THURSDAY, SEPTEMBER 28, 1882

MODERN PHYSICS

The Concepts and Theories of Modern Physics. By J. B. Stallo. (London: Kegan Paul, Trench, and Co., 1882.)

THIS is, in many respects, a curious work. It shows very extensive reading, as well as much patient thought, on the part of its author; and is, throughout, eminently "readable," although somewhat disfigured by the use of strange and uncommon words, such as "questionability," "irrecusable," "luminar," "consiliences," &c., and even of words apparently made for the occasion. With engaging frankness, the author tells us in the Preface that a previous work of his was written when he

"was under the spell of Hegel's ontological reveries:—at a time when I was barely of age and still seriously affected with the metaphysical malady which seems to be one of the unavoidable disorders of intellectual infancy. The labour expended in writing it was not, perhaps, wholly wasted, and there are things in it of which I am not ashamed, even at this day; but I sincerely regret its publication, which is in some degree atoned for, I hope, by the contents of the present volume."

His recovery from this direful malady has been unusually complete; but the *sequelae* are still of a somewhat distressing character, for the work is "designed as a contribution, not to physics, nor, certainly, to metaphysics, but to the theory of cognition."

Having been himself at one time enchanted in the Circean sty of metaphysics, the author now sees the evil thing everywhere rampant, and specially in scientific writings. With a subtlety which is occasionally almost admirable, he seems to endeavour, under cover of perfect candour and confidence along with intense zeal for the interests of science, to insinuate into the reader's mind doubts of the validity of some of the most fundamental of scientific hypotheses and reasonings. We rise from a perusal of his volume with a feeling of dawning doubt, which happily vanishes the moment we attempt to find a justification for it. We can, however, fancy some ardent student, unversed in laboratory work and with no great knowledge of physical principles, falling an easy victim to the doubts here suggested; the author all the while smiling grimly to himself as did the spirit of negation when his admiring victim exclaimed—

. . . . mir wird so dumm
Als geh' mir ein Mühlrad im Kopf herum.

This insidious weakening of the student's faith in principles and methods is perhaps even more dangerous to scientific progress than what the author in his Preface speaks of as

"the shallow and sciolistic materialism—I allude, of course, not to its supposed ethical but to its purely intellectual aspects—which for a time threatened to blight the soil and poison the atmosphere even of the old highlands of thought on the continent of Europe, [and which] claims to be a presentation of conclusions from the facts and principles established in the several departments of physical science."

The author is seen at his best and also at his worst in the Chapters on the "Kinetic Theory of Gases;" and the whole character and tendencies of his work will be easily gathered by any one who carefully peruses the following extracts from that chapter. To these we need scarcely add a word of comment:—

"It thus appears that the pre-supposition of absolute elasticity in the solids, whose aggregate is said to constitute a gas, is a flagrant violation of the first condition of the validity of an hypothesis—the condition which requires a reduction of the number of unrelated elements in the fact to be explained, and therefore forbids a mere reproduction of this fact in the form of an assumption, *à fortiori* a substitution of several arbitrary assumptions for one fact. Manifestly the explanation offered by the kinetic hypothesis, in so far as its second assumption lands us in the very phenomenon from which it starts, the phenomenon of resilience, is (like the explanation of impenetrability, or of the combination of elements in definite proportions by the atomic theory) simply the illustration of *idem per idem*, and the very reverse of a scientific procedure. It is a mere *versatio in loco*—movement without progress. It is utterly vain; or rather, inasmuch as it complicates the phenomenon which it professes to explicate, it is worse than vain:—a complete inversion of the order of intelligence, a resolution of identity into difference, a dispersion of the One into the Many, an unravelling of the Simple into the Complex, an interpretation of the Known in terms of the Unknown, an elucidation of the Evident by the Mysterious, a reduction of an ostensible and real fact to a baseless and shadowy phantom." . . .

"It were work of supererogation to review in detail the logical and mathematical methods by which it is attempted, from an hypothesis resting on such foundations, to deduce formulæ corresponding to the facts of experience. I may be permitted to say, however, that the methods of deduction are only less extraordinary than the premisses. To account for the laws of Boyle and Charles, resort is had to the calculus of probabilities, or, as Maxwell terms it, the method of statistics. It is alleged that, although the individual molecules move with unequal velocities, either because the velocities were originally unequal, or because they have become unequal in consequence of the encounters between them, nevertheless, there will be an average of all the velocities belonging to the molecules of a system (*i.e.* of a gaseous body) which Maxwell calls the 'velocity of mean square.' The pressure, on this supposition, is proportional to a product of the square of this average velocity into the number of the molecules multiplied by the mass of each molecule. The product of the number of molecules into the mass of each molecule is then replaced by the density—in other words, the whole molecular assumption is, for the nonce, abandoned—and the velocity is eliminated as representing the temperature; it follows, of course, that the pressure is proportional to the density."

"Similar procedures lead to the law of Charles and the 'law' of Avogadro (according to which the number of molecules in any two equal volumes of gases of whatever kind is the same at the same temperatures and pressures—a law which is itself a mere hypothesis). It is claimed, on statistical grounds again, that not only the average velocity of a number of molecules in a given gaseous body is the same, but that 'if two sets of molecules, whose mass is different, are in motion in the same vessel, they will, by their encounters, exchange energy with each other till the average kinetic energy of *a single molecule of either set* is the same.'"

"'This,' says Maxwell, 'follows from the same investigation which determines the law of distribution of velocities in a single set of molecules.' All this being granted, the law of Charles and the law of Avogadro (called by Maxwell the law of Gay-Lussac) are readily derived. And at the end of these devious courses of deduction Maxwell adds a disquisition on the properties of the molecules, in which he claims to have made it evident that the molecules of the same substance are 'unalterable by the processes which go on in the present state of things, and every individual of the same species is of exactly the same magnitude as though they had all been cast in the same mould, like bullets, and not merely selected and grouped according to their size, like small shot,' and that, therefore, as he expresses it in another place, they are not the products of any sort of evolution, but, in the language of Sir John Herschel, 'have the essential character of manufactured articles.'"

"Now, on what logical, mathematical, or other grounds is the statistical method applied to the velocities of the molecules in preference to their weights and volumes? What reason is given, or can be given, why the masses of the molecules should not be subjected to the process of averaging as well as their motions? None whatever. And, in the absence of such reason, the deductions of the kinetic theory, besides being founded on rickety premisses, are delusive paralogisms."

"Upon these considerations I do not hesitate to declare that the kinetic hypothesis has none of the characteristics of a legitimate physical theory. Its premisses are as inadmissible as the reasoning upon them is inconclusive. It postulates what it professes to explain; it is a solution in terms more mysterious than the problem—a solution of an equation by imaginary roots of unknown quantities. It is a pretended explanation, of which it were unmerited praise to say that it leaves the facts where it found them, and is obnoxious to the old Horatian stricture: '*nil agit exemplum, litem quod lite resolvit.*'" . . . .

"It may seem strange that so many of the leaders of scientific research, who have been trained in the severe schools of exact thought and rigorous analysis, should have wasted their efforts upon a theory so manifestly repugnant to all scientific sobriety—an hypothesis in which the very thing to be explained is but a small part of its explanatory assumptions. But even the intellects of men of science are haunted by pre-scientific survivals, not the least of which is the inveterate fancy that the mystery by which a fact is surrounded may be got rid of by minimising the fact and banishing it to the regions of the extra-sensible. The delusion, that the elasticity of a solid atom is in less need of explanation than that of a bulky gaseous body, is closely related to the conceit that the chasm between the world of matter and that of mind may be narrowed, if not bridged, by a rarefaction of matter, or by its resolution into forces. The scientific literature of the day teems with theories in the nature of attempts to convert facts into ideas by a process of dwindling or subtilisation. All such attempts are nugatory; the intangible specter (*sic*) proves more troublesome in the end than the tangible presence. Faith in spooks (with due respect be it said for Maxwell's thermo-dynamical 'demons' and for the population of the 'Unseen Universe') is unwisdom in physics no less than in pneumatology."

"*Pure Being* is simply the specter (*sic*) of the copula between an extinct subject and a departed predicate." It is a pity that a man who can so smartly show up the absolute nonsense of the professed metaphysicians (past and present alike) should weaken the force of his really valuable remarks by attacking in a similar style some of the best-ascertained truths of mathematical and of physical science. We repeat that the volume is lively reading, that its smartness is visible in every page, but that its author (having once been bitten by metaphysics) has, in his desire to save others, run a-muck not merely through gossamer webs but also against stone walls. No doubt he has done good:—some of the supposed stone walls he has encountered have proved to be mere stage "properties." But the reader cannot fail to doubt the validity of a method which upsets with equal ease the most irrefragable truth and the most arrant nonsense.

P. G. T.

OUR BOOK SHELF

Amazulu; the Zulus, their Past History, Manners, Customs, and Language, with Observations on the Country, and its Productions, Climate, &c.; the Zulu War, and Zululand since the War. By the Rev. T. B. Jenkinson. (London: W. H. Allen and Co., 1882.)

THE Rev. Thomas B. Jenkinson, having been a missionary in Natal between the years 1873-79, proposes to give us his experiences of the country and its people in a work bearing the above ambitious title. But so little information is to be gleaned from its pages on these subjects that the judicious reader will do well to begin and end with the short appendix, which contains a few remarks on the present political situation of Zululand. This appendix consists of extracts from two letters not written by Mr. Jenkinson, and nearly the whole of the book is found to be made up in the same way of quotations from diaries and private letters written by the missionary or members of his family to friends in England, or else of stale passages from the *Cape Argus*, Livingstone's journals, *Macmillan's Magazine*, or the diaries of other missionaries, who flourished half a century ago. Thus the section devoted to "Historical Notices of the Zulu Nation" consists largely of extracts from the journal of the Rev. Francis Owen, originally published in the Missionary Register for 1838! Deducting these wholesale appropriations, the actual amount of text attributable to the compiler will occupy a very small portion of the work. This, however, may be regarded as fortunate, for the quantity is not compensated by the quality of the composition, which is written in a crude, jerky style, and made up mainly of trivial incidents of missionary life. The contributions to science and history are remarkable, as, for instance, the statement that "the British exchanged Java for St. Helena with the Dutch!" (54); that the Zulus are somehow connected with Israel, although they seem to be descended from Ham, "still a common name among them" (33); that the Zulu language "resembles" the Hebrew (18); that in Natal there is a curious animal "called a rock-coney rabbit, a rhinoceros in miniature!" (8); and that Mr. Jenkinson "killed ten of those large rock-pigeons with one shot" (188).

A. H. K.

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.*]

Lighthouses

IN Dr. Siemens's inaugural address to the British Association, reported in NATURE, vol. xxvi. p. 398, reference is made to the system originally suggested by Sir William Thomson some years ago, "of distinguishing one light from another by flashes following at varied intervals."

Now in Sir William's article "On the Lighthouses of the Future," in *Good Words*, March 1873, it is shown that the proposal to distinguish lighthouses from each other by diverse groups of occultations had been made by Charles Babbage at least so early as 1851; while, more recently, Capt. Colomb had adopted intervals of unequal length for a code of signals corresponding to the Morse Telegraph Alphabet. This, however, was, as I understand, for ships' night signals, and not for lighthouse purposes.

Further it seems only just to add that, so early as March 27, 1871, Mr. Robert Louis Stevenson described to the Royal Scottish Society of Arts forms of intermittent lighthouse apparatus for exhibiting groups of flashes of occultations of unequal period; these arrangements, possessing the advantage over Babbage's original proposal, that during dark intervals the light is not simply stopped by a screen and thus lost, but sent usefully in other directions to strengthen the bright intervals or flashes.

WILLIAM SWAN

Ardchapel, Dumbartonshire, September 21

The August Meteors

As noted in NATURE, vol. xxvi. p. 378, I observed a bright display of meteors on the night of August 6, at Aberfeldy. On the 7th the sky was overcast with dense clouds all night; but on the following night I saw a more brilliant shower of meteors than on the 6th, with this difference that the meteors of the night of the 8th were mostly of several seconds' duration, and generally left a long, bright train of light behind; also, in place of being on the north of the Milky Way, as on the 6th, they were chiefly on the south of it. A very large and bright meteor burst out about half way to the zenith, and moved nearly horizontally from the south-east towards the west, leaving a long shining streak behind, and lasting close on fifty seconds. I watched the meteors for the next three nights from the parish manse of Logie-Almond, and witnessed on each night (9, 10, and 11) a gorgeous shower. On the evening of the 10th, before the twilight was quite gone, I noticed thirteen very large meteors during the space of a few minutes, although my view of the heavens was very much intercepted by trees and by the manse. Between 11 and 12 o'clock a meteor considerably larger and brighter than Venus under the most favourable circumstances, sailed over the southern heavens, leaving a long train of light which lasted fully a minute. Its position, time, and appearance, were nearly the same as those of the large meteor I saw at Aberfeldy on the night of the 8th. I have not for years, during any month, witnessed such a gorgeous display of meteors as I have seen on the nights specified in August last. But I have scarcely seen any since, except a few bright ones on Sunday night, September 17, at High Blantyre. The display of the August meteors was of a very short duration on each night, and after 12 o'clock not one scarcely could be seen.

Govanhill, Glasgow, September 21 DONALD CAMERON

ANIMAL INTELLIGENCE[1]

FROM the time of Locke downwards the question, How far animals have the power of abstraction? has often been discussed. Locke himself maintained that "the having of general ideas is that which puts a perfect distinction betwixt man and brutes, and is an excellency which the faculties of brutes do by no means attain to." And this view is warmly advocated by Prof. Max Müller and other living thinkers. On the other hand Mr. Romanes, who has made the subject of Animal Intelligence a special study, writes:—"Give a cat or a dog some kind of meat or cake which the animal has never met with, and the careful examination which the morsel undergoes before it is consigned to the mouth proves that the animal has properly abstract ideas of sweet, bitter, hot, nauseous, or in general, good for eating, and bad for eating, *i.e.*, abstract ideas of quality as apart from the object examined—the motive of the examination clearly being to ascertain which general idea of quality is appropriate to the particular object examined."—NATURE, vol. xx., p. 123.

Our first duty in a case like this is to make quite sure of the meaning of the words we employ. Much confusion may be, and has been, introduced into this subject by a lax use of words. Let us consider, then, the several meanings which these terms abstraction and abstract idea may have.

In the first place it seems to me that our most ordinary impressions involve abstraction. An object is capable of affecting us in a number of different ways, but of all these at any given moment we only pay attention to one or two which happen to interest us. The rest are practically non-existent for us. The mind automatically rejects or eliminates them. This is certainly a process of abstraction, but for the sake of clearness I venture to call it *elimination*. By means of elimination we get definite clear-cut mental impressions.

In the second place our general conceptions involve abstraction. A general conception is one which does not stand for a particular object but for a group of objects. It is arrived at by abstracting the essentials and neglecting the unessentials. In the great number of dogs I see around me, there are certain essential characters in the midst of some diversities. As I consider them in the mass, however, the diversities cancel each other in my mind, and I obtain a general conception of a dog. We may for the purpose in hand call this process *generalisation*. The product is *not* a definite and clear-cut image.

In the third place, I may by a process of abstraction consider a quality apart from the things that possess that quality—whiteness for example, apart from white objects, edibility apart from edible things. We will here retain the term abstract idea to denote such qualities, and we will for the present term the process by which they are obtained *isolation*. Of a completely isolated quality no mental image can be formed.

That dogs and the lower animals in general make use of the process I have above termed elimination, cannot I think, for one moment be doubted. For if they do not then we must suppose that they are able mentally to grasp an object in the entirety of its qualities, which is more than the average human being can do. Let us suppose that a dog sees what he believes to be a soaked dog-biscuit. The impression he receives through his eyes at once suggests certain possible olfactory impressions and certain possible gustatory impressions. This of course implies what is commonly called the association of ideas. But there are other possible impressions which might be suggested but probably are not, such impressions, for instance, as may be produced by the hardness, temperature, and weight of the object. These impressions are not suggested, they are eliminated, so to speak. In other words, certain possible impressions are abstracted from certain other possible impressions. Suppose, now, the dog proceeds to smell the biscuit that he has hitherto only seen. If it answers to his expectations he at once begins to eat it. His nose tells him that it is good for eating. If, however, it does not answer to his expectations, if, perhaps, it has received the drippings of a paraffin tin, he turns sorrowfully away. His nose tells him that it is not good for eating. One kind of smell suggests that the biscuit will be pleasant to the taste: another kind of smell suggests that it it will be unpleasant. And the dog, unless he be a very young one, having confidence in his nose, acts upon the suggestions without verification. It is to these suggested impressions that Mr. Romanes applies the term "abstract ideas of quality, as apart from the object examined." And I do not suppose that any one is prepared to deny our dumb companions abstract ideas *in this sense of the term*.

Let us now consider how far we may suppose animals to possess the power of generalisation in the sense in which I have above used this term. A dog lying asleep upon the hearth-rug hears outside the window an unusual footstep. He at once pricks up his ears and gives a half suppressed growl. Must we not suppose that in such a case as this the footstep suggests to the dog the idea of a strange man? And if so, will not the suggestion—of whatever character it might be—be general rather than particular? If it be a mental picture—and we are often told that dogs think only in pictures[1]—must not the picture be generic

[1] From a Lecture delivered in Cape Town, South Africa.

[1] I do not know that I quite understand what thinking in pictures means, but I should imagine that sounds and smells entered pretty largely into the current of canine thought. And on the other hand, I should be disposed to think that Spenser and Shakespeare possessed in no slight degree the power

in its character, like Mr. Galton's composite photographs of the average blackguard? And if it be a symbol of some kind, must it not be a symbol that stands for strange man in general, since there is nothing to suggest any particular strange man? But if this be so, and if a general conception is one which stands not for a particular object, but for a group of objects, I do not see how we can deny general conceptions, in this sense of the word, to our four-footed friends. And if the word abstract idea stand, as it is sometimes made to do, for general conception, we must admit, I think, that such abstract ideas are possible for the brute.

We come now to such abstract ideas as result from the process I termed isolation. Are these, too, possible for the brute? I have only to say that it has always seemed to me that when we speak of being able to form abstract ideas of redness, emptiness, justice, and the like, all we can possibly mean is that we can make use of the *words* as symbols in a train of thought I have only to say this to indicate the nature of my answer to this question, I believe such abstract ideas to be impossible for the brute, I believe them to be the outcome of the use of language. We see a plum, and we find that it is round, and blue, and resisting. From these words we form abstract nouns, roundness, blueness, resistance. We then proceed to manufacture a something to which each of these words may answer, and we call that something a quality. Having thus made the quality, the next thing we do is to try and endow it with a separate existence, and to the results of our endeavours we give the name abstract idea. All this is a process which grows out of our use of words under the influence of a developed power of reflection; it is an attempt to conceive a reality-in-thought answering to certain of our symbols. Without a considerably developed use of symbols such a process is impossible. Hence I believe that no animal can form an abstract idea in this sense of the term. He does not possess the only possible means of doing so. To form such abstract ideas as these, is certainly "an excellency which the faculties of brutes do by no means attain to." Here we may agree with Locke and his followers.

May we say, then, that the power of forming abstract ideas, in this sense, is that which distinguishes the intelligence of man from the intelligence of the brute? I think not. There are, I believe, among the lower races of man, whole tribes which are unable to form abstract ideas. Abstract ideas are made possible by language, but the use of language does not necessarily imply the ability to form abstract ideas. Philologists tell us that there are languages or dialects in which no abstract words are to be found. This, however, is certain, that there is no known savage tribe which has no language. Man is the one being that can make use of spoken signs.

