What Can We Do About Pollution?

It is not easy to say anything new about pollution of the environment. It is a bad thing. We all oppose it in theory. Why, then, does it continue? Because, when it comes down to specific instances, specific pressures — generally economic — appear. Someone's self-interest is threatened. Each writer must approach the problem from his own experience and interests. The popular and technical press are now full of facts and figures about pollution. The legislatures and the executives are proposing programs right and left. Pollution can be controlled, here and now. The cost is greatly increased taxation and control of the size of our population. Neither, alone, will help. We must have both.

I am appalled by the unsanitary conditions that pollution forces our society to endure. I am aware of local needs and pressures to convert undeveloped land to "useful" purposes. I have to admit that some of these needs and pressures are valid. I realize that a balance must be struck between the preservation of open space and the needs of people for places to live. The sub-rural environment that I desire for my children is also desired by others, and so I have to admit that undeveloped land must be made available to others for housing. My concern is that the development of undeveloped land should be orderly and in the best interest of all.

Although the Boston-Washington megalopolis is the largest concentration of cities in the world, there is now more "wild" land in southern New England than there has been for more than 100 years Massachusetts, Rhode Island, and Connecticut are three of the four most densely populated states in the Union. Despite this, only 9% of the land area is devoted to industry, commerce, or residences; 17% of the land is devoted to agriculture; 65% of the land is in forest, and the remaining 9% is under water or covered by non-forested wetlands. One hundred and ten years ago 60% of the land area of Massachusetts was cleared and used for agriculture, residences, or industry; 20% was "waste," and only 20% under forest. Wildlife also has increased over the last hundred years, even over the last forty

years. In 1930 E. J. Palmer recorded that rabbits were rare or lacking in the Arboretum; they are common today. Within this same period the raccoon and opossum have become firmly established in the Boston metropolitan area.

This is not to say that all is well. All is not well, and we know it. But there is a larger picture that we must attempt to see. Urbanization and concomitant pollution, as they concern us, are localized in a few river valleys, in the Boston and Narragansett basins, and on the outer edge of the coastal plain from New Haven to New York. Our water resources (brooks, rivers, ponds, marshes, and sea coast) are badly polluted. The air over our larger cities is polluted. The effect of insecticides on wildlife, and on us, is a problem of considerable proportions. But, excepting these special cases, we are in much better shape than we might expect. Our greatest concern should not be Man's effect upon wildlife but, rather, Man's effect upon himself. Nature will survive; Man may not.

The problems that we face with regard to environmental pollution are serious. I do not think that overstating any facet of the situation does us any great good. What I would like to do is to present both sides of some environmental questions. I shall offer some comments and recommendations on the general problem. After that I shall deal with the consequences of a few specific problems.

General Considerations. Basically, all of our pollution problems are caused by what is currently called over-population. Our population is growing at a rate that is greater than our ability to provide municipal services for it. Generally, every new family in a community costs the town or municipality more for services than it can recover from that family in taxes. Hence, the taxes on all of us must continually increase. In the inevitable competition for funds the schools, rightly, are placed at the top of the list. Unfortunately, sanitation, which bears directly on environmental quality, is almost inevitably given a low priority.

Every animal or plant population pollutes its environment with its wastes. Under natural conditions, the total environment is able to accommodate the natural rate of pollution, converting wastes to useful nutrients. If any single species increases out of balance with the total environment, the population of that species is reduced, either by starvation, disease, or by strangulation in its own waste.

In the case of human population, the problem of waste dis-

posal is now acute, as are the problems of starvation and disease. It is doubtful that we can find money enough to construct waste disposal facilities fast enough to prevent further environmental deterioration. Indeed, we shall be lucky to keep pace with increasing population. Even if we could construct facilities fast enough, it is even more doubtful that trained personnel to operate them would be available. Like it or not, these are the problems we face. We cannot leave these problems and migrate to the frontier. We must stand where we are and fight this battle on this ground.

In Massachusetts, and in the country as a whole, the rights of the individual are correctly given prime protection by the courts. Unfortunately, these rights include the right to befoul our own property. Only when danger to the life or property of others can be clearly demonstrated will the courts be prevailed upon to act restrictively. If the amenity of open or underdeveloped land is to be securely protected and preserved, it must be accomplished by public or private ownership. We cannot, by law, impose our individual standards of amenity upon others.

