LETTERS

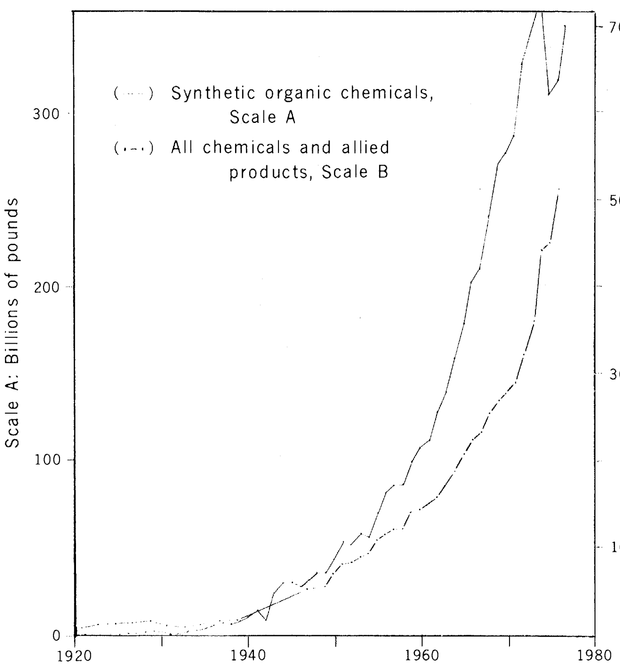
Cancer and Industrial Chemical Production

Considerable debate continues about the health risks associated with industrial chemicals (*1*). Much of the discussion has focused on cancer, although other health effects need to be considered as well.

Current views on the causes of cancer differ. Some scientists (*2*) claim that most cancers are caused, not by industrial activities, but by life-style factors; and that future cancer rates can best be affected by changes in those factors, rather than by government regulation of chemical production, use, and disposal (*3, 4*). Critics of regulation assert that, if industrial chemicals truly constitute an important cause of cancer, then the current cancer burden should be greater. They point to the lack of a cancer epidemic now as evidence that the high volume of industrial production beginning in the 1940's has not had an important impact on cancer rates (*5, 6*). Others are concerned that the substantial recent increase in the production of bioavailable compounds, carcinogens, and other hazardous substances will contribute to a major rise in cancer incidence and other public health problems (*7*).

We have addressed some of these matters as part of a study of regulatory priorities and have examined cancer rates in light of the production histories of industrial carcinogens. We have found that it is too soon to reach any conclusions about the magnitude of the cancer risk to the general population posed by industrial chemicals.

As for the cancer rates, while they are not skyrocketing, they are increasing. In 1978 Marvin Schneiderman of the National Cancer Institute reported to the Occupational Safety and Health Administration that the incidence of many types of cancer had increased significantly and that some rates for mortality lag behind those for incidence by 6 years (*8*). Certainly much of the overall mortality increase results from the rapidly increasing lung cancer rate for males, but even when half or more of lung cancers are subtracted, the overall rate is in-



