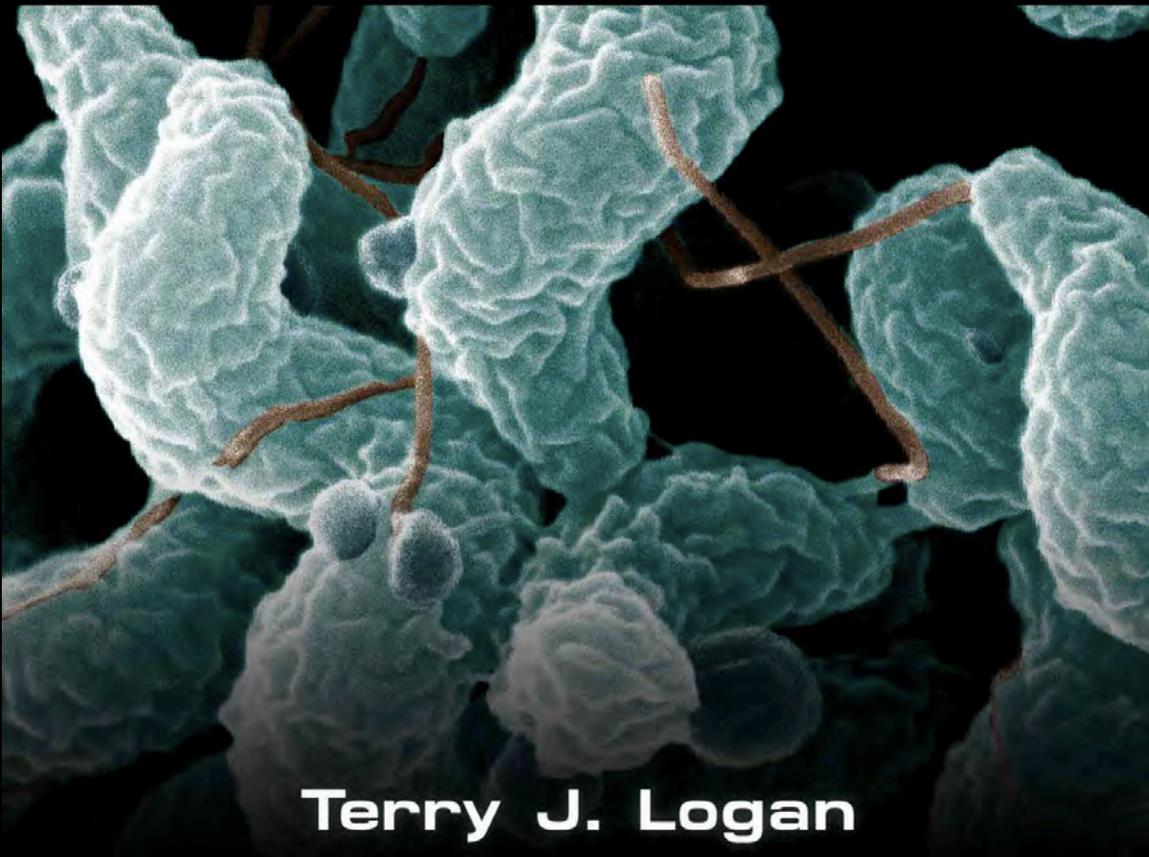
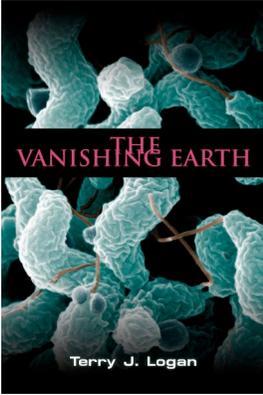


THE VANISHING EARTH



Terry J. Logan



A science mystery with global implications involving exotic microorganism.

The Vanishing Earth

by Terry J. Logan

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The Vanishing Earth

By

Terry J. Logan

Terry J. Logan

This book is dedicated to my wife Billie Lindsay

Vanishing Earth

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Preface

This is a work of fiction that is based on the author's more than forty years experience in the field of soil and environmental science. While many of the facts, places, and institutions are real, the central story is fictional. There is no island of Vista Verde in Puerto Rico but the Navy did use the island of Vieques as a bombing range until 2003. The Archaea are real and have been extensively studied in the last thirty years using the then new techniques of molecular genetics. Readers familiar with the places will recognize similarities to agricultural research centers in Florida, Puerto Rico and the Dominican Republic. The University of California-Riverside is as experienced by the author when he was there on sabbatical leave in 1985.

