**If present trends continue, the world in 2000 will be more crowded, more polluted, less stable ecologically, and more vulnerable to disruption than the world we live in now.**
Council on Environmental Quality
*Global 2000 Report*, 1980

## The Price of Cigarettes

The direct costs of smoking cigarettes are well known: more than 400,000 people die each year in the United States from tobacco-related diseases such as lung cancer and heart disease, according to the Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia. Less well recognized are the indirect effects smoking has on the environment, particularly the production of waste from consumption (including paper and plastic packaging and cigarette butts) and the deforestation associated with tobacco farming.

**No butts about it.** The environmental costs of tobacco products are more than just smoke.

"The waste products of cigarettes are clearly visible whenever you walk down the street or use a public beach," says Thomas E. Novotny, a public health physician at the CDC. After analyzing the available data on cigarette consumption, Novotny and colleague Feng Zhao concluded that cigarette debris requires attention from environmental groups, industry, and government. The results of their study were published in the August 1999 issue of *Tobacco Control*.

Worldwide, an estimated 5.5 trillion commercially produced cigarettes were consumed in 1995 (the last year for which statistics are available) and 83% of cigarettes were filter-tipped. Filters and plastic wrap from packages remain in the environment for long periods. Cigarette filters contain cellulose acetate, which persists under normal environmental conditions for 18 months or longer. Moreover, cigarette butts pose a health hazard to children and animals if they eat them.

In Australia, cigarette butts ranked sixth among all items of trash collected from roads, parks, and public facilities on one recently monitored cleanup day. Volunteers with the Washington, DC-based Center for Marine Conservation participate in the International Cleanup Project along shorelines in 90 countries each year. According to the center, in the 1998 cleanup, cigarette butts were the leading item collected, accounting for almost 24% of all items found. Cigarette butts were nearly four times as likely to be found as the next most frequently found items (pieces of plastic).

In addition to the waste generated by cigarette consumers, the tobacco manufacturing process itself produces liquid and solid wastes. Novotny and Zhao's research showed that in 1995 worldwide tobacco manufacturing produced 2.26 billion kilograms of solid waste and 209 million kilograms of chemical waste. Ironically, the trend toward "healthier" low-nicotine cigarettes spawns nicotine as a waste product. The U.S. Environmental Protection Agency (EPA) includes nicotine on its Toxics Release Inventory, a list of hazardous chemicals that require special disposal. "The tobacco industry is moving manufacturing processes to developing countries, and this has environmental consequences," says Novotny, who explains that developing nations generally lack environmental watchdogs such as the EPA.

To remedy tobacco waste problems, Novotny and Zhao propose enforcing laws against cigarette butt littering, levying taxes on cigarettes to offset cleanup, forcing the tobacco industry to improve the biodegradability of filters and packaging, and increasing public awareness of the magnitude of the waste problem. "We should insist that tobacco companies and consumers become more environmentally responsible," says Novotny.

Just as litter is an offshoot of tobacco consumption, so deforestation is the result of tobacco production, argues geographer Helmut Geist of the University of Louvain in Belgium. According to research by Geist published in the same issue of *Tobacco Control*, between 1991 and 1995 an estimated 200,000 hectares of forests worldwide were removed to make way for tobacco farming each year, mostly in developing countries in Africa, Asia, and Latin America. In 1961, world tobacco production was 3.8 million tons, half of which was grown in developing countries. In 1998, world tobacco production reached 7.8 million tons, with 80% being grown in developing countries.

Woodlands are often considered free goods in developing countries, and are cut without concern for replacement. Trees are burned to cure (dry and flavor) tobacco leaves in barns (which are also built from local wood). Globally, tobacco curing requires 11.4 million tons of solid wood annually, according to Geist's study. Adding insult to injury, tobacco plants may replace the trees cut down and leach large quantities of vital nutrients from the soil. Although the environmental consequences of deforestation due to tobacco farming are not well studied, Geist suspects that soil erosion, nutrient depletion, changes in microclimates, and land degradation do occur. "Tobacco deserves to be integrated into research programs on global environmental change," he says.

