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A CONTRIBUTION TO LAMARCKIAN EVOLUTION.

Sexual Dimorphism in the Animal Kingdom; a Theory of the Evolution of Secondary Sexual Characters. By J. T. Cunningham, M.A. Pp. xi + 317; with 32 illustrations. (London: Adam and Charles Black, 1900.)

HOWEVER much readers of this work may dissent from the views of the author, there can be no doubt that the volume is worthy of the most careful perusal. For the first time since the publication of Darwin's theory of sexual selection we have been provided with a bold and intelligible attempt at explaining secondary sexual characters on Lamarckian principles, and although many of us may arrive at the conclusion that Mr. Cunningham has not succeeded in establishing his case, it will be generally admitted that he has discussed the problem, on the whole, in a more or less scientific spirit, and has supported his arguments by a body of well-considered and, in many cases, original observations, which make his book exceptionally valuable as a storehouse of facts.

The author, as is well known, belongs to that school of anti-Darwinian evolutionists which accepts the broad doctrine of descent with modification, but which denies the sufficiency of natural selection as the cause of species formation. In the introduction he re-states some of the chief difficulties and objections which have been urged, over and over again, by the opponents of Darwinism. An analysis of these objections, as set forth by Mr. Cunningham, will show that they resolve themselves mainly into the inutility of incipient stages, the dictum of Romanes that natural selection is a theory of the origin of adaptations, the inutility of specific characters, the failure of natural selection to account for the origin of variation and so forth. Students of evolution are so familiar with these much-discussed topics that we may be excused from dealing with them again in detail. It is ancient history that Darwin admitted "use and disuse" and the "direct action of external conditions" as factors of some value in the production of species. But he assigned a subordinate function to these agencies, and it is quite unfair to Darwin's position to state, as Mr. Cunningham does (p. 12), that "if once we admit this, selection becomes a secondary and subordinate character."

What concerns us most here, however, is not so much the destructive part of the present work, because the author, in brilliant contrast to many critics belonging to his school, has not contented himself with mere cavil or with the watering-down process which is rife among certain sections of naturalists who regard with horror any attempt at dealing with the species problem by scientific method. Mr. Cunningham has formulated his own views, and has applied them to the particular, and, we may add, absorbingly interesting, class of phenomena presented by animals with dissimilar sexes. These views are, as the author will admit, purely Lamarckian—in fact we might say grossly mechanical, since the secondary sexual characters are regarded as the direct result of mechanical irritation or stimulation (p. 37). It is needless to point out that this view is absolutely at variance with that held by selectionists. It is a doctrine which has been broached of late years to account for floral structures, and which, if we are not mistaken, has received but little favour from botanists.

In defining Mr. Cunningham's position as a Lamarckian, it is necessary to point out, in order that full consideration may be given to his views, that he has introduced a certain modification into that doctrine which he claims—and we think rightly—to be original. Lamarckism, of course, carries with it the admission that acquired characters are hereditary, and the author's attitude towards this question will be considered subsequently. But whereas the original, or proto-Lamarckian, or his modern successor, the neo-Lamarckian, never appears to have troubled himself very much about the precise period in the life of the individual at which the "acquired" characters were produced, Mr. Cunningham has laid it down, as the essential part of his amendment, that these characters only become developed (by heredity) at "that period of life and in that class of individuals in which they were originally acquired" (p. 37). He further postulates that, in order to produce such hereditary acquired characters, the stimulations must "be regularly recurrent," and their transmitted effect is then only developed "in association with the physiological conditions under which they were originally produced" (p. 41). In other words, he restates Darwin's "inheritance at corresponding periods of life" and "inheritance as limited by sex" from the Lamarckian platform, and imposes a new restriction in the way of "physiological conditions" which are nowhere defined throughout the work excepting in the case of secondary sexual characters, where the supposed conditions are vaguely associated with the change of constitution accompanying sexual maturity.

From these considerations it follows that the external stimulus or irritation which (admittedly) can modify a part or organ of an individual during its lifetime, is only capable of producing modifications of specific rank when applied continuously, throughout many generations, at some particular, and at present undetermined, state of physiological activity. Supposing we admit, for the moment, that the author's position is sound for the only case in which such special physiological conditions are hinted at, viz., the period of puberty, then it follows that those mutilations which have been carried out through successive generations in many tribes of savages at the precisely critical period required by the hypothesis might, at any rate, be expected to show now and again a tendency to appear spontaneously in the offspring at that period. The evidence on this point is certainly against the author, and the case for Lamarckism in its amended form receives no more support by virtue of Mr. Cunningham's amendment than did the original Lamarckism from the consideration of such classes of facts. It is, perhaps, not going too far to say that the author's position is less tenable by virtue of his own restriction than that of the older Lamarckians, because the whole explanation of sexual dimorphism, from Mr. Cunningham's standpoint, is made to depend upon the action of external stimuli applied at the period of breeding, *i.e.* at sexual maturity.

It has already been stated that the author repeats, and therefore presumably gives weight to, the stock objection against Darwinism that that doctrine does not account for the *origin* of the variations which selection has to deal with (p. 30). True; but the writer of this notice is not aware that the selectionists have ever pretended that it did, or that it might be expected to. There have been supplementary hypotheses of variation, and there is reason to believe that variability or instability of form, if of advantage to a species subject to rapid changes of environment, might be seized upon and perpetuated by selection like any other character, structural or physiological. But this has nothing to do with the origin of variation as the result of physiological processes. On the other hand, if the theory of natural selection is considered to break down because it fails to account for the origin of variations (which at any rate are facts) what value can be assigned to a theory which *assumes* a special plasticity of the organism under particular "physiological conditions" at a certain period of its life without any adequate proof that such plasticity does exist, and which further *assumes* that external stimuli, acting upon the individual at that period, produce hereditary modifications of structure?

I hope I am not misrepresenting the author's views in pointing out how much in the way of assumption exists in them. It will, no doubt, be said by Mr. Cunningham that his method is logically sound and scientifically correct. Having come to the conclusion that selection is inadequate to account for the facts of sexual dimorphism, he has a perfect right to ask naturalists to examine the evidence which he considers to weigh in favour of his alternative explanation. He says (p. 42):—

"I maintain . . . that theories of selection being found on application to the facts to be insufficient for their explanation, and the theory of the inheritance of acquired characters being found to harmonise with the facts, we are logically bound to believe that such inheritance does take place, at any rate until some other explanation can be found. I do not concern myself with the question how such inheritance can be produced, *it is a fact that the modifications are hereditary, and my object is to produce inductive evidence that they were determined by special stimulations*." (Italics the author's.)

The author's position towards the question of the inheritance of acquired characters may be paraphrased thus:—Secondary sexual characters appear to be, on critical examination, the result of direct mechanical action upon the individual; therefore we must believe that these characters have been so produced. The non-transmissibility of acquired characters is not an established truth, but only a belief (p. 15); therefore, in view of the foregoing conclusion, we must believe that acquired characters are transmitted.

In answer to this we can only repeat the statement so frequently made in reply to Lamarckian arguments:—All the evidence hitherto adduced in favour of the view that acquired characters are hereditary is either negative or ambiguous, and in cases where, on such hypothesis, the evidence might fairly be expected to be positive, it is also negative or ambiguous. The probabilities are therefore antecedently against Mr. Cunningham's explanation of secondary sexual characters, and we are justified in asking that his proofs shall be very cogent and convincing before we abandon a theory so probable *à priori* as Darwin's sexual selection in favour of a theory which is based on unproved principles. If the non-transmissibility of acquired characters is not an established truth neither is the opposite view, and the author—outside the domain of sexual dimorphism—adduces no new evidence in favour of this view. He says explicitly (p. 37) that he does not propose to prove that acquired characters are inherited, but a few paragraphs further on he lays down a statement of his own opinion which is tantamount to a declaration that such characters are inherited. It may be well, also, before attempting to deal with the detailed statements contained in the seven chapters following the introduction, to point out once again that the obvious adaptation of the parts of an animal to the life habits is no proof that the structural modifications have been produced by the habits. It may appear, *primâ facie*, that the structure is caused by habit, but this is no proof that it is so caused. The same result can be brought about by selection, and it is quite unnecessary to insist here that this is the essence of the Darwinian theory. But Mr. Cunningham is quite consistently Lamarckian in his inversion of the Darwinian position. Throughout this work the reader will meet with statements which remind us of the old Lamarckism—that such and such a structure *is produced by* such and such habit. In one illustration (p. 171) he even goes so far as to demonstrate that by moving a pen-holder coated with sealing-wax to and fro in hot water the softened wax forms a lamina above and below in the plane perpendicular to the plane of the motion, from which he apparently wishes us to believe that the crest of the male crested-newt "is due to the active movements of the male in courting the female in the breeding season"!

The special evidence which the author brings forward in support of his views is contained in some two hundred and sixty pages, divided into seven chapters, each dealing with the secondary sexual characters of some class or classes of the animal kingdom, from mammals downwards. It is impossible to deal with the various cases in detail, but a few typical examples may be selected in order to illustrate the position of those who, like Mr. Cunningham, regard habit as the cause of structure. The discussion of the sexual differences in man, in the first chapter, will be found particularly instructive. The hair on the face of the male is supposed to be "due to the stimulation of the growth of the hair by teeth or hands in the combats of mature males" (p. 49). That is to say that man's ancestors, by pulling each other by the hair of the face during their struggles for the female, developed a beard and moustache. But if mechanical irritation or stimulation of the hair follicles is the cause of increased growth of hair, why should the hairless condition of man's body, as compared with that of the apes, be attributed to the wearing of clothes (p. 52); the baldness of civilised races to the wearing of hats (p. 53), and the greater length of hair in woman to the wearing of lighter head-gear (p. 54)? Surely the hair follicles of a clothed animal are subject to more pressures and stimulations than in the naked animal? In a similar way, the author discusses, in this chapter, the origin of antlers, horns and tusks, which, being used for fighting, have, according to his views, been developed by pushes and stimulating shocks. The cheek prominences of the male mandrill are considered to have been produced by a similar process, and their furrows and colour are regarded as "inherited swellings and scars" (p. 58). The case for Lamarckism, as based on a study of antlers, is worked out at great length also in this chapter, this being a subject to which Mr. Cunningham has devoted special attention. The tusk-like development of the upper canines of the male musk deer is explained in these words :

"The enlargement of a tooth is as natural a consequence of excessive use as is that of an antler, the pressure stimulating the papilla or pulp from which the tooth is developed" (p. 96).

The author adds, however, that the evolution of the musk gland of the male "is more difficult to explain."

Those who are familiar with Darwin's weighty body of evidence in favour of sexual selection derived from his studies of the secondary sexual characters of birds will turn with interest to the discussion of this subject in the second chapter of the present work. The excessive development of male plumage is, according to the author, the result of use—*i.e.* to erection by muscular action during display. But the most striking sexual differences among birds are not only due to development of plumage, but also to colour and pattern, and just on this point Mr. Cunningham's application of Lamarckism becomes most unsatisfactory :—

"With regard to the coloration and markings of special plumage I have little to say. I regard them as due partly to the same excessive growth as that which increases the size of the feather, partly to the universal regularity and symmetrical repetition of marks, due to the rhythmical nature of growth processes, and partly perhaps to the action of the light from particular surroundings" (p. 109).

From this point of view, it is interesting to see how the author deals with the ocelli of *Polyplectron* (p. 114). Darwin, as is well known, attributed the dull ocelli of the female to partial transference of the male characters. Mr. Cunningham inverts this explanation, and suggests that the present condition of the female represents the original condition of the male. In other words, the ocelli of the male as at present seen are the female ocelli developed and enhanced by "use inheritance." The writer of this notice fails to see wherein this explanation offers any advantage. The duller ocelli of the female have, on this view, still to be accounted for. What direct action or external stimulus or impact can be conceived which is capable of producing regular patterns? The "action of light from particular surroundings" (even if we admitted such action) could not produce an ocellus, and if the "rhythmical nature of growth processes" is considered a sufficient explanation, this and all similar cases are at once removed from the discussion, and have no more to do with the author's Lamarckism than with the older Darwinism.

The whole treatment of colour and pattern throughout the work leaves no doubt that the author proposes to bring these characters within the domain of his amended Lamarckism. Among Amphibia, for example, the more vivid colouring of the male *Molge aspera* is attributed to the greater sexual excitement of the male, which causes, "through nervous stimulation, more active production of pigment in the skin" (p. 175). Among fish—a class to which Mr. Cunningham has paid special attention—the same explanation is offered again and again to account for the brighter colours of males. In those exceptional cases where, as in *Solenostoma* (p. 227), the female is the more brilliantly marked and coloured, the author is obliged to reverse the nervous excitement of the sexes. Perhaps the most instructive case dealt with under this division is that of the male dragonet, *Callionymus lyra*, because it is discussed at great length (pp. 199—214), and may be taken as a typical example of the author's treatment of the problem of colour as a secondary sexual character. The habits of the fish have, moreover, been most thoroughly observed and recorded by Mr. Holt at the Plymouth Marine Station. In summing up this case Mr. Cunningham concludes, as before, that the increased sexual excitement of the male at the breeding period causes, through nervous stimulation, an increased deposition of guanine and pigment in the skin.

"That the marked excitement of the male dragonet's brain should cause increased nervous stimulation of the skin is not an extravagant supposition, and it is definitely supported by the fact that the blue bands, if not the yellow, are flashed out in more intense brilliance as the fins are raised in his amatory rushes. When the question is regarded physiologically, instead of merely from the selectionist's point of view, the significance of such reasoning as I have used cannot be ignored."

In this paragraph Mr. Cunningham takes up a position that is very frequently assumed by opponents of the selection theory, and from which the writer of this notice desires to take this opportunity of again expressing his dissent. The fact that the blue bands are flashed out as the fins are raised is surely an optical effect. I can hardly imagine that even the Lamarckian zeal of the author would lead him to desire that his readers should suppose that the "amatory rush" of the male caused an immediate and suddenly increased secretion of guanine! But apart from this, supposing we admit that he has discovered the true physiological explanation of the colour—and that given on p. 211 may be perfectly correct—wherein does this favour the Lamarckian and discredit the Darwinian explanation? It appears to be constantly assumed by anti-Darwinians that because they have found the physiological and histological mechanism of a colour they have thereby disposed of selection. We say that selection is capable of acting upon *all* characters, external and internal—whatever their physiological origin; and, in this particular case, if the male fish were capable at the breeding period of secreting guanine to such an extent and in such an arrangement as to produce a visible blue colour, we should say that there is here a character which is quite as capable of being enhanced and developed by sexual selection as is any other character of biological value to the species by natural selection.

In association with the hypothesis that colour is the result of increased deposition of pigment due to sexual excitement, it may be pertinent here to raise the question why, on Lamarckian principles, the increased secretory and excretory activity should take the form of colour at all. It can be admitted in a general way that increased nervous stimulus might lead to increased secretion and excretion generally. But there is no evidence of any kind brought forward in support of this—the evidence which Mr. Cunningham asks us to accept in favour of his view centres round *local deposits* either of osseous or horny matter, &c., in the case of mammals, or of pigment. Colour, as such, is meaningless from the Lamarckian standpoint, and we have a right to ask where is the "use" (in the Lamarckian sense) which accounts for the accumulation of such deposits in definite stripes and patterns in one part of a wing or feather. If it be suggested that the definite arrangement is the external expression of an internal law of growth, then the diversity of pattern among allied species remains unexplained; and, if we allow the direct action of light as a cause of pattern, we are invoking an improbable and an unproved principle. It must be presumed that the author considers his experiments on the coloration of the *Pleuronectidae*, to which he refers on p. 41, as a sufficient proof of "the direct effects of stimulations." At any rate this is the only instance specifically mentioned which has any direct bearing on the question of the action of light as a colour-producing stimulus. It appears to the writer, however, that the results which Mr. Cunningham made known in 1896 are open to another interpretation from the point of view of the selection theory, but the discussion of this point would be out of place in the present notice.

If the "nervous excitement" theory of colour is considered sufficient as regards deposition of pigment, the production of colour by purely physical methods, such as striation and lamination, has yet to be faced by the Lamarckian school. This aspect of sexual coloration is very lightly dealt with by Mr. Cunningham, although, in the case more especially of birds and insects, some of the most gorgeous male characters are due to such colours. It is, perhaps, hardly right to attribute unfairness to an author who evidently has done his best to give due consideration to the doctrine which he is opposing, but impartial readers of the present book who happen to be acquainted with the subject at first hand cannot fail to detect the anti-selectionist bias which here and there makes itself manifest in Mr. Cunningham's pages. Nowhere is this more obvious than in the fifth chapter, dealing with the secondary sexual characters of insects. The bias is no doubt unconscious, but when we consider that among butterflies, to which the author devotes the larger part of the chapter, this kind of colouring plays such a very important part, the treatment will be found, to say the least, disappointing by those who wish really to know what the Lamarckians have to say on this subject. The explanation offered is that the colours—pigmentary and physical not being separated—are caused by the direct action of light:

"If we assume that variations in definite directions are excited by external conditions, in this case principally by light of different colours, the facts become intelligible in general," &c. (p. 243).

"By exposure I mean the kind of light to which the surface is exposed, and I believe that in Lepidoptera the coloration has chiefly been determined by the quality of the light" (p. 245).

We do not believe that the author will make many converts to his amended Lamarckism by such explanations as these. When and how does the light act, and how can such action produce pattern? Is the pattern focussed on to the wing by some mysterious agency capable of acting as a lens, or how does the light of different "qualities" (? wave-length) get separated so that each component produces its proper chromatic effect? Upon what organic tissue can light produce such direct photo-chromatic action, and does such action take effect through the skin of the pupa, in which stage the colours, both pigmentary and physical, are formed in the rudimentary wing? It seems to the writer that, instead of the facts being made "intelligible in general" by invoking such strained explanations, they have been rendered hopelessly inexplicable from the Lamarckian standpoint For example, to take his own illustration, does Mr. Cunningham wish us to believe that the hind-wings of *Catocala nupta* have been exposed to red and black light for generations—if so, where is the evidence? Does he seriously believe that the mottled-grey of the fore-wings, which, as he admits, makes them "indistinguishable on surfaces of bark or rock" (p. 246), is better explained by the direct action of the light from such surfaces than by a straightforward admission of natural selection for the purposes of protection? If he does prefer this explanation it must be left for the readers of this review to consider whether any bias is displayed by the author of the work under notice.

