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Risks of Using Biological Agents in Drug Eradication

A briefing paper with emphasis on human health.

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I Introduction

Plans to introduce a dangerous new technology in the Drug War are very close to reality. The United States, with limited support from the United Kingdom, is pressuring countries with illicit crops of plants from which narcotics are produced to use pathogenic fungi to forcibly eradicate crops. The Vienna-based United Nations Drug Control Program (UNDCP) supports the biological eradication strategy; but the controversial policy lacks endorsement from governments.

Reducing the use and traffic in illicit drugs is desirable; but the biological eradication strategy is fundamentally unsound, undermining international prohibitions on biological weapons, posing dangers to the environment, and - as emphasized in this paper – presenting risks to human health. These risks are especially acute for indigenous people and farmers in remote areas where health services are limited.

Pleospora papaveracea, an agent to eradicate opium poppy, is currently being field tested in Central Asia and the US. It is scheduled to be ready for use in 2002. Another fungus (*Fusarium oxysporum*) to eradicate coca is being developed in the US. Plans to field test *F. oxysporum* in South America in 2001-2 were temporarily halted after strong resistance from civil society. Another type of *Fusarium oxysporum* is being developed to eradicate cannabis (also called marijuana or bhang).

Despite mounting opposition, UNDCP has not renounced the use of biological agents in drug eradication, and senior US officials indicate they not stepping down pressure on countries. Once the technology is used in one country, it will be difficult for other to resist the intense bilateral pressure. Urgent action by intergovernmental agencies is necessary to avert a potentially catastrophic escalation of the Drug War.

II Background on the Agents and the Proposals to Deploy Them

Pleospora sp.

Pleospora papaveracea is a fungal pathogen that attacks opium poppy (*Papaver somniferum*). Candidate strains for use in crop eradication were isolated in the 1980s by the Institute of Genetics in Tashkent, Uzbekistan. At the time, the facility was part of the Soviet Union's offensive biological weapons program.[1]

P. papaveracea is now nearly ready for use. In February 1998, UNDCP signed a contract[2] with the Tashkent Institute of Genetics to develop the fungus and related technology, including mass production of fungal spores and field tests in four neighboring countries. The field tests and the development of production systems are due to be finished in 2001.[3] There is an imminent danger that deployment in eradication programs will start as early as 2002. The *P. papaveracea* project is funded by the UK and US Governments and implemented through the UNDCP-Institute of Genetics contract. In addition to the Tashkent project, the US Department of Agriculture is conducting its own research into *P. papaveracea* in its laboratories in Beltsville, Maryland.[4]

Fusarium oxysporum is a well-known plant pathogen causing damage and large losses in food and industrial crops worldwide. Researchers of the US Department of Agriculture (USDA) have developed highly virulent strains that attack cannabis (marijuana) and coca plants, the source of cocaine. The coca-killing strain favored by the US is named EN-4 and was isolated in 1987 during USDA-funded experiments at a government coca plantation on Hawaii. Work to isolate *F. oxysporum* strains to attack cannabis has been ongoing at least since the early 1970s, when the US Drug Enforcement Agency and USDA funded research at the University of California at Berkeley.[5] After extensive investigation of 1970s and 80s US Fusarium research, including interviewing participants and extensive Freedom of Information Act requests, MacArthur Foundation grantees Jeremy Bigwood and Sharon Stevenson recently concluded that most of the early US work conducted on Fusarium was a project of the US Central Intelligence Agency. The CIA later passed control of the work to other government institutions to allow overt US Congress funding.[6]

F. oxysporum EN-4 is awaiting its first field trial. In 1999-2000, the US applied significant pressure on the Colombian government to agree to field test the fungus. Field testing of the EN-4 pathogen, often referred to as a mycoherbicide by the US government, was introduced as a legal condition for the release of nearly US $1,300,000,000 in (mainly military) aid to Bogotá for its "Plan Colombia" counterinsurgency and anti-narcotics efforts.

The USA and UNDCP believe that *P. papaveracea* and *F. oxysporum* are of "global significance".[7] The total potential target acreage planted in illicit crops is well in excess of one million hectares. The bulk of the world's opium is produced in Southeast Asia (principally Burma) and Afghanistan and nearby Central Asian countries. To the south in India, the world's largest licit crop of opium poppy is produced for pharmaceuticals (France and Australia are also major producers). In the Americas, Colombia and Mexico have significant production of illicit opium and heroin, mainly for the US market.

Although it has no clear mandate to do so from governments, the Vienna-based United Nations Drug Control Program (UNDCP) has acted as an intermediary between the US and Colombia, offering its service as a pass through to "internationalize" the US EN-4 funding. UNDCP has promoted a secretive arrangement in which it receives the US money, passing it on to the Colombian government in the form of contracts for field trials. UNDCP's attempted "internationalization" of the EN-4 program has been welcomed by the United States, which views UNDCP's involvement as lending intergovernmental legitimacy to its controversial research.

In a memorandum obtained by non-profit researchers under the US Freedom of Information Act, former US Secretary of State Madeline Albright urged UNDCP Director Pino Arlacchi to seek further international partners for the project, "*we urge UNDCP to solicit funds from other governments, in order to avoid the perception that this is solely a USG initiative*" (USG = US government).[8] The effort to find other sponsors failed. No other government was willing to finance the research. But both the US and UNDCP continued.

The UNDCP-Colombia negotiations for a contract to conduct the US-financed field tests were beset with leaks from angry and concerned people in both UNDCP and the Colombian government. Senior Colombian officials publicly expressed reservations about using "foreign" biological agents; but claimed they could develop a domestic coca eradication fungus to accomplish the same ends. Colombian civil society sarcastically dubbed this local biological agent "*el hongo criollo*" ("the creole fungus"), mocking the nationalistic banner Colombian officials used to try to implement the US idea of using fungi in forced crop eradication programs.

Public opposition increased with each new revelation about the secret proposals. In August 2000, following a discussion on EN-4 by the US National Security Council, former President Clinton overrode the US Congress and waived the requirement it had placed on Colombia to test biological agents in return for counterinsurgency funding. According to Clinton, moving ahead with fungal pathogen testing in Colombia required "*a broader* [US] *national security assessment, including consideration of the potential impact on biological weapons proliferation and terrorism, provid*[ing] *a solid foundation for concluding that the use of this particular drug control tool is in our national interest.*"[9]

Despite the statement, Clinton did not turn off the financial spigot for fungal pathogen research. UNDCP and Colombia continued negotiating with tacit support from parts of a divided US government. A consultation with civil society convened by the Colombian Environment Ministry in September 2000 turned disastrous when many of the Ministry's guests not only solidly resisted biological eradication; but called for an end to chemical eradication.

In the region, Colombia's neighbors including Brazil, Peru, Ecuador, Venezuela, and the Andean Community all expressed concern (see Opposition, pg. 13). In apparent response, the inventor of the anti-coca fungus, Dr. David Sands, an plant pathologist funded by the US government for over a decade, told the BBC on camera that he believes biological weapons should be unilaterally used by force in retaliatory strikes, in violation of national sovereignty. According to Sands, producer countries are complicit in the narcotics trade. Countries, says Sands, "*that knowingly are unleashing a chemical, a drug, on our children, an addictive drug... should suffer the consequences of that decision*."[10] (See longer interview excerpt on p. 11.)

Within days, Sands comments were the lead story on Colombian television news. Despite Sands and other proponents' efforts (or perhaps because of them), in November 2000, opposition became overwhelming and a besieged UNDCP announced it was dropping proposals for EN-4 field trials in Colombia. The Colombian government followed suit and in January 2001 announced it was abandoning proposals to develop the *hongo criollo*.[11]

But the defeat of last year's proposals to test and use biological agents in drug eradication in South America has led to no changes of US or UNDCP policy. Neither has renounced the strategy of using fungi to kill illicit crops. Both continue to continue to support Pleospora research in Asia and advocate for F. oxysporum to eradicate coca. Unless a global ban on the use of these agents is implemented, the use of EN-4 or another pathogen is only a matter of time.

The Changing Sex Life, Appearance, and Names of Fungi

Fungi can be difficult to identify, acting and appearing differently under varied conditions. Most fungi have more than one stage of life and a sexual and an asexual state in which their appearance changes dramatically. Like a caterpillar and a butterfly, these different forms are the same species at a different stage. In some cases, the asexual state ("anamorph") of a fungus has a different name than the sexual state ("teleomorph") or the fungus as a whole ("holomorph").

