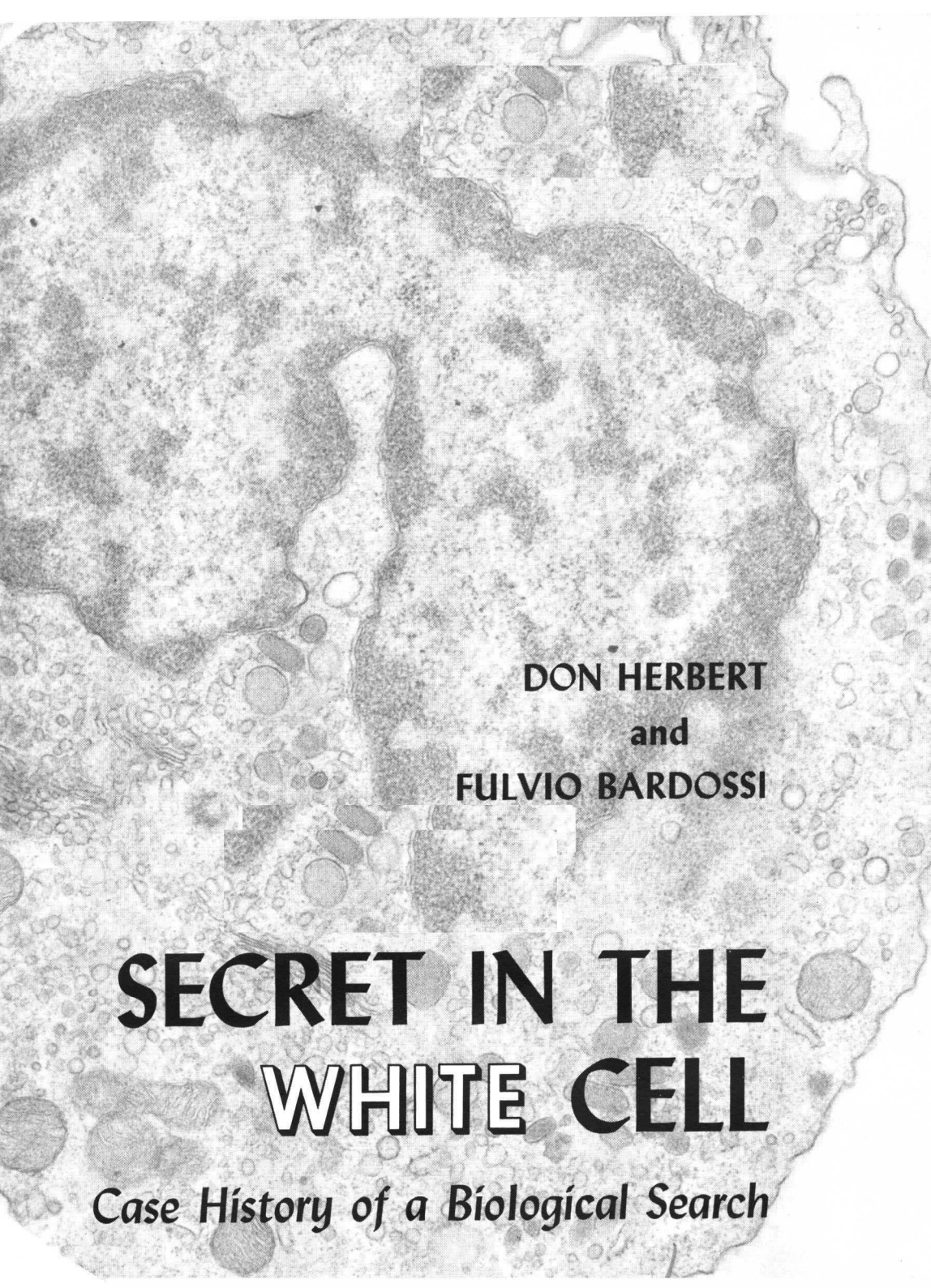

DON HERBERT
and
FULVIO BARDOSSI

SECRET IN THE WHITE CELL

Case History of a Biological Search

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SECRET IN THE WHITE CELL:
CASE HISTORY OF A BIOLOGICAL SEARCH

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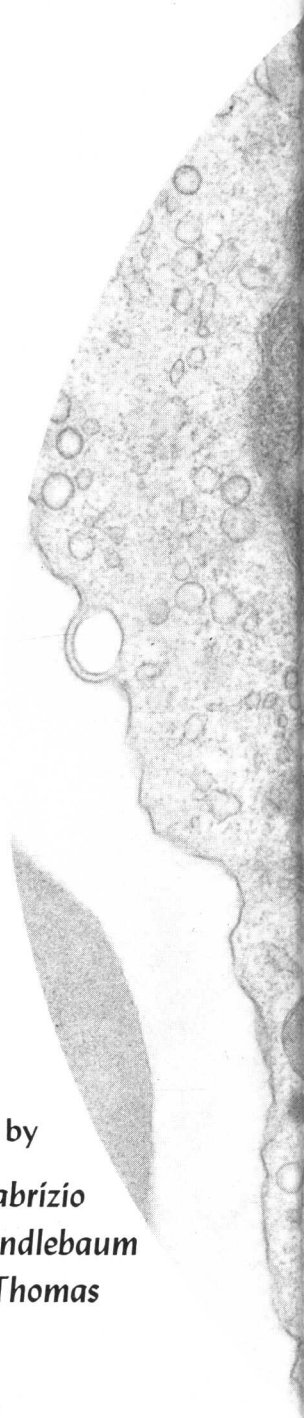

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AUTHORS' NOTE

The idea for this book grew out of the production of a television film about research into the role of white blood cells as defenders of the body by Dr. James G. Hirsch and others at Rockefeller University. The program, "The Secret in the White Cell," was one of eight in a series called *Experiment*, underwritten by the Sloan Foundation and the National Science Foundation and produced for National Educational Television by Prism Productions, Inc.

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We are also grateful for the co-operation and many courtesies extended to us by members of the staff and faculty of Rockefeller University.

For the photographs, we are indebted to many contributors. Their names are given in the captions. We appreciate Dr. Dorothea Zucker-Franklin's co-operation in supplying the original electron-micrographs so important to the climax of our narrative.

We have drawn our information from many sources and have tried to list in the bibliography all those from which we have benefited or borrowed in any way. We thank all concerned and apologize to anyone we may have inadvertently omitted.

We thank Cambridge University Press for permission to quote from Sir Macfarlane Burnet's book, *Natural History of Infectious Disease*. The Metchnikoff quotations are as they appear in Dr. Hirsch's paper "Immunity to Infectious Disease: Review of Some Concepts of Metchnikoff." For

permission to use them we are indebted to Houghton Mifflin Company and Constable and Company, Limited, publishers of *The Life of Elie Metchnikoff*, and to Routledge, Kegan Paul, Limited, publisher of *Lectures on the Comparative Pathology of Inflammation*.

To Lois Brandon, secretary, editorial assistant, and photosleuth, we can only say thank you again for the usual unusually fine assist.

SECRET IN THE WHITE CELL

CONTENTS

ILLUSTRATIONS

