DAVID BURNEY

Back to the Future in the Caves of Kauai

A Scientist's Adventures in the Dark

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Contents

FIFTEEN
Finding a Future in the Past

Preface

This is a book about time, although I don't claim to understand what time is. The physicists may be getting a handle on that, but it's not something I understand well enough to judge. I do claim, however, to know a little something about what time *does*, because I am a paleoecologist, a type of ecologist who studies past environments and the changes that climate and humanity have put them through. From three decades of thinking about this issue and studying ancient sites around the world, I am convinced that humans represent a kind of watershed in time on this planet. Something about human intelligence and how we use it to manipulate our environment is fundamentally different from anything that came before us. But why are humans so universally devastating for nature, particularly in the early stages of contact?

I want to tell three stories about time and humans as deliberate or unwitting environmental engineers. These three examples are all on quite different time scales. On a scale of tens of thousands of years, there is this big overriding question: *What is it about human arrival in any place that is so inevitably troublesome for nature?* The second story is about Kaua'i, where my wife, Lida, and I currently live, that northernmost of the inhabited islands of the Hawaiian Archipelago. *What has happened there in recent millennia and might happen in the near future, and what can this tell us about the rest of the planet?*

The third question is the one that will take me a whole book to answer, or maybe even more. *How is it that one place on Kaua'i, a particular cave, changed two people's lives so profoundly?*

This is an entirely true story, drawn from my field notebooks, articles I have published, and the memories of people whose lives have been touched by this special place, a place I often refer to as my "Poor Man's Time Machine."

Makauwahi Cave may be as close as some of us will ever get to time travel, I suspect. With hard work, one can coax out of this place a lot of information about the past. We know that for sure now, and this longer view can lead to a lot of thinking about the future. For nearly two decades, I have experienced in my research there a sense of the immensity and power of time that I had only known abstractly before. After sharing the place with thousands of visitors, I am convinced that it does the same thing to a lot of other people. Makauwahi Cave is only one place, but it has lived in many times. More than anything else, this book is about that place and those times.

Acknowledgments

I am in various ways indebted to all the thousands of people who have visited Makauwahi Cave in the course of the many years that Lida and I have been working there. This book is in a sense about them and the thousands more who I hope will pass that way in the future.

The manuscript was produced with support from the John Simon Guggenheim Memorial Foundation. I owe special thanks to the foundation and to my employer, the National Tropical Botanical Garden, for allowing me the time to do this. Chipper Wichman, the executive director and CEO of the botanical garden, deserves special thanks for being so supportive of this diversion from my regular duties.

To my wife, Lida Pigott Burney, I owe the most thanks, as she put in way more than half of the personal energy required to see Makauwahi Cave Reserve become a reality. To our grown-up children, Florence Lillian Mara Burney and James Alexander Pigott Burney, *mahalo* for being so patient with your parents' unusual lives, and for absorbing so well these unique experiences offered by our lives together as you grew up in exotic places. Thanks also for translating that into your own rapidly expanding lives in ways that make your parents proud.

All of the many scientists and conservationists who have worked at Makauwahi and our other sites deserve a lot of the credit for what we think we know about the cave, Kaua'i, and the extinction process. Drs. Storrs Olson and Helen James of the National Museum of Natural History (Smithsonian Institution) Bird Division and their children, Travis and Sydney, deserve a lot of thanks for their almost daily contributions as this project took shape from 1996 to 1999.

The late William Kenji (Pila) Kikuchi, and his wife, Dolly, and their three daughters, Kristina, Kathleen, and Michelei, as well as Pila's cousin Katsuo Kikuchi, took us in like family and probably did more than anyone to convince us we should be living on Kaua'i. Our friends Reg and Sandy Gage had a hand in that as well, and Reg led us to many other good sites on Kaua'i and taught us about the local land-snail fauna.

Other scientists who moved us along in the process of discovery at Makauwahi include Fred Grady of Smithsonian Paleobiology, Dr. Julian Hume of the Natural History Museum (London), and more recently Dr. Nicholas Porch of the Australian National University. Thanks for being so useful in identifying difficult taxa and visualizing elements of past landscapes. Drs. Dan Livingstone, Ross MacPhee, and Paul Martin helped me as a graduate student to see the bigger picture concerning extinction and environmental change.

Thanks also to key scientific collaborators at the University of Hawaii. In addition to Pila, these have included Brian Yamamoto, Mike Kido, Ken Kaneshiro, and Terry Hunt. At Bishop Museum in Honolulu, we thank Frank Howarth for his guidance on how to manage blind cave invertebrates. At the National Tropical Botanical Garden, Ken Wood, Steve Perlman, Mike De Motta, Dave Lorence, Warren Wagner, and Bob Nishek have been great sources for information on rare Hawaiian plants.

