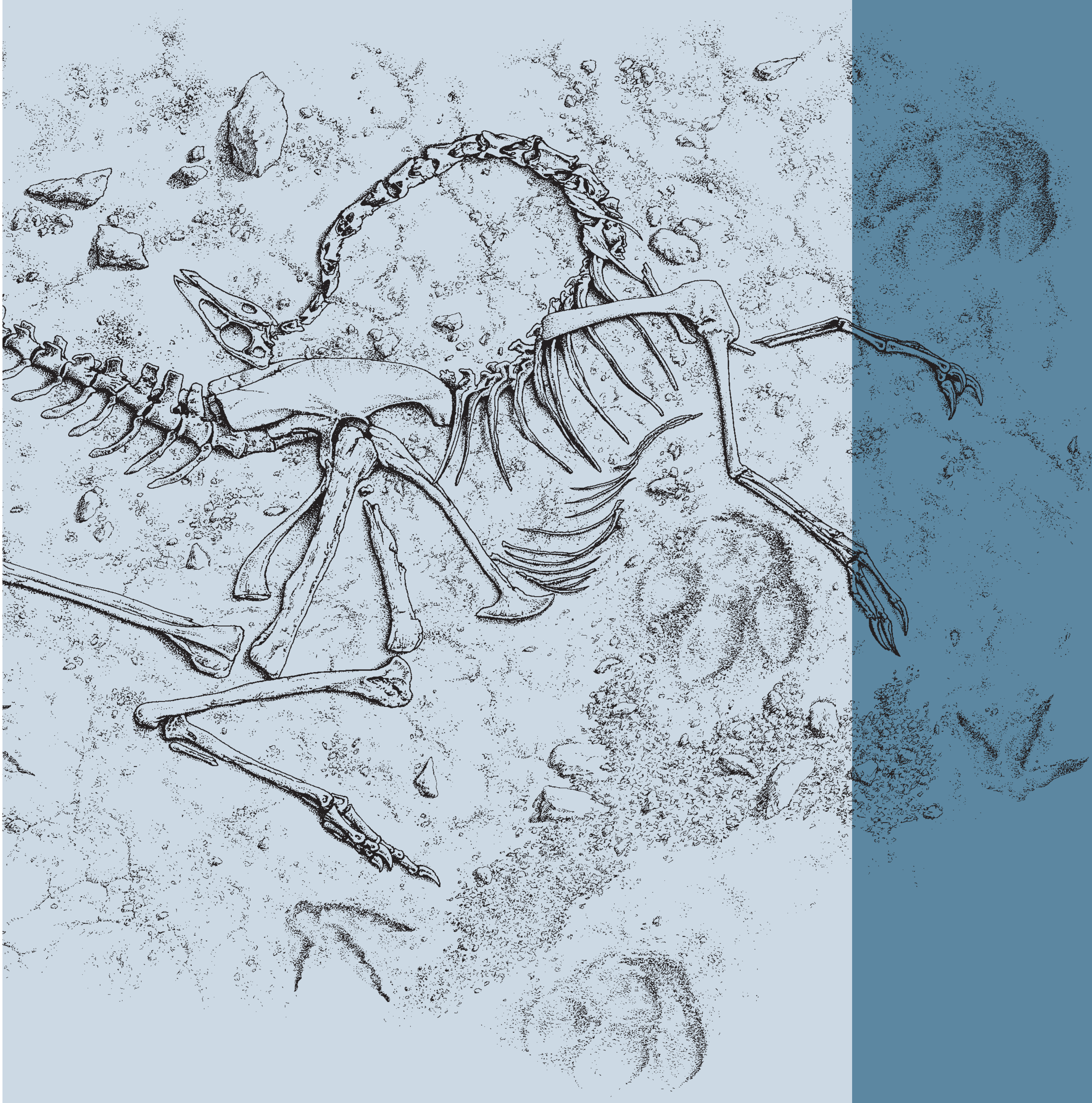
Cambridge University Press
978-0-521-71902-5 - Dinosaurs: A Concise Natural History
David E. Fastovsky and David B. Weishampel
Excerpt
More information