In discussing the colours of Lepidoptera, the author begins with those cases in which there is mimicry combined with sexual dimorphism, the females being, generally speaking, the mimetic forms. His object in doing this is to bring into prominence the undisputed fact that in such cases the two sexes have different habits. His contention, of course, is that the habits have produced the differences between the sexes. But if we do not admit this—and selectionists will not accept this doctrine until some much stronger evidence is forthcoming—the whole force of the argument is lost, because the difference in habit is also precisely in harmony with the requirements of the selection theory. What is really wanted to make this argument of any value is the proof that in species which are *not mimetic*, but which are nevertheless sexually dimorphic, there is a sufficiently marked difference between the habits of the sexes to account for the greater brilliancy of the one sex. So far as the writer has observed, there is no marked difference of habit leading to different exposure, for example, between the male and female in species of *Colias*, *Anthocharis*, *Pieris*, *Gonepteryx*, *Hipparchia*, *Satyrus*, *Argynnis* *Hesperia*, &c. Yet in all these there is in most of the species a marked dissimilarity of sex. To narrow down the issue, why, on Lamarckian principles, should the male orange-tip (*A. cardamines*) have an orange patch on the fore wings, and the female *Colias edusa* a row of orange spots round the black border? Why should the male *Gonepteryx rhamni* be bright yellow and the female greenish-white?

In all cases where direct observation is wanting, or where there is no observable difference of habit between the sexes, the author assumes that there must be some such difference. Of course this is a very easy way of "explaining" things by Lamarckism or any other hypothesis; but as this method is freely indulged in throughout the book, and since Mr. Cunningham is nothing if not logical, it may be well to examine a little more critically his position in this respect. The kind of assumption to which reference is made is well illustrated, not only by the chapter on insects, where colour is chiefly dealt with, but also in other classes where structures of unknown use are possessed by the males. Thus, among birds, the males of *Chasmorhynchus nudicollis* and other species of the genus are supposed, without evidence from observation, to fight and to

"seize their adversaries by the skin at the base of the beak, the attack being directed to the chin or the forehead, according to the species" (p. 145).

This is put forward as a "probable conjecture," because the male characters require such Lamarckian stimulations to account for their presence. Among chamæleons, the male, *C. Owenii*, has three slender horns which are not known to be used for fighting;

"but the animals are known to be quarrelsome, and it is probable that the appendages are thus used" (p. 166).

In this case the author even allows his logic to go by the board, because he follows up this statement, which is only conjectural, with the remark:

"Here again, therefore, we find that the existence of outgrowths corresponds to the impacts produced by definite actions, both being confined to the male sex."

That is to say, that a function which is conjectured to be probable in one sentence is treated of as an established truth in the following sentence. Examples of this kind might be multiplied, but the foregoing will suffice. Now the point which the writer of this notice wishes to urge is that all the arguments of this class are arguments of analogy only, and the weight which attaches to them is dependent on the antecedent probability of the hypothesis in support of which they are brought forward. Mr. Cunningham has, by implication, admitted the antecedent probability of Lamarckian factors; but if we do not follow him—and no selectionist will—much, if not all, the force of the analogies is lost, and we have a right to demand proof of actual connection between male structures and their use in every case described by the author. It is not to the point, in such cases, to urge that because in one species the male has been seen to use appendages or excrescences for fighting, therefore in other species with similar growths these must be used for the same purpose. The theory of sexual selection allows that male characters of the kind referred to may have been developed for ornament or as weapons of attack or defence, or for both purposes. But Lamarckism must have a definite mechanical cause for each excrescence or appendage, and the failure to discover such cause in any particular case is so fatal to the doctrine that most impartial readers of Mr. Cunningham's work will, on this ground alone, reject his conclusions. In one case (*Turnix taigoor*, p. 118) where the females are known to fight, and where there is no modification of structure corresponding to this habit, the author suggests

"that the pugnacity of the females has but recently arisen in the evolution of the genus, but it may be that the wounds inflicted are not very severe" (p. 120).

Many other points in the volume under consideration are open to criticism, and, in view of the importance of the issues, demand notice. Reverting again to the chapter on mimicry, the author, in rejecting the obviously simple explanation offered by selection for protective purposes, says that

"the theory of specific mimicry involves assumptions that have not been sufficiently realised. It assumes that birds or other enemies of butterflies are as precise in entomological discrimination as the human specialist" (p. 241).

This is hardly a correct statement of the case; the assumptions made by the theories of mimicry (Batesian and Müllerian) have been thoroughly well realised, and a body of evidence, both observational and experimental, has been brought to bear upon these theories, which Mr. Cunningham has either overlooked or chooses to ignore. But his own assumption, which precedes this statement, displays such an astonishing misapprehension of the whole subject that we can only come to the conclusion that the author has not really made himself master of the theory which he is endeavouring to overthrow. Having admitted that mimicking forms may belong to persecuted groups, he still suggests that, after all, the mimics may not owe their safety entirely to deceptive *appearance*, and he then goes on to say:—

"Inedible forms, such as the Heliconidæ, the gooseberry caterpillar and others, are distasteful largely in consequence of the presence of the pigments which make them conspicuous. *Therefore when a mimicking form acquires similar pigments it probably likewise ceases to be palatable to insect eaters*, and would be equally unmolested even if it possessed no particular resemblance to a species of another family" (p. 241. Italics ours.)

It really appears from this as though the author believed that the mimicry extended to similarity of pigment, which is not only contrary to the truth, as established by the researches of Mr. Gowland Hopkins, but is in itself so improbable *à priori* that it is surprising that Mr. Cunningham should have committed himself to the statement.

Considered as a whole, there can be no doubt that this fifth chapter is the least satisfactory in the book. It not only contains misstatements such as the above, but its omissions show that the author has not made himself acquainted with the recent developments in this direction. As the Arachnida are not considered at all, the splendid observations of Mr. and Mrs. Peckham on the courtship of spiders are not discussed. The reference to Poulton's experiments on the influence of the colour of the surroundings on the colour of the larva and pupa, as an illustration of the modifying action of the "quality of the light" (p. 231) upon the colour of the wing of a butterfly, is a false analogy. The statement (p. 248) that "the beauty of a butterfly's wing is equally visible whenever the insect flies" does not convey the whole truth, because in many of the most gaudily coloured males the full splendour of the colour is only seen from the front aspect, *i.e.* facing the insect and looking across the surface of the wing, the aspect that would be first seen by the female if the male were flying straight towards her. Nowhere is this iridescent colouring better seen, by the way, than in the male *Hypolimnas bolina*, figured by the author on p. 233.

Although there can be no doubt that Mr. Cunningham's plea for Lamarckism and the inheritance of acquired characters is on the whole very ably supported, it will not fail to strike many of his opponents that his anti-selectionist zeal carries him too far in some of his most fundamental arguments. Like many of the recent critics of Darwinism, the author now and again reads into the theory of selection certain deductions of his own, which he then proceeds to demolish without considering whether his deductions are legitimate or not. For example, he considers it an objection to the Darwinian explanation of flying mammals (p. 15) that

"the variations in the condition of the skin in animals that do not fly or take long leaps through the air are not such as to justify the belief that these variations would make any difference in the struggle for existence when long leaps became necessary."

That is to say that other animals besides those that do fly might be expected to show, on occasion, the raw material, so to speak, for potential flight. This is a kind of argument which has constantly been used by anti-Darwinians. Why, because a certain species has been enabled to develop such and such a useful character, have not similar characters been developed in other species to which they might be equally useful? It appears to be again necessary to point out (1) that it is not part of the Darwinian theory to suppose that every species is capable of varying *in every possible direction*; (2) that modification in the direction of flight may not have been possible in the species which "do not take long leaps through the air"; and (3) that such species have, no doubt, survived by the development of some other method of escape or defence which is quite as effective. Arguments of this sort might equally well be urged against the Lamarckians. Why, for instance, do not the flying lemurs, squirrels and foxes, &c., fly as well as bats, seeing that the membranous expansion of skin is constantly being used for gliding through the air? The writer has no desire to press this point against the author of the present work.

Then, again, Mr. Cunningham insists frequently that his (Lamarckian) explanation accounts for unisexual inheritance, while sexual selection does not. I believe that I shall not be singular in declaring my inability to see any force in this argument. Inheritance, as limited by sex, is a fact. Mr. Cunningham says (*e.g.* on p. 252) that this limitation is due to the "stimulations" having been applied to one sex and not to the other. But even if this were the true origin of the male characters there is absolutely nothing in the Lamarckian explanation which accounts for their non-transmission to the female. All characters, whether secondary sexual or not, must on either hypothesis (Lamarckian or Darwinian) originate in an individual, which individual must—it is needless to say in the case of bisexual animals—be either male or female. Why, then, should there ever be any blending of characters at all? According to Darwin's theory, the male characters originate through the selection of spontaneous variations by the females; according to the amended Lamarckism, the male characters are, as it were, hammered out of the male by stimuli applied at the period of sexual maturity. Why should this latter view be supposed to account for the limitation of the male characters to the male, and the former view (Darwin's) to fail? Or, to put the case in another way: Why should characters impressed mechanically upon the male during a particular period of his life be hereditary, and characters arising by spontaneous variation at that period not be hereditary? If the author had contented himself with the acknowledgment that unisexual inheritance required further explanation, both schools of biologists would agree. The selectionists might even have suggested an answer on the lines laid down by Wallace—that the female, being in most cases in greater need of protection and concealment, had had any tendency to inherit the male characters eliminated by natural selection. The author will no doubt reject this explanation; but whether he does so or not, it is manifestly absurd to claim for Lamarckism a fictitious superiority as regards the explanation of unisexual inheritance. The advantage seems to the writer to be distinctly on the side of the Darwinians.

If, as we believe, this latest attempt to reinstate Lamarckian evolution is unsuccessful, its failure is due to the inherent weakness of the doctrine rather than to the treatment which it has received in the present volume. It was an excellent idea on the part of Mr. Cunningham to test this theory by applying it to secondary sexual characters, but it does not appear that the light shed by Lamarckian assumptions is in any way clearer than that offered by the theory of sexual selection. There are, confessedly, difficulties in the way of both theories, but those offered by the Lamarckian doctrine are certainly the more serious. The writer, at any rate, has come to the conclusion that few biologists in this country wil accept the mass of material offered in the present volume as "inductive evidence" in favour of the heredity of acquired characters. Most of the cases discussed are equally well explained by the theory of selection—some cases are better explained by this theory. Assumptions and deductions have to be made by the supporters of both theories; those required by the Lamarckians seem to be much the less warrantable. It may be fairly said that if Lamarckism breaks down in its application to such characters as those dealt with, its career as a working hypothesis has ended fatally. It would certainly be interesting to know whether the author limits his Lamarckism to the production of secondary sexual characters, or whether he regards his amended form of the theory applicable to *all* specific characters. Limitation hardly seems possible logically, because any stimulus or impact of any kind whatever must (on this hypothesis) produce its effect if applied at the right stage of physiological activity. The author, if he accepts this wider application, will thus have narrowed down the issue between the two schools of evolutionists to the simple question whether hereditary modifications can be produced by such means. We believe the answer will be in the negative, but if this wider view is not accepted, then Mr. Cunningham must show cause why the modification should be restricted to such characters as those which he has so ably discussed in the volume which has been considered in this notice.

R. MELDOLA.

OPTICAL SCIENCE.

A Treatise on Geometrical Optics. By R. A. Herman, M.A., Fellow of Trinity College, Cambridge. Pp. x + 344. (Cambridge: University Press, 1900.)

IN the preface to a recent book dealing with photographic optics, Prof. S. P. Thompson expressed the view that Sir John Herschel's article, "On Light," in the "Encyclopædia Metropolitana" of 1840 marks the culminating point of English writers on optics. Whether this is still the case or not perhaps need hardly be discussed; it may safely be said that Mr. Herman's book, which contains many novel points, constitutes a marked advance, and brings before English students a quantity of information which was not easily accessible to them before.

At the same time, the book undoubtedly suffers as a treatise on the subject from being a text-book for mathematical students at Cambridge. Mr. Herman has aimed at attracting a wide circle of students. The most elementary proofs of the simplest theorems are given alongside of mathematics which require a considerable training to follow easily. The book would have gained as a treatise if the author had assumed his readers to possess some elementary knowledge of the subject and its simplest formulæ. A Cambridge coach might put it in the hands of a beginner, marking, say, two-thirds as to be omitted at first reading; that two-thirds, with some slight re-arrangement and addition, would make a more interesting book for the more advanced student than the actual volume now under review. Thus the theory of geometrical foci, the methods of constructing a figure to find the image of a small object placed perpendicularly to the axis, of a system of spherical reflecting or refracting surfaces and similar problems could all be put more briefly.

In Chapter ix. (General Theorems) we come to Fermal's theorem; the general theory of geometrical foci is here given, based on this theorem. The author remarks that all the theorems hitherto obtained for small pencils passing directly through a coaxial refracting system might be obtained from the formulæ arrived at; the advanced student would have gained a closer grip of the subject as a whole had this course been taken. The formulæ can be extended to establish the collinear relation between the object space and the image space, and, when once this is done, the existence of the principal and nodal points follows, and the geometrical constructions based on a knowledge of their position are easily generalised. The introductory methods of Drude's recent "Lehrbuch der Optik" seems, in this respect, more suited to a treatise on the subject than those chosen by Mr. Herman, who appears to have been deterred from using them by his wish to make it clear throughout that the method of geometrical foci is only an approximation. But in spite of this the merits of the book are very great. The author, in his introduction, states that it has been one of his aims

"to introduce a new method of determining the properties of a symmetrical optical instrument in which the angle of divergence of a small pencil, rather than any coordinate of its origin, has been adopted as a leading feature."

The method rests on a combination of Cotes' theorem of the apparent distance, and Helmholtz's expression for the linear magnification.

The simplification that results from its use in the case of a symmetrical pencil traversing a coaxial system of lenses is most marked; the lengthy calculation of the continued fraction by means of which the results are arrived at in Gauss's treatment of the subject is entirely avoided. The application of the method to the determination of the axial aberration of such a system is a striking example of its power; this is easily seen by comparing Chapter viii. (Aberration) with the corresponding portion of some earlier text-book.

In the chapter on instruments the discussion of telescopes is very satisfactory. The same can hardly be said for that on microscopes; probably it would be too much to expect an explanation of the complete theory within the limits of space which could be assigned to the subject, but the discussion should have come after the chapters on aberration and achromatism; it would then have been possible to refer to the problem of the manufacture of suitable glasses which Abbé set himself to solve in 1881—this is alluded to in a perfunctory manner in § 123—and to indicate in a general way the outlines of the theory and the methods in which the defects of one lens are corrected by the next.

The problems to be solved in the construction of photographic lenses can, perhaps, hardly be discussed fully without more complete calculations of the aberrations of oblique pencils than is possible in a general treatise; still, space might have been found for a reference to von Seidel's work, and some discussion of the physical meaning of his five equations of condition would have been interesting and valuable even if the reader had been referred to the original papers for a proof of the conditions. In fact, the book would be improved in many places if the account given of modern German work were more complete; in the chapter on achromatism, for example, full details are supplied of the refractive indices and dispersive powers of several specimens of crown and flint glass; details as to Abbé's glasses, which contain salts of boron, phosphorus and barium, together with some note as to the effects produced on the optical properties of the glasses by these salts, might well have been added. The book is so notable and valuable an addition to the literature of a rather neglected subject, that it is a pity it is not more complete in these respects. It is printed by the Pitt Press in its usual admirable style; the collection of examples, both worked and unworked, is specially full, and will be found very useful to the student. As a text-book it is a marked advance on anything yet published in England.

OUR BOOK SHELF.

By Land and Sky. By the Rev. John M. Bacon, M.A., F.R.A.S. Pp. viii + 275. (London: Isbister and Co, Ltd., 1900.)

MEMBERS of the British Association who were at the Dover meeting may find in this book, among other things, some account of the intentions and the performance of the balloon that occupied for so long a time the grounds of Dover College.

Whether the book was intended to be the British counterpart of its ponderous contemporary in three volumes recently issued by the Aëronautical Society of Berlin does not appear from anything that is written therein. It deals with the same large subject—scientific balloon voyages—but it is not a work of reference. It could hardly be so, for it has no index, and the table of contents serves more to stimulate curiosity with attractive head-lines, as "Marooned" and "How I bombarded London," than to guide the reader to any scientific results. It is not even effective as an indication of what is to be found in the chapters, for what the author has to say, for example, on the natural history of gorse and bracken is to be found in the chapter headed "fog signals."

The leading motive of the book, in so far as it is not autobiographical, is the application of balloon observations to certain problems connected with the transmission of sound, and this leads to spending midnight hours on a tower of St. Paul's, to a long stay at the Maplin Lighthouse, and other eerie expeditions, but to no effective scientific results except the destruction of the author's belief in aërial echoes.

The book has, in fact, all the discursiveness of the *dilettante*. Its scientific investigations lack the definiteness which quantitative measurements give. It describes in one chapter how a certain echo always arrived behind time, but it does not say how the time-table was drawn up. Still, it deals with a number of interesting balloon excursions and the adventures that they afforded; the style is racy in its way, the illustrations are good, and the printer has given effective assistance. The reader will at least learn that ballooning is still in the adventurous stage, and, if he thinks about it, he will conclude that some scientific methods are better than others.

Der Aufbau der Menschlichen Seele; Eine Psychologische Skizze. Von Dr. H. Kroell. Pp. v+392. (Leipzig: Engelmann, 1900.)

