ting a beam of light to enter a dark room and fall upon the face of a diamond such as used in rings. The diamond is held a few inches from the hole through which the beam of light enters and upon this screen is thrown a large number of bright spots very closely resembling the X-ray patterns. By moving the diamond to and fro from the screen or by rotating it the form of the pattern can be altered. The portions of rays that enter the diamond and are reflected from the rear surfaces may show the spectral colors.

This experiment can be demonstrated to a class very easily and should be of some use in explaining crystalline structure.

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A NEW METHOD OF PREPARING SPIDERS FOR EXHIBITION IN MUSEUM GROUPS

The preservation of spiders for museum purposes has always presented serious difficulties on account of the fact that the abdomens of the Arachnids lose their shape and color on drying. The usual method of preservation in liquids is of course out of the question when spiders are to be used as part of a faunal group. By preparing an artificial abdomen of wood and fastening it to the cephalothorax of the actual specimen I have found it possible to produce an imitation which can scarcely be distinguished from the living animal.

A large number of specimens of the desired species must be collected, to allow for the selection of full-grown animals. It is advisable to keep them alive for several days and to supply them with plenty of food; as it often happens that either conditions of the weather do not allow an ample food supply or else the insect may be abnormal on account of a recent or impending molt. In such instances the abdomen may often be not quite half the size of that of a well-fed specimen or one filled with eggs.

After the insect body is fully developed, the imitation abdomen must be made before killing. For this purpose a piece of light soft wood is used, carved in the exact form and size. Then the coloration is put on in precise shade and pattern.

Next the spider is killed. The best way to kill it is by putting it in a corked bottle containing cyanide. According to the strength of the cyanide and the size of the spider this takes from one to two hours. If the length of time is not sufficient the spider may later recover. After being sure that the spider is dead an insect pin is driven through the center of the cephalothorax and the insect fastened into a cork sheet, the legs being put in position and supported with pins. After being prepared in this manner, the insect must be kept in a warm and dry place, protected from dust.

After a few days, when the insect is thoroughly dry, the shrunken abdomen may be carefully removed and replaced by the wooden model.

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SCIENTIFIC BOOKS

Igneous Rocks and Their Origin. By Reginald Aldworth Daly, Sturgis-Hooper Professor of Geology, Harvard University. New York and London, McGraw-Hill Book Company, Inc., 1914.

In a previous publication Professor Daly expressed the opinion that "to be more productive geology should be more speculative." In this sense the author has become highly productive. In the introduction to his book on "Igneous Rocks and Their Origin," which is an elaboration of his previous publications, he qualifies the estimate commonly put on the value of experimental research in physics and chemistry by remarking that, while the mathematical methods employed are precise the premises relied on are not. How much lower value then must be placed on the results of a procedure in which both the premises and the mode of reasoning are seriously at fault!

The author pays a just tribute to the effectiveness of a regulated imagination, but fails to warn the student of the havoc which may be wrought by a badly regulated one, which like a defective aeroplane may bring destruction not

only to the aviator but to those who may be under him; a simile suggested by his observation that geology is "a science involving long excursions into space." It is to be hoped that in his contributions to higher education Professor Daly will keep this risk constantly before his readers.

His statement that "science is built on a long succession of mistakes" is inexact. Very serious mistakes have been made in the past, and obviously are being made still by those who are earnestly endeavoring to build it up, but it is to be hoped that very little of the structure of modern science is built upon mistakes. It is true as the author says that "their recognition means progress." Most surely, perhaps, when we recognize our own, for "thus we rise on stepping stones of our dead selves to higher things."

The author seems to be outside of petrographical conceptions when he imagines that "science is drowning in facts." The solid facts of petrology should furnish the best building material for a scientific structure, as well as for a foundation, and are not in such a flux as his metaphor suggests. There are many evidences in the book before us that its author confuses facts and subjective conceptions or hypotheses about them; indeed, he closes the introduction with the statement that "The 'facts' of to-day are the hypotheses of yesterday," and he demonstrates his confidence in this assertion by citing as facts in one chapter what were his own hypotheses in a previous one.

In his zealous endeavor to advance the science of petrology Professor Daly has the earnest sympathy of his fellow workers, however much some of them may disagree with him as to his methods of thought and of presentation, or as to his assumptions and conclusions, but the present writer is somewhat at a loss as to how one should interpret Professor Daly's statement that "the best sympathy is expressed in constructive criticism." If this means that the construction should be an elaboration of his hypotheses and theories, then the reviewer regrets that his sympathy is not of that kind. However, if constructive criticism consists in the presentation of other hypotheses, built with the aid of the imagination on other premises, which seem to the writer to be more secure and more in accord with modern conceptions regarding the physics of the earth and the essential characteristics of igneous rocks and their molten magmas, then he would present Professor Daly with the views expressed in the writer's recent lectures on volcanism at Yale University as a token of his sympathy, and would ask him to look upon the present criticism of his work on "Igneous Rocks and Their Origin" as an evidence of the serious concern which the writer feels for the science which both of us are striving to promote, and of his sense of duty in pointing out what seem to the writer some of the mistakes of method employed with such dangerous effectiveness by the brilliant but, as it seems to the writer, mistaken author of the volume in hand.