But it may be said that, although their language differs from ours, animals too have their language, imperfect it is true but still a language of their own, a means of communication with their fellows. And this is perfectly true. It is true, too, that my dogs can understand *my* language. But all that a dog can communicate to his fellow—all that I can communicate to my dog is a sign which he has learnt to associate with certain feelings or with certain actions to be performed. The communication deals, too, with immediate feeling or action; its sphere is the here and the now. There can be no doubt that dogs associate with barking in certain tones, special emotional states in their companions. In fact it is probable that dogs can in this way communicate with each other a wide range of states of feeling. But these states are present states, not states past or future. They are their own states, not the states of others. A dog can call his companions' attention to a worriable cat, or he may have his attention roused by my exclaiming "cat." But no dog could tell his companion of the successful "worry" he had just enjoyed or suggest that they should go out for a "worry" to-morrow morning. And here we come upon what seems to me the fact which raises man so immeasurably above the level of the brute. *The brute has to be contented with the experience he inherits or individually acquires. Man, through language spoken or written, profits by the experience of his fellows.* Even the most savage tribe has traditions extending back to the father's father (Sproat). And the civilised man—has he not in his libraries the recorded results of many centuries of ever widening experience and ever deepening thought? Thus it is that language has made us men. By means of language and language alone has human thought become possible. This it is which has placed so enormous a gap between the mind of man and the mind of the dog. Through language each human being becomes the inheritor of the accumulated thought and experience of the whole human race. Through language has the higher abstract thought become possible.

of thinking in pictures—pictures far truer and more beautiful than even they could describe in words. All processes of thought, in fact, are carried on by association. And in the chain of association there may be links of all kinds furnished by all the senses we possess. All that we can say with regard to man is that he adds to the natural symbols which form links in this chain of association, certain arbitrary symbols of his own manufacture.

But though I look upon the difference between human intelligence and brute intelligence as very great, *I do not believe that there is any one faculty which all men possess and which no brute possesses.* I have already stated my views on the subject of abstraction, and to what I have said I have nothing now to add. But concerning the converse process of *construction* or object—forming a few words may be said. Let me first explain what I mean by construction. Our conception of an object is the result of a synthesis of its qualities. But this synthesis is, I imagine, of two kinds. There is a synthesis by immediate association, and a synthesis by reflection. When a dog sees before him a soaked dog-biscuit, his conception of the object is a synthesis by immediate association. The sight of the biscuit at once suggests by association a certain smell and taste. The object he mentally constructs is built up of these three, sight, smell, and taste. All other properties are rejected or eliminated. Now, suppose the dog capable of reflecting thus—the biscuit is light enough to carry, soft enough to bite, cool enough not to burn my mouth—he would then add to his synthesis by immediate association, a further synthesis by reflection, and would construct a more complete object. By the synthesis by reflection, in fact, all those qualities are added which are unconsciously eliminated in the immediate construction by association. I do not imagine that brutes have sufficient power of reflection to affect to any great extent this further synthesis. Indeed I imagine that savages and young children do not habitually go further than the construction by association. The further process has been added mainly under the influence of a developed language. The *word* groups around itself not only the cluster of associated ideas which make up the ordinary unreflecting conception of the object it symbolizes, but also all those further ideas which are the result of scientific study. The word is the peg upon which we hang those abstract qualities which by means of words we have isolated.

C. LLOYD MORGAN

AINO ETHNOLOGY

THE already somewhat voluminous literature of the Aino race has been recently increased by two valuable memoirs by competent original observers.[1] Hence, if neither Dr. Scheube nor Herr von Siebold has anything very new to tell us, it may be fairly concluded that most of the available data have now been collected. Extended research in the unexplored districts of Yeso may doubtless bring to light some further interesting facts

[1] "Die Ainos," von Dr. B. Scheube, Yokohama, 1882; and "Ethnologische Studien über die Aino auf der Insel Yeso, von Heinrich von Siebold, Berlin, 1881.

bearing on the physical and social characteristics of the aborigines. But no fresh discoveries of any moment are likely to be made, nor is it at all probable that anything will be brought forward in the least calculated to shake the general conclusions already arrived at.

Until the appearance of Herr Rein"s large work on Japan,[1] one of the most universally-accepted of these conclusions was that, whatever be their affinities, the Ainos must certainly be separated from the Mongolic connection. No little surprise was accordingly produced by Rein's attempt to affiliate them to the surrounding members of the Yellow Race. But it was soon seen that his arguments, apparently inspired by a love of paradox, were sufficiently refuted by the very illustrations of the Aino type introduced into his work. It is therefore satisfactory to find that his views meet with no countenance in these memoirs, the authors of which emphatically reject the Mongol theory. "I cannot discover,'' writes Dr. Scheube. "the Mongolic type in the Ainos. The great development of the hair, the disposition of the eyes, the nasal formation, the moderate breadth between the cheek bones, the absence of prognathism, are all so many traits separating them from the Mongolians" (p. 3). So also Siebold: "The whole physiognomy and configuration of the Ainos has little of a Mongol character. The general impression they made on me was rather that of Europeans living under unfavourable conditions. I had a feeling, which also seemed to dawn upon them, that I was not associating with an alien race; and however strange it may appear, I cannot but compare the Ainos with the Russian peasantry" (p. 10).

Topinard had already declared that "the Ainos of Japan, the Miaotze, and the Lolos of the province of Yunnan belong, in my opinion, to the European group" ("Anthropology," p. 476). And it is extremely suggestive to find this writer also comparing them with the inhabitants of the Moscow district. "Chose absolûment singulière, ce type célèbre des Ainos, avec ses traits aujourd'hui bien connus et sa barbe inculte, serait celui de certains paysans russes des environs de Moscou" (*Rev. d'Anthrop.*, 1879, p. 637). The same resemblance with the Russians has no doubt been detected in the Itelmen people of Kamchatka and among some of the Ghiliak tribes of the Lower Amur districts. But the presence of the Aino element has long been suspected in both of these regions. Most of the Kurile islands are still peopled by them, while the nomenclature of the whole archipelago is distinctly Aino, as shown by the term *Moshir* = *Island*, reaching as far north as *Para-moshir*, close to Cape Lopatka, at the extremity of Kamchatka. In the Lower Amur valley also W. G. Aston speaks of an Aino tribe called Santal or Sandan (*Church Missionary Intelligencer*, August, 1879); Siebold (p. 12) refers the Kilengs and Kachengs of the neighbouring Hingpu River to the same connection, and also mentions certain Aino communities about Castries Bay, over against Sakhalin. The southern portion of this island is itself Aino domain, although, since its annexation to Russia, a considerable emigration has set in towards Yeso. In Nippon the Japanese records bring the Aino at least as far south as the latitude of Tokio, whence they were gradually driven north or absorbed, leaving traces of their presence both in the Japanese type and in the geographical terminology of the northern provinces of the main island. Lastly, the national traditions point to North-East Asia as the region whence they migrated to their present homes.

It is thus sufficiently evident that the Mozin (Mao-chin, *i.e.* "Hairy Men"), as both the Chinese and Japanese often call them, were formerly far more widely diffused than at present. And this renders more intelligible the feeling with which the Ainos, *i.e.* "Men," as the word means in their language, at one time regarded themselves as the centre of the universe, a feeling embodied in the old national song: "Gods of the sea, open your divine eyes. Wherever your eyes turn, there echoes the sound of the Aino speech."

This speech, as might be expected, shows not the slightest resemblance to the Japanese, or to any of the idioms current amongst the surrounding Mongoloid peoples. Siebold, who points at a relationship with the Itelmen, a relationship denied by the elder Siebold, has collected copious materials for its study, but, pending the publication of these materials, the student must rest satisfied with the somewhat meagre account contained in Dr. Scheube's memoir. From this the Aino language appears to be of an extremely primitive type, scarcely on a higher level than was the extinct Tasmanian, and, like it, supplementing its scant relational forms by means of signs and gestures. Thus the ideas of affirmation and negation, for which there are no distinct terms, are respectively conveyed by a nod and a shake of the right hand or else of the head. Winking also plays a large part in supplementing grammatical concepts.

There are, of course, no nominal or verbal inflexions beyond a sort of passive restricted to some verbs, and formed by combining the root with what appears to be the substantive verb prefixed. Thus KIK = to strike; *aēn-kik* = to be struck, from *an* or *ana* = to be (?). The parts of speech seem to be restricted to the noun, adjective, verb, a few adverbs and pronouns, of which latter the first and second only have been developed. This absence of a third personal pronoun places Aino at the very bottom of the scale in linguistic evolution, and this low position is further shown by its absolutely isolating condition. Although polysyllabic, it has not yet reached the agglutinating stage, so that each word in the sentence remains isolated, as in Chinese. Thus:—

Koandi dándo oman = I go to-day.
Koandi núman oman = I go yesterday.
Koandi inháta oman = I go to-morrow.

But it differs from the Indo-Chinese, and approaches the American polysynthetic system in the extent to which it has carried word-building. This important feature is not noticed by Scheube, who is no philologist, but attention has been called to it by Dr. A. Anuchin, in an able paper on the Ainos in the *Memoirs* of the Russian Society of Natural Science, vol. xx., Supplement, Moscow, 1877. A curious instance is the word *Kamui*, the general term for God, or any minor deity, which both Scheube and Siebold seem disposed in some way to connect with the Japanese *Kami*. In reality it is an Aino compound form derived from Kam-trui = "flesh-strong," that is, rich in flesh. Before their contact with the Japanese the great god of the Ainos was the bear, as it still is of the Ghiliaks, and some other Amur tribes. As is well known from Miss Bird's "Unbeaten Tracks," and other sources, this animal is not only worshipped, but also killed and eaten at certain periods, and with much ceremony, by all these primitive peoples. To be rich in flesh came thus to be regarded as the highest attribute of the deity, and when the etymology was forgotten, Kamui was easily generalised as a name applicable to any god. Have the divinities of Aryan mythology any less realistic origin?

It may be incidentally remarked that in these memoirs Miss Bird's very graphic description of the physical features, habits, and customs of the natives of Yeso, is fully confirmed in nearly all their details. An important exception is the texture of the hair, which according to her, "never shows any tendency to curl." But the hair of seven Ainos from different parts of Yeso, examined by Dr. Scheube, is, with one exception, described as more or less "gelockt," that is, "curled" or "ringletted." Of one the hair is said to be "überall gekräuselt," frounced or frizzled all over. Except amongst the Aborigines of the south-west Chinese highlands, one may travel over the whole of China, Tibet, and Mongolia, without meeting a single case of even wavy, much less curled hair.

[1] "Japan nach Reisen und Studien," 2 vols., Leipzig, 1881.

And as the quality of the hair is a much more durable feature than the complexion, or almost any other physical trait, the necessity of separating the Ainos from the Mongolic stock becomes all the more obvious. If all this, combined with a distinct orthognathism, mesocephalic head (index No. 76), a light complexion, often scarcely darker than that of Europeans, brown iris, large well-shaped nose, and low cheek bones, is not sufficient to affiliate them to the Caucasic stock, then anthropologists must discover some other sufficiently differentiated physical type with which to group them. That various branches of the Caucasic race reached the East Asiatic seaboard in prehistoric times has been pointed out by this writer in a recent paper on the Koreans (see NATURE, vol. xxvi., p. 344). From Korea to the Japanese Archipelagos, the transition is easy, although it is not pretended that the line of migration necessarily followed this route. But enough has perhaps been stated to show that there is nothing extravagant in the theory of a Caucasic origin of the Aino race. Some of the intermediate links between them and their western kinsmen have already been brought to light. The others must be looked for in the still unexplored uplands of South-west China and Further India.

It is also to be noticed that the Ainos can only in a relative sense be regarded as the Aborigines of Yeso and Nippon. Scheube tells us that they are entirely ignorant of the potter's art (p. 11). But abundance of ancient pottery, often highly ornamented, has been found in many parts both of Hondo and Yeso. These remains are referred by the Ainos themselves to the extinct Koro-pok-Guru, or "People of the Hollows," their precursors in Yeso, who dwelt in huts built over pits, and who had a knowledge of pottery. The Japanese also refer the pits found on an island near Nemuro, north-east coast of Yeso, to the Kohito, a dwarfish race, said to have been exterminated by the Ainos, and apparently identical with the Koro-pok-Guru. It becomes a question whether with these potters, rather than with the Ainos, are to be associated the earthenware and other prehistoric remains found by Milne in the kitchen middens of the Tokio district and other parts of Japan. These remains show clear traces of cannibalism, a practice which seems entirely alien from the mild and inoffensive disposition of the Ainos.

But however this be, the present Aborigines seem destined at no distant date to disappear like their predecessors. The total number of full blood Ainos is estimated by Scheube at about 17,000 for Yeso, to which must be added, perhaps, 1000 or 1500 for Sakhalin and the Kuriles. Siebold, however, thinks that one-third of the inhabitants of Yeso, say 45,000 altogether, are either pure or half-caste Ainos. But the former are known to have decreased in the government of Sapphoro from over 16,000 in 1871, to 13,326 in 1878, while the latter seem to be correspondingly on the increase. The result is inevitable—the effacement of the Ainos as a distinct nationality, and their ultimate absorption in the dominant race. The process that has been completed in Nippon is in rapid progress in Yeso.

A. H. KEANE

ON A NEW ARC ELECTRIC LAMP[1]

ELECTRIC lamps on the arc principle are almost as numerous as the trees in the forest, and it is somewhat fresh to come upon something that is novel. In these lamps the carbons are consumed as the current flows, and it is the variation in their consumption which occasions the flickering and irregularity of the light that is so irritating to the eyes. Special mechanical contrivances or regulators have to be used to compensate for this destruction of the carbons, as in the Siemens and Brush type, or else refractory materials have to be combined with the carbons, as in the Jablochkoff candle and in the lamp Soleil. The steadiness of the light depends upon the regularity with which the carbons are moved towards each other as they are consumed, so as to maintain the electric resistance between them a constant quantity. Each lamp must have a certain elasticity of regulation of its own, to prevent irregularities from the variable material of carbon used, and from variations in the current itself and in the machinery.

In all electric lamps, except the Brockie, the regulator is in the lamp itself. In the Brockie system the regulation is automatic, and is made at certain rapid intervals by the motor engine. This causes a periodic blinking that is detrimental to this lamp for internal illumination.

M. Abdank, the inventor of the system which I have the pleasure of bringing before the Section, separates his regulator from his lamp. The regulator may be fixed

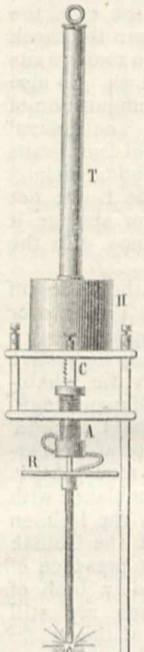

FIG. 1.

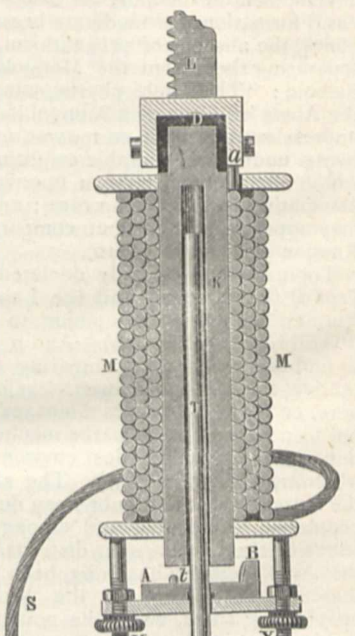

FIG. 2.

anywhere, within easy inspection and manipulation, and away from any disturbing influence in the lamp. The lamp can be fixed in any inaccessible place.

The Lamp (Figs. 1, 2, and 3).—The bottom or negative carbon is fixed, but the top or positive carbon is movable, in a vertical line. It is screwed at the point C to a brass rod, T (Fig. 2), which moves freely inside the tubular iron core of an electromagnet, K. This rod is clutched and lifted by the soft iron armature, A B, when a current passes through the coil, M M. The mass of the iron in the armature is distributed so that the greater portion is at one end, B, much nearer the pole than the other end. Hence this portion is attracted first, the armature assumes an inclined position, maintained by a brass button, *t*, which prevents any adhesion between the armature and the core of the electromagnet. The electric connection between the carbon and the coil of the electromagnet is maintained by the flexible wire, S.

[1] Paper read at the British Association, Southampton. Revised by the Author.

The electromagnet, A (Fig. 1), is fixed to a long and heavy rack, C, which falls by its own weight and by the weight of the electromagnet and the carbon fixed to it. The length of the rack is equal to the length of the two carbons. The fall of the rack is controlled by a friction break, B (Fig. 3), which acts upon the last of a train of three wheels put in motion by the above weight. The

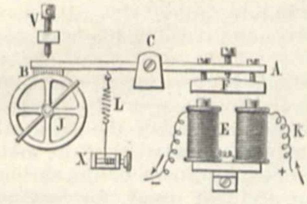

FIG. 3.

break, B, is fixed at one end of a lever, B A, the other end arrying a soft iron armature, F, easily adjusted by three screws. This armature is attracted by the electromagnet, E E (whose resistance is 1200 ohms), whenever a current circulates through it. The length of the play is regulated by the screw, V. The spring, L, applies tension to the break.

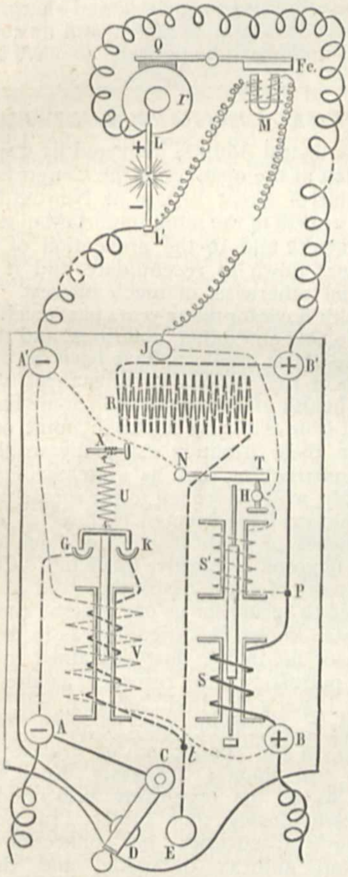

FIG. 4.

The Regulator.—This consists of a balance and a cut-off.

The Balance (Figs. 4 and 5) is made with two solenoids, S and S′, whose relative resistances is adjustible. S conveys the main current, and is wound with thick wire having practically no resistance, and S′ is traversed by a shunt current, and is wound with fine wire having a resistance of 600 ohms. In the axes of these two coils a small and light iron tube (2 m.m. diameter and 60 m.m. length) freely moves in a vertical line between two guides. When magnetised it has one pole in the middle and the other at each end. The upward motion is crontrolled by the spring N T. The spring rests upon the screw, H, with which it makes contact by platinum electrodes. This contact is broken whenever the little iron rod strikes the spring, N T.

The positive lead from the dynamo is attached to the terminal, B, then passes through the coil, S, to the terminal, B′, whence it proceeds to the lamp. The negative

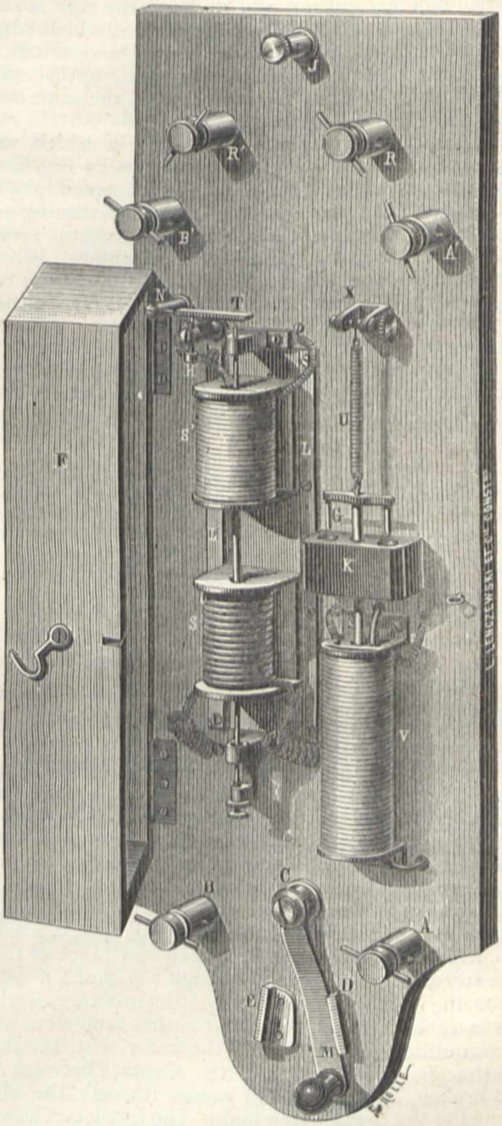

FIG. 5.

lead is attached to terminal A, passing directly to the other terminal, A′, and thence to the lamp.

