

# Iraq's Chemical Warfare: Case Proved

*A U.N. team found mustard and nerve gas bombs on the battlefield; now the challenge is to prevent the war from spreading*

In a narrative as bleak as its message, a group of United Nations (U.N.) scientists released proof on 26 March that Iraq is using forbidden chemical weapons in its war with Iran. Without naming Iraq as the villain, the U.N. document\* confirms an earlier charge to this effect made by the United States. Iraq has been manufacturing lethal mustard and nerve gas weapons and using them against Iranian troops apparently for months.

On 30 March, the *New York Times* quoted unnamed "Pentagon, State Department, and intelligence officials" as saying there is "overwhelming" evidence that Iraq is embarking on a major nerve gas (Tabun) production plan. According to this report, five nerve gas centers have been built underground and fortified against aerial attack. The *Times* said that a West German scientific supply company, Karl Korb, arranged to sell the pesticide production equipment that will be used to manufacture the weapons. The company denies this.

The State Department confirms that it is talking to West Germany about the possibility that such equipment "may have been shipped" to Iraq, and a spokesman says the Germans are investigating on an "urgent basis." Officials would not comment for the record on the nature of the Iraqi weapons program on grounds that doing so would compromise intelligence sources. However, one policy-maker and expert in the chemistry of gas weapons confirmed the thrust of the *Times* story in a telephone interview with *Science*. He said it may be an exaggeration to say there are five deeply buried gas factories. But "there may be five buildings." Of the German firm's denial, he said, "Don't trust it."

The U.N. paper contains the most substantial evidence in the case. On 13 March, four investigators went into a

war zone on the Iraq-Iran border called Shatt-e-Ali, a "marshland surrounded by firm ground." There they found "seven partially damaged aerial bombs" which seemed designed for spreading a liquid. They concluded the weapons had been aimed at a nearby Iranian artillery base. In Hoor-ul-Huwaizeh, "a completely open, flat desert area without vegetation or cover," the investigators found three more identical bombs, one still unexploded. It bore the marking "BR 250 WP" and had a yellow band around the



**Hard evidence**

*U.N. team examines bomb near Iraq's border.*

nose cone. Fuse instructions were written in Spanish.

This weapon and others found on the battlefield were taken to Teheran and dismantled. Samples of a "dark brown, oily liquid" were removed; they tested positive in a field test for mustard gas. Three days later, the U.N. team obtained another liquid sample. This and some of the dark liquid were sent to laboratories in Sweden and Switzerland for analysis. The dark liquid was identified as nearly pure mustard gas [bis(2-chloroethyl)sulfide] and the other sample as the nerve agent Tabun (ethyl *N*-dimethylphosphoramidocyanidate), first manufactured in Germany in the 1930's. But "No evidence was found in either sample of the presence of mycotoxin," the fungal poison allegedly put in Yellow Rain.

The findings are ominous. Chemical

warfare, contained since the Geneva Protocol of 1925, has broken free of political constraints and is being waged openly in the Iran-Iraq conflict. For precedents, one must turn back to the 1930's, when Japan was thought to have used nerve agents and biological weapons in Manchuria, and when Italy unquestionably used mustard gas against Ethiopian troops. In 1966 to 1967 Egyptian forces were accused by the International Red Cross of using a lethal agent of some kind, probably mustard gas, in the Yemeni civil war. Recent charges that the Soviets supplied mycotoxin weapons for use in Southeast Asia and Afghanistan are still in dispute.

Iraq has denied using illicit chemicals. When confronted earlier this year, an Iraqi general, Hisham Sabah al-Fakhri, told reporters that he would not use such weapons, but added: "We never welcome an enemy with flowers."

Thus an atrocity rejected as too brutal even in war by the parties to the Geneva Protocol (including Iraq and Iran) may be coming back with a vengeance. Other small nations with industrial power, if trapped like Iraq in a desperate situation, might see chemical warfare as an acceptable way out. "If military leaders in the Third World get the idea that gas is here to stay," one U.S. official said, "they will begin to gear up. And the guys who start with defense will eventually want something shinier," meaning weapons.