Lastly, the author in no way impugns the tremendous reputations of The United States Navy nor the Woods Hole Oceanographic Institution but has nothing but admiration for the work they do..

Chapter 1

The Soil Science building at the University of Puerto Rico field laboratory on the island of Vista Verde was old, one-storey and wooden, with peeling white paint. The offices were small and the air conditioning rarely worked. The island sits about five miles off the north Atlantic coast of Puerto Rico and is accessible from nearby San Juan by ferry. The island housed a leper colony prior to WW II when the Navy established a base on the east side. After the war, the naval base was downsized and the University took over the surplus barracks and service buildings for its agricultural research experiment station. The base was currently being used as a training area for U.S. submarines and to house deep-sea submersibles of the Woods Hole Oceanographic Institution in Falmouth, Massachusetts that were currently exploring the Puerto Rico Trench, the deepest point in the Atlantic Ocean.

The experiment station's research focused on integrated tropical fruit and vegetable production. In addition, the station maintained one of several worldwide banana-breeding programs. The number of commercial banana cultivars had declined in the last hundred years, and today only the Cavendish remained. Every one of the one hundred billion Cavendish bananas consumed worldwide is an exact clone. This has occurred because bananas can only be propagated by cloning and not by seed. This lack of biological diversity makes the Cavendish susceptible to disease and pest attacks, and some have predicted its extinction in the not so distant future. In the last decade, agricultural researchers around the world have been looking for new cultivars to replace the Cavendish. The Vista Verde experiment station was in the process of exchanging its new cultivars with other research programs.

Roger Starling was sweating in more ways than one in his cramped office in the experiment station. He had just been notified that his latest National Science Foundation grant application had been rejected. His career as a university research professor was going nowhere and he was stuck in this backwater institution - the only university that would offer him a sabbatical appointment.

Starling at fifty-one was a tenured professor of soil microbiology at the University of California at Riverside (UCR). When he had graduated at age twenty-six from The Ohio State University, he was considered a potential star and he had turned down several other offers to go to Riverside. Born in Jamaica to Scots and Portuguese parents, he had endured the dismal and frigid years in Columbus pursuing his graduate degrees. Riverside's warm climate and its proximity to the Southern California beaches were inviting. Roger, an only child, loved growing up in Jamaica with its laidback environment and warm Caribbean climate. His parents divorced when he was in high school and his father moved with his new English wife to the Isle of Wight. Roger would not see his father again until he had finished his undergraduate studies. Roger remained with his mother in Kingston until he left for college in the U.S.; she never remarried but had a succession of disastrous relationships. He never saw his mother again. She drowned in a

boating accident two years after he left; she was with one of her boyfriends - they had been drinking and she fell overboard.

Roger was ready to get away when college in the U.S. beckoned. He had been accepted to a small state college in California that had a strong agricultural focus. Roger's father had been the manager of a large sugar cane plantation in Jamaica and they lived in the manager's plantation house. Roger excelled in science in his Jesuit high school in Kingston, and as graduation neared, he gravitated towards an agricultural science career. As a freshman in college, Roger went through the culture shock of being in the U.S. after his third-world upbringing. The college he had chosen had low tuition but Roger's parents were in no position to help him financially. He took several part-time jobs and won a small scholarship. His high school education was greatly superior to that of his classmates and Roger felt he was spinning his wheels waiting for them to catch up. One day he walked by a Marine Corps recruiting table in the student union. The Marines were glamorous, the U.S. was between wars, and an enlistment would earn him a green card and future citizenship. He had no family or future in Jamaica. Roger completed basic training down the coast at Camp Pendleton. Tall and rangy at six feet tall and one hundred and fifty pounds, the training only managed to convert a few pounds of baby fat to hard muscle. The Marine Corps shaved off his long black hair and gave him a crew cut. He would wear it that way thereafter. His grey-blue eyes gave him a cold look that his boyish smile could not quite negate. After advanced infantry training, he shipped out to Okinawa; it had a climate similar to that of Jamaica and he enjoyed garrison duty. He did his share of drinking in the off-base bars and taking up with some of the Japanese women who hung around the bases. He was prepared to serve out his four-year enlistment when a training accident crushed his left knee. After months of rehab in San Diego, the Marines discharged him and he resumed his studies, this time with help from the GI Bill. By his sophomore year, he realized that he had an aptitude for science, particularly biology, and really enjoyed the introductory course in soil science. He majored in it and did his senior thesis in soil microbiology.

