How Trees Help Clean The Air

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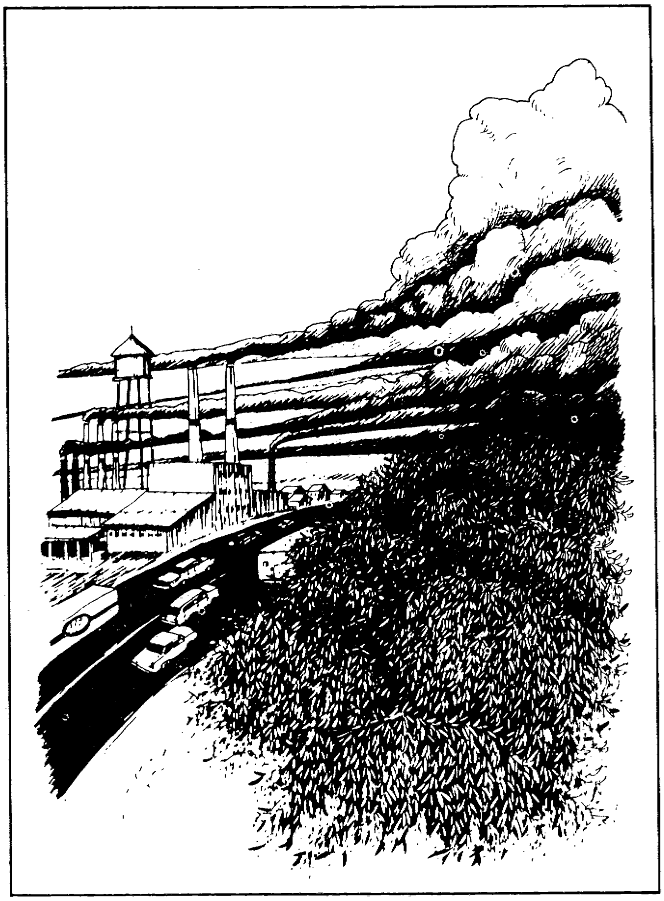


Air pollution has both industrial and municipal sources.

People have been polluting the atmosphere since they began to breathe, cough, and sneeze.

As society grew more civilized and industrialized, contamination of the air increased by leaps and bounds. Today we have an amazing, even pathological, ability to pollute the air. Smoking, cooking, driving, heating, manufacturing—thousands of people-oriented activities contribute to the overload of air pollution.

Some air pollution would exist even without our help. Volcanos, decaying plants and animals, and dust are natural sources of pollution. In limited amounts, pollution may provide nutrition for trees and other plants. But because of industrial growth and urban expansion, we now contribute 300 million tons of pollution per year to the atmosphere, much more than natural systems can safely absorb.

Air pollutants are two kinds: primary and secondary. Primary pollutants, such as sulfur dioxide and fluorides, have an identifiable source. Secondary pollutants are the result of chemical reactions between primary pollutants, or between primary pollutants and compounds in the air.

