



C R I T I C A L FOCUS

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Censoring the Cell: How the Microscope is Abused by the Media

When was the last time you saw living cells through a microscope on television? Not cartoons or computer graphics but lustrous, dynamic, living cells? Don't stop to think of it now, or you'll never finish this article. The truth is that the wondrous world of the microscope has been largely banished from the small screen.

Television shows us almost everything you ever want to see, from World Series showdowns to the playful tossing of seals by killer whales; from erupting volcanoes to roadside bombs. You can follow a heart surgeon at work, or watch an anatomist dissect a great white shark. They may have banned frog dissection from schools, but the eviscerated shark is right there on prime time TV. Yet cells have been banished and we're not allowed to watch them. Yes, you will sometimes see microscopes — wrongly used — as props in those crime-scene TV programs, but you won't see anything alive down there.

The world of natural history has been dominated for years by the BBC, yet it is the BBC themselves who continue to ignore the extraordinary universe that lies beyond our sight through the microscope. One current BBC series takes us down caves rich in hydrogen sulfide, which is metabolized by communities of microorganisms to form sulfuric acid. This is captivating stuff, and I watched it all eagerly. The presenter was particle physicist Brian Cox, who is very good on tele-

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vision, but the people who make these programs can't tell one end of a microscope from the other. Worse, they don't even want to. Cox went equipped with a neat digital H₂S meter to ward against excessive inhalation of this toxic gas. We saw the glutinous hanging colonies, which had been aptly named "snottite" by Dr. Jim Pisarowicz of Hot Springs, South Dakota, when he discovered them in 1998. The pH of the colonies was known to be very low, and so Cox said he would measure it and show us.

And how? No, not with a digital pH meter but with old-fashioned indicator papers. He ran the test strip up and down the color chart and eventually said he found the perfect match near pH 0.5. Why they would go to all the expense of traveling to Pisarowicz's cave and not bring the proper equipment is beyond me. What were these astonishing organisms like? We never saw. There was no mention of microscopes and, as usual, nothing on the organisms. It's like screening soccer without any goals.

Another BBC series called "The Atom" features Robert Brown's observations of Brownian motion. This phenomenon is widely referenced on the Web, so there's no reason for even an inexperienced researcher to miss it. Still, the series poorly portrayed Brownian motion. You know the story: Brown observed pollen through his microscope and saw tiny particles within each grain vigorously jiggling. The most common mistake



In a BBC program shot in a cave rich in hydrogen sulfide and glutinous “snottite” colonies, the presenter didn’t bother using the right equipment to measure the pH of the colonies. Instead, he relied on old-fashioned pH-indicator papers of dubious accuracy.