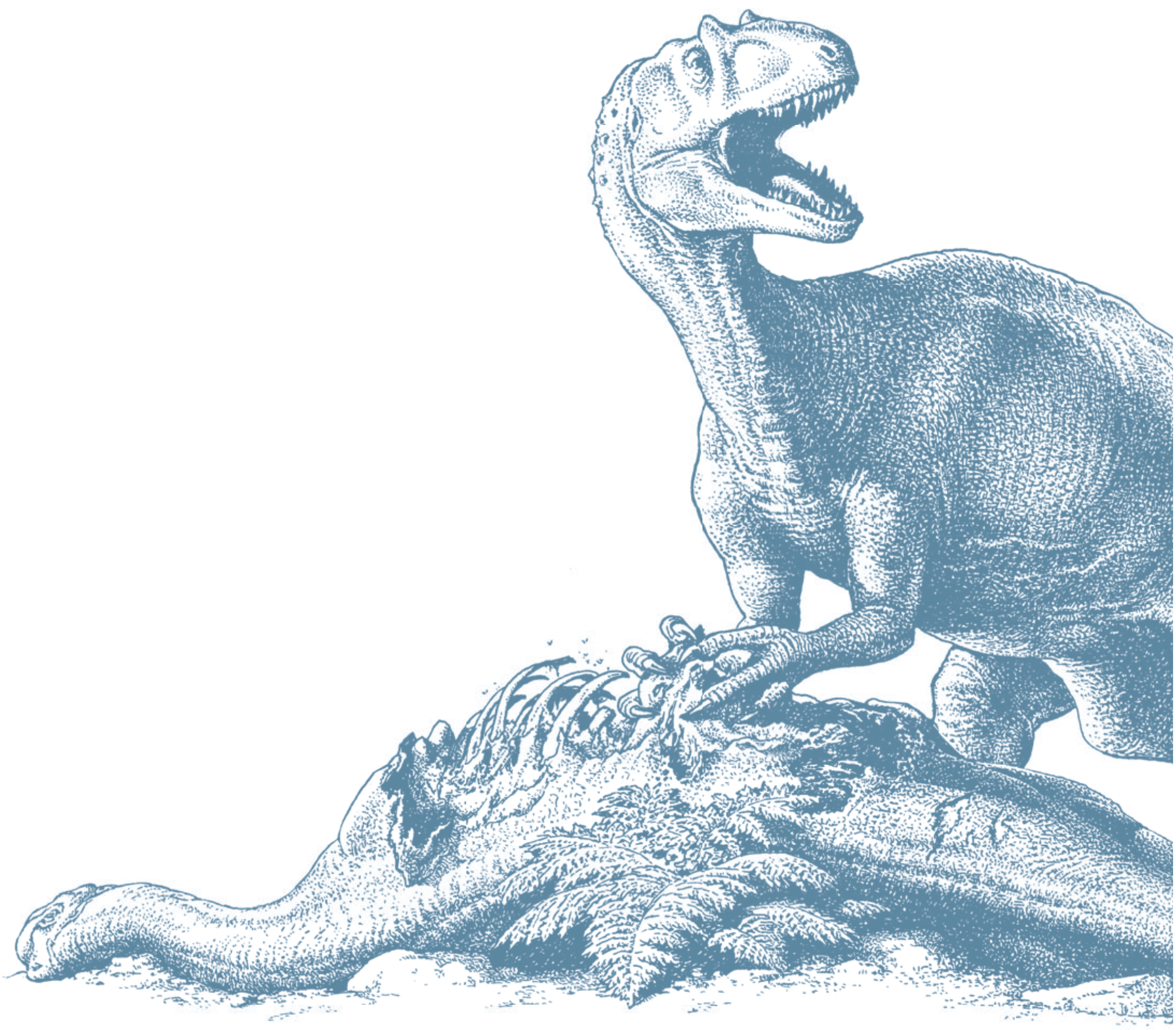
Cambridge University Press
978-0-521-71902-5 - Dinosaurs: A Concise Natural History
David E. Fastovsky and David B. Weishampel
Excerpt
More information

Reaching back in time

Part I



Cambridge University Press
978-0-521-71902-5 - Dinosaurs: A Concise Natural History
David E. Fastovsky and David B. Weishampel
Excerpt
More information