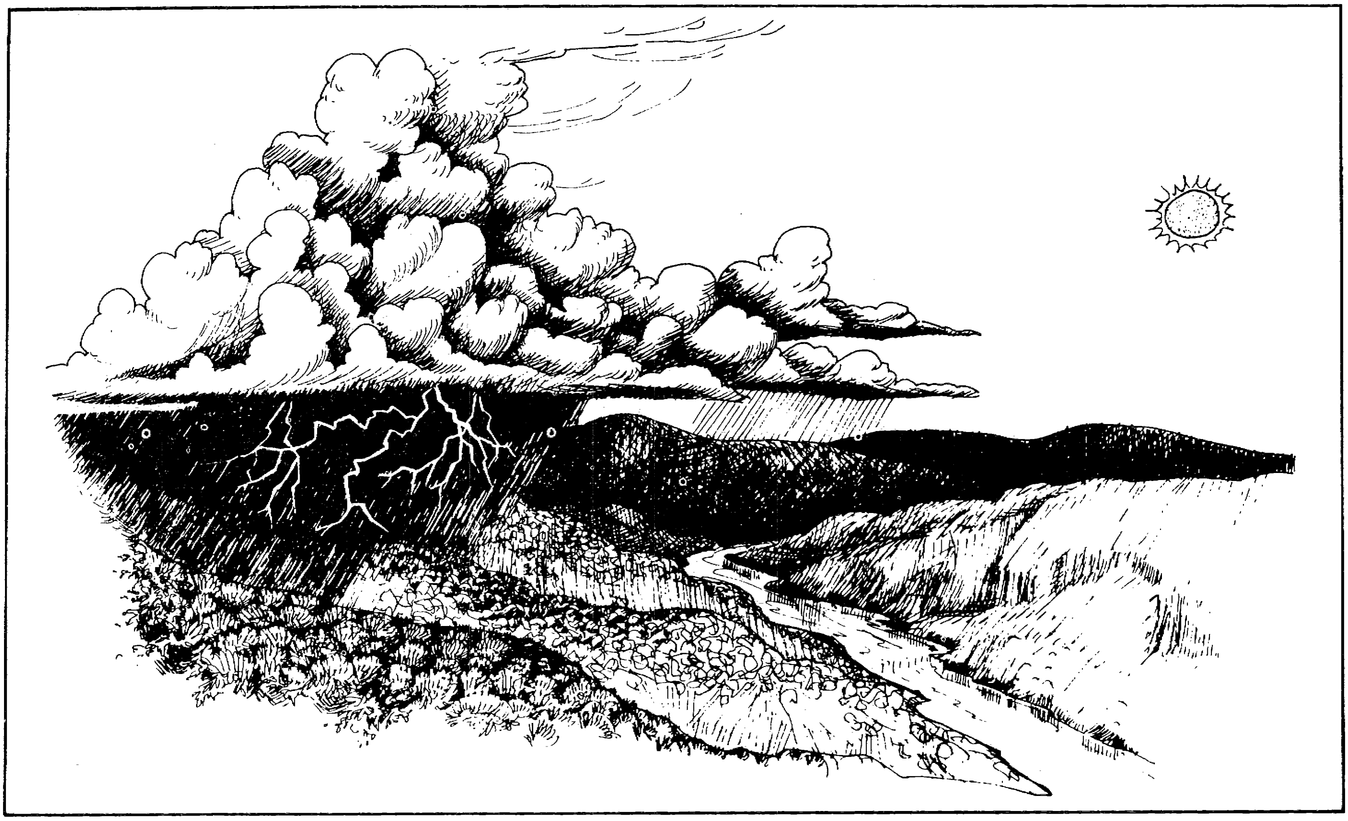
Air pollution has both industrial and municipal sources. Industrial sources include pulp and paper mills, petroleum refineries, chemical plants, and smelters. Municipal emissions include those from utilities, mass transit (primarily automobiles), home heating systems, and burning of organic wastes.

The biggest contributors to air pollution are three gases: sulfur dioxide (SO_2), fluorides, and ozone (O_3).

Sulfur dioxide comes from burning fossil fuels such as coal, roasting sulfur-containing ores during smelting, and producing and using sulfur-based products.

Fluorides originate from wastes emitted during the manufacture of steel, aluminum, and other metals not containing iron. Burning coal and manufacturing ceramics and phosphate fertilizers also produce fluorides.

Ozone occurs where population and traffic are dense. Automobiles and industry emit tons of hydrocarbons and nitrogen oxides. These compounds are energized by sunlight and yield ozone and other oxidants.



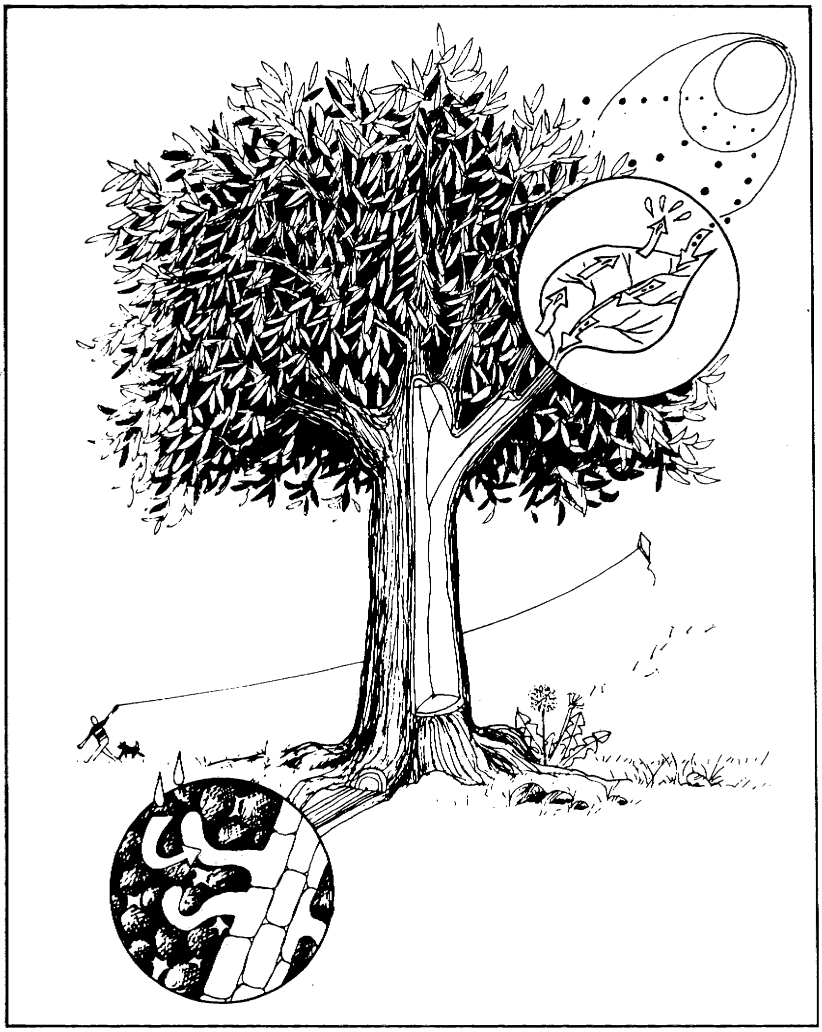
Lightning is one possible natural source of ozone.

