The NEW YORK TIMES ran a long article July 5th explaining the theories of Bruce N. Ames, the controversial biochemist from Berkeley.[1] Ames' basic idea is that most of the poisons we ingest are natural toxins appearing in our food; from this, he concludes that money spent controlling industrial chemicals is largely wasted. The TIMES's story occupied 87 column-inches and contained only one sentence that challenged Ames, thus suggesting that Ames' ideas are almost beyond question.[2] That is not the case. Here is an incomplete list of problems with the Ames hypothesis:

1) Production and use of synthetic pesticides (and other synthetic organic chemicals) emits large quantities of hazardous materials into the environment. Workers and neighbors at manufacturing and waste disposal facilities are exposed to toxins. THE NATIONAL CANCER INSTITUTE'S CANCER MAPS REVEAL CANCER CLUSTERS NEAR INDUSTRIAL FACILITIES. IT IS VERY UNLIKELY THAT SUCH CLUSTERS OCCUR BY RANDOM CHANCE. In the TIMES, Ames acknowledged this problem when he said, "Environmental pollutants are not an important cause of cancer. They account for a tiny percent of cancers in Americans but might be a problem in people like farm workers who apply pesticides if they are heavily exposed." Or in anyone else heavily exposed, he might have added.

2) Natural toxins and pesticides that occur in vegetation do not build up in the environment; nature has ways of reassimilating (decomposing) them. On the other hand, the concentration of synthetic (human-created) pesticides and other synthetic organic chemicals is increasing in the environment. Synthetic pesticides are now measurable in groundwater in many states, and the concentrations are growing as time passes. Many pesticides, and industrial poisons such as PCBs, are measurable in all the world's oceans, and even in the polar ice caps. There is compelling evidence that wildlife is being harmed (in some instances, driven to extinction) by this buildup of exotic chemicals throughout the global ecosystem.[3]

3) Ames presents himself as an expert on cancer, yet he makes sweeping generalizations that go far beyond his studies of cancer. In this, he has abandoned science and taken up politics. (Ames opposes government regulation on principle.) He says, for example, "We're shooting ourselves in the foot with environmental regulations that cost over 2 percent of the G.N.P., much of it to regulate triva." Even if it were true that industrial chemicals cause only a small fraction of all cancers, cancer is not the only problem that we should consider when we examine the wisdom of dumping billions of pounds of pesticides and other industrial poisons into the environment each year. During the past decade, much new information has come to light indicating that many chemicals damage the nervous, immune and endocrine systems of wildlife (fish, birds, and mammals) and humans. According to these studies, one clear result is reproductive and developmental damage in the affected species, and an increased likelihood of succumbing to bacterial and viral infections as well as cancers. Ames ignores the non-cancer effects.

To cite but one example, the National Academy of Sciences acknowledged in a 1992 study, "In the general population, increasing numbers of people suffer from disorders of the immune system, such as allergies, asthma, and AIDS. The incidence of asthma[4] has increased 58% since 1970, and it is well known that nitrogen dioxide and ozone, common air pollutants, interact with allergens to increase the frequency and severity of asthma attacks."

4) Chemical toxicity and exposures are poorly understood because current knowledge is based on:

(a) chemical tests that do not take into consideration children and the elderly, people who are already sick from something else, and populations that eat unusual quantities of one or more food items (e.g., native people who eat a lot of fish);

(b) chemical tests that omit the combined effects of multiple exposures because science has no affordable way of assessing combined and cumulative effects.

This is a point worth emphasizing because Ames makes sweeping generalizations based on data derived from testing one chemical at a time, as if combinations of chemicals don't occur in the real world.

A recent study focused on this problem. In June, three scientists from the National Institute for Occupational Safety and Health (NIOSH) in Cincinnati, Ohio announced an "inherent problem with the way workplace risks are characterized."[5] The "inherent problem" is that workers are usually exposed to many contaminants simultaneously, while "health standards are almost always designed to protect workers from a single exposure." In 25 percent of cases studied, the NIOSH researchers reported what they called an "alarming finding." They reported that, "when animals were exposed to several [chemical] agents at once, the animals (or their offspring) experienced a dramatically increased number of adverse health effects." "In fact," the NIOSH researchers said, "the reported health effects were many times greater than expected by simply adding the effects of each substance." (They also found, in 25% of cases, that combinations of chemicals produced FEWER effects than they would have expected.)

