Arsenic: Poison turned carcinogen

Still reeling from the barrage of criticism they have faced since the news broke of vinyl chloride-related cancers (see p. 154), two large U.S. chemical firms are beating the critics to the petition in a new area. Dow and Allied chemical companies submitted, and the Government last week released, studies on the cancer danger of exposure to inorganic arsenic, a widely used industrial chemical. As many as 1.5 million American workers and countless consumers are exposed to the carcinogen, the Occupational Safety and Health Administration (OSHA) estimates.

Although arsenic compounds have been suspected for decades to be a cause of human skin cancer, routine industrial health measures presumably protected workers from that danger and the highly toxic effects of arsenic ingestion. But monitoring of death certificates turned up a pattern of suspiciously high cancer rates among arsenic workers, so Dow and Allied contracted independent studies.

The Dow study shows that among former workers in a Midland, Mich., arsenic plant (closed since 1956), about a third of the 178 workers exposed during the plants' 32-year operation have died of cancer. The Allied study reports that of 27 workers who died during the last 13 years after exposure in a small Allied arsenic plant in Baltimore, 19 died from cancer. Lung and lymphatic cancer rates were found to be six and seven times higher than expected for male workers.

An Allied spokesman emphasizes that the Baltimore plant recently changed its arsenic manufacturing process to cut down on worker exposure, and that only long-term fairly high-level exposures are implicated.

Arsenic compounds are used in the manufacture of metal alloys, ceramics, dyes, drugs and glass; in garden and farm pesticides; as a defoliant during cotton harvesting; as a growth stimulant for livestock and poultry; as a wood treatment to prevent rot, and for the control of sludge in lubricating oils.

OSHA will conduct hearings later this month on tightening arsenic exposure standards from their present level of 0.5 milligrams per cubic meter to the proposed 0.05 milligrams per cubic meter. Dow and Allied are supporting the change, but several other firms have objected (before this latest evidence).

Setting minimum exposure levels is often difficult without solid scientific data on the health effects from low-level exposures. William Lloyd, director of the occupational health surveillance office of the National Institute of Occupational Safety and Health, says the 0.05 milligram standard would "definitely reduce the incidence of disease." But Lloyd says the institute will reassess the proposed standard in light of the new evidence to decide whether to recommend an even stricter standard.

Allied spokesman Norman Harington told SCIENCE NEWS the company has contracted for additional independent epidemiological studies on threshold levels and dose effects to help set meaningful exposure standards.

One OSHA administrator says he is worried about consumer exposure to arsenic in home and garden pesticides and in commercial poultry and swine. Research is needed on arsenic compounds in the food chain, he says. Food and Drug Administration poultry science division chief Paul D. Lepore says that although inorganic arsenic is used to make feedstock growth-promoting drugs, the drugs themselves are organic arsenicals that have been thoroughly tested on animals and "have been shown not to be carcinogenic."

If the Dow and Allied studies have a bright side, it is that a controversy of many years duration has ended. Until now, there has been no proof that inorganic arsenic is carcinogenic in man. The proof is now strong. □

Animal virus used on cancer patients

It has been close to a century since scientists have been trying to prove that cancer is caused by a virus. The proof is in for some animal cancers, but not yet with human cancers. However, working on the premise that animal cancer viruses share characteristics with putative human cancer viruses, scientists in Texas, Maryland and Tennessee have accomplished something new. They have used an animal cancer virus to immunize cancer patients.

Their results, published in the August JOURNAL OF THE NATIONAL CANCER INSTITUTE, showed what the investigators hoped to show: Immunizing cancer patients with an animal cancer virus definitely makes them respond immunologically to such a virus. They now hope to conduct more experiments to see whether such immunization might also help patients overcome their cancer, presumably by activating immunity against a causative cancer virus.

The investigators are E. M. Hersh, J. U. Gutterman, G. Mavligit, C. R. Gschwind and E. J. Freireich of the University of Texas and M. D. Anderson Hospital and Tumor Institute in Houston; P. H. Levine and E. J. Plata of the National Cancer Institute; and M. G. Hanna Jr. and M. Yurconic Jr. of the Oak Ridge National Laboratory.