Along with manmade ozone, there are several possible natural sources. Ozone may be transferred from its natural resting place in the upper atmosphere to the earth's surface during severe weather disturbances. Also, during an electrical storm, the ozone produced by lightning may occur at concentrations harmful to sensitive plants. As part of its respiration cycle, vegetation emits gases that have been considered another ozone source. But scientific evidence shows that manmade emissions are the main sources of ozone, both in urban and rural areas.

Other pollutants are present in the atmosphere in small amounts, but their importance is increasing. Nitrogen oxides have their sources in fuel combustion, motor-vehicle exhaust, petroleum refining, and burning organic wastes. Ammonia is another pollutant that may be released during accidental spillage, industrial operations, and breakdown of organic compounds. Chlorine and hydrogen chloride fumes are emitted during the manufacture of chlorine, production of polyvinyl chlorine plastic, and as by-product wastes from light industry. A fourth pollutant, particulate matter, enters the air from burning organic wastes, refining metal, cement and lime kiln operations, and heavy manufacturing industries.

Air pollution interacts in a variety of ways with all living things. Since trees are the dominant lifeform in size and number over most of the earth's surface, they carry on a large part of the interaction.

Forests and trees provide many benefits, including the ability to condition the atmospheric environment. In addition to regulating temperature, humidity, and air movement, trees interact with air pollutants in various ways. Some trees are injured by gases and particles in the air, while others absorb and use contaminants without apparent harm.