DR. KROELL'S work might be judged from two very different points of view. As a popular and generally intelligible account of the present state of our knowledge as to the localisation of function in the brain and the stages of cerebral development, some of his chapters may be highly commended for their clearness and accuracy. As a "psychological sketch" of human life and thought, written with the avowed object of establishing the materialist position, the book is an unqualified failure. Dr. Kroell brings out materialism in his results simply because he has put it into his premisses. He is content to assume the first principles of mechanical physics, not, as a real physicist might do, as working hypothesis, but as unquestionable and ultimate truth. Moreover, he states even those principles in an unsatisfactory way. The difficulties which beset the problem of the relation of matter and energy are ignored by the convenient device of asserting that each is one aspect of a double reality which the author calls "Kraft-stoff"; unfortunately he omits to tell us how "Kraft-stoff" is to be measured. He assumes, with equal recklessness, that all energy is kinetic (p. 28) and (pp. 30, 31) that the phenomena of life *must* be capable of being adequately described in terms of rotatory motion. Dr. Kroell's psychology is of the same type. He can see no difference in principle between the photo-chemical changes produced on the retina by a light-stimulus and the transformation of molecular motion into consciousness which, on his theory, take place in the cortex. The "picture in the brain" is a reality of the same order as the "picture on the retina." That neither "picture," as distinct from its physical conditions, exists except for the eye of an observer does not occur to him. A sensation (p. 70) is actually said to be a cerebral process which has become "conscious of itself," though, of course, our own cerebral processes are in point of fact precisely that of which we are *never* directly conscious. The sensation as a mental state is confused with its own cortical concomitants and baptised by the name of "picture in the cortex" (p. 98); and the unmeaning question has then to be discussed how it comes about that the "picture in the cortex" is "referred away outside" to the periphery of the body or to a spot in the external world. The questions of animal psychology, which all serious students of the subject know to require the most cautious handling, are settled by Dr. Kroell in the same spirit of jaunty confidence. For instance (p. 125), the higher animals have memory-images. This is roundly affirmed without evidence, apparently in utter ignorance of the actual experimental work which has been done in the study of the animal mind and the much more guarded conclusions to which that work points. Animals (*ib.*) have "concepts," though no word is said as to the evidence which has satisfied the author upon this thorny and debated subject. These are but a few specimens of the confusions of thought and reckless assertions with which the book abounds; they should be enough, however, to indicate the worth of an argument for materialism founded on such premisses. Psychologists have no right to quarrel with physiologists and medical men for not being themselves psychologists; they surely have a right to expect that psychology, as much as any other science, should be protected against the dogmatism of outsiders who disdain to make themselves acquainted with its problems and methods. No knowledge of physiology can give its possessor the right to dogmatise *à priori* in physics and in psychology.

A. E. TAYLOR.

Shakespeare's Greenwood. By George Morley. Pp. xx + 289. Illustrated. 16mo. (London: D. Nutt, 1900.)

OF this daintily turned out volume, some portions have already seen the light in an abbreviated form in the columns of *Knowledge*, *Country Life* and the *Art Journal*, but the greater part is new. And the author, who is already known to the public by other descriptions of Warwickshire scenery, claims for his present effort the position of being the only work that deals with the survival of old-time feeling and custom in Shakespeare's country.

Naturally the work is in the main interesting to the antiquarian, the philologist and the student of folk-lore rather than to the zoologist; but there is a chapter on birds from which the ornithologist may possibly glean a few facts in regard to habits and local nomenclature. As an example, we may refer to the incidental statement on p. 194 to the effect that the name "landrail" (like corncrake) is derived from the cry of the bird to which it is applied. It may be that this derivation, although previously unknown to ourselves, is familiar to ornithologists, but we have failed to find mention of it in three standard works on British birds.

The popular superstitions connected with the redbreast and the wren are sympathetically referred to on pp. 153 and 154. And an old-time belief connected with egg-shells is detailed on p. 173. It appears that in Warwickshire it is the custom to scrupulously preserve these, although, at the pain of ill-luck, on no account should they be kept in the house. "But if by any mischance," says our author, "some person, unacquainted with the folk-lore of the subject, should burn the egg-shells, then, in the rustic belief, the hens will cease laying. Where this faith is the strongest is in the isolated homesteads on the waste or by the side of a wood, and there the utmost care is taken to prevent any single egg-shell being thrown into the fire, so that the fecundity of the hens may be stayed." It would be very curious to discover the origin of this and many other strange superstitions referred to by Mr. Morley.

To those of our readers interested in folk-lore, as well as to all Shakespearian students, the elegant little work before us may be heartily commended.

R. L.

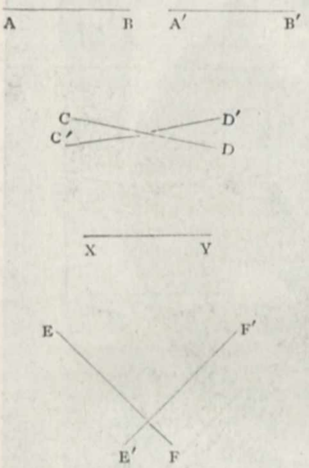
LETTERS TO THE EDITOR.

[*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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Relative Motion of the Earth and the Ether.

IN recent issues of NATURE and the *Philosophical Magazine*, Profs. Larmor and Fitzgerald and Lord Kelvin have expressed themselves as if satisfied that the negative result of the celebrated Michelson and Morley experiment as to a relative motion of earth and ether is genuinely decisive, and as if the only present escape from the dilemma between this experiment and the bulk of the evidence which necessitates a relative motion of earth and ether is to be found in a possible change of the dimensions of bodies caused by changes in their motion through ether.

I should like to point out that a much less heroic alternative is offered in an article of mine on relative motion of earth and ether in the *Phil. Mag.*, January, 1898. It is there shown that the optical apparatus used by Michelson and Morley was probably in a less sensitive condition than was assumed, and, therefore, failed to determine the very minute distance which was the subject of measurement in their experiment. The argument of my paper can be illustrated by the following considerations. Let AB be a source of light, and let A′B′ be a duplicate of it, for example AB and A′B′ may be the two images in Fresnel's production of interference fringes by a biprism. The distance apart of the fringes at any place is inversely proportional to the distance between AB and A′B′.



But if, instead of a duplication such as AB and A′B′, we have one such as CD and C′D′, then an eye at XY can see fringes whose width depends on the angle at which CD is inclined to C′D′. These are two simple limiting cases with correspondingly simple laws. Michelson and Morley assume that their apparatus gives them the case of CD and C′D′, but there is nothing in the arrangement of their apparatus to ensure that the case shall not be like that of EF and E′F′, where the two images have suffered both the angular displacement of CD and C′D′, and the lateral displacement of AB and A′B′. The law of the width of the fringes due to EF and E′F′ must be such as will include the laws of AB and A′B′, and of CD and C′D′ as limiting cases. I hold, therefore, that the Michelson and Morley experiment is vitiated by the assumption that their apparatus gave them the full sensitiveness of the CDC′D′ position, whereas it really gave the unknown smaller sensitiveness of the EFE′F′ position.

They found that the displacement which they measured was probably less than a fortieth of what might be expected as due to the earth's orbital motion. I maintain that a possible alternative to this conclusion is that the sensitiveness of their apparatus was probably less than a fortieth of what they assumed it to be.

On account of the great importance of the subject it is very desirable that this experiment should be repeated with a definite experimental measurement of the actual sensitiveness of the apparatus employed. It would be indeed a great help in astronomy if we could have Michelson and Morley apparatus of known adequate sensitiveness in our observatories furnishing continuous record of the earth's motion relative to the ether, from which we could calculate the drift of the solar system, and ultimately express all stellar movements with reference to the ether.

WILLIAM SUTHERLAND.

Melbourne, November 6.

Virgil as a Physicist.

IT seems to have escaped observation that, just as Homer appears to have known of, and even given names to, the two attendants or satellites of Mars, so Virgil is the earliest to mention that now familiar substance, "liquid air." In proof of this I may cite the following passages:—

(*a*) Georg. i. 404 (a meteorological passage, describing various signs of fine weather).

Apparet liquido sublimis in aëre Nisus.

"Nisus (the hawk) is seen high up in the liquid air."

(*b*) Æneid vi. 202 (where the author is speaking of the sacred doves which conducted Æneas to the golden branch which was to be his "open sesame" to the infernal regions).

Tollunt se celeres, liquidumque per aëra lapsæ
Sedibus optatis geminæ super arbore sidunt.

"Swiftly they soar aloft; then, dropping through the liquid air, together settle on the wished-for tree."

Virgil does not seem to have made any scientific examination of the substance he terms "liquid air"; but he must have noted its transparency since he makes a point of the visibility of birds through a thick stratum of it, and in the second passage he evidently considers (whether from actual experiment or not must be uncertain) that immersion in it had no effect on the "conducting power" of Venus's doves.

H. G. M.

The Sentinel Milk Steriliser.

A RECORD of certain observations upon the action of the "Sentinel" steriliser is given in your issue of December 13 (p. 166).

The results of the temperature determinations are there stated as follows:—

		Bell Form.		Cut-off Form.
Water	Half pint	94° and 95° C.	....	95° and 93° C.
	One pint	87·5° ,, 89°	....	86° ,, 87°
	Two pints	87° ,, 86°	....	84° ,, 85°
Milk	Half pint	98° (frothing)	....	95°
	Two pints	87°	....	84°

and your reviewer adds: "It will thus be seen that there is considerable variation in the temperature."

We trust that you will allow us to point out that the instrument used was of the size designed for the sterilisation of *two* pints of milk. An inspection of the above table proves that the apparatus worked in a satisfactory manner even when *one* pint only was placed in the vessel (the temperature readings being 87° to 89° in the bell form and 86° to 87° in the cut-off apparatus), and also that when the proper volume of liquid was inserted, the variations in temperature were still further reduced.

As the apparatus is purposely made in different sizes, and as it was at no time supposed that any one size would be used with but one-quarter of the correct volume of liquid, the conclusion that "there is considerable variation in temperature" certainly conveys a wrong impression to the reader.

Your reviewer appears to doubt the wisdom of selecting temperatures in the neighbourhood of 85° C. Now it is generally acknowledged that Prof. Bang, of Copenhagen, is one of the leading authorities on this subject, and therefore we give the following passage from Scurfield's translation of Nocard's "Animal Tuberculosis" (p. 73).

"The extremely well-conducted experiments of Bang have established the fact that the bacilli of tuberculous milk are destroyed with certainty when the milk is heated to 85° C. for five minutes; between 75° and 80° they are sometimes killed, but not always; they resist a temperature of 70°, and are afterwards able to render guinea-pigs and rabbits tuberculous when inoculated into the peritoneum; but their vitality is lowered, and they are no longer able to resist the action of the digestive juices of those animals. At 60° their virulence does not seem to be modified. Galtier has obtained results almost identical with those of Bang."

It is worthy of remark that one practical application of these investigations is to be found in Denmark, where the law compels all dairies that return unconsumed milk to "heat this milk to 85° C. for a short time, and then rapidly cool the same."

(For the Cambridge Sentinel Manufacturing Co., Ltd.),
D. BERRY (manager).

IN the directions for use issued with the "Sentinel" steriliser, it is not stated that the apparatus should be filled or thereabouts; in consequence the variations in temperature with different volumes were tested. It may not always be convenient or requisite in the household to sterilise the full amount, and unless explicit directions on this point are given, smaller quantities will be treated, with the result indicated. With regard to the thermal death point of the tubercle bacillus, I am acquainted with the researches of Bang, Galtier, de Man, MacFadyean, and others. Undoubtedly 85° C. is a safe temperature, but the claim that the milk is unaltered in flavour and nutritive qualities thereby cannot be substantiated. In view of Theobald Smith's most careful work, which, so far as I know, has not been challenged, it seems that, provided the milk be heated in a closed vessel so that no skin forms on the surface, pasteurisation at 68° C. for 20 minutes will kill the tubercle bacillus with certainty, and this treatment but slightly alters the flavour of the milk. It may be wise to select the higher temperature, but it should not be stated that the milk is practically unaltered thereby.

YOUR REVIEWER.

TYCHONIANA AT PRAGUE.[1]

ON October 24, 1901, three hundred years will have elapsed since the death of Tycho Brahe, and this memoir has been published in order to draw attention to that day and at the same time to give some account of the very few relics existing at Prague of the great astronomer, who spent his last years there and whose tomb is in the Teinkirche in that city. Print and illustrations of this memoir are excellent, but we could have wished that the text had been fuller and that at least one of the relics had been discussed in some detail. Tycho Brahe's instruments seem to have been destroyed during the Thirty Years' War, and not one of those he used at Uraniburg has been preserved; his library was scattered, but his manuscript observations fortunately found their way back to Denmark after having been thoroughly utilised by Kepler. The relics at Prague are therefore very modest ones—a few books from his library and a few manuscripts of no great importance. In the library of the Bohemian National Museum there is an album which Tycho gave his eldest son in 1599; on the first page of it is a portrait of the astronomer, reproduced in the present memoir. It is the well-known engraving by Geyn, coloured by hand. The book contains an autograph dedication by Tycho and a picture of his family arms, both of which Dr. Studnicka gives in facsimile. In the University Library there is a more important MS., containing on twenty leaves a short text-book on trigonometry, dated 1591. This was published in 1886 in photolithographic facsimile by Dr. Studnicka, who is exceedingly irritated with the writer of this review for having ventured to say that "Tycho has written his name under the title of the MS., but the handwriting of the remainder does not seem to be his." He even insinuates that the writer had perhaps never seen the facsimile reprint when he uttered this shocking heresy. The fact is, that the excellent reprint showed that the MS. in question was written in an extremely legible and distinct hand, while Tycho's astronomical MSS. in Copenhagen are anything but pleasant to wade through, and we are still of the opinion that it is very doubtful (to say the least) whether the MS. in question was written by Tycho himself. But this is really of no consequence, as nobody doubts that he is the author of it. The University Library also possesses a MS. copy of the table of sines of Copernicus, written by Tycho. Of much greater interest is a copy of the edition of Ptolemy's works of 1551, on the title-page of which Tycho has written that he bought it at Copenhagen on November 30, 1560, for two thaler. He was barely fourteen years of age when he obtained this standard work, and he made good use of it, as appears from the great number of marginal notes which he entered in it from time to time. We should have liked very much to have learned something about these notes, which doubtless would throw much light on the growth of the owner's knowledge, but

FIG. 1.—Portrait of Tycho Brahe.

[1] "Prager Tychoniana." Gesammelt von Prof. Dr. F. I. Studnicka. 65 pp. 8vo, with a coloured frontispiece and illustrations in the text. (Prague, 1901.)

we are told nothing about the nature of the notes, nor about those written in a copy of the work of Copernicus (the Basle edition of 1566), which are also supposed to be in Tycho's hand.

One of the finest Tychoniana at Prague is a copy of the original edition of the "Astronomiæ Instauratæ Mechanica," printed (apparently in a small number of copies) in 1598. As in several other existing copies, the illustrations in this one have been coloured by hand, and there is a portrait inserted in it of which we are glad to be able to append a copy as well as a copy of the author's dedication to the Bohemian Baron von Hasenburg. As we have already remarked elsewhere ("Tycho Brahe," p. 263), this portrait does

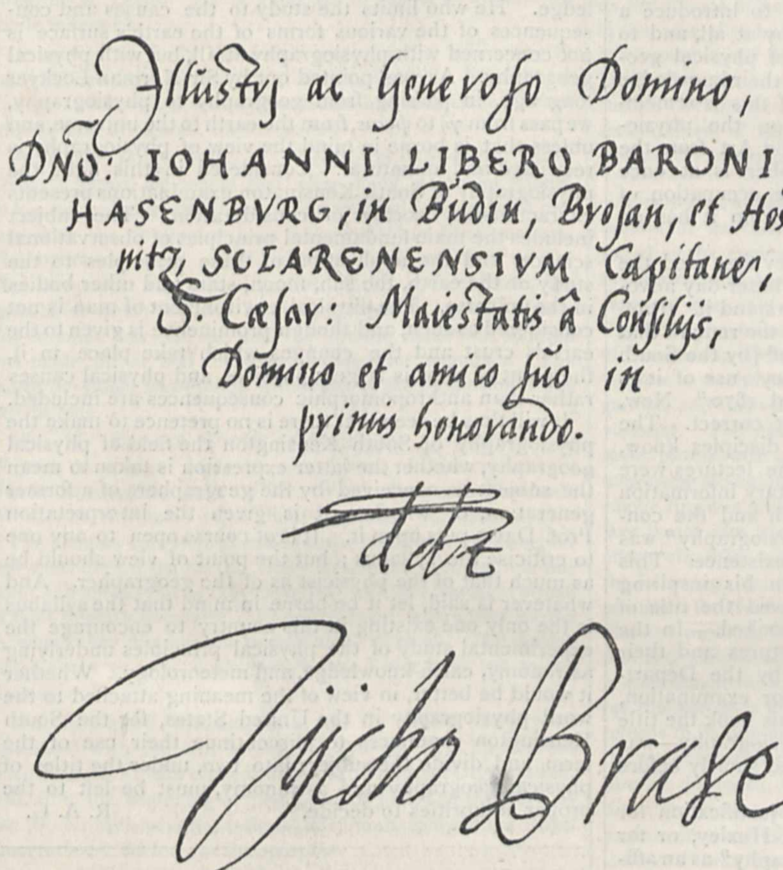


FIG 2.—Autograph Dedication by Tycho Brahe.

not offer much resemblance to those already published; but as Tycho himself distributed copies of it pasted into this magnificent book, we shall perhaps be justified in thinking that he considered it a good likeness.

Finally, Dr. Studnicka gives a picture of a sextant made by Habermehl, of Prague, in 1600, and which tradition insists must have belonged to Tycho, though it has none of the characteristics of his own instruments. Though this memoir does not bring out any new facts, the numerous illustrations in it are very interesting, and it is a pleasant proof of the veneration in which the memory of the great astronomer is held in the country where he finished his career. J. L. E. D.

PHYSIOGRAPHY AND PHYSICAL GEOGRAPHY.

THE progress of science, and human perversity, are jointly responsible for remarkable variations undergone by scientific words and terms with the lapse of time. Natural science, which once comprised all knowledge obtained by experiment and observation, now, as many think, only signifies natural history; physical science includes chemistry; physical astronomy is no longer the astronomy of Kepler, but that of the telescope and spectroscope; and physical geography is gradually assuming the name of physiography without acquiring the breadth of view which characterises this science. An article by Prof. W. M. Davis in the *School Review*, published by the University of Chicago Press, brings this nominal metamorphosis prominently before us. Prof. Davis defines physical geography—or physiography—which he considers as synonymous, as "the study of those features of the earth which are involved in the relation of earth and man; that is, the study of man's physical environment." So far as physical geography is concerned, this statement of its boundary lines is satisfactory, but when Prof. Davis uses the definition as a touchstone to test the character of physiography as understood by the examiners for the Department of Science and Art, he employs a criterion having no logical basis whatever.

Though, unfortunately for precision of scientific expression, physiography is often taken to mean physical geography, especially in the United States, the two departments of knowledge ought to be distinctly recognised as separate and fundamentally different in scope. It is perhaps a little late in the day to insist upon the distinction, for a hybrid has been produced which has commendable features and gives hopes of fertility; but what we do object to is that the hybrid is being used as a type-specimen, and its parents are being compared with it to their own detriment. To drop the metaphor, the physiography of South Kensington is criticised by Prof. Davis because it does not possess the points of virtue characteristic of physical geography in the sense understood by him. As he appears to be under a misapprehension as to the original use of the word and the scope of the subject—an obliquity shared, moreover, by many other physical geographers—it may be worth while to recall the circumstances which led to its adoption.