This story would have ended abruptly well before the best parts if it had not been for the forbearance of the landowner, Grove Farm Company. Thanks to the support of Allan Smith, David Pratt, Mark Hubbard, Warren Haruki, Marissa Sandblom, and Mike Tresler of that firm, our continual presence and unusual activities at Makauwahi over the years have been not only tolerated but positively supported, even financially, by the company.

Five persons who played a large role down at the cave over the years are no longer with us: Adena Gillin, Dr. William Klein, Dr. Pila Kikuchi, LaFrance Kapaka-Arboleda, and Dave Boynton each gave us critical help along the way and will always be an important part of the history of this place. Makauwahi Cave Reserve is dedicated to their memory. We also thank the members of local organizations that have played a role in the cave's story, particularly Malama Maha'ulepu and the National Tropical Botanical Garden's volunteer organization, Na Lima Kokua. Special thanks go to our most regular volunteers, Mel Gable, Ed Sills, and Mary and Barry Werthwine. To Jimmy Miranda and the cowboys of CJM Stables and farmer Adam Killermann, thanks for being good neighbors to the Cave Reserve.

For the production of the book I owe special thanks to Lida, Mara, and Alec for reading it over and telling me the truth until I got it right. Down East in Carteret County, North Carolina, where I hid out while writing, close friends generally did me the favor of coming around and keeping my spirits up without coming around too often for me to get the work done. In this regard I especially thank Robin and Captain Dennis Chadwick, Brian Blake and Barbara Garrity-Blake, Allyn and JoAnn Powell, and Mike and Elizabeth Peeler. Prolific author and local storyteller Sonny Williamson read an early draft and warned me against "using too many big words." In hindsight, I think that was some of the best advice I received, and his wife Jenny's stewed hard crabs were the best, too.

The research projects discussed here have been supported by major grants from the National Science Foundation, the National Geographic Society, the National Oceanic and Atmospheric Administration (Human Dimensions of Global Change Program), and the Smithsonian Institution. Additional

research support has come from Kaua'i Community College, the University of Hawaii, the Bette Midler Family Trust, the Kilauea Point Natural History Association, the Waipa Farmers' Cooperative, the National Park Service, and faculty research grants and fellowships from Fordham University. Our conservation projects have been supported by grants and contracts from the Wildlife Habitat Incentives Program of the Natural Resources Conservation Service (U.S. Department of Agriculture), the U.S. Fish and Wildlife Service, Grove Farm Company, and private donors and foundations.

Lida and I have been really lucky to live on Kaua'i. We appreciate the help and tolerance of its good people, and we especially owe a debt of gratitude to the island's children, as a large percent of them have visited, learned, and worked down at the cave with us.

ONE

Time's Most Important Moment

VISITORS COME TO HAWAII seeking paradise. But the truth is, these islands have become a kind of living hell for nature. The place is a microcosm of the world condition, where the role of humans in transforming nature stands out in high relief. This is a story that matters, because humans need to know that they are a threat to the rest of creation. Can we learn to tread more lightly on this speck of dust in the universe that we call home? Will anything we hold dear make it into the future? How did we get to this point?

For about 50,000 years *Homo sapiens* has been expanding its range. Starting out from the primordial cradle in Africa and Eurasia, humans have taken the rest of the world by storm, one landmass at a time (figure 1). We spread first to New Guinea and Australia, and ended with places never colonized prehistorically, such as the Mascarene and Galapagos Islands and Antarctica. It is fair to say that our species is native to Africa and Eurasia and a biological invasion everywhere else. We are an extremely successful weed. A global pattern of catastrophic extinction and landscape transformation tracks this human diaspora perfectly—too much so for coincidence. No use denying it: we humans can really pack a wallop, and have, time and time again, across the face of the planet.

This slow human wave has been washing over the globe for tens of thousands of years, and it has taken out Australia's giant extinct marsupials, the Serengeti-like large mammal diversity of the prehuman Americas, and even the giant lemurs that once lived on Madagascar.[1] But what do

these phenomena have to do with the Hawaiian island of Kaua'i?

Kaua'i is one of those very remote islands reached late in the human expansion, perhaps as recently as a thousand years ago by most current estimates. As a result, the wave of extinctions continues to break over isolated places like the Hawaiian Islands, and may be getting worse. Ever more species, now mostly plants and invertebrates but also some of the remaining few native vertebrates, are disappearing on our watch. Hawaii is the endangered species capital of the United States, with more listed than any other state—273 plants and 34 animals—all in only 0.2 percent of the nation's land area, one five-hundredth of the United States. If federally listed endangered plant species were apportioned by land area, Hawaii would be entitled to about one. If each state got an equal number, about 12. The official figures for Hawaii are a gross underestimate of the extinction challenge, as roughly *half the entire native flora* is considered at risk by most local experts.[2] Kaua'i, with a preponderance of single-island endemics (species found only on Kaua'i), is especially vulnerable.

