ANIMAL BIOLOGY

AN INTRODUCTION TO ZOÖLOGY FOR COLLEGE AND UNIVERSITY STUDENTS

BY

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ONE HUNDRED FIVE ILLUSTRATIONS

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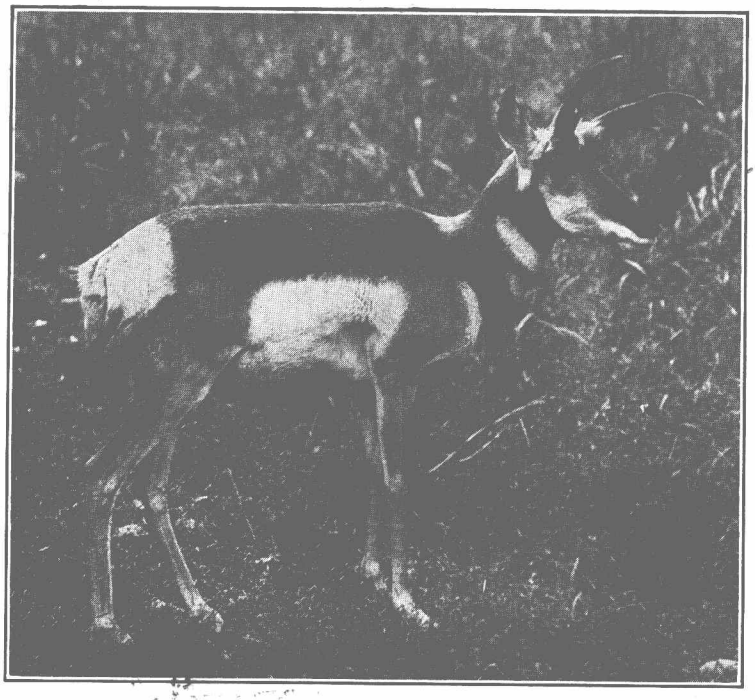

Frontispiece.—The Pronghorn Antelope (*Antilocapra americana*), a mammal peculiar to North America. (Photograph by courtesy of the Smithsonian Institution: National Zoölogical Park.)

To
FATHER AND MOTHER,
this book is
Affectionately dedicated
by the Author

PREFACE

Another textbook of zoölogy to stand on the ten-foot shelf already crowded with the products of previous authors should have some distinguishing characteristics to justify its publication. The present book has been written primarily to present the *animal as a living organism*. Other texts with this point of view, have usually been faulty in that they present the general principles without first laying a foundation in morphology. On the other hand, those that have given an adequate knowledge of morphology are built on the plan of "types" and pay slight attention to general principles. The present book records an effort to steer between the two extremes; morphology is stressed, but an extended systematic review of the phyla has been avoided, and the greater part of the discussion has to do with general principles.

In the second place, while seeking to offer the necessary amount and variety of zoölogical information, the impossibility of making a "finished zoölogist" out of the average freshman has been recognized; it is far more important to stimulate his interest and to whet his appetite so that he may be inclined to pursue the subject farther in advanced courses. The attempt has, therefore, been made to write in a style more familiar and lively, and less pedantic than that commonly found in textbooks. Accuracy of statement has been striven for, but, it is to be hoped, without undue sacrifice of a literary quality which certainly should not be out of place in such a publication.

In the third place, technical terms, when first introduced, are defined with fullness, and, it is hoped, with sufficient clearness, so that the student will gain clarity of understanding. Haziness of ideas has no excuse in any course in a science; in so far as they are engendered in the student's mind, the course has failed of its full purpose and rightful measure of success. Yet, in aiming at clearness of concept, the author has not intentionally, at least, "written down" to the level of students with a low IQ. A course that does not daily put some strain upon the student's gray matter breeds indolence and inattention, and destroys interest.

Throughout there has been the constant intent of the illustration and application of the "scientific method," in the hope that the student who may never go farther in science than this elementary course, may yet form the habit of looking for facts, of facing the truth squarely, and of drawing logical conclusions from relationships observed. Only in this way may he be equipped to attack and solve the problems of his post-collegiate life. There is set forth in this text, the crystallization of ideas which has resulted from over a quarter-century's experience in teaching zoölogy to college students. It covers the ground somewhat more intensively, but not more extensively, than in the course given under the author's direction at the University of Kansas.