The Iraqi case summons up Israel's earlier concern that Iraq planned to use its French-built reactor, Osirak, not for research but rather to launch a nuclear weapons program. Israel destroyed the reactor in an air attack in 1981, and the Israeli physicist who recommended this action, Yuval Ne'eman, recently claimed that the Iraqi gas attacks have vindicated the decision.

U.S. State Department officials wonder whether the pattern of events seen in 1981 may be recurring. There is some concern about Iraq's potential to export gas weapons to other Arab nations. "If the Israelis thought there was a serious possibility for a nerve gas production program in the Middle East, they wouldn't sit still," said an official. He added that the Australian government

\* "Report of the Specialists Appointed by the Secretary-General to Investigate Allegations by the Islamic Republic of Iran Concerning the Use of Chemical Weapons," United Nations Security Council, 26 March 1984. The investigators were Gustav Andersson of Sweden's National Defense Research Institute in Umea, Colonel Manuel Dominguez of Spain's Army Medical Corps and Universidad Complutense in Madrid, Peter Dunn of the Australian Defense Department's Materials Research Laboratory in Melbourne, and Col. Oberst. Ulrich Imobersteg, chief of Switzerland's chemicals defense division in Bern.

has already warned that if Iraq cannot be persuaded to turn back, a "third party" might intervene to stop it.

Those are the dark implications of the U.N. report. But there is an encouraging one, too. Through its inquiry, the U.N. has shown it is ready to wade into bitter disputes such as this and collect evidence for the world to see. The investigation has produced an impartial and thus very strong indictment. Unfortunately, exposing the evidence in this case may not be enough. The next step—bringing chemical weapons back under control—may require a lot more work.

The Secretary-General of the U.N., Javier Perez de Cuellar, commissioned this inquiry on an emergency basis early in March. Iran had pleaded for help several times, beginning on 28 October 1983. The U.N. considered the request but took no immediate action. Then, apparently, the Iraqis began to renew the chemical attacks. On 5 March, the United States accused the Iraqis of deploying "lethal chemical weapons" and said it "strongly condemns" their use.

On 13 March the four U.N. scientists traveled to Iran, visited the war zone, collected samples, and examined victims of chemical attacks in Iranian hospitals. They returned to Geneva on 19 March and reported the unanimous findings: all the details fit a pattern of mustard and nerve gas poisoning.

One charge for which the U.N. team saw no evidence was the claim in the *Wall Street Journal* on 12 March that mycotoxins had been used by the Iraqis. The allegation was based on work done by a toxicologist named Aubin Hendrickx of the Toxicological Institute in Ghent, Belgium. According to the *Journal*, Hendrickx analyzed "blood, urine, and stool samples" from Iranian soldiers. The *Journal* announced in an editorial:

This time the tests showed residues of both mycotoxins and mustard gas. Presumably the two agents were mixed to enhance the effect. . . . We can confidently assume that the identification of mycotoxins in the Iraq-Iran war represents yet another Soviet violation of the Biological Weapons Convention of 1972, which banned the development, possession, or transfer to third parties of biological and toxin weapons. It seems the Soviets have not only developed such weapons but are handing them out around the world like candy.

The U.N. report states simply that "no evidence" of mycotoxins was found. In official statements, the United States has said the same. The Swedish scientist who analyzed the liquid samples from Iraq—Johan Santesson—and a U.S. policy official have said they cannot imagine why anyone would mix myco-

toxins and mustard gas, for the two would react. The toxin probably would be rendered impotent. Hendrickx's report thus seems to carry little weight at the State Department.

The task of stabilizing the crisis and bringing the gas weapons under control

has just begun. The U.N. Security Council took the first step on 30 March, formally condemning the use of chemical weapons and urging Iraq and Iran to negotiate a peace. On a more pragmatic level, the United States has stopped one U.S. company from shipping some po-

## Pentagon Names Star Wars Czar

The Pentagon has appointed James Abrahamson, an Air Force Lieutenant General now in charge of the space shuttle program, to head its new effort to protect the public from the threat of attack by nuclear missiles. The effort, which has been officially titled the "strategic defense initiative," originated a year ago in a speech by President Reagan, popularly dubbed the "star wars" speech.