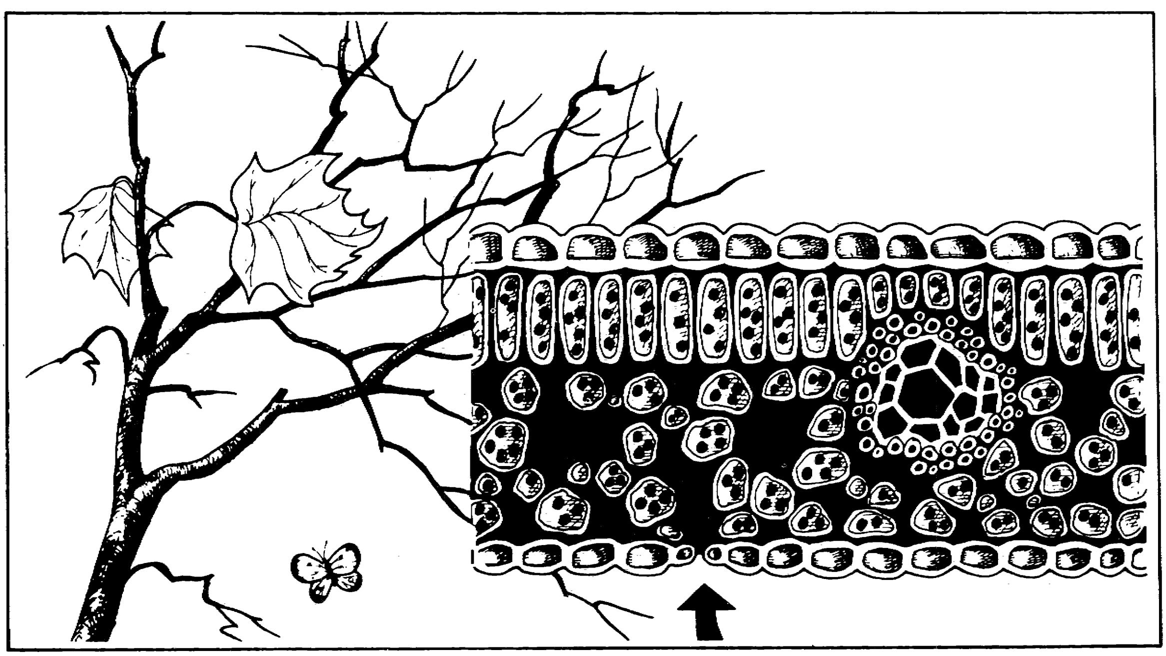


Trees may absorb some pollutants in the natural life processes common to all plants. In an exchange of gases, plants take in carbon dioxide, convert it to food, and release oxygen. This exchange occurs through stomata or pores on the leaf's surface. During normal opening of these pores, other elements may also enter. These include pollutants such as chlorine, sulfur dioxide, and fluorides.

The plant uses some of these materials as food, and releases others into the air or soil. In this way, plants receive nutrition and possibly help to purify the air as well.

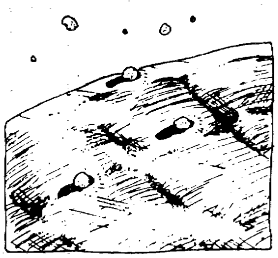
Evidence of trees' cleansing abilities can be seen in dust-coated trees along unpaved roads. Other examples are the whitish mass of chemical deicers that collects on plants during winter and the gritty gray film found on trees near quarries and kilns.

Trees contribute to the life cycle on earth through processes such as photosynthesis.

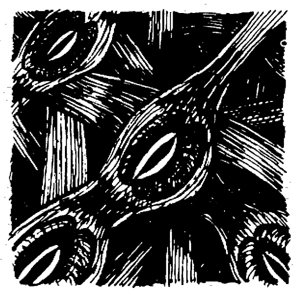


The plant exchanges O_2 for CO_2 during photosynthesis.

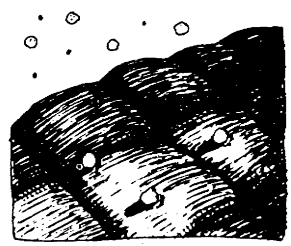
Pollution can be trapped by spines or hairs,



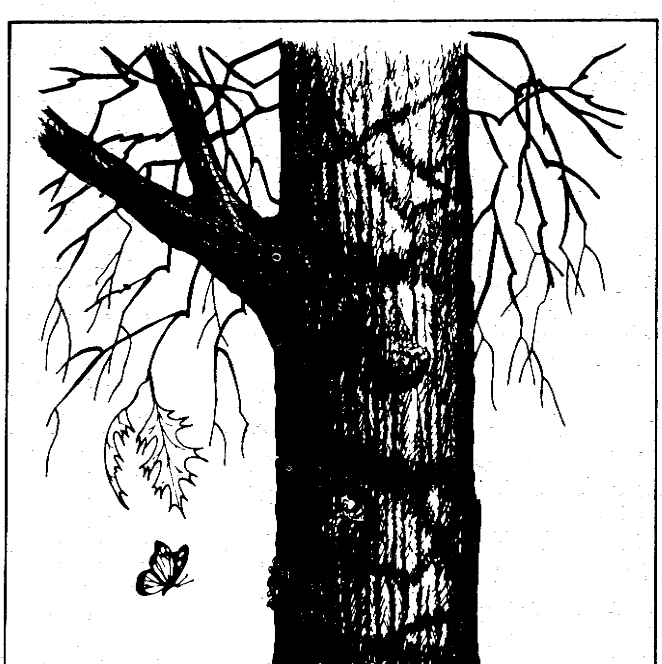
waxy surface,



pores,



or an electrical charge on a leaf's surface.

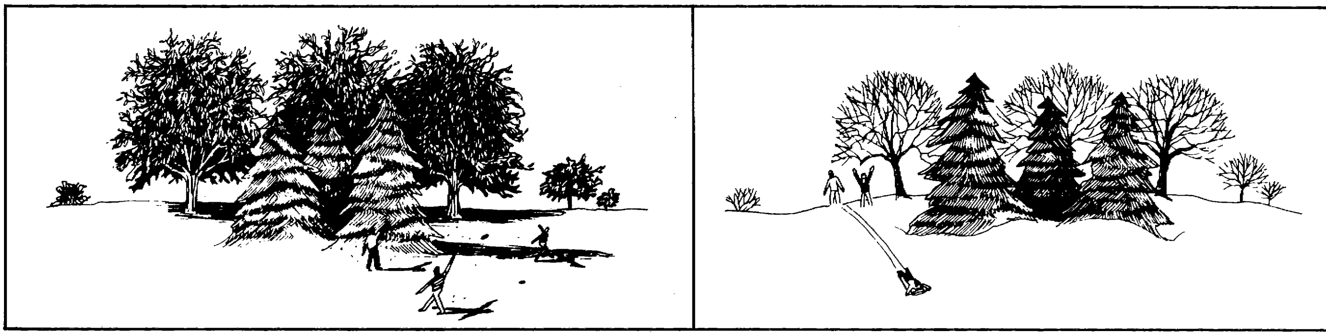


Particles can be trapped on rough, fissured bark.

