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INTRODUCTION

We hold in our mouths the legacy of our evolution. Nature has sculpted our teeth over countless generations into tools adapted to chew the foods our ancestors had to eat to survive. And paleoanthropologists, those of us who study human origins, spend a lot of time thinking about them. Teeth are our bridge to the past. They allow us to track changes from one species to the next to trace our evolution. Yes, we have fossilized skulls and skeletons to work with too, but teeth are special. They are essentially ready-made fossils that have remained virtually unchanged for millions of years. More important, they are the most commonly preserved part of the digestive system, and the key to unlocking the diets of our ancestors. We look to tooth size, shape, pattern of wear, and chemistry to work out details of the foods eaten by long-gone species.

Because we can use teeth to reconstruct diet, they are also the key to unlocking an extinct species' place in nature. In *Love and Death*, Woody Allen's character Boris Grushenko described nature as "big fish eating little fish, and plants eating plants, and animals eating an . . ." He continued, "It's like an enormous restaurant the way I see it."[1] I prefer to think of nature as a buffet: animals can pick and choose from among the living things in whatever part of the biosphere they inhabit. Items on this "biospheric buffet" are constantly being swapped in and out with changing environmental conditions. For example, fruits and leaves are replaced by grass roots and tubers as forest gives way to savanna when and where the climate becomes cooler and drier. Different habitats mean different options, choices, and relationships between a species and its environment. In short, a species' choices help define its relationships with other organisms, both eaters and eaten, and its place within the larger community of life that surrounds it.

This book tells a story of teeth, diet, and human origins. My goal is to show that we can use teeth to understand the diets of our ancestors,

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and, by extension, our place in nature and how we came to be the species we are today. Central to this story are the effects of climate and environmental change on our ancestors, a story only now coming into focus as scientists begin to understand that our success as a species is due, in no small measure, to how our ancestors dealt with an increasingly variable and unpredictable world in the distant past.

When we bring together these new insights from Earth system science and paleoclimate studies, along with new approaches to how teeth work and new discoveries in paleontology, primatology, archaeology, and other fields, we arrive at a more complete view of life in the past and how it changed over time. The story used to be simpler. The spreading savanna coaxed our ancestors down from the trees, and the challenges it brought made them human. It is now becoming clear, however, that environmental conditions actually swung back and forth between wet and dry in the past. This fluctuation winnowed out the pickier eaters among us, leaving only those flexible enough to find something with which to fill their plates from an ever-changing biospheric buffet. We are the most versatile of primate species, able to find something to satiate us no matter where we roam. That explains how we came to take over much of the world. Climate change provided the motive, and evolution offered the opportunity to make us human.

I decided to write this book to help me see the big picture in human evolution, and to share what I've learned from being involved in the work for the past three decades. But as I began to think about it, it became clear to me that there's much more to the tale than the science itself; there's also the passion, ingenuity, and determination of those who gave us the knowledge we have. They make the story compelling and bring it to life. And so, in the chapters that follow, we travel around the world, visiting with my colleagues and other scientists along the way. We look over their shoulders as they make their discoveries and chart new paths to understanding the past.

We begin with teeth, how they work and how they are used. If we assume that nature selects the best tools for the job, animals with different diets should have teeth to match. Understanding how teeth work

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is the first step in figuring out relationships between dental form and function. And working out those relationships is fundamental to using teeth to reconstruct diets of fossil species. But it's not enough. We know from watching living primates in their natural habitats that food choice is about much more than what an individual is capable of eating. The difference between how teeth work and how they are used is key to understanding diet, place in nature, and ultimately evolution. This is our point of departure from business as usual in paleontology, the assumption that animals are fated to specialize on the foods to which their teeth have evolved. Yes, every species is limited by its anatomy in what it can eat, but it's equally important to remember that the dishes on the table vary from place to place, and that they get swapped out from time to time. In other words, food choice is not just about dietary adaptation but also about availability. When the options change, so too does diet and, along with it, the relationship between an organism and its environment.

With lessons learned in the laboratory about how teeth work, and in the forest on how they're used, we move forward into the past. We consider the cast of characters in human evolution, both the fossil species and those who worked to find and make sense of them. The idea that human evolution was somehow triggered by our changing world is not a new one. But as scientists sort out the details of Earth's climate history and reconstruct ancient environments, our old model of human ancestors descending from the trees to meet a spreading savanna falls like a house of cards in a stiff wind. We're taught that the dithering tilt of the Earth and its orbit about the Sun set the pace for climate change, and that shifting continents transform the face of our restless planet. The cradle of humankind didn't simply become cooler and drier; conditions wavered back and forth with increasing intensity over time. Our ancestors met a more and more unpredictable world, and it was their responses that drove our evolution.

What were those responses? With what did our ancestors choose to fill their plates as nature swapped dishes on the biospheric buffet? The sizes and shapes of fossil teeth offer some clues, but those are more about what our ancestors could eat than what they actually ate on a daily basis. We have to turn to what I call *foodprints*, actual traces left by foods eaten during life. Distinctive patterns of tooth wear and the

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chemistry of dental tissues help us fill the gaps. Only then can we begin to understand the roles of our ancestors in their larger communities of life, and their places in nature.

We can also use our new approach to explore other great transitions in human history. How did a changing world make us human? That's the story of the origin of our biological genus, *Homo*, and the start of the hunting and gathering lifestyle that gave our ancestors the versatility they needed to spread across the planet. And how did we change the rules of the game and begin to stock the buffet ourselves? That's the story of the Neolithic Revolution, the shift from foraging to farming. Monkeys and apes don't work as models anymore. We must look to the few peoples that today still eat wild plants and animals, those whose ancestors never jumped on the food-production bandwagon. Archaeologists have moved countless tons of dirt to document and explain these transitions too. To make a long story short, both are tied to environmental change, and both left marks we can decipher on the teeth and bones of our ancestors.

This takes us up to the present but, in an interesting twist, right back to the past. Paleolithic diets are hugely popular today, and they bring attention to the kind of research I do. Many argue that there is a mismatch between our diets now and those our bodies have evolved to eat. They believe that this explains most of the chronic degenerative disease plaguing our health care systems. In effect, the adaptations for dietary versatility that led to our success have at the same time made us a victim of it. We *can* eat much more than we should. And while I am not a fan of Paleolithic diets for the simple reason that there is no single ancestral diet to which we evolved, there's little doubt that an evolutionary perspective can teach us a lot about our bodies and their welfare.

The book ends where it began, with teeth. Other species don't have crooked, crowded, and impacted teeth riddled with holes. Why do we? It is clear that, while our ancestors ate different foods at different times and in different places, there is a genuine mismatch between our diets today and our teeth. If we consider them in this light, they remind us of our evolution. Our teeth connect us to our ancestors.

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