The shunt which passes through the fine coil, S′, commences at the point, P. The other end is fixed to the screw, H, whence it has two paths, the one offering no resistance through the spring, T N, to the upper negative terminal, A′; the other through the terminal, J, to the electromagnet of the break, M, and thence to the negative terminal of the lamp, L′.

The Cut-off.—The last part of the apparatus (Fig. 4) to be described is the cut-off, which is used when there are several lamps in series. It is brought into play by the switch, C D, which can be placed at E or D. When it is at E, the negative terminal, A, is in communication with the positive terminal, B, through the resistance, R, which equals the resistance of the lamp, which is therefore out of circuit. When it is at D the cut-off acts automatically to do the same thing when required. This is done by a solenoid, V, which has two coils, the one of thick wire offering no resistance, and the other of 2000 ohms resistance. The fine wire connects the terminals, A′ and B. The solenoid has a movable soft iron core suspended by the spring, U. It has a cross piece of iron which can dip into two mercury cups, G and K, when the core is sucked into the solenoid. When this is the case, which happens when any accident occurs to the lamp, the terminal, A, is placed in connection with the terminal, B, through the thick wire of V and the resistance, R, in the same way as it was done by the switch, C D.

Electrical Arrangement.—The mode in which several lamps are connected up in series is shown by Fig. 6. M is the dynamo-machine. The + lead is connected to B_1 of the balance, it then passes to the lamp, L, returning to the balance, and then proceeds to each other lamp, returning finally to the negative pole of the machine. When the current enters the balance it passes through the coil, S, magnetising the iron core and drawing it downwards (Fig. 4). It then passes to the lamp, L L′, through the carbons, then returns to the balance, and proceeds back to the negative terminal of the machine. A small portion of the current is shunted off at the point, P, passing through the coil, S′, through the contact spring, T N, to

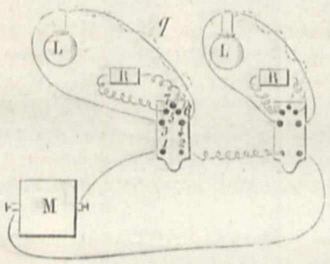

Fig. 6.

the terminal, A′, and drawing the iron core in opposition to S. The carbons are in contact, but in passing through the lamp the current magnetises the electromagnet, M (Fig. 2), which attracts the armature, A B, that bites and lifts up the rod, T, with the upper carbon a definite and fixed distance that is easily regulated by the screws, V V. The arc then is formed, and will continue to burn steadily as long as the current remains constant. But the moment the current falls, due to the increased resistance of the arc, a greater proportion passes through the shunt, S′ (Fig. 4), increasing its magnetic moment on the iron core, while that of S is diminishing. The result is that a moment arrives when equilibrium is destroyed, the iron rod strikes smartly and sharply upon the spring, N T. Contact between T and H is broken, and the current passes through the electromagnet of the break in the lamp. The break is released for an instant, the carbons approach each other. But the same rupture of contact introduces in the shunt a new resistance of considerable magnitude (viz. 1200 ohms), that of the electromagnets of the break. Then the strength of the shunt current diminishes considerably, and the solenoid, S, recovers briskly its drawing power upon the rod, and contact is restored. The carbons approach during these periods only about ·01 to ·02 millimetre. If this is not sufficient to restore equilibrium it is repeated continually, until equilibrium is obtained. The result is that the carbon is continually falling by a motion invisible to the eye, but sufficient to provide for the consumption of the carbons.

The contact between N T and H is never completely broken, the sparks are very feeble, and the contacts do not oxidise. The resistances inserted are so considerable that heating cannot occur, while the portion of the current abstracted for the control is so small that it may be neglected.

The balance acts precisely like the key of a Morse machine, and the break precisely like the sounder-receiver so well known in telegraphy. It emits the same kind of sounds, and acts automatically like a skilled and faithful telegraphist.

This regulation, by very small and short successive steps offers several advantages: (1) it is imperceptible to the eye; (2) it does not affect the main current; (3) any sudden, instantaneous, variation of the main current does not allow a too near approach of the carbon points.

Let now an accident occur, for instance, a carbon is broken. At once the automatic cut-off acts, the current passes through the resistance R instead of passing through the lamp. The current through the fine coil is suddenly increased, the rod is drawn in, contact is made at G and K, and the current is sent through the coil, R. As soon as contact is again made by the carbons, the current in the coil S is increased, that of the thick wire in V diminished, and the antagonistic spring, U, breaks the contact at G and K. The rupture of the light is almost invisible, because the relighting is so brisk and sharp.

I have seen this lamp in action, and its constant steadiness leaves nothing to be desired. W. H. PREECE

THE SANITARY INSTITUTE

THE Inaugural Address delivered by Captain Douglas Galton at the opening of the Congress of the Sanitary Institute of Great Britain at Newcastle-upon-Tyne, traces the growth of the more important questions relating to public health and to the prevention of disease from remote times down to recent date, and it is, both historically and otherwise, of much interest. Questions of public health have for many years past received increasing attention in this and other countries, and the energies of some of the ablest intellects have been devoted to the investigation of the various circumstances which tend to injure the health of communities. Some have dealt with the subject from a purely scientific point of view, others have given their attention especially to the defects in works of construction, such as systems of sewerage and water-supply, which have led to the spread of disease, and many physicians have devoted themselves exclusively to those branches of medical science which deal with preventive as opposed to curative medicine. Captain Galton refers to many of these researches, and shows how they have tended to secure for us our present knowledge. Dr. Tyndall's well-known investigations as to the existence of low forms of life in the dust contained in air, and his studies on putrefaction are recorded, as also Dr. Bastian's and Mr. Lister's kindred labours, and the practical applications to which they may be put. The several discoveries as to the connection of disease with definite organisms are noted; Professor Koch's recent contributions as to the organisms associated with tubercular disease closing this subject, in point of time. M. Pasteur's discoveries in connection with fowl-cholera and anthrax in cattle, and the associated question of the attenuation of the infectious property of the virus of these diseases, as the result of the processes to which they are subjected are dealt with in some detail. As to accepting M. Pasteur's conclusions in their entirety, it may however be desirable to await further experiments, the more so as certain investigations of Dr. Klein, an account of which has recently been submitted by the Local Government Board to the Veterinary Department of the Privy Council, have tended to conclusions adverse to the general adoption of M. Pasteur's proposal to inoculate cattle with an attenuated virus as a protection against anthrax. Knowledge as to these subjects is shown in the address to be rapidly increasing, but it is maintained that the science of the prevention of disease advances quite as rapidly as the knowledge relating to its causation. Thus, the application of systems of sewers is shown by statistics to have led to a great decrease in enteric or typhoid fever, both in this and other countries, and it is rightly contended that where a similar result has not followed on such provision, defective and faulty methods of construction, and not the systems as such, must be held responsible. The improvement in the water-supplies for our towns and villages has in like manner led to much saving of life and health, but dangers still lurk even in our modern systems of supply, and some of them are extremely difficult of detection. As to this subject Captain Galton says he is disposed to think that there has never been a well-proved case of an outbreak of disease resulting from the use of drinking water, where the chemist would not unhesitatingly on analysis have condemned the water as an impure source. The inference here implied must unquestionably be regarded as considerably in advance of that which our more eminent chemists themselves would lay claim to. Indeed, Dr. Frankland has distinctly admitted that chemical analysis is unable to detect those small quantities of morbific matter which are capable of conveying disease, and he has himself mingled choleraic dejecta with water without being able to detect any noteworthy chemical alteration in its quality. The standard which should be aimed at in this matter of water-supply is the same as that advocated by Captain Galton in other matters such as sewerage, ventilation, &c., and that is to get rid of all conditions involving risk, rather than to hope that their influence for mischief may never have opportunity for manifesting itself. The address gives many instances, whether in connection with Indian fairs or elsewhere, to show that scrupulous cleanliness should be the aim of sanitarians, and this is at least as desirable in connection with water services and water-courses as elsewhere.

The address having been delivered at Newcastle-upon-Tyne, it was but natural that frequent reference should have been made to sanitary administration in that borough, and to the results attendant upon it. The need for the isolation of infectious diseases is a matter of public concern, which called for and received attention, and it is satisfactory to note from the recently issued Report of the Medical Officer of the Local Government Board, that a considerable proportion of the sanitary authorities in England have already recognised the necessity for making some provision for the removal of the infectious sick from amongst crowded communities. But it is also evident that the accommodation provided should be of an efficient character. At Newcastle there is hospital provision for the infectious sick, but we fear that even whilst the Congress is sitting, the inadequacy of the accommodation available there is causing anxiety to those who are responsible for the health of the borough. The extension of sanitary hospitals to every part of the kingdom is much to be desired, and the suspicion of their possible influence for evil which is adverted to in the address, need not in any way hinder action in this direction. The only disease which has ever been alleged to extend from such hospitals to the surrounding neighbourhoods is small-pox, and even that disease is not suspected of having any such influence except when a large number of patients are aggregated together. The very essence of these hospitals is to have them in actual readiness, so that first attacks being at once isolated any further spread is prevented; and if by any chance this becomes impossible, it is, to say the least, doubtful whether, the disease having once extended, we have not in vaccination an even more potent method of prevention than isolation can at such a stage afford. The compulsory notification of infectious diseases will some day come powerfully to the aid of isolation as a measure of prevention, but public opinion as yet hardly appears ripe for any general measure to that effect.

In the concluding portion of his address Captain Galton endeavoured to convince his audience of the truth of the aphorism that public health really means public wealth. The advantages of dealing efficiently with the refuse of the population by sewage farms and otherwise was pointed out, and some of the results indicated went clearly to show that after all filth is but matter in a wrong place. The saving of life and health amongst persons inhabiting our model dwellings and improved lodging-houses was also shown to be striking, and it needs but little argument to prove that a distinct pecuniary advantage accrues to the community which can, by providing proper dwellings for the poor, retain amongst them, and in health, the bread-winners of each family. A large death-rate always means a heavy sick-rate and an increased poor-rate, and there is no form of death-rate which indicates a greater loss to a district than that which results from those infectious diseases which find their victims amongst the youth and adult members of the population. Fortunately it is these diseases above all others which are most easily prevented by the adoption of an intelligent and efficient sanitary administration.

NOTES

We regret to have to record the death, at the age of forty-three years, of M. Georges Leclanché, the inventor of the oxide of manganese constant elements, which are used so largely all over the world.

Dr. Oscar Dickson has purchased and presented to the Botanical Museum at Upsala the magnificent collection of Scandinavian mosses and algæ which the two Swedish naturalists, Messrs. J. and C. Hartman had collected during sixty years. The three botanical collections which form the basis for the study of the Scandinavian flora, viz., the Fries, Hahlenberg, and Hartman are now, by this last donation, in the possession of the University of Upsala.

The inauguration of the Becquerel statue took place on Sunday at Chatillon-sur-Loing, a small country town of the Montargis arrondissement, in the department of Loiret, where the eminent electrician was born in 1788, and where his family are still living. The statue represents Becquerel holding in his hands the small apparatus of which he made use for producing by electrical agencies his artificial crystals. On the pedestal is carved the names of the principal battles which Becquerel fought when in the French army, which belong mostly to the campaign of 1813, especially the siege of Saragossa. M. Cochery, the Minister of Postal Telegraphy, who is the representative of Chatillon-sur-Loing in the French Lower House, delivered the inaugural speech—an eloquent address, summarising the principal discoveries of Becquerel, and insisted on the services rendered by him to the cause of telegraphy. M. Dumas, the President of the Committee for erecting the statue, having been unable to attend the meeting, sent a written address, which was read on his behalf by M. Daubree, Director of the School of Mines. In this eloquent address the Perpetual Secretary of the Academy of Sciences presented a picture of the results obtained by modern industry and drew a most ingenious parallel between the Greeks and Romans erecting statues to demigods, and the modern nations conferring the same honours on the real benefactors of mankind. He eulogised Guillaume, the eminent artist, whose masterpiece was offered to the inhabitants of Chatillon to commemorate the life of a great man. M. Fremy advocated the cause of the Museum. He reminded the audience that just fifty years ago the lectureship occupied by

Becquerel had been created expressly for him, in accordance with a recommendation of the Academy of Sciences. To give a proof of the exceptional activity exhibited by Becquerel up to the age of ninety years, M. Fremy stated that he had published during his life not less than 529 works or papers in scientific periodicals. M. Barras, Perpetual Secretary of the French Agricultural Society, reviewed the services conferred by Becquerel by his works on agriculture. M. Berthelot, a member of the Municipality, returned thanks to the *savants*, and the proceedings terminated by a banquet given to the scientific guests by the Becquerel family. All the speakers made allusion to the merits of M. Becquerel the younger and of his son, now *répétiteur* to the Polytechnic School.

THE burthen of the address of Mr. Woodall, M.P., in the Education Department of the Social Science Congress at Nottingham, was that without science in our systems of education, our industries are bound to wane before those of other countries where a scientific system of technical education exists. He showed what is being done in Germany and France in this respect, and how much headway we have to make before we can reach the standpoint of these countries. In this department Mr. Rowland Hamilton read a paper on the endowment of research. "As to the endowment of the more special forms of research as more commonly understood," he said, "there is hardly any limit which it is desirable to assign to it provided due assurance is given that the work desired is efficiently carried out. The services thus rendered are pre-eminently of general and national importance, and must be provided for by national expenditure. The economic doctrine of supply and demand as regards the interchange of individual services is wholly inapplicable to the question. The difficulty lies in the administration of the funds devoted to such purposes so as to insure that they are given to those duly qualified to use them. The method of State grants in aid, dispensed through the agency of existing societies and learned bodies who have earned a title to public confidence, might be largely developed with the greatest advantage and the relative functions of the Government and of such societies in their relation to this subject were discussed. The multiplication of 'idle fellowships' had a demoralising tendency. While any undue interference on the part of the central administration was to be altogether deprecated, it was essential to reserve to the State an ultimate and *quasi* judicial control, which would best secure that publicity and definite responsibility which are the best safeguards against abuses in any direction." In speaking on the subject of technical training Mr. Hamilton remarked that it was not necessary to teach special crafts in primary schools, but it was most desirable that a general scientific groundwork in technical knowledge should be included in a system of national education.

THE Iron and Steel Institute meeting at Vienna has evidently been a great success. Several subjects of great manufacturing importance have had the benefit of being discussed by men experienced in various methods; and the hospitality towards the English visitors has been profuse.

WHEN Admiral Mouchez received the news of the observations made by Thollon of the new comet he telephoned it to the Havas agency, and it was telegraphed by them to every paper in France. This is the first time that this organisation has been used in France for scientific purposes, and for the future it will be employed for any notable celestial occurrence.

WE are pleased to learn that the result of the letter which appeared in our columns a few weeks ago has been that a short course of popular science lectures has been planned, to be given on Friday evenings at the Victoria Hall, Waterloo Road. If this experimental course is successful it is proposed to extend it. Admission is one penny (or threepence and sixpence for balcony seats), and the hall will seat 2500.

MESSRS. KEGAN PAUL, TRENCH, AND CO. will shortly add to the International Scientific Series, translations of Ribot's work on "Diseases of Memory, an Essay in the Positive Psychology," and of N. Joly's work on "Man before Metals." These will be followed by Mr. Robert H. Scott's "Elementary Meteorology," and Prof. Sheldon Amos's "Science of Politics."

WE have received three new parts of the "Encyclopædia der Naturwissenchaften," published by Trewendt, of Breslau—parts 5 to 7 of the second division. Part 5 contains the continuation of Kenngott's Word-book of Mineralogy, Geology, and Palæontology; in this we find two specially interesting articles by Lasaulx—on Continents and Delta Formations. In the 6th part we have the Word-book of Chemistry by Ladenburg and Collaborateurs. One of the leading articles in this part is that on Alkaloids, by Jacobsen, of Rostock. The 7th part is devoted to Pharmacological Botany, by Wittstein.

"THE Tropical Agriculturist" is the title of a monthly record of information for planters of coffee, tea, cocoa, cinchona, india-rubber, sugar, tobacco, cardamoms, palms, rice, and other products suited for cultivation in the tropics, published by Messrs. A. M. and J. Ferguson, of Colombo. Haddon and Co. are the London agents.

AFTER an address by the President, Mr. Shadworth H. Hodgson, LL.D., on October 9, and a paper on Spinoza on October 23, the Aristotelian Society propose devoting the meetings in November and December to a series of papers on the relation of Leibnitz and Wolf, and Locke, Berkeley, and Hume, to Kant. In January the Society will commence the study of Kant's *Critic of Pure Reason*, which will raise for discussion the validity of the primary concepts of science, and which will occupy the remainder of the session. The meetings will be held at 8, John Street, Adelphi, at 7.30 p.m. Particulars may be obtained from the Honorary Secretary Dr. A. Senier, 1, Bloomsbury Square, W.C.

IT is estimated by Prof. Dufour (*Arch. des Sciences*) that in a disastrous hailstorm on August 21 last year, about 100,000 cubic metres of ice fell in the district of Morges alone in a few minutes, and probably more than 1,000,000 cubic metres in the whole canton de Vaud that afternoon. Yet this is a small matter compared with the terrible hailstorm of July 13, 1788 (regarding which he makes some calculations). He gives some interesting facts, which seem to have been overlooked, in the history of *paragrêles*, or hail-preventers. Old men in the Canton de Vaud remember such apparatus, of lightning-rod character, being set up in several vineyards in 1825; the object being to hinder the formation of hail, by withdrawing electricity from the clouds. A hailstorm in July 1826 devastated, it is said, the best protected vineyards, and the *paragrêles* were then removed. Yet it was on receipt of encouraging and credible testimony from Italy and France (Prof. Dufour shows by extracts) that this brief experiment was made. Considering the distance of hail-forming clouds from the highest *paragrêles*, it is difficult, the author considers, to admit an influence of such apparatus; yet it must be remembered that electricity is "*un veritable fluide à surprises*"; often showing new and unexpected properties. Lately it is said to have been observed in some Swiss cantons, that showers of hail are more rare near forests than in unwooded districts. Prof. Dufour notes this as a matter calling for investigation. A forest may be regarded as a collection of *paragrêles*, and should it be proved to have the influence referred to, the theories which prevailed in 1824 and 1825 would gain new support.

AT a recent meeting of the Franklin Institute it was shown by Mr. Grimshaw that the microscope may be of good service in estimating the value of structural materials. It may determine whether or not the material is good enough to warrant trial with the testing machine. The author produced photographs of a chip of timber from a highway bridge that was wrecked two years ago, after a few days of service, through the strain caused by an empty truck; and the poor character of the wood was at once apparent. Such micro-photographs of timber, in fact, show that in the strong specimens, the concentric rings are close in texture and of slight width, and the radial plates frequent, wide, long, and thick, while the reverse is found in the poor material. As a parallel in metal-work, Mr. Grimshaw exhibited two portions of pure Lake copper, one an ordinary ingot, of coarse and crystalline grain, dark red colour, and full of blow-holes; the other, cast with proper precautions against oxidation, the grain close and fine, the colour *salmon*, and no blowholes. Tests of tensile strength of sheet and wire from these materials strikingly confirmed the indications of the microscope.

THE *Journal* of the Franklin Institute for September contains a fine plate (produced by the phototype process invented by Mr. Jacobi, of Neuendorf-Coblentz), representing the great bell of Moscow, from a photograph recently taken by Mr. Nystrom, who gives some interesting information about the largest ringing bells in the world.