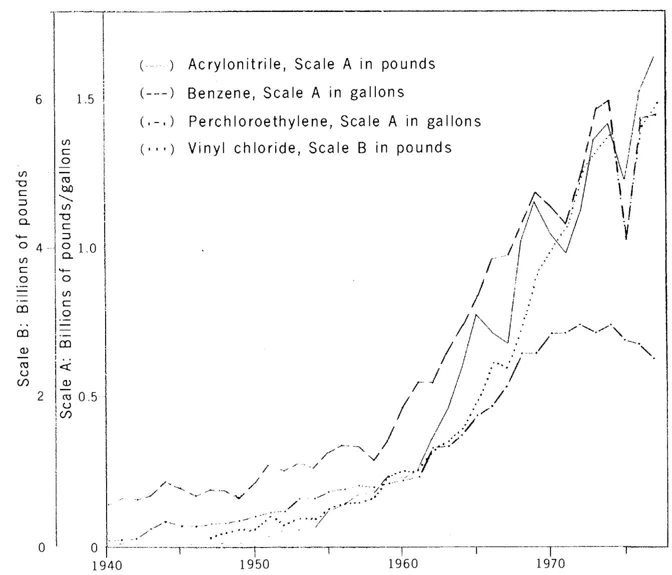
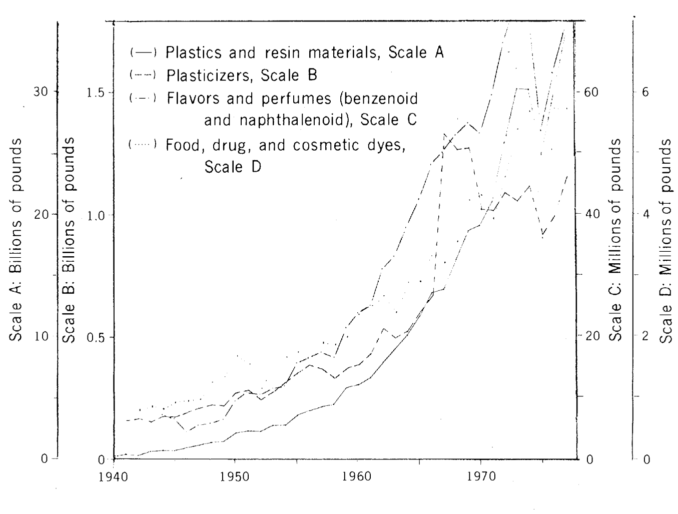


Fig. 1 (left). Total synthetic organic chemicals, annual production (excludes tar, tar crudes, and primary products from petroleum and natural gas) (*14*); total chemicals and allied products, annual value added (*15, 16*).

Fig. 2 (right). Annual production of selected carcinogenic substances (*14*).



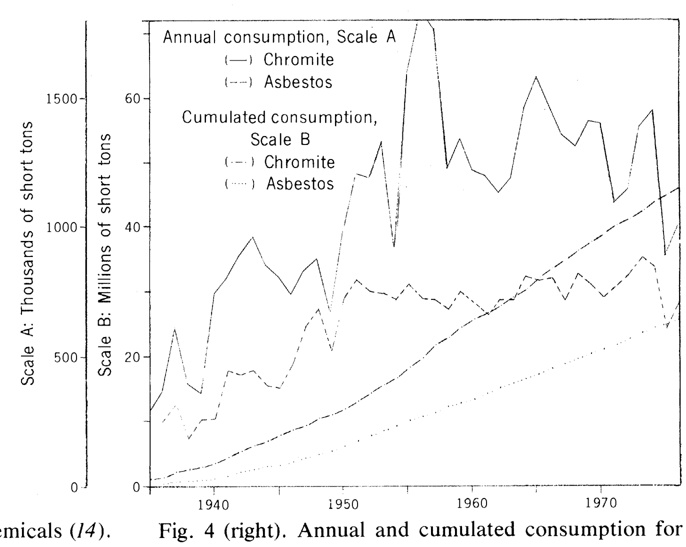


Fig. 3 (left). Annual production of selected, bioavailable classes of chemicals (*14*).

Fig. 4 (right). Annual and cumulated consumption for selected carcinogenic substances (*17*).

creasing (9). In fact, a recent study shows that the lung cancer mortality rate among nonsmokers has risen significantly since 1935 (10). Thus, the appropriateness of subtracting any fixed proportion of lung cancers thought to be attributable to smoking is questionable. The extent to which the large increase in lung cancer reflects cigarette smoking alone, or the extent to which it reflects synergies between cigarette smoke, environmental carcinogens, and constitutional factors, cannot be accurately determined with current methodologies.