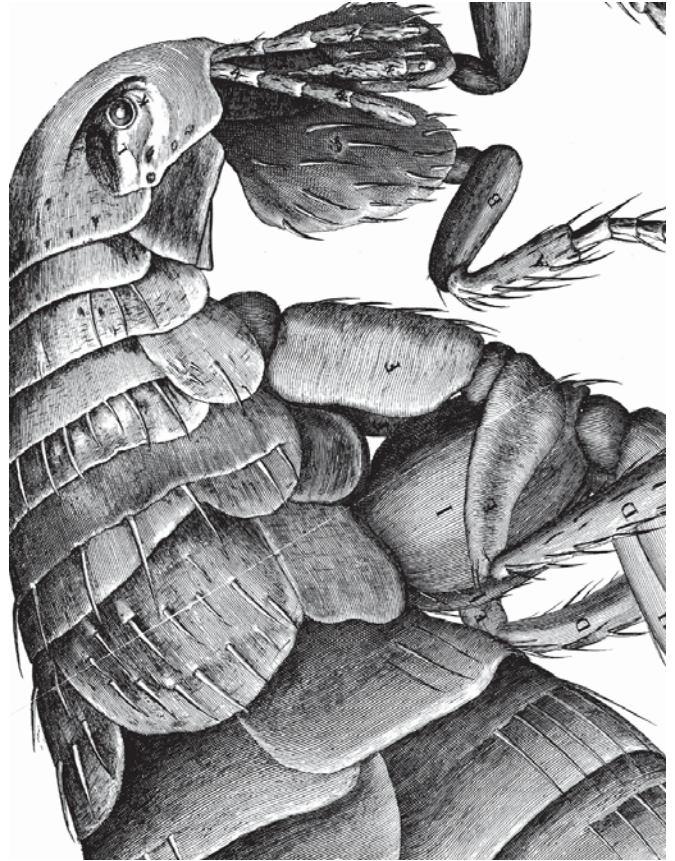
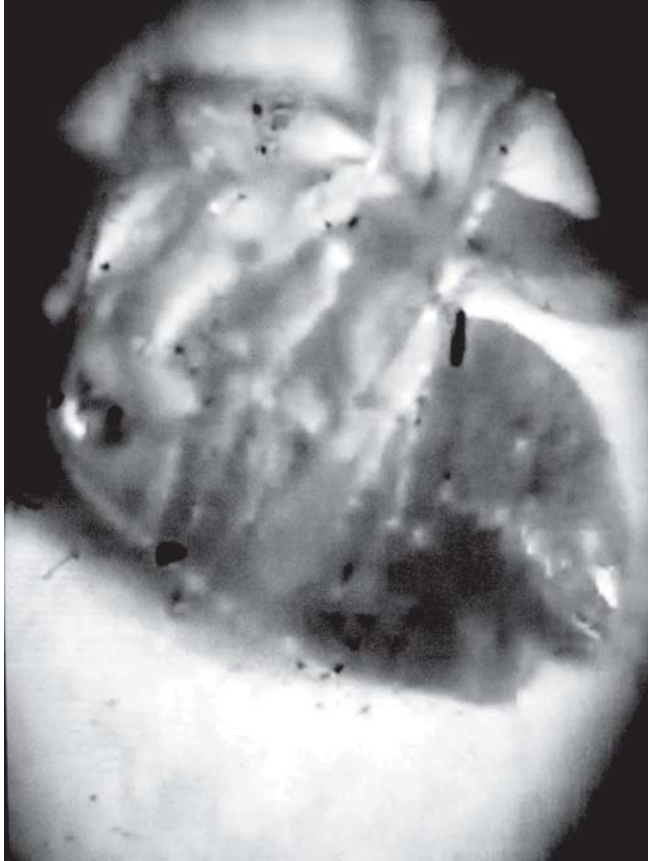
is to claim that he saw the entire grains themselves moving, because they are, of course, far too massive to move. This BBC program made that mistake, but what was much worse was the way they recreated the observation. Instead of making a slide, the presenter sprinkled powder into a fish tank and portentously announced: “Instead of the pollen grains floating gently in the water, they danced around furiously, almost as though they were alive.” He faked a completely misleading account of it all. First, the sprinkling of the powder (like powdered parmesan on a plate of pasta), then a cutaway shot of the presenter squinting through a modern microscope, followed by a sequence of India ink particles filmed through a modern achromatic instrument. Talk about a fix – this was the most dishonest piece of television I have seen for a long while. Whoever did that should be severely castigated or, even better, made to read a science book.

Channel 4 television in London has just made a series called “Genius of Britain.” Professor Richard Dawkins was brought in to demonstrate Robert Hooke’s microscopic view of nature. Dawkins and I have lectured together in London; he is clearly a capable character, but the sequence was confused. Dawkins showed Hooke’s engraved image of the flea that had been published in *Micrographia* in 1665. People could see the astonishing detail and marvel at Hooke’s skill. Dawkins then shoved his entire finger into a specimen tube of preserved fleas (no, he didn’t use instruments) and showed a blurry image generated through Hooke’s microscope. The way it was set up, the resolution was less than you would have with the naked eye.

In Hooke’s engraving, every hair of the insect was precisely delineated, and Dawkins announced how excited people were in the 17th century about discoveries made with the “compound microscope.” This is an obvious point of confusion, because Hooke’s compound microscope could not reveal the details shown in his pictures. He used a single-lens simple microscope to make his detailed studies; this was not the type of instrument shown in the program. The blurred flea, incidentally, was one of the few biological specimens seen through a microscope in the entire series. Although we heard a great deal about cells and bacteria, we didn’t see any living cells. It was as though they didn’t exist.