Since the book is an elaboration of papers already published by the author, which are familiar to most students of petrology, it will not be necessary to state at length the contents of the work which are given in a brief abstract in the first chapter, from which may be gotten more definite ideas of the author's views than are obtainable in some instances from the involved discussions in subsequent chapters. Moreover, the book is so full of statements, citations and tabulated material, much of which is open to criticism and debate, that it would require an exhaustive treatise to discuss the whole work thoroughly. The volume represents a great amount of energy and thought expended through years of study and speculation, evidences of which may be found in extensive tables compiled to illustrate the author's hypotheses, as well as in abundant bibliographic references which must represent but a small part of the author's researches into the literature of petrology, a large part of which would seem to be of little value for his purpose.

It seems to the writer that the most fundamental feature of the book is the mistaken method employed by its author in his attempts to solve the problems of volcanism,

which involve the character and origin of igneous rocks and their antecedent magmas, a method which is disclosed by the construction of the book, as well as by the statements of the author regarding it. The work is divided into three parts. The first broadly treats of what the author considers the facts which need explanation in a philosophy of igneous rocks. The second contains a general, "eclectic" theory of the subject. The third outlines the results of applying this theory to the so-called "facts" previously mentioned.

By way of introducing the "facts" in the case the author devotes a chapter to the Classification of Igneous Rocks, and thereby reveals his lack of acquaintance with some of the fundamental principles of modern petrology, those based on the physical chemistry of crystallizing solutions so far as known. The chapter also demonstrates the inexactness, or incoherence, of his logic, or his indifference to the meaning of words, for on page 2 he says that "Reasons are stated for preferring a classification founded on actual mineral composition," and on page 9 it is shown that it is not possible to determine the actual mineral composition of igneous rocks, and that recourse must be had to chemical analyses. He then proceeds on the assumption that a collection of rock analyses grouped by Rosenbusch according to Rosenbusch's system of mineralogical classification is a classification according to the mode of a rock, the mode having been defined as the actual mineral composition of a rock expressed quantitatively. Rosenbusch himself states that his classification is based on the most noticeable minerals, in porphyritic rocks, with little or no regard in some instances to the minute minerals in the groundmass, which may form a large part of the rock. The author's misuse of the term mode as well as his statements regarding the Quantitative System of Classification, which he calls the Norm System, show plainly his failure to comprehend the fundamental principles both of this system of classification and of the chemico-mineralogical relations in igneous rocks on which the system was founded. This is further shown by his effort to indicate its methods by a hypothetical jumble of biological species.

The author pays a high tribute to the leadership of Rosenbusch in connection with rock classification, whose system he professes to adopt, with modifications of his own, but he violates absolutely the essentials of the system in the third part of his book, and he ignores Rosenbusch's judgment on principles which conflict with the main thesis of his "eclectic" theory. Rosenbusch based his system on the microscopical petrography of igneous rocks, in which branch of petrology he was the acknowledged leader, and it was not to be expected that in the later years of his brilliant career he would have undertaken to reconstruct his system of classification in the light of new discoveries in allied branches of science. But it must not be supposed that he had no appreciation of the march of events; toward new or revolutionary ideas he held a conservative course, and upon one occasion in a discussion of new ideas with which he was in sympathy he remarked to the present writer that he must not introduce such changes into his book suddenly, but gradually in successive editions, for otherwise his readers would not follow him. On the same occasion he volunteered the remark: "I do not know what the future petrography will be, but it will be quite different from what it is now," in 1890. It was as though this great leader of a wandering people had had a vision of a land into which he himself was not permitted to enter.

For the rocks grouped together by Rosenbusch Professor Daly calculates average analyses, chiefly from the tables of analyses published by Osann, and assumes that these averages represent types of each group, the subjective character of such calculations not being considered by him as objectionable. A fundamental error in his procedure with respect to igneous rocks appears in the misstatement, copied from Rosenbusch, that coarse-grained intrusive rocks differ from their corresponding porphyry and lava forms by the relative proportions of their chemical constituents.

