due to the same law operating with a different velocity.

HENRY FAIRFIELD OSBORN

## SCIENTIFIC BOOKS

*Temperatur und Zustand des Erdinnern—eine Zusammenstellung und kritische Beleuchtung aller Hypothesen.* Von HERRMANN THIENE. Jena, Fischer. 1907. Pp. 107. Price two and a half marks.

This useful paper is the result of a prize offered by the Jena philosophical faculty for a critical review of the literature and theories as to the temperature and state (solid, fluid or gaseous) of the earth's interior—a useful undertaking since the literature is much scattered. Astronomers, mathematicians and physicists as well as geologists, have contributed to it. The conclusions of the author, an assistant in the Jena Mineralogical Institute, are that the earth has an outer crust, of the composition of diorite, and an iron core. The surface density is about 2.8; the mean density is between 5.4 and 5.7. The density at the center according to Stieljes must be between 7 and 12.16, having due regard to all the facts, including the moment of inertia (resistance to change in its axis of rotation and the effect of the attraction of the sun and moon on the equatorial bulge) and the difference of gravity at pole and equator. Thiene does not describe the methods, but the results and assumptions merely of the different writers. The reviewer would note that our knowledge of the density must be the more inaccurate the nearer the center since the density of any ellipsoidal layer has less and less importance and effect either on the mass or the moment the nearer the center respectively the axis of rotation it is. Laplace's law of density is shown by the author to agree with the known facts. But any law in which the constants were so taken as to be consistent with the known data would, if expressed and expanded in a series in which the density is a function of the ratio of the distance from the surface of the earth to its radius, according to Maclauvin's theorem, reduce to Laplace's law for the first two terms.

It is obvious, though Thiene does not remark it, that other things being equal the law of density will be different and the densities at the center less if the temperature keeps on increasing clear to the center than if it increases less rapidly or attains a maximum.

Thiene leans to the view that the temperature increases toward the center more and more slowly from a rate of something like 1° C. in thirty-three meters to begin with so that the greatest heat reached is probably from 2,000° C. to 10,000° C. He is not aware of the arguments of See and Chamberlin for an increase in temperature clear to the center and a possible increase in the gradient. He would attribute the heat to the original warmth of condensation. The Kant-Laplace theory is taken as established.

The interior he believes a plastic crystalline (anisotropic) solid mass, which would, however, turn into a fluid or possibly a gas were the pressure removed.

A list of references at the end and an alphabetical list of authors are valuable additions and enable one to grasp the scope of the work which seems fairly full for Germany. An American can hardly think that the hope of the author that nothing essential has been overlooked is fulfilled. He mentions the metallic interior without mentioning Durocher. He could not, of course, have had access to so recent a work as Chamberlin and Salisbury's geology, but many of the thoughts therein collected have appeared in the *Journal of Geology,* to which he seems also not to have had access.[1] He discusses and turns down theories of a gaseous interior without mentioning See. And by the way he does not note that a temperature of 10,000° C., together with the theory of an iron core favored by him, and the critical temperature of iron and platinum which he cites, from 5,000° to 7,000°, would needs imply the possibility of a gaseous center.

The bearing of theories of isostasy is but mentioned. Neither Dutton nor Gilbert's work with Putnam is mentioned nor that with Woodward, only one of the least important of whose papers is cited. To the

[1] Other writers too recent to be mentioned are Hayford, Gregory, and those cited by Love in SCIENCE, N. S., Vol. XXVI., No. 669, Oct. 25, 1907.

reviewer the work of Gilbert and Woodward on Lake Bonneville seems of fundamental suggestion, in considering subcrustal fluidity. Consideration of the early stages of the planet without mentioning Winchell, of the cooling at the surface without mentioning Angström, of the increase of heat in deep borings without mentioning Darton or Hallock, of the coolness of the Keweenaw copper mines without mentioning Wheeler or Agassiz or Jackson, or Pierce or the reviewer (hinc illæ lacrimæ!) seems seriously defective. He mentions earthquake vibrations, which are a most promising source of enlightenment, but without mentioning Milne. Two excursuses on the age of the earth and the cause of glacial periods might have been omitted, and might certainly have had more value. The reviewer wonders if Thiene ever saw Joly's paper which he pronounces wholly worthless! One is led to doubt if he had good command either of English or of mathematics. The caliber of his mathematics may be gauged quite early by his critique of Suckow, taking his own account of it, as the reviewer has not access to Suckow's paper. Suckow "tries to prove that the temperature of the earth can not decrease with the square of the distance from the center" ($x$). "Let $C/x^2$ be the drop at the distance $x$, and the intensity of the heat decrease by $du$ if $x$ increases by $dx$ then" differentiating and noting the peculiar definition of $du$ which eliminates the minus sign customary

$$\frac{du}{dx} = \frac{2C}{x^3} \therefore C = \frac{x^3}{2}\frac{du}{dx}$$

"Letting $du = 1°$, $dx = 100$ feet and $r$" ($= x$ when $x =$ radius of earth) "19,608,944, $C$ would be $75{,}398 \times 10^{15}$"—or really half this—and, substituting in $C/x^2$, the surface of the earth if it was independent of this heat of the sun, would have a temperature of 196,090°" (or rather half this and *below* that at the center).