Currently, Channel 4 is screening programs (fronted by Stephen Hawking) about the universe. How did life begin? “Just by chance,” says the script. “One molecule formed that could multiply itself.” We see digital art golf balls on screen. “Then began the slow process of evolution . . .” intones the narrator. “That led to the extraordinary diversity – of life!” This is all good, edge-of-the-seat stuff. You are highly tuned, just waiting for the first glimpse of a living cell. And what do we see next? Copepod water fleas. In a flash, we have dismissed 99% of evolution and the miracle of the cell. It is edited out of reality, as if you had condensed the evolution of transportation to sandal, wheel, airliner.

Hooke surfaced again in the BBC series “The Story of Science,” which reported his discovery of cells in cork. The program stated that after Hooke, cells virtually disappeared from scientific view until they resurfaced in the middle of the 19th century. Leeuwenhoek, Malpighi, Wolff and Milne-Edwards, Mirbel, Brown, du Trochet, Raspail, Schleiden and Schwann, Corti, Link, Trembley and Treviranus, and scores of others were carelessly omitted from this piece of media entertainment. And where did the cell re-emerge, according to this novel account? Why, “in the research laboratories of Prussia,” because they were using histological stains for the first time. Once again, the presenter was trapped by the BBC’s inability to use a microscope properly. We saw a glimpse of a Victorian compound instrument, and then the commentary said: “Even with the best microscopes available, this is all they could see: a nucleus in a translucent mush.” My mouth fell open. On the screen was a blurred ellipse within which were faint images of cells. The substage had not been restricted, and light was flooding the image field. It wasn’t even in focus. Curiously, I had carried out exactly the same demonstration on TV more than 20 years ago and showed just how much you can see without staining the cells.



A Channel 4 London documentary on Robert Hooke showed viewers a blurry image of a flea (left) as it would appear through Hooke's "compound microscope." However, Hooke's engraving of a flea (right) for his *Micrographia* book published in 1665 reveals astonishing detail and was actually seen through a single-lens microscope, which the documentary failed to mention.

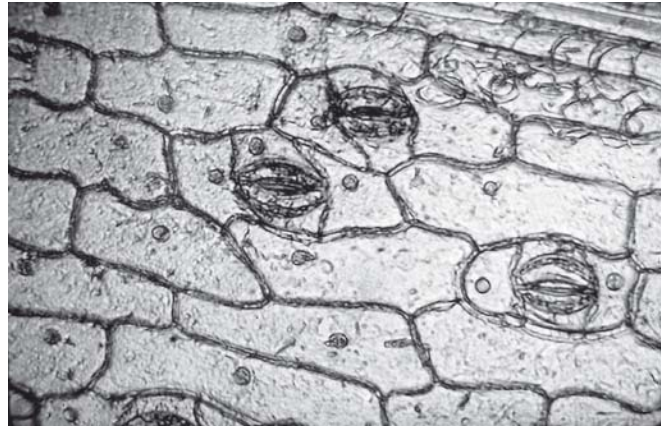
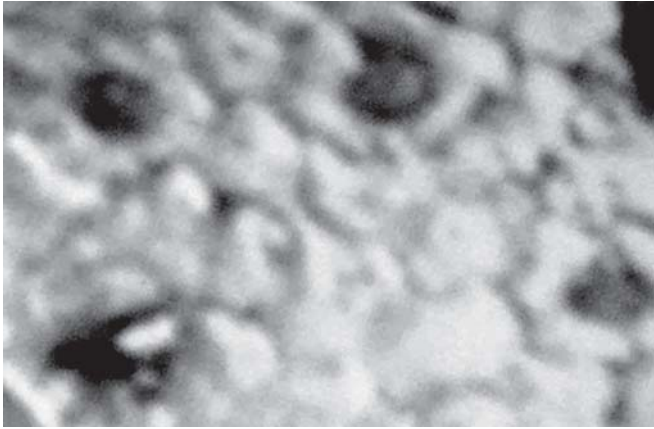
People will go a long way to prove that early microscopists had an inferior view of reality, to argue that more modern microscopes are so much better. This is not the case. Most of the discoveries made with light microscopes could have been done with a Leeuwenhoek lens of the 1600s. Those who followed my recreation of Brown's experiments in the 1820s, and of Leeuwenhoek's 150 years before, will know how clear the images could be.