This error vitiates some of the fundamental hypotheses developed in subsequent parts of the book (p. 229). It has been clearly demonstrated that these supposed differences rest on the failure of the qualitative system of Rosenbusch to classify rocks by their actual mineral compositions, or modes, and also upon the fact that the modes of chemically similar magmas may differ because of the different physical conditions which may have controlled the chemical equilibria within solidifying magmas. This well-known principle is lost sight of by Professor Daly. Apparently the author's units for classification have been petrographical names and definitions, and not the rocks themselves, with which he seems to be less familiar.

Having qualified the Qualitative System of Rosenbusch to suit his conceptions of it, the author proceeds in the third chapter to employ it quantitatively, and undertakes to determine the relative abundance of various groups of names which he has called "clans," assuming that the areal distribution of igneous rocks, as represented on maps made at various times by many geologists and petrographers, will furnish a reliable basis for the comparison of actual rock bodies and of the relative amounts of various kinds of igneous rocks! To one familiar with the methods of geological cartography, with methods of observation and petrographical determination of large areas of igneous rocks, and also with the modes of occurrence of rocks in the field, the idea of employing the areal representations of such bodies as a means of estimating the relative quantities of rocks grouped by Professor Daly into "clans" is remarkable both as an evidence of the author's respect for the data before him and as an indication of his conception of the structural geology involved. Great areas of igneous rocks are commonly so complex that their mapping is not attempted in detail on many maps, and in some regions a thin surface flow of lava may overlie hundreds of square miles of other igneous rocks, which is the case in eastern Idaho, for example, where basalt overlies rhyolites which are not represented on maps of the region. The value of his efforts to determine the relative quantities of various kinds of igneous rocks, as well as of the classification he has applied to the rock bodies studied, appears in his conclusion that the rocks of the globe belong quantitatively to two types, "granite" and "basalt"; a statement which shows that his petrography goes back to that early period when "granites" and "greenstones" were considered to be the chief groups.

In shutting his eyes to the great volumes of intermediate rocks which form the chief bulk of igneous magmas Professor Daly exhibits the results of the method which controls his researches, and also to what extent an observer may "feel the pressure of the category" (p. 62). It goes without saying that the writer disagrees with Professor Daly as to the value of the observer under such circumstances. The lack of breadth in his discussions of some subjects is shown by his failure to give proper weight to the effects of erosion in revealing the deeper-seated intrusions of older times, as well as in removing older surface lavas, which accounts for the apparent differences he finds in the modes of eruption of magmas in different geological periods.

The chapters on intrusive and extrusive rock bodies are full of excellent diagrams and illustrations of many instances which have been taken from many sources, as the author states, and they contain a great deal of valuable material. However, with his opinions regarding batholiths the writer takes many exceptions which have been expressed in the lectures on volcanism already referred to. It is to be regretted that in his discussion of these bodies Professor Daly is constantly confounding observed facts with hypotheses to the serious confusion of the reader. His suggestion as to the origin of the rhyolite plateaux of the Yellowstone National Park, which is expressed diagrammatically in Fig. 71, shows the limits to which he is willing to be led by his speculations, and becomes a *reductio ad absurdum* for his batholithic hypothesis, of which he says it is a logical outcome, when one considers the geological structure of the region and the character of the rhyolite lava flows

forming the plateaux. The diagram referred to would seem to be a limiting case of the author's indifference to rational geodynamics, yet in the introduction to Part II. he states that "Throughout the preceding chapters the attempt has been made to admit only such descriptions and classifications as are direct expressions of objective facts."

The second part of the book begins with a discussion of the possible temperature and constitution of the earth, which he concludes consists superficially of an outer "acid" or "granitic" shell with a partial covering of stratified rocks, underlaid by a liquid "basaltic" shell. He states that the phenomena of intrusion and of rock variation can all be explained by the interaction of these shells, to demonstrate which the succeeding chapters were written. The hypothesis of concentric zones of granitic and basaltic magmas is like those of von Waltershausen, Durocher and others, and the synthetic features are similar to those of von Cotta. These hypotheses were evolved before the closer study of igneous rocks had shown the error of their fundamental conceptions. This modern knowledge Professor Daly ignores, and any attempt to convince him of his mistake would involve a course of instruction which he does not appear to desire. It is not too much to say that the statements he makes in support of his hypotheses regarding the constitution of the lithosphere, the processes of magmatic intrusion, of overhead stoping, assimilation and subsequent differentiation appear to the writer to be in part fundamentally wrong and in many cases thoroughly misleading to the reader. It would be an extensive undertaking to criticize his elaborate and voluminous arguments in detail, and it would be a task the writer does not care to attempt.