Roger had several offers of graduate assistantships. He based his final choice of Ohio State on two criteria –a personal letter he received from his future advisor, and a crude survey he made that showed Columbus, Ohio had the cheapest beer. However, he neglected to pay attention to the climate. Roger's Ph.D. dissertation research was in the emerging field of microbial genetics. Although his advisor was a classical soil microbiologist, Roger had taken as many courses as he could in this new field and had several of the proponents of microbial genetics on his dissertation committee. At Riverside, he quickly turned his new expertise to the study of soil bacteria in extreme environments. Riverside had plenty to offer. Extremely hot in the summer, many of the soils in the area were also highly saline. He set out to characterize bacteria in these environments that were responsible for important soil processes.

Starling began to study a unique group of microorganisms called the Archaea. These species are similar in shape and size to bacteria but were placed in separate domains in the classification system. These organisms had been found in extreme environments, such as deep-sea vents, thermal pools, and Arctic ice. Members of the Archaea were

responsible for the formation of methane in ruminants and for the decomposition of organic waste in sewage treatment plants.

One of the problems with studying the Archaea was their resistance to classical bacterial culture and identification methods. Since Pasteur, microbiologists had cultured bacteria on various growth media and identified them by their shapes and by their production of various enzymes. The Archaea couldn't be cultured. Instead they were identified by the techniques Roger Starling had picked up in graduate school. These involved two steps, polymerase chain reaction (PCR) and 16S rRNA. PCR was used to greatly amplify bacterial DNA and the DNA was then analyzed for 16S rRNA. Each species of Archaea had its own unique 16S rRNA, a kind of fingerprint.

Chapter 2

The lab was the only modern room in the old building on Vista Verde. Roger Starling had renovated it with his grant money and funds provided by the University of Puerto Rico. It was air-conditioned and air-filtered, and under positive pressure to keep out contaminants. The lab followed clean room procedures, similar to that in the most advanced hospital operating rooms. The problem with researching microbes is that they are everywhere and so tiny that they can be easily transported by air. Roger employed two laboratory technicians from the University, Carlos and Luis. They spoke rudimentary English, but fortunately Roger spoke passable Spanish from his research time in Costa Rica and the Dominican Republic. The two young men were assigned the tasks of taking soil samples and processing them in the outer lab. The PCR and 16S rRNA equipment sat in the clean room and operated by Roger alone. Today he was analyzing soil samples from a long-term field experiment with various tropical crops. Annual crops like sweet potato were intercropped with tree crops including bananas and coffee. Starling wanted to see if this crop diversity affected the species distribution of soil microorganisms, including Archaea species. In addition to the more sophisticated microbial genetics work, the soil samples were also analyzed for more routine parameters like pH, nutrients, and organic matter.

Roger looked over some of these routine soil analyses and compared them to data from previous years. He didn't expect to see much change since this experiment had not changed in over a decade. What he did see was totally unexpected. While most of the other analyses were relatively unchanged, as expected, the organic matter content of all of the samples had decreased by more than twenty-five percent from the previous year. This couldn't be real, he thought.

"Carlos, come in here por favor," Starling yelled. Roger was an impatient man and had little use for those less gifted than him. "Diga me," Carlos replied from the outer lab.

"Carlos, this organic matter data from the most recent samples can't be right. The values can't have dropped by twenty-five percent," Roger said.

"Professor Starling I *know* my analyses are correct. I'll bring in my lab book and show you." Carlos returned with his lab book and showed that the analytical standards and sample blanks were correct.

"Well something is wrong. Organic matter doesn't just evaporate from the soil," Roger insisted. "Perhaps that idiot Luis took the wrong samples or got them mixed up with samples from other areas," Carlos said with a smirk. He was higher in the pecking order than Luis because he worked in the lab and not in the field.

"OK, get Luis in here and let's sort this out." Carlos returned an hour later with a pissed off Luis.

“Professor Starling, no es mi culpa. I took the samples properly and I checked them against the chain-of-custody sheet. Everything is in order.”

“All right, all right,” Roger said. “Luis, I need you to take new samples tomorrow and I will be there myself to make sure you don’t screw up. Carlos, I want a rush job on the analyses, and I am going to be looking over your shoulder as well.”