This work is cited widely on the Web, so there really is no excuse for dragging the viewer back through those time-honored myths. No other area of television would do it – imagine sports done this way: "Baseball is played by striking the shuttle with a pool cue . . . and one must be careful not to trip on a brick."

Sir David Attenborough has hosted natural history documentaries since the 1960s. His programs are classics, yet there's never been one devoted to microscopic life. David recently finished narrating a 10-part definitive series simply called "Life," which is show-

ing all around the world. Rather than using taxonomy or geography as their guide, the producers broke the series down into categories such as "Hunters and Hunted" and "Creatures of the Deep." No microbes, even though plenty of those are "creatures of the deep" and would provide hours of captivating hunters-and-hunted footage.

Although the wildlife programs that the BBC has pioneered are among the best in the world, they won't do justice to the microbe. The vast, spectacular universe of living cells is off producers' radars. If microbes were a political party or a race of humankind, they could go to court and the producers would lose their homes. You can see the attitude outlined on the BBC's wildlife search pages. Hit bbc.co.uk/nature/animals and you will see the results. They start with Amphibians, then go to Birds and Mammals. Scrolling further down the list we come to Barnacles, then Starfish – aha, getting closer! – until the page ends with Sea Urchins and Polychaete Worms. There aren't even any nematodes,



In a BBC program on the discovery of cells, Robert Brown's microscope and its No. 2 lens were used to recreate what he observed. The results are inferior, showing no defined cell structure or nucleus (left). An image taken by the author (right) with the same No. 2 lens of Brown's microscope from 1820 proves how wrong it is to dismiss the image quality obtained by early microscopes.

because that might lead us into the microscopic realm. Search for "algae," and the only hit is for giant kelp. Sparkling cells of *Micrasterias*, *Euglena* exploring or sexually active *Spigoryra* filaments are nowhere to be seen.

MICROBES IN THE NEWS

But surely there *are* living microbes on television? Most people can vaguely recall seeing them, and they're right – it's those germs on the disinfectant commercials. These costly little gems of digital art are a prime-time showcase for graphic artists' impressions of what microorganisms are like. The results are vivid and most people remember them. Germs have specific characteristics: gruff voices, eyes on stalks, sharp stained teeth. Some are orators, holding forth on their victory over the human realm, only to be submerged by a wave of disinfectant from a blue plastic bottle that sweeps them away in a cleansing tide. The viewer is left with the impression of microbes as parasites with psychoses, bright pants and bad breath.

This is not a global phenomenon. In some countries, television commercials do not assume that everyone is dumb. Instead, they show micrographs of actual pathogens, which are what their public expects to see. These are countries with high standards of philosophical debate, which seek to advance real scientific principles. In India and in Pakistan, for example, they show zoomed images of actual organisms – and they are properly labeled "bacteria" or "viruses."

Curiously, it was not always assumed that Western television viewers were too indifferent about watching bacteria in a disinfectant commercial.

Twenty years ago, advertisers did indeed show real germs in the commercials. There were television advertisements for Domestos that featured micrographs of enteric bacteria. But that was back in the day. Now, advertisers in the modern Western world believe the public to be too apathetic about realities and too uneducated to know the difference.

There is one area where you can glimpse microbes – they crop up in current affairs. That sounds like good news, but unfortunately they don't use the right ones. On British commercial TV, a major report on MRSA showed a picture of the entirely unrelated *E. coli*. That's as bad as using a picture of a fern to talk about flowers or a toad to typify a tortoise. A BBC television inquiry into the use of anthrax by terrorists was even worse. As their microbe, they showed a colony of the harmless green algae *Volvox* sunning itself on the slide. You might as well use a jungle jaguar to explain how a winding vine climbs or exemplify a giraffe by a bean pole.

WHERE ARE THE TV PROGRAMS?