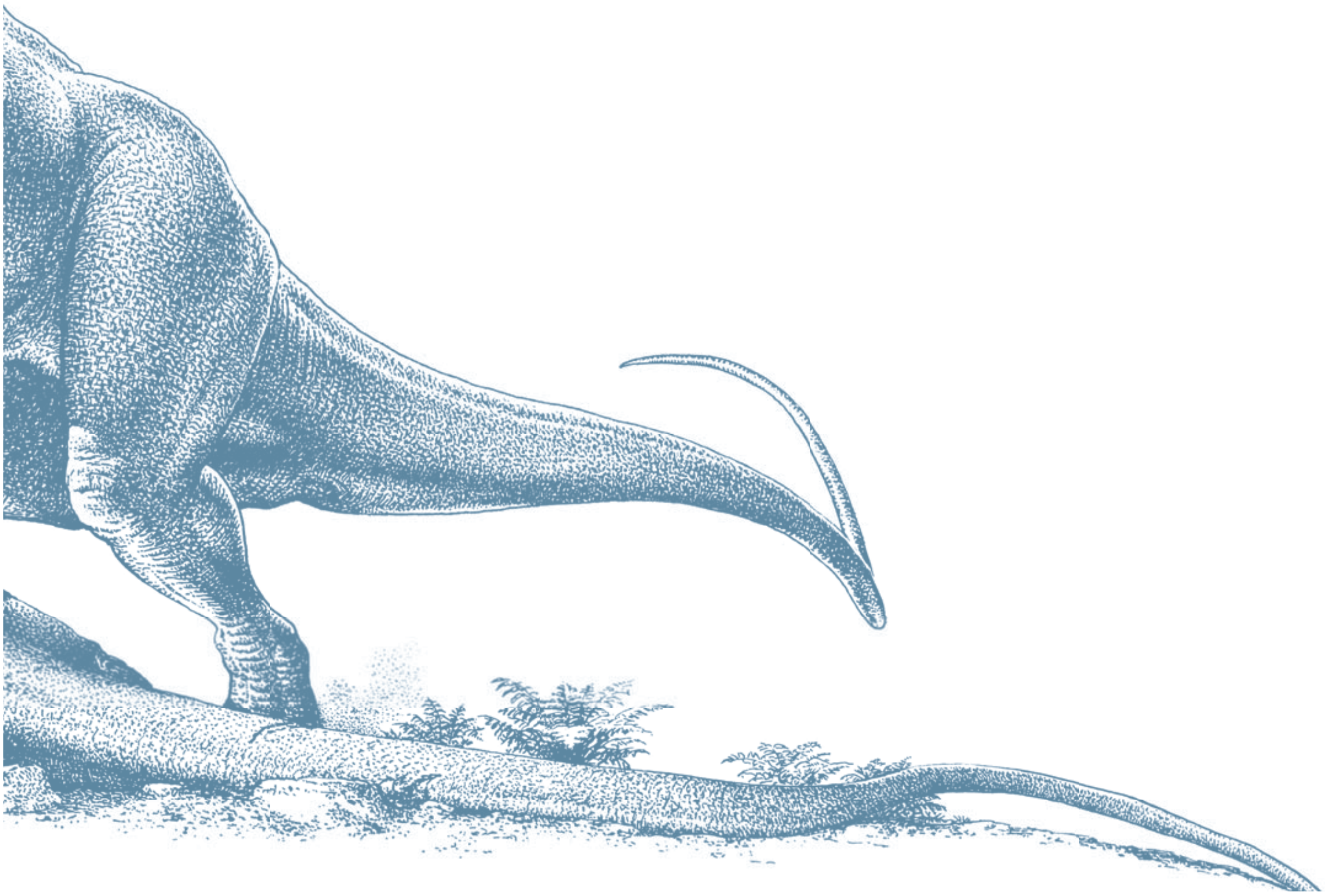
Cambridge University Press
978-0-521-71902-5 - Dinosaurs: A Concise Natural History
David E. Fastovsky and David B. Weishampel
Excerpt
More information

To catch a dinosaur

1

Chapter objectives

- Understanding fossils and fossilization
- Collecting dinosaur fossils
- Preparing dinosaur specimens