His discussion of "abyssal injection" which is based on the assumption that the earth consists of a "relatively thin crust overlying a fluid basaltic substratum of unknown thickness" (p. 192), and the diagrams illustrating his conception of the process, as well as of that of batholithic intrusion, and also the scheme of rock genesis which is given in Part III., are all based on the principle of contrasting two assumed antithetical qualities, or groups of properties, such as a "solid crust" and a "liquid substratum," an "acid" rock mass and a "basic" rock magma; corresponding to the two magma hypothesis of Bunsen with its synthetic corollaries. It is a system which does not appear to be in harmony with modern notions of evolution, but finds its counterpart in metaphysics, with its antithetical right and wrong. It seems to the writer that physics, not metaphysics, should furnish the basis for modern petrology.

In calling his speculations an "Eclectic" theory Professor Daly has not distinguished it from any other complex theory of the present day, which in the nature of science must be derived from many other theories or hypotheses, previously enunciated. All modern complex theories are eclectic, or are but slight modifications of previous ones. The theory to which that of Professor Daly is most closely related, as he points out, is that of Loewinson-Lessing, published fifteen years ago, which its author called a "synthetic-liquation theory of differentiation," a name which has the merit of being descriptive.

The third part of the book before us outlines the result of applying the author's theory to the problem of petrogenesis. The result is a most remarkable distortion of petrographic relationships, and a thoroughly artificial scheme. The grotesqueness of the conclusions might be relied on to condemn the process of reasoning by which they have been attained were it not for the eminence of the author, the magnetism of his personality, and the effectiveness of his address, which give a seriousness and force to his writings that will carry conviction to many readers who have no means of independent judgment, both as to the correctness of his direct statements in each case and as to which are realities and which subjective conceptions.

With Professor Daly's tireless energy and vigorous methods of attack; with the acknowledged honesty of his conviction as to the correctness of his reasoning, but with his lack of discrimination between the relative values of objective realities and subjective conceptions;

with his chivalrous devotion to a "complete mental system," and with his courage in the use of his speculative imagination—he is a veritable knight errant in petrology.

J. P. IDDINGS

BATAVIA, JAVA,
August 3, 1914

Bacteria in Relation to Plant Diseases. By ERWIN F. SMITH, in charge of Laboratory of Plant Pathology, Bureau of Plant Industry, U. S. Department of Agriculture. Volume three. Vascular Diseases (Continued). Washington, D. C. Published by the Carnegie Institution of Washington, 1914. Quarto, viii + 309 pp.

It is not so many years since we were assured by some foreign bacteriologists that bacteria did not and could not produce diseases of plants. Less than a dozen years ago the writer of this review took part in an impromptu discussion in the bacteriological laboratory of one of the German universities in which it was vehemently contended on the one side that American bacteriologists showed their incompetence by thinking that the bacteria they found in plants had any pathological significance. Even pear blight was held to be due to some other than bacterial action. The sweeping assertion was made that no plant diseases whatever were due to the presence of bacteria.

The three stately volumes which Dr. Smith has already issued remind one of these recent opinions, and one wonders what can now be said by these same disbelievers in the pathogenic relation of bacteria to the diseases of plants. At any rate, Dr. Smith has here marshaled an array of facts that must be staggering to one who still feels that bacteria do not cause plant diseases.

The present volume deals about equally with diseases of monocotyledons and dicotyledons, principally with diseases of sugar-cane and maize, and with those of potato, tomato and tobacco. A full account is given of Stewart's disease of sweet corn and all the evidence going to show that it is disseminated on the seed. The morphology and cultural characters of *Bacterium solanacearum* which produces the "Brown Rot" of potatoes and other related plants are given in full. The destructive tomato disease, due to *Aplanobacter michiganense,* is also illustrated and distinguished from that due to *Bacterium solanacearum.* Growers of tobacco will find a separate chapter on the bacterial wilts of tobacco.

Throughout the book are found more than 150 text illustrations, and 47 full-page plates, some of the latter colored. The reader will share the author's satisfaction with the way that the printer has been able by the use of excellent paper and ink, and carefully selected type, to bring out the text and the illustrations. In passing it should be noted that only twenty-nine of the illustrations are borrowed from other authors, so that in this regard also this book is a contribution to the literature of plant pathology.

Although this volume was issued in the early part of August, 1914, it is known that the manuscript left the author's hands about two years earlier. During its slow progress through the printer's hands Dr. Smith has added many a paragraph and illustration, so that in fact the volume has been brought down as close as possible to its date of issue.

We need only pause a moment to call attention to the admirable index, which is all that an index should be. It is first of all an alphabetical index of the topics treated and the terms used, but, in addition, these are so systematically arranged that the index is a conspectus of the whole volume, and especially of its various sections.

As the writer of this review runs over this volume and its predecessors he is still more impressed with the feeling that some of these days the botanists of this country must ask very emphatically for a text-book on plant diseases prepared by Dr. Smith. A text-book from his hand could do much to place plant pathology on a truly scientific basis.

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The Bacteriological Examination of Food and Water. By W. G. SAVAGE. Cambridge, England, University Press.