

**SMITHSONIAN INSTITUTION.  
UNITED STATES NATIONAL  
MUSEUM. THE RELATION OF  
BIOLOGY TO GEOLOGICAL  
INVESTIGATION, PP. 247-368**

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**CHARLES A. WHITE**

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UNITED STATES NATIONAL MUSEUM.

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THE RELATION OF BIOLOGY TO GEOLOGICAL  
INVESTIGATION.

BY

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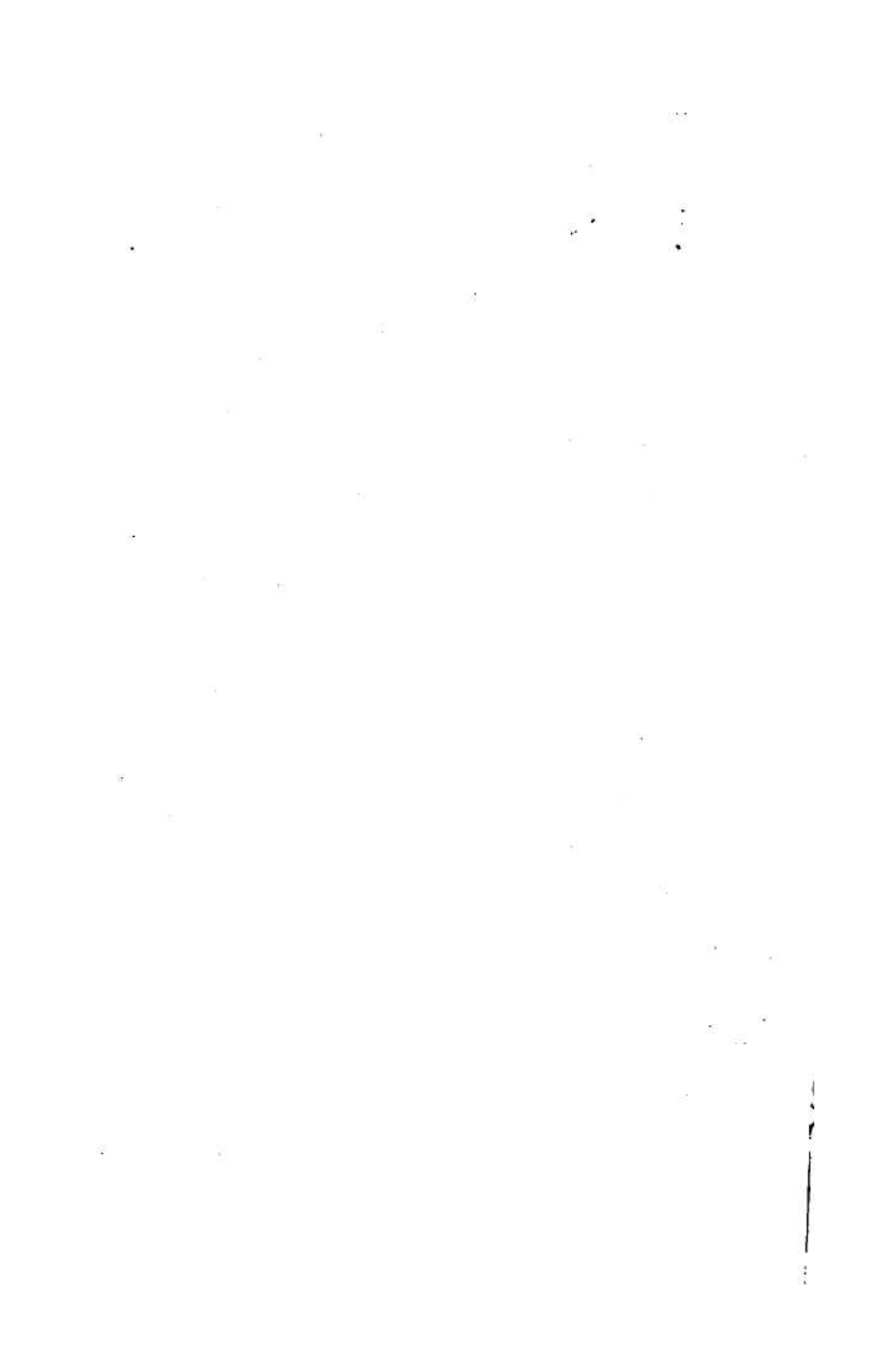
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THE RELATION OF BIOLOGY TO GEOLOGICAL INVESTIGATION.

A SERIES OF ESSAYS DISCUSSING THE NATURE AND SCIENTIFIC USES  
OF FOSSIL REMAINS AND THE NECESSITY FOR THEIR SYS-  
TEMATIC COLLECTION AND PERMANENT CONSER-  
VATION IN PUBLIC MUSEUMS.

By CHARLES A. WHITE.

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## P R E F A C E .

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In the preparation of these essays I have had several objects in view, among which are a further presentation of elementary matter pertaining to biological geology than has before been published, the defense of biology as an indispensable aid in geological investigation and the repudiation of certain untenable claims that have been made in its favor, an application of the principles discussed to the practical work of the geologist, and the demonstration of the necessity of the preservation of fossil remains in public museums as storehouses of evidence upon geological questions. These essays are therefore confined mainly to a discussion of questions pertaining to biological geology, including both its structural and systematic branches, only incidental reference being made to other important branches of geological science, such as mineralogy, lithology, dynamic geology, etc.