Cambridge University Press
978-0-521-71902-5 - Dinosaurs: A Concise Natural History
David E. Fastovsky and David B. Weishampel
Excerpt
More information

Tales of dinosaurs

This book is a tale of dinosaurs; who they were, what they did, and how they did it. But more significantly, it is also a tale of natural history. Dinosaurs enrich our concept of the **biosphere**, the three-dimensional layer of life that encircles the Earth. Our biosphere has a 3.8 *billion*-year history, and we and all the organisms around us are products of yet a fourth dimension: its history. To be unaware of the history of life is to be unaware of our organic connections to the rest of the world. Dinosaurs have significant lessons to impart in this regard, because, as we learn who dinosaurs really are, we can better understand who *we* really are.

Ours is also a tale of science itself. In an increasingly technical world, an understanding of science and how it affects lives is important. Science depends upon imagination and creativity, as well as data. In the following pages, we hope to build a sense of the intellectual richness of science, as well as a feel for what philosopher of science Karl Popper called the "logic of scientific discovery."

The word "dinosaur" in this book. The term "dinosaur" (*deinos* – terrible; *sauros* – lizard) was invented in 1842 by the English naturalist Sir Richard Owen (see Box 14.2) to describe a few fossil bones of large, extinct reptiles. With modifications (for example, "large" no longer applies to all members of the group), the name has proven resilient. It has become clear in the past 10 years, however, that not all dinosaurs are extinct; in fact, most specialists now agree that *birds are living dinosaurs*. We could use the technically correct term **non-avian dinosaurs** to specify all dinosaurs except birds, but we'd prefer to use the term "dinosaurs" as shorthand for "non-avian dinosaurs." The distinction between non-avian dinosaurs and all dinosaurs will be most relevant only when we discuss the origin of birds and their early evolution in Chapter 10; there, we will take care to avoid confusing terminology.

Fossils

That we even know there ever were such creatures as dinosaurs is due to dumb luck: some dinosaurs just happened to be preserved as **fossils**, the buried remains of organic life, in rock. Dinosaurs last romped on Earth 65 million years ago. This means that their **soft tissues** – muscles, blood vessels, organs, skin, fatty layers, etc. – are, in most fossils, long gone. If any vestige remains at all, it is usually **hard parts**: generally, bones and teeth. Hard parts are not as easily degraded as the soft tissues that constitute most of the body.

Making body fossils

Before burial. Consider what might happen to a dinosaur – or any land-dwelling vertebrate – after it dies (Figure 1.1). Carcasses are commonly **disarticulated** (dismembered), often by predators and then by scavengers ranging from mammals and birds to beetles. As the nose knows, most of the heavy lifting in the world of decomposition is done by bacteria that feast on rotting flesh. Some bones might be stripped clean of meat and left to bleach in the sun. Others might get carried off and gnawed. Sometimes the disarticulated remains are trampled by herds of animals, breaking and separating them further. So the sum total of all the earthly remains of the animal will end up lying there: a few disarticulated bleached bones in the grass.

Figure 1.1. Bones. A wildebeest carcass, partly submerged in mud and water and on its way to becoming permanently buried and fossilized. If the bones are not protected from scavengers, air, and sunlight, they decompose rapidly and are gone in 10–15 years. Bones destined to become high-quality fossils must be buried soon after the death of the animal.

If the animal isn't disarticulated right away, it is not uncommon for a carcass to bloat, as feasting bacteria produce gases that inflate it. After a bit, the carcass will likely deflate (sometimes explosively), and then dry out, leaving bones, tissues, ligaments, tendons, and skin hard and inflexible.

Burial. Sooner or later bones are either destroyed or buried. If they aren't digested as somebody's lunch, their destruction can come from **weathering**, which means that the minerals in the bones break down and the bones disintegrate. But the game gets interesting for paleontologists when weathering is stopped by rapid burial. At this point, they (the bones, not the paleontologists) become fossils. A **body fossil** is what is produced when a part of an organism is buried. We distinguish these from **trace fossils**, which are impressions in the substrate left by an organism. Figure 1.2 shows two of the many paths bones might take toward fossilization.