Leaves are the primary receptors in all of these instances. Certain surface features of leaves help to trap pollutants. One of these is spines or hairs on a leaf's surface. Particles also adhere to a waxy surface or to a moisture film. Another important characteristic is the size and number of pores or stomata. The electrical charge on a leaf may also work to attract pollutants with an opposite charge.

The overall pattern of leaves—their number, arrangement, and density—as well as the closeness and configuration of trees, may affect trees' ability to reduce the level of air pollution. A sparse canopy, for instance, has less potential for cleansing than a big, thick canopy.

Trunks and branches may also aid in purifying the atmosphere. Trees with a huge frame of many branches can be more effective cleansers than trees with few branches. Likewise, a large trunk with rough, fissured bark traps more particulate pollutants than a small or smooth bark trunk.



Deciduous trees may or may not be better cleansers than conifers.

At first glance, deciduous trees may appear to be better cleansers than conifers. True, deciduous trees have bigger leaves, but conifers keep their greenery all year and actually may have more leaf surface area.

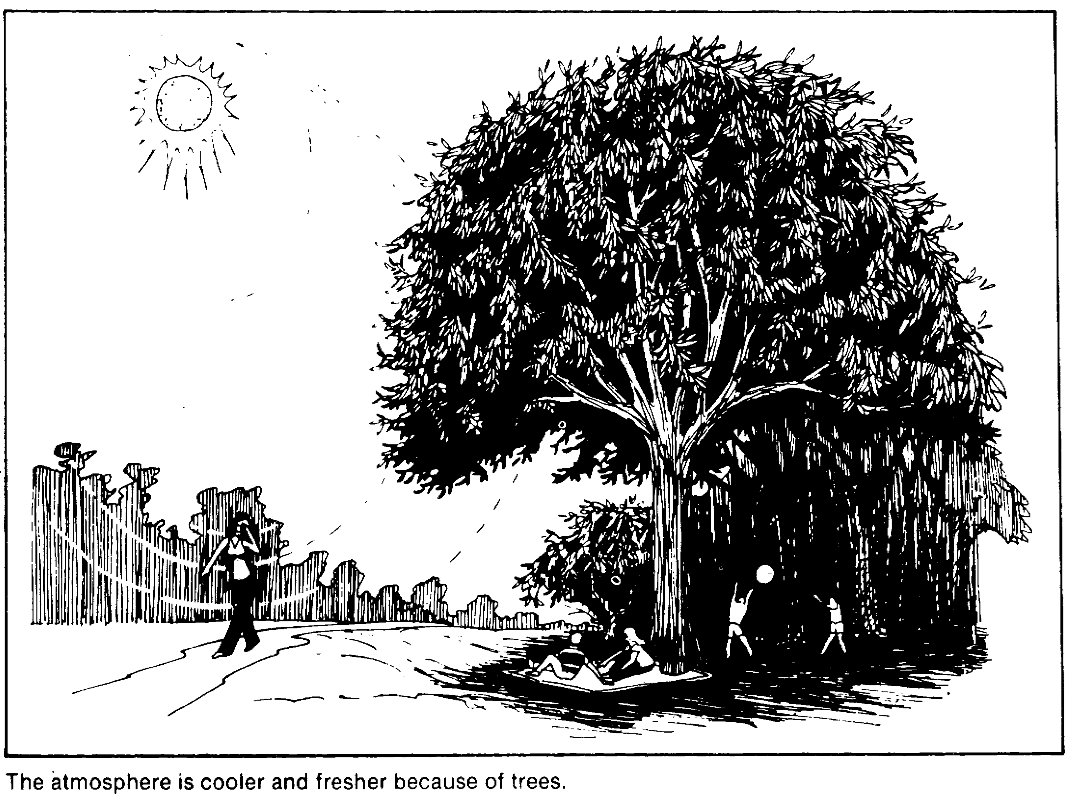
While trees do a good job of helping to reduce air pollution, the best place to fight pollution is still at its source. We need to find new and cleaner sources of energy, make better use of mass transportation, and centralize combustion facilities. With appropriate legislation and changes in land-use policy sources of industrial pollution could be dispersed. Fuel-use policies also need to be reevaluated.