AN attempt has been made by Signor Serpieri to connect, in an indirect way, two very dissimilar phenomena, viz., the attraction of the sun and moon, and the periodical revival of vulcanism in its more common manifestations. He finds support for his view (*Reale Ist. Lombard.*, August 3) in a recent observation by M. Daubrée in the deep gallery (for the Channel tunnel) made in the Rouen chalk, where it was noticed that the pits showed oscillations of level quite concordant with the varying tide above, the water abundant at high tide, and scanty at low tide; which is easily understood (says M. Daubrée), since all aquiferous strata there pass under the sea. Accepting this variation in the water of terrestrial depths with the sea-level, and knowing, on the other hand, that sea water has a principal part in the activity of volcanoes (as proved by the nature of their products and the immense quantity of aqueous vapour, which cause and maintain eruptions), it is natural, Signor Serpieri says, to conclude that the volcanic activity must present phases agreeing with those of the tide, and thus there appears a certain connection with the age and the position of the moon. Observations of a large number of earthquakes should also present the relation in question, as these are known to be mostly of volcanic origin, and to preferably affect coast regions; and M. Perry observed they were more frequent at syzygies and perigee of the moon. Prof. Bombicci has also observed in some parts of Italy a greater frequency of earthquakes at times of heavy and prolonged rains, which he regards as the exciting cause in such cases; and precisely because not all seismic centres are fed with sea-water, it is vain to expect that the luni-solar influence on earthquakes may be always made out. Thus the anomalies recorded by Schmidt and others may be explained.

THE additions to the Zoological Society's Gardens during the past week include a Rude Fox (*Canis rudis*) from Demerara, presented by Mr. W. F. Bridges; three Common Hedgehogs (*Erinaceus europæus*), British, presented by Mr. W. Bayes; two Chimachima Milvagos (*Milvago chimachima*) from Demerara, presented by Mr. G. H. Hawtayne, C.M.Z.S.; a Common Barn Owl (*Strix flammea*), British, presented by Mr. G. Paul; a Purple-headed Glossy Starling (*Lamprocolius auratus*) from West Africa, presented by Mr. J. Biehl; a Radiated Tortoise (*Testudo radiata*) from Madagascar, presented by Capt. R. Elwood; a Blue-crowned Hanging Parrakeet (*Loriculus galgulus*) from Ceylon, deposited; a Polecat (*Mustela putorius*), British, a Bengal Pitta (*Pitta bengalensis*) from India, purchased; four Banded Grass Finches (*Poëphila cincta*), bred in the Gardens.

UNWRITTEN HISTORY, AND HOW TO READ IT[1]

II.

BUT the flint arrow-heads and scrapers, and the use of stone for battle-axes, carry us back to a still earlier chapter of unwritten history, when, for want of knowledge of bronze or any other serviceable metal, our predecessors, like many a savage people of recent or comparatively recent times, had to make use of such materials as readily came to their hands—like stone, wood, and bone—for all ordinary appliances. With relics of this period, which, so far as those made in stone are concerned, are almost imperishable, the soil of this country in many districts abounds. We also find the tools and weapons of this Stone Age in many of the grave-mounds or barrows and beneath the floors of some of our caverns. It is by means of these relics that the history of this period is to be read, but here also much is to be learnt from the early lake-habitations of southern Europe and from the habits of savages in other lands who are unacquainted with the use of metal. It is indeed somewhat remakable that those in so low a stage of civilisation should have been able to furnish themselves with so many and such perfect applicances made of stone. Not only do we find hatchets and adzes of flint and other hard stones, with their edges carefully ground. but chisels, and even gouges or hollowed chisels (though these are rare in Britain), drills or awls, hammers knives, saws, and scraping tools of various kinds. One of the most common of these is made from a flat splinter, or flake of flint, trimmed at the end to a semicircular scraping edge. We still find such tools in use for the purpose of preparing skins; and we have corroborative evidence of their having been in use in old times for some such purpose, in the fact that the semicircular edge is often worn away and rounded in precisely the way that would result from its being used to scrape a soft but gritty substance, such as leather exposed to dust and dirt. Though skins probably formed the principal clothing, the presence of spindle-whorls—the small fly-wheels by which spinning by hand is carried on—in some settlements of the Stone Period, proves that the art of spinning was not unknown, and indeed charred fragments of woven linen cloth have been found in some of the lake dwellings of this age. The stone-using people of that time cultivated wheat, barley, and millet for their bread, which they ground into coarse flour by means of rubbing-stones; they flavoured their cakes with carraway and poppy seeds, and laid up stores of nuts and walnuts, beech-mast and acorns, apples and pears for winter use, and ate all the common wild fruits in their seasons.

All this we learn from the charred remains left at the bottom of the lakes where the pile-dwellings were burnt down. The bones thrown away show that not only did they hunt wild animals of the country, but that they had oxen, sheep, and goats, and probably also pigs, as domesticated animals, and the dog was already their faithful companion. Their weapons for the chase were arrows and spears tipped with flint—the former of which, being cheaper than metal and also liable to be lost, remained in use even when bronze was known. They also possibly made use of the sling. Their axes, like modern tomahawks, seem to have been used both for peaceful and warlike purposes, but in this country at least it is doubtful whether any of the stone battle-axes with a hole for the haft belong to an earlier date than the simplest of the bronze daggers. From an examination of the skulls and bones found in the graves of the Stone and Bronze Periods we are able to form an idea of the size of the men of those days, and of the differences between them. From the objects buried with them we can even form some idea of their religious beliefs and hope of a future state. I must not, however, dwell on the details of these chapters in the unwritten history of man in Britain. I may, however, observe that though we may fix within some centuries the date when bronze began to be employed for cutting-tools, and stone in consequence began to fall in disuse, we are as yet at a loss to say at how early an epoch the use of the stone hatchets with

[1] A lecture to the working classes, delivered at the meeting of the British Association for the advancement of science, held at Southampton, *August*, 1882, by John Evans, D.C.L., LL.D., F.R.S., &c. Revised by the Author. Continued from p. 516.

their edges ground or polished first began. The period during which they were exclusively employed has been called the Neolithic or New Stone Period. It has also been called the Surface Stone Period, as the relics belonging to it are usually found upon or near the surface of the ground, and not at a considerable depth below it, like those belonging to an earlier chapter in our history, which actually form constituent parts of extensive geological deposits. There is this also to be observed, that the circumstances under which the stone implements of this periods are found, prove that no very great alteration in the general features of the country has taken place since the time when they were in use. There was the same disposition of hill and valley; rivers ran along much the same course as now, and at much the same level; the same animals frequented the country with but few exceptions, and though there may have been incursions of foreign races of men, we find the Stone Age shading off into the Bronze Age, and the latter into the Iron Age, not many centuries before the Roman occupation Although it is impossible to say for what length of time this Neolithic or Surface Stone Period may have endured in Britain, there is little on the face of the facts which of necessity implies a longer existence for the human race than the six thousand years that used commonly to be assigned to it. In other parts of the world, as for instance in Egypt, there have been circumstances brought to light which prove that the ordinary chronology is insufficient for the history of those countries; and, in addition, there are facts known with regard to the development of language which have led many students to the conclusion that the antiquity of man is much greater than was commonly supposed. And yet five-and-twenty years ago, or less, there was no one who could point to traces of human occupation in Britain of an earlier date than the polished stone instruments. I might, perhaps, make an exception in favour of Mr. John Frere, who, at the beginning of this century, inferred frrom the circumstances under which some stone weapons were found, that they belonged "to a very remote period indeed, even beyond that of the present world."

If it had been my lot to address you in 1858 instead of in 1882, I should myself have assured you that the earliest chapter in our unwritten history was that which related to the polished stone hatchets and the other forms of stone weapons and instruments which are found associated with them. At the same time I should not have agreed with Dr. Johnson, that "all that is really known of the ancient state of Britain is contained in a few pages. We can know no more than the old writers have told us." But within the last twenty years what a lengthened vista of the antiquity of our race has been opened out, and what a marvellous chapter of unwritten history have we not to some extent been able to read!

It is to that chapter that I must now turn, and, in examining it, it will perhaps be best first to state some of the facts which of late years have come to our knowledge, and then to show what inferences have been drawn from them.

Geologists have long been aware that along the valleys of our principal rivers, generally at some height above their present level, and often at some distance from the streams, there are beds of gravel, sand, and brick-earth, frequently containing the remains of land and fresh water shells, and the bones of various animals. That these drift-deposits were not due to the action of the sea is shown by the absence of sea-shells, while the general resemblance of the land and fresh-water shells in them to those in the existing stream and valley prove them to have been deposited by fresh water. The presence in the beds of the bones of land animals is also corroborative of this view; while the fact that several of these beasts, such as the great woolly elephant or mammoth, the rhinoceros, hippopotamus, and reindeer, are of species now extinct, or no longer known in Britain, is suggestive of remote antiquity. In some cases shells and bones have not been found, but the position and character of the beds are such as to prove that they belong to the same class, and are of the same age, as those in which such remains occur. Here at Southampton we are on the tongue of land which separates the valleys of the Test and the Itchen, but the drift-beds in these valleys have not been as yet very carefully examined above Southampton, though at Swathling an elephant's tooth has been found in the gravel. The next valley westward, that of the Avon, which runs into the sea at Christchurch, has been more productive. Along that valley numerous beds of drifted deposits have been examined, and at Salisbury, besides land and fresh-water shells, the bones of elephant, rhinoceros, hyæna, lion, and reindeer have been found in them, as well as those of s me other animals, among which the pouched marmot and the Greenland lemming may be mentioned. These are especially indicative of a cold climate, as are also some egg-shells of the wild goose, which now only breeds in northern latitudes. Some of the drift-beds are at a considerable height, as much as 90 or 100 feet above the existing river, but others are at a much lower level. They consist of materials assorted in much the same manner as would be effected by any existing stream—of gravels more or less coarse where probably the current has been strong, of sand where its force has been less, and of brick-earth or mud such as might be deposited by the waters of a flooded river, or brought down the hill-sides by rain. It is impossible to imagine any floods of such magnitude as to fill the valley to the height of 100 feet; but if such floods ever did occur they would certainly not have deposited coarse gravel at the top of the banks of the stream, but at the bottom of its bed. Nor could we expect to find deposits of loam left half-way down the slopes of a river liable to such floods. From these and other grounds we are driven to the conclusion that the beds of drift, which are now 100 feet or more above the existing river, at one time formed a portion of its bed when it ran at a much higher level than at present, and that, by the action of the stream running along it, the valley has since that time been scooped out to its present depth. The climate at the time of the deposit of the high-level gravels appears to have been cold, so that both frost and a much larger rainfall may have assisted the stream in producing greater effects upon the valley than it now does. The river also, when left to itself, and neither watched nor embanked, would be far more liable to floods which might wear away the valley. Under any circumstances the scooping-out to such a depth must have required an enormous amount of time, and it is hard to picture to one's self what the country must have been like in those days when the beds of the rivers at some little distance from the sea were, say, 100 feet above their present level. Here at Southampton we have beds of these old gravels capping the hill at the Common at something like 150 feet above the sea-level, and yet the top of this hill must at the tine of their deposit have been the bottom of a valley with hills on either side. As old as the hills is a proverbial phrase, but, compared with the age of the hills at the side of the valley which has disappeared, this hill is a thing of yesterday—

> "The hills are shadows, and they flow
> From form to form and nothing stands.
> They melt like mists the solid lands,
> Like clouds they shape themselves and go."

Some of you will begin to think that I have not kept my promise, but have strayed into the geological past. When, however, I tell you that implements made of flint, as undoubtedly the work of intelligent beings as any Sheffield whittle of the present day, form constituent parts of the gravel of which I have been speaking, and are also found scattered through the sands and loam, you will perceive that I am still within the limits of the unwritten history of the human race.

Before proceeding further with regard to the circumstances under which the implements are found, it will be well to say a few words as to their character and probable uses. Some of them are large flat splinters or "flakes" of flint, detached from a block by a single blow, in the same manner as flakes of flint are still produced in the manufacture of gun-flints. The edges of such flakes are very sharp, so they may have been used as knives. When found in gravel they have usually been much knocked about, but when found in sand or clay the edges often show traces of wear, as if they had been used for scraping bones or some such hard substance as well as for cutting. The more highly wrought implements are sometimes oval, with a cutting edge all round, and sometimes provided with a sharp or rounded point. The oval specimen shown in the diagram was found in a pit at the north end of Southampton Common, and the other two near Barton, between Lymington and Christchurch. These implements are chipped out with considerable skill, and may have been used either as weapons for the chase or for the war, or as tools for cutting, grubbing, or piercing. The extreme point of one of the specimens figured has been worn away at each side, as if it had been used for boring a hole. Some of the instruments may have been mounted with hafts as axes or spears, but of this there is at present no conclusive evidence. The larger number of them appear to be well-adapted for holding in the hand, and it is to be observed that their broad end is usually blunt, and the narrow end sharpened for use; whereas in the instruments of the Surface Stone Period it is nearly always the broad end that is sharpened, and this has often been effected by grinding or polishing the edges, while in the implements of the period we are now considering the edges are never ground. The name by which this period is generally known is the Palæolithic or Ancient Stone Period, though it is sometimes also termed the River-drift Period, as the implements belonging to it are usually found in river-drift. Of the other appliances in use among those who made the large palæolithic implements we can best judge by the remains which have been found beneath the floors of some of the caverns both of England and France, which, however, for the most part probably belong to a somewhat more recent date. In the days when those caverns were occupied as dwellings the reindeer still formed a principal article of food in the South of France. Those who hunted it were sufficiently good artists to carve figures of it in bone, or to engrave them on slabs of slate. Some representations of the elephant have also been found. They carved harpoons in reindeer horn, prepared skins with stone scrapers, and sewed them together by means of bone needles, probably using reindeer tendons as thread. The men, however, who were in this state of civilisation lived at a time when the valleys had been excavated to nearly their present depth, Yet even between them and the people of the Neolithic or Surface Stone Period there appears to be a great gulf—a chapter of unwritten history, which at present we have no means of reading.

Let us now return to the river-drift, and see what more it can teach us. I have told you how on the high ground where now is Southampton Common there are beds of gravel containing water-worn flint implements, and that these beds must in all probability have been deposited in the bottom of a river valley. Farther south we find gravels of a similar character, but at lower levels, forming cliffs of no great height along the sea-shore from Hambley to Alverstoke. These cliffs are now being eaten away by the action of the sea, and among the pebbles spread by the waves upon the shore numerous well-wrought implements have been found, while farther east, at Selsey, there are extensive drift-beds containing remains of the mammoth. Nor are traces of the river, which deposited these beds, wanting on the other side of Spithead, for in the shingle at Bembridge implements of the same kind have been discovered, and Mr. Codrington found a good specimen, some 80 feet above the present sea-level, in gravel on the Foreland at the east end of the Isle of Wight.

It will probably be some little strain upon your powers of imagination for you mentally to fill up the great channel of the sea which we know as Southampton Water, and which now forms the basis of the prosperity of this town, and to picture to yourselves a river flowing in the same direction, spreading out gravels along its changing course at a height considerably above the present sea-level, and yet having its shores frequented by that early race of men who fashioned the implements which we find in the gravels. But I shall have to make a still further demand upon your powers of belief.

I have already spoken to you about the drift-deposits along the valley of the Avon, but I must now take you a little farther west, and call your attention to discoveries which have been made at Bournemouth. There, as many of you no doubt remember, the cliffs are formed of beds of sand and clay belonging to a period a little older, geologically speaking, than the Bracklesham beds whch form the subsoil of Southampton. These cliffs are, however, capped with gravel; and in this, also, at a height of more than 120 feet above the sea-level, implements have been found. Farther east, near Boscombe, the height of the gravel is still about 120 feet; at Hengistbury Head it is 90 feet; and at Barton and Hordle, where numerous implements have been found, it is 60 or 70 feet. There can, indeed, be but little doubt that these gravels which now cap the cliffs must originally have been deposited in the bed of a river, and that that river flowed in an easterly direction. But how, it will be asked, can any river have possibly taken such a course? I will ask you, in return, Of what are the Needles at Alum Bay the relics? Are they not the shattered and sea worn remains of an extension of the great chalk ridge of High Down westward from Freshwater? Can you not imagine them still forming part of the down, with other Needles, which have now disappeared, towering still farther to the west? Can you not picture to yourselves the foreland of Ballard Down, on the Dorset coast, and its accompanying pinnacles standing out still farther to the east, and thus in your mind's eye gradually bridge over the gap of fifteen miles, which now exists between the chalk downs of Dorset and those of the Isle of Wight? There must almost of necessity have been a period when these two ranges of downs formed one continuous ridge, and when, in fact, the Isle of Wight was not separated from England by any arm of the sea. At that time the rivers which now discharge their waters at Poole, at Christchurch, at Lymington, and at Exbury, must all have been contributed to form a river the course of which must have been from west to east, in a direction nearly parallel to the chalk downs. Of the bed of this river we have traces in the gravels which now cap the cliffs of our southern coast. The history of the disappearance of this ancient river appears susceptible of being traced. We know not how far the land may have extended to the south of the chalk downs at the time when it first began to flow; but in the course of long ages the never-ceasing wear of the sea, slow but sure in its action, must have effected a breach through the line of chalk downs, and have then more rapidly cut away some of the softer beds to the north, so as to afford a new means of access by which the waters of the river would find a way to the sea. As time went on this breach would become wider and wider, until, as we see at present the whole of the southern slope of the old river valley disappeared for a distance of fifteen miles between Ballard Down and the Needles; while that part of the bed of the old river which still had land to the south was widened out until it became the Solent Sea and Spithead, which now separates the Isle of Wight from the mainland.

I might have given you evidence from which it has been concluded that, at the period when the river gravels containing flint implements were deposited, England was still united to the Continent, and the Straits of Dover did not exist. I might have pointed out the existence of similar implements discovered under nearly similar circumstances in remote quarters of the world. But time will not suffice, and you must be content with my attempt to read this chapter of local history. I must, however, warn you against supposing that, old as may be these relics they represent the first advent of man upon the earth. On the contrary, their similarity in so many regions points to some early home of the human family from which the makers of these flint tools in different countries originally migrated. Of this home, however, as yet no traces have been found. As to the number of years embraced in this chapter of the river-drift it is hard even to speculate. It can only be judged by the changes which have since taken place. We have seen how in the Roman times this part of Britain was, so far as the distribution of land and water is concerned, much the same as at present, and that there can have been but little difference in the days when bronze was in use for cutting-tools or in that lengthened period when stone did duty for steel. But when we come to this earlier chapter in our history, all is changed. We find on the top of our hills and the capping of our cliffs gravels which must have been deposited at the bottom of rivers, but which testify to the existence of man at the time of their deposit. We find a total change in the animal world of the region; we find that deep valleys have been excavated and river-courses widened out into arms of the sea, and the whole shape and form of the country changed. No wonder if, with so wide a room for speculation, different observers adopt somewhat different readings of this chapter of unwritten history. I have given you my reading of it, in which I see the antiquity of man carried back so far into the dim past, that even Egyptian chronology, extending as it does over thousands of years, appears but to cover a small link in the long chain of human existence—a chain of which the first link has still to be discovered. If you on your part will attempt to check and verify my reading, and study attentively what is still going on under your eyes, it will bring home to you the mighty effects which may arise from the small but ever-active agents, rains and rivers, tide and time; and whether in the end you agree with my reading or not, you will find that you have added a new interest to your lives.