Until the year 1877 the Department of Science and Art held examinations in physical geography as generally understood. The Education Department also held examinations in physical geography. Grants in aid of teaching were made for successful candidates by each Department; but it was found that many pupil teachers presented themselves for examination by the Department of Science and Art after they had passed the examination of the Education Department, and they thus earned grants twice over for the same subject. To avoid this duplication, it was decided to limit physical geography to the Education Department, and to give the subject under the Department of Science and Art a wider scope and call it physiography. The subject was instituted in place of physical geography by a minute of the Lords of Committee of Council on Education dated August 15, 1876, and the first examination was held in the following year, the syllabus having been drawn up by Sir Norman Lockyer. The deliberate purpose was to introduce a subject which was not physical geography at all, and to prevent candidates with a knowledge of physical geography only from scoring a success upon their knowledge in the examinations in physiography. If this is remembered, the unreasonableness of criticising the physiography of the Department of Science and Art from the point of view of the physical geographer is at once obvious. There is nothing to justify the occupation of this position, and the comparison made from it has no significance.

The general impression is that Huxley first used the word physiography in the sense in which latter-day advocates of physical geography like to understand it. Prof. Davis commits himself to this opinion in the remark that "the term physiography has been adopted [by the South Kensington authorities] because of Huxley's use of it as a title for a series of lectures in 1869 and 1870." Now, as a matter of fact, this statement is not correct. The subject of the lectures was, as Huxley's disciples know, the Thames and its basin; and when the lectures were published eight years later, some elementary information was added on the movements of the earth and the constitution of the sun, and the title of "Physiography" was given to the book thus brought into existence. This Huxley clearly stated in the preface to his inspiring volume, and he also remarked "I borrowed the title of physiography," but that is usually overlooked. In the interval between the delivery of the lectures and their publication, physiography was adopted by the Department of Science and Art as a subject for examination, and what Huxley really did was to give his book the title of the new subject. The same title—physiography—was used by Prof. Ansted for a book published shortly before Huxley's work.

It therefore appears that there is no justification for fathering the term physiography upon Huxley, or for using the contents of his book "Physiography" as an affidavit testifying to the devolution which the subject has undergone on account of the South Kensington examinations. An acquaintance with the actual circumstances which caused the introduction of the subject and the adoption of its title by Huxley would have enabled Prof. Davis to see the matter in a little better light than that in which he wrote his criticism.

It is, however, not the object here merely to show the weak points of a criticism; that is, after all, a small matter in comparison with the meaning which should be attached to the word physiography. Etymologically considered, physiography is the science which is concerned with the facts and phenomena of the whole of nature, and therefore embraces all the natural and physical sciences. The separate sciences have had their fields of activity staked out, and work is continuously carried on in them; but the boundaries are only marked here and there, and it becomes more difficult to define them every day. The amalgamation of all these interests in a company which aims at increasing natural knowledge, represents in a way the relation between the separate sciences and physiography conceived in the widest spirit. Perhaps a philosopher will one day arise and produce from the discrete collections of scientific facts a structure in which all available material shall be fitted into its true place; and the monument thus erected should be called physiography. Or, using another simile, what is wanted is a Darwin who will trace the complete development of organic and inorganic sciences, and show the mutual relations between the stores of knowledge at present kept in different departments. The work in which this is done will be a work on physiography.

The complete co-ordination of scientific material can, however, only become possible when omniscience is reached; what the apostles of physiography have now to do is to preach the gospel of the study of all natural knowledge. He who limits the study to the causes and consequences of the various forms of the earth's surface is not concerned with physiography at all, but with physical geography. As was pointed out by Sir Norman Lockyer long ago, in passing from geography to physiography, we pass from γῆ to φυσις, from the earth to the universe, and unless that is borne in mind the view of physiography is restricted and unnatural. Considered in this light, the physiography of South Kensington examinations presents characteristics worthy of consideration. The subject includes the main fundamental principles of observational science, and the application of these principles to the study of the earth, the sun, moon, stars and other bodies in the universe. The physical environment of man is not considered as such, and though prominence is given to the earth's crust and the changes which take place in it, the point of view is largely physical, and physical causes rather than anthropomorphic consequences are included.

It will thus be seen that there is no pretence to make the physiography of South Kensington the field of physical geography, whether the latter expression is taken to mean the subject as conceived by the geographers of a former generation, or whether it is given the interpretation Prof. Davis puts upon it. It is of course open to any one to criticise the syllabus; but the point of view should be as much that of the physicist as of the geographer. And whatever is said, let it be borne in mind that the syllabus is the only one existing in this country to encourage the experimental study of the physical principles underlying astronomy, earth-knowledge, and meteorology. Whether it would be better, in view of the meaning attached to the word physiography in the United States, for the South Kensington examiners to discontinue their use of the term, and divide the subject into two, under the titles of physical geography and astronomy, must be left to the proper authorities to decide. R. A. G.

NOTES.

WE learn from the *Times* that on Saturday last Prof. Slaby, of the Charlottenburg Technical High School, gave an interesting lecture before the Emperor of Germany and a distinguished company upon improvements which his former assistant, Count Arco, and himself have made in the art of wireless telegraphy. It has not hitherto been possible to use wireless telegraphy for communicating with several different stations at the same time. Prof. Slaby has now succeeded in overcoming this difficulty, and on Saturday night he communicated from the conference room of the General Electric Company in Berlin with operators in the laboratory of the Technical High School at Charlottenburg and in the works of the General Electric Company at Ober Schönweide. These two stations are distant about two and eight miles respectively from the conference room in which the experiment was conducted. Prof. Slaby used two instruments, both of which were connected with a lightning conductor in the neighbourhood. One of the instruments was made to syntonise exactly with that in the laboratory at Charlottenburg, the other with the instrument in the works at Ober Schönweide. The experiment was a great success, especially in view of the fact that the greater part of Berlin separated the conference room from one of the stations with which messages were exchanged. The German Emperor displayed the greatest interest in the experiments, and afterwards conversed for some time with Prof. Slaby and Count Arco.

WE much regret to announce that Lord Armstrong, F.R.S., died this morning (December 27), at his seat, Cragside, Rothbury, Northumberland.

LORD KELVIN, Master of the Clothworkers' Company, has accepted an invitation to dine with the governors of the Yorkshire College on February 1, on the occasion of their annual gathering at Leeds. He is expected to deliver an address on textile industries.

IN answer to Lady Warwick's appeal for a millionaire to continue and develop the work of her Women's Agricultural College at Reading, a wealthy gentleman has since come forward with an offer of 50,000*l*. for the hostel.

PROF. F. E. NIPHER, of Washington University, Saint Louis, Missouri, announces that, after many months of failure, he has succeeded in developing a fine reversed photographic picture with the developing bath fully exposed to direct sunlight. The operation lasted a full half-hour, with no trace of fog. The developer was a modification of the hydrochinone, the formula for which is given in every box of "Cramer" plates. The bromide was left out, and the sodium carbonate solution was made up at half the strength used for negatives. The mixed developer was diluted with water in the proportion of one part to nine.

MR. W. ERNEST COOKE, Government Astronomer of Western Australia, sends us an account of observations of November meteors, made by Mr. W. C. Best near Newcastle (W.A.), on November 10, at about 9.30 p.m. Mr. Best says:—"The meteors appeared to come from a north-easterly direction and went toward the north. They all seemed to come from one point and spread out as they travelled, each one leaving a streak of light to mark its course. From the point where they started to where they disappeared seemed about 5° or 6°. The display lasted about 30 secs., during which time I saw from 100 to 200 stars shoot."

MR. SOWERBY WALLIS, who was for nearly thirty years associated with the late Mr. G. J. Symons, F.R.S., and has since the latter's death carried on the British Rainfall Organisation, will, from the beginning of next year, be joined in the work by Dr. H. R. Mill, who has resigned the librarianship of the Royal Geographical Society for that purpose.

THE Paris correspondent of the *Chemist and Druggist* states that at the Paris Natural History Museum a laboratory has recently been opened for biological studies applied to the French colonies. The work of the new laboratory will be to reply to inquiries relating to biology, geology and mineralogy, and to prepare precise instructions for foreign correspondents regarding the rearing of animals and cultivation of plants in the respective countries.

OUR attention has been directed to the following surprising announcement, made by the Pekin correspondent of the *Times*: "In pursuance of their regrettable policy of appropriation, the French and German generals, with Count von Waldersee's approval, have removed from the wall of Pekin the superb astronomical instruments, erected two centuries ago by the Jesuit fathers. Half of them will go to Berlin and the rest to Paris. The explanation of this act of vandalism is that, inasmuch as the return of the Court is so improbable, such beautiful instruments should not be exposed to the possibilities of injury when Pekin is no longer the capital."

AN exhibition of photographs by Mr. F. M. Sutcliffe, of Whitby, will be opened on Wednesday next, January 2, in the rooms of the Royal Photographic Society. Admission can be obtained on the presentation of a visiting card.

A NEW meteorological observatory was opened at Aachen (Aix-la-Chapelle) in September last and placed under the superintendence of Dr. P. Polis. From all points of view this establishment is well fitted for carrying on, not only the usual climatological observations, but various researches in atmospherical physics. The last volume of the observations has just been published, for the year 1899, and contains the records for six subsidiary stations, in addition to the records of about thirty rainfall stations, and several valuable discussions, including one on the climate of Aachen. Observations were first commenced in the year 1838 by Dr. Heis, and since 1873 the observatory has formed one of the official stations of the German network. Dr. Polis is a constant contributor to meteorological science in various German periodicals, and we congratulate him upon the establishment of his new observatory and the means now at his disposal for increased usefulness.

THE recent attempts to disperse hail storms by the firing of cannon or mortars, and the suggestion that vortex rings projected by the explosion may be the actual cause which disturbs the storm-cloud, have led Dr. G. Vicentini and Dr. G. Pacher to carry out a series of experiments on the velocity of these so-called "gaseous projectiles." The general conclusions agree with those of Pernter and Trabert, according to which the velocity of these vortices is much smaller than was supposed in the earlier investigations, and this velocity gradually decreases in consequence of viscosity. The authors find that in experiments on a small scale, pistols with a conical barrel give the best results. Some interesting laboratory experiments are described in which a small smoke ring was projected against a target formed of a thin capillary liquid film stretched on a circular frame. The different effects observed, according to the energy of the vortex, include the following: (1) the film bulges out, but returns to its original position, the vortex being arrested; (2) the ring destroys the film and proceeds on its way with diminished velocity; (3) the film is destroyed and the vortex, including most of the smoke, is imprisoned in a bubble which soon falls to the ground; (4) the vortex is imprisoned in a bubble, but the film behind returns to its original position; (5) the bubble which imprisons the vortex remains attached to the film and slowly sinks; (6) the film is destroyed, but the bubble rebounds in the opposite direction to that in which the vortex was projected. These experiments and observations are described in the *Atti del R. Istituto Veneto*, lix. lx.

THE much debated doctrine of partition of energy among the molecules of a gas is once more attacked by Mr. Burbury in the *Philosophical Magazine* for December. The paper consists mainly of an examination of the proofs of the law of equal partition, based on the two alternative methods of Maxwell and Lord Rayleigh, and of Boltzmann respectively, and the conclusions enunciated by Mr. Burbury are as follows: (1) The law of equal partition of energy among the translation velocities is not proved by the Maxwell-Rayleigh method; (2) It is not proved by Boltzmann's method, because the fundamental assumption on which that method is based is not proved; (3) Subject to any proof that may be given hereafter of Boltzmann's assumption, which, however, Mr. Burbury thinks can be disproved, the law is not generally true in any sense whatever. When, however, the density is very small, the mean translational kinetic energies of two molecules of unequal mass will differ only by small quantities of the second order. The law may, therefore, be asserted for the limiting case of an infinitely rare gas.

THE results of a new investigation of the anomalous dispersion of cyanin have recently been published by Dr. C. E. Magnusson in No. 41 of the *Bulletin* of the University of Wisconsin. An attempt has been made to determine the refractive indices throughout the whole spectrum, including the region of the absorption bands, by four distinct methods: (*a*) Direct spectrometer readings in the visible spectrum using solid prisms, the slit being illuminated with monochromatic light produced by an auxiliary spectroscope; (*b*) photographic records of the deviation of a system of monochromatic rays from a Rowland concave grating illuminated by an iron arc; (*c*) a qualitative method, using crossed prisms, and recording the results photographically; (*d*) photographic records of the displacement of the fringes in the Michelson interferometer produced by thin films of cyanin, prepared by dipping plates of glass in alcoholic solutions. To obtain good prisms by Prof. Wood's method, Dr. Magnusson finds that the substance must be heated rapidly, the prism formed and cooled quickly, and at the right temperature; if too cool, the fused mass cannot be pressed between the plates of glass to the required thinness, and if too hot, bubbles make their appearance. The general accordance of the values obtained by the different methods employed results in a fairly accurate dispersion curve for cyanin from the extreme red well into the ultra-violet, and the work with the interferometer gives conclusive evidence of the continuity of the curve through the absorption band in the yellow. It was originally intended to test the Ketteler-Helmholtz dispersion formula for the ultra-violet and extreme red rays, where Pflüger's investigations showed discrepancies. In the case of the ultra-violet it was suggested that the discrepancy might be due to an absorption band, and Dr. Magnusson considers that he has demonstrated the existence of such a band. Until further extensive observations have been made, however, he does not consider a comparison of the new values with the formula likely to be of much service. The results are illustrated graphically, and numerous photographs are reproduced.

AT a meeting of the Anthropological Institute on December 11, Mr. J. W. Crowfoot read a paper on the Bektashis of Cappadocia. Scattered about Turkey in Asia and Persia are many peculiar religious sects, either professing heretical forms of Islam or purely pagan in character, and in both cases hated and persecuted by the orthodox. It has been supposed that the adherents to these sects represent the earliest known inhabitants of the land, and that their religious rites contain relics that go back far beyond the rise of either Mohammedanism or Christianity. With the object of testing this theory, Mr. Crowfoot visited last summer some villages close to the ancient Halys in the Eastern half of Asia minor, occupied by a sect called the Bektash or Kizilbash. Measurements and photographs were taken which corroborate the theory above stated, though evidence was also found of an influx of some more eastern element, driven westwards, probably, at the time of the great Mongol invasions. These people are nominally worshippers of Ali, but in reality the worship of "heroes," from whom they profess descent, plays the greatest *rôle* in their religion. In one village there was a sacred well strongly impregnated with sulphur, and the fumes of this were inhaled by a prophetess who lived there until she fell into an ecstatic condition, in which she used to give answers to the many inquirers who resorted there, either to learn the future or to be cured by the "hero." Other survivals of a similar character were described. Some native weapons from the south-west of Lake Tanganyika, lent by Dr. Felkin, were also exhibited and described at the same meeting.

DR. J. BEARD has sent us a copy of his paper on the morphological continuity of the germ-cells in *Raia batis*, which appeared in the *Anatomischer Anzeiger*, vol. xviii. nos. 20 and 21. Germ-cells appear to be unicellular organisms, passing one stage of their existence within a multicellular sterilised stock, the embryo, which is formed by one of them at a definite period.

MR. E. S. SHRUBSOLE, the curator of the newly-formed Natural History Department at the Crystal Palace, sends us an announcement of the ten "tableaux" of mounted animals he has prepared for exhibition. They are stated to include 15,000 specimens. We are not at present aware of the manner in which they are arranged, but if they are not grouped according to their place of origin, a grand opportunity of familiarising the public with the leading features in geographical distribution will have been thrown away.

WE have received a copy of a memoir by Dr. S. J. Hickson on the Alcyonaria and Hydrocorallinæ of the Cape of Good Hope, published by the Department of Agriculture of the Cape in the series entitled "Marine Investigations in South Africa." Four new species of Alcyonarians are described; but of more importance are certain new investigations the author has been enabled to make into the anatomy of the group, owing to the excellent state of preservation in which the collection was sent to England. As these investigations are not yet completed, the author has published only the systematic work.

RICKETTS in monkeys that have died in captivity forms the subject of a memoir by Signor A Monti, published in the *Memorie* of the Royal Institute of Lombardy (vol. xix., part 3). The author proposes to defer the discussion of the bearing of his observations on zoology to a future occasion; but he claims for them great importance in regard to certain human diseases. For one thing, they definitely controvert the theory advanced by M. Parrot that ricketts in the human species is due to hereditary syphilis.

PHYSIOLOGICAL and pathological heredity in man forms the subject of Dr. T. Oliver's introductory lecture to a course of clinical medicine delivered in the Royal Infirmary at Newcastle-on-Tyne on October 31, a copy of which we have received from the *Lancet* office. The lecturer takes as his example of heredity the modern racehorse, and states that while none but thoroughbreds have won the Derby, no gelding has ever been first past the winning post, and that in all high-class races mares are much less frequently successful than stallions, although it should be added that they are less frequently entered. In one part of his discourse, Dr. Oliver touches upon the question of "telegony," which, in spite of the Penycuick experiments, he appears to think may not be a myth.

FROM Mr. G. E. H. Barrett-Hamilton we have received copies of five papers, four of which deal with local variation in European species of mammals. With one exception (from the *Annals of Natural History*) these latter are taken from the *Proceedings* of the Zoological Society. The species dealt with are the mountain or variable hare, the wood-mouse, weasel, hedgehog, and dormice. Of the first of these no less than eighteen local races are recognised, several being described for the first time. In districts where it normally turns white in winter the weasel is regarded as subspecifically distinct from the form which remains brown at all seasons. The fifth paper received from Mr. Hamilton is from the *Ibis*, and deals with the birds observed by him in Kamschatka in 1896 and 1897. The most important paragraphs in this communication are those dealing with colour and migration.