After burial. Bone is made out of calcium-sodium hydroxy apatite, a mineral that weathers easily. This means that, after **fossilization**, many bones no longer have original calcium-sodium hydroxy apatite present. This is especially likely if the bone comes into contact with fluids rich in dissolved minerals, such as commonly occurs after burial. If, however, no fluids are present throughout the history of burial (from the moment that the bone is buried to when it is exhumed by paleontologists, a time interval that could be measured in millions of years), the bone could remain **unaltered**, which is to say that original bone mineralogy remains. This situation is not that common, and is progressively rarer in the case of older and older fossils.

Ancient, unaltered bone – and even tissue – do exist, and are crucial for our understanding of the growth of bone tissue (see Chapter 12) and other soft anatomy (for example, the discovery of genuine red blood cells and connective tissues from *Tyrannosaurus*; see Chapter 9, footnote 3 and Chapter 10).

Most bones are altered to a greater or lesser degree. Since bones are porous, the spaces once occupied by blood vessels, connective tissue, and nerves fill up with minerals. This situation is called **permineralization** (Figure 1.3). Bones can also be **replaced**, in which case the

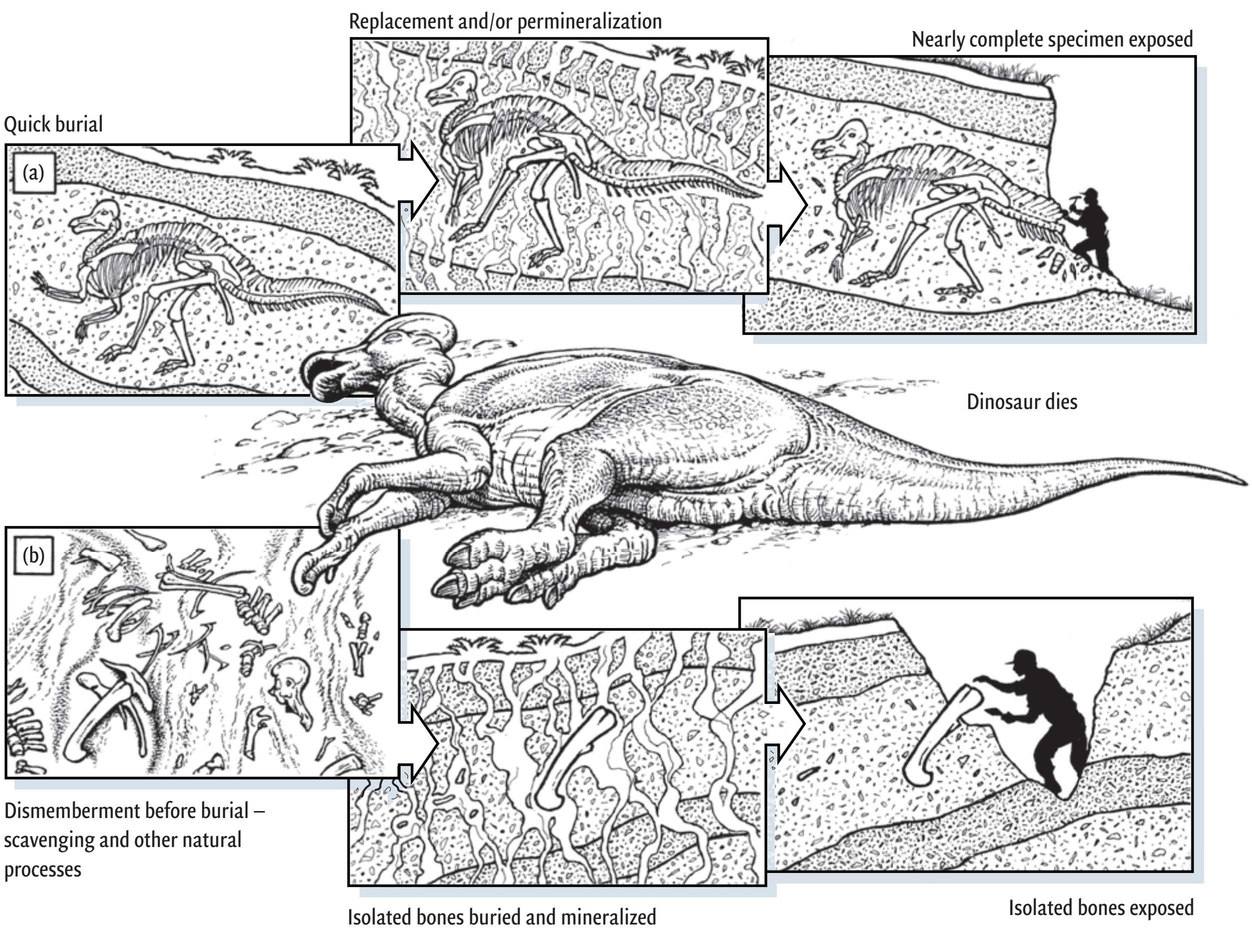


Figure 1.2. Two endpoint processes of fossilization. In both cases, the first step is the death of the animal. Some decomposition occurs at the surface. In the upper sequence (a), the animal dies, the carcass undergoes quick burial, followed by bacterial decomposition underground, and permineralization and/or replacement. Finally, perhaps millions of years later, there is exposure. Under these conditions, when the fossil is exhumed, it is largely complete and the bones articulated (connected). This kind of preservation yields bones in the best condition. In the lower sequence (b), the carcass is dismembered on the surface by scavengers and perhaps trampled and distributed over the region by these organisms. The remains may then be carried or washed into a river channel and buried, replaced and/or permineralized, eventually to be finally exposed perhaps millions of years later. Under these conditions, when the fossil is exhumed, it is disarticulated, fragmented, and the fossil bones may show water wear and/or the gnaw marks of ancient scavengers. Different conditions of fossil preservation tell us something about what happened to the animals after death.