Twenty patients with advanced cancer were immunized with a killed Rauscher leukemia virus. This is a virus that causes leukemia in mice. Antibodies against this virus had already been shown to react with antigens on human leukemia cells, suggesting that human leukemia might be caused by a related virus. The patients were immunized with the virus every two weeks for eight weeks.

As a result of the immunization, two-thirds of the patients developed cellular immunity specifically against the virus. Responses did not differ significantly among patients with different types of tumors or receiving different types of therapy. The data suggest that patients with metastatic (growing) cancer or with acute leukemia can make cellular immune responses against cancer viruses.

Half the patients also developed antibodies specifically against the cancer virus. Antibody responses were most vigorous in patients with melanoma (a malignant tumor containing dark pigment) and in patients receiving chemotherapy plus BCG (bacillus Calmette Guerin). BCG has been found to assist patients in cancer regression, presumably by generally priming their immune systems (SN: 6/23/73, p. 408). Antibodies against the cancer virus were least pronounced in those patients with other kinds of solid tumors than melanoma or with acute leukemia, and in those receiving drugs without BCG.

Although all the patients had advanced cancer, some of them are still experiencing cancer remissions. The investigators believe that the remissions are due to chemotherapy and BCG, rather than to cancer virus immunization. However, they hope that animal cancer virus immunization can eventually be used, along with other therapy, to boost cancer remissions in patients. First they want more assurance that cancer virus immunization counters human tumors. They are now trying to see whether human antibodies to Rauscher virus, or to primate cancer viruses, will kill human tumor cells. If the antibodies will, then animal cancer virus immunization indeed looks promising as a means of successfully countering cancer.

As might be expected, the investigators thought long and hard before they gave a known cancer virus to people. But they took precautions, such as killing the virus and performing their experiments only on advanced cancer patients. The patients were also well informed of the possible hazards of such an experiment, and gave their consent to participate. The scientists were happy to find that immunizing the patients with a cancer virus produced no undesirable side effects and so are

now extending their studies.

The Houston scientists also have a large program under way to explore the value of other immunotherapies for cancer patients, such as BCG or transfer factor (SN: 2/9/74, p. 86). BCG added to chemotherapy clearly prolongs cancer remission and patient survival, they have found. They hope to have results on transfer factor within six months to a year. On the whole, they believe immunotherapy for cancer looks exciting. □

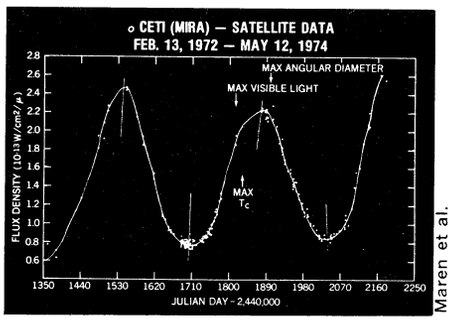
New infrared astronomy results include first from orbit

In its early days infrared astronomy consisted of "looking at what came across the meridian," as Wayne Stein of the University of California at San Diego and the University of Minnesota puts it. Nowadays it is far more sophisticated. Infrared astronomy is beginning to study such things as intensity variations and polarization in infrared sources, to chart their positions more accurately and to obtain better resolution of their spectra. "The field has become very large."

With these remarks Stein opened a session on infrared astronomy at the meeting of the American Astronomical Society in Rochester, N.Y. It was a session that heard, in addition to Stein's general review, a number of new specific results including the first observation of infrared stars from telescopes in earth orbit, what is believed to be the first high-resolution infrared spectrum of the planet Mercury, a determination of the helium-hydrogen ratio in the atmosphere of Jupiter that could have cosmological repercussions, and a study of the polarization of the distant galaxy NGC 1068 that bears on the question of just what the galactic infrared sources are.

Optical, radio and X-ray telescopes have been put into orbit around the earth or are being publicly planned. But ask any member of the astronomical community or the general public or even the space fraternity about infrared telescopes in orbit, and he would say that he had never heard of any. Yet these unheard of and possibly officially nonexistent satellites are there. They belong to the U.S. Air Force, and whatever their cloak and dagger function may be—snooping on what the Russians and the Chinese do in the dark is one that springs immediately to mind—they have been looking at certain long-period variable stars, the kind called Mira variables.