At this point, I can almost read your thoughts. Why haven't I presented TV programs on the microscopic world? I *have* presented them, both in Britain and abroad (even hosted a computer game show on TV), and I regularly discuss science in the news programs. There are several reasons for the omission. One, I have never much liked the way television is used as a medium. It is not as intimate as radio and – although it could be compelling and exciting – it's mostly done superficially and on the cheap. Another reason is that



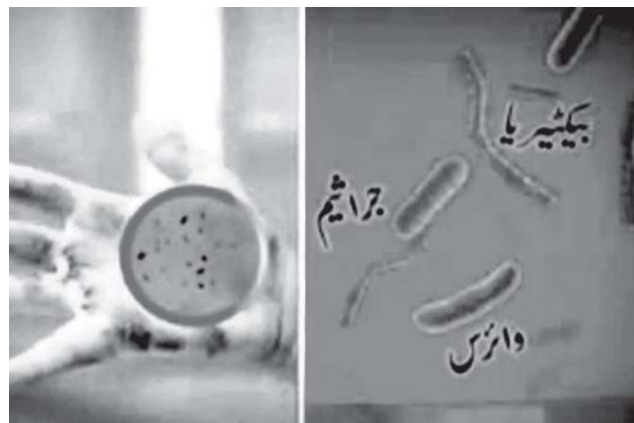
Public knowledge of pathogens is largely influenced by cartoonish “germs” shown on many TV commercials. A gruff voice and surly attitude single out these critters as enemies of humankind.

there are far better presenters to do the job. Although reviewers have commented generously on my programs, my productions seem good largely because of a conspicuous lack of competition.

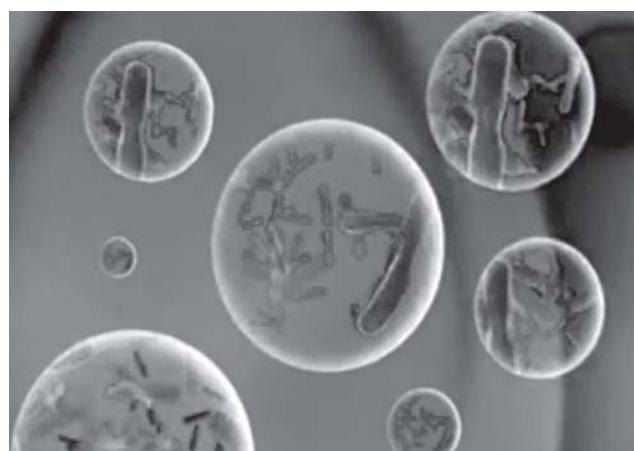
Today’s television is dominated by arts personnel who know nothing about science. They believe that it is noisy and wild with much waving of arms and loud sound effects, whereas we all know that the true magic of science is its wondrous revelations and enticing sense of intellectual engagement. Today’s television producers don’t know what they want — they only want what they know.

Thirty years ago, I made a TV report on head lice, and the 16 mm film I took showing the organism in human hair made people’s skin creep. Carol Vorderman, a top British television presenter came to my home to make a BBC film of microscopic life. Later, I made a documentary on microscopes for French television with many forms of pond microbes. On radio, microbes were often discussed in my weekly BBC series “Science Now” and the public lapped it up. We have since had a range of foreign TV companies, including Japanese, German and Korean, come to Cambridgeshire to report my investigations, and I have been asked to talk about microbes on television in other countries, from India to Singapore. In those places, there seems to be a greater emphasis on science (and the microscope) as common culture.

Knowing how the BBC excels at life-science documentaries, I raised it with their science department a few years back. They thought it was a good idea but explained that it should go to the famed Natural History Unit in Bristol, England. As it happens, I have



There are countries whose programming promotes true scientific principles. In this disinfectant commercial from Pakistan, real germs are depicted and accurately labeled as “bacteria” and “viruses.”