I have intended an approximately full statement of the subjects selected for discussion as well as scientific accuracy in my conclusions, but in the manner of their presentation I have chosen to address general readers and students of geology as well as special investigators. I have accordingly presented a more detailed and methodical statement of the principal facts upon which biological geology is based than otherwise would have been thought desirable. Every working geologist is necessarily more or less familiar with the principles and criteria which are based upon these facts, but a comprehensive knowledge of them is not yet accessible to the student except by personal experience or didactic instruction; that is, because these principles and criteria have not yet been systematically and fully stated in published works the greater part of accessible knowledge concerning them is traditional.

It is true that some of the knowledge referred to has been briefly and more or less clearly presented in text-books, but the elements of biological geology are too comprehensive to allow of a satisfactory summary in even the largest of them. All discussions of principles and criteria pertaining to that subject are also usually omitted by authors of other works, evidently upon the reasonable ground that scientific writings ought not to be encumbered by a repetition of elementary principles, and upon the less reasonable assumption that the

reader is familiar with and accepts as trustworthy those which they have adopted for their own guidance.

If it were not for my evident need of frequent reference to such elementary matter the desirability of publishing it in this connection might perhaps be questioned by those who are already familiar with it and with the range of its applicability. Still, the working geologist needs only to recall his early embarrassments and later experiences to be assured that the time has not yet passed when even the frequent enunciation of elementary truths is of material benefit to the student. I not only have not hesitated to adopt such a treatment of the subjects of these essays, but I have not sought to avoid numerous trite remarks and commonplace statements. These, however, are employed not so much for the purpose of conveying information as for that of giving logical continuity to the statement of my own ideas and of leaving the least possible room for doubt as to my meaning.

The relation of biology to geological investigation is so fundamental and the facts pertaining to it are so concrete and so accordant with both biological and physical laws, that the prevalence of any opposition to its legitimate claims seems unnatural. It is also unnatural that claims should still be made in favor of that relation which are not supported by the principles of modern biology. Of late years, however, such wide differences of opinion have become prominent, some of them being especially so among American geologists. In their writings some of these authors either entirely ignore biological evidence as furnished by fossil remains or treat the best of it as being of little importance in the investigation of structural geology. Others have taken quite opposite ground, not only making the just claim that biological evidence is indispensable in structural geology, but the untenable one that it is absolute and exclusive in systematic geology. Notwithstanding the prevalence of these extreme views, I have abstained from a controversial attitude in the treatment of the subjects to which they pertain, preferring to attempt their statement in such a way that the reader will necessarily reach correct conclusions.

Because it is necessary to discuss those differences of opinion in these essays, it is desirable to refer briefly to their origin and the causes of their perpetuation. Doubtless some of the causes of their existence are remote or obscure, but it is apparent that they are largely due to the broadening of the field of geological investigation, making it necessary that it should be divided into numerous specialties. In such cases it is natural that differences of opinion should be greatest between those investigators whose chosen studies are most diverse in character. Another cause is doubtless one of inheritance from the early condition of both geological and biological science.

A special cause of the perpetuation of these extreme views evidently exists in the form of personal domination by such of those who entertain them as happen to possess unusual opportunities for their

enforcement. It is well known that such influence has at various times and in various ways retarded the progress of geological science and that there is danger of its being exercised in all cases when the personal judgment of an observer is liable to be modified or controlled by official or other temporary authority.

The opinions which have been referred to as the result of inherited errors are mainly those which relate to the application of biology to systematic geology. They are evidently due to the difference of ability or of inclination among the authors who have written upon those subjects, to adjust the early methods of thought which they have adopted to those which were made necessary by the great revolution in the views of naturalists upon the subject of evolution, which took place after standards for both biology and geology had been formulated and generally adopted. I regard this cause as being so important that I have arranged the discussions of the geological scale now in use so that they embrace references to the condition of thought among promoters of geological science from about 25 years before the revolution to the present time.

It is apparent, however, that, besides, the tendency to follow established channels of thought, which has just been referred to the continuance of these differences of opinion, and the consequent differences in practice among geologists, are largely due to the fact that the principles and criteria which are necessary to constitute a standard or series of standards which shall accord with modern views of biology have never been conventionally formulated and published. It is very desirable that concerted attempts toward such formulation should be made, but it is nevertheless true that the necessity for a special exercise of personal judgment in every act of geological investigation renders exact formulation peculiarly difficult.

The attempts toward enunciating principles and formulating criteria which are made in these essays have been suggested by those of my own geological investigations which have been prosecuted mainly from a biological standpoint. Among the incentives to these attempts has been a desire to give to the readers of my published writings upon the subjects referred to a more explicit statement of the grounds of certain opinions therein expressed than it was practicable to make in those writings. Indeed I believe the present general condition of geological science in all its departments demands from its active investigators some more definite public exposition of principles, and even of certain elements, than has yet been published. It is at least apparent that such publications for each subordinate branch of geology would be of great service to students because it would give them greater facility in comprehending the meaning of authors, and it would enable the latter to write more concisely and intelligibly, as well as more accurately, upon the results of their investigations. It would also give authors in the different branches of geology an opportunity to become better