The NIOSH researchers reported that exposure of rats to the common plasticizer, di(2-ethylhexyl) phthalate (DEHP), produced prenatal death in 16 percent of the fetuses and congenital defects (birth defects) in 21 percent of the surviving fetuses. Exposure of rats to caffeine produced prenatal death in about 9 percent of fetuses and defects in 3 percent of the surviving fetuses. However, exposure to DEHP and caffeine simultaneously produced prenatal death in 80 percent of the fetuses and defects in 73 percent of the surviving fetuses.

The researchers point out that risk assessments should consider not only job-related chemical exposures but also prescription and non-prescription drugs. In addition, they say physical agents such as vibration, heat and noise must be considered as well. (And, if Ames is correct in his estimate of the potency of natural toxins in our food, natural toxins must be factored in too.)

The NIOSH team points out that, in nearly every work environment, there is a pervasive physical agent: non-ionizing electromagnetic radiation. One type of non-ionizing radiation, radio-frequency (RF) radiation, is used in a number of industries, including communications, electronics, medical and manufacturing. Many workers in these industries are exposed to RF energy at the same time they are exposed to exotic chemicals.

For years, RF exposures were assumed to be benevolent because they do not ionize (knock electrons off of) molecules or cells the way higher-energy radiation (ionizing radiation, such as x-ray energy) does. To test the hypothesis that RF might enhance the effects of chemicals, the NIOSH researchers exposed rats to a combination of 2-methoxyethanol (2ME) and RF energy. 2ME is a common glycol ether used in some degreasing solvents, and in some paints and varnishes. Alone, 2ME causes developmental toxicity in every species of animal tested to date, including non-human primates (monkeys). To test the interaction of RF energy and 2ME, rats were exposed to these substances on the 13th day of gestation, alone and in combination. RF radiation caused malformations in 30 percent of the rat fetuses, and 2ME produced malformations in 14 percent. Yet, combined exposure to 2ME and RF induced external malformations in 76 percent of the fetuses, "and these malformations were more severe than after single-agent exposure," the NIOSH researchers reported. Subsequent studies of

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different doses during various gestation times confirmed these findings, they said.

Another study reported by the NIOSH researchers indicates that noise and solvents combine to induce hearing loss in workers to a greater degree than either solvents or noise alone. They studied 200 workers (50 controls, 50 exposed to noise, 39 exposed to organic solvents alone, and 51 exposed to noise and toluene, a common organic solvent). The authors concluded that simultaneous occupational exposure to excessive levels of toluene and noise increased the probability of developing hearing loss. The NIOSH workers summarized, "The effect of combined exposure also suggested a synergistic [multiplier] interaction between noise and toluene on hearing loss. The level of hearing loss was much greater in workers exposed to both hazards than would be predicted by adding the effect of each agent."

Thus we can see that Bruce Ames—and others like him who belittle effects of chemicals on human and environmental health based on incomplete data and erroneous assumptions—may be underestimating the true hazards because they test only one substance at a time. Humans almost never encounter substances one at a time. Toxins in food, drugs (both pharmaceutical and "recreational"), air pollution, water pollution, noise, vibration, heat, electromagnetic radiation and ionizing radiation usually impact us simultaneously. They not only cause cancer but they affect the nervous, endocrine and immune systems in ways that are poorly understood. Risk assessment has no way to take into account such complex and cumulative interactions. The only approach that can consider all these effects together is prevention, the principle of precautionary action. (See RHWN #284, #319, and #378.) Bruce Ames represents solid 19th-century toxicological thinking, but a complex technological world requires that we adopt more modern and more prudent views, based on real-world exposures to combinations of natural and industrial hazards. For developing such a modern approach, many of Bruce Ames's sweeping generalizations are not only wrong and wrong-headed; they are also largely irrelevant.

--Peter Montague

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[2] In Brody, cited above, David Rall, former director of the National Institute of Environmental Health Sciences, says Ames's generalizations are based on "incomplete data" since "most of the chemicals we're exposed to haven't been tested for carcinogenicity."


Descriptor terms: bruce ames; cancer; carcinogens; policies; immunotoxicity; immune system; nervous system; endocrine system; niosh; occupational safety and health; standards; regulations; studies; teratogens; dehp; caffeine; electromagnetic fields; radio frequency radiation; non-ionizing radiation; 2-methoxyethanol; glycol ether; 2me; toluene; solvents; hearing loss; noise; synergism; multiplier effect; precautionary principle; prevention;