A week later Roger looked over the new data in shock. The new analyses were within experimental error of the first ones. How was this possible? Soil organic matter is very stable. It has a half-life of between 10 and 8,000 years, the time required for half the organic matter to decompose. Soil organic matter, also called humus, is formed by soil microorganisms when they decompose vegetative matter like fallen leaves, plowed under crop residues, and plant roots. Soil microorganisms use this plant material to build their own biomass, and for energy. Most of it goes off as carbon dioxide, while a very small part, less than one percent, becomes soil organic matter. Studies showed that the organic matter content of soils reaches steady-state conditions, i.e., as much humus is formed as is decomposed, unless there is a major disturbance. When the humus-rich soils of the grassland prairies in Iowa and Kansas were first put to the plow, the organic matter content declined by more than 90 percent, but it took a century to do so. A twenty-five percent decline in one year was impossible, but the data did not lie. What could have caused this, Roger thought.

He decided to wait until Monday to deal with this puzzle. It would give him time to think it out. There had to be a simple answer somewhere. Roger took the early afternoon ferry to San Juan, dressed in his usual uniform of baggy khaki shorts, white guayabera shirt, frayed Marine Corps baseball cap, and his old Merrell sandals. Many of the island workers lived on the mainland and commuted daily. Roger saw Raphael, one of the experiment station workers, and pulled him aside. Raphael was on the field crew and had been there for ages. Maybe he had some ideas.

“Raphael, have you noticed anything different about the soils in the farm plots recently?”

“What do you mean different, Señor Starling?”

“Anything about how the soils look, their color, how they plow?”

“Not that I can think of Señor. You’ve asked the wrong campesino. I just do my job.”

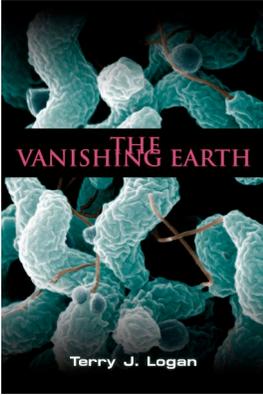
“OK, Raphael, but keep your eyes open and ask the other obreros if they have noticed anything.”

“Si Señor. Enjoy your weekend.”

Roger debarked the ferry and caught a taxi to the University of Puerto Rico’s Rio Piedras campus just outside the city where they provided a set of furnished apartments for visiting scholars. This greatly helped Roger’s budget and allowed him to spend his spare cash on more worldly pleasures.

Roger had never married, although he came close once. In undergraduate school, he had little time or money for dates and he was still a little self-conscious about his accent. American girls were much more confident than the ones he dated in Kingston. He met Sandy in Columbus in the Ohio Union one Friday night when he was starting his dissertation research. She was a second-year nursing student and her family was from the area. She was four years younger and a little shy. They began dating regularly and moved in together after about six months. At first the relationship went well – he enjoyed having someone to come home to and their mutual studies gave them a lot to talk about. Things started changing when his research moved into high gear. He spent late nights in the lab and on most weekends. On the other hand, her studies were winding down and she looked forward to graduation and her first nursing job. They had never talked about it, but she clearly wanted to get married, while Roger thought about faculty jobs and post doc positions. Sandy knew that he had been offered a two-year post doc with one of the microbial geneticists on his committee and assumed that he would take it and stay in Columbus. It all came to an end when Roger told her he had accepted the position at Riverside. He wanted her to come with him, although neither mentioned marriage, but she would never leave her family. Roger kept in touch with her by phone and later by email for a while, but eventually they went their separate ways. Sandy married a Columbus lawyer about three years later; they still exchange Christmas cards.

Roger dropped his briefcase and laptop in the apartment and walked over to the Soil Science Department to get his mail. There wasn't much – a few technical journals and his monthly swim magazine. After busting up his knee in the Marine Corps, he had taken up swimming for exercise. Roger was quite vain about his looks and he constantly watched his weight. It took a lot of swimming to overcome the effects of his other hobby – drinking expensive booze. He competed on the masters swim team at UCR, and enjoyed ocean swimming in Southern California. He also swam off the beach at Vista Verde but stayed near to the shore for fear of sharks. Roger decided to go to the campus library to check out some research journals he couldn't get online. This organic matter thing still bothered him - maybe he could find some clues in the library. One of the books he checked out was a classic, Stevenson's "Soil Humus." Roger was pretty familiar with the subject although this text covered mostly chemistry. Scanning the pertinent sections reinforced what he knew – soil organic matter just doesn't burn up overnight. Soil humus does turn over relatively rapidly in tropical climates but not at the rates he had found.



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