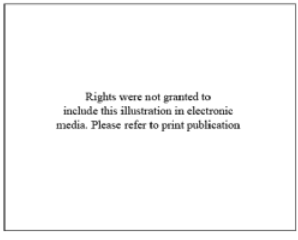

Figure 1. This map illustrates how scientists think humans spread across the planet and how their dispersal is associated with late prehistoric catastrophic extinction events. Modern humans arose in Africa and southern Asia (1), where large mammal extinctions were relatively light and mostly occurred more than

50,000 years ago. Roughly 50,000 years ago (2), humans spread to New Guinea and Australia. Meanwhile, they gradually moved northward in Asia after the last Ice Age (2–3), crossing over the Bering land bridge to the Americas (3) perhaps about 13,000 years ago. Although debate continues on the exact timing, large animal extinctions in the Australian and American regions seem to correlate at least approximately with human arrival. Humans then spread to large, moderately isolated island groups over the past 5,000 or so years (4), starting with Mediterranean and Caribbean islands, followed by Madagascar roughly 2,000 years ago. Again, extinction of the largest animals on these remote sites occurred about the time of human arrival. About 1,000 years ago (5), people reached Hawaii and New Zealand from South Pacific islands they had colonized earlier. Extinctions of large ground birds and other species followed. Finally, some of the most remote landmasses, such as the Mascarenes in the Indian Ocean and Galapagos in the Pacific, were apparently never colonized prehistorically, but the earliest written accounts detail the human toll on the dodo in Mauritius, the solitaire in Rodrigues, and giant tortoises there and in the Galapagos as well (6).

I have been ruminating about this unique colonization moment in the history of any land—human advent and its subsequent consequences—for at least thirty years. I was studying the effects of human activities on cheetahs in the Masai Mara region of Kenya in the late 1970s for my master of science degree in conservation biology at the University of Nairobi.[3] Camped out for over a year in this northern end of the great Serengeti ecosystem, I kept asking my partner in this work, Lida Pigott Burney, the same simple question: *Why does Africa have all these wonderful big animals and other continents mostly don't?* It was an old question, we acknowledged, but with some recently proposed answers that were intriguing. This quest led us to the writings of Paul Martin, who has long been working on this topic, and getting scientists stirred up about it, with provocative articles starting with one in *Nature* over forty years ago

titled "Africa and Pleistocene Overkill." In that article, Martin made a good first attempt at explaining precisely why Africa has so many big animals and other continents mostly don't: people and animals co-evolved in Africa and southern Eurasia; in most of the rest of the world, initial contact between arriving humans and a naive fauna was disastrous for the animals, because these technically advanced human hunters quickly overhunted any prey that didn't run away. This idea became known as "Pleistocene Overkill," and a mathematical model that illustrated how this could happen led to Martin's "Blitzkrieg Hypothesis."[4]This provocative idea about a human role in late prehistoric extinctions has spawned many others, and sparred with a few, particularly the climate-based and disease-based alternatives (figure 2).

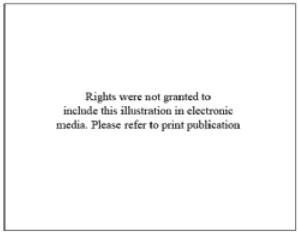

Figure 2. This plot shows the global trend in climate for the past 100,000 years as inferred from a high-resolution calcium concentration record from the GISP2 Greenland ice core. The calcium variation is caused by the relative amount of atmospheric dust, an index for cool and dry conditions (large values) versus warmer and wetter (much lower values). Comparison to the vertical bars, indicating the range of "last occurrence" dates for extinct faunas on various continents and islands, shows no correlation with climate change in general, occurring on different landmasses according to approximate time of human arrival, regardless of glacial or interglacial climate conditions.

TABLE 1. Hypotheses proposed to explain the late prehistoric extinctions

Climatic hypotheses	
Climate change	Climatic changes, in the form of a slow transition from mosaic vegetation to a more zonal pattern, lead to less hospitable environmentsfor large herbivores[1,2]
Rapid climate cooling	As above, but change develops rapidly at the Younger Dryas cooling event about 11,000 years ago[3]
Environmental insularity	Applied only to the extinction of the American mastodon; extinction occurs because boreal forest retreats northward after glaciation, resulting in expansion of deciduous forest, which is less hospitable to the species[4]
Overkill hypotheses	