References and Notes

1. A. Szent-Györgyi, *Science* **149**, 34 (1965); *Introduction to a Submolecular Biology* (Academic Press, New York, 1960), p. 124.
2. J. van Overbeek, *Sci. Amer.* **219**, 75 (1968).
3. J. Weiss, *J. Chem. Soc.* **245**, 18 (1942).
4. R. S. Mulliken, *J. Phys. Chem.* **56**, 801 (1952); *J. Amer. Chem. Soc.* **74**, 811 (1952); *Rec. Trav. Chim.* **75**, 845 (1956); *J. Chim. Phys.* **61**, 20 (1964).
5. A. Szent-Györgyi, *Proc. Nat. Acad. Sci. U.S.* **58**, 2012 (1967).
6. L. G. Együd, *ibid.* **54**, 200 (1965).
7. A. Szent-Györgyi, L. G. Együd, J. A. McLaughlin, *Science* **155**, 539 (1967).
8. L. G. Együd and A. Szent-Györgyi, *Proc. Nat. Acad. Sci. U.S.* **55**, 388 (1966); L. G. Együd, *Currents Mod. Biol.* **1**, 14 (1967).
9. The cancerostatic action of substituted ketoaldehydes has been noted by various authors [see F. A. French and B. L. Freelander, *Cancer Res.* **18**, 172 (1958)]. The use of SH groups for attack on cancer has been advocated by F. E. Knock [see F. E. Knock, *Anticancer Agents* (Thomas, Springfield, Ill., 1967)].
10. L. G. Együd and A. Szent-Györgyi, *Proc. Nat. Acad. Sci. U.S.* **56**, 203 (1966); H. Otsuka and L. G. Együd, *Cancer Res.* **27**, 1498 (1967).
11. H. Otsuka and L. G. Együd, *Currents Mod. Biol.* **2**, 106 (1968).
12. L. G. Együd, *ibid.*, in press.

13. The experimental work discussed in this article was supported by grant GM10383 from the National Institutes of Health.

NEWS AND COMMENT

Smog: Los Angeles Running Hard, Standing Still

Los Angeles. The Los Angeles basin, which is said to have the most vigorous air pollution control program in the nation, has made little progress in recent years in its struggle to cleanse the air of smog.* Though the Los Angeles County Air Pollution Control District (APCD) has pioneered in imposing stiff curbs on industrial polluters, and the state of California has pioneered in cracking down on motor vehicle emissions, the gains made thus far have been offset by new pollution stemming from the growth of population, automobile traffic, and industry. As a result, air quality in Los Angeles has shown no appreciable improvement in this decade, though pollution authorities now profess to see "light at the end of the tunnel."

The continuing high level of pollution, coupled with the likelihood that it will be many years before air quality is significantly improved, has led some medical leaders here to warn people away from the Los Angeles area. They have taken such drastic action despite what many scientists regard as a lack of solid scientific proof that existing levels of pollution constitute a serious health hazard.

Early in August some 60 members of the UCLA medical faculty issued a statement to the Los Angeles *Times* asserting that "air pollution has now become a major health hazard to most of this community during much of the year." The statement advised "anyone who does not have compelling reasons to remain to move out of smoggy portions of Los Angeles, San Bernardino, and Riverside counties to avoid chronic respiratory diseases like bronchitis and emphysema."

The statement has been criticized privately by some UCLA faculty members as being unduly alarmist and based on insufficient evidence. But William Hildemann, professor of microbiology and immunology, who circulated the statement for signatures, told *Science*: "I'll be the first to admit the evidence implicating smog as a major health hazard falls far short of conclusive scientific proof at the present time. But the evidence strongly suggests that long-term exposure to polluted air presents a very real and serious hazard indeed. Common sense should dictate that we take vigorous community action soon before a smog catastrophe is at hand. Twenty years from now we might have lots of hard evidence, but by that time it may be too late for hundreds of thousands of people."

The statement from the UCLA medical faculty members echoed similar warnings expressed in recent years by the medical profession here. In a survey conducted in 1960–61 it was estimated that Los Angeles physicians had advised more than 10,000 patients to leave the area for reasons of health during the previous year, and nearly all the doctors interviewed cited air pollution as a reason for the recommendation. At least 2500 of the patients acted on their doctors' advice and left the area. Since the survey, the doctors have expressed increasing concern about smog. Last October the Los Angeles County Medical Association asserted that "air pollution is becoming increasingly worse and may lead to great lethality in this community." The doctors' group said air pollution posed an especially serious threat to "those who are ill, the very young and the aged," but added that it also endangers "those who are presently in good health."

Much of the smog problem is caused by climatic and geographic factors peculiar to this area. These include frequent temperature inversions which trap pollutants near the ground; mountains that hem the pollutants in; breezes too gentle to push the pollutants away; and abundant sunshine, which converts the individual pollutants, notably hydrocarbons and nitrogen oxides, into the peculiar blend of photochemical smog† for which Los Angeles is noted. Photochemical air pollution exists in some other cities, but it is particularly identified with Los Angeles, where it occurs 200 or more days a year and affects more than 80 percent of the population, often causing people's eyes to sting and tear. Smog is so common here that local broadcasting stations and newspapers provide smog forecasts along with the daily weather report.

