Making wetlands safe from avian botulism


Rocke

Poisoned by avian botulism, this northern shoveler in the Sacramento (Calif.) National Wildlife Refuge can no longer raise its head.

More and more birds are dying of avian botulism, the most serious disease of wetland bird species. Wetland managers have few good strategies for combating the threat, but they may soon have some effective weapons against the toxin that causes the disease, says animal disease specialist Tonie E. Rocke.

Rocke and her colleagues at the National Wildlife Health Research Center in Madison, Wis., have developed new genetic techniques for studying the botulism toxin, and they report new findings on the importance of salinity and pH in the life of the poison.

A problem worldwide, avian botulism kills hundreds of thousands of birds, including zoo animals, every year in the United States alone. A single outbreak in Russia in 1981 killed more than 1 million birds. The botulism toxin acts by disrupting the nervous system and causing paralysis.

During the last 5 years, Rocke and her colleagues have compared 31 wetlands in the United States where botulism outbreaks have occurred and similar locations where they haven't. She reported the results at the American Society of Zoologists meeting last week in Washington, D. C.

The scientists found that the risk of a botulism outbreak peaks when wetlands have a relatively neutral pH—between 7 and 8 for soil and between 7.5 and 8.5 for water. Also, the risk of botulism decreases when wetlands are salty.

A virus carries the gene that codes for the botulism toxin, but the virus must enter an anaerobic bacterium, *Clostridium botulinum*, in order to produce the toxin. Most soil and many wetland inhabitants carry the bacterium, but it often remains dormant until, for example, an animal dies and its tissue becomes anaerobic. Birds may get sick after ingesting insects that obtained the toxin by eating carrion.

Laboratory studies suggest that *C. botulinum* grows best in neutral pH conditions and that the gene-carrying virus is sensitive to salt, Rocke says. But the researchers have yet to determine whether pH and salinity alter toxin production. Salinity and pH may, for example, change the behavior of insects carrying the toxin or influence the populations of bacteria that compete with *C. botulinum*.

The team has recently developed genetic tools to help untangle the relationship between soil and water conditions and toxin production. Using a technique for amplifying DNA segments, Rocke and her colleagues can now detect the gene responsible for the toxin. They are also developing methods for determining whether the gene is producing the poison.

To help prevent outbreaks, the group is planning to explore how managers might change the pH and salinity of wetlands. Rocke wouldn't recommend adding chemicals to a wetland but might suggest instead encouraging different vegetation to grow or managing existing vegetation differently.

"We don't understand what factors are conducive to outbreaks . . . so the kind of work [Rocke] is doing is really important," says Mary Ann Ottinger of the University of Maryland in College Park.

— *T. Adler*

Glimpsing glueballs in collider debris

A calculation that took 2 years on a powerful special-purpose computer has provided evidence that a hypothesized subnuclear particle called a glueball actually exists.

The result suggests that glueballs may be observed in particle accelerators when electrons or protons and their antimatter counterparts collide at high energies. Until now, glueballs had gone unrecognized because theorists had been unable to provide sufficient information on distinctive characteristics that would distinguish glueballs from other particles.

Physicists James Sexton, Alessandro Vaccarino, and Donald Weingarten of the IBM Thomas J. Watson Research Center in Yorktown Heights, N. Y., describe their computation as "the largest single numerical calculation in the history of computing." They report their findings in the Dec. 18, 1995 Physical Review Letters.

The team based its calculation on a simplified version of the theory of quantum chromodynamics (QCD). This theory describes the force that binds different quarks and antiquarks together to create protons, neutrons, and other subatomic particles.

Just as an electrically charged particle generates an electric field, a quark gives rise to a so-called chromoelectric field. This force field can also be described in terms of the actions of particles called gluons, which shuttle between quarks, seemingly gluing them together.

Quantum chromodynamics theory predicts that under certain circumstances, gluons themselves can stick together briefly to form composite particles called glueballs. However, the great difficulty of solving the relevant equations had prevented theorists from determining the masses and lifetimes of these hypothetical particles.

To help guide the search for glueballs, Weingarten and his coworkers turned to a simplification of quantum chromodynamics. In this formulation, quarks and antiquarks sit at points in a finite, four-dimensional lattice, and gluons correspond to the links between these points.

By solving the equations for a large number of quark and gluon arrangements, researchers can deduce characteristics of quark-containing particles. Increasing the number of points and expanding the region covered by the lattice, while decreasing the distance between the points, brings this approximation closer to the continuous space and time of the full theory. But this improvement occurs at the cost of greatly increased computation time.

To speed up the calculations, Weingarten and his coworkers used an experimental computer designed and built especially for this task. Called the GF11, it has 566 processors, each a powerful computer in its own right.

In 1993, the IBM team succeeded in computing from theory the masses of eight quark-containing subatomic particles (SN: 5/22/93, p. 325). Soon after, they calculated that the lightest glueball would have a mass (expressed in energy units) of about 1,707 megaelectronvolts (MeV).

To determine whether such a glueball would stick together long enough to be observed in a particle accelerator, the researchers calculated the glueball's rate of decay into different combinations of other particles.

The calculation demonstrated that a glueball has a sufficiently long lifetime for the particle to be detectable. Indeed, it's possible that physicists have already sighted a glueball in accelerator experiments. The best candidate is a particle labeled f_J (1710), which appears as the product of a quark-antiquark annihilation and has a mass of 1,710 MeV.

— *I. Peterson*