Now Thiene criticizes this calculation because "it is dependent upon the unit chosen to measure the earth radius." But while the calculation as Thiene gives it is slightly in error, his criticism is not right. The expression $C/x^2$ would vary with the unit chosen for $x$, were it not that $C$ also depends on that unit and is of the same dimensions. One can hardly fairly criticize for lack of mathematical equipment, except that by criticism the author had laid himself open, since this difficult subject requires really a scientific syndicate to handle. We are not surprised, therefore, that in giving account of the results of various authors he has often not shown their bearing one on the other. For instance, he does not show how the theory of a metallic core affects Kelvin's theories, nor is there any discussion of the effect of varying diffusivities in detail, though a table of them is cited from Winkelmann. The greater the diffusivity the lower the gradient unless there is a constant source. It is clear that if we imagine a large core of metal of high diffusivity covered by a stony rind of relatively low diffusivity we are likely to have the flow of heat, in the latter, reduced to the constant state, the gradient depending not on the time but upon the difference in temperature of the earth and the hot core, which will take billions of years to cool, and also upon the varying diffusivity and thicknesses of the rocks composing the crust or rind. It is the reviewer's belief that it is more than probable that the flow of heat in the crust early attained this constant condition.

The author rejects the theory of a gaseous interior, as he rejects the theory that the greater density of the interior is due to pressure. Would it not be better to ask rather to what extent is each factor important? Pressure must have some effect on density. What will it be in view of the various probable or possible changes in temperature and composition?

Without making a sweeping statement at the start as to the gaseous interior of the earth, it is perhaps safe to say in view of what we know of solid solutions and of the gas-like behavior of molecules in dilute solutions, that some of the elements of the earth's interior are in a gaseous condition, and the earth, for them at least, might be likened to a toy balloon, but one in which the gas was so condensed, under such pressure, that one could easier dent a steel ball than it. Under conditions of temperature not easy to

disprove that should be the condition of all of the earth's elements toward the center. The study of seismic vibrations will probably settle this question. A. C. LANE

*Modern Chemistry, Theoretical and Systematic.* By SIR WILLIAM RAMSAY. 12mo, pp. 327. New York, The Macmillan Co. 1907. Price, 70 cents.

Sir William Ramsay's epitome of modern chemistry, issued originally by Dent as two volumes of his dainty series of Temple Encyclopedic Primers, can not fail to find many new readers in the present one-volume form. Chemists should not need to be told of its merits, but if there be any who have overlooked the book they can only be envied for the treat which its perusal has in store for them. Students of other sciences will find in the book that for which many of them have been looking. They will find an account of the science, in which the chief results of modern physicochemical work are not only described, but are so incorporated into the chemistry of our school days that the nature of the debt of the latter to physical chemistry is plainly visible. The book fulfills its purpose singularly well, for it is brief, yet admirably clear and readable. To bring the present edition up to date a few minor changes only were required. The chief of these seems to have been the addition of a paragraph on the radium emanation.

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*Selection and Cross-breeding in Relation to the Inheritance of Coat-pigments and Coat-patterns in Rats and Guinea Pigs.* By H. MACCURDY and W. E. CASTLE. Carnegie Institution of Washington, Publication No. 70, May, 1907.

The authors publish some important data concerning the heredity of the spotted coat in rats and in guinea pigs. They confirm the conclusion of previous observers that the uniform or self color is dominant to the spotted coat and the latter to the albino. Two types of spotted rats were used, the Irish, with white on the ventral side, only; and the hooded, with black head and rump and a dorsal black stripe—the remainder of the body being white. Both of these types the authors call partial albinos, although the spotted condition appears to be a different "unit-character" from that of the albino. In other words, the albino is the allelomorph of the spotted coat and not a graded condition of the latter as the term partial albino might seem to indicate, although the authors recognize the distinction just given. It has not been found possible to produce an albino by selection or otherwise from the spotted coat.

Within the range of the spotted coat the authors find that it is possible by selection to produce races that breed approximately true to any special degree of spottedness. They argue from this that selection of a continuous or fluctuating variation may produce fixed types within the limits of the variation. They contend, therefore, that their results are opposed to the conclusion of de Vries that fixation of fluctuating variations by means of selection can not take place. But do the results really establish this point. May not there be several or even many semi-stable states of the spotted coat that ordinarily overlap, *i. e.*, may there not be within the limits of apparent fluctuation certain individuals that reproduce the parent type? A comparison with Lang's results on snails and of Tower's on the potato beetle would have been a welcome addition to the paper in this connection. However this may turn out in the end—and there is clearly something peculiar in the inheritance of spotted types that does not conform to the idea of unit characters—the authors' data are a valuable contribution to the subject.

The attempt of the authors to fix certain color patterns in guinea-pigs—nose spots or head spots, or Dutch marked individuals, gave a negative result—a fact already familiar to practical breeders. The experiments led, however, also to a positive conclusion of no little interest. It was found from the study of 1,048 guinea pigs "that one can, by selection, either increase or decrease the extent of the pigmented areas, but it is impossible by selection to fix this pigmentation in a particular pattern, retaining pigment areas on