Almost all pollution experts agree that automobiles are the chief source of noxious pollutants in the Los Angeles basin, but there is disagreement over how serious a problem is caused by pollutants from industry and other stationary sources. The local APCD claims it has largely controlled stationary sources and says 85 to 90 percent of the remaining problem (in terms of the weight of pollutants emitted) is caused by automobile emissions, an

* Though *smog* was a word apparently coined to describe a particular form of pollution—smoke plus fog—it has become the word popularly used to describe air pollution in Los Angeles.

† The action of sunlight on a mixture of hydrocarbons, oxides of nitrogen, oxygen, and other materials results in a series of complex reactions leading to a variety of intermediate and end products which, together, are called smog. Among the products reported, according to a prepublication review by Irving R. Tabershaw and his colleagues at the University of California, Berkeley, are aldehydes, ketones, alcohols, alkyl nitrites and nitrates, acids, ethers, peroxylacyl nitrates and nitrites, carbon monoxide, carbon dioxide, and particulate matter.

A classic "before and after" picture of downtown Los Angeles shows the effect of smog in reducing visibility.

area which falls under state and federal jurisdiction. In 1967, motor vehicles emitted an estimated 12,230 tons of pollutants daily (about 80 percent of it carbon monoxide) during the 7-month period between 15 April and 15 November, which included the major smog months of August, September, and October, while stationary sources were responsible for 1320 tons. The chairman of the state Air Resources Board (ARB), Caltech chemist Arie J. Haagen-Smit, agrees that the automobile is the major contributor, but says stationary sources still constitute a significant minor source of pollution, particularly with respect to the hydrocarbons and oxides of nitrogen that play a crucial role in photochemical smog. He notes that most of the automobile's contribution is carbon monoxide. (It was Haagen-Smit who discovered the photochemical nature of Los Angeles smog.) "There's a growing belief that the automobile is the only source of pollution out here," he says. "If you live near a refinery, you know damn well it's not just the automobile."

Smog first attracted significant public notice in Los Angeles near the end of World War II. In 1947, after passage of enabling legislation, the APCD was established, with authority to regulate all sources of air pollution. The district, which is often called the leading local air pollution authority in the country, has imposed controls on stationary sources of pollution that seem unusually strict as compared with controls in other localities.

The district has clamped down on industry, notably on the numerous refineries and power plants, by setting emission standards, by limiting the sulfur content of fuels, and by specifying the kinds of equipment that must be used in various industrial and agricultural operations. Coal, seldom used in Los Angeles, has been outlawed. Oil with a high sulfur content is banned 7 months of the year in favor of natural gas or low-sulfur oil brought in from Indonesia or Alaska. Natural gas must also be used during the remaining 5 months when it is available. Petroleum storage tanks, oil-effluent water separators, and gasoline loading facilities must all be equipped to prevent vapor loss.

The district has also eliminated 57 open burning dumps, about a dozen large municipal incinerators, most commercial building incinerators, and about 1½ million domestic incinerators. In recent years, as other industrial sources have been brought under increasing control, the district has started to regulate processes involving organic solvents, even to the extent of banning the sale or use of paint containing photochemically reactive solvents.

California has also led the recent nationwide drive to control motor vehicle emissions. In 1960, the local APCD restricted the olefin content of gasoline sold in the county; such restriction is said to reduce the degree of eye irritation caused by automobile emissions. The state, meanwhile, has pioneered in in setting motor vehicle emission standards. California required crankcase emission controls on new cars and on some used cars starting in 1963, and made exhaust controls mandatory on 1966-model cars, thus paving the way for mandatory nationwide crankcase and exhaust controls on 1968-model cars. California will also require that evaporative losses from the fuel tank and carburetor be controlled on 1970-model cars, a year before similar federal controls became effective. Moreover, the state recently enacted legislation which will progressively tighten automobile emission standards from 1970 through 1974 and will control emissions of nitrogen oxides for the first time (provided the federal government, which has preempted the field of new-automobile pollution control, approves the standards as feasible and necessary). If the standards go into effect, they will require control of more than 90 percent of the hydrocarbons, about 80 percent of the oxides of nitrogen, and about 75 percent of the carbon monoxide that would be emitted from an uncontrolled car, according to the state ARB.

What has been the effect of all this activity on Los Angeles? On the plus side, it's still possible to live here. "The habitability of Los Angeles without strict controls really would be questionable at this time," says John R. Goldsmith, chief of the environmental hazards evaluation unit of the state department of public health. Moreover, Los Angeles seems not to be plagued by the dust and dirt that afflict many other cities. Local officials boast that Angelenos can wear white shirts to work and not find them grimy with industrial soot at the end of the day. The APCD estimates that its program prevented the emission of about 5560 tons of air pollutants daily in the Los Angeles basin during the smog months of 1967, while the crankcase and exhaust control devices already installed on motor vehicles eliminated another 1680 tons.

