Chapter 59

Evolutionary Aside 59.1--Mass Extinctions and the Course of Evolution

Traditionally, evolutionary biologists viewed mass extinctions simply as periods in which rates of environmental disturbance were particularly high. According to this view, rates of extinction increase, but there is no qualitative difference in the pattern of extinction. That is, at times of low extinction rates, only the most poorly adapted species go extinct. By contrast, at times of high extinction rates, only the very best adapted species survive. The difference, then, is just a matter of degree, and at all times, we would expect species survival to be related to how well-adapted a particular species is. A corollary of this approach is that through time we should see signs of evolutionary progress: species should get better and better adapted through time as less well adapted species perish.

By contrast, suppose that mass extinctions are qualitatively different from the regular "background" extinction rate. Suppose, for example, that they result from some rare process, such as asteroid impact or extreme temperature change. Because such events are extremely rare, we would not expect species to have evolved adaptations to survive them; natural selection cannot anticipate what will happen in the future. Consequently, we would not expect that the species that previously were best adapted would necessarily be the ones that survived during a mass extinction event. Thus, species, or entire lineages, that otherwise were dominant might, nonetheless, be wiped out. As a result, “evolutionary progress” would be episodic at best, with periodic setbacks.

Consider, for example, the rise of the dinosaurs. Dinosaurs appeared in the Triassic period (approximately 250 MYA), but they were by no means the dominant animals of that time. In addition to dinosaurs, other groups extant at that time were large and common (such as synapsids, like cynodonts and *Placerias*, on the line to mammals, and archosaurs like *Postosuchus* and the crocodile-like phytosaurs [see chapter 34]). At the end of the Triassic, a mass extinction event occurred. The event seemed to occur quite rapidly, but beyond that, the cause is still little known. Nevertheless, the dinosaurs survived while many other groups did not, and the dinosaurs went on to rule the world for the rest of the Mesozoic era.

Why did the dinosaurs survive and not others? Traditionally, it was attributed to the superiority of dinosaurs: their erect body posture perhaps gave them superiority over other forms that had a sprawling posture, it has been suggested. But this idea does not seem compelling. Why, for example, were these forms able to coexist for millions of years before suddenly dinosaurs triumphed? Comparisons of morphological diversity of dinosaurs and other Triassic reptiles give no real indication that dinosaurs were in any way superior. Perhaps it was just a fluke; some rapid and random change in the environment, due to either events on Earth or

perhaps a meteorite impact. Perhaps the entire success of dinosaurs was triggered by a lucky break.

Of course, the same argument could be made for mammals. We like to think that we mammals, with our big brains and warm-bloodedness, are inherently superior to reptiles. Thusit is not surprising to us that mammals outlasted the dinosaurs. Perhaps mammals were even responsible for their demise, using their bigger brains to outwit the dullards.

But this idea doesn't hold water: mammals and dinosaurs coexisted for most of the Mesozoic. And for that long, 160-million-year stretch, if anything, we would have to conclude the opposite. The reptiles were superior to the mammals. They dominated terrestrial ecosystems, filling most ecological niches and exhibiting a vast array of different shapes and sizes. Mammals were minor elements of the fauna for millions of years, occupying minor niches; small, out-of-site, perhaps active only at night. It is hard to make a case that mammals were in any way superior to dinosaurs or responsible for their decline. Maybe, in fact, it was due to good fortune that mammals happened to have the traits, whatever they were, that allowed them to survive. Similarly, crocodilians were much less successful than dinosaurs and other marine reptiles, but crocodilians survived and the others didn't. What this implies is that we owe our existence here today to our lucky stars, or at least to one lucky asteroid. Had that asteroid zoomed by and missed planet Earth, we—or our mammalian equivalents—might still be cowering in the underbrush, as even bigger and more terrifying dinosaurs continued to rule the land.