THE greater portion of the December issue of the *Zoologist* is taken up with a discussion on conscious protective resemblance in animals. Mr. G. A. K. Marshall commences the discussion with criticisms on Mr. Distant's articles on mimicry which appeared some time ago in the same journal. First of all he expresses the opinion that the term "mimicry" should be restricted to resemblances assumed for the purpose of attracting attention; resemblances for the purpose of concealment being denoted by the terms protective and aggressive resemblance. He then proceeds to inquire whether any of such resemblances can be rightly termed conscious, concluding that the only instance which affords anything like proof of consciousness is one narrated by Mr. E. Thompson concerning the actions of a fox. But even if this be a true instance, the fox is such an abnormally clever animal that the case does not affect other supposed examples; and it is concluded that "there are good grounds for opposing the suggestion that active mimicry is of any general occurrence in the animal kingdom." Prof. E. B. Poulton continues the discussion in the form of notes, in which he gives a general support to the views of Mr. Marshall. Incidentally he mentions that the posture usually given to the leaf-butterfly (Callima) is incorrect. Mr. Distant adds a few remarks in defence of his own views, stating that the questions at issue are largely matters of opinion.

WE have received the first part of a new work by Prof. Der Vries, of Amsterdam, entitled "Die Mutations Theorie." It deals with the origin of new species; and these the author considers to arise solely as the result of sudden sporting, or of discontinuous variation. He does not regard the ordinary variation usually to be observed amongst the individuals of any given race as contributing towards the evolution of new species, but looks upon them as the transient and easily reversible expression of altered circumstances of life. The latter part of the book is occupied with an account of his observations on the "mutations" exhibited by *Œnothera Lamarckiana*, and he claims to have secured a number of discontinuously produced forms which retain their character in successive generations, and which show no tendency towards reversal, nor to the production of forms intermediate between themselves and the parent stock. Even if one does not feel inclined to accept all the author's conclusions, and even if lurking doubts as to the actual purity of the original strain of his Œnothera obtrude themselves on the mind of the reader, the book is worth a perusal for the sake of the lucid manner with which the arguments and facts are brought forward, and (sometimes) constrained to give support to the views therein advocated. It would be, however, premature to discuss the theory as a whole until the completion of the book enables one to form a mature estimate of its real value.

THE November *Journal* of the Royal Horticultural Society provides students of botany and others interested in problems of evolution with plenty of material for thought. Among the subjects dealt with in papers are the evolution of plants illustrated by the cultivated nature of gardens, by Mr. R. I. Lynch; problems of heredity as a subject for horticultural investigation, by Mr. W. Bateson, F.R.S.; aquatic plants, by Prof. G. S. Boulger; protoplasm, the instrument of evolution among plants, by the Rev. G. Henslow, who also contributes several instructive papers on plant structure and growth; the strawberry and gooseberry mildews, by Mr. E. S. Salmon, and descriptions of new plants exhibited at the meetings of the Society. Every one concerned with the science or the art of gardening will find in the *Journal* much suggestive and interesting information.

As a handy compendium of biographical particulars referring to men and women whose names are known in the worlds of literature, art or science, or who are distinguished in other ways, "Who's Who?" now stands alone, for with the 1901 edition, which Messrs. A. and C. Black have just published, is incorporated "Men and Women of the Time." The annual is a good index to the works, recreations and careers of practically every one alive whose influence upon human progress is recognised. All the living Fellows of the Royal Society appear to be included among the biographies, as well as numerous members of other scientific societies. The information tabulated before the biographies includes lists of abbreviations, peculiarly-pronounced proper names, the names and addresses of the chief newspapers and magazines, pseudonyms and pen-names, Fellows of the Royal Society, names, addresses and conditions of admission to scientific and other learned societies, chairs and professors in the universities, university degrees, and other matters of general interest. In the abbreviations we notice "anat.," signifying anatomy or anatomical, and "bot." for botany; but it is not easy to understand why these should be given, while other conventional abridgments, such as "math." for mathematics, "astr." for astronomy, "mech." for mechanics, "mag." for magnetism or magazine, "phys." for physical, "soc." for society," and "phil." for philosophical, are not explained. Either "anat." and "bot." should be omitted or others in just as common use should be inserted. The principle which has led to the selection of other abbreviations is also not clear. We find A.K.C. signifying Associate of King's College, and K.C. for King's College; but we do not see A.R.C.S. for Associate of the Royal College of Science, or U.C. for University College. B. Eng. is given for Bachelor of Engineering, but B.E. is the form usually adopted. D.Sc. is given, but not Sc.D.; and M.I.M.E. (Member of the Institution of Mechanical Engineers) is also omitted, while fellowship of the unrecognised Society of Science and Art is dignified by F.S.Sc.A. In the next edition the professors in the universities of London and Birmingham ought to be added to the list of those occupying chairs in the older universities.

THE additions to the Zoological Society's Gardens during the past week include a Cuvier's Gazelle (*Gazella Cuvieri*) from Algeria, presented by Mr. B. T. Barneby; a Golden Eagle (*Aquila chrysaëtus*) from Scotland, presented by Mr. H. E. Bury; a Rose Hill Parrakeet (*Platycercus eximius*) from Australia, presented by Mrs. Stoughton; a Burmese Tortoise (*Testudo elongata*) from Burmah, presented by Captain A. Pam; a Slow Loris (*Nycticebus tardigradus*) from the Malay Peninsula, three Ring-tailed Coatis (*Nasua rufa*) from South America, a Maximilian Parrot (*Pionus maximiliana*) from Brazil, two Lettered Aracaris (*Pteroglossus inscriptus*) from Para, two Adelaide Parrakeets (*Platycercus adelaidae*), four Plumed Ground Doves (*Geophaps plumifera*) from Australia, two Common Cassowaries (*Casuarius galeatus*) from Ceram, an Ural Owl (*Syrnium uralensis*), a Passerine Owl (*Glaucidium passerinum*), European, five Chestnut-bellied Finches (*Munia rubro-nigra*), six Bungoma River Turtles (*Emyda granosa*), a Roofed Terrapin (*Kachuga tectum*) from India, two Leopard Tortoises (*Testudo pardalis*) from South Africa, a South Albemarle Tortoise (*Testudo vicina*) from South Albemarle Island, three Wrinkled Terrapins (*Chrysemys scripta rugosa*) from the West Indies, a Muhlenberg's Terrapin (*Clemmys muhlenbergi*) from North America, an European Pond Tortoise (*Emys orbicularis*), European, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JANUARY, 1901.

Jan. 2–3. Epoch of the January meteors (Radiant 230° + 53°).
3. 9h. Venus in conjunction with Neptune. Venus 1° 10′ N.
3. 11h. 7m. Minimum of Algol (β Persei).
5. 9h. 45m. to 10h. 50m. Moon occults 1 Cancri (mag. 5·9).
6. 6h. 36m. to 7h. 31m. Moon occults A^1 Cancri, (mag. 5·6).
6. 7h. 56m. Minimum of Algol (β Persei).
6. 13h. 48m. to 15h. 4m. Moon occults 60 Cancri, (mag. 5·7).
9. 4h. 45m. Minimum of Algol (β Persei).
15. 9h. Venus in conjunction with Jupiter. Venus 0° 22′ N.

Jan. 15. Venus. Illuminated portion of disc = 0·902, Mars = 0·949.

17. 21h. Jupiter in conjunction with moon. Jupiter 2° 13′ S.

18. 2h. Venus in conjunction with moon. Venus 2° 12′ S.

18. 16h. Saturn in conjunction with moon. Saturn 2° 41′ S.

19. 18h. 37m. to 21h. 21m. Transit of Jupiter's Sat. III.

24. 8h. Venus in conjunction with Saturn. Venus 0° 20′ S.

28. 8h. 3m. to 8h. 28m. Moon occults 13 Tauri (mag. 5·4).

29. 6h. 0m. to 6h. 37m. Moon occults DM+20°, 785 (mag. 5·8).

30. 14h. 41m. to 15h. 36m. Moon occults χ^1 Orionis (mag. 4·7).

EPHEMERIS FOR OBSERVATIONS OF EROS.—The following is an abridgment of Herr Millosevich's ephemeris for January:—

Ephemeris for 12h. Berlin Mean Time.

1901.	R.A. h. m. s.	Decl. ° ′ ″	Mag.
Jan. 1	2 3 52·80	+37 55 14·5	
3	9 2·80	37 3 39·5	8·44
5	14 27·17	36 12 7·3	
7	20 4·92	35 20 39·0	8·45
9	25 55·21	34 29 15 8	
11	31 57·23	33 37 59·2	8·45
13	38 10·17	32 46 50·5	
15	44 33·19	31 55 51·2	8·46
17	51 5·61	31 5 3·0	
19	2 57 46·65	30 14 27·1	8·47
21	3 4 35·62	29 24 5·4	
23	11 31·79	28 33 59·3	8·49
25	18 34·34	27 44 10·1	
27	25 42·53	26 54 39·0	8·52
29	32 55·50	26 5 26·8	
31	3 40 12·48	+25 16 34·8	8·55

DIAMETER OF VENUS.—In the *Astronomische Nachrichten* (Bd. 154, No. 3676) Prof. T. J. J. See announces the results of a long series of measurements of the diameter of Venus, made with the filar-micrometer on the 26-inch refractor of the U.S. Naval Observatory at Washington. He also prefaces his remarks by a *résumé* of the observations of the diameter which have been made since the time of Galileo (1620).

The difficulties of the determination are summarised thus:—

(1) The enormous change in the geocentric distance of the planet renders the apparent diameter extremely variable.

(2) The thin line-like horns presented when the planet is near inferior conjunction are easily affected by atmospheric disturbances, rendering bisection with the micrometer wire difficult.

(3) As the crescent enlarges the diameter decreases.

(4) Near superior conjunction, although the disc is nearly round, its diameter is so small, and the time of observation is necessarily such that the heated atmosphere has a great disturbing effect on the definition.

(6) Irradiation, which is always great on account of the brilliancy of the planet.

Much of the difficulty due to the brilliancy has been eliminated by the use of coloured screens between the eye and telescope, as described in *A.N.* Nos. 3636, 3665.

The mean of Prof. See's determinations on 22 days gives a mean diameter of

$$16''{\cdot}80 \pm 0''{\cdot}022$$

which is in close agreement with the value 16·820 deduced by Dr. Auwers in 1894 from the transits of Venus in 1874 and 1882.

Several suggestions are included comparing the work with heliometer and filar micrometer on planetary diameters, the two giving variable results with different planets.

REDUCTION OF OCCULTATIONS.—M. L. Cruls, director of the Observatory of Rio Janeiro, has published an improved method of time determination from lunar occultations, based on the exact knowledge of the instant of apparent conjunction of the two bodies. The formulæ of Bessel are slightly modified, and both analytical and graphical solutions given at length, with examples of each.

NATURAL AND ARTIFICIAL PERFUMES.

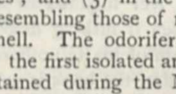
THE passing century has seen the rise and subsequent decay of several great branches of chemical industry. Early in the century, when the chemical methods applicable to the manufacture of alkalis and of alkali products were being actively developed, profits were large, whilst now that the chemical difficulties encountered in the manufacture of alkali have been practically overcome, the financial prosperity of an alkali works depends mainly upon economy in carrying out certain engineering processes; the science of the chemist is now of rather less importance than the art of the engineer. The younger industry of coal-tar dye-stuff manufacture is similarly, though more gradually, developing into a branch of engineering, and in consequence money is not made so rapidly as was once the case. During the last twenty-five years a new chemical industry, that concerned with artificial perfumes, has made rapid progress and would seem to give more promise of both chemical and financial prosperity than either of its elder sisters. Perfumes are only needed in small quantities, but, in accordance with the law that anything ministering to our pleasures fetches a far higher price than a mere article of utility, profits upon a really gigantic scale may be easily obtained; again, the enduring chemical prosperity of the new industry is assured in that a constant succession of new perfumes is absolutely necessary; by the time that improved methods of manufacture and competing processes have lowered the price of a perfume, the material has become unfashionable. No lady would use a cheap perfume. Further, the sense of smell in man is as yet wholly uncultured; in walking through the country we can rarely identify a particular odour caught until the sight of the plant from which it emanates makes us wonder at our hesitation. The coal-tar colour industry found us provided with a highly-developed system of colour perception, whilst the newly-inaugurated artificial perfume industry has to cultivate a neglected sense probably possessing similar artistic potentialities.

The scientific methods adopted in the new industry consist, in the main, of three: (1) in the extraction of odoriferous compounds from the natural products in which they occur; (2) in the artificial preparation of naturally occurring odoriferous compounds by synthetic processes; and (3) in the manufacture of materials possessing odours resembling those of naturally occurring substances of pleasant smell. The odoriferous principle of bitter almond oil was one of the first isolated and subsequently synthesised; the oil was obtained during the Middle Ages by distilling bitter almonds with water, whilst, nowadays, only very small quantities are prepared from the almond. Apricot kernels are first freed from fatty oils by hydraulic pressure, and then caused to undergo a fermentative process. The kernels contain a glucoside, amygdalin, which, at a suitable temperature, is hydrolysed by an unorganised ferment, emulsin, also present, with formation of benzaldehyde, $C_6H_5.CHO$, hydrogen cyanide and grape sugar, in accordance with the equation

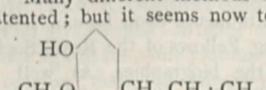
$$C_{20}H_{27}NO_{11} + 2H_2O = C_6H_5.CHO + 2C_6H_{12}O_6 + HCN.$$

The mass is then distilled in a current of steam, and the resulting oil separated from the aqueous distillate and freed from the prussic acid which it still retains. Liebig and Woehler first separated pure benzaldehyde from crude bitter almond oil in 1832. Benzaldehyde is prepared on a large scale by the hydrolysis and oxidation of benzyl chloride by boiling it with cupric or lead chloride solution; the artificial oil retains with great tenacity traces of benzyl chloride, and the penetrating, unpleasant odour of this impurity renders the product fit only for scenting common soaps and prevents its use in perfumery. Nitrobenzene, $C_6H_5.NO_2$, the highly poisonous so-called oil of mirbane, has an odour very similar to that of benzaldehyde, and is sometimes used in its place.

Vanillin, the odoriferous principle of the vanilla bean, is an aldehyde of the constitution

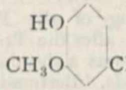


, and was artificially prepared in 1874 by Tiemann and Haarmann; the original method of preparation consisted in oxidising coniferin, a glucoside contained in the sap of various coniferæ, with chromic acid. Many different methods of preparing vanillin have been patented; but it seems now to be mainly obtained from eugenol,

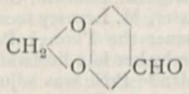


a phenol contained

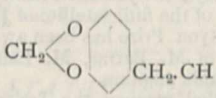
to the extent of 70 to 90 per cent. in oil of cloves; this is heated with alkali, which converts it into isoeugenol

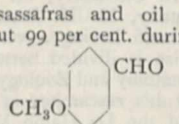
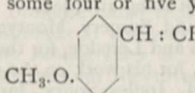
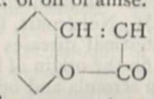


and the latter is then oxidised to vanillin. Synthetic vanillin has practically displaced the vanilla bean for use in perfumery and the manufacture of confectionery, and, in spite of frequent adulteration with sugar, acetanilide and other comparatively valueless materials, the price of the genuine synthetic article is now only a little more than 1 per cent. of that obtained in 1876. The nearly related aldehyde, piperonal,



which has a very powerful odour resembling that of the heliotrope, and is consequently used in perfumery under the name of "heliotropin," is largely prepared from safrole



a methylenic ether contained in oil of sassafras and oil of camphor; its price has dropped by about 99 per cent. during the last twenty years. Anisic aldehyde,  , which has an intense odour resembling that of the hawthorn flower, was greatly in use some four or five years ago; it is prepared from anethol,  , the ether constituting 80 or 90 per cent. of oil of anise. Coumarin, orthohydroxycinnamic anhydride,  , is the material to which the tonka bean, sweet woodruff and new-mown hay owe their characteristic odours; it was synthetically prepared by W. H. Perkin, sen., in 1868, by heating sodiosalicylic aldehyde with acetic anhydride, and was obtained commercially by this method until its recent discovery in considerable quantities in *Liatris odoratissima*, a herb indigenous to Florida, provided a cheaper method of preparation. The pleasant smell of cassia oil is due to its containing from 75 to 90 per cent. of cinnamic aldehyde, $C_6H_5.CH:CH.CHO$, which was first synthesised by Strecker; the aldehyde is readily obtained by condensing benzaldehyde with acetaldehyde in presence of soda, and has, indeed, been commercially obtained by this method at times when the Chinese cassia oil distillers adulterated the oil to too great an extent with petroleum, resin, &c.

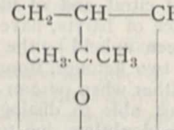
The greater number of the ethereal oils prized in perfumery owe their pleasant odours, not to one constituent alone, but to several, and the smell of the more valuable, such as lavender oil, rose oil, Ylang-Ylang, &c., is a blend of the odours of a number of odoriferous components; the determination of these constituents and their preparation in a state of purity with a view to an ultimate successful imitation of particular ethereal oils has long constituted one of the most intricate problems of industrial chemistry, one, however, which has been attacked with astonishing success. A few of the more important odoriferous principles may be briefly discussed. The aldehyde citral or geranial, $C(CH_3)_2:CH.CH_2.CH_2.C(CH_3):CH.CHO$, constitutes about 6 per cent. of oil of lemons and about 80 per cent. of lemongrass oil, and gives to these oils their lemon-like odour; it is largely prepared, commercially, from lemongrass oil, and is accompanied in nature by its dihydro-derivative, citronellal, $C(CH_3)_2:CH.CH_2.CH_2.CH(CH_3).CH_2.CHO$. Citral was synthesised from acetoacetic ether by Tiemann in 1898, and is converted by reduction into the alcohol, geraniol,

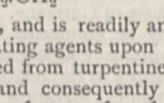
$$C(CH_3)_2:CH.CH_2.CH_2.C(CH_3):CH.CH_2.OH.$$

Similarly, citronellal yields on reduction the corresponding alcohol, citronellol,

$$C(CH_3)_2:CH.CH_2.CH_2.CH(CH_3).CH_2.CH_2.OH;$$

geraniol, further, can be converted into an isomeric alcohol, linalool, $C(CH_3)_2:CH.CH_2.CH_2.C(CH_3)(OH).CH:CH_2$, by heating with water. These three alcohols, geraniol, citronellol and linalool, yield esters with acids, such, for example, as linalyl acetate, $C(CH_3)_2:CH.CH_2.CH_2.C(CH_3)\langle{}^{CH:CH_2}_{O.CO.CH_3}$. These aldehydes and alcohols, together with a number of the esters formed with fatty acids, occur in many ethereal oils. French oil of lavender is distilled from wild lavender in the hills of southern France, and contains 30 to 40 per cent. of linalyl acetate and about an equal quantity of linalool and small quantities of geraniol; English oil of lavender is distilled from the cultivated plant, and contains only 5 to 10 per cent. of linalyl acetate, but considerable amounts of cineol,

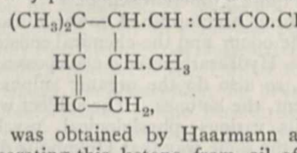


The fact that English oil fetches about ten times the price of the best French oil is a frequent source of unfavourable comment by Continental merchants. Ylang-Ylang oil contains linalool and geraniol, and apparently also the acetic and benzoic esters of both alcohols; the similar, though less valuable, Cananga oil contains smaller quantities of the esters and larger quantities of a sesquiterpene, $C_{15}H_{24}$. Otto of roses, which has for centuries been the most highly prized of all perfume oils, is obtained in the East, in Bulgaria, Germany and, to a small extent, in France, by distilling freshly-gathered roses with water; it contains a wax-like hydrocarbon, the so-called stereoptene, and during the last month Walbaum and Stephan have shown that German rose oil owes its odour to geraniol, citral, citronellol, linalool, nonylic aldehyde, $C_9H_{19}.CHO$, and phenylethylic alcohol, $C_6H_5.CH_2.CH_2.OH$. It is interesting to note that Neroli oil, which contains linalool, geraniol and linalyl acetate, owes its odour in part to the presence of a small percentage of methyl anthranilate,  ; this substance, in an undiluted condition, has a somewhat unpleasant odour, but when highly diluted smells very much like oil of bitter orange. An alcohol termed terpineol,

$$CH_3.C(OH)\langle{}^{CH_2.CH_2}_{CH_2.CH_2}\rangle C:C(CH_3)_2,$$

is found in many essential oils, and is readily and cheaply prepared by the action of dehydrating agents upon terpin hydrate, which in turn is easily prepared from turpentine oil; terpineol has a powerful odour of lilac, and consequently finds extensive application as a basis in the manufacture of perfumes.

