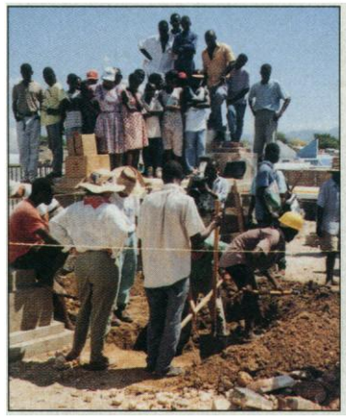
FORENSIC MEDICINE

International Experts Help Probe Haiti's Bloody Past

GONAÏVES, HAITI—Under a blistering sun, a team of foreign scientists began digging in this town's dusty cemetery last week to uncover the details of a bloody moment in Haiti's history. Led by forensic anthropologist Karen Burns of the University of Georgia, the team is trying to determine what happened on 2 October 1991 in an incident known locally as "the Raboteau massacre." It was one of many violent clashes in Haiti in 1991 to 1994. And it is one of a growing number of cases around the world in which researchers are using techniques of forensic anthropology and biology to document mass killings.



PHOTOS BY E. MARSHALL

Mute witness. Anthropologists unearth remains of Jean-Pierre Dazme, allegedly shot by soldiers in 1991.

Townspeople say that government soldiers shot and killed four men near the Raboteau military post in this poor region of northern Haiti. The incident took place, according to a local priest, Daniel Roussiere, shortly after a protest march against the coup of 30 September 1991 that deposed President Jean-Bertrand Aristide and installed a group of generals under Raoul Cedras. When Aristide was returned to office, following the September 1994 invasion by U.S. troops, his supporters demanded that the alleged crimes of the Cedras period be punished. But the government is moving carefully: It hopes to establish the facts before offering amnesty or taking the accused to court. And that's where the foreign scientists come in.

The Aristide government has created a quasi-independent "National Commission of Truth and Justice" to probe the events of 1991 to 1994. The Truth Commission, consisting of four government-named members and three chosen by a United Nations group, is getting advice on forensics from a team that has documented civilian massacres in Argentina and other parts of the Americas. Some members of this group—sponsored by the Science and Human Rights Program of the American Association for the Advancement of Science (AAAS), *Science*'s publisher—were trained by Burns.

These efforts began when forensic anthropologist Clyde Snow led a major AAAS research and training program in Argentina in 1986–87 to identify remains of people who "disappeared" when the country was under military rule. Some of those trainees have become international investigators in their own right, including Mercedes Doretti, who is coordinating the field work in Haiti. The AAAS sponsored similar efforts in El Salvador in 1992 and in Guatemala in 1993. The team's previous investigations—and similar ones under way around the world (see box)—have involved high-tech biology, including DNA analysis.

The Haiti project is less ambitious technically, but no less challenging: It aims to employ traditional forensic techniques in a country that hasn't used them before. The team is recovering human remains from graves up to 4 years old, confirming identities, and searching for clues such as bullet wounds or bone breaks that may support eyewitness accounts. In addition, AAAS advisers in Haiti helped create a database of alleged atrocities.

Françoise Boucard, the sociologist who presides over the Truth Commission, said the goal of exhuming bodies at Gonaïves and conducting forensic studies "is to bring proof of the means of repression" that will be credible to neutral observers. Some Haitians have denied that there were any mass murders, Boucard explained, and she hopes that when the Truth Commission issues its final report in December, the scientific data will help establish a consensus.

The commission's computer expert, Liszt Quitel, says the staff has collected about 4500 accounts of rape, torture, murder, and other abuses. He adds that human rights groups claim that 3000 to 4000 Haitians were killed in the Cedras era, but these estimates have not been confirmed as yet. With the help of AAAS consultants, Quitel created a computer database, and staffers are now entering data from interviews, including the names and locations of former military groups and commanders. The goal, says AAAS human rights officer Daniel Salcedo, coordinator of AAAS's technical assistance, is to uncover any "patterns of abuse" that

Tracing Croatia's 'Disappeared'

Dragan Primorac, an M.D. postdoc in David Rowe's pediatrics lab at the University of Connecticut, will be going to Croatia next week along with a $150,000 DNA sequencer—a gift from the manufacturer, Perkin Elmer. But his mission won't be a typical scientist's trip abroad. Primorac will be heading for Bosnia's war zone to use the tools of molecular biology for a humanitarian purpose—identifying the dead in mass graves. With a small grant from AmeriCares, a medical relief agency, he will be accompanied by some well-known forensic scientists, including Henry Lee of the Connecticut state police, Michael Baden of the New York state police, and Mitchell Holland of the U.S. Armed Forces DNA Identification Laboratory.