## Herbal Authority

As consumers worldwide continue to buy medicinal herbs in an effort to find what they hope to be safer and more natural remedies, health care providers are finding themselves unable to answer their patients' questions or to predict the health effects of various herbal preparations. A collaborative project of the World Health Organization (WHO) Traditional Medicine Programme and three scientists from the University of Illinois at Chicago (UIC) College of Pharmacy may provide the answers physicians and patients alike are seeking. In June 1999 the WHO–UIC group published a comprehensive review titled *WHO Monographs on Selected Medicinal Plants, Volume I*, which covers the safety, efficacy, and quality requirements of some of the world's most commonly used medicinal plants.

The volume comprises 28 technical monographs covering 39 distinct species of medicinal plants, which were chosen because of their wide use. According to coauthor Gail Mahady, a research assistant professor in the Department of Medicinal Chemistry and Pharmacognosy (the study of the bioactive substances in organisms), the volume is intended for healthcare professionals, drug regulators, and people interested in technical information on medicinal plants. The monographs will act as guidance in the preparation of quality control standards, future monographs, and formularies for the use of the plants described.

According to a survey of trends in alternative medicine use that was published

in the 11 November 1998 issue of the *Journal of the American Medical Association*, U.S. consumers were spending as much as $5.1 billion annually on herbal products as of 1997. In addition, about 18% of all prescription drug users reported using herbal remedies or high-dose vitamins along with their prescribed medications, despite the fact that much is currently unknown about the drug interactions and contraindications of the herbal products so readily available to the public.

To compile the monographs, the WHO–UIC team, which also included Harry H. S. Fong, a professor of pharmacognosy in the Program for Collaborative Research in the Pharmaceutical Sciences in the College of Pharmacy, and Norman R. Farnsworth, director of the same program, systematically reviewed literature published around the world since 1975, relying heavily on another highly credible source of information on medicinal herbs, the Natural Products Alert, or NAPRALERT, database. This database, administered by the Program for Collaborative Research in the Pharmaceutical Sciences, contains over 100,000 citations from the world scientific literature on the safety and efficacy of herbal medicines, plants, marine organisms, and fungi. The writing team also reviewed various pharmacopoeias including the *European Pharmacopoeia*, the *Deutsches Arzneibuch*, and the *Farmakope Indonesia*, as well as monographs produced by other bodies such as Commission E, which researches and regulates medicinal herb use under the German government.

The first part of each monograph includes pharmacopoeial summaries of quality assurance—a description of each plant's botanical features, correct Latin binomial, geographical distribution, methods to identify the plant, purity requirements, chemical assays, and a listing of the major chemical constituents. This information may help with one of the biggest problems with commercially sold herbal remedies, which is that there is little or no standardization of the therapeutic dose of many medicinal plants. As matters stand, herbal products may not contain enough of the purported key ingredient to produce any beneficial effect or the product may not contain the correct part of the plant. In other cases, experts say, remedies may contain herbal ingredients whose dangers outweigh any beneficial properties.

The second part of each monograph describes medicinal uses, pharmacology, contraindications, warnings, precautions, adverse reactions, and dosage. This part is aimed at health care practitioners who may be faced with patients taking herbal products or who may wish to prescribe medicinal herbs themselves, and is written so that the busy clinician can quickly become familiar with each herb's medicinal properties without having to winnow through the entire pharmacology of the plant.

The WHO–UIC team's work was reviewed by a panel of over 120 authorities from 40 different countries. The panel included academics, experts in the field of herbal medicine, industry specialists, and regulatory authorities, including representatives from the U.S. Pharmacopeia, which establishes standards to ensure the quality of medicines intended for human and veterinary use. The team has already completed a second volume of 32 additional monographs that is scheduled for publication in early 2000. The researchers and the WHO are discussing the possibility of a third volume.