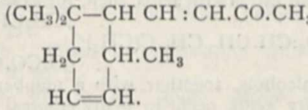
Oil of orris, mainly obtained from Italian orris root, consists, to the extent of about 35 per cent., of the odourless myristic acid. In 1893 Tiemann and Krueger showed that the odour of fresh violets possessed by the oil is due to the presence of a small proportion of a ketone to which they gave the name irone; as the result of an important piece of experimental work, they proved that irone has the constitution



and a patent was obtained by Haarmann and Reimer for a method of separating this ketone from oil of orris. Tiemann and Krueger, before actually ascertaining the constitution of irone, conceiving the possibility of preparing a substance of the same molecular composition as irone from citral, endeavoured to do so in order to obtain information as to the constitution of the ketone. They found that, on allowing a mixture of citral and acetone to remain in contact with baryta solution, an ordinary acetone condensation slowly occurs with formation of a ketone, the so-called pseudoionone, having the constitution

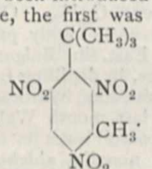
$$CH(CH_3)_2.CH_2.CH:CH.C(CH_3):CH.CH:CH.CO.CH_3.$$

Pseudoionone has a peculiar but not very pronounced smell, and, when heated with a mixture of water, glycerol and sulphuric acid, undergoes conversion into an isomeric ketone, termed ionone, which possesses the constitution



Ionone possesses an odour of fresh violets, which also feebly recalls that of grape blossom; it is manufactured on a large scale for use in the preparation of violet perfumes. The preparation of homologues of ionone from citral and methylethylketone has also been protected, and numerous attempts to evade the original patents have naturally been made; the use of lemongrass oil in place of citral, and of bleaching powder as a condensing agent in place of baryta, have been patented, but these patents have not been upheld by the Courts. It is a very remarkable fact that the two ketones, irone and ionone, possess odours so similar that, either when pure or diluted with alcohol, a trained nose is only just able to distinguish between them. The similarity in odour is doubtless due to the almost identical type of molecular grouping contained in the two compounds. Oil of turpentine consists essentially of a hydrocarbon of similar molecular type to irone and ionone, and it is a very noteworthy fact that turpentine, when administered internally, imparts a strong odour of violets to the urine; so far as can be ascertained, this fact has received no commercial application.

A number of substances have been introduced into commerce as substitutes for musk; of these, the first was the trinitroisobutyltoluene of the constitution



It is obtained by nitrating isobutyltoluene, which is, in turn, prepared by the interaction of isobutyl chloride and toluene brought about by aluminium chloride. This and other trinitro-derivatives of benzenoid hydrocarbons containing two alkyl groups in the meta-position possess a powerful odour of musk, and have been used to a considerable extent in perfumery.

The investigation and manufacture of artificial and synthetic perfume materials have been only carried on to a very small extent in this country; the new industry is almost wholly of German origin. During recent years, however, France appears to have been making great strides in synthetic perfume manufacture, and at the Paris exhibition this branch of chemical manufacture seems to be the only one in which the French exhibits equal, or even excel, those of Germany. The cause of this is obscure, but may possibly be connected with the generally recognised principle that supremacy in any particular industry goes hand in hand with supremacy in the related sciences; and all students of contemporary chemical literature will agree that in Germany the science of chemistry has been in rapid decadence during recent years. A good organisation, administered by a master, accomplishes great results; but when the directing hand is gone, the very organisation itself is found to have stultified the faculty for independent thought on the part of those originally destined by nature to take the lead. Subsequently the system aids only in the filling up of immaterial details, and the pioneer work is transferred to men from quite a different school.

Little has yet been accomplished towards ascertaining the relation between the odour and the chemical constitution of substances in general. Hydrocarbons as a class possess considerable similarity in odour, so also do the organic sulphides and, to a much smaller extent, the ketones. The subject waits for some one to correlate its various physiological, psychological and physical aspects in the same way that Helmholtz did for sound. It seems, as yet, impossible to assign any probable reason to the fact that many substances have a pleasant odour. It may, however, be worth suggesting that certain compounds, such as the volatile sulphides and the indoles, have very unpleasant odours because they are normal constituents of mammalian excreta and of putrefied animal products; the repulsive odours may be simply necessary results of evolutionary processes. W. J. P.

PRIZE LIST OF THE ACADEMY OF SCIENCES.

AT the annual public meeting of the Paris Academy of Sciences, on December 17, after the Presidential Address of M. Maurice Lévy, in which was a short account of the life work of MM. Milne-Edwards, Bertrand, Blanchard and Grimaux, the list of awards for the year 1900 was given.

In Geometry, the Grand Prize of the Mathematical Sciences was awarded to M. Mathias Lerch for work on the number of certain classes of quadratic forms; the Francœur Prize to M. Edmond Maillet, and the Poncelet Prize to M. Léon Lecornu. No memoir was received complying with the terms of the Bordin Prize. In Mechanics, the Extraordinary Prize of 6000 francs was divided between MM. Laubeuf, Charbonnier, Aubusson de Cavarlay and Grasset, M. Lerosey receiving the Montyon Prize, and Mme. Moissenet the Plumey Prize as a mark of esteem for the work done by her late husband.

In Astronomy, the Lalande Prize was adjudged to M. Giacobini for his work on comets; the Damoiseau Prize to M. J. von Hepperger for his work on the influence of the planets upon comets: the Valz Prize to M. l'Abbé Verschaffel for work done at the Abbadia Observatory; the Janssen Prize to Prof. Barnard for his brilliant discovery of the fifth satellite of Jupiter.

In Statistics, the Montyon Prize has been awarded to M. du Maroussem, the works of M. Barras, M. Laussedat and M. Pailhas receiving honourable mention.

In Chemistry, M. Béhal receives the Jecker Prize, and in Botany, M. H. Bruchmann the Desmazières Prize, M. Gyula Istvanfi having a very honourable mention. The Montagne Prize is divided between MM. Delacroix and Boistel. In Anatomy and Zoology the Thore Prize is awarded to M. Seurat for his researches on the parasitical larvæ of the Hymenoptera, and the Da Gamo Machado Prize to Mme. la Comtesse de Linden, M. Siedlecki, M. P. Carnot and M. Bordas, the Savigny Prize not being awarded.

In Medicine and Surgery, Montyon Prizes are adjudged to MM. Hallopeau and Leredde, for their treatise on dermatology; M. Guilleminot, for his work on the medical applications of the X-rays; and M. Joules Soury, for his book on the central nervous system. In connection with these prizes, mentions are accorded to M. Nobécourt, for his work on the pathogeny of the gastro-intestinal diseases of young children; M. Sabrazès, for his work on the origin of blood corpuscles; and M. Gallois, for a book on scrofula and odenoidal diseases; MM. Cunéo and Toulouse receiving citations. The Barbier Prize is divided between M. Marage, for a memoir on the theory of vowel formation, and M. Guinard, for a pharmacodynamic study of morphine and apomorphine, a mention being accorded to MM. Bræmer and Suis. In default of the discovery of an absolute specific for cholera, the arrears of interest on the Bréant Prize are divided between M. Auclair, for researches on the toxic substances contained in tubercle bacilli, and M. Paul Remlinger, for a memoir on some rare complications of dysentery, and the association of dysentery with typhoid fever. The Godard Prize is given to M. Léon Bernard, for his researches on the functions of the kidney in chronic nephritis; the Parkin Prize to M. Henri Coupin, for work done in plant physiology; the Dusgate Prize to M. Icard, for methods of diagnosis of real and apparent death; the Baron Larrey Prize to MM. Nimier and Laval, for three works on projectiles and explosives; the Bellion Prize being divided between M. J. Brault, for his treatise on tropical diseases, and M. Samuel Gache, for his treatise on workmen's dwellings in Buenos Ayres; the Lallemand Prize between M. Maurice de Fleury, for various treatises on medicine, and M. de Vabias, for his researches on the nervous system of aquatic gasteropods. Honourable mentions are accorded to MM. Knopf, Jacquet and M. Finck.

In Physiology the Montyon Prize is divided between M. Pachon for studies on cardiac and vascular mechanism and Mdlle. Jotéyko for memoirs on nervous effort and fatigue, and the Philipeaux Prize between M. Delezenne for his reseaches on anti-coagulating substances and M. Nicloux for experimental researches on the elimination of alcohol in the organism, M. Roussy receiving honourable mention; the Pourat Prize is awarded to MM. Bergonié and Sigalas for a determination of the principal anthropometric data; and the Martin-Damourette Prize to M. Long for his studies on the central paths of general sensibility. In Physical Geography, M. Lugeon receives the Gay Prize for his theory on the origin of Alpine valleys.

Among the General Prizes, a Montyon Prize is awarded to

M. Trillat for his applications of formaldehyde to industry, and to MM. Sévène and Cohen for their use of phosphorus sesquisulphide in the manufacture of matches in the place of ordinary phosphorus; the Cuvier Prize to M. Antoine Fritsch for his treatises on European Birds and on Palæontology, the Wilde Prize to M. Delépine, for his experimental researches on aldehydes; the Vaillant to M. Henri Gautier, for his work on alloys and on the atomic weight of boron; and to M. F. Osmond, for his researches on iron and steel; the Frémont Prize to M. Ch. Frémont, for his results on the testing of the resistance of metals; the Gegner Prize to Mme. Curie; the Delalande-Guérineau Prize to M. Maurain and M. Lacombe, for their work on the measurement of an arc of meridian at Quito; the Jérome Ponti Prize to MM. P. Girod and Massénat; the Tchihatchef Prize to M. de Loczy, for work on the Physical Geography and Geology of Eastern China; the Houllevigne Prize to M. Wallerant, for his researches in Crystallography. The Boileau Prize is divided between M. Sautréaux, M. Delemer and M. Nau; the Cahours Prize between M. Mouneyrat, M. Metzner and M. Defacqz.

The Saintour Prize is awarded to M. Debureaux, the prize founded by the Marquise De Laplace to M. Macaux, and the prize founded by M. Félix Revot to MM. Macaux, de Schlumberger, Martinet and Hardel.

UNITED STATES GEOLOGICAL SURVEY.

THE work of the Geological Survey of the United States comes before us in almost overwhelming amount, and yet, as we take note of the publications, we have no sentiment but that of admiration for the evidence they give of brilliant, useful and painstaking research: research, too, of very varied character.

Bulletins.

A dozen numbers of the *Bulletin*, dated 1898 and 1899, have all been received since midsummer of this year.

Nos. 156 and 162 on the Bibliography of North American Geology for 1897 and 1898, contain the titles with, in many cases, brief notes of the contents of all geological publications dealing with the United States and Canada. Seven hundred and forty-two articles are recorded for 1897, and 941 for 1898. Here, indeed, is the index to a vast amount of information, which to be made available for general reference requires, ultimately, to be tabulated and summarised under many subjects.

Bulletin No. 154 is "A Gazetteer of Kansas," containing a list of all hamlets, post villages and townships, with, as far as possible, notes of their area, population and altitude; the whole prefaced with general statistics. No. 160 is the third edition of "A Dictionary of Altitudes in the United States," a work of 775 pages, arranged alphabetically, according to the localities in the several States. In Nos. 155 and 161 we find records of the earthquakes which happened in California in 1896, 1897 and 1898. A scale, divided into ten numbers, is given for estimating the intensity of shocks Thus No. vi. notes "general awakening of sleepers; general ringing of bells; swinging of chandeliers; stopping of clocks; visible swaying of trees; some nervous persons run out of buildings; window glass broken"; while No. x. tells of "Great disasters; overturning of rocks; fissures in the surface of the ground; mountain slides."

We pass on to other Bulletins, and in No. 152 have "A Catalogue of the Cretaceous and Tertiary Plants of North America," by Mr. F. H. Knowlton; and in No. 152, "A Bibliographic Index of North American Carboniferous Invertebrates," by Mr. Stuart Weller. These works must prove of the greatest value for reference. They are clearly printed, the synonyms are recorded, and there are lists of works on the subjects dealt with.

Other numbers of the Bulletin are of a different character. In No. 151 we have an account of "The Lower Cretaceous Gryphæas of the Texas Region," by Messrs. R. T. Hill and T. W. Vaughan. Fossil oysters have always been regarded as a troublesome and variable group, mainly, as the authors believe, because they have not been properly understood and classified. These fossils are, however, important, not merely from a zoological, but from a stratigraphical point of view, as shown by certain deep borings for artesian water in Texas. Abundant material is to be found in that country for their study. They lie strewn upon the surface in such numbers that they are sometimes used for road material or collected and burned into lime. Extensive masses of indurated strata are composed of them. The pebbles in the streams are largely made up of oysters. They represent many genera and species, and are of all sizes, from individuals less than an inch in length to shells which weigh 5 lbs. and more. They are found at various horizons throughout 4000 and more feet of rocks constituting the Cretaceous system in Texas. There is thus ample material for a study of the fossils from a phylogenetic and morphologic standpoint, and the authors here give their special attention to the Gryphæas. The work is admirably illustrated, and it is not obscured in any way by the indiscriminate naming of specimens.

No. 157, on "The Gneisses, Gabbro-schists and Associated Rocks of South-western Minnesota," by Mr. C. W. Hall, No. 158, on "The Moraines of South-eastern South Dakota," by Mr. J. E. Todd, and No. 159, on "The Geology of Eastern Berkshire County, Massachusetts," by B. K. Emerson, are all well illustrated, full of information of local importance and of much that is of general interest.

Indiana Report.

The geology and natural resources of Indiana are treated of by Mr. W. S. Blatchley, the State geologist, in the twenty-fourth annual report of the department (1899). The volume is one of 1078 pages, and is largely occupied with a catalogue, by Mr. S. Coulter, of the flowering plants and of the ferns and their allies indigenous to Indiana. A considerable portion is also taken by a descriptive and illustrated catalogue of the mollusca of the State, by Mr. R. E. Call. These include a large number of *Unios*. The dragon flies of Indiana are enumerated and described by Mr. E. B. Williamson, and there are notes on the batrachians and reptiles of Vigo county, by Mr. W. S. Blatchley. The economic resources of Indiana include coal, petroleum, natural gas, stone and clays. The amount of natural gas is restricted, and a failure of supply is expected. A great increase of activity in the coal regions is noted. There is estimated to be forty billions of tons of coal in Indiana, of which one-fifth is reckoned as workable under present conditions. Excellent coal for steam and household purposes and for blast-furnaces is obtained. Dr. A F. Foerste contributes an article on the Middle Silurian rocks of the Cincinnati anticlinal.

U.S. Annual Reports.

Parts i., iv. and vi., and portions of Part ii. of the nineteenth annual report were noticed in NATURE for April 19. We have since received Parts ii., iii. and v., four volumes, including an atlas. Part ii., which comprises 958 pages and 172 plates, is somewhat heavy and unwieldy as a work of reference. Of articles not previously noticed, one by Mr. C. W. Hayes deals with the physiography of the Chattanooga district in Tennessee, Georgia and Alabama. The city of Chattanooga lies almost in the centre of this district, and the term physiography is used in a purely geographical sense. The article is an essay on denudation, written according to the principles of modern geography. The author deals with the formation of three successive peneplains, and shows how the drainage has been modified and diverted until the present topographic features were developed. The peneplains are considered as the product of subaërial erosion. The term geomorphology is used for the description, classification and correlation of the land forms; and geomorphogeny for the natural processes by which these forms have been developed. The author gives definitions of other physiographic terms, which are being introduced at a somewhat alarming rate.

Another article in Part ii. is on the Geology of the Richmond Basin, Virginia, by Messrs. N. S. Shaler and J. B. Woodworth. The area is important from an economic point of view as it contains the only free-burning coal immediately adjacent to tide-water in the eastern portion of the United States. The strata are of Jura-Trias age, the fossils from the lower portion of them being more closely related to the Rhætic deposits of Europe than to those of any other horizon. The beds are grouped as the Newark formation, and they rest locally on a surface of igneous and crystalline rocks. Natural coke occurs in the strata, and is due to the intrusion of igneous rocks; it is denser than artificial coke. The bituminous coals are sharply parted from the cokes as the effects produced by the igneous rocks end abruptly. Mr. F. H. Knowlton contributes some notes on fossil coniferous wood from the Richmond Basin.

In Part v. the subject of Forest Reserves is elaborately dealt with by Mr. Henry Gannet and others. An endeavour is made to estimate the present amount of woodland distributed in the different States. Texas has the largest area, of about 64,000 square miles, while Arkansas has the largest percentage of woodland. The question of the protection of forests is one that is engaging much attention, so that the statistics and general information here brought together must be of great value. The report is illustrated by an atlas.