The materials used have been drawn from sources too numerous to mention; indeed, in many cases they have been so long the substance of the author's own thinking that their ultimate source has long since been forgotten; most of them are the common stock in trade of all zoölogists. Some few new contributions may be mentioned. Thus, the division of the animal kingdom into the *Histozoa* and *Anhistozoa* (see p. 146–8) seems more in accord with fact and logic than the current usage of

Metazoa and *Protozoa*. The restriction of the term "tropism" *to the reactions of organisms without a nervous system* is a response to a need widely felt and often expressed, but which previous authors have apparently not had the temerity to undertake. The term "tropism" has been used in so many senses by different authors as to have lost its primitive exactness of meaning. Sticklers for "priority" may argue that it therefore should be wholly discarded and some other term substituted for it. However, no equally appropriate term has been coined for the purpose, so that the writer feels justified in giving it redefinition and definiteness of restricted application. The term "collogenesis" has been coined as a name for an hypothesis of the origin of life which is perhaps not new but for which no convenient appellation seems to have been previously proposed.

The illustrations borrowed from other sources have been properly acknowledged in the legends under each. The drawing of *Chaos diffluens* was made especially for this book by Professor A. A. Schaeffer and has not previously been published. Other original drawings, contributed by Miss Ruth Shaw, by Miss Miriam Morse and by Mr. Juan Casilan, are properly accredited in the legends. Where no other source is indicated, the author alone is responsible. To Mr. Harold Lucas, the author is indebted for the careful, accurate typing of the manuscript.

H. H. LANE.

UNIVERSITY OF KANSAS,
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CONTENTS

ANIMAL BIOLOGY

CHAPTER I

INTRODUCTION

Nature is ever inviting investigation; she hides her beauty behind a cloud; she buries her truth in the earth; her goodness is whispered among the stars. She spreads before man areas he may never compass, heights he may never scale, depths he may never fathom. Yet she plants within him insatiable curiosity to peer within the veil; indefatigable perseverance to mine the ore of truth; a mind to compel the stars to speak aloud; she rewards him according to his deserts. The Can't-learns she fills with dread and superstition; the Don't-learns she afflicts with pain and regret; the Won't-learns she utterly destroys; but the Do-learns reap, as they have sown, understanding and wisdom. To them she grants command over all the forces of the universe; they are able indeed to build a civilization.

Some students of this book are having their first introduction to a science, and may expect to find that *science* —which literally means *knowledge*—differs greatly in kind from ordinary knowledge. It seems to be a popular idea that a scientist is a sort of wizard, or at least a genius, who makes wonderful discoveries by some intuitive power not possessed by ordinary people. This is not the case; the mode of investigation which the

scientist employs is in principle not different from that which is used in the common affairs of life. Whoever tries always to see the facts as they really are, without bias or prejudice, and undertakes to reason from these facts to sound conclusions, is using the scientific method. Science differs from the knowledge derived from every-day experience mainly in being based on more rigidly accurate observation, or on carefully planned experiment, and with its results coördinated by a process of reasoning which is "merciless to fallacy in logic."

Science,* then, may be defined as that body of knowledge concerning the facts of nature, and their relations one to another, which has been patiently and methodically established by the observations and experiments of many men, and verified over and over again by them and their successors, and subjected to the most critical examination of which minds trained in accuracy of observation and alert to fallacies in logic are capable.

"Whoso will question the validity of the conclusions of sound science must be prepared to carry his scepticism a long way; for it may be safely affirmed that there is hardly any of those decisions of common sense on which men stake their all in practical life, which can justify itself so thoroughly on common-sense principles as the broad truths of science can be justified" (Huxley).

The field of science in general embraces the whole universe of nature. Anything that can be counted, weighed, or measured,—in short, anything that can be apprehended by the mind of man as perceived through

* This is often called a "scientific age;" yet many absurd statements are made in the name of "science" which do not stand the test of real scientific scrutiny or of ordinary common sense criticism. The trouble generally lies in the failure to apply the "scientific method" to the study of the facts on which the conclusions are based. Needless to say, such pseudo-science is the product of minds without an adequate scientific training or background. Not every one who claims to speak in the name of science has a clear right to do so, and unfortunately the non-scientific man cannot always judge correctly the credibility of what he reads.