PROFESSOR HAECKEL ON DARWIN, GOETHE, AND LAMARCK[1]

WHEN five months ago the sad intelligence reached us by telegraph from England, that on April 19 Charles Darwin had concluded his life of rich activity, there thrilled with rare unanimity through the whole scientific world the feeling of an irreparable loss. Not only did the innumerable adherents and

[1] Lecture given at the Eisenach meeting of the German Naturalists and Physicians.

scholars of the great naturalist lament the decease of the head-master who had guided them, but even the most esteemed of his opponents had to confess that one of the most significant and influential spirits of the century had departed. This universal sentiment found its most eloquent expression in the fact that immediately after his death the English newspapers of all parties, and pre-eminently his conservative opponents, demanded that the burial-place of the deceased should be in the Valhalla of Great Britain, the national Temple of Fame, Westminster Abbey, and that there in point of fact he found his last resting-place by the side of the kindred-minded Newton.

In no country of the world, however, England not excepted, has the reforming doctrine of Darwin met with so much living interest or evoked such a storm of writings, for and against, as in Germany. It is therefore only a debt of honour we pay, if at this year's assembly of German Naturalists and Physicians we gratefully call to remembrance the mighty genius who has departed, and bring home to our minds the loftiness of the theory of nature to which he has elevated us. And what place in the world could be more appropriate for rendering this service of thanks than Eisenach, with its Wartburg, this stronghold of free inquiry and free opinion! As in this sacred spot 360 years ago Martin Luther, by his reform of the Church in its head and members, introduced a new era in the history of civilisation, so in our days has Charles Darwin, by his reform of the doctrine of development, constrained the whole perception, thought, and volition of mankind into new and higher courses. It is true that personally, both in his character and influence, Darwin has more affinity to the meek and mild Melanchthon than to the powerful and inspired Luther. In the scope and importance, however, of their great work of reformation, the two cases were entirely parallel, and in both the success marks a new epoch in the development of the human mind.

Consider, first, the irrefragable fact of the unexampled success which Darwin's reform of science has achieved in the short space of twenty-three years! For never before since the beginning of human science has any new theory penetrated so deeply to the foundation of the whole domain of knowledge or so deeply affected the most cherished personal convictions of individual students; never before has a new theory called forth such vehement opposition and so completely overcome it in such short time. The depicture of the astounding revolution which Darwin has accomplished in the minds of men in their entire view of nature and conception of the world will form an interesting chapter in the future history of the doctrine of development.

In 1863, four years after the publication of Darwin's great work, opening up a new path for the human mind, when at the meeting of naturalists at Stettin, I for the first time openly drew attention to the work, the great majority were of opinion that "nature-philosophical fantasies" of this sort were no proper subject for earnest discussion. An esteemed zoologist pooh-poohed the whole theory as the "harmless dream of a man napping," while another compared it with table-turning and "Odic force." A celebrated botanist maintained that there was not one single fact to support this "untenable hypothesis," but that on the contrary it contradicted all experience, and a noted geologist believed that the passing vertigo would soon inevitably sink into dull sobriety. A well-known physiologist later on spoke of the whole history of filiation as a romance, and an anatomist prophesied that in a few years there would be no more talk of it. In thick-tomed works and in numberless treatises it was demonstrated that Darwin's theory was false from beginning to end, unproved by facts, delusive in its conclusions, ruinous in its consequences. Nay, no further back than five years ago, when in the meeting of Naturalists at Munich (1877) I expounded "the current doctrine of development in relation to the whole body of science," I encountered the most unqualified antagonism in one of our most celebrated naturalists, who even went the length of demanding the exclusion from education of Darwinism as an "unproved hypothesis." I was compelled in my paper on "Free Science and Free Teaching," to take the right of the latter emphatically under my protection.

And of all these damnatory judgments on the part of our numerous opponents, how much remains current at the present day? Nothing. The very number and bulk of their many-sided attacks have only redounded to the completion of our triumph. For the more the immovable citadel of the new theory of nature was attacked from all sides and assailed by weapons of the most varied kind, the more did its undaunted defenders feel called upon to fill up the gaps which here and there disclosed themselves in their inclosing wall of defence. Every charge on the part of the superannuated dogmas went to pieces against the iron panoply of the united experimental sciences. The gifted commander who had discovered the long-sought bond of union for the sciences, and had led the defence under the conception of oneness or monism, was able three years ago, on the celebration of his seventieth birthday, to look with entire satisfaction on the complete victory won by his troops, and with Goethe might say—

> "Es wird die Spur von meinen Erdentagen
> Nicht in Æonen untergehn" [1]

That such is really the case, and that in the evening of his life Darwin was enabled to rejoice in the complete triumph of his good cause is a fact indisputably testified by the present state of the natural sciences. We have only to cast a glance into the numerous periodicals and the most important works in those departments which are more immediately and more integrally affected by Darwin's teaching—zoology and botany, morphology and physiology, ontogeny and palæontology. In these subjects scarcely any work of superior merit now appears which is not penetrated by the idea of natural development. With vanishingly few and unimportant exceptions, almost all investigations start with the assumption of Darwin's fundamental conception, that the form-relationship between different species of animals and plants is rooted in their essential blood-relationship, and that the complicate relations of the organic world are to be explained by the two factors of common origin and gradual transformation.

Darwinism, too, in its more specific sense, the theory of selection, has maintained its ground in the face of all attacks; for this it is which first discovers to us the physiological causes through which the struggle for existence mechanically produces transformation. And if natural selection is by no means the only agent in transformation it at all events still remains its most important instrumen. Darwin, by his discovery of it under the light of artificial selection, solved one of the greatest biological riddles. For the doctrine of "natural selection through the struggle for existence" is nothing less than the final solution of the great problem: "How can forms of organisms constituted for a particular purpose come into being without the aid of a cause acting with a particular purpose? How can an edifice replete with design build itself up without design and without architect?" A question which our greatest critical philosopher, Kant, a hundred years ago, declared to be insoluble.

But in no province of natural science do Darwin's grand achievements appear so conspicuous as the one in which our own investigations revolve, in the wide province of morphology, comparative anatomy, and the history of development. For in morphology, which was also Goethe's special favourite, *all* knowledge that is not merely superficial, depends directly on the recognition of the doctrine of filiation; and here it is, particularly, that by its help the most brilliant results have been attained in the shortest time. The genealogical trees of particular groups of forms, which at the beginning hardly dared venture into the light of day as new-fangled (*heuristische*) hypotheses, are now, in the case of many organic groups, completely established facts. To cite but a few examples, no competent zoologist any longer calls in question the descent of horses from tapir-like palæotheria, of ruminant animals from swine-like anoplotheria, of birds from lizard-like reptiles. Nor does any one any longer doubt that all higher air-breathing vertebrates have their origin in lower gill-breathing fishes. The most important and most disputed, however, of all hypotheses of descent, that, namely, which derives man from ape-like mammals, has of late years, in consequence of more matured knowledge, gained for itself such general recognition at the hands of competent experts, that the great majority of them now deem it just as well grounded as any of the foregoing phylogenetic hypotheses.

In the face of such encouraging unanimity we can afford quietly to ignore the opposition which is still raised here and there by some single opponents of transformation. There is one capital fact in our favour, the whole of the younger generation is working in Darwin's spirit, and far beyond the limits of professional circles his doctrine is operating as a ferment, stimulating to nearer solution the greatest problems of human knowledge.

Celebrating here to-day the complete victory of Darwin's doctrine of development, as we are, accordingly, entitled to do,

[1] The influence of my earthly days
Will last through eons.

it is also implied that the end has come to the dreary period of violent literary warfare; and we may give all the more emphatic expression to our jubilant feeling of triumph in this respect, that we have ourselves been largely involved in those hard battles. Seeing, however, that according to Heraclites, struggle is the father of all things, it was not possible that the struggle for existence should spare the theory which itself laid down this principle and raised it to be the most valuable instrument in its store-house of arguments. With all the greater welcome we now greet the new period of peace following on that victory, and of quiet progress in which we look forward to the fairest fruits in the new courses of inquiry. It well becomes the Association of German Naturalists and Physicians who have repeatedly been witnesses of the loud tumult of those battles, now when they are happily concluded, to sanction the treaty of peace, and to solemnly recognise the doctrine of development as the sure foundation-stone of scientific inquiry.

If we now look for the causes of the extraordinary effect produced in such a short time by the Darwinian doctrines, in the teeth of the most violent opposition, we will find them by no means exclusively in the convincing force of their inherent truth, but also in the peculiarly favourable outward circumstances in which they entered the scientific world. Not the least of these favourable conditions lies in the rare characteristic qualities of the man on whom devolved the solution of such a gigantic task. Charles Darwin united in himself a wealth of diverse intellectual gifts which generally are to be found only apart. His fund of knowledge and his acumen as a naturalist were just as great as his far-sightedness and comprehensiveness as philosopher. To what degree he harmoniously combined these two sides of intellectual activity, often in conflict with each other, may be inferred from the fact that many short-sighted experimentalists see in him only the conscientious observer and ingenious experimentalist, regretting that his theory should be but speculative aberration; while on the other hand many high aspiring thinkers look down with great depreciation on his experimental achievements, but admire the acuteness of his judgment and the lucidity of his logical train of thought. In this respect he reminds us of our two greatest German naturalists, Johannes Müller and Carl Ernst Baer. If the latter in his title-page described his classical "History of the Development of Animals" as "Observation and Reflection," Darwin might say the same of all his works. With these rare powers of observation and judgment were associated other noble qualities of character greatly enhancing their value and profit; indefatigable perseverance in the pursuit of his aims, scrupulous conscientiousness in grouping the assured results, purest aspiration after natural truth, and open simplicity in communicating his conclusions. No less praiseworthy was the extraordinary modesty with which he set forth his views, and the mild meekness with which, while answering all the sharp objections of his opponents, so far as they were to the purpose, he simply ignored personal aspersions.

Truly admirable is the patience and forethought with which Darwin took in hand and carried out the weightiest task of his life—the explanation of the origin of animal and vegetable species through natural selection. The first basis to this work was laid in his twenty-third year, when in 1832, in South America, he drew up geographical and palæontological observations on the animal species of this continent. The rich observations he accumulated in that voyage round the world, a voyage lasting five years, and of such consequence to him, did not, however, come to their full utilisation till long afterwards. The injury to his health wrought by the severe hardships to which that voyage subjected him forced him to withdraw completely from the restless turmoil of London, and to reduce his circle of personal friends to the narrowest compass. In 1842, in the thirty-third year of his age, he betook himself to his quiet, idyllic country seat of Down, lying gracefully between the green meadows and the wooded hills of the sweet county of Kent.

In the harmonious solitude of this verdant seat of the Muses Darwin lived full forty years, devoting himself singly and exclusively to the continuous study of nature and to the solution of the great problem she had revealed to him. Practising, himself, for many years the active work of gardener and cattle-rearer, he could see under his own eyes the transformation of the corporeal forms of plants and animals. Examining into the physiological causes of these transformations, the laws, namely, of Inheritance and Adaptation, he clearly perceived that in the domain of uncultivated as well as of cultivated nature the same mechanical laws condition change of species. He became convinced that artificial and natural rearing rested essentially on the same processes of selection. What in the one case is produced in a short time by the purposively active will of man for his own advantage is in the other produced in a much longer time by the purposelessly active "Struggle for Existence" to the advantage of the transformed organisms.

But although Darwin had early conceived this fundamental thought of his "Theory of Selection," and throughout many years had collected the richest material of observations in its evidence, he could not for a long time resolve on the publication of his theory. It would ever appear to him too full of gaps, the mass of facts required for its support too defective, the chain of inferences too incomplete. He was ever wanting to accumulate fresh evidence, to bring ever more light from all sides on the questions in hand, and as far as possible to anticipate and refute objections to his conclusions. Perhaps in the end he would never have come to communicate the treasures of his knowledge to the world, had it not been for an outward impulse which constrained him to this step. At length then, in 1859, after the author had completed his fiftieth year, appeared his era-inaugurating chief work on the "Origin of Species," a work to which all the rest of his writings are but deductions and commentaries. This event happened just a full century after Caspar Friedrich Wolff in Germany had discovered the true development of the animal germ, and just half a century after Lamarck in France had prophetically propounded the principles established by Darwin.

The extraordinary modesty and unassumingness which Darwin showed to such a degree on the subject of the publication of the most important of his writings, displayed itself also on all hands in his extensive correspondence, and not less in his personal intercourse. Every one who had the happiness of making his personal acquaintance could not part from him without a feeling of the sincerest reverence and highest appreciation. Were it here allowed me to intercalate a few words on my personal meeting with Darwin, I would give expression especially to the high admiration of Darwin as an ideal man with which my three visits to him in Down inspired me. The first time was in October 1866, on the occasion of a voyage I was undertaking to the Canary Islands. I had just completed the "General Morphology," a work in which I had ventured on the experiment of mechanically establishing the science of organic forms on the basis of the theory of filiation as reformed by Darwin. By means of the proof-sheets I had sent him, Darwin was acquainted with my essay, and took all the more interest in it because these morphologic investigations lay rather remote from his own studies, which were principally experimental. It was, therefore, with the greatest pleasure that I responded to an invitation to come to Down, which he had sent me during my short stay in London.

In Darwin's own carriage, which he had thoughtfully sent for my convenience to the railway station, I drove one sunny morning in October through the graceful hilly landscape of Kent, that, with the chequered foliage of its woods, with its stretches of purple heath, yellow broom and evergreen oaks, was arrayed in the fairest autumnal dress. As the carriage drew up in front of Darwin's pleasant country-house clad in a vesture of ivy, and embowered in elms, there stepped out to meet me from the shady porch overgrown with creeping plants, the great naturalist himself, a tall and venerable figure with the broad shoulders of an atlas supporting a world of thoughts, his Jupiter-like forehead highly and broadly arched, as in the case of Goethe, and deeply furrowed by the plough of mental labour; his kindly mild eyes looking forth under the shadow of prominent brows; his amiable mouth surrounded by a copious silver-white beard. The cordial preposessing expression of the whole face, the gentle, mild voice, the slow, deliberate utterance, the natural and *naive* train of ideas which marked his conversation, captivated my whole heart in the first hour of our meeting, just as his great work had formerly, on my first reading it, taken my whole understanding by storm. I fancied a lofty world-sage out of Hellenic antiquity—a Socrates or Aristotle—stood alive before me.

Our conversation, of course, turned principally on the subject which lay nearest the hearts of us both—on the progress and prospects of the history of development. Those prospects at that time—sixteen years ago—were bad enough, for the highest authorities had for the most part set themselves against the new doctrines. With touching modesty Darwin said that his whole work was but a weak attempt to explain in a natural way the origin of animal and vegetable species, and that he should not live to see any noteworthy success following the experiment, the mountain of opposing prejudice being so high. He thought I had greatly over-estimated his small merit, and that the high praise I had bestowed on it in my "General Morphology" was far too exaggerated. We next came to speak of the numerous and violent attacks on his work, which were then in the ascendant. In the case of many of those pitiful botches, one was in fact quite at a loss whether more to lament the want of understanding and judgment they showed or to give the greater vent to the indignation one could not but feel at the arrogance and presumption of those miserable scriblers who pooh-poohed Darwin's ideas and bespattered his character. I had then, as on later occasions repeatedly, expressed my just scorn of the contemptible clan. Darwin smiled at this, and endeavoured to calm me with the words, "My dear young friend, believe me, one must have compassion and forbearance with such poor creatures; the stream of truth they can only hold back for a passing instant, but never permanently stem."

In my later visits to Down in 1876 and 1879 I had the pleasure of being able to relate to Darwin the mighty progress which in the past intervals his doctrines had made in Germany. Their decisive outburst happened more rapidly and more completely here with us than in England, for the reason chiefly that the power of social and religious prejudice is not nearly so strong here as among our cousins across the Channel, who are better placed than ourselves. Darwin was perfectly well aware of all this; though his knowledge of our language and literature was defective, as he often complained, yet he had the highest appreciation of our intellectual treasures.

Darwin having in his great work of 1859, planting the basis of his doctrine, said nothing regarding its anthropological consequences, and having with wise reserve maintained silence on this subject down to the year 1871, it was for me of the highest interest, even as early as my first visit to him in 1866, to converse with him at large on that topic. As was to be expected, the great thinker felt not the slightest misgiving in recognising the necessary extension to man of the application of his doctrine of filiation. I had, therefore, the highest satisfaction in being able to set forth to him the first genealogical tables which I had then designed, and in all essential points to receive his approval. Though the special study of comparative anatomy and ontogeny, on which I based my phylogenetic plans, lay out of Darwin's province, he yet completely perceived their importance. In his celebrated work, in two volumes, on the "Descent of Man and Selection in relation to Sex" (1871), he has, therefore, declared himself to be in all principal points in harmony with me, and has expressly emphasised the importance in relation to the history of filiation of the numerous animal hereditary relics we possess in our human vertebrate organism.

If now we survey the huge mass of facts which in this and other works Darwin has gathered together with just as much forethought as boldness to serve as a support for his ideas—if we regard the innumerable observations and experiments he has himself instituted to establish their accuracy, we cannot but wonder at the strength of the giant-mind which has amassed such an abundance of knowledge and power, of experimental knowledge and philosophical science in the narrow compass of a single human life. Involuntarily we exclaim what a rare constellation of happy circumstances there must have been to render possible such extraordinary performance conjoined with commensurate success.

We must then, undoubtedly, admit that in the case of Darwin, merit and fortune went hand in hand, and that rare favour on the part of fate made it possible for him to execute completely his great life-task. Free from all the cares and worries of a week-day existence, enjoying in security a comfortable home and a happy family life, undisturbed by professional business and official duties, he was able to devote himself throughout half a century exclusively to his favourite studies. While the solitude of his tranquil country-seat saved him from the turbulent traffic in knowledge which in large cities consumes the best powers of a man, it also supplied him with those conditions which were most favourable to the composure and harmony of his rich world of thoughts. In our opinion nothing is more prejudicial to scientific work of a deep and earnest character than the pedantic wrangling of our great universities and the partisanship of scientific colleges. From this as from all posts of honour and other such disturbing influences of the outside world Darwin his whole life long kept himself remote, and he acted wisely in so doing!

While, therefore, the great naturalist owed his unexampled success in the first place to himself and his noble endowments, some share in the credit must also be allowed to the favourable scientific situation of the time, which was furthersome in a high degree. Ever since the failure of the older nature-philosophy in the beginning of our century, since Goethe and Kant in Germany, Lamarck and Geoffroy in France, failed in their attempts to direct the minds of men to the natural development of the organic world, a strictly experimental method became the universal practice in the domain of biology. The task thus set before scientific labourers was that of the most exact investigation into all the particular forms and phenomena of animal and vegetable life; the monistic explanation of the whole, and, in particular, the solution of the problem of creation being abandoned. The foundation of embryonic history by Baer, of comparative anatomy and palæontology by Cuvier, the reform of physiology by Johannes Müller, the propounding of the theory of cells and of the doctrine of tissues by Schleiden and Schwann had opened up new and grand provinces to natural experiment, whence was drawn by numerous labourers inquisitive for knowledge an astounding abundance of facts. In the short space of half a century there arose quite a series of new sciences.

The more, however, that from year to year the number of new discoveries accumulated, the higher that the flood of literature swelled, the more confused became the chaos of the general theory of nature, and the greater was the necessity felt by thoughtful inquirers for an elevation above the stifling mass of detached observations to universal monistic points of view and to the knowledge of real causes. This requirement was now most happily met by the new doctrine of development. It is true that, as early as 1809, in the year of Darwin's birth, Lamarck had clearly demonstrated that the similarity of organic forms was to be explained by their common derivation and their diversity by their adaptation to the conditions of existence. He had, however, failed to attain a knowledge of the active causes which Darwin fifty years later disclosed in his theory of selection.

It is therefore in complete contradiction with the historical facts and a proof of utter ignorance of the history of biology, when even at the present day a few individual opponents of Darwinism declare the theory to be a vague hypothesis, in support of which evidence has yet to be adduced. In reality the very opposite is the case. The actual evidence for the common descent of the manifold forms of life had already long been adduced before it was formulated by Darwin into a clear scientific theory. Numerous physiological experiments even had long before been carried out in support of it. For the total results of our horticulture and animal rearing—and the mass of new forms of life which civilised man has artificially produced to his own profit and advantage are just so many experimental proofs of the theory of selection. And as concerns the "struggle for existence," the essential element in Darwinism, no particular arguments, in truth, are needed; for the whole history of mankind is nothing else!