## EPA Sees the Light on Fluorescent Bulbs

Finalization by the U.S. Environmental Protection Agency (EPA) of a rule that places mercury-containing fluorescent bulbs under the Universal Waste Rule, regulated by the Resource Conservation and Recovery Act (RCRA), will encourage recycling and proper disposal of the bulbs by making it easier and cheaper to recycle them. The rule will thus reduce the amount of hazardous waste reaching municipal landfills. Placing fluorescent bulbs under this rule will "better protect public health and the

### WHO Monographs on Selected Medicinal Plants, Volume I*

*Allium sativum* **(garlic)**
*Aloe vera*
*Astragalus membranaceus* **(huang qi)**
*Brucea javanica* **(Chinese gall)**
*Bupleurum falcatum* **(thorow-wax)**
*Bupleurum falcatum* **var.** *scorzonerifolium*
*Cassia senna* **(senna)**
*Centella asiatica* **(gotu kola)**
*Chamomilla recutita* **(chamomile)**
*Cinnamomum verum* **(cinnamon)**
*Coptis chinensis* **(huang lian)**
*Coptis deltoides*
*Coptis japonica*
*Curcuma longa* **(turmeric)**
*Echinacea angustifolia* **var.** *angustifolia* **(coneflower)**
*Echinacea angustifolia* **var.** *strigosa* **(coneflower)**
*Echinacea pallida* **(pale purple coneflower)**
*Echinacea purpurea* **(purple coneflower)**
*Ephedra sinica* **(ma huang)**
*Ginkgo biloba*
*Glycyrrhiza uralensis* **(gan cao)**
*Paeonia lactiflora* **(Chinese peony)**
*Plantago afra* **(psyllium)**
*Plantago asiatica* **(che qian zi)**
*Plantago indica* **(black psyllium)**
*Plantago ovata* **(blond psyllium)**
*Platycodon grandiflorus* **(balloon flower)**
*Rauvolfia serpentina*
*Rheum officinale* **(Indian rhubarb)**
*Rheum palmatum* **(Chinese rhubarb)**
*Thymus vulgaris* **(common thyme)**
*Thymus zygis* **(Spanish thyme)**
*Valeriana officinalis* **(valerian)**
*Zingiber officinale* **(ginger)**

*Monograph covers varieties and select plant parts of the plants listed above.

environment from mercury contamination," said EPA administrator Carol M. Browner in a 28 June 1999 EPA press release.

Fluorescent lamps contain mercury, an essential compound for operation that generates ultraviolet rays that react with the bulb's phosphorous coating to emit fluorescent light. Because fluorescent bulbs have been inconsistently disposed of, specific numbers on the amount discarded are unavailable. However, according to the EPA, mercury-containing bulbs account for 3.8% of all mercury now going to municipal landfills. Such bulbs continue to be a health and environmental concern. Mercury toxicity can cause impaired growth and development, reduced reproductive success, and death in humans. Mercury bioaccumulates most efficiently in the aquatic food chain, where it's converted into toxic methylmercury by bacteria. The primary pathway of exposure for humans and wildlife is by eating fish contaminated with mercury.

**Lamps in the landfill.** A new EPA rule will make it easier to recycle fluorescent bulbs, thus preventing disposal of many such mercury-containing lamps in landfills.

The EPA's primary objective in placing mercury-containing bulbs under the Universal Waste Rule is to minimize mercury emissions into the environment while encouraging recycling and proper disposal of fluorescent bulbs. The rule also encourages the manufacture of bulbs with lower mercury content. Items that fall under the category of universal waste include trash—such as batteries and thermostats—that is often thrown out by households and small businesses. Under the Universal Waste Rule, consumers can avoid many of the previously more stringent regulatory requirements for storing, transporting, and collecting mercury-containing bulbs. For example, the rule extends the amount of time that companies can accumulate such materials on site and allows them to transport such waste via a common carrier instead of a hazardous waste transporter.

