Smithsonian

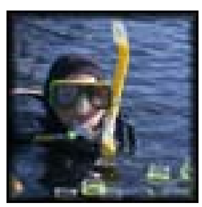
Spotlight on Science at the Smithsonian

Bi-Weekly Newsletter | Vol. 4, No. 21 | 24 November 2006

- Introduction from Dr. David Evans, Smithsonian Under Secretary for Science

- A Deep Sea Haven from Extinction?

- When the Jaguars are Gone



- Mercury in Lakes: Old or New?

- Print, Podcast, Download MP3

Spotlight on Science at the Smithsonian

Spotlight on Science at the Smithsonian is a bi-weekly electronic newsletter about Science at the Smithsonian. It is produced for the Smithsonian community by the Office of the Under Secretary for Science. To subscribe to the newsletter or Podcast, visit science.si.edu.

- Dr. David Evans, Under Secretary for Science
- Theresa Mellendick, Editor, mellendickt@si.edu

Spotlight on Science at the Smithsonian

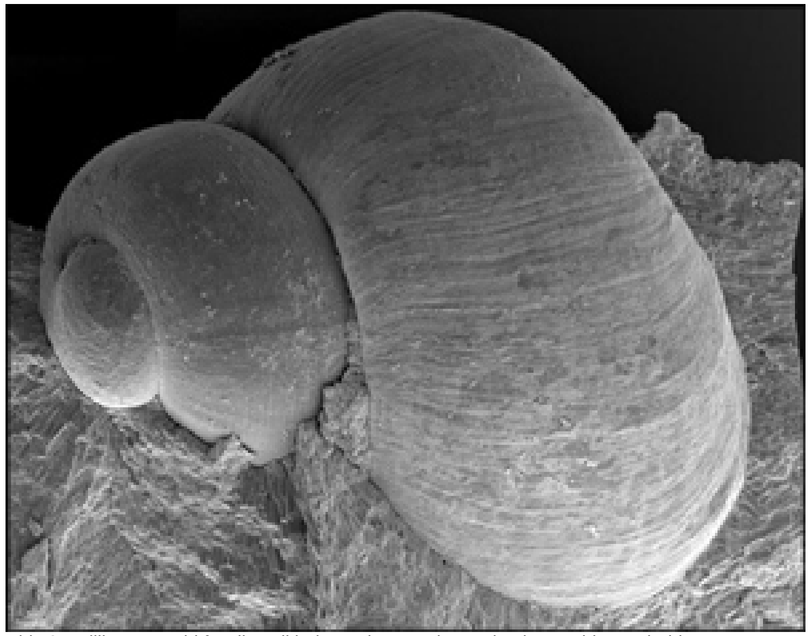
Vol. 4, No. 21 | 24 November 2006

Introduction from the Under Secretary for Science

In this installment of Spotlight on Science we first explore the depths of the sea with a Natural History researcher whose studies of fossil molluscs have led him to the conclusion that unusual deep sea environments called “cold seeps” might be safe places to ride out a mass extinction – if you can manage survive there in the first place. Next we go to Panama, where researchers at the Smithsonian Tropical Research Institute have been keeping tabs on the diets of two cat species to find out how they’ve fared in forests where jaguars are absent. With the top predator gone, do pumas and ocelots go after bigger and meatier prey? And, finally, we look at the work of a microbial ecologist at the Smithsonian Environmental Research Center. By studying the bacteria in Canadian lake mud she is helping trace the path of toxic mercury through the environment. To clean up mercury from contaminated lakes, we need a clearer idea of how it gets there. And bacteria can provide part of the answer.

Spotlight on Science at the Smithsonian

Vol. 4, No. 21 | 24 November 2006


This 35 million year old fossil snail belonged to species endemic to cold seep habitats.

A Deep Sea Haven from Extinction?