PROLOGUE: The Black Death

THIS IS THE END OF THE WORLD, people said. Why toll the bells? Mourning seemed meaningless as the horror spread like flame in stubble. The bloody, nauseous harvest was human bodies, thousands upon thousands. Everyone waited, equally vulnerable—prince and priest, knight and lady, peasant, poet, beggar. At any moment, anywhere, the Black Death might appear and, with a bony finger, beckon them to join him in a dance of death.

It had begun in 1347 at Caffa, a port in the Crimea, where Italian merchants maintained a center for trade with the East. Tartar warriors, fired up by campaigns in the Kirghiz steppes, had laid siege to the port and kept the traders bottled up for several years. Then a greater enemy, the plague, ravaged the Tartar ranks and put them to flight. The Italians hastily boarded ship and set sail for Genoa, without realizing that there was a sinister stowaway on board. Three days after the traders had scrambled onto the docks of their home port and embraced their families, the plague revealed itself and struck savagely.

That same year, the plague came ashore with sailors and travelers at Constantinople, along the coast of Greece, at Adriatic ports in Dalmatia, in Sicily, and at Naples. Everywhere it moved rapidly inland, infecting the larger villages and towns, and finally bringing desolation even to remote hamlets and farms. By June of the following year, the Black Death was sweeping through France and Spain. By autumn, it had leaped the Channel and was scourging England and Ireland. All winter and during the spring and summer of a terrible new year, the plague progressed—through Germany, into Russia and Scandinavia, to Iceland, and even across the frozen wastes of Greenland.

In Rome, out of an Easter throng of 1,200,000 pilgrims from all over the

continent, barely one in ten escaped the plague. The magnificent palaces and resplendent residences of Florence became sepulchers and mausoleums for 100,000 of her citizens. In Paris, 500 plague patients died each day at the height of the epidemic. At Avignon, the River Rhone bore a cargo of rotting corpses, consigned to the water with the hurried prayers of the overworked survivors. At Oxford, two thirds of the students perished. Half the population of London was wiped out.