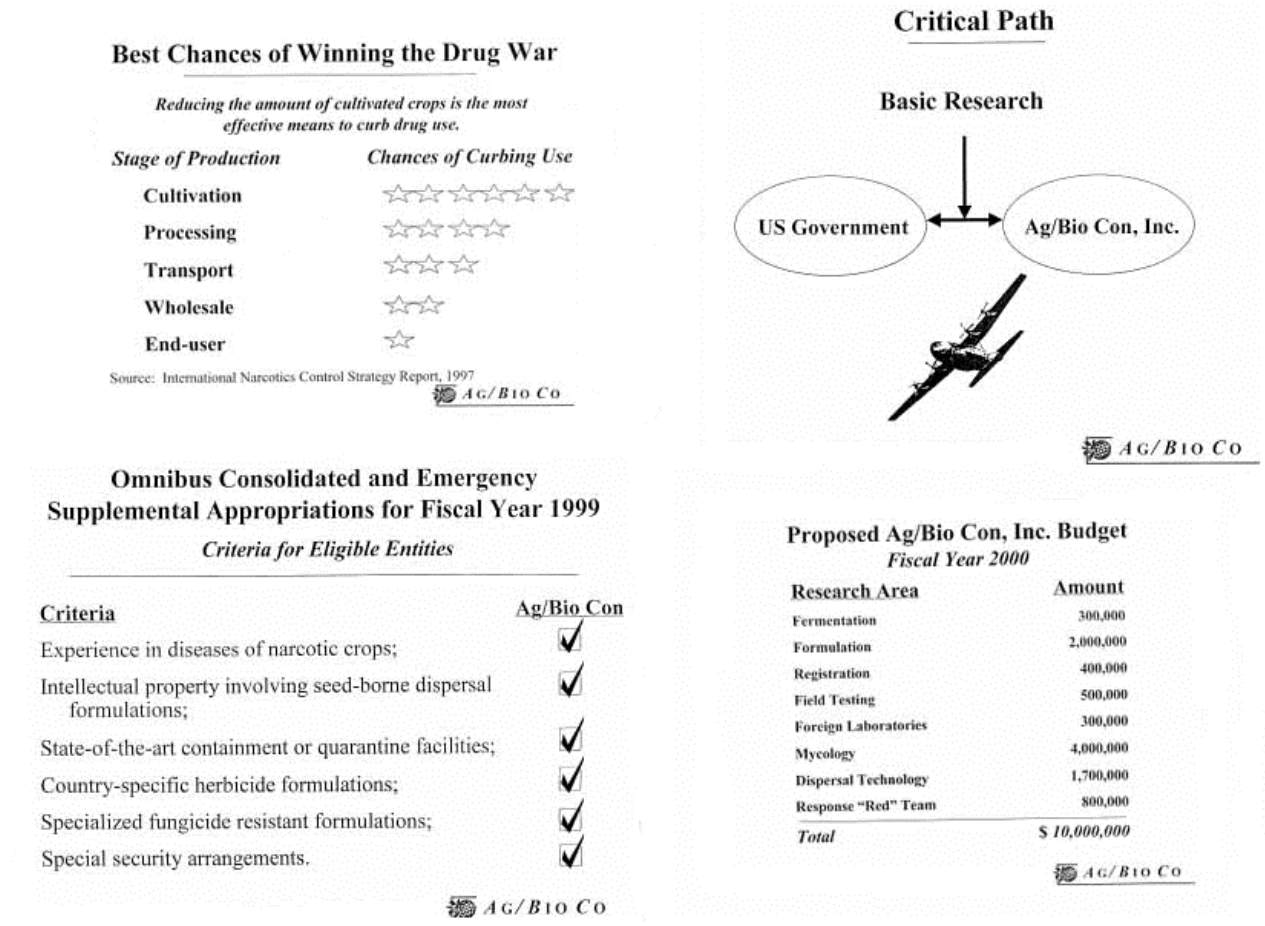
In fact, the identity of the asexual state of *Pleospora papaveracea* is still under discussion. While traditionally the asexual state was identified as *Dendryphion penicillatum,*[12] this has recently been questioned and the name *Dendryphiella* was suggested for the anamorph of *Pleospora papaveracea*.[13]

There are also synonyms for several formae specialis of *Fusarium oxysporum*, including *F. bulbigenum, F. vasinfectum, F. angustum, and F. bostrycoides*.[14]

III Methods of Delivery and Exposure

Promoters of fungal eradication are developing delivery systems to massively apply the agents from airplanes. Farmers, their families, and other persons will be exposed to the fungus sprayed from the air and, after the fungus reaches the ground, in the course of the widespread plant disease epidemics which proponents plan to provoke. A report in the *South China Morning Post*, citing unnamed drug control officers based in Bangkok, says that *P. papaveracea* has been formulated for aerial spraying in a mixture with talc and silica gel.[15] According to documents from the Tashkent research operation quoted by the Post article, researchers describe the formulation's impact on opium poppy as "aggressive, infectious, self-propagating, and deadly." In 1998, over 219,000 hectares of illicit opium poppy were cultivated in the eight primary countries of production, although US government only publishes data on a limited number of countries.[16] Preventive spraying of *Pleospora* to prevent movement of opium poppy cultivation into new areas may also be being contemplated, as suggested by US researchers focus on the capability of *P. papaveracea*'s ability to overwinter and persist in soils.[17]

In the case of *Fusarium oxysporum*, Ag/Bio Con, a private enterprise founded by Dr. David Sands and a retired US Air Force general, has publicized details about dispersal methods. Ag/Bio Con proposes to equip US-built C-130 transport aircraft to spray loads of *F. oxysporum*, each of several tons, from specialized equipment attached to the bottom of the plane. The proposal is to disperse from a high altitude to avoid ground-based gunfire that has claimed the lives of chemical eradication pilots. Ag/Bio Con favors spraying where coca is currently cultivated (in 1999, about 135.900 hectares just in Colombia)[18] and, as a preventative measure, over areas where coca *could be* sown.[19]



Winning the Drug War by attacking overseas … giving up on treating addiction and domestic law enforcement. Slides from an Ag/Bio Con presentation (March 1999).

Such massive deployment of the microbes would expose not only persons and communities currently involved in coca cultivation, but people in rural areas over most of Colombia. Coca, traditionally a high altitude crop, is increasingly adapted to the lowlands. Thus, sweeping areas are targets - from the *llanos* (plains) shared by Colombia and Venezuela in the northeast, easterly almost to Brazil, from the Sierra Nevada de Santa Marta in Colombia's north, south to the Ecuadorian and Peruvian borders along the eastern foothills of the Andes in the Amazon Basin, and west across the Andes nearly to the Pacific.

IV Human Health Risks

The health risks associated with use of fungal pathogens in crop eradication are many. Human Fusarium infection (fusariosis) is an emerging, life threatening disease with a mortality rate as high as 70%. Concentrated aerosols of fungal spores are known to cause dermal and respiratory difficulties in humans. Some strains of *Fusarium oxysporum* produce mycotoxins with deleterious effects on animals and humans. UNDCP scientists working with *Pleospora* have complained of respiratory and skin problems. In addition, the medicinal, cultural, and nutritional uses of poppy, coca, and cannabis by indigenous people and traditional communities is endangered.

As early as 1989, even the "inventor" of EN-4 and other strains to be used on coca and cannabis, admitted in a letter to the US Drug Enforcement Agency that *F. oxysporum* is "*a problem in immunocompromised patients*".[20] But the danger to this population, and other known health risks, has not stopped the US and its researchers from proceeding.

The human health risks of the use of fungal agents to eradicate crops can be divided into two broad categories: a) direct human health impacts on persons exposed to the agents; and b) Indirect human health effects on target farmers, their families, and nearby communities. Different dangers within these categories can be identified. Direct human health impacts include:

i. Invasive fungal infections
ii. Mycotoxins

iii. Cutaneous and eye infections
iv. Harm to consumers (legal and illegal)
v. Undiagnosed cases due to lack of access to care or absence of appropriate medical training and protocols.

Indirect human health effects include:

i. Effect on traditional medicine
ii. Nutritional impact of crop loss
iii. Unanticipated effects due to environmental modification

The State of Knowledge on Fusarium and Lack thereof on Pleospora

A contaminant in many crops, foods and feedstuffs, Fusarium has been widely investigated. But little research has been done on *Pleospora*. Consequently, most scientific data on the health risks of anti-illicit crop fungi is related to *Fusarium oxysporum*. The comparative lack of data for *Pleospora*, however, should not be interpreted as an absence of risk. There are indications that *Pleospora* has an allergenic potential. Researchers working with Pleospora have suffered from respiratory difficulties.

Fusarium infections: an emerging, life-threatening disease

Fusarium species have emerged as major cause for fungal infections.[21] The first invasive fusariosis was reported in a child in 1973.[22] Invasive Fusarium infections represent an increasing cause of infectious morbidity and mortality in patients with blood cancer.[23] While aspergillosis remains the most common mycosis, *Fusarium* is the most frequently occurring new opportunistic pathogen that causes life-threatening infections.[24]

In a recent study at a cancer center in the USA, the mortality rate of patients with a Fusarium infection was between 52 – 70%. [25] Other researchers reported mortality rates of 70%[26] or 76%[27]. Researchers from a German university hospital recently reported a case of a patient with a weakened immune system that died of a *F. oxysporum* infection, even after treatment with appropriate antifungal therapy.[28]

Since infection with *Fusarium* is very difficult to diagnose[29] and may mimic aspergillosis, patients are usually treated with the antifungal agent such as amphotericin B, which show poor activity against *F. oxysporum* in many cases.[30] Fusarium infections are especially dangerous and difficult to treat as they disseminate easily due to the ability of Fusarium to build new, infectious spores within the body.[31]

One theory holds that Fusarium infections are on the rise mainly because the number of risk patients with a compromised immune system has been increasing for the past two decades. Patients after organ transplants or bone marrow grafts, persons treated with cytostatic drugs or immunosuppressive therapy, and HIV infected persons are most vulnerable to fungal infections.[32] While the immune status of the host is important, the extent of exposure is another critical factor[33], which might be extraordinary high during deliberate spraying of Fusarium spores in drug eradication programs.