Of the Twentieth Annual Report we have received Part i. and Part vi. (2 vols.). Part i. contains the report of the Director, Mr. Charles D. Walcott, an admirable record of systematic work, which evidently receives the sympathy and substantial support of Congress. The appendix contains details of triangulation and spirit-levelling, and the work is accompanied by maps showing the progress of the surveys. Part vi. is on the Mineral Resources for 1898, the subject being under the direction of Mr. David T. Day. The total value of the mineral productions is the largest ever recorded in the history of the United States. All the metals, except nickel, made large gains, copper, lead, zinc, aluminium and antimony reaching their maximum, both in production and value. The amount of pig-iron produced was greater than in any other year, but the value was less. The non-metallic products also show an increase, especially bituminous coal, and in a lesser degree stone, petroleum and natural gas. The coal product amounted to about two hundred millions of tons.

Monographs.

Monograph No. 32, Part ii., is a large and handsome volume on the Geology of the Yellowstone National Park, by Mr. Arnold Hague and numerous colleagues. It opens with an account, by Messrs. J. P. Iddings and W. H. Weed, of the Gallatin Mountains, which consist of sedimentary strata ranging from Cambrian to Carboniferous, Jura-Trias, and Cretaceous (Laramie). Disturbances at the close of the Laramie formation were accompanied by igneous intrusions in the form of large laccolites, mainly andesitic in character. Electric Peak and Sepulchre Mountain are described as parts of a Tertiary volcano which was faulted across the conduit, the amount of vertical displacement having been more than 5000 feet.

Mr. Hague describes a mountainous area in the southern part of the Park, comprising ridges formed partly of Palæozoic but chiefly of Cretaceous rocks. The irregular outline of the mountains is due to the rhyolites of the Park Plateau that abut against the slopes of the upturned sedimentary strata. The Snake River hot springs are situated near the contact of the rhyolite with the Madison (Carboniferous) limestone, whence the travertine of the springs is derived. Mr. Iddings gives a particular account of the Miocene volcano of Crandall Basin, which arose on a ridge of Palæozoic rocks and on remnants of Eocene breccias and lava flows. The volcano consisted of andesitic breccias capped by basalt flows and traversed by dykes. It must have risen 13,400 feet above the limestone floor. The igneous rocks of the Absaroka range, and others which lie within Yellowstone Park, are specially dealt with by Mr. Iddings. The Cambrian fossils are described by Mr. C. D. Walcott, the Devonian and Carboniferous by Mr. G. H. Girty, the Mesozoic by Mr. T. W. Stanton, and the Fossil Flora (Laramie and Tertiary) by Mr. F. H. Knowlton.

Monograph No. 33 contains an account of the geology of the Narragansett Basin, a tract which includes Providence on the north and Newport on the south, being parts of Rhode Island and Massachusetts. The section on general geology is contributed by Mr. N. S. Shaler, while the detailed accounts are furnished by Mr. J. B. Woodworth and Dr. A. F. Foerste. Mr. Shaler remarks that the region originally contained an extensively developed series of pre-Cambrian ro ks, which "may for convenience be referred to that limbo of ill-discriminated formations, the Upper Archæan (of Dana), or Algonkian." On these lie remnants of the Olenellus-beds of the Lower Cambrian, and above these are granites which have broken through the Cambrian, and have in turn been much eroded. On top lie the Carboniferous strata, which occupy the greater part of the basin and attain a thickness of several thousand feet. The general proposition is that this and other basins which lie along the Atlantic coast from Newfoundland to North Carolina are old river valleys which have been depressed below the sea-level, filled with sediments—the sedimentation increasing the depth of the depression—and afterwards corrugated by the mountain-building forces. The memoir is well illustrated with maps, sections and pictorial plates.

Monograph No. 34 is on the glacial gravels of Maine and their associated deposits, by Mr. George H. Stone. The subject is treated with a wealth of letterpress (499 pages) and illustrations. It is essentially a local memoir, but as the result of careful observations commenced so long ago as 1876, it is a most valuable record of facts on water-assorted glacial drift, useful to those studying glacial features, terraces, eskers and the probable effects of subglacial and englacial streams.

In Monograph No. 36 the Crystal Falls iron-bearing district of Michigan is described by Messrs. J. Morgan Clements and H. Ll. Smyth. This is the third of a series of reports on the iron-bearing districts of Lake Superior. The iron-ore (hæmatite and limonite) occurs in the Upper Huronian series. It is associated with white and reddish chert, and lies between carbonaceous slates in synclinal troughs. The memoir, however, deals with the structure, stratigraphy and physiography of a large area, approximately 540 square miles, and not only with Archæan and Huronian, but more particularly with various volcanic and intrusive rocks, microscopic sections of which form a main feature in the illustrations. A general introduction is written by Mr. C. R. Van Hise, and a final chapter on the Sturgeon River tongue in the south-eastern part of the district is by Mr. W. S. Bayley.

Monograph No. 37 is on the Fossil Flora of the Lower Coal-measures of Missouri, by Mr. David White, and is illustrated by seventy-two plates of Carboniferous plants, and one of a coal-seam.

Monograph No. 38, a large volume of 817 pages, numerous maps and other illustrations, is given up to a description of the Illinois Glacial Lobe, by Mr. Frank Leverett. This ice-tract formed the south-western part of the great ice-field that formerly extended from the high lands east and south of Hudson Bay over the basins of the Great Lakes and the north-central States as far as the Mississippi Valley. It overlapped a previously glaciated region on the south-west, whose drift was derived from ice which moved southward from the central portion of Canada. The evidence for separating the drift of the Illinois glacial lobe from the outlying and underlying drift is briefly stated. Remarkable instances of the transportation of limestone ledges are noted. These ledges in some instances occupy an area of several acres. They have been moved westward from the crest of rock ridges without completely destroying their stratification. Descriptions are given of well-defined soils and weathered zones which occur between successive accumulations of drift; various moraines and associated sheets of till are described, and there is a general discussion on the influence of the drift on drainage systems. The thickness of the Illinois drift is estimated at from 100 to 130 feet, and its bearing on water-supply is fully considered. Reference is made to gas-wells. In some the gas appears to be derived from the decay of vegetable matter in the drift; in most cases, however, it is probable that the underlying rocks contribute the gas, which is pent up beneath compact drift beds. A final chapter treats of soils, and these are classified into residuary soils, boulder-clay soils, gravelly, sandy and bluff-loess soils, silts slowly pervious to water, fine silts nearly impervious, and peaty or organic soils. The residuary soils show variations which correspond in a rude way with variations in the structure of the rocks, whether shale, limestone or sandstone, from which they are derived.

ON THE RELATIONS OF RADIATION TO TEMPERATURE.[1]

THE key to this subject is the principle, arrived at independently by Balfour Stewart and Kirchhoff about the year 1857, that the constitution and intensity of the steady radiation in an enclosure is determined by the temperature of the surrounding bodies, and involves no other element. It was pointed out by Stewart[2] that if the enclosure contains a radiating and absorbing body which is put in motion, the temperature being uniform throughout, then the constitutions of the radiation in front of it and behind it will differ on account of the Doppler effect, so that there will be a chance of gaining mechanical work in the restoration of a uniform state. There must thus be some kind of thermodynamic compensation, which might arise from æthereal friction, or from work required to

[1] A paper read by Dr. J. Larmor, F.R.S., before Section A of the British Association at Bradford, September, 1900.

[2] *Brit. Assoc. Report*, 1871; *cf.* also *Encyc. Brit.*, art. "Radiation" (1886), by Tait.

produce the motion of the body against pressure excited by the surrounding radiation. The hypothesis of friction is now out of court in ultimate molecular physics; while the thermodynamic bearing of a pressure produced by radiation has been developed by Bartoli and Boltzmann (1884), and that of the Doppler effect by Wien (1893).

Application of the Doppler Principle.—The procedure of Wien amounts to isolating a region of radiation within a perfectly reflecting enclosure, and estimating the average shortening of the constituent wave-lengths produced by a very slow shrinkage of its volume. The argument is, however, much simplified if the enclosure is taken to be spherical and to remain so; for it may then be easily shown that each individual undulation is shortened in the same ratio as is the radius of the enclosure, so that the undulatory content remains similar to itself, with uniformly shortened wave-lengths, whether it is uniformly distributed as regards direction or not, and whatever its constitution may be. But if there is a very small piece of a material radiator in the enclosure, the radiation initially inside will have been reduced by its radiating and absorbing action to that corresponding to its temperature. In that case the shrinkage must retain it always, at each stage of its transformation, in the constitution corresponding to some temperature. Otherwise differences of temperature would be effectively established between the various constituents of the radiation in the enclosure; these could be permanent in the absence of material bodies; but if the latter are present this would involve degradation of their energy, for which there is here no room, because, on the principles of Stewart and Kirchhoff, the state corresponding to given energy and volume and temperature is determinate. Thus we infer that if the wave-lengths of the steady radiation corresponding to any one temperature are all altered in the same ratio, we obtain a distribution which corresponds to some other temperature in every respect except absolute intensities.

Direct Transformation of Mechanical Energy into Radiation.[1]—There is one point, however, that rewards examination. When undulations of any kind are reflected from an advancing wall, there is slightly more energy in the reflected beam than there was in the incident beam, although its length is shorter on account of the Doppler effect. This requires that the undulations must oppose a resistance to the advancing wall, and that the mechanical work required to push on the wall is directly transformed into undulatory energy. In fact, let us consider the mechanism of the reflexion. Suppose the displacement in a directly incident wave-train, with velocity of propagation c, to be $\xi = a\cos(mx - mct)$; that in the reflected train will be $\xi' = a'\cos(m'x + m'ct)$, where a', m' are determined by the condition that the total displacement is annulled at the advancing reflector, because no disturbance penetrates beyond it; therefore, when $x = vt$, where v is its velocity, $\xi + \xi' = 0$. Thus we must have

$a' = -a$, and $m' = m\dfrac{c-v}{c+v}$, in agreement with the usual statement of the Doppler effect when v is small compared with c. Observe, in fact, that the direct and reflected wave-trains have a system of nodes which travel with velocity v, and that the moving reflector coincides with one of them. Now the velocities $d\xi/dt$ and $d\xi'/dt$ in these two trains are not equal. Their mean squares, on which the kinetic energy per unit length depends, are as m^2 to m'^2. The potential energies per unit length depend on the means of $(d\xi/dx)^2$ and $(d\xi'/dx)^2$, and are of course in the same ratio. Thus the energies per unit length in the direct and reflected trains are as m^2 to m'^2, while the lengths of the trains are as m' to m; hence their total energies are as m to m'; in other words, the reflected train has received an accretion of energy equal to $1 - m'/m$ of the incident energy, which can only have come from mechanical work spent in pushing on the reflector with its velocity v. The opposing pressure is thus in numerical magnitude the fraction $\left(1 - \dfrac{m'}{m}\right)\dfrac{c}{v}$ of the density of the incident energy, which works out to be $\dfrac{c^2 - v^2}{c^2 + v^2}$ of the intensity of the total undulatory energy, direct and reflected, that is in front of the reflector.

[1] The present form of this argument arose out of some remarks contributed by Prof. FitzGerald, and by Mr. Alfred Walker of Bradford, to the discussion on this paper. Mr. Walker points out that by reflecting the radiation from a hot body, situated at the centre of a wheel, by a ring of oblique vanes around its circumference, and then reversing its path by direct reflexion from a ring of fixed vanes outside the wheel, so as to return it into the source, its pressure may be (theoretically) utilised to drive the wheel, and in time to get up a high speed if there is no load: the thermodynamic compensation in this very interesting arrangement lies in the lowering of the temperature of the part of the incident radiation that is not thus utilised.

When v is small compared with c, this agrees with Maxwell's law for the pressure of radiation. This case is also theoretically interesting, because in the application to æther-waves ξ is the displacement of the æther elements whose velocity $d\xi/dt$ represents the magnetic force; so that here we have an actual case in which this vector ξ, hitherto introduced only in the theoretical dynamics of electron-theory, is essential to a bare statement of the facts. Another remark here arises. It has been held that a beam of light is an irreversible agent, because the radiant pressure at the front of the beam has nothing to work against, and its work is therefore degraded. But suppose it had a reflector moving with its own velocity c to work against; our result shows that the pressure vanishes and no work is done. Thus that objection to the thermodynamic treatment of a single ray is not well founded.

This generalisation of the theory of radiant pressure to all kinds of undulatory motion is based on the conservation of the energy. It remains to consider the mechanical origin of the pressure. In the special case of an unlimited stretched cord carrying transverse waves the advancing reflector may be a lamina, through a small hole in which the cord passes without friction: the cord is straight on one side of the lamina, and inclined on the other side on account of the vibration; and it is easily shown that the resultant of the tensions on the two sides provides a force acting on the lamina which, when averaged, agrees with the general formula. In the case of an extended medium with advancing transverse waves, which are reflected directly, the origin of the pressure is not so obvious, because there is not an obvious mechanism for a reflector which would sweep the waves in front of it as it advances. In the æthereal case we can, however, on the basis of electron-theory, imagine a constitution for a reflector which will turn back the radiation on the same principle as a metallic mirror totally reflects Hertzian waves, and thus obtain an idea of how the force acts.

The case of direct incidence has here been treated for simplicity; that of oblique incidence easily follows; the expression for the pressure is reduced in the ratio of the square of the cosine of the angle of incidence. If we average up, after Boltzmann, for the natural radiation in an enclosure, which is incident equally at all angles, we find that the pressure exerted is one-third of the total density of radiant energy.

Adiabatics of an enclosed Mass of Radiation, and resulting General Laws.—Now consider an enclosure of volume V containing radiant energy travelling indifferently in all directions, and of total density E; and let its volume be shrunk by δV. This requires mechanical work $\frac{1}{3}E\delta V$, which is changed into radiant energy: thus

$$EV + \tfrac{1}{3}E\delta V = (E - \delta E)(V - \delta V),$$

where $E - \delta E$ is the new density at volume $V - \delta V$. This gives $\frac{4}{3}E\delta V = V\delta E$, or $E \propto V^{-\frac{4}{3}}$.

As already explained, if the original state has the constitution as regards wave-lengths corresponding to a temperature T, the new state must correspond to some other temperature $T - \delta T$. Thus we can gain work by absorbing the radiation into the working substance of a thermal engine at the one temperature, and extracting it at the other; as the process is reversible, we have by Carnot's principle

$$\tfrac{1}{3}E\delta V/EV = -\delta T/T,$$

so that $T \propto V^{-\frac{1}{3}}$.

Thus $E \propto T^4$, which is Stefan's law for the relation of the aggregate natural radiation to the temperature, established theoretically on these lines by Boltzmann.

Moreover, the Doppler principle has shown us that in the uniform shrinkage of a spherical enclosure the wave-lengths diminish as the linear dimensions, and therefore as $V^{\frac{1}{3}}$ or inversely as T by the above result. Thus in the radiations at different temperatures, if the scale of wave-length is reduced inversely as the temperature the curves of constitution of the radiation become homologous, *i.e.*, their ordinates are all in the same ratio. This is Wien's theoretical law.

These relations show that the energy of the radiation corresponding to the temperature T, which lies between wave-lengths λ and $\lambda + \delta\lambda$, is of the form $\lambda^{-5}f(\lambda T)\delta\lambda$. The investigation, theoretical (Wien, Planck, Rayleigh, &c.) and experimental

(Lummer and Pringsheim, Paschen, &c.), of the form of this function f is perhaps the most fundamental and interesting problem now outstanding in the general theory of the relation of radiation to temperature. The theoretical relations on which this expression is founded have been shown to be in agreement with fact; and it appears that the form $c_1 e^{-c_2/\lambda T}$ fairly represents $f(\lambda T)$ over a wide range of temperature.[1] These relations have been derived, as usual, from a dynamical discussion of the aggregate intensity of radiation belonging to the temperature; it may be shown that the same results, but nothing in addition, will be gained by applying the same principles to each constituent of range $\delta\lambda$ by itself, assigning to each its own temperature.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xxii., No. 4.—Asymptotic evaluation of certain totient sums, by D. N. Lehmer, is an attempt to account for what seems to be a remarkable law, first observed in particular cases in 1895. It is thus stated: Consider any set s of k linear forms, $an+b_i (i=1 \ldots . k)$, all of which have the same modulus a, and where $[a, b_i]=1$, $[a, b]$ stands for the G.C. divisor of a and b. Consider, further, a function $\theta_s(x)$ such that $\theta_s(x)=1$ or 0, according as each of the prime divisors of x belongs to one of the forms of the set s or not. If, then, $\nu(x)$ denotes the number of distinct primes in x, we have

$$\lim_{N=\infty} \frac{\sum_{x=1}^{N} 2^{\nu(x)} \theta^s(x)}{N} = \text{constant}$$

The author's aim here is to prove this law where s is the set of linear forms belonging to a binary quadratic form. He also determines the constant in this case (pp. 293–335). Dr. E. H. Moore's paper concerning Klein's group of $(n+1)!$ ary collineations is a modification of a communication made to the American Mathematical Society, December 30, 1898. This short note is related to several papers by the author, amongst others with one communicated to the London Mathematical Society (December 1896, *see* vol. xxviii., p. 357). The closing paper (pp. 343–380), is one by H. E. Slaught, entitled "The Cross-ratio Group of 120 Quadratic Cremona Transformations of the Plane. Part i., Geometric representation." The group specially studied is a particular case, $n=5$ of the general cross-ratio group of order $n!$ Its consideration was undertaken as a dissertation at the University of Chicago at the suggestion and under the direction of Dr. Moore, and so is closely connected with the two papers referred to above. A few plates of figures are given at the end of the number, and also an obituary notice of Prof. T. Craig by Prof. S. Newcomb.

Symons's Monthly Meteorological Magazine, December.—Climatological table for the British Empire for the year 1899. This interesting summary of the climatological tables which have been published for a number of selected stations for the last quarter of a century shows that, generally speaking, the extreme values fall much to the same stations as usual. Adelaide records the maximum shade temperature, 113°·6 (in February). This temperature has only once been exceeded in these tables—viz. by 114°·2 in 1876. It had also the maximum temperature in the sun, 175°·7; this value is also unusual, the only higher reading being 180°, in 1882. It is also the driest station, the mean humidity being 59. The dampest station was Colombo, mean humidity 79; this station also records the highest mean temperature, 81°·9, and the greatest rainfall, 73·5 inches. The lowest temperature in the shade was −46°·5 at Winnipeg (in February); this station had also the greatest range in the year, 135°·9, the greatest mean daily range, 22°·3, and the lowest mean temperature, 34°·2. Mauritius was the most cloudy station—viz. 5·7; this extreme has several times been recorded at London, but in 1899 the cloud value was 5·6, only three out of the preceding forty years having been less cloudy.