At sea, ships drifted ghostlike without a hand on wheel or sail. The countryside was given over to weeds and brush. Wolves sniffed at peasants' hovels, stinking of unburied corpses. Vast estates stood untended and exposed to a mounting wave of looting and vandalism; the lord and mistress and all their heirs gone with Death. Cattle perished in the fields. The traffic of trade and diplomacy and the military had practically vanished from the highways. In the swirling snow, the howl of the wolf was heard even on the outskirts of large cities. Huge fires blazed at the crossings and panic-stricken crowds huddled together in the streets, afraid of the terror that lurked in every home.

As 1350 drew to a close, the Black Death had visited two thirds of Europe's people and taken almost half—a harvest of twenty-five million dead.

CHAPTER 1

THE INVADERS

BEFORE BIRTH you were cozy and secure in a private environment. But in the process of being born and gulping your first breath of air, you were exposed to a dirty, crowded world. Despite the precautions of nurses at the hospital and your mother's dedication to cleanliness when she got you home, you soon had millions of invisible creatures—germs°—in the folds of your skin, in your nose, mouth, and throat, between your toes, on the lining of your intestinal tract.

Every moment of your life—first rolling in your crib, later crawling about the house, then at play, at school, and at work—you move through other hordes of microscopic organisms. The earth beneath your feet is heavy with them. Everything you touch, everyone you meet is covered with unseen life. The rim of the glass from which you drink, the dollar bill in your wallet, a friend's handshake, a kiss, all may be agents by which you unknowingly pass on thousands of microorganisms° (or microbes°) and receive thousands of others in return.

Your environment will pretty much determine the specific kinds that will settle on you. Once established, many of them will stay with you until the day you die. Most of them are harmless. Some may turn nasty. A few are killers. These germs may be the cause of your death.

Because microorganisms are invisible to the unaided eye, the astronomical numbers and varieties present at any one time are almost impossible to imagine. A teaspoonful of soil from a vegetable garden may be jammed with half a billion microorganisms of all kinds.

The rim of a drinking glass resting on an unclean surface will collect

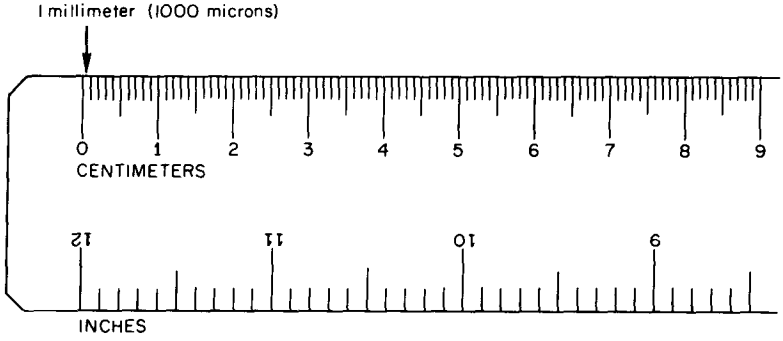
° Indicates word or another form of it defined in the Micro-Glossary beginning on page 137.

about 50,000 bacteria° alone. There may be as many as 100,000 in a drop of milk. Your freshly laundered shirt may have about 100 bacteria per square inch. After a day's wear, it might have almost 1,000,000 bacteria per square inch.

One scientist interested in the invisible crowds on his outer skin scrubbed his hands with soap, rinsed them in sterile water, then counted the bacteria. He estimated that each time he rinsed his hands five million invisible creatures were sluiced away. In a tiny speck of matter scraped from between a man's teeth, there are millions of microbes of various types. Scientists have counted a billion in a half teaspoon of saliva. And right now every human being is carrying around in his intestines many more bacteria and other microorganisms than there are people; more, in fact, than all the people who have ever lived on this earth.

Not only do microorganisms outnumber people, and animals, they also outweigh them. The total mass of microbial life in the world is about twenty times greater than the total mass of animal life. Yet a gathering of a million million bacteria would weigh less than an ounce. The weight of an average man equals the weight of 70,000,000,000,000,000 bacteria.

These numbers point up the other extreme of microbial arithmetic—their infinitely small sizes. With your unaided eye you can barely make out



objects as small as 1/250 inch, or slightly less, in diameter. Almost all the germs that invade or inhabit you are smaller than that and definitely invisible. To measure microbes, scientists use tiny units called microns,° which are 1/1000 millimeter or about 1/25,000 inch in length.