> *People in a position of responsibility who are indifferent to the health risks of eradication with Fusarium are engaged in the modern-day equivalent of the 16th Century European conquerors' debate over whether native people are human beings and, if so, whether they have souls.*
>
> - Dr. Oswaldo Jave, Chief of the Asthma, Environment, and Tobacco Unit, Hospital Dos de Mayo, Lima, Peru.

Who is immunocompromised?

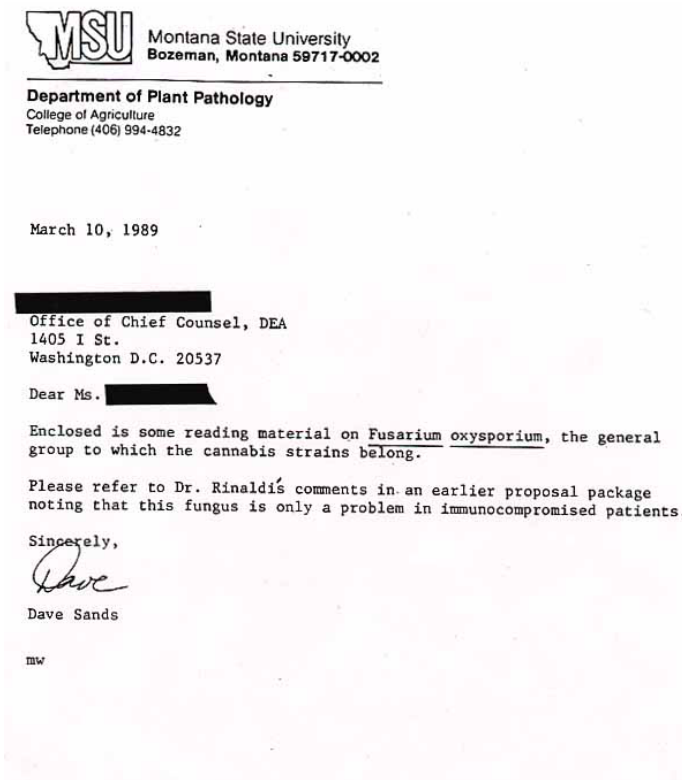
The lead researchers involved in developing *F. oxysporum* are well informed about the infection risks, but have played them down by maintaining that only a narrowly defined group of immunocompromised persons are vulnerable. Displaying disregard for the variability of health care and epidemiological conditions in different world regions, a report by the US drug czar's office claims that only immune-suppressed cancer patients, who are already vulnerable to almost any microbe, could be affected. But, even then, according to the US drug czar, there is little reason to worry since these patients "*would be hospitalized and quarantined and not exposed to coca spraying.*"[34]

Claims that fusariosis and similar fungal infections are only a concern in rich countries where patients can afford immunocompromising cancer treatment or transplantations[35] have been met with skepticism by Southern medical experts and ignore the fact that bone marrow transplantation is only one cause for a severely weakened immune system. Other illnesses including diabetes or AIDS can strongly compromise a patient's immune system.

According to Dr. Oswaldo Jave, a physician at the Hospital Dos de Mayo in Lima, Peru (the 2nd largest hospital in Peru and a major public teaching institution), immunocompromised illness in the rural Andes is not typically due to

the same reasons or found in the same proportions as in the North and wealthy urban areas. In the rural Andes, viral hepatitis infection and incidents of consumption of methyl alcohol, for example, are common. Both problems lead to hepatic cirrhosis - an immunocompromising illness. In addition, while epidemiological data is incomplete, an estimated 5% of the Latin American population suffers from asthma. Many of these people take corticoids, rendering them an easier target for Fusarium.

Malnutrition, particularly among children, could also be a factor. Chronic undernourishment may suppress the immune system and increase the possibility of opportunistic infections. In many countries, malnutrition is especially prevalent in remote rural areas where illicit crops are grown. In Colombia, one in five children in rural areas suffers from malnutrition, with the incidence even higher in Cauca and Nariño Departments,[36] both focuses of current chemical eradication of coca and opium poppy crops. In Peru government statistics show that nearly 60% of children in rural areas suffer from malnutrition, compared to 21% in urban areas.[37] Afghanistan, the world's largest producer of opium poppy, is also one of the world's most malnourished countries, with an estimated 70% of the entire population lacking basic food security.[38]



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March 10, 1989

[redacted]
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Dear Ms. [redacted]

Enclosed is some reading material on Fusarium oxysporium, the general group to which the cannabis strains belong.

Please refer to Dr. Rinaldi's comments in an earlier proposal package noting that this fungus is only a problem in immunocompromised patients

Sincerely,

Dave

Dave Sands

mw

A 1989 letter from David Sands to the US Drug Enforcement Agency obtained by researcher Jeremy Bigwood under the US Freedom of Information Act.

Head of Dos de Mayo's Asthma, Environment, and Tobacco Unit, Dr. Jave attends lung infections caused by fungi and believes there are a large number of immunocompromised (and potentially immunocompromised) people in coca-growing regions susceptible to fusariosis. Jave detects a callousness and disregard for health, saying policymakers who downplay the risks of *F. oxysporum* to poor farmers and their families "are *engaged in the modern-day equivalent of the 16th Century European conquerors' debate over whether native people are human beings and, if so, whether they have souls*."

Fusarium infections are not restricted to immunocompromised patients

Fusariosis and deaths from it are not restricted to the immunocompromised. Recently, an immunocompetent patient in Germany died of a *Fusarium oxysporum* infection. The 42 year-old man with no medical history to indicate susceptibility to mycosis was admitted to a hospital with acute pneumonia and died 25 days later of septic shock. *Fusarium oxysporum* was the only fungal or bacterial pathogen that could be isolated from the man's organs.[39] A similar report from India also suggests that *F. oxysporum* infections can occur even in patients that are not severely immunocompromised.[40]

Mycotoxins

Some fungi are capable of producing poisonous substances, known as mycotoxins, which have serious impacts on human and animal health. Indeed, it has been clearly demonstrated in scientific experiments that some strains of *Fusarium oxysporum* can produce an array of highly toxic compounds, including:

- Trichothecenes (T-2 toxin, Diacetylnivalenol, Diacetoxyscirpenol, and five others) [41]
- Moniliformin[42]
- Fumonisin B1[43]
- Fusaric acid[44]
- Fusarin C[45]
- Zearalenone[46]
- Fumonisin C derivatives.[47]
- Neosolaniol[48]

Trichothecenes belong to the most dangerous mycotoxins and are toxic enough to be listed as biological weapons in the draft Verification Protocol to the UN Convention on Biological and Toxin Weapons.[49] According to WHO, certain Trichothecenes have an immunodepressive effect in animals, resulting in decreased resistance to secondary

infections. The T-2 toxin, which is also embryotoxic and teratogenic, is one of the most toxic Trichothecenes, with an oral LD50 in mice of 10.5 mg/kg body weight.[50]

Several outbreaks of Trichothecenes-related disease in humans have been reported. Two outbreaks in China (1984) and India (1987) were caused by consumption of contaminated cereal products. Animal feed contaminated with Trichothecenes has repeatedly caused lethal poisoning in horses, poultry, hogs and cattle. [51]

According to WHO, Fumonisin B1 is toxic to the liver and kidneys in a variety of laboratory animals and is suspected to be carcinogenic to humans.[52] In domestic animals, fumonisins have been identified to cause a neurological disease in horses, pulmonary edema in swine, hepatotoxic and nephrotoxic effects in other domestic animals, and carcinogenesis in laboratory animals.[53] Mycotoxins may cause reduced growth rate, decreased resistance to infection, fatty liver syndrome and death.[54]

Neuropharmacological effects of *Fusarium oxysporum* extracts have been observed, including an increased aggressive behavior in rats[55] and a general dopaminergic effect on test animals.[56] These effects are probably due to the production of fusaric acid by *F. oxysporum*.

Not all strains of *Fusarium* produce all types of mycotoxins. The metabolism of fungi and thus the production of mycotoxins is dependent on environmental parameters. On different growth substrate, and depending on the temperature or humidity, the metabolites produced by *F. oxysporum* may vary.[57] Similarly, deadly mycotoxins might be produced only under specific stress situations in the natural environment, situations not reproduced under laboratory conditions.

Even if the strain is tested and does not produce mycotoxins at a given time under laboratory of small-scale field testing conditions, Fusarium species have a high degree of mutagenicity which can effect both a species host range (see environmental concerns, following section) and the potential of a given strain to produce mycotoxins. This phenomenon was the basis of the Environmental Protection Agency of the US State of Florida's rejection of a proposal to use a strain on Fusarium oxysporum for cannabis eradication.

