Yellowstone

Bioprospecting & Benefits-Sharing

Yellowstone National Park
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The Issue

Should researchers who study material obtained under a Yellowstone National Park research permit be required to enter into benefit-sharing agreements with the National Park Service before using their research results for any commercial purpose?

Definitions

Bioprospecting is the search for useful scientific information from genetic or biochemical resources. It does not require large-scale resource consumption typical of extractive industries associated with the term "prospecting" such as logging and mining.

Benefits-sharing is an agreement between researchers, their institutions, and the National Park Service that returns benefits to the parks when results of research have potential for commercial development.

Summary

1966: The microorganism *Thermus aquaticus* was discovered in a Yellowstone hot spring.

1985: An enzyme from *T. aquaticus,* which is synthetically reproduced, contributed to the DNA fingerprinting process that has earned hundreds of millions of dollars for the patent holder.

1997: The park signed a benefits-sharing agreement with Diversa Corporation, ensuring a portion of their future profits from research in Yellowstone National Park will go toward park resource preservation.

1999: A legal challenge put on hold implementation of this agreement until an environmental impact statement (EIS) is completed.

Status

- NPS is conducting an environmental impact statement (EIS) to decide whether benefits-sharing should be a part of NPS policy for parks nationwide. It will examine the potential impacts of implementing and not implementing benefits-sharing agreements.
- Each year, approximately 40 research permits are granted to scientists to study microbes in Yellowstone. Research permits are only granted for projects that meet stringent park protection standards.
- Research microbiologists continue to find microorganisms in Yellowstone that provide insights into evolution, aid in the search for life on other planets, and reveal how elements are cycled through ecosystems.

History

In 1966, Dr. Thomas Brock discovered a way to grow *T. aquaticus* in the laboratory. This led to one of the most exciting inventions in the 20th century, the polymerase chain reaction (PCR).

Two decades ago, our ability to study DNA was limited. DNA fingerprinting to identify criminals, DNA medical diagnoses, DNA-based studies of nature, and genetic engineering were unimaginable. But in 1985, PCR was invented. PCR is an artificial way to do something that living things do every day—replicate DNA. PCR is the rocket ship of replication, because it allows scientists to make billions of copies of a piece of DNA in a few hours, which in turn allows DNA analysis. An enzyme discovered in *T. aquaticus*—called Taq polymerase—made PCR practical. Because it came from a thermophile (heat-loving organism), Taq polymerase can withstand the heat of the PCR process without breaking down like ordinary polymerase enzymes. A laboratory version of this enzyme has made DNA studies practical and affordable.

Many other species of microbes have been found in Yellowstone since 1966, each producing thousands of uncommon, heat-stable proteins. Researchers estimate more than 99 percent of the species in Yellowstone's hydrothermal features have yet to be identified.

Science

Because much of modern biotechnology is based on the use of enzymes in biochemical reactions—including genetic engineering, fermentation, and bioproduction of antibiotics—heat-stable catalytic proteins that allow reactions to occur faster are important in advancing science, medicine, and industry. In addition, genetic studies using knowledge developed from the study of microbes are important to medical and agricultural research. Yellowstone's variety of high-temperature physical and chemical habitats support one of the greatest concentrations of thermophilic biodiversity. Research on these thermophiles can contribute to further advances.

Ongoing Research

Approximately 40 research studies are being conducted in Yellowstone on the ecology of thermophiles, and how to search for traces of similar life forms in the inhospitable environments of other planets. Research on park microbes also has proved useful in producing ethanol, treating agricultural food waste, bioremediating chlorinated hydrocarbons, recovering oil, biobleaching paper pulp, improving animal feed, increasing juice yield from fruits, improving detergents, and a host of other processes.

Controversy

Federal law encourages research in Yellowstone if it does not adversely impact park resources and visitor use and enjoyment. Only research results, i.e. information and insight gained during research on park specimens, may be commercialized—not the specimens themselves. Nonetheless, some people question the appropriateness of allowing scientists to perform research in a national park if they are bioprospectors.

The invention of the polymerase chain reaction (PCR), discussed above, was patented by Cetus Corporation, which sold the patents to a pharmaceutical company for a reported $300 million. Annual sales of Taq polymerase remain approximately $100 million. Yellowstone National Park and the United States public have received no direct benefits even though this commercial product was developed from the study of a Yellowstone microbe. The companies and the researchers acted lawfully throughout the development and sales of Taq polymerase.

At issue is whether or not the National Park Service (NPS) should require researchers who study material obtained under a research permit to enter into benefits-sharing agreements with NPS before using their research results for any commercial purpose.

Benefits-Sharing

Federal law authorizes the National Park Service to negotiate benefits-sharing agreements that provide parks a reasonable share of profits when park-based research yields something of commercial value. In 1997, Yellowstone National Park became the first U.S. national park to enter into a benefits-sharing agreement with a commercial research firm. The Yellowstone–Diversa Cooperative Research and Development Agreement (CRADA) provided that Diversa Corp. would pay Yellowstone $100,000 over five years (even if research resulted in no commercially valuable discoveries) and a royalty based on any sales revenues related to results from research in the park. The CRADA did not authorize collecting specimens or conducting research in the park, which require a research permit that enforces strict resource protection standards. Diversa, which had research sites around the world, was collecting DNA samples directly from nature and screening the genes for the ability to produce useful compounds. In its labs, scientists spliced the most useful genes into microbial "livestock," and these microbes then produced the compound or enzyme. (Diversa no longer exists; it merged with another corporation.) As with all NPS research specimens, the Yellowstone microbes and DNA collected in the park remain in federal ownership and are never sold.

Into Court

Shortly after the Yellowstone-Diversa CRADA was signed, opponents sued NPS in federal court arguing that the policy put into play a new commercial activity and was illegal and inappropriate in parks. In 1999, the judge ordered NPS to prepare an environmental analysis of the potential impacts of benefits-sharing agreements and suspended the CRADA pending completion of the analysis. In 2000, the court dismissed the remainder of the case, ruling the CRADA: 1) was consistent with the NPS mission of resource conservation; 2) that bioprospecting did not constitute a consumptive use; 3) that bioprospecting did not represent a "sale or commercial use" of park resources; and 4) Yellowstone fell within the definition of a federal laboratory and appropriately implemented the CRADA.

NPS is conducting an environmental impact statement (EIS) to examine the potential impacts of benefits-sharing agreements.

For More Information

www.nature.nps.gov/benefitssharing/