Many laws and programs have been passed by the various legislative bodies to protect society from the abuses of individuals. Pollution, however, continues only slightly abated. Why? In Massachusetts, and probably in many other states, we do not need radically new legislation or programs. The problem in this state, and I believe in most other states, is that the present laws are neither obeyed nor enforced. The laws are not obeyed because the legislatures have not voted sufficient money to provide the trained manpower necessary to enforce them. Towns

and municipalities, even if they choose to attempt to obey the laws, do not have the personnel to enforce them. Further, the towns and municipalities have found that state agencies either will not challenge them or, if challenge occurs, the judicial process can be dragged out so as to make the challenge nearly meaningless. The single answer, then, is money: money on both the state and local levels to enforce compliance with the laws. Until manpower is available, legislation is futile. It appears that we will not have sufficient money for this task until the size of the population is stabilized. The problem is as simple as that.

It is dangerous to wait, however; we must face the situation in its current context. First, local government must be pressured to obey the laws with the exercise of police action by the state. Qualified engineers and other technicians must be prevailed upon to serve, *gratis*, on the appropriate town or municipal boards. The general population must be prevailed upon to learn the laws and to report problems as they arise. People must demand that local government act promptly to rectify the problems. Second, in the absence of appropriate local response the appropriate state agency — usually the state Department of Public Health — must be pressured to provide police action. In general, the state Department of Public Health is the primary agency charged with maintenance of environmental quality. In Massachusetts the Department has developed a series of minimum standards for the protection of the environment. Unfortunately, in Massachusetts the state pay scale is too low for the Department to hold the qualified personnel it needs. Also, the table of staffing provided by the legislature does not permit enough people for effective enforcement activities. The current work load of the present staff is such that a citizen's complaint must wait an average of three weeks before it can receive even a preliminary investigation. Resolution of that complaint may take three months or longer. The situation is intolerable.

Local complaints arise from the inability of local boards of health to deal with their own problems. The engineers employed by communities are not, in general, qualified to deal with public health problems. This problem is compounded by the lack of knowledge of the local boards of the long-term consequences of environmental deterioration — or, to be blunt, of the results of deviation from the requirements of the sanitary code.

Tactically, environmental problems should be handled as follows: (1) Determine the exact circumstances of the particular case, including the presumed deviations from local or state laws.

(2) Contact the local board of health (in writing, by certified mail) detailing the problem and requesting an answer, in writing, by a given date. (3) If satisfaction is not forthcoming from the local board, contact the district state sanitary engineer, in writing, (again, by certified mail) enclosing a copy of the letter sent to the local board, and request an answer by a given date. (4) If need be, contact the head of the state Department of Public Health (also by certified mail) enclosing copies of all relevant correspondence.

It is important to remember that, given the pressure of increasing population, development of undeveloped land cannot be stopped. It can only be regulated and directed into acceptable directions. In the long run land can only be preserved in its natural state by public or private ownership. The nature conservancy or local land trusts can accomplish this. Further, we have to accept the fact that any method of preserving land in its natural state will cost money. If sufficient public employees are to be engaged to protect the environment, the money must come from some source. Either taxes will have to be raised or some other activity will have to be curtailed. Perhaps roads will suffer, or perhaps we will have to do without a new municipal building or a sports stadium. This is the choice that the public has to make.

I am not particularly hopeful that local communities will solve their own problems by their own choice. Most people are not concerned with anything other than their own personal problems. By and large local officials will not act in the public interest — as distinct from their own private, financial, or prestige interests — unless there is the threat of police action from the state. The vast majority of the population will oppose the additional taxation that is necessary for pollution control. It is up to the state legislatures and executives to provide legislation and money to enforce that legislation for the public good. To date we have seen plenty of legislation but very little money for its implementation and enforcement.

Pollution of Soil and Water. A particular level of pollution can occur in one, or both, of two ways: a low level of pollution by a large number of sources, or a relatively high level of pollution by a few sources. It is easy to see the high level of pollution produced by an industrial establishment and equally easy to think that if only industrial pollution could be stopped our problems would end. However, the situation is not so clear-cut. Of course, industrial plants should curb their pollution of the en-

vironment. Yet if all industrial pollution were eliminated, our job would be only half done.

At least 50% of soil, water, and probably air pollution is produced by the individual home owner. At least half of the surplus nutrients that now befoul our lakes and rivers originate from the effluence of the sewage disposal facilities of individual home owners, the fertilizers they apply to their lawns and gardens, and farms. There is no question that industrial pollution can and should be controlled, but what of the balance? The home owner's dry well, cesspool, or septic tank is simply not an acceptable solution to the problems of household waste disposal. The ground water in many of our suburban communities is already hopelessly contaminated with bacteria and chemicals. The only satisfactory solution is for all homes to be connected to a public sewer system, and for the wastes to be treated in a modern, efficient sewage disposal plant.