Figure 1.3. Permineralized bone from the Jurassic-aged Morrison Formation, Utah, USA. The fossilized bone is now a solid piece of rock.

original bone minerals are replaced with other minerals, retaining the exact original form of the fossil. Most fossil bones undergo a combination of replacement and permineralization. The resultant fossil, therefore, is a magnificent natural forgery: chemically and texturally not bone, but retaining the exact shape and delicate features of the original bone.

Other fossils

Bones are not all that is left of dinosaurs. Occasionally the fossilized feces of dinosaurs and other vertebrates are found. Called **coprolites**, these sometimes impressive relics can give an intestine's-eye view of dinosaurian diets. Likewise, as we shall see later in this book, fossilized eggs and also skin impressions have been found.

Still, the single most important type of dinosaur fossil, other than the bones themselves, is trace fossils. Dinosaur trace fossils (sometimes also called **ichnofossils**; (*ichnos* – track or trace)) come as isolated **footprints** or as complete **trackways**. Figure 1.4 shows a **mold**, or impression, of a dinosaur footprint. We also find **casts**, which are made up of material filling up the mold. Thus a cast of a dinosaur footprint is a three-dimensional object that formed inside the impression (or mold).

Figure 1.4. Theropod dinosaur footprint from the Early Jurassic Moenave Formation, northeastern Arizona, USA. Human foot for scale.

In the last 20 years the importance of ichnofossils has been recognized. Ichnofossils have been used to show that dinosaurs walked erect, to reveal the position of the foot, and to reconstruct the speeds at which dinosaurs traveled. Trackways tell remarkable stories, such as that fateful day 70 or so million years ago when a large theropod was harassed by a pack of smaller theropods (Figure 1.5).

Finding fossils

So, if the fossils are buried, how is it that we find them? The answer is really in the luck of geology: if fossil-bearing **sedimentary rocks** happen to be eroded, and a **paleontologist**