Stephen P. Maran of the NASA Goddard Space Flight Center reported the results of a study done by him and five others of data on two such stars, Mira (also known as Omicron Ceti) and R Aquilae. The data were given to NASA by the Air Force at NASA's request. The important thing that the orbital observations can do that ground-based ones cannot is record single cycles. Ground-based observations give means of many



Mira's cycle from satellite data.

cycles. Knowing individual cycles is important, because the brightness profile does not repeat exactly but varies considerably from cycle to cycle. The infrared cycles are also not in phase with the optical ones. For Mira the two observed infrared maxima lag behind the optical ones by 37 and 39 days. (The total cycle period is 278 days.) For R Aquilae the infrared leads the optical. The checkpoint this time was a minimum, which came 20 days before the corresponding optical minimum.

Knowing all these details is a help toward an understanding of the physical processes going on in the stars. In the case of R Aquilae there is a connection to radio astronomy because natural-maser radio emanations of water and hydroxyl are associated with the star. Knowing the relation between the infrared and radio emissions can tell something about the characteristics of the maser.

Aside from knowledge of particular stars the conclusion that Maran draws that will be most exciting to infrared astronomers is that "infrared telescope systems can be built that will survive for long periods of time in earth orbit." And it comes as a surprise because few people knew they were there.

The planets have been a staple subject of infrared investigation. They are cool bodies in a temperature range characteristic for infrared emission, and infrared can reveal much about them. Always the most difficult planet to observe in any range of the electromagnetic spectrum is Mercury because it lies so near the sun, a very strong emitter across the spectrum. Thus a high-resolution infrared spectrum of Mercury is an achievement just in itself. Ming Hing Tai and Martin Harwit of Cornell University performed the study. The spectrum they got ranges from 8.2 to 10 microns wavelength. It seems to show a surface temperature of 600 degrees K., which conflicts with radio evidence that gives 400 degrees. The discrepancy may be because the infrared measurements are dominated by the sunlit side of the planet and especially by the very hot point where the sun is just overhead.

The atmosphere of Jupiter is of great cosmological interest because it is deemed to be primitive—it represents the ratios of certain gases as they were when the solar system formed. To find the ratio of hydrogen to helium at the time when population II stars (the class the sun belongs to) were formed, the best way is to observe Jupiter. It can't be measured on earth because the earth's primitive atmosphere is long since gone away. The datum is cosmologically relevant because most helium dates from the big bang.

R. A. Reed of Cornell University working with colleagues D. F. Schaak and J. R. Houck, went to Jupiter for the information by means of infrared observations from a NASA Lear jet. If the total amount of both gases is taken as 100, there are 85 hydrogen to 15 helium. The cosmological implications remain to be worked out.

NGC 1068 is an especially interesting galaxy to infrared astronomers because of its large output in the infrared part of the spectrum. Working at Kitt Peak National Observatory, R. F. Knacke of the State University of New York at Stony Brook and R. W. Capps of the University of Arizona succeeded in measuring some polarization in the infrared emitted by NGC 1068. The radiation is 0.4 percent polarized at 3.5 microns wavelength and 2.3 percent polarized at 10.2 microns. The result gives some insight into the mechanisms that are producing the emission, says Knacke.

Interstellar dust grains in NGC 1068 may be doing the polarizing or the source may be a synchrotron process (charged bodies spiraling in a magnetic field) rather than thermal (heat vibrations). The Compton effect, collisions between electrons and photons that can change the photons' wavelength from one spectral range to another, is ruled out because it does not produce polarization. Still it is difficult to imagine a strong nonthermal source that would produce a radio flux much lower that the infrared as is observed. Knacke suggests there might be two sources, a point source in the center of NGC 1068 producing 36 percent of the flux and a more extended source producing the rest.

Thus in one afternoon, infrared astronomy provides a tour of the universe from nearby planets to distant galaxies with way stops in between. □