Again, we are faced with the problem of money. Sewers are expensive to lay. Efficient sewage treatment plants are expensive to build, maintain, and staff. They seldom occupy a high place in the budget priorities of towns and municipalities. In the long run increased taxes are the only answer. Federal grants are not free. They are all paid for with taxes, yours and mine.

If the problem of sewage disposal is not enough, another one is forcing itself upon our consciousness: common table salt — sodium chloride — pollution. The use of salt is one of the most effective and economical techniques for clearing roads of snow and ice in winter. One frequent, observable result of this practice is the death of grasses and herbaceous vegetation along the sides of roads that have been salted during the previous winter. In addition, we may note the decline in vigor, or even death, of some roadside trees. The obvious line of reasoning is: (1) salt is used to clear snow and ice from the road; (2) we have used salt in the past to kill weeds and grass in driveways and paths; (3) salt has killed the roadside grasses and herbs; (4) salt is killing the trees. Unfortunately, like so many obvious lines of reasoning, this one is only partially valid. Statements (1) and (2) are obviously true, statement (3) probably follows, but statement (4) is questionable as a generalization, though probably true in individual cases. I can do no better than to quote from a talk by Dr. F. W. Holmes of the Shade Tree Laboratories of the University of Massachusetts: "Obviously a great many factors that are present along a road can harm a tree. Salt is only one of them. Others include fill, compaction of soil, absence of topsoil, limited surface area for air and water to

reach the roots, pavement over the roots, all the usual insects and infectious diseases (especially diseased root systems), natural drought, artificial droughts from alteration of the water table by drainage systems, increased numbers of injuries through artificial transplantings of trees (through automobile accidents and vandalism) cutting of roots in ditches for the sake of various installations, gas leaking into the soil, electrical injuries, herbicides and other chemicals and air pollution fumes; to lump it all in a single phrase, all the ills of civilization. After a decade of diagnostic work in Massachusetts, I am strongly inclined to say that 'civilization' is the most serious disease agent affecting shade trees, not standing second even to the famous Dutch elm disease! When we are faced with a tree which has undergone all of these site injuries, and which may therefore be especially subject to all those diseases and insect pests that preferentially attack weakened or wounded trees, then how are we to judge to what extent salt has played a detrimental role?"

Salt is definitely a factor in the decline in vigor and death of some roadside trees. The relationship may be direct, as in the case of species such as the sugar maple in which salt may be absorbed by the tree in lethal quantities; or it may be indirect, since it appears that salt-treated soils are low in soluble nutrients, and the tree may be literally starving. The problem of what to do about roadside trees is easy to handle. Salt-intolerant species should be replaced with salt-tolerant trees. Roadside soils should have a regular program of fertilization.

Since salt is very quickly leached through the upper levels of the soil, its effects on roadside vegetation are temporary. It reaches subsoil water tables quickly and gets into ponds and streams. In Massachusetts we are now beginning to have problems, which will undoubtedly continue and intensify, with salt contamination of domestic wells and water supplies. In addition, we will have to cope with salt contaminating streams and lakes, destroying fish and other wildlife, and polluting public water supplies. The problem of the selective killing of roadside vegetation is one that we can live with, but I am not sure that we can live with polluted reservoirs.

At present there is no economical method for removing common salt from water. It can only be diluted with unpolluted water to an acceptable level of palatability. With our present population growth and the resulting pressure on water supplies, it is questionable how long this technique will serve us. If we stop using salt to clear the roads, we will need to compensate with a vast capital expenditure for mechanical equipment to

plow and remove snow and to spread sand. Operating expenses will also rise, not only for drivers and mechanics, but also for personnel to clear the sand from roadsides and gutters at the end of the winter. Are we willing to accept more taxation for unpolluted water?

Air Pollution. Many, perhaps most, metropolitan areas have problems with air pollution. Boston is no exception. That our problems are not greater is due in part to nature — the lay of the land and the prevailing winds — and in part to a long history of legislation aimed at air quality control in our metropolitan area. However, inadequate funding has prevented the State Department of Public Health from employing a sufficient number of qualified engineers to assess the conditions to formulate adequate regulations promptly, and to enforce the regulations once they are established as law. The situation can, perhaps, be best described by quoting from a special report to the Massachusetts legislature prepared by the department, and submitted in September of 1968.