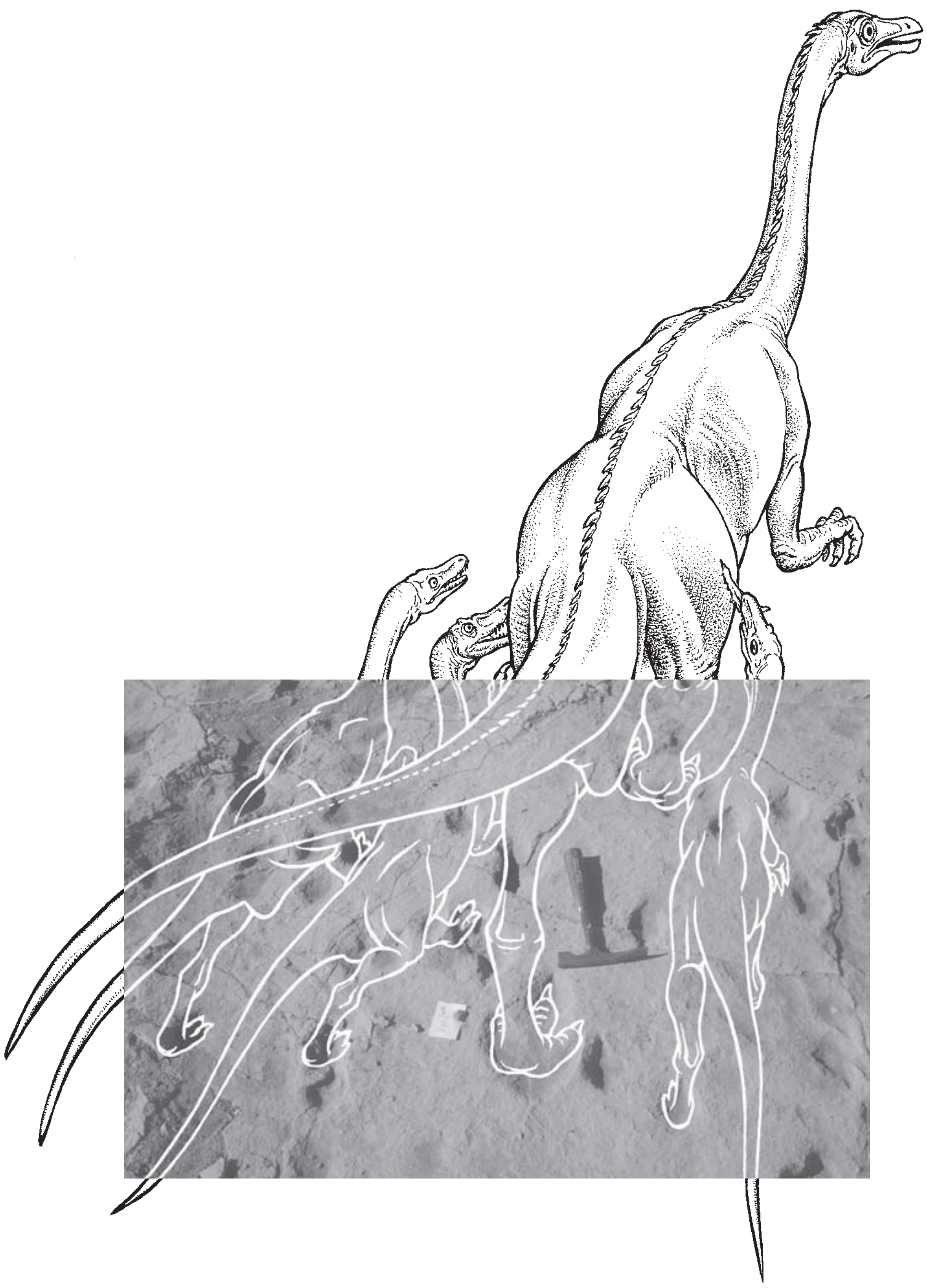


Figure 1.5. Photograph from Shar-tsav, Gobi Desert, Mongolia, showing the tracks of a medium-sized theropod dinosaur among those of a pack of smaller theropods. Our drawing suggests one interpretation, consistent with the evidence: the trackway could record a pack of *Velociraptor* hunting down a single *Gallimimus*.

happens to be looking for fossils at the moment that one is actively eroding from a rock, the fossil *may* be observed and *may* be collected. Indeed, we may be sure that, throughout their 160 million-year existence on Earth, dinosaurs walked over the exposed fossils of earlier ancestors, now lost to eternity (Figure 1.6)!