Twenty years ago, Domestos commercials showed Western viewers examples of genuine bacteria. They were artificially colored electronmicrographs of coliform organisms, which provided a valid impression of what bacteria are like in the real world.

known many of their people over the years. The producer of my “Science Now” series went to work there, and it was easy to find the right people to approach. They had already asked for a copy of my book, *The Secret Language of Life* (published in 2000), which was the subject my “Evening with Brian” presentation at the Inter/Micro conference in 1991. They clearly wanted to do something along those lines, but they decided that it was really a scientific subject (rather than wildlife), so nothing more had happened. They said much the same about my proposal for a series on the living cell. “It would have to be a London science



A BBC program on the use of anthrax by terrorists used a shot of the harmless chlorophyte *Volvox* to illustrate the death threat posed by germ warfare. Why are such uneducated practices tolerated in science programs? In sports, for instance, they would be scorned.

project rather than a natural history idea," wrote the producer. "It's a shame, as many of us here would love the opportunity to make some more science-based series alongside our natural history output . . ." which abruptly ended that line of inquiry. Catch-22 began to emerge in my mind.

The fact remained that programs were skating past microscopical realities at every opportunity. And so, pressed by enthusiastic audiences (including those at Inter/Micro), I wrote a crisp and convincing single-page proposal for a series about cells. It began:

"Six startling and visually beautiful television documentaries will give viewers, for the first time, a 'natural history of the living cell'. These are nature documentaries that enter the one remaining field that has yet to be explored by television: the microscopic view of nature. Viewers will see cells making decisions, building homes, repairing themselves, patrolling for marauders and living sexually active lives. We will watch them hunt for prey and fight among themselves. The series will create a wonderful impression of the visually stunning microscopic universe that has created the world in which we live."

I wanted to ensure that the idea received full attention, so I sent it personally to the director-general of the BBC, Mark Thompson. I had first met Mark when he was head of the great Channel 4 television network based in London, and we had since remained in contact. After much discussion and delay, their commissioning editor said no, the BBC would not be the producer. It would have to be a single program and not a six-part series, and it would have to be made by an independent company. It was saddening to think that

the BBC would not produce a series on the cell, and the trail went cold once again.

DISAPPOINTMENT ON SCREEN

Several months later we had surprising news. The BBC was planning to produce programs on the cell – indeed it was to be a series of documentaries. It soon emerged that several other series were being planned in which the microscopic world would be featured. One would be presented by a motoring journalist under the title "Invisible Worlds." Another BBC series would look at microscopic life on other planets, and a third BBC series would be following the early years of the Royal Society, when microscopy was born. Their producer asked for reprints and several of my books on microscopy, and said they would like to schedule filming some of the work here.

This kick-started a series of experiments in which we took videos of microorganisms through single lenses of 17th century design. This had never been done before. There was even going to be a section on bacteria in a new popular science series for the BBC. We next heard that Channel 4 was mounting a series about science, in which the microscope would also play a prominent part. Suddenly, after being kept in the dark, the microscope was everywhere.

The series on living cells was based on a 1999 book entitled *The Birth Of The Cell* by Henry Harris, whose main interests were the personal rivalries between pioneering cell biologists like Robert Remak, Jan Purkyne and François Raspail. The book contains some small portraits of the main proponents, which comprise a fascinating collection, though there are few scientific illustrations and not a single micrograph of living cells. When work on the programs began, the producers contacted the Linnean Society of London. They were on the track of the micrographs I had taken with Brown's microscope. I have served as the Honorary Surveyor of Scientific Instruments at the Society for many years and received an e-mail asking how they should respond. We replied expressing interest in showing how it was done, but they filmed during my absence on an overseas lecture tour and the BBC never followed it up.

The series appeared under the title "Cell," but the images in the programs were crude. The BBC's expert photographers failed to obtain clear views of the cell with Brown's microscope, for example. For all their technical expertise, the attempt to see spermatozoa with a replica Leeuwenhoek microscope was a failure. In London, *Laboratory News* published a two-page fea-



For all their six-figure budgets and technical expertise, photographers of the BBC series the "Cell" failed to capture a clear image of spermatozoa with a replica Leeuwenhoek microscope (left). The author's micrograph of a single human spermatozoon (right) was taken with a lens comparable to the best lens that Leeuwenhoek used and is far superior to the BBC's version.

ture reporting the BBC's failure and comparing their results with those I had obtained (see www.brianjford.com/a-09-lab-beeb.jpg).

Centuries earlier, Brown and Leeuwenhoek had obtained better results that this six-figure television extravaganza could match. There may be a lesson in that. Most of the cells that did appear in these programs were modeled on computers or seen in sterile, clinker-like scanning electron micrographs. Nobody watching the series would have any sense of wonder for the beauty of microscopical life, nor any grasp of the immense ingenuity of living cells.