Trees cannot prevent all air pollution problems, but forests, woodland glens, roadside parks, and even trees along expressways can help decrease the amount of pollutants.

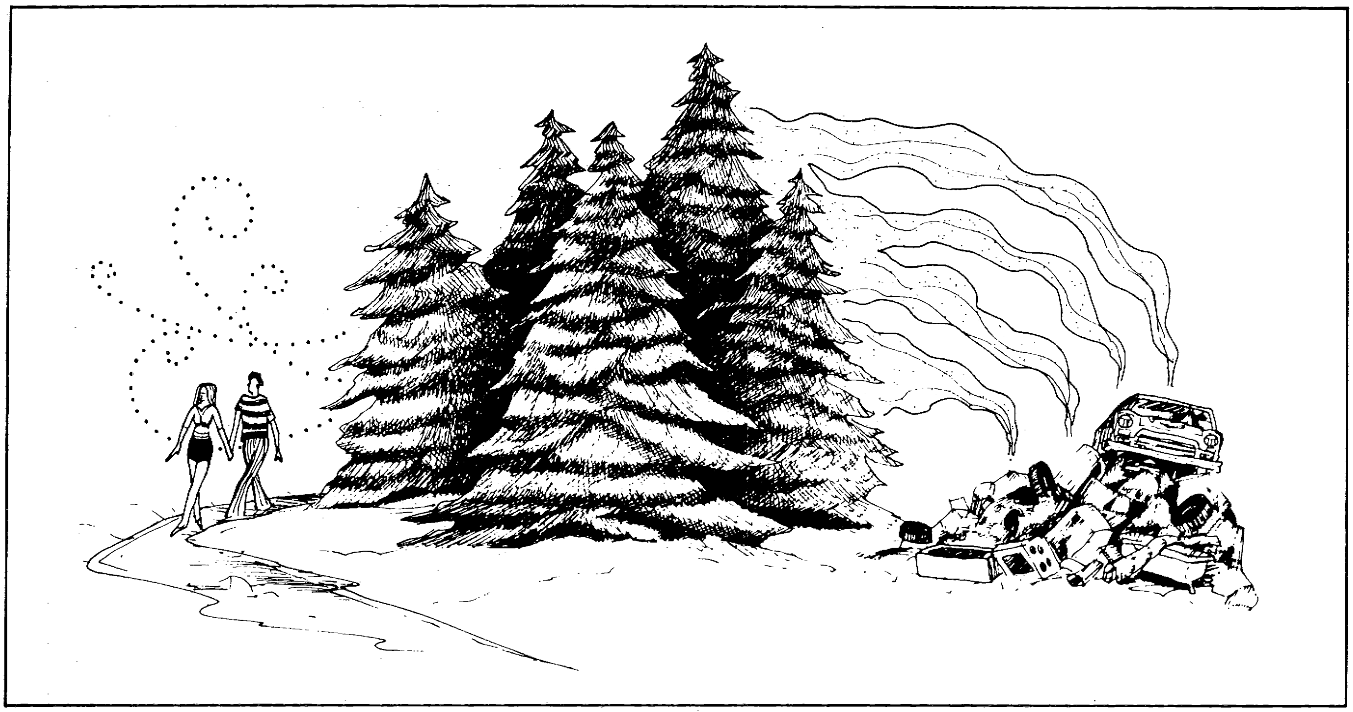
Here are some of the cleansing acts that groups of trees perform.

When pollution-bearing winds pass through a tree canopy, they lose speed and some of their pollution load. By contact with trees, air streams are partially redirected, sometimes benefiting people and animals beneath the forest canopy.

Warm air, especially when trapped beneath cooler air as during a temperature inversion, increases the ill effects of air pollution. Because leaves transpire large amounts of moisture, trees have a cooling effect on the surrounding environment. By cooling and cleansing the atmosphere, trees help to make air safer for breathing.



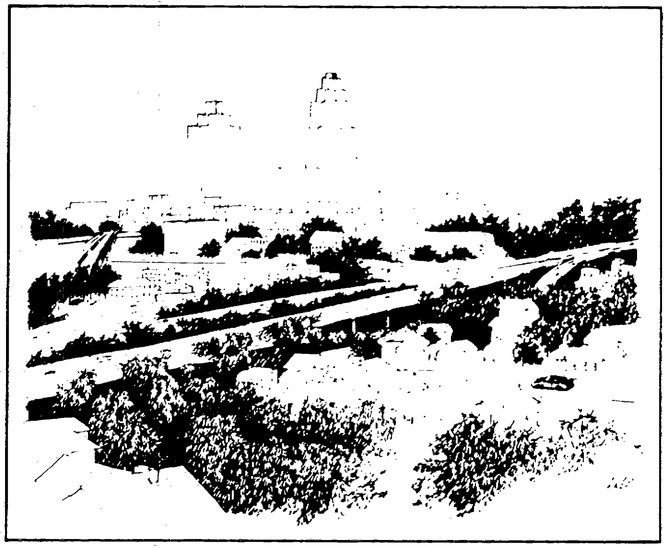
The atmosphere is cooler and fresher because of trees.