On the negative side, however, there has been essentially no improvement in the quality of Los Angeles' air in this decade. "The smog hasn't gotten any worse—it's more or less stabilized," says Haagen-Smit. The net impact in Los Angeles must be assessed as no improvement in the quality of the atmosphere since 1960, says Louis J. Fuller, chief official of the APCD.

Emissions of oxides of nitrogen, one of the two major ingredients of photochemical smog, have soared upward. (Ironically, the devices that reduce hydrocarbon emissions from automobiles are said to have increased the

output of nitrogen oxides). Emissions of hydrocarbons, the other major ingredient, are at best only slightly lower than in 1960. Carbon monoxide emissions have leveled off in recent years. And emissions of oxides of sulfur have followed a zigzag course, plunging downward in the late 1950's and early 1960's as industry was controlled, then increasing sharply in the mid-1960's with the introduction of new power plants, and now headed down sharply again with greater use of low-sulfur fuels. The number of smog alerts called was on a downtrend until 1962, then turned upward.

Most California pollution authorities agree that, if the laws and standards now on the books go into effect and are strictly enforced, air quality in Los Angeles should ultimately reach an "acceptable" level, which they define as roughly the level existing in the 1940's before air pollution was identified as a problem. However, these "acceptable" levels would probably not be reached until the 1980's because the strictest automobile emission standards would not go into effect until the 1970's and would not apply to used cars, which would thus continue to pollute the air until they disappear from the road in the 1980's. Moreover, no one is certain that the smog-reducing devices proposed for new cars would perform well over the full lifetime of the car, and there is no requirement for inspection.

In an effort to speed cleansing of the Los Angeles atmosphere, pollution authorities are considering a further crackdown on industry, including a complete ban on high-sulfur oil, curbs on oxides of nitrogen from industrial sources, and a prohibition against construction of any more conventional power plants in the county. They are also considering controls on used cars, aircraft, forklift trucks, motorcycles, farm vehicles, and space and hot-water heaters, as well as further changes in the composition of gasoline and in traffic flow patterns.

However, some experts believe a more fundamental approach is required. Haagen-Smit suggests that the ultimate solution lies in "attacking the root of the problem, the excessive use of the car at the expense of other less polluting means of transportation." He urges a search for new engine types and power sources, and the promotion of alternative means of transportation. Similarly, Irving R. Tabershaw, head of environmental health and safety at the University of California, Berkeley, suggests that emphasis be placed on improving the process of combustion. Citing Los Angeles as an example, Tabershaw concludes that air pollution control has been "a gigantic game of trial and error. . . . Each step has helped but an acceptable solution seems as far away as ever."—PHILIP M. BOFFEY

Space: Vienna Meeting Examines Value for Developing Nations

Vienna. Telling the poor nations of the world about outer space activities is a bit like reciting gourmet recipes to a starving man. In both cases, the listeners are likely to be acutely fascinated, but what's being said has little or nothing to do with their immediate problems.

Nevertheless the "haves" of space are usually eager to talk of their achievements—in fact, the creation of international awe is one of the enduring goals of both the Soviet and American space programs. The poor, or at least some of their conference circuit representatives, are even more eager to listen and also to seek some crumbs from the programs of the big powers. And these factors together account for the remarkable proceedings that took place 14–27 August in and around the Neue Hofberg, a splendiferous Hapsburg palace that today earns its way as an international conference center, a fall from grace that might be kept in mind by the proponents of various contemporary monumental structures of one sort or another.

The Vienna gathering, to which 67 nations sent some 600 participants and observers, is, of course, part of a long train of international space meetings, but, officially, it was the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space. Specifically, it was charged by the U.N. General Assembly with examining "the practical benefits of space programs on the basis of technical and scientific achievements, and the opportunities available to non-space powers for international cooperation in space activities, with special reference to the needs of the developing countries."

Now, taking this mandate at face value, it is plain that a day or two of serious talk—rather than 2 whole weeks —could easily cross and crisscross all the realities, and not a few fantasies, vis-à-vis space and the developing nations. But it was the developing nations themselves that pushed hardest for the conference, and it was Austria, long active in U.N. space activities and eager to make Vienna an international meeting center on the Geneva style, that played the principal part in setting up a 2-week meeting, to be held in Vienna.

Though some of the mini-nations were represented by bored or bewildered-looking ambassadors dispatched from nearby capitals, a natural selection process more or less dictated that most of the developing nations were represented by professional staff members drawn from their inevitably tiny and struggling research establishments. These delegates were obviously delighted to be in the presence of the big leaguers from the two major space powers, and it is likely that they learned a good deal and also acquired some prestige and arguments for dealing with the politicians who control their budgets back home. How the Russians felt about the meeting is a matter on which they did not choose to chat, though it is said that they first proposed a conference of this sort back in the late 1950's, but then changed their minds. In 1966 they agreed to take part in a conference to be held in 1967; later, at their request, it was postponed to this year.

It is also said that, lacking any large inventory of space applications, such as weather or communication satellites, the Soviet wanted to stress science, but when the developing nations said they wanted to stress space applications, the Soviets went along. As it turned out, the Soviets had relatively little to say about space applications, but for whatever it's worth these days, they did execute some skillful digs at the United States. As for the United States delega-