Amazingly, neither UNDCP nor US researchers have even attempted to test the fungi for production of mycotoxins, although USDA researchers are well aware of the risk. During USDA meetings, fact that Fusarium is producing "*mycotoxins which are toxic to humans*" has been discussed (although not in the context of coca-eradication, but in the context of legitimate biocontrol activities of USDA).[58]

Cutaneous and Eye Infections

Fusarium species have long been recognized as a cause of cutaneous infections.[59] Many cases of nail infections (onychomycosis) caused by *Fusarium oxysporum* have been reported,[60] and it has been suggested that these result from handling of contaminated soil during gardening jobs.[61] *F. oxysporum* can also cause keratitis, an infection of the eye.[62] The percentage of Fusarium involvement in eye infections varies according to geographical location. In some areas, 98% of keratitis is bacterial. In other regions, for example the southern United States, roughly a third of all keratitis cases are fungal, and a third of these are caused by *F. oxysporum*. These infections are difficult to treat and may result in severe damage to vision or even eye loss.[63]

Skin infection from Fusarium

Spore aerosols - dermal and respiratory diseases

Like plant pollen, fungal spores can cause severe allergies in humans. Pleospora species are listed as potential allergens[64] and are included in hay fever forecasts.[65] One of UNDCP's own research reports indicates that staff at the Tashkent Institute of Genetics *"have already complained of symptoms of dermatitis and respiratory difficulties after exposure to the high concentrations of the fungus"*.[66] UNDCP officials did not react with alarm for possible impacts on the thousands of farmers and their families who would be exposed to the fungus if it were used in a field. Instead, they merely recommended the acquisition of a safety cabinet to protect the scientists.

Fusarium oxysporum aerosols may also have respiratory effects. Fusarium species are involved in pulmonary mycotoxicosis (also termed organic dust toxic syndrome or silo unloader's syndrome), an acute illness resulting from massive inhalation of microbial toxins in organic dusts. Fusarium fungi have been identified in biopsy specimens of affected patients.[67]

Effects on Consumers - "Paraquat Fever" and Contemporary Uses of Coca and Poppy

In addition to field exposure concerns, ingestion of sprayed plant material poses an additional health threat. Indigenous peoples in the Andes, Amazon, and nearby regions chew coca leaves. Cannabis and opium poppy is used for medicinal and industrial purposes in many cultures, even in the United States. The health of these legitimate users of target plants may be compromised.

Illegal drug users could also be affected, as was the case with paraquat[68] poisoning of cannabis users. In the 1970s, Mexican cannabis plantations were sprayed with the herbicide paraquat. Inhalation of toxic amounts of this material could lead to severe lung damage, and some instances of acute toxicity have occurred.[69] Up to 2mg paraquat per gram was detected on seized marijuana samples in the USA.[70] Ironically, the ensuing panic among recreational cannabis users in the US, popularly dubbed "paraquat fever", was a stimulus to the US to look into alternative eradication strategies, including fungi.[71]

Problems with Diagnosis and Treatment

Health facilities in regions where illicit crops are cultivated are generally not equipped to quickly conduct procedures to diagnose fusariosis. Nor are personnel trained to recognize invasive fungal infections, increasing the chance that patients may be erroneously diagnosed with more common diseases, such as tuberculosis or pneumonia. In such cases, treatment is unlikely to be effective and would be erroneously reported in to authorities in epidemiological reports. Even in cases where patients are promptly and correctly diagnosed, rural health care facilities in the Andes generally do not have the intensive care equipment (artificial respirators, cardiopulmonary monitoring and resuscitation equipment, etc.) and appropriate medicines to treat fusariosis. Even if such equipment and diagnostic training and protocols existed, few residents of coca-growing regions would be able to pay for the treatment.

The possibility that Pleospora (used on opium poppy) may provoke life-threatening illness is less clear than in the case of Fusarium. But if Pleospora produced serious illness, it is probably even less likely that rural citizens of illicit opium poppy producing countries like Afghanistan and Burma would have access to appropriate medical care.

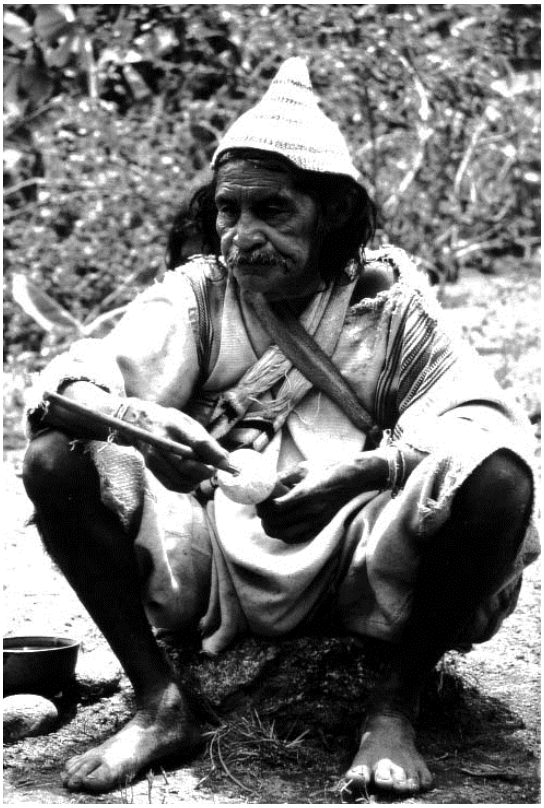
Indirect Effects: The "Collateral Damage" of the Military Strategy of Biological Agents

In considering the impacts of using fungi to eradicate crops, or any forced crop eradication program targeting traditional cultivars, it is necessary to consider secondary or spillover effects on health, and traditional health care and nutrition in particular.

Coca, opium poppy, and cannabis have legitimate, traditional uses for many indigenous people and rural communities across the world. Indeed, it is through millennia of work by these peoples that the plants were domesticated, developed, and came into use in medicine worldwide. Each - especially coca and opium poppy - have been of incalculable value for global public health as sources of analgesic drugs. Currently, these uses are expanding. Cannabis is finding increased popularity as an effective and inexpensive treatment for the effects of chemotherapy and as a painkiller in terminally ill patients. The plants also find use in industry (hemp fabrics), animal husbandry (fodder), and foods (including the world's best-known brand name, Coca-Cola).

Effects on Traditional Medicine

In many indigenous and traditional cultures, coca, opium poppy, and cannabis have great cultural and health importance. In South Asia, poppies are used in traditional ayurvedic medicine. Andean indigenous peoples from Colombia to Argentina have used coca for thousands of years playing, crucial religious and medical roles.[72] The leaves are chewed as a mild stimulant and used to treat sore throat, gastric dyspepsia, diarrhoea, mild altitude sickness and more.[73] Cannabis is used traditionally in the Kalahari and elsewhere.



Traditional Use: A man of the Kogi People of Colombia's Sierra Nevada de Santa Marta. He carrys a bag with coca leaves and chews a quid. In his hands is a lime-filled gourd. Mixed with leaf and masticated, the lime liberates small amounts of alkaloids.

In Southeast Asia, or in regions such a Colombia's Putumayo, narcotics producers who sow the same crop for different purposes have invaded tribal peoples' land. In other narcotics-producing areas, traditional farming communities, whether by economic pressure or faced with the barrel of a gun, have no choice but to sow illicit crops.

If governments accept that forced crop eradication is an acceptable and effective tactic in the Drug War (and many do not), sadly, the pilot of a high-flying C-130 or even a small plane, much less the unintelligent fungus itself, cannot distinguish crops planted for traditional use from those sown for the purpose of manufacturing narcotics. Once sprayed across an area, the persistent fungi will attack indigenous people, small farmers, and everyone else alike.

Invoking the mantra of protecting children in rich countries (presumed future addicts), and giving up attempts to distinguish tradition from trafficking and medicinal use from addiction, proponents of fungal eradication propose to repay the invaluable medical contributions of indigenous people and traditional communities with a bullet right in the heart of their culture and health systems.

Nutritional Sources

Targeted crops are also the direct or indirect source of nutrition and well being. Roasted coca leaves are a staple food for many indigenous peoples in South America and an important source of minerals and vitamins.[74] Loss of this nutritional source could be devastating to some peoples. In South Asia, opium poppy plant material is used as animal fodder. For some communities, loss of this feed source for domestic animals could have nutritional consequences (e.g., lower milk production).

Unanticipated Effects

Other human health effects of fungal agents cannot be ruled out. Two possible types can be identified. The first is the possibility of physical dislocation from cultivated areas as a result of spraying (and accompanying anti-narcotics and/or counterinsurgency efforts). If fungal eradication separates farmers from their food crops by, for example, coating nearby maize with fungus and its spray mix, food security will deteriorate, rendering families susceptible to disease or even starvation, and creating refugees. This problem is already being experienced in Colombia, where chemical crop eradication is displacing families in coca-growing regions (some across international borders), sending them to camps and rendering them dependent on food assistance.

A second set of possibly unanticipated effects relate to questions about the host specificity of *P. papaveracea* and *F. oxysporum.* That is, which plants it will attack. It is possible they may affect other crops or wild plants, animals, and soil biodiversity, with unforeseen consequences including possible effects on human health. (Environmental aspects are discussed in greater detail in the following section.)

For example, *coca pescado* ("fish coca", a close relative of cultivated coca) is very valuable for indigenous peoples in the western Amazon. Growing beside water, *coca pescado*'s vegetation provides cool shade and its falling fruit food for fish, especially on nutrient-poor blackwater rivers. As a consequence, the plant is a well-known fisherman's friend. Fish from near the *coca pescado* often provide human dinners. If *F. oxysporum* EN-4 attacked *coca pescado*, indigenous people would lose a valuable aid to their food security.[75]

V ENVIRONMENTAL ASPECTS

Like any other biological agent, the fungi will be very difficult to control after a release into the environment. They are infectious agents that spread uncontrollably beyond the target area. The have already fungi proved to be beyond human control in greenhouse experiments in Asia[76] and field experiments in Hawaii.[77]

Damage to Alfalfa by a Pleospora species.