Abrahamson, 51, is an experienced and highly regarded manager of military research and development programs. A graduate of the Massachusetts Institute of Technology, he earned a master's degree in aeronautical engineering from the University of Oklahoma in 1961. He worked, in succession, as a project officer with satellites designed to detect nuclear explosions, as an Air Force test pilot, as a potential astronaut in the Manned Orbiting Laboratory program, as an inspector general of the Air Force Systems Command, and as a director of the F-16 jet fighter program. He became associated with the space shuttle program after chairing a panel in 1979 that sharply criticized its management.

In Abrahamson's new post, his first involving pure research, his managerial power will be derived primarily from the ability to shift funds from one area to another, to prepare long-term budgets, and to express his views directly to Defense Secretary Caspar Weinberger. Agency officials have apparently not yet decided whether he will also have the power to veto proposals made by the various fiefdoms where ballistic missile defense (BMD) research is presently conducted. Although only one person, Major Peter Worden, an astrophysicist, is presently working full-time on the star wars plan, Abrahamson's office is expected eventually to employ several dozen specialists.

Much of the program's budget for 1985 has already been decided. The largest amount—\$721 million—will be spent on space surveillance, target acquisition, tracking, and kill assessment. Additional funds will be expended on directed energy weapons (\$489 million) and kinetic energy weapons (\$356 million), as well as command, control, and communications (\$99 million). Skeptics who wonder about the survivability of space-based BMD components, as well as potentially devastating Soviet countermeasures, will be relieved to learn that the Pentagon intends to increase its research on these topics by a whopping 355 percent, to reach a total of \$112 million.

Five percent of the budget, or roughly \$85 million, will be allocated to long-term, high-risk scientific research. Among the topics to be investigated are the feasibility of constructing space-based antimatter beam weapons to be used against Soviet missiles shortly after their launch, and the practicality of using materials mined from asteroids or the moon for shielding space-based weapons against a preemptive attack.

Worden says that the Pentagon is also interested in providing funds to the National Science Foundation for university research. He describes this as "one way to get around the scientific community's reluctance to work with the Defense Department on this topic." Although the details are still under discussion, the Pentagon is considering a transfer of funds amounting to "a few hundreds of thousands of dollars" for NSF research on solar physics and large, high-resolution space telescopes in fiscal year 1985. According to Morris Aizenman, who directs NSF's astronomy division, all of the projects will be funneled through NSF's normal peer-review procedures, none will be supported solely by the Pentagon, and no restrictions will be placed on the researchers' publication rights.—R. JEFFREY SMITH

tassium fluoride (a precursor of nerve gas) to Iraq. The shipment attracted attention because Iraq had requested that it be air freighted, immediately.

The Commerce Department is preparing a list of chemicals to be banned from export to Iraq and Iran. The first five are

potassium fluoride, dimethyl methylphosphonate, methylphosphonyl difluoride, phosphorus oxychloride, and thio-glycol. The action was triggered by the unexpected volume of these chemicals ordered by Iraq within recent weeks. All may be used in the production of chemi-

cal weapons, although they have other legitimate uses as well. This interdiction of supplies is a temporary measure. A long-term remedy will require the cooperation of all the industrial nations, something not easily won.

—ELIOT MARSHALL

## Lawyers Flush Out Toxic Shock Data

*Battle over researcher's findings raises questions about access to sensitive scientific information in legal disputes*

In 1979, Tammy Lynn Wallace, a young music teacher from Fort Worth, Texas, was one of hundreds of women who fell victim to toxic shock syndrome. Wallace, who was lucky enough to survive sued Procter & Gamble, the manufacturer of a tampon that she had used, and recently won a large sum of money in an out-of-court settlement. An important factor in her success was the unveiling during the trial of provocative research data developed by a University of Wisconsin researcher. The findings were said to demonstrate for the first time that Procter & Gamble's Rely tampon, in laboratory experiments, was linked to the toxin associated with toxic shock. These data could similarly play an important role in the hundreds of lawsuits still pending against Procter & Gamble.