Our whole science of living nature, which in one word we designate Biology, was, accordingly, perfectly prepared for the reception of the fertilising ideas of Darwin, and hence in large measure we explain their extraordinary success, in contrast with the pre-maturity and inefficacy of the similar theories of his predecessors. The high merits of these predecessors Darwin with his noble sense of justice has on all occasions recognised. It is, therefore, far from the spirit of the great master when in our day some over-zealous disciples of his (particularly in England) are intent on celebrating him as the sole founder of the new doctrine of development, as though it had all at once sprung ready-made from the head of the thinker, like Minerva armed from the forehead of Jupiter. On the contrary, we believe that we are acting perfectly in the spirit of our deceased master and friend if we here call to honourable remembrance his great predecessors. The splendour of his name can only be enhanced by showing that in the most important principles of his theory of nature he was in unison with a select number of the greatest minds the history of human civilisation can boast of.

We have to go back no less than twenty-five centuries, into the grey fore-time of classic antiquity, to come upon the first germs of a philosophy of nature, pursuing Darwin's goal with distinct consciousness; the demonstration, namely, of natural causes for the phenomena of nature, and thereby the eviction of faith in supernatural causality, of faith in miracles. The founders of the Greek philosophy of nature in the seventh and sixth century before Christ were the first who laid down this true foundation-stone of knowledge, and endeavoured to discover a natural common original basis of all things. This conscious aspiration after absolute causality, after the unifying knowledge of a common cosmic cause, appears all the more admirable that proper experimental investigation of nature was at that time quite out of the question.

Perhaps the most important among these Ionian natural philosophers was Anaximander. He assumes that out of infinity of matter through eternal revolution numerous world-bodies came into being as condensations of the air, and that the earth, too, as one of these world-bodies, issued out of a state originally fluid and afterwards aëriform. He consequently anticipated the fundamental conception, valid at this day, of the natural development of the world, which 2400 years subsequently, in 1755, our greatest German philosopher, Immanuel Kant, in his "Universal History of Nature and Theory of the Heavens," universally established. As here in the cosmological kingdom, Anaximander appears as forerunner of Kant and Laplace, so also at the same time in the biological kingdom he prophetically prefigures Lamarck and Darwin. For according to him the earliest living creatures on this globe originated in water through the operation of the sun. From these creatures, later on, were developed the land-inhabiting plants and animals which left the water and adapted themselves to life on dry land. Man, likewise, has gradually worked himself up from animal organisms, and, in reality, from fish-like aquatic animals.

If here to our surprise we find clearly enunciated some of the most important fundamental conceptions of our current theory of development, we recognise it still more distinctly in its integrity one hundred years later in Heraclites of Ephesus. He it was who first propounded the principle that a great uninterrupted process of development prevades the whole universal world, that all forms are involved in an everlasting current, and that struggle is "the father of all things." Seeing that nowhere in the world exists absolute rest, and that all standing—still is but apparent, we are compelled everywhere to assume a perpetual change of matter, a constant variation of form. That is only possible, however, through the fact that one form thrusts out the other, and that the new violently usurps the place of the old; or, in other words, through the universal "struggle for existence."

This principle of nature set forth by Heraclites that everlasting movement or the struggle among all things is the fundamental agent of the world received a much deeper interpretation a little later in Empedocles of Agrigent in Sicily. He, too, assumes an uninterrupted change of phenomena, but finds the universal fundamental cause of the everlasting universal struggle in the two counteracting principles of hate and love, or, as our modern physics expresses it, of the attraction and repulsion of parts. As the mixture of bodies is effected by love so is their separation by hate. If in the present day we regard the attraction and repulsion of atoms as the ultimate ground of all phenomena we find, then, this fundamental proposition of our modern doctrine of atoms already anticipated in Empedocles. It is however still more remarkable that Empedocles makes the purposive forms of organisms come into existence through the accidental conjunction of counteracting forces. Out of this great struggle the living forms now existing have issued victoriously because they were best prepared for the battle, and therefore most capable of life. Here we have not only the fundamental conception of Darwin's theory of selection forestalled, but also the solution of the great riddle indicated, "How can organic forms constituted for a particular purpose come into existence in a purely mechanical way without the co-operation of a final cause acting with a particular purpose?"—the same riddle the solution of which we account to be Darwin's highest philosophical merit.

Among all the great philosophers of classical antiquity, the three we have already named, Anaximander, Heraclites, and Empedocles, are undoubtedly those who have most clearly enunciated the most important elements of the monistic theory of nature now prevalent. But besides these we find other contemporaries of theirs who held similar conceptions of development, such as Thales, Anaximenes, Democritus, Aristotle, Lucretius, &c. Yet were these various attempts at a genetic theory of nature soon thrust into the background by an opposing scheme of the world, that, namely, of the "Philosophy of Ideas," which was propounded by the sophists, and had its centre in Plato.

If these fresh-minded experimentalists of Ionian philosophy sought to explain the totality of the world by natural causes through mechanical processes, the Platonic school set up, in opposition to this view, supernatural causes, in the form of teleological ideas. There thus arose a mode of thought and inquiry which, withdrawing the mind from the objective knowledge of nature, placed the subjective being of man in the forefront of our contemplations, a mode which throughout a space of more than 2000 years exercised its baleful influence in ever increasing measure. In complete contradistinction to the "Unity of Nature," everywhere demonstrated by the causality of her phenomena, there developed mightily the dualism invented by Plato, a harsh antithesis between God and world, between idea and matter, between force and stuff, between soul and body. The numerous forms of organic nature which we distinguish as animal and vegetable species no longer appear as different stages in the development of common original forms, but as embodiments of so many innate, eternal and unchangeable "ideas," as "constant species"—or, as Agassiz, Darwin's greatest opponent, expressed it, "embodied creative thoughts of God."

This Platonism found its strongest support in the dogmas of Christianity which preaching retirement from nature came into friendly agreement with the "philosophy of ideas." The accelerating decline, again of the sciences which followed the tragic destruction of noble Hellenism operated in favour of both Platonism and Christianity. Throughout the whole long spiritual night of the Christian Middle ages there was no inward impulse to a monistic theory of nature on the ground of experimental investigation. In truth, however, there were not wanting attempts in this direction on the ground of pure speculation. In particular, the Pantheistic systems of Giordano Bruno and of Benedict Spinoza in the sixteenth and seventeenth centuries are admirable essays towards a monistic and natural comprehension of nature. These Pantheistic cosmologies, however, which in all material things assume an impelling world-soul in inseparable unity, were yet especially directed on the province of ethics or practical philosophy, and lacked, alas too desperately, all experimental foundation through immediate observation of nature—for in truth there was then no such thing. The whole sense and tendency of most thinkers of that time were turned away from Nature and bent exclusively on man, who was considered to hold a position beyond and above Nature. Even those monistic systems, therefore, of Bruno and Spinoza had no power to establish themselves in the face of the all-mighty dualism which, through Platonism and Christianity, attained to universal supremacy.

Not till a long period afterwards, not till the middle of the last century, did the natural reaction against that dualistic scheme of the world finally assert itself. Then at length did man begin to turn to the true source of all knowledge, to nature herself. Especially in regard to the knowledge of animate bodies in nature, knowledge which had hitherto for two thousand years been drawn almost exclusively from the well of Aristotle, a new era of independent observation sprang up. The outward form and inward structure of plants and animals, their vital phenomena, and their development were now for the first time the subject of zealous and extensive investigation on the part of numerous naturalists. The plenitude of interesting facts which this source of natural revelation supplied could not, however, but again excite inquiry after the efficient causes, and soon the idea of natural development as an answer to the question forced its way out again.

The so-called school of the "older philosophy of nature," towards the end of the last and the beginning of the present century, first appears, simultaneously in Germany and France, as the new banner-bearer of this idea. But independently of this school, we see a number of the greatest thinkers and poets of our classical literary period moved by the same idea, above all Goethe, Lessing, Herder, Kant; later, Schelling, Oken, and Treviranus. In France, again, we notice Lamarck, Geoffroy St. Hilaire, and Blainville; in England Erasmus Darwin, the grandfather of our reformer who, in accordance with the laws of latent heredity, transmitted a whole series of characteristic intellectual qualities to his grandson. Time does not allow us to-day to follow with a view towards comparison of the different expressions of the conception of development in these eminent thinkers, and, besides, much in this respect is already universally known. We will on this occasion confine our attention to two of the most eminent minds, to Goethe and Lamarck—as in our opinion, of all Darwin's predecessors, they are the most important.

The significance of Goethe as naturalist has in our time been so often and so searchingly treated by several of our most esteemed biologists, that we may assume the most of it also to be common property. We will therefore on this occasion expound only that point which for us to-day is of quite peculiar interest, and has at the same time been very variously conceived, the question, namely, how far the general theory of nature held by our greatest poet agrees with Darwin's. In 1866 in my "General Morphology" I placed Goethe and Lamarck side by side with Darwin as the most important of the founders of the theory of filiation, and in the way of evidence had compiled from their writings a great number of specially remarkable passages. Their number has lately been increased by others. In the case, however, of a universal genius like Goethe, the question depends far less on the number and form of particular passages in which he communicates his view of the "formation and transformation of organic natures" as on the whole spirit of his grand and thoroughly monistic theory of nature, and on this subject those who have a general knowledge and comprehension of Goethe cannot now entertain any doubt. In that valuable legacy entitled "God and the World" he has left us in superabundance a collection of confessions as perfectly beautiful in their form as they are significant in their substance.

The preface to these confessions, the Proem, at once expresses the fundamental monistic thought of Goethe's general view of nature, the inseparable unity of Nature and God, in a manner which leaves us in no doubt:—

"Was wär' ein Gott, der nur von aussen stiesse,
Im Kreis das All am Finger laufen liesse!
Ihm ziemt's, die Welt im Innern zu bewegen,
Natur in Sich, Sich in Natur zu hegen,
So dass was in Ihm lebt und webt und ist,
Nie Seine Kraft, nie Seinen Geist vermisst!"[1]

Consider, in addition, the following wonderful poems: "The World-Soul," "One and All," "Legacy," "Parabase," "Epirrhema," &c.; consider, moreover, his pronounced confession to Spinoza's doctrine, and we cannot really find any essential divergence from our current monistic comprehension of the world as newly established by Darwin. And what a high value Goethe himself attaches to it is seen in his question:—

"Was kann der Mensch in Leben mehr gewinnen
Als dass sich Gott-Natur ihm offenbare,
Wie sie das Feste lässt zu Geist verrinnen,
Wie sie das Geisterzeugte fest bewahre?"[2]

That, accordingly, our great Prince of Poets considered the world only as a monistic process of development in the sense of the Hellenic philosophy of nature, is further demonstrated, among other passages, by the dialogue between Thales and Anaxagoras in the Classical Walpurgis-Night. We would also point out the emphasis with which in geology he held fast to the theory of a gradual and uninterrupted development of our planet and its mountains. From the very beginning he was the most decided opponent of the fallacy of repeated violent revolutions in our globe, a fallacy which developed itself in the beginning of our century, and through Cuvier, in particular, came to be generally accepted. "The violence and leaps in this doctrine," he said, "I cannot away with, for they are not in accordance with nature. Be the matter as it will, it must stand written, that I curse this confounded hurly-burly apparatus of the new creation of the world. And, assuredly, a talented young man will yet arise with the courage to oppose this universal craze!" Only a few years passed till this expectation was fulfilled. For in 1830 appeared Darwin's like-minded countryman, the great geologist, Charles Lyell, and delivered his continuity-theory, the doctrine which is now universally received, of the gradual and uninterrupted development of the earth from natural causes, a mechanical geological theory which, perfectly in Goethe's sense, excluded all violent revolutions of the earth from supernatural causes.

If here in the province of geology Goethe shows himself as a most decided adherent to a monistic theory of development, we find him much more so in the province of biology. For the knowledge of the living substance, this "precious, glorious thing" was truly his peculiar pet-study. Here, especially in Morphology, his "Doctrine of Forms," he has cast glances into the inner origin and birth of organic forms, glances deep and clear such as were possible only to a genius who was simultaneously thinker and artist, naturalist and philosopher.

[1] What kind of God were He who impelled things only from outside, and let the universe twirl round His finger! It seems proper to Him to move the world inwardly, to cherish nature in Himself, Himself in Nature, so that whatever lives and works and exists in Him never misses His power nor His spirit!

[2] What greater gain in life can man achieve than the revelation of God-Nature to him, the evolution of spirit from substance and the substantiation of spirit?

Among the many interesting contributions Goethe has made to morphology, the most valuable and most elaborate is the "Metamorphosis of Plants," which appeared in 1790. In this mature product of his botanical studies, which lasted throughout many years, and which most seriously engaged him during his travels in Italy, he deduces, as is well known, the whole endless wealth of forms in the vegetable world from one single protoplant, and makes all its different organs come into being through manifold transformation and process of development on the part of one single fundamental organ, the leaf. With this work occurred, in point of fact, the first attempt to refer the endless multiplicity of individual vegetable forms to one common original type.

"Alle Gestalten sind ähnlich, doch keine gleichet der andern;
Und so deutet das Chor auf ein geheimes Gesetz.[1]

This "secret law," this "sacred riddle," is the common descent of all plants from that protoplant, conjoined with the fact that the special differences are effected by the different circumstances and conditions of their existence.

As in the "Metamorphosis of Plants," so also in the "Metamorphosis of Animals," Goethe seeks, likewise, after the common prototype out of which all the allied forms have been produced through diverging development.

"Alle Glieder bilden sich aus nach ew'gen Gesetzen,
Und die seltenste Form bewahrt im Geheimen das Urbild.
Also bestimmt die Gestalt die Lebensweise des Thieres,
Und die Weise zu leben, sie wirkt auf alle Gestalten
Mächtig zurück. So zeiget sich fest die geordnete Bildung
Welche zum Wechsel sich neigt durch äusserlich wirkende Wesen."[2]

As is clearly seen in numerous other passages of his morphological studies on "Formation and Transformation of Organic Natures," that "primal form" or "type" was the inward original community which lies at the basis of all organic forms and the original formation-tendency which is transmitted by inheritance. On the other hand, the "unrestrainable progressive transformation which arises from the necessary conditions and relations of the external world," is nothing else than *Adaptation* to outward conditions of existence. This latter is the centrifugal formative-energy of "Metamorphosis"; the former, again, is the centripetal formative-energy of "Specification." The clear knowledge of these two formative-energies, counteracting and balancing each other, was so highly prized by the poet that he enthusiastically extols it as the "highest thought to which creative nature soared."

The province in animal morphology to which Goethe applied himself with peculiar predilection was comparative osteology, the skeleton-theory of vertebrates. The reason for this is to be found in the fact that nowhere perhaps to such a degree as here does the operation of that highest nature-conception of manifold development out of one single typical fundamental form meet us with such all convincing force. Down to the present day, consequently, the comparative skeleton-doctrine has remained the special favourite of morphologists. While in this province Goethe demonstrated the unity of the vertebral formation in the different divisions of vertebrates, and while in his celebrated skull-theory he further showed that the skull was composed of a series of transformed vertebræ, he arrived in 1796 at the following remarkable utterance: "So much then have we attained as to be able to assert without any misgiving that all the more perfect organic natures—under which we imply fishes, amphibious animals, birds and *mammals with man at their head*—have all been formed after one original image, which in its highly persistent parts only deviates more or less here and there, and yet daily by propagation transforms and perfects itself."

Some of our opponents have raised the objection that these and similar passages of Goethe are no "scientific truths," but only poetical or rhetorical flourishes and images; the type he meant was only an "ideal pro-type," no real genealogical form. It appears to us that this objection betrays little understanding of the greatest German genius. He who is acquainted with Goethe's thoroughly objective mode of thought, who appreciates his thoroughly living and realistic view of nature, will, with us, entertain no doubt that under that "type" was intended a perfectly real descent of kindred organisms from a common genealogical form. That the great understander of man did not thereby exclude man

[1] All forms are similar, yet no one exactly the same as the other; and so the chorus points to a secret law.

[2] All members work themselves up according to everlasting laws, and the rarest form preserves in secret the primitive type. The form, therefore, determines the animal's mode of life, while, reciprocally, the mode of life reacts powerfully on all form. Thus the regulated structure firmly maintains to itself whilst yielding to change through the action of outward substances.

from the development series of the other vertebrates is indicated with special clearness in his comparison of the human skull with that of lower mammals. He here expressly points out several places in the human skull as remains of the animal skull "which are found in stronger proportions in such a low organisation, but have not quite disappeared in man, in spite of his elevation."

No less does his celebrated discovery of the intra-maxillary bone testify to the same conviction. Man, like the other mammals, having cutting teeth must also, Goethe concluded, possess the intra-maxillary bone which showed itself in the other mammals; and in point of fact after the most careful anatomical investigations he established his point, although it had been disputed by the highest anatomical authorities.

Highly remarkable, moreover, in this respect is the agreement Goethe expresses with the kindred view of Kant in his "Critique of the Faculty of Judgment," a work the "great main thoughts of which were entirely analogous with his own work, action, and thought hitherto." The great Königsberg philosopher had enunciated the descent of all organic beings from a common original mother (from man down to polyp) as a hypothesis which "alone was in harmony with the principle of the *Mechanism of Nature, without which a Science of Nature was altogether impossible.*" This theory of descent, however, he had at the same time called "a daring adventure of reason." In reference to this passage Goethe remarks: "Had I first unconsciously and in obedience to inward impulse restlessly pressed forward in the direction of that Original Form, that Type—had I even succeeded in building up a scheme conformable with Nature; now at length could nothing hinder me from *boldly maintaining* the *Adventure of Reason*, as the sire of Königsberg calls it."

Finally, nothing can more strongly show the extraordinary interest with which Goethe followed this transformation-theory, down to the end of his life, than the well-known attention he gave to the dispute between Geoffroy St. Hilaire and Cuvier. "This event is for me of altogether incredible importance," exclaims the grey-headed old man of eighty-one years, with youthful fire, "and I have a right to jubilate over the universal victory, at last witnessed, of a cause *to which I have devoted my whole life*, and which, too, is mine in a quite especial manner." The vivid representations of this most significant dispute, completed by Goethe in March, 1832, just a few days before his death, is the last literary legacy the greatest poet and thinker of the German nation has left behind him; and to this great intellectual contention also his last word applies, "more light."

It is deeply to be regretted that the "Philosophie Zoologique," by Lamarck, a work of the highest moment which appeared in 1809, was wholly unknown to Goethe. For just in the development theory of this work, which is quite differently arranged and strictly systematically composed, he would have found much that was wanting to himself, much that would have yielded him the most complete supplement for his own incomplete studies. In reference as much to the monistic and complete elaboration of the development theory as to the many-sided experimental establishment of it on fact, the great work of Jean Lamarck is much more important than the similar essays of all his contemporaries, more particularly of the like-named work of Geoffroy St. Hilaire. When one considers with what extraordinary interest Goethe took up the latter work, it may be concluded that he would have given a much warmer reception still to the rich-thoughted work of Lamarck.

We cannot but regard it as a truly tragic fact, that the "Philosophie Zoologique" by Lamarck, one of the greatest productions of the great literary period in the beginning of our century, met, from its outset, with but extremely little attention, and in the course of a few years was utterly forgotten. Not till Darwin fifty years later on breathed new life into the Transformation theory therein established, was the buried treasure again brought into the light of day, and we cannot now but describe it as the completest representation of the theory of development prior to the time of Darwin. Nay, it seems to us the necessary atonement of a great historical injustice, if again to day (as was done sixteen years ago in the "General Morphology"), we place the great Frenchman side by side with the greater Briton and the greatest German. Each of the three great middle—European nations of culture has in the course of a century presented mankind with an intellectual giant of the first rank, who grasped in its entire significance the fundamental conception of the monistic development of the world from natural causes.

