Could Ancient Microbes in Polar Ice Cause Epidemics?

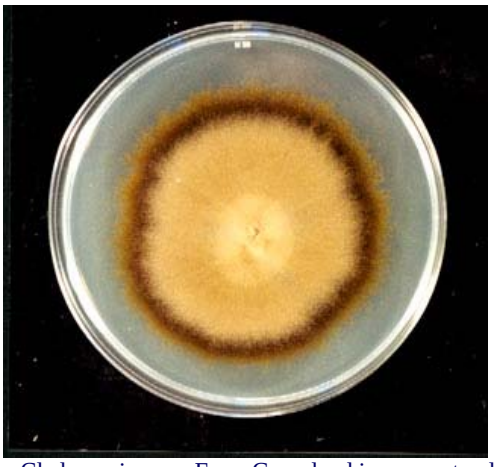
September 26, 1999 Syracuse, New York The recent encephalitis outbreak in New York City that has killed three people and made fifteen others very ill has now been traced to a microbe called the West Nile-like virus, a bird virus never seen in the United States or the entire Western Hemisphere before, according to the Center for Disease Control. Until now, it's a virus that was only known in eastern and northern Africa and western Asia. Now CDC officials fear the dangerous virus could spread to Central and South America as birds migrate for the winter season and fly south.

How exactly this African and Asian bird virus got to the United States is not known. It might have come in an illegal import of a bird from the other side of the world. But this encephalitis outbreak and the associated human deaths show that when microbes are released into an environment where they have not been before, the microbes can be especially dangerous because what they infect has no immunity against them.

Back in 1918, there was a world pandemic called "the swine flu" which killed an estimated twenty million people worldwide and more than half a million people in the United States. The reason was that a virus crossed over into pigs and then transferred into people who had no immunity. Could another pandemic occur? Some scientists worry that melting ice at the poles and glaciers could unleash microbes trapped for years, centuries even, that are still infectious.

That question is especially relevant since researchers at the State University of New York in Syracuse have already discovered for the first time an ancient virus, bacteria and fungi frozen in Arctic ice. Reporting in a recent volume of *Polar Biology* (Vol. 22, Page 207) plant pathologists Scott Rogers and John Castello described their examination of four ice cores ranging in age from 500 to 140,000 years old at three sites in Greenland. They found 15 strains of a common plant pathogen, tomato mosaic tobamovirus (ToMV) and the frozen viruses are probably still infectious. The scientists have also been able to grow bacteria and fungi from frozen ice specimens shown below.

Culture of an unidentified bacterium from Greenland ice core at a depth of 134 meters. That depth of the ice core corresponds to an age of approximately 500 years old, or about 1500 A.D. Photograph © 1999 by Catherine Catranis.



Culture of the fungus Cladosporium sp. From Greenland ice core at a depth of 158 meters. The depth of this ice core corresponds to an age of approximately 500 years old, or about 1500 A.D.
Photograph © 1999 by Catherine Catranis.

This week I interviewed Dr. John Castello, Professor of Plant Virology in the College of Environmental Science and Forestry at State University of New York in Syracuse. Since the fungi and bacteria have been able to come back from the ice, I asked him about the viability of the tomato mosaic virus.

Interviews:

1) John Castello, Ph.D., Prof. of Plant Virology, College of Environmental Science and Forestry, State University of New York, Syracuse, New York:
"This is the first time to my knowledge that anybody has detected a viral nucleic acid in anything, any sample, this old. So, it raises the possibilities that there are living viruses there, infectious viruses, and that's what we're trying to test.

COULD THE ICE MELTING CYCLE INTO THE OCEANS AND ON TO LAND EXPLAIN POSSIBLY SOME OF THE EPIDEMICS THAT HAVE BEEN CYCLIC?
Exactly. That's what we're looking at in the long range. That's exactly right. So, what we need to do - and we now have a National Science Foundation grant to expand our work is to look for viruses that could infect humans or animals that might be trapped in ice. So, that work now is beginning and we've got additional ice not only from Greenland but from Antarctica as well. And we will be searching it for some likely candidate human viruses that would be present in this ice. And some of them that are likely candidates for preservation in ice would include some of the human pathogens that are water borne and are very stable. And some of these would include influenza virus, polio virus, some of the human enteroviruses like Echovirus (enteric cytopathic orphan) and Coxsackie viruses which cause gastroenteritis in people and in animals. So, these are some of the things we're going to be looking for.