Attorneys for toxic shock victims have had a tough time obtaining first hand the test data introduced in the Texas trial. For 2 years, Procter & Gamble and microbiologist Merlin S. Bergdoll, who conducted the experiments with money from Procter & Gamble and other tampon manufacturers, have strenuously tried to block access to the information by legal means. Bergdoll, a professor at the university's Food Research Institute at Madison and one of the leading researchers in the toxic shock field, has repeatedly refused to release the data, arguing they are preliminary and inconclusive. He has, however, discussed his findings with Procter & Gamble.

The company, which withdrew Rely from the market on 22 September 1980, has won numerous court rulings that bar outsiders from examining company records, including Bergdoll's data. Even though his findings were revealed in the Texas trial, Procter & Gamble persuaded the presiding judge to prohibit the victim's attorneys from disseminating the data sheets. These events have raised questions about whether the information

has been unfairly withheld from scientific scrutiny or whether, as Bergdoll maintains, his findings have been misinterpreted and misused in court.

Since 1979, when toxic shock syndrome was identified, scientists have been searching for its cause. Researchers in the field now believe that a toxin produced by *Staphylococcus aureus* is the most likely culprit. But it is not clear whether tampons contribute to toxin production and, if so, how this happens. Research demonstrating a link would fill an important gap in information about the syndrome, which still occurs. In fact, in 1982, a National Academy of Sciences panel, formed to evaluate the research needs related to toxic shock syndrome, reported that "characteristics of tampons that may be related to [toxic shock] should be studied. Such characteristics could include tampon ability to affect growth and toxin production by microorganisms *in vitro* and in the vagina." At the time, Bergdoll had already undertaken the research to address these questions.

Since 1980, he has conducted a variety of experiments supported solely by industry. Bergdoll and other researchers have had to depend on industry money because the federal government has not taken much interest in supporting grants for toxic shock research. For 4 years, Bergdoll's laboratory has received about \$150,000 a year from four tampon manufacturers. Of this amount, Procter & Gamble contributed roughly \$50,000 annually, Bergdoll told *Science*.

Although he has not yet submitted any of his test results for publication, a transcript of the Texas trial, held in U.S. District Court in Fort Worth, provides a substantial amount of information about his experiments. Even though Bergdoll refused to testify, his data were revealed through testimony by Bruce Hanna, a microbiologist at New York University

Hospital who was brought in by Wallace's attorneys as an expert witness. Hanna is also conducting research on the toxic shock toxin. Under court order, he was allowed to read company records that described in general terms Bergdoll's methodology and listed his specific test results.

According to Hanna's subsequent testimony, in which he read the data sheets before the jury, Bergdoll conducted a series of 13 experiments to examine the growth of three strains of *S. aureus* under various conditions. Bergdoll tested the strains in several tampons and in the different material components of Rely. The three strains produce a variety of toxins but all of them produce *S. aureus* enterotoxin F or SEF, now considered the toxic shock toxin.

Despite changes in the experimental conditions, Rely tampons consistently produced more toxin than other brands, according to Hanna's interpretation of Bergdoll's data. For example, when one strain was grown in standard medium, Rely regular and Rely super tampons produced far more toxin than the other major brands. Two Rely super tampons tested yielded a total of 252 and 391 micrograms ( $\mu\text{g}$ ) of SEF. A few other brands of super absorbent tampons produced up to 162  $\mu\text{g}$ , but most tampons yielded less than about 50  $\mu\text{g}$ . No toxin was detected in the controls. In another test, similar in design, Bergdoll added pig's blood to the growth medium and, according to Hanna, found that Rely again "produced more [SEF] than did the controls certainly and [than] did other tampons."

Bergdoll then experimented on two new materials that had been developed to increase absorbency in tampons. Unlike other tampons, Rely regular and super, Kotex super, and Tampax slender regular in 1980 contained a material called cross-linked carboxymethylcellu-