Reference

S. Kiel and C. T. S. Little. 2006. Cold-Seep Mollusks Are Older Than the General Marine Mollusk Fauna. *Science*, 313: 1429 -1431

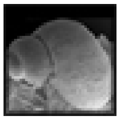
The earth's biosphere is largely powered by solar energy captured by green plants and algae via photosynthesis. But in the deep sea, where sunlight never penetrates, there are biological communities with an entirely different energy source. First discovered in the 1970's, these communities tap not the sun but chemical energy from submarine volcanic vents, hydrocarbon-rich sediments, and even rotting whale carcasses. The sulfide-rich fluids at these sites are toxic to most life forms, but with the help of symbiotic bacteria an unusual fauna of mollusks and other invertebrates manages to survive. It might seem like a precarious existence, but in the long term these unique and isolated habitats may actually serve as a buffer against extinction.

That's the intriguing conclusion of a new study by Steffen Kiel, a recent postdoctoral fellow in the Department of Paleobiology at the National Museum of Natural History, and Crispin Little of the University of Leeds. Kiel and Little compared the fossil record of 36 mollusk genera endemic to cold seep environments – areas of the sea floor where sediments exude low temperature fluids rich in hydrocarbons and hydrogen sulfide – with the record of marine mollusks overall. The results, published in the September 8 issue of the journal *Science*, showed that the evolutionary longevity of cold seep forms was on average a full geological epoch longer than that of other mollusks.

Like the mollusks found at hydrothermal vents, the bivalves, snails, and chitons living in cold seep environments differ from other mollusks at high taxonomic levels – some families and even orders are found in these environments and nowhere else. This led previous researchers to suggest that the communities consisted of so-called "living fossils," that is slowly-evolving relicts from earlier time periods. But Kiel and Little's data cast doubt on this idea: the communities were in fact continually changing, with new forms appearing in nearly every geological interval studied.

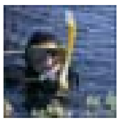
The conclusion that cold seep environments have been havens from extinction is bolstered by the fact that their mollusk communities were seemingly unaffected by global crises such fluctuations in oxygen levels and as the end-Cretaceous mass extinction that wiped out the dinosaurs and numerous marine organisms.

What is it that makes these extreme environments so safe? It may be that the seeps provide a steady and reliable source of energy, unperturbed by the seasonal



A Deep Sea Haven from Extinction?

When the Jaguars are Gone



Mercury in Lakes: Old or New?

and climatic fluctuations that affect productivity in more conventional ecosystems. But it may simply be the relative constancy of the deep sea environment as a whole. When Kiel and Little compared the geologic ranges of seep mollusks with those of other deep sea mollusks, there was no discernable difference between the two groups.

In an interesting twist, the fortunes of cold seep communities may also have been linked to the evolution of an entirely different group of creatures: whales. Many of the same mollusk species are found in both cold seeps and rotting whale carcasses, and the first appearance of whales in the fossil record roughly coincides with a diversification of seep mollusks. Kiel and Little doubt that the early whales would have been abundant or widespread enough to have triggered the diversification. But as ocean-crossing whales began to fill the seas, their sunken carcasses would have provided convenient stepping stones for seep-dwelling species to spread to new regions.

Spotlight on Science at the Smithsonian

Vol. 4, No. 21 | 24 November 2006

STRI biologist Ricardo Moreno with "Bobby," one of Barro Colorado Island's resident population of ocelots. Captured and anesthetized by researchers, Bobby weighed over 18 kilograms, the largest ocelot ever recorded in the wild.

When the Jaguars are Gone

Reference

Ricardo S. Moreno, Roland W. Kays, and Rafael Samudio, Jr.. 2006. Competitive Release in Diets of Ocelot (*Leopardus pardalis*) and Puma (*Puma concolor*) after Jaguar (*Panthera onca*) Decline. *Journal of Mammalogy*, 87(4):808–816.

In Oz, Dorothy and her companions worried that the forest they were traveling through was full of "lions, tigers and bears." In the real world, however, scientists worry about the opposite possibility: that forests and other natural habitats are becoming increasingly empty of top predators. Large carnivores have historically been seen as threats and competitors to human interests, so have been deliberately hunted down and extirpated from some regions. But their vulnerability to extinction lies mainly in the basics of their biology: their high place on the food chain, their small population sizes, and the need of many to roam large areas for hunting. So as human development whittles away at natural habitats, top carnivore species are often the first to disappear. No wonder that close to half of all mammalian carnivore species are in danger of extinction in at least some part of their natural range.