Primorac, born and educated in Croatia, says that after the Bosnian-Serb war began, he wanted to offer help, and this seemed the best way. In earlier trips he organized, he and some colleagues used genomic DNA to identify 13 bodies among 65 in a mass grave in Kupres in northern Croatia near the Bosnian border. In many cases, however, the DNA had become too degraded to be useful. Now, Primorac says, he intends to return and use the sequencer to conduct studies of more abundant mitochondrial DNA, hoping to identify the 10 to 12 bodies from Kupres that remain anonymous. "At first, the local people didn't believe DNA" could yield any answers, says Primorac; "now they expect more than we may be able to offer."

Primorac's next objective: to visit a freshly uncovered grave containing 500 bodies in a region of western Bosnia that's still under fire. After that, if the Serbs will grant access, he would like to go to Vukovar, where 2000 or more people are missing. Ultimately, he hopes this work may provide evidence to the international court in The Hague when it considers allegations of crimes against humanity. He says: "All the data in our books will be available to prosecutors," no matter who committed the crimes.

–E.M.

may exist. For example, Salcedo says, in South America it was possible to document the influence of certain Argentine-trained interrogators. "Whenever they moved into a new area," Salcedo explained, "about a month or two later you'd start to see reports of torture with electricity."

But it is not clear whether Haiti—where resources are scant and records are chaotic—will yield such clear results. For example, one candidate site for forensic investigation—an abandoned prison of the "Papa Doc" Duvalier era called Fort Dimanche—has been set aside because it contains a jumble of human remains dumped over decades. Sorting the bones would be time consuming and might yield little new evidence on events during the Cedras years. Another site known as Titanyen was passed up because it has long been a grave for paupers and a dumping ground for murder victims. Bodies often were lost because they were left above ground. Salcedo says, "The damn pigs made off with the evidence."

The lack of infrastructure also makes research difficult. Burns, who led forensic investigations of mass executions in Argentina and Guatemala, says Haiti presents a special challenge. The State University hospital in Port au Prince, where investigators are examining the remains, has inadequate plumbing. Even the pathology lab lacks running water and a sanitary disposal system for diseased tissue. The crematorium cannot be used; its stack is too short and ashes come down on the hospital grounds. Meanwhile, unclaimed bodies of the poor are accumulating at an alarming rate in the hospital morgue.

In these circumstances, the AAAS investigative team has decided it will be enough simply to use modern forensics and not attempt more exotic methods of analysis. Although the Truth Commission has identified some mass graves, the recovery efforts have focused on well-defined sites, such as those in the cemetery at Gonaïves. Neither the Truth Commission members nor the AAAS team is ready to say how many deaths have been explored or documented. These details will be released later, according to Boucard.

As the investigations proceed, one of the goals of the AAAS team is to instruct Haitians—starting with the government's prosecution staff—in criminal investigation techniques. Until now, it appears, Haiti has not had access to modern forensics. But Burns and her colleagues have already begun training a small cadre of Haitians in field methods. One of the good things that may come of Haiti's terrible upheaval in the 1990s, they hope, is an increased respect for evidence and investigative procedures.