There is a high risk that non-target plants will be affected by the fungi. This might include licit crops of poppy, hemp (cannabis) or coca - for industry or legal local use - as well as wild relatives of target plants. It is well known that some strains of *F. oxysporum* can infect many different plants, even distantly related species.[78] Several single *F. oxysporum* strains have been identified that attack ***both*** sweet potato and tobacco plants, two species that are only distantly related.[79] Concerned Colombian scientists cite reports that some strains can increase their host range, including one that attacks tomatoes (*F. oxysporum* f.sp. *lycospersici)* but also produces infection in radishes and carnations. Another strain that fiercely attacks carnations resulted in infections when applied to tomatoes.[80] Research commissioned by USDA revealed that at least two species not closely related to coca were attacked in inoculation tests by the EN-4 fungus strain.[81]

In growth chamber tests conducted on about 50 crops (but few close relatives), EN-4 attacked not just one coca species; but two members of the coca genus. While the developers of EN-4claim these very limited host range studies suggest EN-4 is host-specific. But the data suggests a different conclusion to other scientists. A team of biocontrol specialists at Colombia's National University with extensive experience with *F. oxysporum* (a major pest of Colombia's flower crop), interpret studies as suggesting that EN-4 may be pathogenic to a wide range of *Erthroxylum* species.[82] In the *Erythroxylum* genus there are over 200 species of wild relatives of coca, which might be affected by the fungus. In Colombia, four are listed as endangered.[83]

The host specificity of *Pleospora papaveracea* is similarly confused. USDA experts who analyzed the poppy pathogen concluded "*the extent to which this fungus is found on hosts others than Papaver is unclear*."[84] The genus *Papaver* includes

50 different wild species,[85] at least 7 of which are used as ornamentals, for hunting poisons, and for coloring.[86] No systematic attempt has been made to determine which *Papaver*-species are subject to *Pleospora* infections.

It has been common knowledge for 50 years that *Pleospora papaveracea* attacks plant species other than opium poppy. German researcher Maria Meffert found in 1950 that the fungus can be isolated from *Papaver argemone, P. setigerum* and *P. rhoeas*, the corn poppy. Under laboratory conditions, even a plant from another genus, *Chelidonium*, was infected with the fungus.[87]

UNDCP's "weed" has value in Africa: A recent Algerian postage stamp celebrating corn poppy.

This was confirmed in UNDCP's own research: "A*n isolate of* P. papaveracea *has been obtained from a diseased plant of corn poppy (*P. rhoeas*). This indicates that the specificity of this fungal species is not absolute.*"[88] This is a very strong indication that non-target wild relatives of poppy might be infected.

Upon this discovery, UNDCP's scientific machine did not hesitate to rationalize that damage on a non-target species was acceptable, because corn poppy (Flanders poppy) is:

"*a weed throughout Europe and North America and has no significant conservation value*" [89]

The ignorance and ecological disregard of such statements are important reasons why UNDCP's conclusions on the safety of biological eradication agents cannot be trusted. UNDCP provides no enlightenment on its views about provoking damage to non-European uses of the corn poppy, or whether they were considered at all. The plant is found not only in Europe and North America; but also across North Africa and temperate Asia, extending southward into tropical parts of South Asia.

Corn poppy, (also called Flanders poppy) is the flowering plant central to "In Flanders Field", Canadian John McCrae's tribute to the dead of the First World War. It is a weed in many situations in industrialized agriculture; but is also used for coloring in wine and medicines, and has considerable aesthetic value as an ornamental.[90]

P. papaveracea is closely related to (and probably developed from) a fungus called *Pyrenophora trichostoma*, a species that is very often encountered on cereals.[91] It is unclear whether *Pleospora papaveracea* has completely lost its ability to infect major staple crops and whether under certain circumstances this might occur.

Although some testing of specificity was done with the fungi, it was totally inadequate and very narrow in scope. With both, *F. oxysporum* and *P. papaveracea*, the tests have been limited to a range of cultivated (often horticultural) crops. No systematic testing has been conducted on wild relatives of coca and opium poppy.

Other environmental concerns are related to difficult to predict indirect effects including, for example, impacts on microbial biodiversity in soils, which is very poorly understood in ecosystems such as the western Amazon. Russian researchers found that a *F. oxysporum* strain killed other fungi in the soil. This change in soil led to an increase of fungi that can produce detrimental toxins. After this discovery, the researchers recommended against using a strain of *F. oxysporum* as a biocontrol of broomrapes.[92]

Other ecosystem level impacts concern insect species that feed on coca plants and its relatives. Some of the most highly prized butterflies in the world, the strikingly beautiful species of the *Agrias* genus, are completely dependent on wild relatives of coca. Found from Mexico to the Southern Cone, each kind of *Agrias* relies on a different species of wild coca as its host. Several species are endangered. If *F. oxysporum* attacks coca's wild relatives, reducing populations of wild cocas, the *Agrias* will also suffer.

A selection of Agrias butterfly species from Colombia. The range of Agrias species extends from southern South America to Mexico. Agrias are dependent on wild relatives of coca.

But the fungi can also directly impact other animals. *F. oxysporum* has recently been identified as a parasite of shrimp,[93] and Indian researchers found that it was infecting several insects like the sugarcane stalk borer (*Chilo auricilius),* the sugarcane stemborer *(C. infuscatellus), the* purple stem borer *(Sesamia inferens)* and others.[94] *F. oxysporum* is known to cause harm to domestic animals and may also attack wild mammals ad other species.

The persistence of the fungi in the soil adds to environmental concerns. A focus of US research on *Pleospora* has been on its ability to survive for lengthy periods – and lasting through the winter in cold climates to infect plants for a second planting season. *Fusarium oxysporum* spores can survive for lengthy periods in the soil. The fungus builds survival structures that may survive indefinitely if the fungus fits into the soil ecology. USDA estimates the survivability of Fusarium spores to be in the range of 40 years.

VI BIOLOGICAL CONTROL OR BIOLOGICAL WEAPON?

SANDS: This fungus is the closest thing I've ever seen to a silver bullet … I have seen it take out 99% of plants in a field. I think that's incredible and I think people should know that this technology exists… This would be a green kind of warfare…

BBC: Okay, but we're talking semantics here. You call it green warfare. Other people call it biological warfare. That is semantically correct, it is biological warfare.

SANDS: That can be right. It's biological warfare or green warfare. I just want you to understand my opinion is it's a good thing if it's done to eradicate something that the entire world feels is noxious.

BBC: What happens if consent is not forthcoming… I put to you a hypothetical - you never get consent - what should happen then?

SANDS: You're saying that two countries [Colombia and Afghanistan] that knowingly are unleashing a chemical, a drug, on our children, an addictive drug, that they are consenting to do that and they are not consenting to do biological control, I think they should suffer the consequences of that decision.

BBC: Which means that we should go in without consent.

SANDS: I think somebody should.

BBC: And it should be treated as an act of counter terrorism?

SANDS: Well it's a pretty high stakes game. Just go to any rehab clinic and check it out yourself.

BBC: You're saying yes?

SANDS: Yes.

- BBC television interview with David Sands, professor of plant pathology, inventor of EN-4, co-founder of Ag/Bio Con, man with many friends in the US Congress, and recipient more than a decade of US anti-narcotics research funding. Broadcast 2 October 2000.

From the outset of its biological eradication program, US policymakers have appropriated the language of a legitimate branch of science – biological control – to describe their work.[95] By equating biological control with biological warfare, the US program has put the reputation of a growing and promising field of research at risk. Legitimate biological control protects cultivated crops from pests;[96] but fungal eradication kills the crop instead of the pest. According to a statement circulating among biological control scientists:

> *Labeling these programs as "biological control" puts the reputation of our field of research at risk, as the growing opposition could be turned against all biocontrol research. We strongly reject any equation of legitimate biological control and the use of biological agents in drug eradication and want to emphasize that legitimate biological control is environmentally safe and should never be used without the consent of farmers and ranchers, an aspect ignored by those promoting biological eradication of plants.*

Despite the obvious difference between biological control and crop eradication, a trick of language used by proponents of *Fusarium* and *Pleospora* is to call target crops "noxious" or "weeds", equating them with invasive species or plants that

Different strains of ***F. oxysporum*** infect different plant species. Some attack more than one kind of plant. These are the effects of a ***F. oxysporum*** strain that causes disease in maize.

interfere with crops. According to the scientists statement:

> *... the term "noxious organism" solely relates to organisms that are noxious in the context of agriculture or food storage/processing. While manufacturing illicit narcotics from certain plants is certainly undesirable, to kill a drug producing plant for the sole reason that it produces a narcotic substance does not qualify it as a noxious plant in an agricultural sense and therefore they are not a legitimate target of biological control. Programs to kill drug producing plants with biological agents are not "biological control" by any scientific definition. In fact such practice goes against the fundamental principles of the science of biological control: to work with and not against nature, and to involve farmers in the practice of the approach.*

The Biological and Toxin Weapons Convention (BTWC) bans any development or production of biological agents for hostile purposes.[97] By UNDCP's own admission, the biggest areas of coca and opium poppy cultivation are combat zones. In January, 2001 Klaus Nyholm of UNDCP admitted to Bogotá's biggest newspaper, "*Drug traffickers don't want peace." "Colombia has been strong in anti-drug repression*", says Nyholm, using "*a lot of stick and very little carrot.*" And not just in South America, "*The other two large producers of drugs, Afghanistan and Burma, are also confronting armed conflicts.*"[98] Under such circumstances law enforcement and military action often become tightly intertwined. But even States with no civil war or open conflict, the biological agents would still be used on farmers' fields by force.