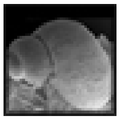
It's one thing to lament the possible loss of these charismatic animals, but another to predict its likely ecological consequences. When predators are gone, prey populations can explode, overtaxing food resources and leading to what some ecologists have called an "ecological meltdown." But the effects can be less dramatic, especially when only the top predator species is lost. The surviving predators are presumably more resilient and adaptable, but can they pick up the slack in controlling prey populations?

Jaguars are the top predators in Latin American forests, but are now extirpated from much of their former range. Two smaller species of cats, pumas and ocelots, have generally fared better. Both are regularly found on Barro Colorado Island, located in Panama's Lake Gatun and the site of a research station operated by the Smithsonian Tropical research Institution. Jaguars, on the other hand, are only sporadic visitors. Ricardo S. Moreno, Roland W. Kays, and Rafael Samudio of STRI have been studying how the resident cat populations have responded to the jaguar's population decline. With the big cat away, have they expanded their diets to include prey jaguars would have eaten? For much of their work on the animals' life habits the researchers used camera traps and radio telemetry. But to monitor diets and identify prey species, they had to do it the old-fashioned way: by examining the cats' droppings for telltale scraps of bone and hair.

The researchers found that the pumas and ocelots on Barro Colorado Island have indeed altered their hunting preferences. Barro Colorado pumas are more likely to feed on collared peccaries, a jaguar favorite, than are pumas in forests still frequented by jaguars. For ocelots, the dietary shift has even more dramatic. Usually ocelots hunt only small prey such as mice and other rodents, but on Barro Colorado Island they go after medium-sized animals such as sloths and

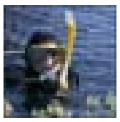
Spotlight on Science at the Smithsonian

Vol. 4, No. 21 | 24 November 2006



A Deep Sea Haven from Extinction?

When the Jaguars are Gone



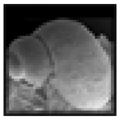
Mercury in Lakes: Old or New?

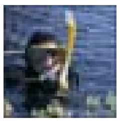
agoutis. These species are occasional meals for ocelots when jaguars are around, but on Barro Colorado they make up a third of the ocelot diet.

There are limits to the flexibility of these predators, however. At a nearby mainland site, which lack not only jaguars but also pumas as competitors, the ocelots still eat only small to medium- sized animals. Even without competition from bigger cats, ocelots hesitate to take on deer and peccaries. So, to keep a forest in balance, there’s no substitute for jaguars. Or, for that matter, lions and tigers and bears.

Spotlight on Science at the Smithsonian

Vol. 4, No. 21 | 24 November 2006





Divers sample the bottom sediments of Experimental Lake 658 to test for methylmercury produced from mercury isotopes added to lake water. An aim of the METAALICUS project is to understand how quickly mercury enters the food web.

Mercury in Lakes: Old or New?

Every year health authorities across the country issue advisories against eating fish caught in freshwater lakes because of unsafe mercury levels. In some places, the mercury comes from old mining sites or nearby waste dumps. But mostly it comes down in the rain from mercury in the atmosphere, put there by volcanic eruptions and by human sources, such as coal-burning power plants. In its biologically active form, mercury is a potent neurotoxin, made especially insidious by its tendency to become increasingly concentrated in animal tissues with each step up in the food chain. The concentration of mercury in the body of a top predator can exceed that of the surrounding water by a factor of more than a million.

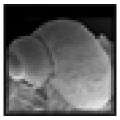
Mercury deposition rates in at least some parts the US have declined since the 1980's, thanks to reduced use of mercury, and restrictions on burning waste. Yet further improvements have been frustrated by scientific uncertainty over how and at or what rate mercury moves through the environment. Are high mercury levels in fish the result of current emissions? Or does the mercury come from stores accumulated in the landscape by more than a century of contamination? If most mercury in lakes comes from "old" mercury, then further restrictions on power plant emissions are unlikely to yield immediate benefits.