It would carry us much too far were we here to attempt setting forth an abstract of Lamarck's work and comparing it with Darwin's. It will suffice to cite some of the weightiest fundamental conceptions which characterise his theory of nature, and indicate how far he was in advance of his time. For many decades the great French biologist had occupied himself very searchingly with systematic botany and zoology. Testimony of this we have in his two celebrated and much used special works, the "Flore française," and the "Histoire naturelle des animaux sans vertèbres." While he was engaged in substantially classifying and describing not merely the forms already in existence, but also their extinct ancestors which he incorporated into his system, there was disclosed to him the inner morphologic connection between the former and the latter, and from this disclosure he inferred their common descent. All animal and vegetable forms which we distinguish as species, possess, accordingly, but a relative temporary persistence, and the varieties are the beginnings of species. The form-group of the species is, therefore, just as artificial a product of our analytic understanding as is the genus, the order, the class, and every other category of the system. The change in the conditions of life, on one hand, the employment or non-employment of the organs, on the other, exercise a constantly transforming influence on the organisms; they effect by means of adaptation a gradual transformation of forms, the fundamental lineaments of which are through inheritance transmitted from generation to generation. The whole system of animals and plants is in reality, therefore, their genealogical tree, and portrays to us the relations of their blood-kindredship. The course of development of life on our globe was, accordingly, continuous and uninterrupted, just as was the course of development of the earth itself.

While Lamarck thus clearly enunciates all the essential fundamental conceptions of our current doctrine of filiation, and by the depth of his morphological knowledge excites our admiration, the clear advanced outlooks he takes in his conceptions of physiology are no less surprising. While in his time the fallacy of a supernatural vital force was yet universally prevalent, Lamarck rejected that idea, and maintained that life was only a very complicated physical phenomenon. For all vital phenomena are based on mechanical processes which are themselves conditioned by the constitution of organic matter. The phenomena of soul-life (*Seelenlebens*) are also, in this respect, not different from other vital phenomena. For the ideas and activities of the understanding are based on motional processes in the central nerve-system; the will in truth is never free, and reason is only a higher degree of development and combination of the elements.

In these and other propositions Lamarck raises himself far above the general theory of nature held by most of his contemporaries, and sketches a programme of future biology which only in our days has come to be carried out. In view of the great clearness and consistency of his system it is only a matter of course that he should assign to man his natural place at the head of the vertebrates, and explain the causes of his transformation out of ape-like mammals. With equal acumen, however, he handles one of the darkest and most difficult questions of the whole theory of development, the question regarding the origin of the first living beings on our globe. For the answering of this question he assumes that the common earliest genealogical forms of all organisms were absolutely simple beings, and that they came into existence immediately out of inorganic matter in water by *Spontaneous generation*, through the combined effect of different physical causes. Such simplest organisms, however, were at that time not yet at all discovered; not till half a century afterwards were they actually come upon in the Monera.

Lamarck reached the great age of eighty-five years; consequently he lived two years longer than Goethe, and twelve years longer than Darwin. But while the two latter enjoyed the happiness of beholding the long beautiful evening of their life glorified by a sun-like splendour of success and worldly fame, poor Lamarck closed his long and laborious life misunderstood, solitary and needy. Ten years before his death he suffered the misfortune of blindness, and could only from memory dictate the last part of his great natural history of invertebrate animals to his two daughters who tenderly nursed him, and whom he left behind him without any means of support. Let us hope that the bitterness of his hard fate was qualified by the consciousness of his having cast the deepest glances into the mysteries of creative nature, and that the clear intellectual eye of the blind prophet often descried the laurel garland which thankful posterity would one day lay on his lonely grave.

Unquestionably the greatest defect in Lamarck's work was the insufficiency of the stock of observations and experiments he brought forward in proof of his far-reaching principles. For then, as now, the great majority of naturalists want, above everything, to have palpable facts in the hand. Then as now we find the paradoxical phenomenon, that the great majority of people accept without any misgiving and trample under foot the most absurd hypotheses and dogmas, while on the other hand they encounter well-founded scientific theories with the more suspicion and opposition the more they approach the truth. Among the experimental proofs of theories, moreover, to most people those are not the most welcome which are furnished by a continuous series of phenomena and a whole large class of facts. What they most desire is the particular observation, the single experiment. A large part of Darwin's immense success is due to the fact that he brought into the field to a truly overwhelming amount exactly such particular pertinent observations and experiments. Poor Lamarck on the contrary, trusting to the logical conclusion-drawing faculty of naturalists, for the most part neglected the business of palpable particulars.

The comparison of these three great natural philosophers in whom the foundation-laying development theory of our current natural science was most powerfully and comprehensively revealed is of high interest, for all three are very different among themselves both in respect of their general genius and the fortunes of their life outwardly and inwardly, as also, very especially, in respect of their courses of study and the ways by which they pursued their high aims. Lamarck starts from the most careful special studies of individual animal and vegetable forms, and by his many years' systematic examination and comparison of them is brought to the conviction that all living and fossil species have developed themselves out of a few simple common geneological forms. Goethe arrives at the same conclusion on the ground of his general studies in comparative morphology, directed by the conviction that the unity of the common type or the hereditary protoform can be traced out, everywhere in all the different organic forms, however manifoldly they may be transformed in individuals through adaptation to outward circumstances. Darwin, finally, first answers to his own satisfaction the question by what causes the new culture-forms of animals and plants reared by men come into being, and then demonstrates that the struggle for existence is the same cause which in like manner by the inter-action of adaptation and inheritance constantly produces new organic species in the free state of nature.

In these wholly different ways and by application of wholly different methods of investigation, all these three naturalists arrive ultimately at the same conclusion—to the acceptance, namely, of a monistic and continuous development of the whole of organic nature, through the operation alone of natural causes, to the exclusion of all supernatural creative miracles. All three, however, being at the same time deep-thinking philosophers and keeping constantly in their eye the unity of the whole world of phenomena, their idea of development expands to a grand pantheistic conception of the world, to that doctrine of oneness which forms the essence of our current monistic theory of nature.

The immeasurable effect which the decided triumph of this monistic view of nature already in this day exercises on all provinces of human knowledge, an effect increasing in geometrical progression from year to year, opens to us the happiest prospect regarding the further intellectual and moral development of mankind. I repeat here my firm personal conviction that in future this progress of scientific knowledge will be esteemed the greatest turning-point in the intellectual history of man.

We would in a quite especial manner emphasise this reconciling and compensating influence of our genetic theory of nature, all the more that our opponents are constantly endeavouring to obtrude disruptive and decomposing tendencies on it. These destructive tendencies are said to be directed not merely against science, but against religion and so against the most important foundations, in general, of our civilised life. Such grievous charges, so far as they really rest on conviction and not merely on sophistic fallacies, can be explained only by the fact of a mischievous misunderstanding of what forms the genuine kernel of true religion. This kernel does not consist in the special form of one's confession of faith, but rather in the critical conviction of an unknowable, common, ultimate ground of all things and in practical ethics springing immediately from the purified theory of nature.

In this confession, that with the present organisation of our brain the last ultimate ground of all phenomena is unknowable, the critical philosophy of nature comes athwart dogmatic religion. This faith in God, however, of course, assumes, endlessly different forms of confession according to the endlessly different degrees of the knowledge of nature. The further advances we make in the latter—the more we approach that unattainable ultimate ground—the purer will be our idea of God.

The purified knowledge of the world in the present day knows that natural revelation alone which in the book of nature lies open to every one and which every unprejudiced man with sound senses and sound reason can learn out of it. From this is derived that purest monistic form of faith which attains its climax in the conviction of the *unity of God and Nature* and which has long ago found its most complete expression in the confessions of our greatest poets and thinkers, Goethe and Lessing at their head. That Charles Darwin, too, was penetrated by this religion of nature, and did not acknowledge a particular church-confession is patent to every man who knows his works. . . .

Only in law-regulated society can man acquire the true and full culture of the higher human life. That, however, is only possible when the natural instinct of self-preservation, Egoism, is restricted and corrected by consideration for society, by Altruism. The higher man raises himself on the ladder of culture, the greater are the sacrifices which he must make to society, for the interests of the latter shape themselves evermore to the advantage of the individual at the same time; just as, reversely, the regulated community thrives the better the more the wants of its members are satisfied. It is therefore quite a simple necessity which elevates a sound equilibrium between Egoism and Altruism into the first requirement of natural ethics.

The greatest enemies of mankind have ever been, down to the present day, ignorance and superstition; their greatest benefactors, on the other hand, the lofty intellectual heroes who with the sword of their free spirit have valiantly contended with those enemies. Among these venerable intellectual warriors stand at the head, Darwin, Goethe, and Lamarck, in a line with Newton, Keppler, and Copernicus. These great thinkers of nature by devoting their rich intellectual gifts, in the teeth of all opposition, to the discovery of the most sublime natural truths, have become trne saviours of needy mankind, and possess a far higher degree of Christian love than the Scribes and Pharisees who are always bearing this phrase in their mouth and the opposite in their heart.

How little, on the other hand, blind belief in miracles and the domination of orthodoxy is in a position to manifest true philanthropy is sufficiently testified not only by the whole history of the middle ages but also by the intolerant and fanatic procedure of the militant church in our days. Or must we not look with deep shame on those orthodox Christians who, in our day, again express their Christian love by the persecution of those of other faith and by blind hatred of race? And here in Eisenach, the sacred place where Martin Luther delivered us from the gloomy ban of adherence to the letter, did not a troop of so-called Lutherans venture some years ago to try anew to bend science under that yoke?

Against this presumption on the part of a tyrannical and selfish priesthood it will to-day be permitted us to protest on the same spot where 360 years ago the great Reformer of the church kindled the light of free inquiry. As true *Protestants* we shall rise up against every attempt to force independent reason again under the yoke of superstition, no matter whether the attempt be made by a church sect or a pathologic spiritism.

Happily we are entitled to regard these mediæval relapses as but transitory aberrations which will have no abiding effect. The immeasurable practical importance of the natural sciences for our modern culture-life is now so generally recognised that no section of it can any longer dispense with it. No power in the world is able again to roll backwards the immense progress to which we owe our railways and steamers, telegraphy and photography, and the thousand indispensable discoveries of physics and chemistry.

Just as little, too, will any power in the world succeed in destroying the theoretic achievements which are inseparably bound up with those practical successes of modern science. Among those theories we must assign the first place to the development doctrine of Lamarck, Goethe, and Darwin. For by it alone are we authorised firmly to establish that comprehensive *oneness of our theory of Nature* in which every phenomenon appears as but efflux of one and the same all-comprehensive law of nature. The great law of the conservation of force thereby finds its universal application, embracing also those biological provinces which hitherto appeared closed to it.

In face of the surprising velocity with which in these last years the development theory has paved an entrance into the most diverse departments of inquiry we may here express the hope that its high pedagogic value also will be even more recognised, and that it will quite perfect the education of the coming generations. When five years ago, at the fiftieth Meeting of Naturalists in Munich, I laid stress on the high significance of the development theory in relation to education, my remarks were so misunderstood that a few words of explanation may here be allowed me. It stands to reason that with these words I could not mean to claim that Darwinism should be taught in elementary schools. That is simply impossible. For just like the higher mathematics and physics, or the history of philosophy, Darwinism demands a mass of previous knowledge which can be acquired only in the higher stages of learning. Assuredly, however, we may demand that all subjects of education be treated according to the *genetic method*, and that the fundamental idea of the development-theory, the *Causality of Phenomena*, find everywhere its acknowledgment. We are firmly persuaded that by this means, thinking and judging conformably with nature will be promoted in far greater measure than by any other method.

At the same time through this extended application of the development-doctrine, one of the greatest evils of our day in the culture of youth will be removed—the cramming of the memory, we mean, with dead lumber, which smothers the best powers and prevents both soul and body from coming to a normal development. This excessive cramming is based on the old fundamental ineradicable error that the *quantity* of *factual knowledge* is the best measure of culture, while, in truth, culture depends on the *quality* of causative *science*. We would therefore deem it especially useful that the selection of the material of instruction be much more carefully made, and that in making the selection, those departments which cram the memory with masses of dead facts do not receive the preference, but those which cultivate the judgment through the living stream of the development idea. Let our worried school youth only learn half as much, but let them understand this half more thoroughly, and the next generation will in soul and body be doubly as sound as the present.

In the most gladdening manner these requirements are being met by the reforms which are simultaneously in process of accomplishment in the most diverse provinces of science. Everywhere is stirring and moving fresh young life, stimulated by the idea of natural development—in the Comparative Study of Languages and in the History of Culture, as also in Psychology and Philosophy; in Ethnography and Anthropology no less than in botany and zoology. Everywhere the most joyful blossoms are bursting forth from the most varied branches of science, and its fruits will concurrently testify that they all spring from one single tree of knowledge and draw their nourishment from one single root. Thanks and honour, however, to the great masters who by their genetic and monistic theory of nature have led us to this clear height of knowledge from which with Goethe we may say:

> "Dieser schöne Begriff von Macht und Schranken, von Willkür
> Und Gesetz, von Freiheit und Mass, von beweglicher Ordnung
> Vorzug und Mangel, erfreue dich hoch; die heilige Muse
> Bringt harmonisch ihn dir, mit sanftem Zwange belehrend.
> Keinen höhern Begriff erringt der sittliche Denker,
> Keinen der thätige Mann, der dichtende Künstler; der Herrscher,
> Der verdient es zu sein, erfreut nur durch ihn sich der Krone.
> Freue dich höchstes Geschöpf der Natur, du fühlest dich fähig,
> Ihr den höchsten Gedanken, zu dem sie schaffend sich aufschwang
> Nachzudenken. Hier stehe nun still und wende die Blicke
> Ruckwärts, prüfe, vergleiche und nimm vom Munde der Muse,
> Dass du schauest, nicht schwärmst, die liebliche volle Gewissheit." [1]

OUR ASTRONOMICAL COLUMN

THE BINARY STAR 70 OPHIUCHI.—This star has received even more than a fair share of attention at the hands both of observers and computers, but there remain notwithstanding large outstanding differences between observation and calculation. As regards the orbit a very complete discussion of all the reliable measures to 1868, was made by Dr. Schur of Strasburg, while with eight years later measures, the elements were rigorously investigated by M. Tisserand in a memoir published by the Academy of Sciences of Toulouse. If Dr. Doberck in the course of his skilful and elaborate researches on the motion of the binaries has given attention to this star, his results have escaped our notice, but we subjoin the orbits deduced by Dr. Schur and M. Tisserand:—

	SCHUR.	TISSERAND.
Periastron passage ...	1808·791	1809·664
Node	125° 22′	127° 22′
Node to periastron ...	155° 44′	149° 44′
Inclination	57° 56′	60° 0′
Excentricity	0·49149	0·47287
Semi-axis major	4″·704	4″·770
Period of revolution ...	94·370 years ...	... 94·929 years.

In 1879 the star was measured by Prof. Asaph Hall on five nights with the 26-inch refractor at Washington, generally under a magnifying power of 600; his epoch is—

1879·588 ... Position, 71°·32 ... Distance, 2″·930

Comparing with Schur's elements we find—

$$dP\,(c-o) = +\,5^{\circ}{\cdot}61 \quad \ldots \quad \ldots \quad dD = +\,0''{\cdot}726$$

While the errors of Tisserand's orbit are—

$$dP = +\,3^{\circ}{\cdot}01 \quad \ldots \quad \ldots \quad \ldots \quad dD = +\,0''{\cdot}497$$

The question naturally arises, how is it that after the most careful and complete determination of the orbit, it happens that in so short a time after the date of the latest measures employed in the calculations, the star appears to *bolt*, so to say, from its predicted course.

There have been suspicions from time to time that perturbation is indicated by the apparently anomalous differences between observation and computation. Mädler, discussing the elements of the orbit in 1842, when truly he had but a very limited and comparatively imperfect series of measures at his command to what we can now utilise, went so far as to doubt the efficiency of the theory of gravitation to explain the motion of the components of this double star, or at least he considered the question reduced to one of two alternatives, which he thus presents:—

(1) "The motion in this binary system does not follow the Newtonian law."

Or (2) "The middle point of the images which the stars form to us is not the centre of gravity of the masses."

And he recommended the star to close scrutiny with the most powerful instruments, with the view to ascertain whether there were any visible disturbing body.

The existence of a third star was suggested by Jacob, to explain similar anomalies which he believed to have been indicated by the measures, but Mr. Burnham, in 1878, examined 70 Ophiuchi with the 18½-inch Alvan Clarke refractor at Chicago with only negative evidence: "Both stars were perfectly round, with the highest powers on this occasion, . . . and no trace of any third star near." Such had also been his previous experience.

It thus becomes all the the more desirable to ascertain how far the suspected deviations from unperturbed motion may exist in the observations themselves, and more attention might perhaps be given with advantage to the investigation of personal equation between the various observers, the elimination of the effect of obliquity of direction of the components, or other cause which could possibly affect the comparison of the separate results. The evidence that such influences exist is pretty evident in the case of this particular star. For instance if we compare the above orbits with an epoch, only one year later than that of Prof. Hall, viz., Jedrzejewicz's for 1880·656, giving the position 62°·82, distance 2″·75, we get the following differences between calculation and observation:—

In Schur's orbit ... ... $dP = +10^{\circ}{\cdot}81$ ... $dD = +0''{\cdot}72$
In Tisserand's orbit ... $dP = +\;7^{\circ}{\cdot}88$ ... $dD = +0''{\cdot}51$

Exhibiting an increase of errors in the course of a year which cannot be wholly attributed to errors of elements depending upon a long course of measures.

Another circumstance connected with 70 Ophiuchi, which is attended with some difficulty of explanation, may be mentioned here. Prof. Hall, in addition to measuring the principal com-

[1] This fair idea of might and limit, of will and law, of freedom and measure, of order in movement, of excellence and defect, gladden thee deeply; the holy Muse brings it harmoniously to thee, instructing thee with generous constraint. No higher idea achieves the moral thinker, no higher the active man, the creative artist; the regent worthy to rule finds happiness in his crown through this idea alone. Rejoice, oh highest creature of Nature, that thou feelest thyself able to think after Nature the highest thought to which the creatively soared. Here now stand still, and turn thy looks backwards, examine, compare, and hear the words of the Muse, that without illusion thou mayest contemplate the full, lovely truth.

panion in 1878, also measured two small neighbouring stars which he estimated of "about the 13th mag." with these results—

(a) 1878·842	...	Position 49°·59	...	Distance 87″·209
(b) 1878·842	...	„ 197·85	...	„ 71·384

Secchi, in *Memorie dell' Osservatorio del Collegio Romano*, 1859, p. 119, publishes measures of "70 *p* Ofiuco preso colla più vicina," thus:—

1856·627	...	215°·08	...	87″·574	(4)	...	11m.
1856·627	...	67·2	...	... ...	(4)	...	12m.

The proper motion of 70 Ophiuchi by comparison of Bradley with the Greenwich catalogue of 1872, appears to be +0″·2014 in right ascension, and −1″·1170 in declination, and transferring with the aid of these values Hall's angles and distances to Secchi's epoch, we find:—

(a)	...	1856·627	...	190°·63	...	94″·38
(b)	...	1856·627	...	65·89	...	77·65

It can hardly be doubted that Secchi's stars are identical with Hall's, but the difference in both position and distance of the star (*a*) seems to merit further examination; if there be no error in Secchi's measures proper motion of the thirteenth magnitude, as Hall estimated it, is probable.

Smyth refers somewhat vaguely to two small companions of 70 Ophiuchi; at his first date the Washington measures carried back as above would give:—

(a)	...	1830·76	...	87°·9	...	76″·1
(b)	...	1830·76	...	185·7	...	122·3

THE GREAT COMET OF 1874.—Mr. T. W. Backhouse writes from Sunderland, pointing out that the tail of this comet attained a much greater length than was assigned in this column, p. 483. The length there mentioned 23°, was that given by observation in the suburbs of London on July 13, when the head of the comet was about to descend below the horizon. On the same evening Mr. Backhouse found the tail 26° long, and 35° on the 14th, and he refers to greater lengths subsequently noted. These, however, refer to dates when the head was no longer visible in these latitudes, Prof. Julius Schmidt gave the following estimations made at Athens:—

July 16 ... 47°·2	July 18 ... 55°·9	July 21 ... 65°·8
17 ... 54·0	20 ... 63·3	22 ... 64·6

These, with other observations, will be found in his description of the appearance of the comet, in No. 2067 of the *Astronomische Nachrichten*.