Trees' naturally pleasant fragrances help counter the foul odors of dirty air.

In a forest, a person is usually surrounded by pleasant smells. Trees may help to freshen dirty air by filtering and filling the air with their own naturally pleasant fragrances.

In cities, where greenspace is often compromised for urbanization and industrial expansion, the atmosphere is more subject to problems with buildups of heat islands, stagnated air, photochemical smog, and imbalances in visibility and solar radiation. Greenbelt plantings in urban areas may help reduce the harmful effects of low-level pollution.



In cities, greenspace often gives way to urbanization and industrialization.

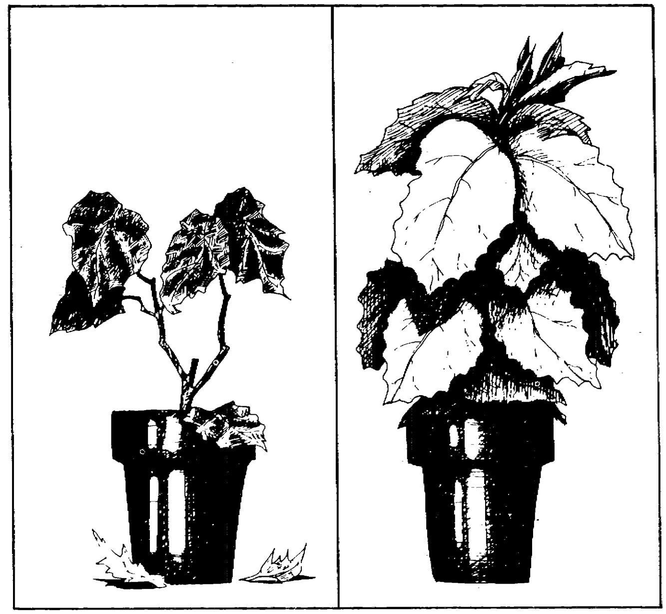
The wonder is that trees can provide all these atmospheric benefits and still survive. Unfortunately, air pollution may be causing damage even when the effects are unseen.

Trees vary in their tolerance and reaction to air pollution. In experiments with bigtooth aspen, plants of the same size were grown under identical conditions and fumigated regularly with sulfur dioxide, a toxic gas. Some plants grew vigorously; they seemed to thrive on pollution. Others became stunted and sickly. Why did plants of the same species respond so differently?

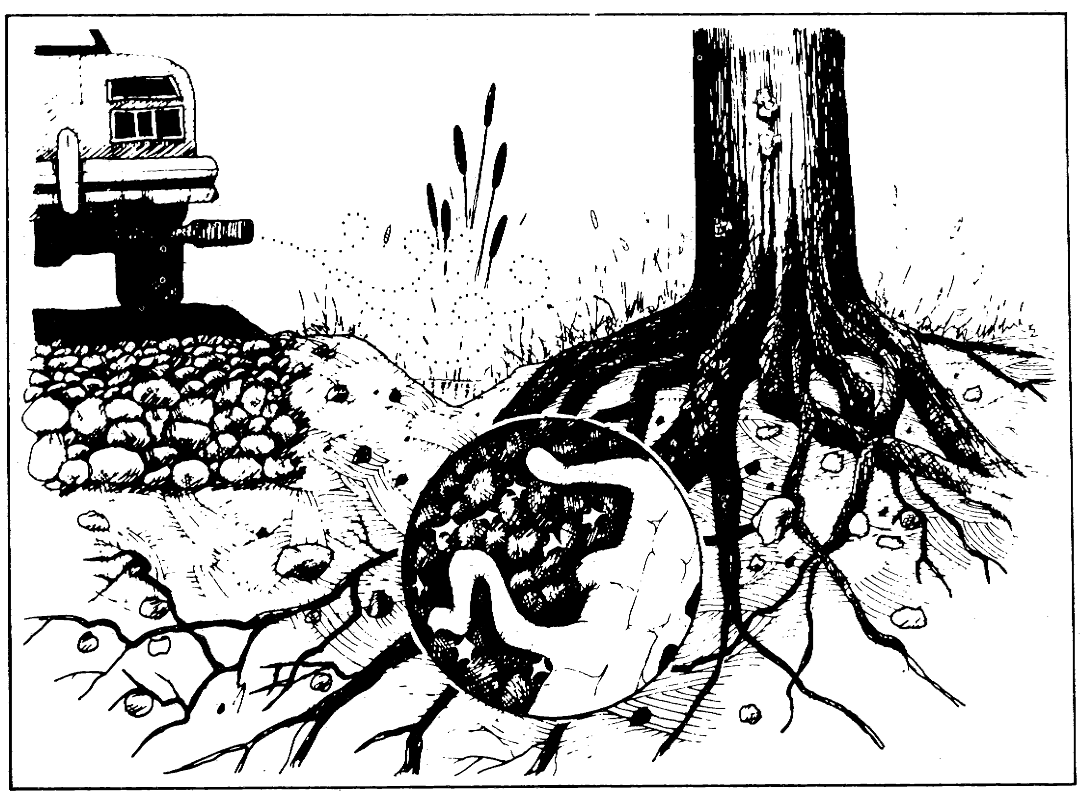
Interaction of the environment and the genetic makeup of the individual tree probably accounts for the difference in growth. The presence or absence of certain chromosomes makes some trees more tolerant to air pollution. Finding trees with this genetic tolerance is basic to the breeding and selection of pollution-tolerant trees.

