ELEMENTS

OF

PHYSICAL BIOLOGY

BY

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"Voilà un homme qui a fait son mieux pour ennuyer deux ou trois cents de ses concitoyens; mais son intention était bonne: il n'y a pas de quoi détruire Persépolis."
—*Voltaire*

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ELEMENTS
OF
PHYSICAL BIOLOGY

DEDICATED
TO THE MEMORY
OF
JOHN HENRY POYNTING

PREFACE

The preface is that part of a book which is written last, placed first, and read least. As I approach my concluding task I am moved to reflect why a preface should be written at all. This question, if followed into all the intricacies of which it holds potentiality, should apparently result in a composition new in literature, a Preface to the Preface. Such precedent should not be lightly established, for it suggests a vista of future degenerations after the pattern of Josiah Royce's infinite succession of maps, each containing within itself its own replica on a reduced scale. But without going to such lengths as this, the philosophy of the preface may perhaps briefly be summarized to this effect, that it is the author's subjective introduction to the more objective matter that should follow. Here he may, if this is deemed of any interest, say something regarding the circumstances that gave origin to the work, and the conditions under which it came into being. He may express his feelings as to its alleged purpose, and may follow custom by giving voice to pious wishes as to the function which the product of his presumptive mind may fulfill in an Universe in which no event, however trivial—be it no more than the addition of one more book to the groaning library shelves—is without distant reverberations.

As to origin, the first plan of the work was laid about 1902, in the author's student days in Leipzig. The development of the topic is recorded, in outline, in various publications, of which the first appeared in 1907 in the American Journal of Science. Reference to this and to its various sequels will be found in pertinent places in the text that follows. The last stage of the work, arrangement of the matter in collected form, and filling in the flesh about the skeleton framework elaborated in the journal literature, was carried out at the Johns Hopkins University upon the invitation of the Department of Biometry and Vital Statistics. For the courtesies so extended to him the author wishes here to express his thanks, as well as for the interest shown in the progress of the work by Dr. Raymond Pearl and the members of the Department, notably Drs. W. T. Howard, L. J. Reed and J. R. Miner. Outside the walls of this University I think with very particular appreciation of the never-failing succor in times of mathematical trouble, which I found at the hands of Prof. F. R. Sharpe of Cornell University; also of the patient assistance, upon more than one occasion, from Prof. W. B. Fite of Columbia University. And I gratefully recall encouragement received from Dr. G. K. Burgess, Director of the Bureau of Standards, especially in the earlier stages of the work, when encouragement was most needed.

Acknowledgment has been made in the text for numerous quotations. The somewhat extended excerpts from certain articles published in the Scientific Monthly call for special notice here, and I wish to express my thanks both to the author, Prof. G. W. Martin, and to the Editor of the Monthly, for permission to quote thus at length from its pages. I am similarly indebted to the Editor of Harpers Magazine for permission to reproduce here certain portions of an article from my pen, entitled "*Biassed Evolution*", which originally appeared in the May issue (1924) of that publication.

Toward the publishers, Messrs. Williams and Wilkins and in particular Mr. C. C. Thomas, I have every occasion to entertain feelings of the most cordial appreciation. Through their courteous attentions the business of bookmaking was made a pleasure.

My greatest debt is acknowledged in the dedication. Whatever merits this book possesses may well be credited to the influence and teaching of Poynting. There is little danger that its faults shall be charged to his account.

As to the topic of the work it seems unnecessary to say many words here, inasmuch as a delineation of this has been made the subject of a special chapter on *The Program of Physical Biology*. Only this explanation it may be well to offer here, that, as proposed in Chapter V, the term *Physical Biology* has been employed to denote the broad application of physical principles and methods in the contemplation of biological *systems*, whereas *Biophysics*, in common parlance, relates rather to the special field of certain physical aspects of the life processes of the *individual*. With this terminology, Physical Biology would comprehend Biophysics within its scope.

The writer cannot in reason expect to have produced a work without blemish. Even an approach to such absolute perfection is the rare privilege of a few. He would, however, be unjustified in addressing the reading public at all if he did not entertain the hope that, despite shortcomings, these pages may bring to the reader new assets, here and there a new piece for his mental furniture, now and again a new perspective, a new comprehensive outlook over a body of facts and relations in themselves perhaps familiar.

The work has been largely one of systematization, and of development of method. Factual material has been introduced essentially for the purpose of illustrating the point of view to be set forth. There seems therefore hardly any occasion for apologetic explanations that anything of the nature of completeness in the presentation of pertinent facts was in nowise aimed at. Indeed, it must be obvious upon most casual reflection that such completeness, in a subject of the amplitude of that here taken in view, could be achieved only in a cyclopedic work of several tiers of volumes.

Considerable care has been taken to cite in detail the sources consulted. It was felt that, on account of the wide dispersal of these citations over a broad field of scientific literature, few readers could be expected to be familiar with all the branches of pertinent library lore, and for this reason a collation of such references should have a value of its own, even apart from the text. At the same time the compilation of anything like a complete bibliography could not be undertaken on the present occasion.

It is hoped that the mathematical mien of certain pages will not deter biologists and others, who may be disposed to look askance at symbols of the art, from acquiring an interest in other portions of the book. Biometricians will, presumably, not shrink on this score; to them, and to physicists, (whom I should greatly wish to number among my readers) I may perhaps confess that I have striven to infuse the mathematical spirit also into those pages on which symbols do not present themselves to the eye. For this I offer no apology.

For the sake of space economy recapitulary paragraphs have, as a rule, not been given a place in the text. An exception has however been made in Chapters XX, XXXIII and XXIV, the last of which, in particular resumes and amplifies somewhat certain phases of the topics discussed in earlier chapters. The reader who may wish briefly to review the substance of his reading as he proceeds, should find suitable assistance in the rather detailed *Analytical Synopsis of Chapters* that has been placed immediately after the Table of Contents. And finally, a bird's eye survey of the general field covered in this work can be obtained by consulting the Tabular Synopsis at the end.

Here, then, I make my exit from the prefatory stage and commend my work to the tender mercies of the reader; not without some trepidation, for I recall how Voltaire said of one: "Il fit une philosophie comme on fait un bon roman; tout parut vraisemblable, et rien ne fut vrai;" and there comes to mind the language still plainer of du Maupassant—"Depuis qu'ils ont appris à lire et à écrire, la bêtise latente se dégage." I trust that the reader's response to these pages may not be too fervent an Amen to the prayer of *The Sceptical Chymist* "It is to be hoped that these men, finding that they can not longer write impertinently and absurdly . . . . will be reduced either to write nothing, or books that may teach us something . . . . ; and so, ceasing to trouble the world with riddles or impertinencies, we shall either by their books receive an advantage, or by their silence escape an inconvenience."

ALFRED J. LOTKA.

Johns Hopkins University, May, 1924.

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