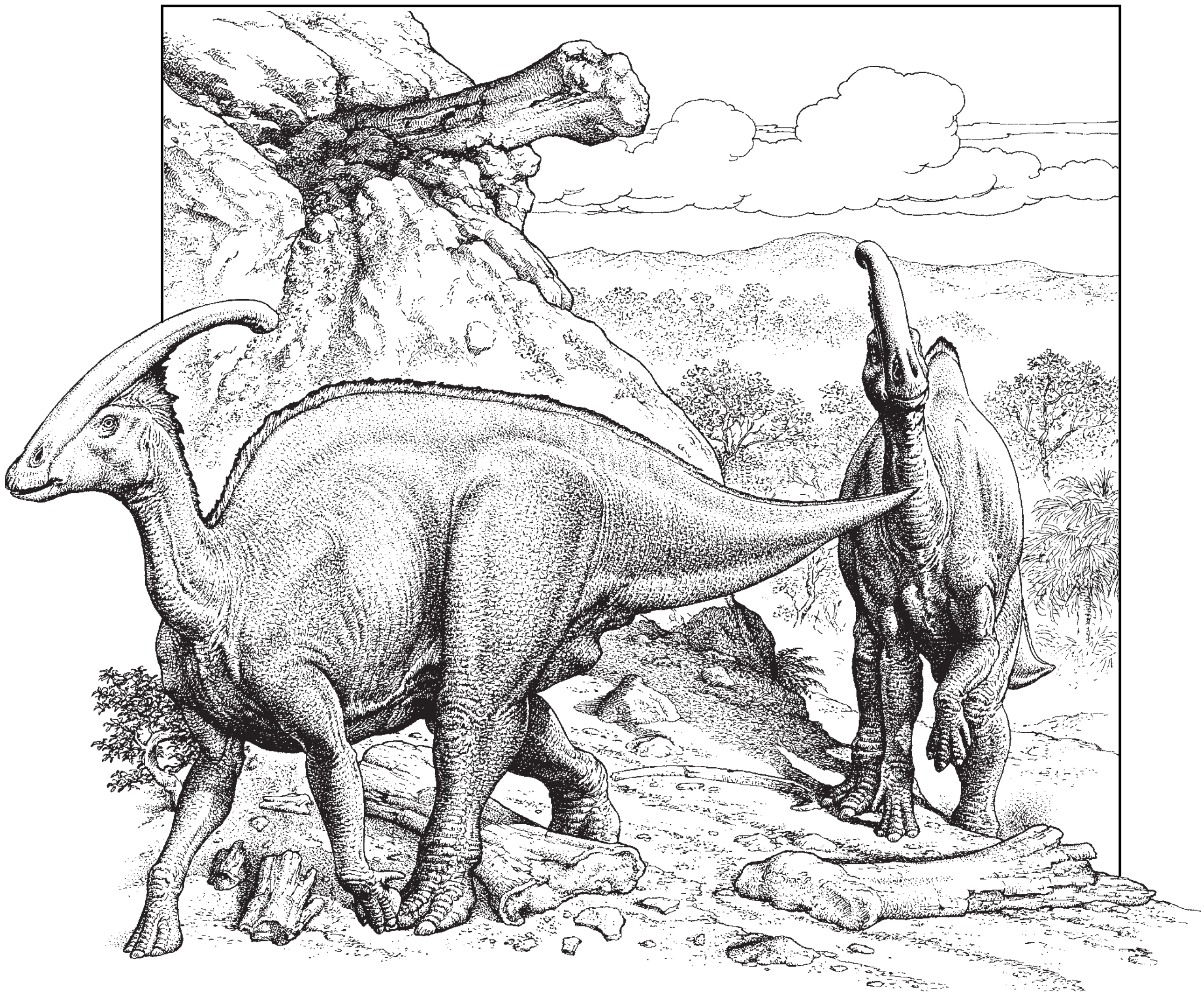


Figure 1.6. A pair of *Parasaurolophus* walking over some exposed fossilized bones of an earlier dinosaur that are weathering out of cliff. Fragments of the fossilized bone have fallen at the dinosaurs' feet.

Collecting

The romance of dinosaurs is bound up with collecting: exotic and remote locales, heroic field conditions and the manly extraction of gargantuan beasts (see Chapter 14). But ultimately dinosaur collecting is a process that draws upon good planning, a strong geological background, and a bit of luck. The steps are:

1. **planning**;
2. **prospecting**; that is, hunting for fossils;
3. **collecting**, which means getting the fossils out of whichever (usually remote) locale they are situated; and
4. **preparing** and **curating** them; that is, getting them ready for viewing and incorporating them into museum collections.