"Legislative authority for control of air pollution in the Commonwealth [of Massachusetts] by a responsible public agency was first established in 1869 at the time of the creation of the State Board of Health. Air pollution control was included in its environmental sanitation program. By the turn of the century certain aspects of air pollution control were recognized to be of a regional nature and the Legislature, in 1901, enacted a General Law to control the emission of dark smoke from sources other than locomotives and brick kilns However, 'special-interest' amendments to exclude public utility corporation, wood-burning plants, and pottery kilns reduced the effectiveness of this law, and brought about the formation of a citizens' committee for smoke abatement to protest to the legislature. . . . The Committee's efforts were rewarded when, as a result of its persuasion, the Boston Chamber of Commerce filed a petition to the General Court, titled 'An Act to Provide for the Abatement of Smoke in the City of Boston and Vicinity,' which became Chapter 651 of the Acts of 1910."

". . . It provided for a 'smoke district' comprising the cities of Boston, Cambridge, Somerville, Everett, Chelsea, and the town of Brookline, and encompassing an area of 66 square miles with a population of almost one million. . . . Enlargement of the 'smoke district' to include 29 cities and towns with a population of over 1,800,000 within an area of 290 square miles, took place in 1928. . . . In 1960, new legislation . . .

was enacted which replaced the 'smoke district' with a Metropolitan Air Pollution Control District . . . , comprising Boston and 29 contiguous cities and towns with an area of 320 square miles and a population of over two million people. . . . The Department of Public Health, under this law, was given authority to regulate all sources of atmospheric pollution within the District. In the Rules and Regulations subsequently adopted in 1961, 'atmospheric pollution' was defined as 'the presence in the ambient air space of one or more air contaminants or combinations thereof in such quantities and of such duration as to (a) cause a nuisance; (b) be injurious or, on the basis of current information, be potentially injurious to human or animal life, to vegetation, or to property; or (c) unreasonably interfere with the comfortable enjoyment of life and property or the conduct of business.' "

"A good air use management program should strive to keep in balance its efforts to reduce air contamination and its sufferance of reasonable use of its air (as a resource) to receive (and transport away) certain wastes resulting from man's individual and collective activities. Such use, however, must be in a manner compatible with, but to an extent no greater than, the capability of the ambient (outdoor) air to tolerate such use without undue detriment to man and his environment of concern. Expensive air pollution control measures for the preservation of pristine purity of air, for preservation reasons alone, and where lack of such would produce no significant hazard to man or to those elements in the environment for which man has a real concern is, per se, a waste of a valuable resource. . . ."

Two categories of pollution which have concerned the Metropolitan Air Pollution Control District have been "particulates," i.e., those particles such as soot and flyash which settle rather rapidly out of the air, and those particles which are so small as to settle very slowly, but cause soiling, odors, and reduced visibility; and sulphur dioxide, which causes sensory and respiratory irritation, corrosion of metal, stone and painted surfaces, and vegetation damage.

"Particulate air contaminants result principally from combustion for the production of heat, power and the destruction of wastes; from industrial (or commercial) processes involving abrasion, fuming, and loss of process materials; from abrasive phenomena such as automobile tire and brake wear; and by natural weathering, wind effects, pollen production and evaporation-condensation. . . . Particulates may be emitted from combustion processes as a result of gaseous suspension of ash, un-

