DRAWING WATER FROM WASTES

By J. R. PORTER

WITH MORE than half the people of the world now suffering from hunger and serious disease, the ingenuity of man will be strained severely during the next thirty-five to seventy-five years if social and economic conditions are to be improved for the majority of the people of the world. We hear talk about sending citizens in spacecraft to distant planets to maintain the population balance on the earth. But we should realize that even at current levels we would need to put into orbit some 6,000 to 7,000 persons every hour of every day to maintain the balance—and this will grow to about 9,000 people per hour in less than ten years.

Microbiology can help in solving some of the ecological problems facing mankind, especially with regard to supplying food and clean water.

The earth's total water supply remains relatively stable, and the "water crisis" is perhaps more related to availability than to supply. About 93 to 98 per cent of the water on earth is unfit for drinking or irrigation because it is too salty or is frozen in glaciers or icecaps. The usable 2 to 7 per cent that remains is not only unevenly distributed, but man is rapidly depleting it and disturbing the normal distilling hydrological cycle. This is a result of urbanization and concentration of industries in our so-called supertechnical civilization. In doing this man has created deserts and waterlogged or salinized areas larger than all the irrigated lands of the world.

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The total available fresh water supply in the United States is estimated to be 700 billion gallons per day. In the year 1960 we used on the average 320 billion gallons a day. Estimated use for the year 1980 is 560 billion gallons and for the year 2000 slightly under 900 billion gallons. Thus, it is imperative that something be done about water resources in this country and in areas of the world where less water is available.

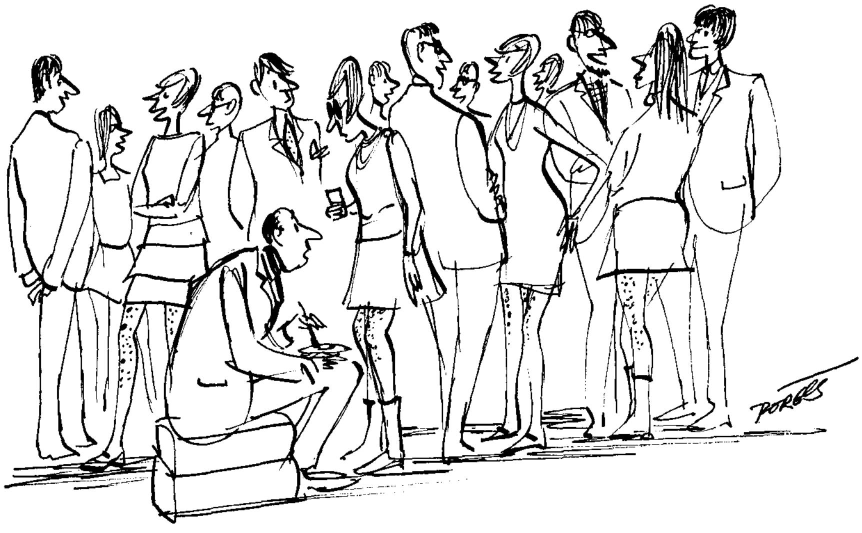
We are told that soon nearly 50 per cent of our water needs can be filled by desalting the oceans. But if this procedure is to supply more than the fringes of the continents, tremendous technological developments and sources of power will be necessary to produce and to distribute the enormous quantities of water involved. For example, for each kilo of dry matter in green plants, some 150 to 225 kilos of fresh water is required.

Microorganisms are most important in our water resources, not only for abating pollution but also for the equally significant recovery of water from sewage. Sewage must be purified if it is not to become a nuisance, injurious to aquatic life, and a danger to human health. But purification presents many problems of a microbial nature. Microorganisms develop rapidly in sewage, and they are capable of consuming their own weight in organic matter each hour. But they require large amounts of oxygen to oxidize organic matter completely to minerals. Because oxygen is soluble to the extent of only about eight to ten parts per million in sewage, and frequently ten times this amount is needed, oxygen often becomes the limiting factor in sewage purification. Additional problems have developed in the past few years with the discharge of synthetic chemicals from the home and industry into sewage systems. In 1965 over four billion pounds of synthetic detergents probably found their way into sewage in the United States. Many of these compounds could be degraded only very slowly by microorganisms.

In the future, it appears that sewage disposal through bacterial activity will have to be combined with oxygen delivery by means of algae. In 1965 Japanese scientists established the first small-scale, chlorella-growing sewage-disposal plant. Approximately 10,000 gallons (6,300 to 12,600 gallons) of purified water per day will be produced along with fifty-five pounds of dried chlorella, based on average weather and use of artificial light. The Japanese have pioneered in the development of purer sewage effluents by this method, and the by-product, chlorella, is a most useful animal feed, having a high nutrient value and vitamin content.

Various industries yield large quantities of waste water containing organic matter. In several countries in recent years, yeasts have been produced from the sulfite waste in the paper industry and from molasses, from whey distillery slops, and from pulp fluid of potatoes. The yeast strains *(Torulopsis utilis, Saccharamyces fragilis)* are rich in proteins, fats, and various vitamins, and are a valuable fodder supplement for animals. Even more important in some cases is that the fermented waste waters are useful for irrigation, whereas the unfermented waters have a harmful effect on soils. Conversion of such waste waters into utilizable products will relieve many industrial plants and municipalities of the serious problems of waste disposal.

The idea of using sewage and industrial wastes as an integral part of man's food-producing garden, and of recycling his drinking water, may seem obnoxious to many people. But the human race cannot afford to persist in practicing the present disposal system based on a maximum demand for water with a maximum of river and lake pollution. Whatever is done to improve the situation, microorganisms will have to be considered as participants.