To some, the lack of a current cancer epidemic exonerates industrial chemicals as a cause of chronic disease (4, 6). This ignores the fact that production and normal use of many carcinogenic, bioavailable, and otherwise hazardous substances have reached very high levels only since the early 1960's (Fig. 1). Most scientists would agree with Higginson that past cancer rates do not primarily reflect industrial pollution and other chemical exposures. The real question is, What proportion of future cancers can be prevented by better control of hazardous substances?

The argument of the regulatory critics is not without merit, although it is incomplete. There has, indeed, been a tremendous growth in overall chemical industry activity since the 1940's, especially in the production of synthetic organic chemicals. Figure 1 shows that the chemical industry has grown exponentially since the late 1930's and early 1940's. Production levels of synthetic organic chemicals have doubled every 7 to 8 years, and total production is now over 175 billion pounds per year.

Aggregate trends for the chemical industry, however, are misleading because individual chemicals do not have identical public health impacts. Annual production statistics are not available for the more than 4 million known chemical substances or the approximately 44,000 chemicals listed on the Environmental Protection Agency inventory of substances in commercial use. Since not all of these are likely to be proved carcinogenic, we considered a special subset of chemicals. It has been reported that 1500 of the approximately 7000 chemicals tested are carcinogenic (11). Because of the inappropriate design of many studies, however, the International Agency for Research on Cancer has systematically reviewed and evaluated the cancer literature. They have so far demonstrated through epidemiological studies that 26 substances or workplace exposures cause cancer in humans and, through laboratory studies, that 221 substances are carcinogenic (12). The Interagency Regulatory Liaison Group has also identified substances for priority regulatory attention, among which are some additional carcinogens (13).

It is extremely difficult to assess human exposures for most of these chemicals. Human exposures to a chemical are certainly *not* directly proportional to its production or use. But the recent large increases in chemical use and disposal have certainly been associated with greater human exposures, stricter environmental controls notwithstanding.

We were able to find statistics for relatively few of these substances in public documents. Those for which we could compile production histories are all high-volume, high-risk agents that are now either regulated or are receiving regulatory attention.

Figure 2 shows the production histories of benzene, perchloroethylene, vinyl chloride, and acrylonitrile. We have similar data for chloroform, carbon tetrachloride, and trichloroethylene. Although some occupational cancers have already been traced to several of these chemicals, widespread and high-level human exposure to these substances are likely to have occurred only since the 1960's. Even if these chemicals have had only a small effect on the current overall cancer rate, they may still have a very large effect on the future cancer rate.

The relatively recent history of rapid production growth of the four chemicals shown in Fig. 2 is not unusual. Figure 3 shows that the rate of growth in the production of several classes of bioavailable substances was also significantly greater after 1960 than before.

These four categories of chemicals: plastics and resin materials; plasticizers; flavors and perfumes (benzenoid and naphthalenoid); and food, drug, and cosmetic dyes all have the common characteristic of being present in products designed for uses in, on, or very near to humans. Any toxic or potentially toxic chemical substances contained therein are very likely to be consumed by or absorbed into the body of the product user.

Not all cancer-causing agents are new products of the chemical industry. For instance, the production and use of both asbestos and chromite, the major chromium-containing ore, grew exponentially in the 1940's and have remained at high levels since that time (Fig. 4). Because these substances are long-lived, they remain potentially available for human exposure once they have been introduced into the environment. Data on these substances can be appropriately expressed in the cumulated form. As Fig. 4 shows, the total cumulated quantity of these materials consumed was 10- and 30-fold greater in 1960 than in 1940 for asbestos and chromite, respectively. No systematic data on disposal are available.

In light of the relatively recent increase in the volume of production of some carcinogenic and other hazardous substances that are bioavailable, we conclude that it is not now possible to determine the extent to which chemical exposures will influence future cancer rates. Because of the long latency periods and multistaged nature of many cancers and the acknowledged cumulative, persistent, and synergistic effects of chemicals in the environment, a prudent regulatory policy is necessary. Control of the production, use, and disposal of chemical carcinogens is advisable if we are to prevent potential cancer increases.

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