HAS ANYONE RAISED THE PROJECTION THAT IF WE ARE MOVING INTO A TIME OF INCREASING GLOBAL TEMPERATURES WITH ACCELERATED RATES OF MELTING - BOTH IN THE NORTH AND SOUTH POLES AND GLACIERS - THAT WE COULD END UP WITH AN INCREASED AMOUNT OF PATHOGENS IN THE OCEAN WATERS WHICH COULD POSSIBLY CAUSE MORE EPIDEMICS IN THE FUTURE?
Yeah, every reporter has been wanting me to say that. But to be honest with you, I think you've got to recognize that glaciers have been melting and calving and ablating in other words, wearing down for millennia. This isn't something new. This global warming is not going to create a catastrophic melt of glaciers at least,

I don't think so. Because these glaciers have been they build up and they melt, and they build up and they melt every year. So, whatever microorganisms are entrapped in this ice are probably continually being recycled into the modern environment and I don't think the process that I've just described is new to the 20th Century. So, whatever is in there is already being re-circulated.

So, maybe again, I'm speculating maybe when we have these outbreaks of plagues like the influenza outbreak of 1918-1919.

THE SWINE FLU.
Right. Maybe that was caused by some ancient flu virus that was trapped in ice and released by some melting event at that point in time. Who knows? We don't know that kind of event hasn't already occurred. You see what I mean?

IS THERE ANYTHING ABOUT THE RELATIONSHIP BETWEEN CURRENT HUMANS WHICH *HOMO SAPIENS SAPIENS* CRO-MAGNON HAS ONLY BEEN IN THIS CURRENT FORM FOR ABOUT 35,000 YEARS. AND VIRUSES, BACTERIA AND MICROBES THAT MIGHT BE 100,000 YEARS OLD - IF THEY WERE RELEASED INTO THE OCEANS AND MADE IT TO LAND - COULD DECIMATE THE HUMAN POPULATION?
Well, if some organism like a flu virus that co-evolved with man thousands of years ago has since become frozen in ice and been entombed there in a kind state of suspended animation if that virus were to be released, say 100,000 years later, when presumably there wouldn't be any immunity to that particular strain of the virus any longer in the human population I supposed it's conceivable that if that virus were to infect a human, it could spread and could cause a disease. But I hate like hell to go out on a limb like that and say that this is going to happen. I just don't know. I really don't know.

BUT IT MIGHT BE THE EXPLANATION FOR WHY THERE HAS BEEN SOME OF THESE CYCLIC EPIDEMICS LIKE THE SWINE FLU THAT HAVE TRULY GONE THROUGH POPULATIONS...
And then disappeared. Yeah, well, the influenza virus is one of those viruses that we don't know precisely where it goes when it's not epidemic. When the virus is not causing an epidemic, where does it go? For example, the outbreak of flu in 1957 caused a pandemic and then the damn thing disappeared for almost twenty years and reappeared in 1977 twenty years later!

THAT WAS THAT HONG KONG FLU VIRUS?
Yeah. So, where was it for twenty years? Where was it hiding? Was it in ducks? Was it in lake sediments? Could it have been in ice? There are some questions like that which perhaps could be explained by some of our findings if indeed there are other viruses trapped in ice. That's why we're looking.

IF ALL THE ILLNESS IS ON LAND HOW DO THE VIRUSES GET FROM DEAD HOSTS BACK INTO THE OCEAN SYSTEM?
Through sewage. You can pass these things out, OK? They can be passed and travel through a sewage treatment system into the soil into the water into the streams into the oceans.

Calicivirus Transfers from Oceans Into Land Animals

ANOTHER MYSTERY THAT DR. CASTELLO'S AND HIS COLLEAGUES' RESEARCH MIGHT SOLVE IS THE TWENTY YEAR CYCLE OF CALICIVIRUSES THAT ORIGINATE IN THE OCEANS, CAN MAKE MARINE ANIMALS SICK AND HAVE TRANSFERRED ON TO LAND INTO PIGS, AND POSSIBLY INTO HUMANS. ONE OF THE WORLD'S EXPERT ON CALICIVIRUSES IS DOCTOR OF VETERINARY MEDICINE, ALVIN SMITH. HE IS HEAD OF THE LABORATORY FOR CALICIVIRUS STUDIES IN THE COLLEGE OF VETERINARY MEDICINE AT OREGON STATE UNIVERSITY IN
CORVALLIS. DR. SMITH THINKS THIS NEW RESEARCH INTO

MICROBES LOCKED UP IN POLAR AND GLACIAL ICE COULD EXPLAIN SOME SUDDEN EPIDEMICS.