The arguments of fungus supporters that law enforcement authorities are allowed to supplement the legal tactic of manual eradication (pulling plants up by hand) with forced biological eradication runs into difficulty with the BTWC. There is no exemption in the Biological and Toxin Weapons Convention for the use of biological weapons in to forcibly eradicate illicit crops. Countries North and South recognize that prohibiting any use of biological weapons is critically important to stop arms proliferation, uphold treaty commitments, and protect human health and the environment. The development and use of Agent Green threatens to undermine the global consensus against biological weapons.

It a remarkable memorandum on August 22, 2000, former US President Bill Clinton conceded that the US plan to use microbial agents to eradicate drug crops may have an impact on biological weapons proliferation. Clinton wrote that his administration would not require the Colombian government to use Agent Green until "*a broader national security assessment, including consideration of the potential impact on biological weapons proliferation and terrorism, provides a solid foundation for concluding that the use of this particular drug control tool is in our national interest.*"[99]

Plant of contradictions: Raw material for pharmaceuticals, source of addictive illegal drugs, fruit of farmers' genius, tool of traditional medicine. Opiate-producing cultivars are as varied as where they are sown. Here: "China White", "Indian Raj", "Golden Triangle", and "Turkish Commercial".

VII EFFECTS ON LICIT CROPS

Cannabis, coca and opium poppy are all grown for legal purposes. Uses include pharmaceuticals (codeine, morphine, etc.) from poppy, fibre and oil from hemp (cannabis), and flavourings (Coca-Cola) and teas from coca. UNDCP reports over 29,000 ha of legal plantations of coca in Bolivia and Peru.[100] Hemp is grown industrially in Canada, China, and many other countries. India is the world's biggest producer of licit opiates, accounting for about half of global production. Opium poppy is also legally planted in Japan, China, Turkey, Australia, France and Spain.[101]

Licit opium poppy production in Turkey.

Developing country production of legal pharmaceutical opiates could be damaged by fungus spread. Microbes have no respect for international borders. Consequences on legal export crops would be severe if, for example, infected planting material was exchanged between Central Asia and India (poppies) or Colombia and Bolivia (coca). Industrialized producers of legal narcotics stand to benefit. Producers in developed countries are less likely to be infected by fungus spray programs, have more direct legal recourse, and are more able to access fungicides and other methods of agronomic self-defense. If, for example, legal production of opiates in India is adversely affected by inadvertent spread of the fungus, other countries could advance their market share. Australia – which has approved Glaxo-Wellcome field-tests of genetically engineered opium poppy[102] - could significantly increase market share.

VIII GROWING OPPOSITION

Although the US is keeping up international pressure, fungal eradication has been clearly rejected within its own borders. In 1999, the Florida Environmental Protection Agency emphatically opposed a proposal to use *F. oxysporum* against illicit cannabis in the state (the US is the world's number one producer of illicit cannabis). According to the Agency's director, who stopped the proposal: *"Fusarium species are capable of evolving rapidly. Mutagenicity is by far the most disturbing factor in attempting to use a Fusarium species as a bioherbicide. It is difficult, if not impossible to control the spread of Fusarium species. The mutated fungi can cause disease in large number of crops, including tomatoes, peppers, flowers, corn and vines and are normally considered a threat to farmers as a pest, rather than as a pesticide."* [103]

The use of fungal pathogens in eradication is heavily opposed across the world:

- In May, 2000, the **African Group** at the Conference of the Parties to the UN Convention on Biological Diversity proposed a resolution that "*Calls on Parties not to approve the release and/or use of biological agents such as 'Agent Green' that may have negative impact on the conservation and sustainable use of agricultural biological diversity.*"
- On March 23, 2000, **Peru** passed a law banning the use of biological agents in coca eradication.[104]
- **Ecuador** prohibited the "*entry and use of the pathogen Fusarium oxysporum in the entire national territory*" on July 20, 2000 by a new law.[105]
- The Environmental Authorities of the **Andean Community** issued a statement against the use of biological eradication at its September 5-6, 2000 meeting.[106]
- **Brazil**'s National Security Council chief Gen. Alberto Cardoso spoke out against the dangers of the fungus in an article for *O Estado de São Paulo*.[107]
- On February 1, 2001, the **European Parliament** approved a resolution 474-1 calling on the European Union to "t*ake the necessary steps to ... prevent the introduction* [in Colombia] *of biological agents such as* Fusarium oxysporum*, given the dangers of their use to human health and the environment alike."* Poul Nielson, speaking on behalf of the **European Commission**, declared that he was "*completely in agreement*" with the resolution's sponsor.
- In **Germany,** both the Parliament and the Deputy Minister of Foreign affairs declared opposition to the use of biological agents in drug eradication.[108]
- In January 2000, UNDCP admitted that **Kazakhstan** and **Turkmenistan** refused to carry out field tests of *P. papaveracea*.[109]

For a more comprehensive review of political opposition, please see the Sunshine Project's Backgrounder #3, "Biological Weapons in the Drug War, A Review of Opposition in South America" (November 2000) and updates available on our website (www.sunshine-project.org).

IX RECOMMENDATIONS

Concerted intergovernmental action is necessary to counter the panoply of negative consequences of the development and use of biological eradication agents. Governments should conclude that recent successes in opposing field tests of *Fusarium* in Colombia mean that the issue is over. Far from it: Research on anti-cannabis and anti-coca agents is continuing in secretive US experiments while Pleospora research is advanced – ready for possible field use in 2002. Neither the US nor UNDCP have renounced their objective of deploying biological eradication agents in the Drug War. Each continues to pressure countries with illicit crops. Once a biological agent is used on one country, pressure will increase on others to submit to biological eradication, leading to a dangerous escalation of the drug war.

Unless the international community acts quickly, shortsighted proponents of biological eradication will push until they succeed. According to Rand Beers, chief of the US State Department's anti-narcotics unit, "*I am never prepared to admit that it* [biological eradication] *is over.*"[110] Beers has been (at least temporarily) promoted by the Bush Administration and is now acting director of global affairs for the US State Department.

A combination of the following actions is urgently necessary to prevent the deployment of pathogens – biological weapons – in the Drug War. In chronological order, they are:

• The **Subsidiary Body on Scientific, Technical, and Technological Advice** (SBSTTA) of the **Convention on Biological Diversity** (CBD) should recommend, at its 6th Meeting in March 2001, under its agenda item on invasive alien species, that the use of biological agents to eradicate illicit crops be prohibited as contrary to the Convention's objectives of conservation, sustainable use, and equitable sharing of benefits of biodiversity and, in particular, the CBD's provisions on liability for transboundary damage to biodiversity (Art. 3), the rights of indigenous peoples and local communities, and conservation of agricultural biodiversity, including soil diversity and that of complex ecosystems. The Conference of the Parties to the CBD, at its 6th meeting in March 2002, can act on this recommendation and adopt such a resolution.

• The large number of countries who are opposed to biological eradication can speak up at the United Nations **Commission on Narcotic Drugs** (CND) meeting in March 2001. The CND can pass a resolution instructing the UNDCP Director to renounce the use of biological agents in drug eradication, to immediately terminate all such ongoing research, and to restrict cooperation with countries developing biological agents. This decision can be based on the health and environmental impacts of biological agents and concerns on biological weapons proliferation. Governments may also wish to assess the possibilities for leadership on this issue offered by candidates for the post of UNDCP Director, which is currently up for replacement (or renewal).

• As desirable as a reduction in the support of illicit drugs may be, the poorly conceived and dangerous biological eradication strategy poses threats to human health. The **World Health Organization** (WHO), meeting at the World Health Assembly in May 2001, should pass a resolution expressing deep concern over the biological agents as a drug control strategy and unambiguously establish that no such agents can be used until an intergovernmental team of health experts, wholly independent of UNDCP and the US government, conclusively establishes that all candidate plant pathogens do not present direct and indirect health risks to farmers, their families, indigenous peoples, and traditional and illicit users of target species.

• Not content to merely undermine the Anti-Ballistic Missile Treaty with a National Missile Defense, US support for biological eradication agents is an attack on another important international arms control agreement, the **Biological and Toxin Weapons Convention** (BTWC). The international community must swiftly and conclusively reject the incorrect arguments that biological weapons prohibitions do not apply to illicit crop eradication because eradication is conducted under color of law enforcement. Failure to do so could result in a dangerous slide down the slippery slope of biological weapons proliferation. At its 5th Review Conference in November 2001, the BTWC should act to prevent the creation of loopholes by affirming in its Final Declaration that there is no exemption in the Convention to allow the development and stockpiling of biological weapons for law enforcement.

Taking these actions promptly will ensure that biological agents are never be used in the Drug War, thereby upholding global consensus against the use of biological weapons and protecting farmers, indigenous peoples, and all people against health and environmental damages resulting from their use.