BIOLOGICAL NOTES

COLOSSAL CUTTLE-FISH.—Mr. T. W. Kirk adds to our rapidly-increasing knowledge of large cuttle-fish in an important paper lately published (*Trans.* New Zealand Institut. vol. xiv). One species referred by him to Steenstrup's genus Architeuthis, and called *A. verrilli*, was found stranded at Island Bay, Cook's Strait, New Zealand, in June, 1880. When first found on the beach, it was not quite dead; the longer arms measured twenty-five feet; the blades had a row of fifteen suckers along each side and a middle row of nineteen. The smaller arms were about eleven feet nine inches, with a width of seven and a half inches. They were furnished with suckers and fleshy tubercles, but these shorter arms were of unequal length. The fleshy membrane connecting these was about eleven inches deep. The head was four feet three inches in circumference, the eyes five inches by four; the body was seven feet six inches in length, and nine feet two inches in its greatest circumference. While this large cuttle differs in some respects from the type of Steenstrup's genus, Mr. Kirk prefers to wait for fresh material ere creating a new genus. Another large cuttle is referred to a new genus, Steenstrupia, but its long pair of arms had been torn off at a length of six feet two inches, when it was found in Cook's Straits; its body was long (nine feet two inches), almost cylindrical, but very slightly swollen in the middle, head long (one foot eleven inches), narrow sides, nearly straight, eyes larger, and with lids, sessile arms, all same length and size (four feet three inches), suckers, thirty-six on each arm, in two equal rows, each with a bony ring armed with from forty to sixty sharp incurved teeth. The fin was rhomboidal, posterior lateral. The internal shell was six feet three inches long. The new species is called *S. stockii*.

JAPANESE COTTON.—The Japanese Government have lately presented to the National Museum of the United States an interesting collection of cotton grown in Japan, accompanying the donation with notes on the specimens, from which we extract the following:—Cotton is produced along the coasts of the districts Kinai, Kanto, Chiugoku, and Kiushiu, where the soil is sandy and the climate warm. In some of the north-eastern parts, where there are early frosts, the attempt to cultivate cotton is rarely made. It is uncertain when the cultivation of cotton in the Japanese empire first commenced, but it would appear that the method of culture adopted in the western provinces came from Kinai, though the seeds grown in the eastern provinces came from Mikawa. In the province of Settsu the crop is the largest, indeed is not surpassed by that of all the other provinces, but the cost of cultivation is high. The staple, moreover, is rather short and hard, so as not to be suitable for very fine yarns. In recent years, however, cotton yarns are imported on a large scale, and fine yarns are easily procured; so the home-produced cotton is profitable in proportion to its yield. This will account for the fact that the cultivation of the long and soft staple is quickly passing away, and that it is becoming the almost universal custom to grow only that seed which will produce a maximum yield. While cotton plants have different names in the different provinces, it is believed that there are but three sorts—the Kanto, which produces a long, soft, and strong staple of glossy appearance, from half to two-thirds of an inch in length, the Kinai, with a hard and short staple, from a quarter to half an inch in length, and rather destitute of glossiness, and the Ainoko, which is a hybrid between the two former. The cultivation of the cotton-plant in Japan is not uniform, varying immensely according to not only the climates and soils, but also according to the customs of each district, but it is to be expected that with the advance of time the mode of culture may become more uniform, and that excellence in quality may even take the place of a maximum in quantity.

AMERICAN WOODCOCK CARRYING ITS YOUNG.—Whilst it is still somewhat uncertain whether the woodcock (*Scolopax rusticula*, Linn.) of Europe carries its young in its claws or between its legs, we believe this habit has, though referred to by Audubon, not been recently observed in the American woodcock (*Phitohelia minor*). It is, therefore, interesting to note the following observations of Mr. F. L. Harvey, of Arkansas. In April last (1882) a woodcock was flushed from a clump of persimmion trees on the border of a slash. Knowing the bird's habit of rising above a clump of bushes and then suddenly dropping behind it out of range, Mr. Harvey fired as soon as it rose. When the smoke cleared away the bird was seen rising with a laboured flight, and concluding it was wounded its fall was expected, but instead it turned and came nearer. It was seen to be holding something between its feet, which on closer observation proved to be a young chicken recently hatched, which was located between the mother's legs, and supported by her feet placed on its sides. So slow was the flight that by a brisk trot the observer was able to gain on the bird, which he tried to tire out so as to compel it to drop its burden, but in this he was not successful. It would appear that this bird and Wilson's snipe often remain in Arkansas to breed (*American Naturalist*, September).

BLIND SUBTERRANEAN CRUSTACEA IN NEW ZEALAND.—The existence of blind Edriophthalmatous Crustacea in wells and subterranean cave rivers in Europe has been long known, and now Mr. C. Chilton describes some quite new forms found in New Zealand (*Trans.* New Zealand Institute, vol. xiv.). They were obtained from a well at Eyreton, about six miles from Kaiapoi, North Canterbury; the well had been excavated about seventeen years previously, was not more than twenty-five feet deep, and was fitted with a common suction-pump through the medium of which these new forms were obtained. These proved to be three species of Amphipoda and one of Isopoda. In none were there to be found in either the living or recent specimens the least trace of eyes. The Isopod is referred to a new genus Cruregens, and is most remarkable from the fact that it has only six pairs of appendages to the seven thoracic segments, whilst the normal number should be seven. In many Isopods the young have at first only six pairs of legs, the last thoracic segment being but slightly developed and destitute of appendages (Fritz Müller, "Facts and Arguments for Darwin"), and hence at first sight it might appear that the new form was but an immature state. Mr. Chilton, however, states that he has examined altogether twenty live specimens, none of which seemed otherwise to have anything immature about them, and these were obtained at various times from January to October, 1881, he would, therefore, refer the absence of the seventh pair of appendages to an arrest of development. In some respects the new genus resembles Paranthura of Spence Bate. The new species is called *C. fontanus*. The Amphipods found with this Isopod are *Cragonyx compactus*, sp. nov., *Calliope subterranea*, sp. nov., and *Gammarus fragilis*, sp. nov., all without eyes. The new species are all figured, and at great length described.

GEOGRAPHICAL NOTES

MR. STANLEY has returned to Europe, after an absence of between three and four years, during most of which time he has been on the Lower Congo. From the station which he established at Vivi, below the Yellala Falls, his object was to make a road past the long line of cataracts, about 150 miles, to Stanley Pool. Much of the road has, we understand, been constructed, and five stations have been established. Mr. Stanley himself has been 300 miles into the interior, with what results to science remains to be seen. Meantime the French are diligently exploring the region lying between the Lower Congo and the Ogové, and have already done much to clear up its hydrography.

BARON NORDENSKJÖLD has under consideration an expedition to the Arctic next summer, and is engaged, in company with Mr. William Schönlanck, of Berlin, a gentlemen much interested in geographical discovery, who is at present visiting Stockholm, as to the detailed arrangements of the same.

THE Swedish Geological Expedition returned from Spitzbergen to Tromsö in the yacht *Bojna* on the 16th inst. It was found impossible to land at Beeren Island, as intended, owing to tremendous seas.

WE regret to hear of the death of Mr. Krarup Smith, who has, since 1867, been Inspector of the Northern Districts in Danish Greenland. During the past winter he suffered from constant sleeplessness, and he expired somewhat suddenly on May 28, aged forty-nine. Every traveller who has passed any time at Godhavn during the last fifteen years has spoken of the kindness and attention of Mr. Smith and his wife. He rendered important services to various Arctic expeditions, and freely placed his house and resources at the disposal of scientific workers—Nares, Markham, Hayes, Pavy, Whymper, Nordenskjöld, Steenstrup, and many others of various nationalities have experienced their hospitality or received their assistance. Although Inspector Smith was not of a robust constitution, he travelled extensively by boat and sledge in summer and winter throughout the Inspectorate, which extends over more than five degrees of latitude, and took much interest in the welfare of the natives, who sustain a real loss by his lamented death.

THE range of the changes of level in the rivers of Russia in Europe has become, since 1876, the subject of accurate measurements, and M. Tillo has just published in the Russian Nautical Review (*Morskoy Sbornik*) an interesting paper on this subject, being the result of measurements made at eighty different places. The highest range is reached by the Oka at Kaluga, the difference between the highest and lowest levels being as much as 45 feet; the average range for the same river from its source to its mouth being 32·2 feet; the average for the Volga from its source to its mouth is 33·6 feet, 30·1 feet for the Kama, 25·2 for the Duna, and 23·1 for the Don. For all other rivers the range is less than 20 feet. Of course this range diminishes very much towards the mouth of each river; but still it reaches 12 feet for the Volga at Astrakhan, and 9 feet for the Duna at Riga. The highest range observed in the lakes of Northern Russia was only 2·1 feet. A map prepared by M. Tillo shows the distribution of hydrometrical stations on Russian rivers, their numbers having been increased in 1880 to 341 stations.

WE regret to learn that the *Neptune*, which was chartered by the American Government to take supplies to the Greely Scientific Expedition, in Lady Franklin Bay, in 81° N., has returned to St. John's, Newfoundland, and reports being unable to get further north than 79°20, owing to an impenetrable barrier of ice. She, however, landed supplies at several ports. From the precautions which have been taken there is, we believe, no danger of the U.S. Polar observing party being in straits for want of food. The fact of the *Neptune* being unable to get north, combined with the news of the early imprisonment of Lieut. Hovgaard's expedition on the coast of Novaya Zemlya, seems to indicate an exceptionally early and severe Arctic winter.

IN the last number (fasc. 3 tome 7) of the *Bulletin* of the Antwerp Geographical Society will be found an interesting discussion on the subject of geographical orthography, and the preparation of maps generally. The president took objection to the distinction made by the Commission to consider the subject between scientific maps and maps for common use. He recognised, he said, only one kind of maps, and that was *good maps*, which indeed might be made to bring into prominence certain features for special purposes. All maps should be constructed on rigidly scientific principles, most of all those for common and school use.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

AT King's College, London, Prof. W. Grylls Adams, F.R.S., will deliver a course of lectures on Electricity during the ensuing session. A course of practical work in electrical testing and measurement with especial reference to electrical engineering will also be carried on under his direction in the Wheatstone Laboratory. The lectures will be given once a week on Thursday, at 2 p.m., and the laboratory will be open daily (Saturday excepted) from 1 to 4.

AT Owens College Prof. Arthur Schuster, assisted by Mr. W. Haldane Gee, will give a theoretical and practical course on the modern applications of electricity one evening a week during next winter. Beginning with the ordinary electrical measurements it is intended to include the usual tests of terrestrial and submarine telegraphy, the construction of telephones, electro-dynamo machines, and all measurements connected with electric lighting.

THE Calendar of Yorkshire College for the ninth Session has just been issued. In addition to the usual information, we note that Prof. Rucker, who has secured a new assistant-lecturer in the person of Mr. C. Spurge, B.A., of Cambridge, proposes some additional work in his Senior Mathematical Class, and, what is of more importance, to add a Third Year Course in the department of Physics. The lectures and laboratories in the Chemical, Geological, and Biological departments, under Professors Thorpe, Green, and Miall respectively, as well as the classes generally, are to be continued as in last session. In the Textile Industries Department Mr. Beaumont has added a third year's course for such of his students as require it. In the Coal-Mining Department the recent alterations in the curriculum will come into full operation at the beginning of this next session. The course is in future to occupy two years, and will include lectures by the Professors of Chemistry and Geology, as well as instruction in practical coal-mining by Mr. A. Lupton. A boon to science teachers has been granted in the shape of Assisted Studentships, under which a teacher may work in the college laboratories on payment of one-fourth of the fees, Government paying the other three-fourths. We may add that the Yorkshire College has, at the present time, about 700*l*. a year to distribute in scholarships.

THE Marquess of Ripon, Viceroy of India, in a letter expressing his warm approval of the decision of the Council of the Yorkshire College, Leeds, to raise a memorial to the first president, the late Lord Cavendish, in the form of a Professorship of experimental physics, announces his intention of subscribing 500*l*. to the fund, which now amounts to 3000*l*.

FROM the Calendar of University College, Nottingham, we see that the teaching staff is well filled up, nearly all branches of a really liberal education being represented. From the interesting statistics given, it is evident that the institution is very largely taken advantage of. The Calendar gives an account of the origin of the College.

THE Winter Session of 1882-83 of the London School of Medicine for Women (30, Henrietta Street, Brunswick Square) will open Monday, October 2. Courses of lectures will be given at the school on Anatomy, Chemistry, Physiology, Practice of Medicine, and Practice of Surgery. A course of Practical Anatomy, with demonstrations, will also be held. Lectures on

Clinical Medicine and Clinical Surgery will be delivered at the Royal Free Hospital, where daily clinical instruction will be given to the students. The number of students admitted since the foundation of the school in 1874 has been 100.

THE new University at Lund was opened on the 26th inst., great preparations having been made for the ceremony. The principal universities of the continent were represented through deputations.

SOCIETIES AND ACADEMIES

SYDNEY

Linnean Society of New South Wales, July 26.—The following papers were read :—Botanical notes in Queensland, Part 3, by the Rev. J. E. Tenison-Woods, F G.S. This paper contained the results of the author's observations on the Mulgrave River, with a list of the species collected by him in that district. —On the forage plants indigenous to New South Wales, by Dr. Woolls, F.L.S.—Description of three new fishes of Queensland, by Chas. W. De Vis, B.A. The species described by Mr. De Vis are :—1. *Oligorus Goliath*, taken in Moreton Bay, a fish of gigantic size, seven feet long, and two feet high. 2. *Synaptura Fitzroiensis* from Rockhampton ; and 3. *Engraulis Carpentariæ*, from the Norman River.—4. Description of a species of Squill, *Lysiosquilla Miersii*, from Moreton Bay, by Chas. W. De Vis, B.A. This Crustacean, which is found in Moreton Bay, differs materially, according to Mr. De Vis, from the two species of the same genus recorded in Mr. Haswell's Catalogue, which belong to Mr. Miers' second section of the genus, while the present species agrees with his first section.—On *Cypræa citrina* Gray, from Rowley Shoals, North West Australia, by John Brazier, C.M.Z.S.—On a variety of *Ovulum depressum*, from the Loyalty Islands, by Mr. R. C. Rossiter.—Notes on the nidification of the spoon-bill, the heron, and the night-heron, by Mr. K. H. Bennett.

VIENNA

Imperial Academy of Sciences, July 15.—L. I. Fitzinger in the chair. The following papers were read :—F. Lorber, a contribution to the determination of the constants of the polar planimeter.—Ph. Knoll, contributions to the theory of respiratory innervation (third communication).—H. Satter, contributions to the history of development of the antheridium of liver-wort.—C. Huellner, on the influence of great amplitudes on the oscillations of elastic bodies.—E. Lippmann and F. Fleissner, on Azylines, a homologous series of azotic bodies.—F. Heindachner, contributions to the knowledge of the river-fishes of South America.—C. Etti, on the combinations of vanillin with pyrogallol and phloroglucin.—L. v. Barth and I. Schreder, on the action of melting caustic potash on orcin and gallic acid.—J. Habermann and M. Hoenig, on the action of cupric hydroxide on some sugar species.—M. Hoenig and F. Berger, on the action of chloroform on naphthalene in presence of aluminium chloride. —C. Nachbaur, examination of the embryos of ingerminated rye, especially on their contents of diastase.—C. Zatzek, to the knowledge of bees-wax.—S. Schubert, on diisobutyl-hydroquinones and some of its derivatives.—F. Exner, on some experiments relating to the contact-theory.—L. Hartinger, on the occurrence of organic bases in the merchantable amyl alcohol.—A. Waage, on the action of ammonia on propionaldehyde.—J. Fruehling, on oxybutyric acid.—B. Brauner, on some earth contained in cerite.

PARIS

Academy of Sciences, September 18.—M. Blanchard in the chair.—The following papers were read :—Note on the life and works of M. Emile Plantamour, by M. Faye.—On marsh-fevers, by M. d'Abbadie. Immunity from such fevers in bad Ethiopian regions is often secured by sulphur-fumigations on the naked body. In Sicily the workmen in sulphur-mines on low ground suffer much less from intermittent fever than the rest of the population. In Greece (M. Fouqué has shown), a once flourishing town of 40,000 inhabitants, Zephyria, has been almost utterly depopulated through marsh fever ; and its decadence has corresponded to a transference of sulphur-mining operations to the east, so that the sulphur-emanations are prevented, by a mountain mass, from reaching the site of the town ; (other similar facts are given).—Geological and historical considerations on the great deserts of Africa and Asia, by M. de Tchihatcheff (Abstract of a British Association paper).—Separation of gallium (continued), by M. Lecoq de Boisbaudran.—Study on the *régime* of the maritime Loire, by M. Bouquet de la Grye. Between Nantes and Saint Nazaire there is deposited annually about 590,000 cubic metres of sand and mud. The volume of the channels has diminished about 56,000 cubic metres annually, for sixty years. The outer bar of the river has risen 0·70m. since 1864, and will probably rise more, presenting a danger for large vessels coming to Saint-Nazaire. The author indicates means of bringing the river back to its former constitution, such as replanting, covering slopes with turf, and he suggests a plan for carrying off quickly into the sea the 40 million cubic metres that have been deposited during the last sixty years. —On the permutation of *n* objects and on their classification, by M. Bourgot.—Absorption by the epidermis of aërial organs, by M. Cornu. A substance emitted in the form of vapour may traverse the epidermis (though very thick) of aërial parts of a plant, and be absorbed without previous dissolution in water. (The experimental case was that of growing grapes exposed to the vapours of heavy oils from distillation of coal tar. The empyreumatic substances were concentrated, as judged by taste, in the central part of the pulp and the bulb of the peduncle.)—The squares of forces of induction, produced by the sun in planets, and due to the velocity of revolution of these bodies, are, all other things equal, in inverse ratio of the seventh powers of the distances from the star ; induction of comets, bolides, and falling stars, by M. Quet.—On a refractometer, for measuring the indices and the dispersion of solid bodies, by M. Soret. He modifies Kohlrausch's refractometer, which has the disadvantage of requiring monochromatic light, and so is unfit for researches on dispersion. A beam of parallel solar rays falls on a crystal immersed in a liquid more refringent, and of known indices ; after reflection it is received on the slit of a spectroscope. With sufficient angle of incidence, all the visible spectral rays are totally reflected, and the spectrum is very brilliant. On gradually diminishing the incidence, the different rays attain in succession their limiting angle, and reach the spectroscope with intensity considerably lessened ; thus a dark screen advances towards the violet. The line of separation in the spectrum, together with the incidence, afford data for arriving at the index. —Influence of temperature on the spectra of metalloids, by M. Van Monckhoven. He proves experimentally that the so-called high temperature spectra may be produced at very low temperatures, and *vice versâ*.—On the action of presence of plates of zinc in boilers, and on a process for avoiding explosions, by M. Trève. The hydrogen liberated with galvanic action should theoretically maintain the boiling (after having started it), and so prevent explosion as a result of super-heating ; for this, however, the plates must be carefully kept clean. The author thinks it well to add the continuous injection of gas (preferably carbonic acid), and so incessantly prevent the super-heating, which may be regarded as a *sleep* of the liquid.—On the winter of 1879-80, by M. Teisserenc de Bort. The exceptional cold is attributed to a displacement of the centre of high pressures of Madeira and the Azores, and to a perturbation in the barometric maximum of Siberia.—On the alteration of grape seeds by mildew, by M. Prillieux.

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