Bacteria, the most numerous of living things, measure between .2 and 2 microns in diameter. More than twelve thousand average-sized bacteria could line up between these two dots . . and you would never notice them. A thousand of them could be herded together on the point of

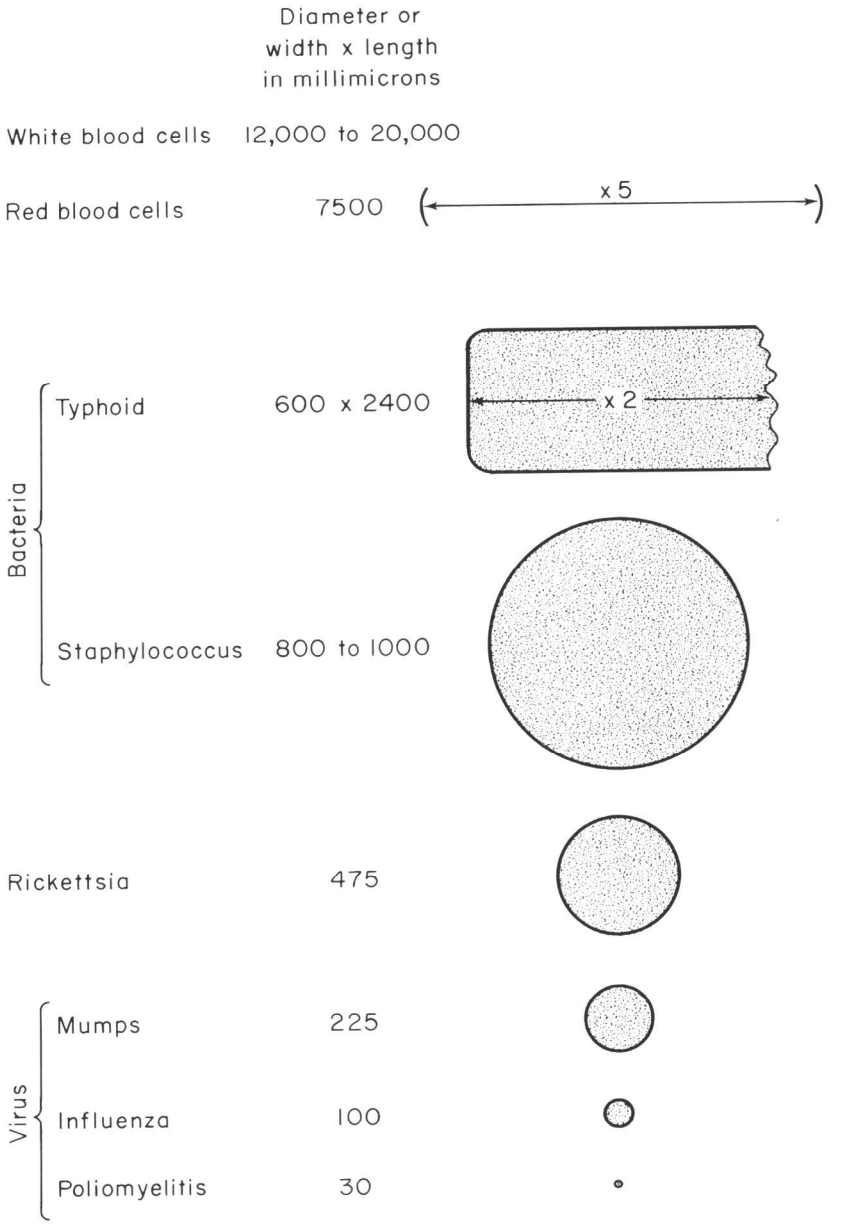


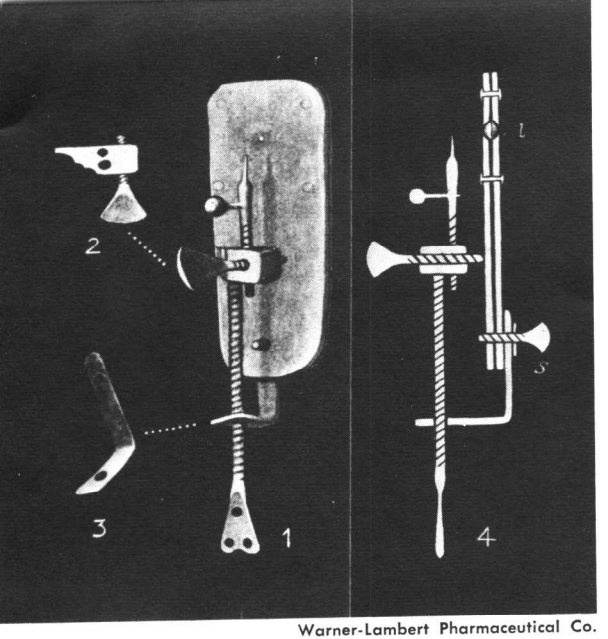
Chart shows comparative sizes of blood cells and representative bacteria, rickettsiae, and viruses. The circles representing each organism are approximately 50,000 times larger than the actual size. (There are 1,000 millimicrons in a micron. A micron is 1/1,000 of a millimeter.)