Which trees are more effective in reducing air pollution—tolerant or sensitive ones? Current theory says that, because they absorb more pollutants, sensitive trees are more useful, but the opposite may be true. Tolerant trees, even if they absorb less, function for a longer time, since they generally live longer than susceptible trees. In the long run, tolerant trees may be better cleansers.

Along with vegetation and water, soil is a major depository or "sink" for air pollution, especially heavy metal particles and gases such as carbon monoxide. During nutrient cycling, trees may use some of these substances for growth and development. Scientists are interested in selecting trees that do the most to reduce soil pollution.

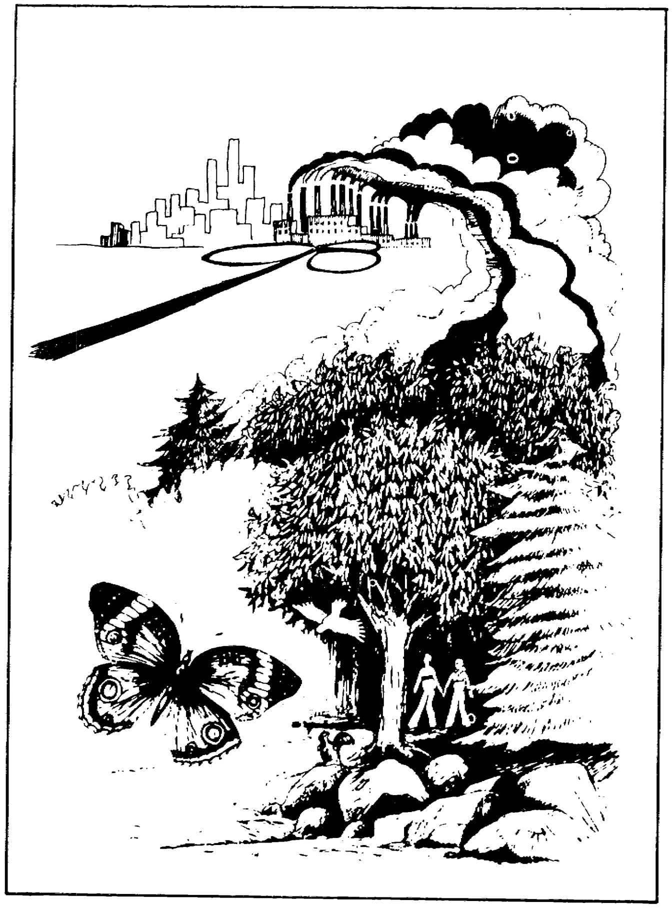


These bigtooth aspen were grown under identical conditions but reacted differently to air pollution.



Soil is another major receptor or "sink" for air pollution.

Eventually, all plants reach a stage where the benefits from air pollutants cease and pollution injury occurs. Research will help us to understand the interactions of trees and air pollution, and make possible a more harmonious balance between society and the natural environment.



The information in this booklet is based on research by Leon S. Dochinger, Supervisory Research Plant Pathologist at the Delaware, Ohio, laboratory of the Northeast Forest Experiment Station, Forest Service, U.S. Department of Agriculture. The booklet was developed with the assistance of Jane Riddle, Information Specialist with the Northeastern Station. Illustrations are by Jim Lockyer, artist and biological laboratory technician at the Delaware laboratory.