–Eliot Marshall

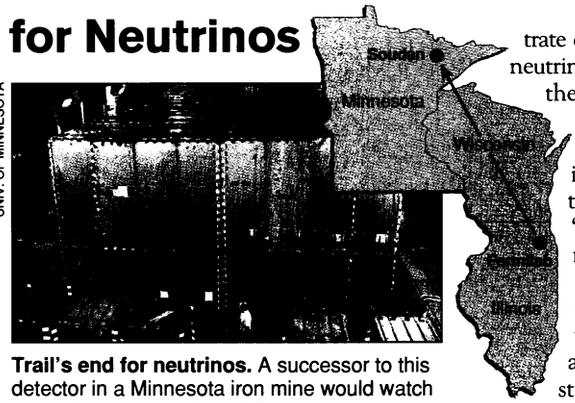
HIGH-ENERGY PHYSICS

Mass Migration Plan for Neutrinos

Nothing attracts interest like playing hard to get. Take the neutrino, a particle that interacts with matter so weakly that even the largest existing detectors can count only a handful of neutrinos in months of running time. That elusiveness has made neutrino experiments notorious for poor statistics and suspect conclusions, especially about the hottest and most contentious question in the neutrino field—whether the particle has mass (*Science*, 22 September, p. 1671). And it has now put neutrinos high on physicists' official most wanted list. A report drafted last week by the Department of Energy's High-Energy Physics Advisory Panel (HEPAP) has recommended that DOE give high priority to an experiment that could make neutrino sightings almost routine.

The experiment, called NuMI for Neutrinos at the Main Injector, would send the most intense beam of high-energy neutrinos ever created from the Fermi National Accelerator Laboratory, outside Chicago, through the Earth to a 10,000-ton detector in a defunct iron mine 730 kilometers away in northern Minnesota. The detector should record thousands of neutrinos per year, which researchers could compare with separate measurements at Fermilab to see if the particles had "oscillated" from one type to another en route—evidence that they have mass.

Proposed by researchers from dozens of institutions in the United States and abroad, the arrangement should yield "the definitive experiments on neutrino oscillations based on accelerators," says Pieramaria Oddone, acting chair of HEPAP and deputy director of Lawrence Berkeley National Laboratory. He cautions, however, that the data wouldn't start flowing until the turn of the century, at best, and DOE budget constraints make funding for the $135 million project far from certain.



UNIV. OF MINNESOTA

Trail's end for neutrinos. A successor to this detector in a Minnesota iron mine would watch for neutrinos generated at Fermilab.

The neutrino beam would owe its intensity to Fermilab's Main Injector—a synchrotron particle accelerator whose main purpose when it is completed in 1999 will be to inject intense proton beams into a higher energy accelerator. For NuMI, bursts of 120-billion-electron-volt protons siphoned from the Main Injector would smash into a graphite target; the pions and kaons in the debris would then decay down a long tunnel, on a beeline for the bottom of the iron mine 150 kilometers north of Duluth. The decays would produce mostly muons and one of the three neutrino types, muon neutrinos.

An absorber at the tunnel's end and the bedrock itself would stop everything but the ghostlike neutrinos, which would continue through the rock and, after a couple of hundred meters, encounter two detectors below the grounds at Fermilab. The first would check for the presence of tau neutrinos—an indication that the muon neutrinos had already oscillated—and the second would concentrate on muon-neutrino counts. "If [muon neutrinos] change that quickly, it tells you they have a large mass," says Regina Rameika, a Fermilab physicist and the NuMI project manager. Masses in that range would mean that neutrinos could make up some of the "dark matter" cosmologists think must permeate the universe.

Hundreds of kilometers farther in their travels, the neutrinos would pass the Minnesota detector, at the bottom of what was once the state's first iron mine. It would make the experiment sensitive to much slower oscillations, indicating smaller masses. Those oscillation rates, says Rameika, could explain another theoretical puzzle: a deficit in the number of muon neutrinos seen in the particle showers produced when cosmic rays hit Earth's atmosphere.

While endorsing the NuMI proposal, HEPAP accepted a subpanel's recommendation not to back a Brookhaven National Laboratory proposal for a less expensive oscillation experiment on a faster schedule, using lower energies and intensities. According to subpanel chair Frank Sciulli of Columbia University, the panel reasoned that money wouldn't be available in time for the Brookhaven experiment because of other ongoing projects. But the rivalry between the two proposals made the meeting "a bit contentious," says Fermilab Director John Peoples.

NuMI's success leaves Marvin Marshak of the University of Minnesota, a project collaborator, with an entirely different kind of problem: how to attract physicists to the chilly reaches of northern Minnesota. "We have a [Native American] gambling casino nearby," he says hopefully. "We have fishing."

–James Glanz