"Your knees are in my egg salad!"

PLANT GROWTH AS A CANCER CLUE

By SOLOMON GARB, M.D.

IT is well-known that plants compete with each other for sunlight, nutrients, water, and growing space. The mechanics of such competition involve several patterns. For example, fast-growing trees tend to shade smaller vegetation. Some plants with widespread roots take up ground water and minerals more readily than other plants. An additional mechanism of plant competition has recently been attracting increasing attention from scientists in several fields. Some plants apparently prevent the growth of competing plants by secreting chemical growth inhibitors. These inhibitors appear to be quite different in nature from inhibitors or anti-auxins which tend to regulate the plant's own growth patterns.

Apparently, the phenomenon of chemical warfare between plants is rather widespread. It is not confined to exotic species in far-away lands, but occurs in the common grasses, weeds, and trees of ordinary American gardens and farms. There is increasing recognition of the importance of understanding this phenomenon, not only as a fundamental factor in ecology, but also as a practical matter that affects lawns, orchards, farms, and may also affect the fate of nations and the development of new drugs for the cure of disease.

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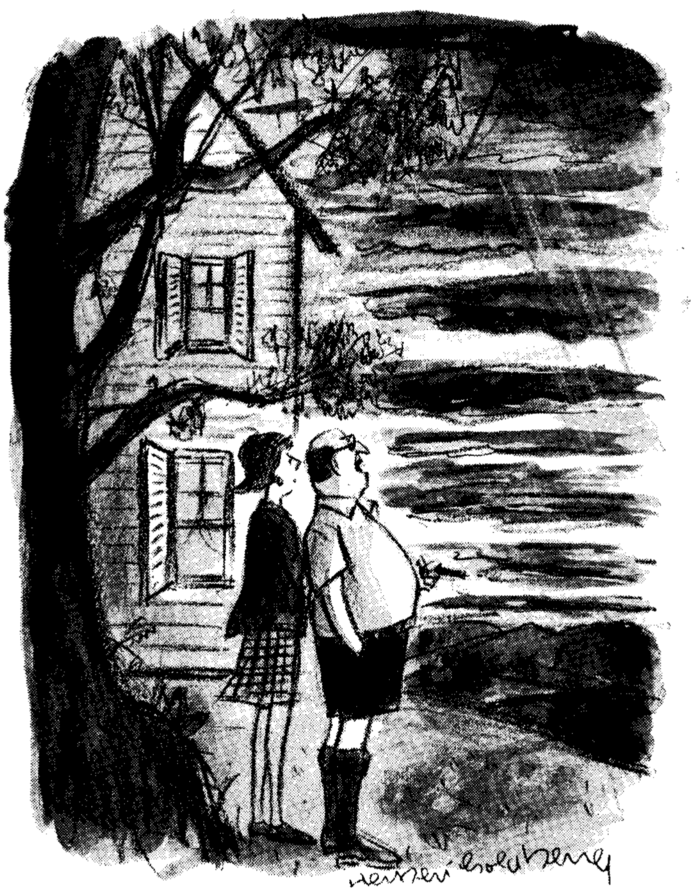
STUDIES done thus far suggest that most of the chemical warfare agents secreted by plants are not general toxins. Thus, the term "toxic" probably is not a good description of their action. Instead, they appear to be, for the most part, highly selective differential growth inhibitors which exert their effects even when well diluted in soil. The selectivity has two separate facets.

Most of the inhibitors tend to affect one set of plant species but not other species that seem closely related. For example, the black walnut tree (*Juglans nigra*) inhibits the growth of blackberry, among others, but not of black raspberry. Furthermore, a list of plants inhibited by the secretions of a particular species seems to be quite mixed, with no apparent relationship between the plants inhibited. For example, the black walnut is also reported to inhibit the growth of poverty grass, dock, common cinquefoil, red and white pine, apple trees, potatoes, tomatoes, asparagus, alfalfa, hydrangea, lilac, and chrysanthemum. Undoubtedly some biochemical feature is common to the inhibited group and not to other groups, but as yet no information is available on this point, nor am I aware of any current studies on it.

A second aspect of the selectivity of the chemical inhibitors is their effect on different parts of the victim plant. Some of the inhibitors, including those found in tonka bean, sweet clover, and mountain ash inhibit root growth. The tops of the victim plants apparently grow normally for a short time and then die abruptly. When dug up, they are found to have tiny, stunted roots. Other inhibitors apparently affect the leaves primarily, and some inhibiting secretions of grasses affect roots and foliage of other grasses.



"A man can really fight for humanity in a place like this."

THE source of the growth inhibitor differs with different plants. Some apparently are produced in the roots and spread out in the soil. The black walnut is believed to be an example of this type. Some plants such as *Encelia farinosa*, *Bergenia crassifolia*, and *Artemisia absinthium* (wormwood) have an inhibitor in the leaves. When the leaves fall to the ground and decompose, they release the inhibitor, which keeps other plants from growing for a prolonged period. Seeds and fruits are also sources of inhibitors. As the inhibitors leach out into the soil, their action provides a small, safe zone in which the seedling can obtain a vital start in its growth. A few plants of genera *Salvia* and *Artemisia* secrete volatile growth inhibitors. The vapor apparently condenses into dew, and the dew inhibits growth of competing plants.

The actions of the growth inhibiting chemicals fall into two general groups. Some inhibit growth of plants of other species. They are referred to as heterologous inhibitors. Other inhibitors act on plants of the same species and are referred to as homologous. As a general rule, the homologous inhibitors are more likely