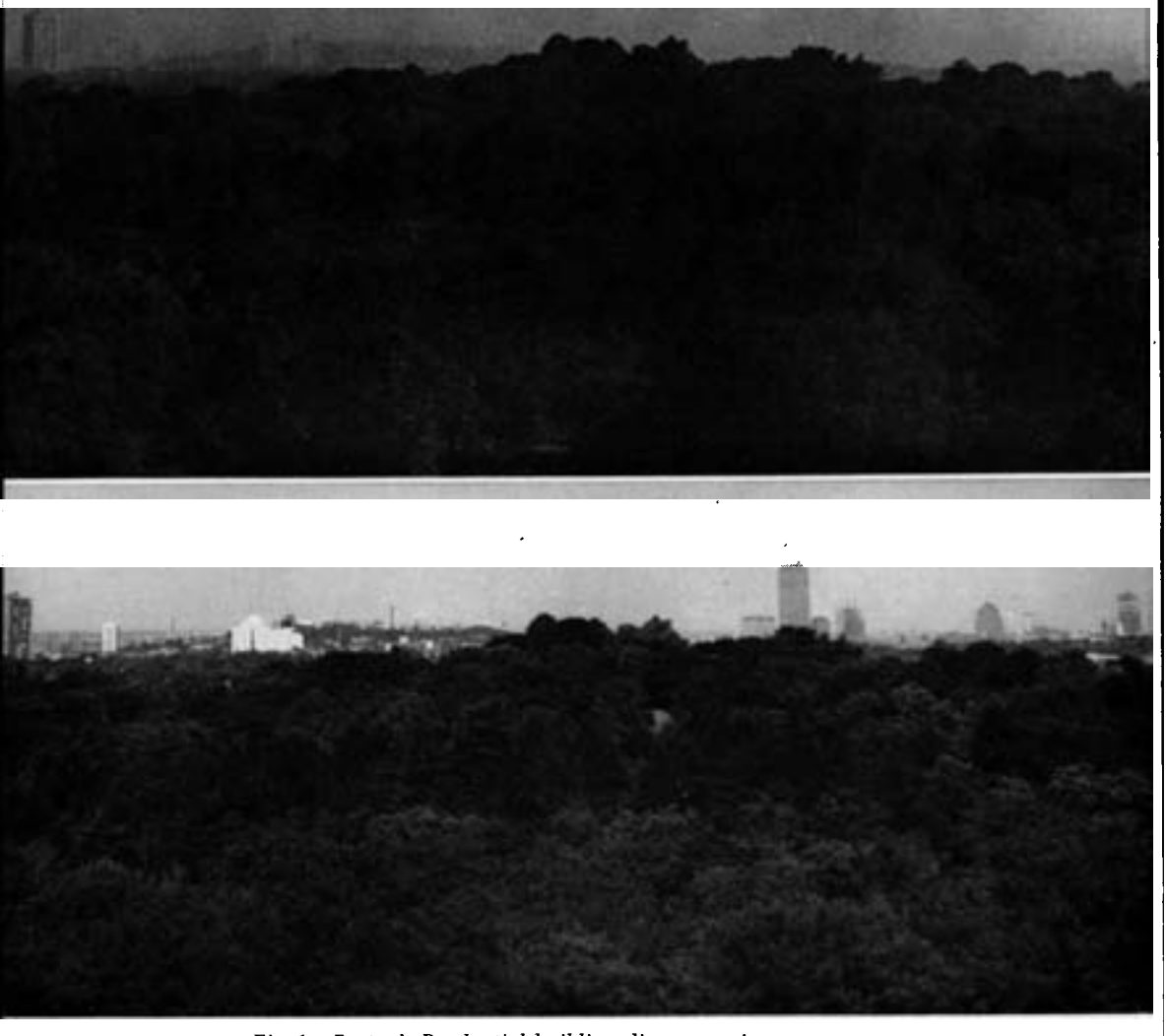

Fig. 1: Boston's Prudential building disappears in smog. Photos: P. Bruns.

burned carbon, and carbonaceous compounds. The amounts vary depending on (1) the amount of ash in the fuel (up to 25% in refuse, 5–15% in coal and 0.5% in oil . . .); (2) the nature of the combustion process . . . ; (3) the efficiency of the process; and (4) the nature and efficiency of air cleaning equipment utilized. . . . The 'natural background' of such suspended particulate material in New England averages about thirty micrograms per cubic meter (30_{μ} g/M^3). This level is the result principally from pollen-scattering, wind-disturbance of soil, other

natural phenomena, weathering of surfaces, evaporation of sea spray, and forest fires. . . ."

On the fringes of the Metropolitan Boston area total particulates average 50μ g/M^3. Close to the city center the average concentration rises to 60μ g/M^3. In the central core the average concentration is approximately 85μ g/M^3, with a winter average in South Boston of 128μ g/M^3. Reports of sulphur dioxide levels are available for the inner portion of the Metropolitan area. These average more than .03 parts of sulphur dioxide per million parts of air, a level which has been determined as being injurious to some vegetation.