The new rule is aimed at large firms and government agencies, which account for the majority of disposed bulbs. The EPA claims that the rule is expected to save companies more than $70 million per year in compliance costs. Currently, companies who use the mercury-containing bulbs in small quantities are not subject to RCRA waste management standards; if the company produces less than 5,000 kilograms of hazardous waste in one month, wastes may be sent to a municipal solid waste landfill. By placing fluorescent bulbs under the federal Universal Waste Rule, the EPA is encouraging states to regulate such bulbs, providing more consistency between federal and state regulations in the management of this kind of hazardous waste. The new rule takes effect 6 January 2000.

## Botanists Plant Ideas

A recently completed project in bioengineering may help alleviate problems of iron and vitamin A deficiency around the world. Scientists at the Swiss Federal Institute of Technology's Institute of Plant Sciences in Zürich have modified rice grains—a staple of the diet of much of the world's population—to improve their content of vitamin A and iron. The results of this project were reported at the meeting of the 16th International Botanical Congress, held in August in St. Louis, Missouri. The congress, held once every six years, brings researchers together to present new knowledge of the intricate relationship between plants and humans. This year's meeting shed new light on topics that included plant bioengineering, global bioprospecting, and mapping the plant genome.

Rice grains normally are notoriously deficient in iron and vitamin A, said Ingo Potrykus, a professor of plant biology at the Institute of Plant Sciences. Because rice is the staple food in many developing countries, the lack of these nutrients contributes heavily to iron and vitamin A deficiency in human populations, which can lead to anemia, impaired intellectual development, and immune system dysfunction. About 400 million people are deficient in vitamin A and an estimated 5 million have become blind as a result, according to Potrykus. An even larger number are iron-deficient.

Potrykus and his colleagues have produced beta-carotene (which converts to vitamin A) in rice grains by inserting two genes from the daffodil (*Narcissus pseudonarcissus*) and one from the bacterium *Erwinia uredovora* into the rice's genetic makeup. The resulting rice grains meet requirements for vitamin A in a typical Asian diet. To increase the bioavailability of iron in the rice grain, Potrykus's team added a ferritin gene from the green bean (*Phaseolus vulgaris*) and a heat-stable enzyme phytase from the fungus *Aspergillus fumigatus* to reduce the inhibition of iron absorption. Also, a gene for cysteine-rich protein was added to enhance iron resorption. If the modified rice is proven to have no adverse environmental and human health effects, there are plans to distribute it free of charge through the International Rice Research Institute of Los Baños, the Philippines, and national agricultural research centers.

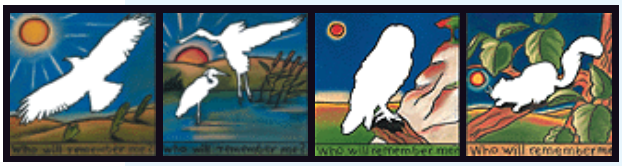
While Potrykus's group is concerned with distributing plant products to the world, other research is focused on locating and harvesting medically valuable plant materials from around the world. In West Africa, traditional healers have for many centuries used the fruit and seeds of the *Garcinia kola* tree, known as "bitter kola," to treat infectious diseases. This treatment has no apparent side effects. *In vitro* tests of the plant identified 46 biochemical principles that appear to kill

I. Potrykus, P. Beyer

**The rice remedy.** A new strain of rice that has been genetically engineered to contain loads of vitamin A and aid in iron absorption will help fight dietary deficiencies in people around the world.

bacteria and viruses, including the deadly Ebola virus, the cause of fatal hemorrhagic fever. "The same forest that yields the dreaded Ebola virus could be a source of the cure," said Maurice Iwu, executive director of the nongovernmental Bioresources Development and Conservation Programme in Silver Spring, Maryland. The program studies sustainable uses of tropical forests as alternatives to deforestation and provides management and technical support to development programs in tropical countries.