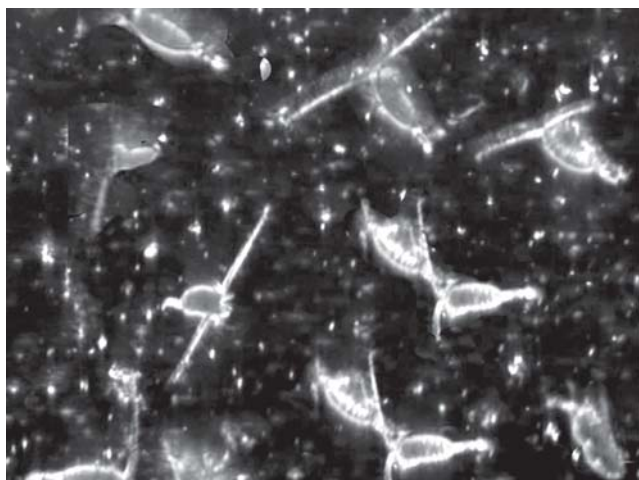
Programs of this sort serve only to debase science, and they create the impression that the microscopic realm cannot make interesting television. The British critic A.A. Gill became a victim of the backlash. Gill is the leading British commentator on television and he reviewed these documentaries. "The story of the cell is also the story of microscopes, and looking down microscopes is not great telly," he wrote in the *Sunday Times* of London. He added: "The story of cells actually is interesting, it's simply not very exciting, and no amount of wishful thinking is going to make it so." The truth is that Gill doesn't know whether the subject makes "great telly" or not. He is basing his views on the programs he's seen in the past and lacks the knowledge to envisage those that might appear in the future. This not the fault of microscopists — it is a problem with television executives.

Microscopes received a worse showing in the BBC series "Invisible Worlds." The title implies that microscopy would be at the heart of the programs, but

by the time they were transmitted, there was virtually no microscope in sight. When the programs were planned, the BBC sent their researcher, and we had a highly productive day in my laboratory. From what he said, the BBC seemed more interested in spectacular demonstrations than in the remarkable revelations that tiny glass lenses can provide. As time went by, they began to say that their needs had been met and they would be downplaying the role of the microscope. When the programs were transmitted, we watched them with interest. There were some spectacular graphic constructions of a world permeated by electromagnetic radiation, reports on the role of ultraviolet in the coloration of flowers and of strange forms of lightning, but where was the microscope?

At one point I thought we were going to see something special, for the camera lens came close to an observer's face, focusing on the eyebrows. Surely we were going to see *Demodex* plucked from a follicle, wriggling in the light? This diminutive acarine mite lives in the facial follicles of people in every nation but is rarely mentioned and seen. That would make sensational television. But, no — we did have a glimpse of the dust-mite *Dermatophagoides* imaged through the variable-pressure electron microscope, but the closest we came to the real "invisible world" of the microscope were a few brief glimpses of marine copepod water fleas hopping about in a drop of ocean water. Once again, the living cell had been banished from the set.

It happened again in the "Planets" series, when Brian Cox was the reporter from an ice cave in Iceland. That is such a fascinating country with its active vol-



The BBC series "Invisible Worlds" began as an exploration of the microscopic world, but not a single living cell was seen. Viewers caught only a few glimpses of copepod water fleas from this image marred by severe chromatic aberration and poor focus.



In the BBC "Planets" series, physicist Brian Cox (left) interviewed Dr. Richard Hoover as he recovered core samples containing microorganisms from a cave in Iceland. "Cells dividing – that's quite incredible!" said Cox. But viewers were not allowed to see them.

canoes and sulfur fields that are primeval and unforgettable. At the other end of the world, I have observed *Chlamydomonas nivalis* in the Antarctic ice sheet, and there are also living microorganisms deep inside the glass-clear ice of freezing caves of Iceland. In the BBC program, we could see someone at work, hammering a core sampler into the ice. It turned out to be Dr. Richard Hoover, an astrobiologist with a mission. We saw him pull out the sampler and eject the core, with delicious closeups as he secured it neatly in a polycarbonate specimen tube, and then . . . nothing. Just as the audience was waiting to find out what organism

Hoover had collected, the sequence ended. We never got to see what was in that tantalizing tube!