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[1] See Rufford N in *Sunday Times* 28 June 1998, "Britain funds biological war against heroin." UNDCP project document AD/RER/98/C37 meaningfully argues "*the Institute of Genetics is well versed in all aspects of confidentiality*."

[2] UNDCP Project Document No. AD/RER/98/C37.

[3] UNDCP Project Document No. AD/RER/98/C37.

[4] O'Neill NR, Jennings JC, Bailey BA, Farr DF 2000. *Dendryphion penicillatum* and *Pleospora papaveracea*, Destructive Seedborne Pathogens and Potential Mycoherbicides for *Papaver somniferum*. Phytopathology 90:691-698.

[5] Hildebrand D, McCain A 1978. The Use of Various Substrates for Large-Scale Production of *Fusarium oxysporum* f. sp. *cannabis* Inoculum. Phytopathology, 68:1099.

[6] Bigwood J 2000. The Drug War's Fungal "Solution" in Latin America. George Washington University and Washington Office on Lartin America Andean Lecture Series, 8 December. Online at: http://jeremybigwood.net/Lectures/GWU-WOLA-JB/GWUNov2000.htm

[7] UNDCP Project Document No. AD/RER/98/C37.

[8] US State Department Cable 1999STATE091579, obtained by independent researcher Jeremy Bigwood under the Freedom of Information Act.

[9] Clinton W 2000. Memorandum of Justification in Connection with the Waivers under Section 3201(a)(4) of the Emergency Supplemental Act, as Enacted in the Military Construction Appropriations Act 2001, 23 August.

[10] BBC Panorama, "Britain's Secret War on Drugs". 2 October 2000, URL: http://news.bbc.co.uk/hi/english/audiovideo/programmes/panorama/newsid_948000/948102.stm

[11] See Sunshine Project News Release of 24 January 2001, URL: http://www.sunshine-project.org/publications/pr250101.html

[12] Shoemaker RA 1968. Type studies of *Pleospora calvescens*, *Pleospora papaveracea*, and some allied species. Can J Bot 46:1143-1150.

[13] Farr D, O´Neill N, van Berkum P 2000. Morphological and molecular studies on *Dendryphion penicillatum* and *Pleospora papaveracea*, pathogens of *Papaver somniferum*. Mycologia 92 :145-153.

[14] Gravesen S, Frisvad J, Samson R 1994. Microfungi. Munksgaard, Copenhagen

[15] Barnes, W. "Fears give reprieve for opium fields Killer fungus could hit other crops" in *South China Morning Post*, 4 October 2000.

[16] United States Office of National Drug Control Policy 2001. 2001 Annual Report, p. 175.

[17] O'Neill NR, Jennings JC, Bailey BA, Farr DF 2000. *Dendryphion penicillatum* and *Pleospora papaveracea*, Destructive Seedborne Pathogens and Potential Mycoherbicides for *Papaver somniferum*. Phytopathology 90:691-698

[18] United States Office of National Drug Control Policy 2001. 2001 Annual Report, 174.

[19] Sands told the BBC that the advantage of this method would be to prevent farmers from moving the crops to new areas, which would be unsuitable for coca cultivation.

[20] David Sands in a letter to the Office of Chief Counsel, DEA, dated 10 March 1989. Released under FOIA to independent researcher J. Bigwood

[21] Hennequin C, et al. 1999. Identification of *Fusarium* species involved in human infections by 28S rRNA gene sequencing. J Clin Microbiol 37:3586-3589

[22] Sander A, Beyer U, Amberg R 1998. Systemic *Fusarium oxysporum* infection in an immunocompetent patient with an adult respiratory distress syndrome (ARDS) and extracorporal membrane oxygenation (ECMO). Mycoses 41:109-111

[23] Boutati, EI, Anaissie E 1997. *Fusarium*: A significant emerging pathogen in patients with hematologic malignancy: Ten years' experience at a cancer center and implications for management. In *Blood* 90:999-1008.

[24] Hue FX, Guerre M, Roouffault MA, deBievre C 1999. Specific detection of *Fusarium* species in blood and tissues by a PCR-technique. J Clin Microbiol 37:2434-2438

[25] Boutati, EI, Anaissie E 1997.

[26] Peltroche-Llacsahuanga H et al. 2000. Case Report: Pathohistological findings in a clinical case of disseminated infection with *Fusarium oxysporum*. Mycoses 43:367-372

[27] Sander A, Beyer U, Amberg R 1998.

[28] Peltroche-Llacsahuanga H et al. 2000.

[29] Hennequin C, et al. 1999.

[30] Boutati, EI, Anaissie E 1997 and Sander A, Beyer U, Amberg R 1998.

[31] Peltroche-Llacsahuanga H et al. 2000.

[32] Sander A, Beyer U, Amberg R 1998 and Engelhart S 1997. Infektiöse Schimmelpilzerkrankungen am Beispiel der Aspergillose. In: Keller R (ed), Biogene Luftschadstoffe in Wohn- und Aufenthaltsräumen. Schriftenreihe des Inst. Med. Mikrobiologie Universität Lübeck.

[33] Hue FX, Guerre M, Roouffault MA, deBievre C 1999. Specific detection of *Fusarium* species in blood and tissues by a PCR-technique. J Clin Microbiol 37:2434-2438

[34] "U.S. seeks to test fungus that kills coca" in *Miami Herald* 3 July 2000.

[35] Dr. Mike Rinaldi, medical mycologist at the University of Texas Health Science Center San Antonio, personal communication with the Sunshine Project, 8 August 2000.

[36] FAO. Nutritional Country Profiles: Colombia, n.d.

[37] ENDES 1996, published in "Plan nacional de nutrción y alimentación". Presidencia de la República (Peru), August 1998.

[38] FAO. The State of Food Insecurity in the World: 2000. Rome, 2000.

[39] Sander A, Beyer U, Amberg R 1998.

[40] Deodhar L et al. 1996. *Fusarium oxysporum* - A rare fungus infection in a diabetic patient. Paper presented at the 36th Monthly Research Meeting of the Medical Research Centre, Bombay Hospital on 8 April 1996. URL: http://www.bhj.org/journal/1996/3804_oct/abstract_03.htm

[41] Marasas et al. 1984. Toxigenic Fusarium species. Penn State University (see parts at www.mycoherbicide.net)

[42] Kim-Jin-Cheol; Lee-Yin-Won (1994) Sambutoxin, a new mycotoxin produced by toxic Fusarium isolates obtained from rotted potato tubers. Applied-and-Environmental-Microbiology 60 (12) 4380-4386 and Gravesen S, Frisvad JC, Samson RA 1994.

[43] WHO International Programme on Chemical Safety, Environmental Health Criteria 219: Fumonisin B1. WHO, Geneva, 2000.

[44] Ganguli S. et al. 1996. Neuropharmacological studies of *Fusarium* toxins II : Total toxin extract from *F. oxysporum*. Indian Journal of Experimental Biology 34:418-426

[45] Cantalejo MJ, Torondel P, Amate L, Carrasco JM, Hernandez E 1999. Detection of fusarin C and trichothecenes in *Fusarium* strains from Spain. Journal of Basic Microbiology 39:143-153

[46] Marasas et al. 1984 and Reiss J 1986. Schimmelpilze. Springer Verlag, Berlin

[47] Seo JA, Kim JC, Lee YW 1999. N-Acetyl derivatives of type C fumonisins produced by Fusarium oxysporum. J Nat Prod 62:355-357.

[48] Marasas et al. 1984.

[49] Rolling Text, 19th Session, March 2000, p. 142-146. Annex A.I. Lists and Criteria. Under D. Toxins, Trichothecene toxins are listed without brackets, indicating inclusion of trichothecenes is currently agreed by all negotiating parties. The Rolling Text can be found at http://www.brad.ac.uk/

[50] WHO. Environmental Health Criteria 105 – Selected mycotoxins: ochratoxins, trichothecenes, ergot. WHO, Geneva, 1990.

[51] WHO. Environmental Health Criteria 105.

[52] WHO International Programme on Chemical Safety, Environmental Health Criteria 219: Fumonisin B1. WHO, Geneva, 2000.

[53] Doyle E 1997. Food Research Institute, UW-Madison. In http://www.wisc.edu/fri/fusarium.htm

[54] J.F. Shanahan, W.M. Brown Jr. Aflotoxins. Colorado State University. In http://www.colostate.edu/Depts/CoopExt/PUBS/CROPS/00306.html

[55] Ganguli S. et al. 1996. Neuropharmacological studies of *Fusarium* toxins II: Total toxin extract from *F. oxysporum*. Indian Journal of Experimental Biology 34:418-426.

[56] Ganguli S. et al. 1996. Neuropharmacological studies of *Fusarium* toxins III: Neurochemical investigations on total toxin extracts from *F. moniliforme* and *F. oxysporum*. Indian Journal of Experimental Biology 34:531-534.

[57] WHO Environmental Health Criteria 105. See also: Turco E, Broggio M, Ragazzi A 1999. Enzymes produced by *Fusarium oxysporum* f.sp. *vasinfectum* compared on a saline and a non-saline substrate. Zeitschrift Pflanzenkrankheiten Pflanzenschutz 106:333-341.

[58] Minutes of the Annual Meeting of the Regional Research Project S-268 "Discovery and Development of Plant Pathogens for Biological Control of Weeds" Falmouth, Massachusetts April 14-16, 1999. URL: http://ipmwww.ncsu.edu/biocontrol/bcwg/s268-99.html.