2) Alvin W. Smith, D.V.M., Head Of The Laboratory for Calicivirus Studies, College Of Veterinary Medicine, Oregon State University, Corvallis, Oregon:
"The very first viruses ever isolated out of any seal species turned out to be caliciviruses. And this was in 1972. And it turned out that these were very important viruses because they were the ones that had caused outbreaks of a very serious disease in pigs in 1932. And the origins of that outbreak were never known. Well, people were feeding fish scraps and stuff to swine before 1932, but this thing hit with a vengeance in pigs. Where did it come from? Something was very different.

Now, I'm here to tell you that the avenues are still open from these viruses in the ocean to land animals and there is some transmission going on, but you're not seeing the same vesicular disease that was seen way back then. So, some of that can be attributable to mutation, but when you seem to get repeated introductions and it's quite different I've wondered about it a lot. What's going on here?

Some of the work we have done, we saw evidence of viruses that had been isolated on the Atlantic coast in 1956 and only there once. We saw evidence of those viruses some 20 years later among California sea lions on the Pacific Coast and then had opportunity to look at some Bullhead Whale materials from Alaska about ten years later than that in the mid-1980s and lo and behold, here was type specific antibody again for this virus.

So, my thoughts are that this thing really moves around. But how does it move around? And the idea that these might be locked in ice and the ice melts and then begins moving through the ocean reservoirs becomes very attractive. And in that way, you could get a sero type that had been sequestered away or hiding out for very, very long periods of time and re-emerging. We preserve viruses by freezing them. That's how it's done. (Viruses are easily killed by heat and exposure to UV light).

This ice research pumps new life into the idea of the oceans as reservoirs for agents that we have to pay some attention to. And that of course hits very close to my work because I have been isolating these things from ocean communities now for 25 years or so, these caliciviruses. And tracking them and seeing who is infected and who isn't and sticking them into various species and see what they do. How do you get this stuff out of the ocean to somewhere else?

Some known ways are if you have a bubble rising through the water say a millimeter in diameter - it will scour the particulates out of a column of water that's a millimeter in diameter for however deep that column is. When it hits the surface, this will project a droplet 15 centimeters into the air. Suddenly you have an airborne particulate that can go with prevailing winds and go wherever it wants to. That's one mechanism. That makes real sense if you hold your hand over a glass that's got an Alka-Seltzer in it. All of a sudden you have a wet hand just from the droplets projected by these bubbles rising to the surface and the bubble pops and projects a droplet.

Then you've got things like marine mammals that breed on land but live in the water. So, you have the land and sea interface broken by those critters all the time. Then you've got fish that go to sea and spend several years there and then run up the streams for a hundred or thousand miles, sometimes from way out in the Pacific clear on up into the Rocky Mountain headwaters in Idaho like for some of the steelhead and salmon. Carrying with them whatever microbes were there.

Then the bears and everything else eat those after they die from spawning and what have you. So, there's lots of mechanisms, plus the fact that we eat fish and throw the brains and viscera into the garbage or feed it to the dogs or hogs or

whatever people do with it so there are ways of moving this stuff (viruses) inland. And once a new species becomes exposed, then the virus they shed is a little more adapted to that particular species. The virus that secondarily-exposed people shed is even more adaptive and all of sudden, you've got an epidemic."

More Information:

The panel of the National Science Foundation that funded the Syracuse ice core investigation is called LEXEN. LEXEN is an acronym that stands for Life In Extreme ENvironments. The long-range objective of LEXEN is to try to develop protocols to search for simple life forms in very harsh environments here on the earth. And ice is only one of those environments. Other harsh environments would include deserts and hot springs and salt marshes. Couldn't the same protocols be used to search for life on other planets? Castello thinks so. He points out that ice has been discovered on the moon and on Mars and now ice on the Jovian moon, Europa. So ice might be where we first find other life forms outside the earth. So far, NASA has not contacted the Syracuse researchers, but Castello hopes they will in the future.

Credits