BACTERIA ON TV

On one recent occasion, bacteria briefly did make it on the BBC screen. This was in a popular TV science series called "Bang Goes the Theory" in which a flask of bacteria was flourished. This segment finished with a quick glimpse down a light microscope at the organisms. The instrument was wrongly set up, so the image filled only a small portion of the screen; the lighting was poor, giving us a dark brown, uneven field of view, though a few presumptive bacterial cells could be seen. The presenter was triumphant. "Yes," she said. "The bacteria have survived. You can see them moving." They were jiggling from side to side in obvious Brownian motion, but it was hard to see any evidence of motility. There was a sense of doubt expressed by another member of the program team, but the presenter was confident. "I trained in microbiology," she said. "I can assure you that they are alive. I know these things."

They always say that good science involves the posing of uncertainties and the addressing of controversy. There were plenty of those in these few, short sentences. As long as microbes and other living cells are misunderstood by television, the public are being poorly served by the producers. No other area of human endeavor could be so disgracefully misrepresented.

Three decades ago, I addressed the issue of promoting the role of the microbe in human society. During the 1970s, when women's liberation and pupil power were all the rage, my book *Microbe Power* appeared. It was subtitled *Tomorrow's Revolution*, and I did all I could to encourage people to feel familiar with single cells and to look at microorganisms as fellow-travelers on this pretty blue planet. It was published in London and New York in 1976, and later in paperback in the U.S. in 1978, followed by a Japanese edition in 1979. The book was enthusiastically reviewed, and to the press it seemed as if a revolution was at hand. Inspired by the book's message, Dr. Monna Itsuyo took me to tour a Japanese organic recycling plant when I visited Tokyo in 2003. To see well-thumbed copies of my book being referred to with great respect by the very people trying to harness the powers of the microbe world was humbling.

Such books, along with my public lectures, have continued to carry the message in a way television declines to do. It must be said that the responses of an

audience to the sight of the remarkable lives of living cells are always intense. Clusters of people gather round to ask more about what they have seen, and they always ask time and again why none of this is shown on television. Although I cannot explain this curious loop-hole, I hope this article will offer some insight into what is the greatest blind spot in science broadcasting.

PROGRAM POTENTIAL

We are left with a project unfulfilled. The extraordinary variety of the microscopic universe remains untapped, television networks are left with a void, and the viewing public remains unaware of some of the most important concepts known to science. A recent program on reed beds processing domestic waste includes an excited presenter speaking of the way that microbes purify the product – but the microbes are not seen. A gardening expert on television shows how to use manure, speaking of the good that microbes do in fertilizing the soil, but we never glimpse the microbes. A geologist in Nevada lifts a sample of desert subsoil close to the camera lens, explaining that the color is due to the microbes. Which ones? The viewer never finds out.

The air of finality of the television producers is depressing. They act as if the microscopical world is

forever condemned to obscurity. The BBC's script for a David Attenborough documentary on caves sums it up. In his unforgettable voice, so rich in authority, David intones the words: "This is an inner world, where only the most adventurous dare to go," he reads. "It is our planet's final frontier."

How wrong can you be! As if to highlight the paradox, as I am writing these words, an interview is just being broadcast on BBC Radio 4. It is with Aaron Bernstein of Harvard Medical School, and he is talking on the new series "Saving Species" about this very subject. Suddenly, I am sitting bolt upright and listening to what he says. "Really, we're utterly ignorant about the microbial world," he explains. And then he comes out with that great truth that those BBC producers refuse to acknowledge: "It is the last great unexplored frontier for life on earth."

There you have it – the situation articulated perfectly by someone else, and on a daytime radio show. If we can ever persuade producers to embrace this most enticing of subjects, then we can see the end of those buffoonish microbes in TV commercials with their googly eyes and twisted mouths. Down would roar that purifying cascade, washing those mythical microbes out to sea. If it can carry off those wayward producers too, then we can make progress – and hope to become properly enlightened into the bargain.