Apart from particulates and sulphur dioxide, the atmospheric pollutant that is currently receiving much attention is so-called photo-chemical smog, a complex mixture of substances caused by the action of sunlight on the chemicals emitted as exhaust gases by automobiles. This is alleged to be the principal problem in and around Los Angeles and to be causing injury and death to pine forests on the mountain slopes some 40–60 miles from that city. Much has been written about the dangers of photo-chemical smog, and much damage has been attributed to it in other parts of the country. One has to say, in all honesty, that relatively few hard facts are available. Some damage to vegetation has been blamed on photo-chemical smog in the Boston area and, undoubtedly, some damage has taken place, but there is a notable absence of information about exactly how much smog produces what kind of damage on which plants. We are lacking measurements of pollution levels that would indicate that smog could have produced the damage reported. I, for one, have not seen any damage in the Boston area that could be unequivocally attributed to smog — drought, yes; salt, yes; but smog, no. On the other hand, Dr. William Feder, of the Waltham Field Station of the University of Massachusetts, has reported that ozone (one of the components of photo-chemical smog) is a problem in this area. He has said ". . . The sensitive tobacco plant used [as an indicator] will react to about 2½ to 5 parts per million of ozone in the ambient air. These same tobacco plants will react to 2–3 ppm of ozone and 0.2 ppm of sulphur dioxide to give another type of leaf reaction. Comparison of plant damage and meter reading information seems to indicate that during a summer like the summer of 1967 total oxidant in and around the Boston area may reach as high as 15–20 parts per hundred million (i.e., .15–.2 parts per million) for as long as 4–5 hours on a sunny day. This amount of oxidant is enough to injure marigold, petunia, and the very sensitive tobacco

plant." This is, however, probably not sufficient to damage most trees and shrubs. What does concern all of us is what effect long-continued exposure to low levels of these pollutants will have both on vegetation and on humans. At present, this kind of information is not available.

Pesticides. The pesticide controversy, like so many other controversies, is a battle fought on false premises. The agricultural chemical industry pictures itself as a knight in white armor fighting valiantly to provide food for mankind while picturing the anti-pesticide forces as trolls, fighting to deny mankind its daily bread. The conservationists see the picture just the other way.

In reality, very few people would deny that agricultural production must be increased. Increased agricultural production is dependent, among other things, upon protection of crops from injury or destruction by insects and other vermin. In the present state of our knowledge protection must be based on protection by chemical agents. Biological protective agents or strategies have been developed in the past for some pests and are now being studied for others. However, effective, widespread protection by biological agents lies sometime in the future. Since we must protect our crops now, the quarrel resolves itself into a choice of chemicals for present use.

Many chemical pesticides are presently available. Some of them are extremely toxic to all life forms. Some have short lifespans in the environment. Others are persistent in the environment and have already been demonstrated to have deleterious effects on various species of wildlife. In the past only two criteria seem to have influenced our use of pesticides: their effectiveness as pesticides and, to a lesser extent, their immediate toxicity to man. The agricultural chemical companies have a heavy investment in particular chemicals which are economically advantageous for them to produce. They also resent being made the culprits of environmental deterioration. They feel that they have played the game by the rules and they dislike having the rules changed to their disadvantage.

The pesticide problem, lest we forget, is not new. Before the Second World War great reliance was placed upon the use of pesticides containing arsenic, such as lead arsenate, Paris Green (copper aceto-arsenite), and calcium arsenate. In the 1940's and early 1950's it became apparent that agriculture was in

trouble. Following many years of heavy applications of arsenical sprays, compounds of arsenic had accumulated in the soil. The presence of these compounds reduced the yields of many crops that had been protected from insect attack. Further, it was found that some crops were accumulating arsenic to the amount of 14 ppm of their dry weight. Since arsenic and lead are both accumulated to lethal levels in the human body, and since the lethal dose for an adult is on the order one half to one teaspoonful, the inherent danger was very real. A radical change of insecticides was necessary, and the synthetic organic insecticides seemed an obvious answer. We were so relieved to have the arsenical problem solved that we chose to ignore the plain warnings that we had, even then, about the intrinsic dangers of the synthetics. Now, with the advantage of hindsight, we are only too ready to blame industry for doing exactly what we asked it to do fifteen or twenty years ago.

What we should do, at present, is determine what is safe — and economical — and concentrate on them. Arsenicals in any form, in my opinion, ought to be banned. That includes the arsenical rodent poisons and herbicides. We do not have to repeat here all that has been written of the ecological tragedies caused by modern synthetic insecticides. There is only one point to make. Among the vast number of chemical pesticides in commerce there are a few that are economically effective and relatively safe ecologically. (See Appendix, page 50.) We should concentrate on using them. It is within the capacity of the industry to produce other similar pesticides. We should stop the noise and get on with the business of producing food.

