results of a judicial investigation made by them in 1874. 700 grammes of (moist) liver of a man who had died after an operation for stone, gave 2 milligr. of copper and 7 mgr. of zinc; 400 grammes liver of a consumptive person gave 6 mgr. of copper and 12 mgr. of zinc. To prove poisoning, it should be shown that the quantities of copper or zinc found in a body are greater than the maxima in normal conditions.—On the determination, in weight, of atmospheric ozone, by M. Lévy. This relates to a supposed influence of platinum on arsenite of potash, which, however, was not manifested in the conditions with which M. Lévy operated.

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