Dr. Cynthia Gilmour, a microbial ecologist at the Smithsonian's Environmental Research Center, has joined a team of US and Canadian researchers in an ambitious project to track mercury's path through the environment. Gilmour studies the bacteria that live in aquatic sediments. These bacteria are key players in the mercury story: they are responsible for converting mercury into its most toxic and biologically important form, methylmercury.

The project is known as the Mercury Experiment to Assess Atmospheric Loading in Canada and the United States,

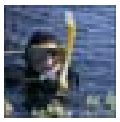
Spotlight on Science at the Smithsonian

Vol. 4, No. 21 | 24 November 2006



A Deep Sea Haven from Extinction?

When the Jaguars are Gone



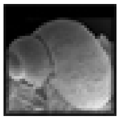
Mercury in Lakes: Old or New?

METAALICUS for short. Despite its long name, the basic idea is simple: experimentally add known quantities of mercury to a pristine lake and see how long it takes for it to show up in different parts of the ecosystem. The lake in question is a 22-acre lake in northwestern Ontario, part of the Experimental Lakes Area, an area set aside by the Canadian government for ecological experimentation. The amounts of mercury involved are minuscule – just a fraction of a teaspoon added per year – but that is enough to put the levels in the remote Canadian lake on a par with water bodies in the heavily-populated eastern United States. To identify mercury entering the lake via different routes, the researchers added different mercury isotopes to the lake, adjacent wetlands, and nearby uplands. The isotopes are chemically identical, but have different atomic masses, and so can be distinguished in the laboratory.

METAALICUS is a continuing project, but results so far are encouraging. Mercury added directly to lake water moves through the system quickly: after five years the mercury content of fish has jumped by 40 percent. But old mercury appears to be much more sluggish. Gilmour suspects that mercury buried in soil or lake sediments becomes progressively more difficult for bacteria to convert to methylmercury, perhaps because over time it becomes more tightly bound to particles. This means that even though the total quantity of old mercury held in a landscape might far exceed new mercury entering each year from the atmosphere, it is primarily the new mercury that gets into the food web. So any measures that reduce mercury fallout from the atmosphere, such as cutting back on power plant emissions, is likely to pay off in lower mercury levels in lake fish.

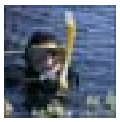
Spotlight on Science at the Smithsonian

Vol. 4, No. 21 | 24 November 2006



A Deep Sea Haven from Extinction?

When the Jaguars are Gone



Mercury in Lakes: Old or New?

Spotlight Your Way - Printable PDFs, Downloadable MP3s, and the Spotlight Podcast

Want to print and carry Spotlight with you, or share it with a friend? Click the PDF PRINT ME icon and, if you have the Adobe Acrobat Reader installed, a new version of Spotlight will open that is optimized for your printer.

PDF PRINT ME

Want to listen to the audio edition of Spotlight on your computer or MP3 player? Click the MP3 DOWNLOAD icon and the file will download to your computer.

MP3 DOWNLOAD

Want to ensure you never miss an audio edition of Spotlight? Copy the web address next to the Podcast Icon below and paste it into any podcast application to subscribe to the Spotlight Podcast and automatically receive every new episode on your PC or MP3 player. A podcast subscription is much like a subscription to our email newsletter, except you will automatically receive an audio version of the newsletter via podcast receiver software.

Podcast

There is a lot of free software allowing you to subscribe to podcast feeds. When you copy an address like ours above into the software, it will automatically and periodically check our website for new audio editions of Spotlight. Whenever the software finds a new edition, it will download it to your PC, and into your MP3 player if you desire. Juice is a free podcast receiver for Windows and Mac OS X. Many others can be found here: http://www.podcastingnews.com/topics/Podcast_Software.html.

We hope you enjoy and take advantage of these new features we created for your convenience.