In global bioprospecting, however, identifying a *G. kola* or certain other medicine-containing species "would be considered lucky 'hits,'" said James Miller, associate curator of the Missouri Botanical Garden in St. Louis. "Normally, it is a slow, plodding process. The payoff could take 10–15 years to realize, from finding promising compounds in a plant to bringing a medicine to market," he estimated. Miller predicted that 1 prospect in 1,000 may contain a novel bioactive compound. Of those, perhaps 1 in 10 or even fewer may lead, directly or indirectly, to new drugs. The numbers, he said, may be a bit more optimistic for dietary supplements.




Other research presented at the congress concerned mapping the plant genome. "This story is not yet finished," said Christopher Somerville, the Stanford University-based director of the Department of Plant Biology of the Carnegie Institute of Washington, referring to a large international project that got under way in earnest in 1989 with the task of mapping and sequencing the genes of *Arabidopsis thaliana*, a plant of the mustard family that has become the white rat of plant researchers. *Arabidopsis* was chosen because its genome, consisting of about 23,000 genes, is only lightly masked by "junk" DNA (DNA that does not code genes).

As of July 1999, 80 million base pairs of an estimated total of 120 million had been sequenced, and completion of the project is expected in December 2000. At the completion of the project, *Arabidopsis* will be the only plant for which complete structural information is available for all of the genes. Plans are being made for a second phase of the mapping project in which the function of all 23,000 genes will be experimentally determined by 2010.

## Making Peace with the Environment

After being bombarded for so long with images of Balkan republics at war, it may be overlooked that before the first NATO shell fell in Kosovo, Central and Eastern Europe (CEE) was a land of tremendous natural resources and unique wildlife. Part of this territory has been designated one of Europe's six centers of biodiversity. It is home to 68% of Europe's mammal species, 74% of its bird species, 51% of its fish species, and 39% of European vascular plants. In addition, CEE also contains important freshwater aquifers and Europe's longest river, the Danube.

In an effort to protect these resources and provide a regionwide forum for addressing environmental problems, the Regional Environmental Center for Central and Eastern Europe (REC) was established in 1990. The REC Web site is located at http://www.rec.org/. Programs have been conceived to address problems from decaying nuclear reactors to untreated sewage that flows into the Danube. The REC has also found itself in the new role of estimating the environmental impact of the war in Yugoslavia.

On its home page, an Environmental News heading links visitors to the REC's newest reports, including one titled *Assessment of the Environmental Impact of Military Activity During the Yugoslavia Conflict* that brings to light the environmental health hazards created through years of ethnic conflict and 78 days of NATO bombing. The REC report states that more than 1,000 metric tons of toxic ethylene dichloride leaked into the Danube during air strikes. Elsewhere on the site, the REC reports that more than 150 tons of the toxic polychlorinated biphenyl pyralene was released from transformer stations as a result of NATO bombing. Just one liter of pyralene can pollute up to a billion liters of water. Other attacks on Serbian petrochemical industries have spilled large amounts of hydrochloric acid, chlorine, mercury, and other pollutants into the Danube just upstream from important Romanian reservoirs.

The conflict in Yugoslavia has also taken its toll on many of the environmental groups and initiatives that were started in the region before the war. The REC is seeking to unify the people of the Balkans under the banner of a civil environmental movement. Details of this initiative are found under the Environmental News link.

This link also contains *The Bulletin*, the REC's free online magazine. Quarterly issues of *The Bulletin* contain descriptions of REC programs in nontechnical language and news on everything from ecotourism to upcoming environmental conferences. The Summer 1999 issue is largely dedicated to the war in Kosovo.

Information on other REC activities can be found under the REC Programs link. The Business & Environment Program helps companies reduce pollution and encourages better communication between businesses and government, while the Sofia Initiatives are an effort by environmental leaders in CEE to identify the most urgent issues. Under the Japan Special Fund link, the Japanese government's $2.7-million effort to help remediate CEE sites is described. In one such project, new waste disposal processes are being developed for heavy metal pollution that was removed from around former leather factories in Siauliai, Lithuania, that had operated with almost no pollution controls.

The site also contains a Grants Program as well as online publications including policy papers, annual reports, and press releases.