[59] de Hoog GS, Guardo J 1995. Atlas of clinical fungi. Centraalbureau voor Schimmelcultures, Baarn and Delft, The Netherlands.

[60] Pereiro M et al. 1997. Superficial white toenail onychomycosis due to *Fusarium oxysporum*: A case reported and review of the literature. Journal de Mycologie Medicale 7:219-222, Gianni C et al. 1997. Unusual clinical features of fingernail infection by *Fusarium oxysporum*. Mycoses 40:455-459.

[61] Gianni C et al. 1997.

[62] Chodosh J, Miller D, Tu EY, Culbertson WW (2000) Tobramycin-resonsive *Fusarium oxysporum* keratitis. Can J Ophtalmol 35:29-30.

[63] Alexandrakis G 1999. Fungal keratitis. http://www.emedicine.com/oph/topic99.htm

[64] See http://pollenuk.worc.ac.uk/Aero/FUNGI/intro.htm Also, the Allergy-Immunology Department of the Walter Reed Army Medical Center in the USA lists *Pleospora spp*. as a possible allergen. See http://www.wramc.amedd.army.mil/departments/allergy/cael/moleng.htm.

[65] See: http://www.tau.ac.il/~ibs/pollen/pollen_alert.html

[66] Annex of UNDCP Project Document AD/RER/98/C37.

[67] Perry LP et al. 1998. Pulmonary mycotoxicosis: a clinicopathologic study of three cases. Mod Pathol 11:432-436.

[68] Paraquat (1,1'-Dimethyl-4,4'-bipyridinium dichloride) is also known as or sold under the names: Gramoxone, Dextrone X, Esgram, Cleansweep, Weedol, Dexuron, TotaCol, Gramuron, Para-Col, Pathclear, and Gramonol (Source: International Chemical Safety Card #0005).

[69] Hollister LE 1986. Health Aspects of Cannabis. Pharmacological Reviews 1986.

[70] Turner CE et al 1978. Detection and analysis of confiscated marijuana samples. UNDCP Bulletin on Narcotics 4:005. URL: http://www.undcp.org/bulletin/bulletin_1978-01-01_4_page006.html.

[71] Jelsma, M. Fungus versus Coca. Transnational Institute (Amsterdam), Feb 2000. URL: http://www.tni.org/drugs/links/fungus.htm

[72] Alvarez, Elena. 1990. "Reasons for the Expansion of Coca Exports in Peru". In Committee on Govermental Affairs, United States Senate. "Cocaine Production, Eradication and the Environment: Policy Impact and Options. Proceedings of a seminar held by the Congressional Research Service. 14 February 1990.

[73] Acosta Solis, M. 1992. Vademecum de Plantas Medicinales del Ecuador, Abya Ayala, Quito.

[74] Constanino, E. 2000. "Posible Impacts of the Massive Use of Biological Agents in the Colombian Amazon", presentation at the international seminar The War on Drugs and the Use of Biological Weapons, Quito, Ecuador, October 10-11, 2000.

[75] Constanino, E. 2000.

[76] In "Alma Ata Fusaria Pathogenicity Testing in *Cannabis sativa*", May, 1994 (USDA research report obtained under the US Freedom of Information Act).

[77] Sands D et al 1997. Characterization of a vascular wilt of *Erythroxylum coca* caused by *Fusarium oxysporum* f.sp. *erythroxyli* Forma specialis Nova. Plant Disease 81:501-504.

[78] Kistler HC 1997. Genetic diversity in the plant pathogenic fungus *Fusarium oxysporum*. In Phytopathology 87:474-479.

[79] Clark CA, Hyun JW, Hoy MW 1998. Relationschips among wilt-inducing isolates of *Fusarium oxysporum* from sweetpotato and tobacco. Plant Disease 82:530-536.

[80] 47% of inoculated radishes and 20% of inoculated carnations were seceptible to the "tomato" Fusarium. See: Garcés de Granada E, Orozco de Amézquita M, Rocío Bautista G, Valencia H. (in press) *Fusarium oxysporum* el hongo que nos falta conocer, National University of Colombia (Bogotá).

[81] Institute of Biological Control. n.d. "Progress Report on USDA Weed Pathology Project (Fox 916) December 1994-Nov. 1995.

[82] Garcés de Granada E, Orozco de Amézquita M, Rocío Bautista G, Valencia H. (in press) *Fusarium oxysporum* el hongo que nos falta conocer, National University of Colombia (Bogotá).

[83] Calderon E 2000. 'Listas Rojas' preliminares de plantas vasculares de Colombia, April 2000, Instituto de Investigación de Recursos Biológicos "Alexander von Humboldt", URL : http://www.humboldt.org.co/Listas_Preliminares.htm.

[84] Farr DF, O´Neill NR, van Berkum PB 2000.

[85] Encyclopaedia Britannica Online at http://members.eb.com

[86] Wiersema J, Leon B 1999. World Economic Plants: A Standard Reference. Available online at http://www.ars-grin.gov.

[87] Meffert ME 1950. Ein Beitrag zur Biologie und Morphologie der Erreger der parasitären Blattdürre des Mohns. Z. Parasitenkunde 14:442-498.

[88] Annex of UNDCP Project Document No. AD/RER/98/C37.

[89] Annex of UNDCP Project Document No. AD/RER/98/C37.

[90] US Department of Agriculture, ARS-GRIN Taxonomic Database, http://www.ars-grin.gov.

[91] Crivelli PG 1983. Über die heterogene Ascomycetengattung *Pleospora* RABH. Dissertation Zurich, Switzerland.

[92] Murasheva-V-N; Sizova-T-P 1995. Consequences of applying broomrape fusaroid wilt to the soil. Mikologiya-i-Fitopatologiya 29 (5-6) 41-45.

[93] Souheil H, Vey A, Thuet P, Trilles JP 1999. Pathogenic and toxic effects of *Fusarium oxysporum* (Schlecht) on survival and osmoregulatory capacity of *Penaeus japonicus* (Bate). Aquaculture 178:209-224.

[94] Varma-Ashok, Tandan BK 1996. Pathogenicity of three entomogenous fungi against insect pests of sugarcane. J Biol Control 10:87-91.

[95] Overhead Slide Presentation by the USDA Agricultural Research Service at the 1999 US Office of National Drug Control Policy International Technology Symposium.

[96] "Biological control is an ecological strategy aimed at controlling insect pests, weeds and diseases, through the use of parasitoids, predators, entomopathogens, antagonists and competitors." (From Scientists statement on use of biological agents in forced drug eradication.) Another standard definition of biological control is "Suppression or prevention of a pest outbreak due to purposeful manipulation of natural enemies". From: Biological Control Principles by Rob Wiedenmann (Illinois Natural History Survey) and Cliff Sadof and Bob O'Neil (Purdue) at http://www.entm.purdue.edu/Entomology/research/cs/mg/mg_pdf/BCPrincip.htm

[97] Article 1 of the Biological and Toxin Weapons Convention reads: "Each State Party to this Convention undertakes never in any circumstances to develop, produce, stockpile or otherwise acquire or retain: (1) Microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes." Full text at http://www.fas.org/nuke/control/bwc/text/bwc.htm

[98] Nyholm was interviewed by *El Tiempo* for "Conflicto disparó producción de drogas", 25 January 2001.

[99] Clinton W 2000. Memorandum of Justification for Presidential Determination 2000-28.

[100] In addition, numerous small communities of *campesinos* and indigenous peoples in coca-growing areas barter coca with communities of coca chewers in higher regions for cold zone crops such as potatoes. These exchanges are fundamental to the economy and food security of many small Andean farming communities.

[101] United Nations Economic and Social Council. E/CN.7/1996/11.

[102] Australian Therapeutic Goods Administration PR-129: Planned release of GMO (*P. somniferum*) oilseed poppy. This application for a field trial in 2000/2001 performed by Glaxo Wellcome Australia in Tasmania was approved by the regulatory authorities. Poppies had been altered to modify the alkaloid pathway. View the document at www.health.gov.au/tga/gene/gmac/pr129.htm. Similarly, German researchers are working (with funds of the German chemical industry) to identify key genes in the morphine synthesis of opium poppy. See Unterlinner B et al. 1999. Molecular cloning and functional expression of codeinone reductase: the penultimate enzyme in morphine biosynthesis in the opium poppy *Papaver somniferum*. Plant Journal 18:465-475.

[103] Bragg R "Marijuana-Eating Fungus Seen as Potent Weapon, but at What Cost?" *New York Times*, 17 July 1999.

[104] Decreto Supremo 0004-2000-AG of 23 March 2000.

[105] Acuerdo Minsterial 162 of 20 July 2000.

[106] See: http://www.comunidadandina.org/document/declar/7-9-00.htm

[107] See: http://www.mre.gov.br/acs/interclip/pb/pbbv1ea171001.htm

[108] German Parliament Resolution No. 14/3766 at http://dip.bundestag.de/btp/14/14113.pdf , page 10732, and Deputy Minister Vollmer's statement at http://dip.bundestag.de/btp/14/14113.pdf , page 10731.

[109] ODCCP Regional Office for Central Asia. Monthly Situation Report – Uzbekistan (January 2000): AD/RER/98/C32.

[110] Rand Beers was interviewed by BBC Panorama 2000.