In general, the following pesticides are environmentally safe for use by the home owner or home gardener:

Malathion	Aphids, caterpillars, beetles, leaf hoppers, leaf miners, plant bugs, scale and mealy bug, springtails, thrips, white fly, cutworms.
Methoxychlor	Caterpillars, spittle bugs, apple maggot, codling moth, Japanese beetle, plum curculio, tent caterpillar.
Carbaryl (Sevin)	Beetles, rose chafer, periodic cicada, pickleworm, squash vine borer, stink bug, bagworm, fall canker worm, codling moth, grasshoppers.
Dicofol	Spider mites, cyclamen mites.

For household insects Malathion will control those listed below. Care must be exercised not to contaminate foodstuffs or eating or cooking utensils.

Ants
Bedbugs
Cockroaches
Fleas (dust dogs and cats with 5% carbaryl powder)
Flies (pyrethrum + piperonyl butoxide is even safer)
Silverfish and firebrats
Spiders
Ticks (dust dogs and cats with 5% carbaryl powder)

Although it is intensely poisonous to man, and the fumes are irritating, nicotine is effective against aphids, thrips and other soft-bodied insects and is safe environmentally. Dormant oil is effective against scale insects when applied during the winter. Summer oil sprays are useful against scale during the growing season. Pyrethrum and Rotenone are effective against many soft-bodied insects. Lime-sulphur, in strong solution, is effective against scale when applied in the winter. In the summer a weaker solution is used as a fungicide.

Summary. The problem of pollution control, then, can be summed up as follows: (1) we can dramatically reduce the present levels of pollution with present technology; (2) this reduction in pollution can be obtained only by greatly increased expenditure of money; (3) the only source of money is increased taxation; (4) beyond money, some activities, i.e., snow removal and pest control, may be considerably less effective than they are at present; (5) if industry and municipalities and private citizens rigorously control their pollution, much increased taxation can be avoided.

I believe that we must control pollution for our own survival and that we must accept increased taxation and reduced efficiency to pay for it. I also believe that, in the long run, we can save ourselves a great deal of taxation and grief by controlling the size of our population. This is the price that we must pay for our survival as a free society. *We must control the size of our population and we must reduce our present level of environmental pollution if we are to survive.* Or, put another way, will you settle for your pocketbook and your present amenities now, or will you sacrifice some of these so that your children and grandchildren can live in the kind of society that you enjoy?

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Appendix.

The following table (pp. 50–55) has been compiled from a number of sources, notably *Agriculture Handbook 331* and the *Pesticide Information Manual.* It is intended to give some idea of the hazards to man and to the environment that are inherent in some of the insecticides in use today. LD_{50} is the amount of chemical in micrograms of chemical per kilogram of body weight needed to kill one half of a population of laboratory animals. As such it is a rough indication of toxicity to humans. The smaller the number, the more lethal the substance.

Pesticide	Toxicity					Hazards		
	LD_{50}	*Rats*	*Fish*	*Birds*	*Bees*	*Persistence*	*Wildlife*	*Environment*	*Applicator*
Abate I	2,000	slight	high	moderate	?	?	?	?	moderate
Acricide-see Binapacryl									
Aldrin I	39–60	high	10–14 high	high	high	long	yes	yes	yes
Allethrin I	480	slight	high	slight	slight	short	(fish)	?	slight
Anthon-see Trichlorfon									
Aramite A	3900	slight	480–730 slight	slight	slight	21–30 days	?	?	? known careinogen
Azinphosmethyl I	16–80	high	high	moderate	high	1 season	yes trained operator only	yes	yes
Baytex-see Fenthion									
Bidrin I	22	high	high	high	high	30 days	Not at recommended application		yes
Binapacryl I,F,A	58–63	moderate	high	slight	slight	several weeks	yes	yes	moderate
Black Leaf 40-see Nicotine									
Butocide-see Piperonyl butoxide									
Captec-see Dicapthion									
Calcium arsenate I	40–298	high			high	long			yes
Carbaryl I	500–850	slight	moderate	slight	high	3–4 months	relatively low		low
Carbophenothion I,A	10–30	high	moderate	high	moderate	7–21 days	yes trained operator only	yes	yes
Chlorbenside I,A	2,000	slight	?	?	?	one season	?	?	low
Chlordane I	335–430	moderate	high	moderate	high	long	yes	yes	moderate
Chlorobenzilate A	1040–1220	slight	moderate	slight	moderate	7–10 days	low	possible	low
Chlorthion-see Dicapthion									
Ciodrin I	125	high	moderate	moderate	high	1–3 days	low	?	yes

