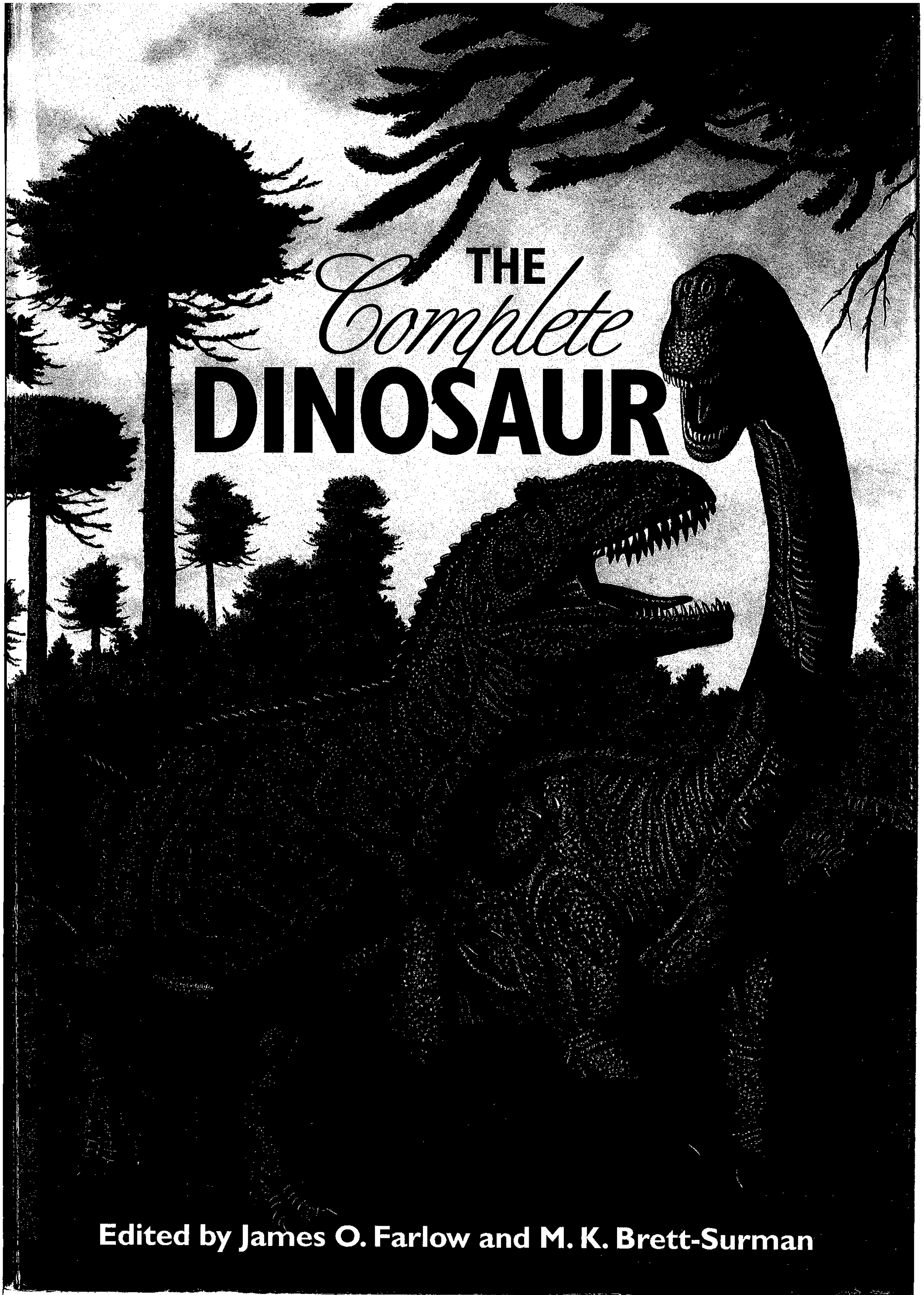
THE
Complete
DINOSAUR
Edited by James O. Farlow and M. K. Brett-Surman

Part Two

The Study of Dinosaurs

> Any one of the larger carnivorous dinosaurs would meet the case. Among them are to be found all the most terrible types of animal life that have ever cursed the earth or blessed a museum.
>
> —Sir Arthur Conan Doyle, *The Lost World*

As summarized in the first part of this book, our knowledge of dinosaurs has accumulated through the combined efforts of many people, professionals and amateurs alike, over the last century and a half. We now know a great deal about these "fearfully great" reptiles, and we are learning more all the time.

So *how* do we know what we know? What are the bases for the statements about dinosaur biology and evolution that will be made by one contributor after another in the remaining sections of this book? Those questions are the subject of Part Two, which describes how paleontologists, and the other professionals who assist them, find, study, and interpret dinosaur fossils.

This section begins by explaining how a paleontologist decides where to look for dinosaur bones, and what is done with them once they are found; both traditional and state-of-the-art methods of collecting and preparing dinosaur fossils are summarized.

It would be very nice to have a living *Anatotitan* or *Triceratops* to study in the field or laboratory, but nature hasn't been that kind to us. Most of our information about dinosaurian evolutionary relationships, or about how the great reptiles functioned as living animals, comes from study of their skeletons. This means that in order to understand how paleontologists interpret dinosaurs, one must have a basic knowledge of the bones of the dinosaur skeleton, and so we devote chapter 7 to a tour of the different bones of a dinosaur's body.