a pin. Yet even the smallest bacterium would look large beside the smallest member of the virus° family. Some viruses, for instance, are only .016 micron in diameter. Almost one million of them would fit between the dots . . with room to spare. At the upper end of the microscopic scale are members of the Protozoa,° animal-like creatures varying in size from a micron or two to giants several hundred microns long. The amoeba that causes one form of dysentery is between 20 and 30 microns in diameter. Also on the large side for microorganisms are the microscopic fungi,° yeasts and molds, between 4 and 50 microns in diameter. A quick glance from top to bottom of this scale shows that, despite the narrow dimensions of even the largest microorganisms, they come in a broad range of sizes, which rivals the variety of the visible world. The ratio between largest and smallest is on the order of several thousand to one.

Less than 300 years ago no one had ever seen a microorganism. First, man had to develop "optical glasses" that could magnify an object many times without distorting it beyond recognition. The invisible world was "sighted" for the first time 183 years after the discovery of America. The Columbus who revealed the variety of life going on unnoticed under everyone's nose (and on it) was a Dutch merchant and amateur scientist whose hobby was grinding lenses. Antony van Leeuwenhoek's "microscopes" were homemade instruments with tiny beadlike lenses. They were much simpler

Rijksmuseum, Amsterdam, Netherlands

Antony van Leeuwenhoek (about fifty-four years of age); steel engraving from a portrait by J. Verkolje in the Amsterdam Rijksmuseum

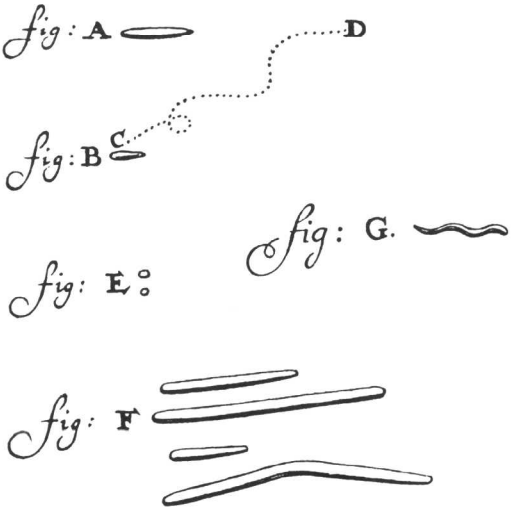


A Leeuwenhoek microscope, viewed from the back (1) and in diagrammatic section (4). A single lens (l), bulging outward on both sides like a glass bead, is held between two metal plates. Leeuwenhoek would impale the specimen on the movable pin, hold the microscope up to the light, and sight with one eye through the tiny hole or lens opening in the front plate. He adjusted focus by using the small screws (s) to move the pin.

Warner-Lambert Pharmaceutical Co.

than some of the other microscopes coming into use at the time. But with them, such was his skill and patience, Leeuwenhoek became the first to see and describe in detail many of the inhabitants of this strange new world.

Leeuwenhoek's discovery was to have as profound an effect on human thought and history as all the explorations of the visible world which had preceded it. But it took another two hundred years of dedicated experimentation and research—and often bitter controversy—to establish microorganisms firmly in the natural scheme of things and to demonstrate their importance to man. Today science is at last beginning to explain the intricate balance of forces between man and his invisible neighbors and guests, which can mean sickness or health, life or death. Yet even today many



Leeuwenhoek's figures of bacteria from the human mouth, as they appeared in his letter of September 17, 1683. The modern names for these bacteria are as follows:

Fig. A, a motile bacillus
Fig. B, *Selenomonas sputigena* (C . . . . D indicates the path of its motion.)
Fig. E, Micrococci
Fig. F, *Leptothrix buccalis*
Fig. G, a spirochete

From C. Dobell, *Antony van Leeuwenhoek and His "Little Animals,"* Dover, New York