[1] This might, however, be multiplied by $(T\lambda)k$, and the experiments would hardly discriminate between the values zero (Wien), unity (Rayleigh), and one-half (Thiesen) for k; the latter value, which is entirely empirical, seems to fit best.

SOCIETIES AND ACADEMIES.

LONDON

Royal Society, December 6.—"On the Bacterial Disease of the Turnip (*Brassica napus*)." By M. C. Potter, M.A., F.L.S., Professor of Botany in the University of Durham College of Science, Newcastle-upon-Tyne. Communicated by Sir M. Foster, Sec. R.S.

This paper gives the results of an investigation into the cause of a special disease of the turnip crop. The disease was discernible in plants still growing in the fields, some roots being found which were quite rotten, the decaying portion being white with a highly offensive and peculiar smell. The most careful microscopic search failed to detect any trace of hyphæ of the higher fungi in the decaying mass, but only a swarming mass of bacteria. The tissues were completely disorganised, the cells separating from each other along the middle lamella; the cell-walls were soft, swollen and faintly striated; the protoplasm, too, had lost its natural colour and become slightly brown and contracted. The disease could be readily communicated to sound, growing roots by merely making a slight incision and inoculating the root at the injured surface.

After a long series of cultures a bacterium was isolated, and pure cultures obtained grown from a single individual, which produced all the symptoms of "white rot" when sown upon sterile blocks of living turnip. This bacterium rapidly liquefies gelatine, it is a short, motile rod with a single polar flagellum, and, adopting Migula's classification, has been described under the name of *Pseudomonas destructaus*. When growing in a living plant tissue or in nutrient solutions, a cytase is secreted; this was isolated by the well-known method of precipitation by alcohol, and has been shown to cause the dissolution of the cells and the softening and swelling of the cell-walls of the host.

The appearance of the diseased tissue could not be entirely explained by the action of the cytase. It was found that the boiled, filtered juice of a turnip, which had become rotten through the influence of a pure culture of *P. destructaus*, had a powerful toxic effect upon the living plant cell. This toxin proved to be oxalic acid. A reaction probably takes place between the calcium pectate of the middle lamella and the oxalic acid produced by the bacteria, the calcium pectate neutralising the oxalic acid and thus permitting the continued growth of the bacteria.

The action of this bacterium upon living plant tissues is similar to that of some of the parasitic fungi; in both cases the invading organism produces oxalic acid, which acts as a toxin to the protoplasm and, decomposing the calcium pectate, furthers the dissolution of the cells; and also there is the secretion of a cytase, which has a destructive action upon the cell-wall and intercellular substance. The question of the parasitism of the bacteria thus stands in these respects on the same platform as that of the fungi, and a complete homology is established between them.

From numerous observations in the fields it would appear that *P. destructaus* is always introduced at a wounded surface, and through the agency of slugs and larvæ.

"On the Tempering of Iron Hardened by Overstrain." By James Muir, B.Sc., B.A., Trinity College, Cambridge, 1851 Exhibition Research Scholar, Glasgow University. Communicated by Prof. Ewing, F.R.S.

It is well known that iron hardened by overstrain—for example, by permanent stretching—may have its original properties restored again by annealing—that is, by heating it above a definite high temperature and allowing it to cool slowly. Experiments described in the paper, of which this is an abstract, show, however, that if iron hardened by overstrain be raised to any temperature above 300° C., it may be partially softened in a manner analogous to the ordinary tempering or "letting down" of steel which has been hardened by quenching from a red heat. This tempering from a condition of hardness induced by overstrain, unlike ordinary tempering, is applicable not only to steel, but also to wrought iron, and possibly to other materials which can be hardened by overstrain and softened by annealing.

The experiments described in the paper were all carried out on rods of iron and steel about $\frac{3}{8}$ths of an inch in diameter and 11 inches long, the elastic condition of the material being in all cases determined by means of tension tests, in which the hardness of the material was indicated by the position of the yield-point.

The method of overstraining and examining the materials employed was analogous to that described in a paper by the present author, "On the Recovery of Iron from Overstrain" (*Phil. Trans.*, A., vol. cxciii., 1899).

Experiments described in the paper, of which this is an abstract, showed that with mild steel which had been hardened by tensile overstrain until it could withstand a load of 50 tons per square inch without yielding, no appreciable softening was produced by heating the material to 300° C. A temperature of 350° C., however, lowered the yield-point to about 47 tons per square inch; 500°, 600° and 700° C. lowered the yield-point to about 40, 35 and 30 tons per square inch respectively.

It was further shown that the same temperature brought the yield-point to approximately the same stress, no matter what might be the original hardness of the specimen under test; and that the harder the material was made by tensile overstrain—that is, the higher the yield-point was raised by permanent stretching—the lower was the temperature which could be shown to produce a slight tempering effect.

The results ascribed above solely to temperature were found to be influenced to some extent by time. Thus it was found that by baking a hardened specimen for several hours at any temperature a greater effect was produced than by simply raising the specimen for a few minutes to that temperature. The effect of time was, however, small compared with that produced by increase of temperature.

All the tempering effects observed with steel were also obtained with Lowmoor iron. The hardening by overstrain and the tempering of soft Lowmoor iron only differed in detail from the analogous hardening and tempering of steel.

The iron and steel employed in this research were also examined when in various conditions of hardness by means of the microscope, and micro-photographs are reproduced in the paper. The ordinary methods of relief-polishing and of etching by dilute nitric acid were employed, and a new method of staining steel by rubbing with ordinary moistened cocoa was made use of and is described in the paper.

Geological Society, December 5.—J. J. H. Teall, F.R.S., President, in the chair.—On the Corallian rocks of St. Ives (Hunts) and Elsworth, by C. B. Wedd. (Communicated by permission of the Director-General of the Geological Survey.) Starting two and a half miles south-west of Elsworth, the author traces the Elsworth rock at intervals through Croxton, Yelling, Papworth Everard, &c., to Elsworth, and thence towards Fen Drayton and near Swavesey. The Oxford clay is found to the west of it, and the Ampthill clay to the east. Frequent fossil lists are given, and the character of the rock is described at the different exposures. Again, from Haughton Hall, west of St. Ives, the "St. Ives Rock" is traced through that town and towards Holywell.—The unconformity of the Upper (red) Coal Measures to the Middle (grey) Coal Measures of the Shropshire coalfields, and its bearing upon the extension of the latter under the Triassic rocks, by W. J. Clarke. The Upper Red Measures have a much greater extension in the Shropshire coalfields than the productive Measures below. In the Shrewsbury field they are the only Carboniferous rocks present, and rest on pre-Carboniferous rocks. When the sections of collieries at and near Madeley are plotted on the assumption that the base of the Upper Carboniferous rocks is horizontal, the Lower Measures are found to be bent into a syncline rising sharply to the north-north-west and more gently to the south-south-east. A second syncline, broader and deeper, extends from Stirchly towards Hadley, but the westerly rise is often hidden by the boundary-fault of the coalfield. This phenomenon is known locally as the "Symon Fault"; and instead of taking Scott's view that it represents a hollow denuded in the Lower Coal Measures, the author considers it due to folding before late Carboniferous times. A third little syncline occurs at the Inett and Caughley. Similar phenomena are exhibited in the Forest of Wyre coalfield, where a series of unproductive measures come in between the Lower and Upper Coal Measures.—Bajocian and contiguous deposits in the northern Cotteswolds: the main hill-mass, by S. S. Buckman. After giving comparative sections at Cleeve, Leckhampton Hill, and Birdlip, to show the disappearance of three horizons at the second locality and five more at the third, the author interprets the absence of the beds as due to "pene-contemporaneous erosion" brought about by the elevation of rocks, due to small earth-movements along a main south-west to north-east axis and subsidiary axes north-west to south-east.

Entomological Society, December 5.—Mr. G. H. Verrall, President, in the chair.—Mr. Jacoby exhibited specimens of *Hypocephalus armatus* from Bahia and *Chrysomela salisburiensis*, a new species, from Mashonaland.—Mr. Bower exhibited a specimen of *Spilosoma montanum*, an Asiatic species, bred from a larva found beginning of September 1897, feeding on birch on a moor near Paisley. The larva hibernated and spun a cocoon the following spring, not feeding after hibernation. Moth bred June 2, 1898. The moor on which the larva was found is used by the Glasgow Corporation for rubbish, the supposition being that an ovum or larva had been introduced with the refuse matter.—Mr. McLachlan exhibited a female of a dragon-fly of the genus *Tetracanthagyna* from North Borneo, similar to *T. vittata*, McLach., but with a very broad ante-apical fascia on the wings, and with some asymmetrical markings. He said there might be a question as to the specific identity or otherwise of the insect. There was also the question as to whether the insect described by Mr. C. O. Waterhouse as *Gynacantha plagiata* in the *Transactions* for 1878 was specifically the same. Mr. Waterhouse was of opinion that his insect was distinct.—Mr. R. Adkin exhibited two aberrant male specimens of *Argynnis aglaia*. In one of them the basal two-thirds of all the wings were almost completely covered with black, and broad black streaks crossed the remaining third of the wings to the outer margin, following the venation. In the other specimen the peculiarity consisted in the presence of a greenish-white blotch on each of the wings on the left side, similar in character to the pale blotches not infrequently observed in *A. paphia*. Both specimens were taken near Brighton in July last, where the species was unusually abundant.—Papers were communicated on observations on some species of *Orina*, a genus of viviparous and ovo-viviparous beetles, by Mr. G. C. Champion and Dr. T. A. Chapman, reported by Dr. T. A. Chapman; illustrations of the sixth male ventral segment in seventeen species of *Osmia* of the *Adunca* group, with a note on the synonymy of three species, and descriptions of five which appear to be new, by the Rev. F. D. Morice, M.A.; and an obituary notice of the late Dr. Otto Staudinger, by Mr. H. J. Elwes, F.R.S.

Linnean Society, December 6.—Mr. F. D. Godman, F.R.S., Vice-President, in the chair.—Dr. A. B. Rendle exhibited specimens, including leaves and fruit, of Grasswrack (*Zostera marina*, L.) recently found by Capt. H. P. Deasy near Yepal Ungar, in the Kwen Lun mountains, at an altitude of 16,500 feet. The plants were not growing in this remarkable locality, but were preserved in a bed 10 to 12 feet thick on top of and interspersed with which were strata of blue clay. The broken leaves and sheaths of which the specimens consisted were dry and brittle, but showed no alteration, the internal structure being as perfect as in the fresh plant. As the country is geologically unknown, it is impossible to estimate the age of the deposit. It probably formed the bed of a salt-lake. There is one in the neighbourhood; and Capt. Deasy is of opinion that the whole district formed at one time a large salt-lake. The specimens were very dusty, but microscopic examination of the dust revealed nothing beyond particles of sand and a few small brown objects, apparently spores of some kind. Capt. Deasy states that he saw similar growths in a lake in the same district, but was unable to procure specimens. This occurrence of *Zostera marina* in the heart of the Asiatic continent, and at so great an elevation, is of special interest. The plant, so far as known, is purely marine, occurring plentifully on our own coasts and throughout Europe, on the Atlantic shores of North America, and in North-east Asia. It has not previously been recorded from an inland lake, though an allied species, *Zostera nana*, L., occurs in the Caspian. Whether its existence in the Kwen Lun range has any relation to the Tertiary marine deposits which connect the Mediterranean area with the Himalayas is matter for conjecture. There seems to be some evidence for the existence of *Zostera* in Upper Cretaceous and Tertiary times; at any rate several species have been described from fossils resembling the rhizome of the plant, found in Central European beds. Dr. Rendle also showed a specimen of another marine monocotyledonous plant, *Halophila stipulacea*, Asch., from Tuticorin in Southern India, sent by Mr. Edgar Thurston. This species is not included in the "Flora of British India," nor in Trimen's "Ceylon Flora," a plant found by Dr. Harvey at Trincomalee, and thus determined by Thwaites, being assigned to the commoner *H. ovata*, Gaud. *H. stipulacea* occurs in the Red Sea, the Mascarene Islands, and Rodriguez.—The Rev. John Gerard exhibited some abnormally large shells of the swan mussel, *Ano-*

donta cygnea, forwarded from Claughton, Garstang, Lancashire, by Mr. W. Fitzherbert Brockholes. The three largest of these measured 8·75 inches, 8 inches and 7·5 inches in width, these measurements being considerably in excess of those given in the text-books, and of the examples figured as *Mytilus cygneus* in *Trans.* Linn. Soc. vol. viii. pl. 3, p. 109, and as *Mytilus stagnalis* (from Kew Gardens) in Sowerby's "British Miscellany," vol. i. pl. xvi. p. 33. It was stated that amongst other specimens found in the pond at Claughton, when drained, there was one of nine inches, twenty-eight measuring from 8 to 9 inches, and about a hundred of 7 to 8 inches.—Mr. F. Chapman read a paper on some new foraminifera from Funafuti, on which some remarks were made by Mr. Sherborne.—Mr. H. Groves, on behalf of Mr. G. C. Druce, communicated a paper entitled, A revision of the British thrifts (*Statice* and *Armeria*), in which he attempted a rectification of the synonymy, and discussed the value of the pubescence on the ribs of the calyx as a distinguishing character.

Royal Meteorological Society, December 19.—Dr. C. Theodore Williams, President, in the chair.—Mr. H. Mellish read a paper on the seasonal rainfall of the British Isles, which he illustrated with a number of lantern slides. He discussed the rainfall returns from 210 stations for the twenty-five years 1866-90, and calculated the percentage of the mean annual rainfall for each season. In winter the largest percentages of rainfall are found, as a rule, at the wet stations, and the smallest at the dry ones. Spring is everywhere the driest quarter, and the percentages are very uniform over the country, rather larger in the east then in the west. In summer the highest percentages are found in the dry districts, and the lowest in the wet ones. As the spring is everywhere dry, so is the autumn everywhere wet, and there is little difference in the proportion of the annual total which falls in the different districts. As regards the relation between the amount of rain which falls in the wettest and driest month at any station, it seems to be generally the case that the range is larger for wet stations than for dry ones. In wet districts rather more than twice as much rain falls, on the average, in the wettest month as in the driest, and in dry districts rather less than twice.

EDINBURGH.

Mathematical Society, December 14.—Mr. J. W. Butters, President, in the chair.—Dr. Third read a paper on triangles triply in perspective, and a paper on four circles touching a common circle, by Prof. Allardice, was communicated to the meeting by Mr. George Duthie.

CAPE TOWN.

South African Philosophical Society, November 28.—M. L. Péringuey, President, in the chair.—The Secretary read a paper by Dr. R. Broom, of Pearston, on the leg and toe bones of *Ptychosiagum*. Dr. Broom described a tibia and fibula, together with the greater part of two toes and a couple of carpal bones, found near Colesberg in association with the skull of *Ptychosiagum Murrayi* and presented to the Eastern Province Naturalists' Society by Mr. Leslie, of Port Elizabeth. The structure of the leg and toes confirm the view, based on the portion of the nostrils, that Ptychosiagum was an aquatic form.—Dr. J. D. F. Gilchrist read a paper entitled "The History of the Local Names of Cape Fishes." The object of the paper was to clear up certain difficulties caused by the use of different names and review their historical origin and development from a philological point of view. A list of over 200 names was procured, many of which were synonyms. These were arranged alphabetically, the synonyms grouped together and followed by the scientific name where possible. Traces of East Indian, French and Portuguese elements were found in the nomenclature, the most prominent being, however, Dutch and English.

NEW SOUTH WALES.

Linnean Society, October 31.—Mr. Henry Deane, Vice-President, in the chair.—Tasmanian land planarians: descriptions of new species, &c., by Thos. Steel.—Contributions to a knowledge of the Australian flora, Part iii., by R. T. Baker. A number of species of phanerogams and fungi not previously known to occur in New South Wales are recorded, as well as additional localities for already recorded New South Wales species.—Studies in Australian entomology: No. x., description of a new tiger-beetle from Western Australia, by Thomas G. Sloane.—Description of a specimen of kerosene shale from Megalong Valley, N.S.W., by Prof. C. E. Bertrand, Lille. A detailed description of the microscopic and macroscopic characters of a kerosene shale from Megalong are given. The shale belongs to the same type as the shales from Mount Victoria and Blackheath containing the alga, *Reinschia australis*. It is noteworthy, however, for the excellent state of preservation of the remains of the minute fossil forms. Associated with the alga are pollen grains and spores. The author has calculated that there are 16,830 thalli of *Reinschia* in a cubic millimetre of the shale.—On the "clouding" of white wine, by R. Greig Smith. A variety of chablis becomes clouded and turbid soon after bottling, which renders the wine commercially useless. The cause has been traced to an acetic-acid-forming bacterium which grows only upon wine and yeast-derived fluids. By inoculation of the pure organism into sterile wine, the trouble was reproduced. The remedy consists in pasteurising the wine.—On some new species of Eucalyptus, by R. T. Baker.

ST. LOUIS.

Academy of Science, December 3.—Mr. William H. Roever, of Washington University, read a paper on brilliant points and loci of brilliant points. The paper gave the analytical conditions which define the brilliant point of a surface, the brilliant point of a space curve, the brilliant point of a plane curve and the brilliant point in space of two dimensions, when the source of light is such that the incident rays are normal to a given surface and the recipient is such that the reflected rays are normal to another given surface. Formulæ were given for the important special case in which the source and recipient are points. The paper also contained a general method for finding the equation of the locus of the brilliant points of a moving or variable surface or curve, together with a number of applications. Such loci may often be perceived when an illuminated polished surface is rapidly moved, as when a wheel with a polished spoke is rapidly rotated. Another interesting example in loci of brilliant points is that of a circular saw which has been polished with emery in a lathe and thus received a great number of concentric circular scratches. The locus of the brilliant points of this family of scratches was shown in this paper to be a curve of the fourth degree. In the special case when the point source of light and the eye of the observer (the point recipient) are in a plane through the axis of the saw, the curve degenerates into a circle and two coincident straight lines.

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