One of the major goals of paleontology is to reconstruct, to the extent that this is possible, the course of evolution. In dinosaur paleontology this involves determining the phylogenetic relationships of the various dinosaur groups to each other, and also to other kinds of animals. How is this done? Chapter 8 explores different approaches to the naming and classifying of organisms, including dinosaurs.

One of the key developments in evolutionary biology over the last generation has been the general acceptance of the principles of phylogenetic systematics (cladistics) in interpreting the evolutionary relationships among different groups of organisms, including dinosaurs. Although a cladistic approach to organizing information about evolutionary patterns is an eminently logical way of doing things, it comes as a shock the first time one encounters it. (Birds *are* dinosaurs? Get out of here. . . .) So our chapter on classification explains how phylogenetic systematics works, and compares its approach to dinosaur classification with a more traditional approach.

To say that dinosaur classification is contentious is like saying that the Atlantic Ocean is a bit damp. The number of different dinosaur classifications operational at any one time can be described by the formula

$$C = (N + A) - 1$$

where C is the number of classifications, A is the number of amateur paleontologists, and N is the number of dinosaur paleontologists. The "−1" represents the true classification, which we shall never know (part of Durham's Law). The stability of any classification can be a double-edged sword. A classification can be stable because we have obtained a close approximation to the actual relationships of the organisms under study. Unfortunately, stability can also reflect consensus due to the lack of an adequate fossil record—or a stagnation of research.

Geologists have constructed a formidable set of terms to describe the intervals of earth history during which dinosaurs and other ancient organisms lived. Readers will not be able to understand how dinosaurs evolved unless they understand the names applied to the various intervals of Mesozoic time. Consequently we include a short chapter to orient the novice in a timely manner.

Although some field and laboratory methods in paleontology have not changed in the last century, new technologies have revolutionized much of the way in which dinosaurs are studied. Chapter 10 describes these new technologies, and the way they are affecting the research methods of paleontologists.

Jurassic Park gripped the imagination of the moviegoing public with the possibility that dinosaurs might be re-created from genetic material in dinosaur blood once imbibed by Mesozoic mosquitoes. Paleontologists are indeed interested in the possibility of recovering dinosaur biomolecules, but there is very little chance that these can be used to populate our zoos with living examples of the fearfully great reptiles. On the other hand, dinosaur biomolecules may well provide us with valuable insights into the relationships of dinosaurs to other animals. It is, in consequence, necessary to include a chapter about the problems and potential of finding and studying such biochemical traces of dinosaurs.

The results of scientific research on dinosaurs are generally published in learned technical journals written by and for scientists. However, the general public has an insatiable interest in dinosaurs, and part of the mission of major natural history museums is to satisfy that curiosity by putting dinosaur fossils, and explanatory material about them, on display. This is not an easy task. Chapter 12 describes all the planning and labor that goes into putting together a successful dinosaur exhibit.

Our most vivid impressions of dinosaurs as living creatures are based on the work of scientific artists. The final chapter of Part Two outlines the thinking and the steps that a paleontological artist goes through in preparing a scientifically accurate drawing or painting of a dinosaur as a living animal.

Dinosaur Studies before the Renaissance 56 Dinosaur Studies of the Recent Past: Beginnings of a Renaissance and a New Legacy 79 Summary 82 Discussion Questions 83 Bibliography 84. CHAPTER 4. Paleontology and Geology as Sciences 87.Â Chapters 18 introduce the major concepts associated with the study of dinosaurs, and provide an understanding of factual information in the basic sciences surrounding dinosaur studies (science literacy), as well as scientic methods used to investigate dinosaurs (scientic literacy). By the time a student nishes these chapters, he or she should be able to speak the language of science by asking the right questions. A student will also be familiar with the terminology used in dinosaur paleontology. Dinosaurs (from the Greek dinosauria, deinos - "terrible" and saurus - "lizard") existed in the Mesozoic era, which included three periods: Triassic, Jurassic and Cretaceous. Today, paleontologists have found and studied more than 500 species of these ancient dinosaurs. Dinosaurs in that era inhabited almost every corner of the globe until the fatal fall of a giant meteorite: then a huge storm arose, and dust clouds for 2 years did not let the sun's rays come to Earth. The process of photosynthesis stopped, and the reptiles of the Mesozoic era began to die out. Triassi History of Dinosaur Studies 55 Dinosaur Studies before the â€œRenaissanceâ€ 56 Dinosaur Studies of the Recent Past: Beginnings of a Renaissance and a New Legacy 79 Summary 82 Discussion Questions 83 Bibliography 84. CHAPTER 4. Paleontology and Geology as Sciences 87 Basic Principles of Geology 93 Recovery and Preparation of Dinosaur Fossils: How They Are Collected 109 Summary 114 Discussion Questions 115 Bibliography 116.Â The study of dinosaurs requires both types of literacy, as well as the use of geology, biology, ecology, chemistry, physics, and mathematics. Accordingly, facets of these fields of study are woven throughout this book. Dinosaur brains and intelligence are interesting topics. Dinosaurs were once regarded as stupid animals, but it is now realised that some of the smaller carnivores had above average intelligence for reptiles. This idea led to exaggerated portrayals in films like Jurassic Park. The idea that Stegosaurus had a "brain the size of a walnut" (an oft-repeated phrase), was not quite accurate. It had a brain the size of a dog's, but in proportion to its body, the brain was very small. In the 1880s a well