the senses lies within the field of science. The scientist turns his telescope toward the sky and observes and records, by the most exact methods that man has been able to devise, the multitudes of suns and planets there revealed to him, measures their distances, their magnitudes, and maps their courses. This is *astronomy*, which has taught us that our earth is relatively but a tiny speck of matter revolving in an elliptical path (orbit) around the sun; that our sun is but one of innumerable stars, many of them with their own systems of planets revolving around them; that there are whole galaxies of solar systems like our own, some so far away from us that it takes their rays 300,000,000 light-years, traveling at the terrific rate of 186,000 miles per second, to reach us! And there is no reason to think that our most powerful telescopes have yet been able to penetrate to the uttermost limits of the whole universe.

Or, the scientist may turn his eyes and thought downward to investigate the structure and history of this earth on which we live. Here he has discovered that our planet is an oblate spheroid, *i.e.*, a ball somewhat flattened at its poles, circling the sun once annually in a definite orbit, and turning around on its axis once each day. The student of the earth is the *geologist*, who has learned that it is made up of some ninety-odd kinds (elements) of matter, combined in countless ways and proportions into the substances which compose its rocks and ores, its gaseous envelope (atmosphere), and the waters of its seas, lakes and rivers. Patient, careful study has shown him that about 53 miles of the superficial crust of the earth is largely made up of rocks which have been formed at different times, in several different ways, and laid down in the order of their formation, in layers or *strata*. Unequal pressure has resulted in the elevation of mountains by the folding of the earth's crust along lines of weakness, and in many cases frost

and ice have cracked and crushed, and the rains have carried away the materials of the higher places and have deposited them in the valleys or have borne them out to sea, thus building up solid land in one place as fast as it is worn away in another. Thus is produced an inequality at different places, which has often resulted in the elevation of the lighter and the subsidence of the heavier portions of the earth's crust. The sea has at times encroached upon the land, and at times has receded as the land rose, so that most of the present land surface has been submerged and elevated several times in its history. These processes are, in general, slow—very slow—so that the surface of the earth has been long in reaching its present form, and the total age of the earth, as indicated by the facts in hand at present, while perhaps not absolutely accurately determined, cannot have been less than 2,000,000,000 years.

But the surface of the earth is occupied by other forms of matter which manifest a series of properties not found in the substance of the earth itself. These properties are what we may term the manifestations of *life*, and the forms of matter exhibiting them are called living things, or *organisms*. These organisms, for the sake of convenience, and because they represent in general two divergent modes of life, are usually spoken of as *plants* and *animals*. The peculiar properties of living matter, or *protoplasm*, may be studied equally well in either plants or animals, and constitute the subject-matter of that branch of science called *biology*. Strangely enough the word "biology" was not coined until near the beginning of the nineteenth century, when it occurred almost simultaneously to two men, Treviranus in Germany, and Lamarck in France.

In this book we are concerned particularly with the life-processes as they occur in animals, leaving the plants to those biologists whose attention may be directed to

their study, which is called *botany*. That branch of science which deals with animals is called *zoölogy*, and those who devote their lives to the investigation of this field of knowledge are called *zoölogists*. Under zoölogy may be included all facts relating to animals, such as their structure, their habits, their relations to one another, to plants, to the physical environment, their similarities and dissimilarities, their distribution over the earth, their geological history, their origin and development, both individually and racially, and their influence upon man. Such a study of the structure and the work performed by animals has an interest and a value not only in itself, but, since man also is an animal, because from it we learn to know and to understand ourselves. The scope of zoölogy is so vast that in this book we can hope to give only the merest outline of the subject, leaving the details to be filled in as fully as may be by further more intensive study of its special branches. Though the student should constantly keep in mind the application of the facts and principles set forth here to his own body and life, he should understand that the illustrative material is purposively chosen mostly from the lower forms, because in them conditions are often far simpler than in man and hence can be more easily observed and understood. Moreover, while as far as possible his attention will be directed to the activities and relationships of living organisms, the student should remember that even the dead bodies of animals which may be dissected in the laboratory reveal by their structure and the arrangement of their parts much that is indispensable to the comprehension of them as *living beings*. In short, we are entering upon a study of *animal biology*, that is, of *life* as it is the property of animals; the sum total of those physical and chemical processes, those permutations of energy and matter, which go on in the animal organism, and we shall find