Compound 338-see Chlorobenzilate									
Co-Ral-see Coumaphos									
Coumaphos S,I	15–41	moderate	moderate	high	moderate	one season	yes	yes	low
Cygon-see Dimethoate									
DDD I	2280	slight	high	moderate	?	long	yes	yes	no
DDT I	113–118	moderate	high	moderate	moderate	long	yes	yes	slight
DDVP-see Dichlorvos									
Delnav-see Dioxathion									
Demeton S,A,I	2–6	high	moderate	moderate	minimum	one season	yes	low	yes
Diazinon	76–108	moderate	high	high	high	two months	trained operator only (birds)	?	yes
Dibrom-see Naled									
Di-Captan-see Dicapthon									
Dicapthon I	500	moderate	moderate	?	?	4–5 weeks	?	?	?
Dichlorvos I	56–80	high	moderate	slight	high	1 day	slight when used as directed		yes
Dicofol A	1000–1100	moderate	high	slight	minimum	months	no	no	low
Dieldrin I	46	high	high	high	high	long	yes	yes	yes
Dimecron-see Phosphanamidon									
Dimethoate S,A,I	215	moderate	moderate	high	high	1–3 months	yes	yes	yes
Dioxathion A,I	23–43	high	high	high	minimum	6 months	yes	yes	yes
Dipterex-see Trichlorfon									
Disulfoton	2–7	high	high	moderate	moderate	one season	yes	yes	yes
Di-Syston-see Disulfoton									
Dithio-Systox-see Disulfoton									
DNBP A,I	37–60	high	high	high	?	short	yes	yes	yes
DN-289-see									

Pesticide	Toxicity					Hazards		
	LD_{50}	*Rats*		*Birds*	*Bees*	*Persistence*	*Wildlife*	*Environment*	*Applicator*
DNBP									
Dylox-see									
Trichlorfon									
Elgetol-318-see									
DNBP									
Embathion-see									
Thion									
Endosulfan I	18–43	high	high	high	moderate	one season	yes	yes	moderate
Endrin I	5–18	high	high	high	moderate	long	yes	yes	yes
EPN I,A	7–36	high	moderate	high	high	3 months	yes	yes	yes
Entex-see									
Fenthion									
ERN-300-see									
EPN									
Ethion I,A	27–65	high	high	?	minimum	one season	yes	yes	moderate
Fenthion A,I	215–245	moderate	moderate	high	high	2–3 months	yes	yes	yes
Genite	500	slight	slight	slight	minimum	30 days	slight	slight	slight
Guthion-see									
Azinphosomethyl									
Heptachlor I	100–162	moderate	high	high	high	long	yes	yes	slight
HETP-see									
TEPP									
Isomeric-see									
Dicapthion									
Kelthane-see									
Dicofol									
Kepone I,F	125	moderate	high	moderate	?	one season	yes	yes	? no
Korlan-see									
Ronnel									
Lead arsenate I	10–1050	high			high	long			yes
Lindane I	88–91	moderate	high	moderate	high	long	yes	yes	? low
Malathion I	1000–1375	slight	high	high	high	2–4 weeks	yes	slight	yes
Marlate-see									

Methoxychlor									
Meta-Systox R-see Oxydemeton									
Methoxide-see Methoxychlor									
Methoxychlor I	5000	slight	high	slight	minimum	long	yes	?	slight
Mevinphos S,A,I	3–6	high	moderate	high	?	1–3 days	yes	yes	yes
							trained operator only		
Mitox-see Chlorbenside									
Morestan F,A	1100–1800	slight	?	moderate	minimum	2 months	yes	yes	low
Morocide-see Binapacryl									
Naled I	250	moderate	moderate	moderate	high	1–4 days	low	low	moderate
Nankor-see Ronnel									
Neguvon-see Trichlorfan									
Nialate-see Ethion									
Nico-Fume-see Nicotine									
Nicotine I	50–60 83	high	high	slight	minimum	one day	low	low	yes
Orthotran-see Ovex									
Ovex A	2000–2050	low	moderate	?	minimum	one month	?	?	low
Ovotran-see Ovex									
Oxydemetonmethyl I,A	65–75	moderate	moderate	moderate	?	3 weeks	yes	yes	yes
Pallethrine-see Allethrine									
Parathion I,A	3–13	high	high	high	high	1 month	yes	yes	yes
							trained operator only		
Paris green		high				long			yes

Pesticide	Toxicity						Hazards		
	LD_{50}	*Rats*	*Fish*	*Birds*	*Bees*	*Persistence*	*Wildlife*	*Environment*	*Applicator*
Piperonyl butoxide	7,500–11,000	low	high	low	?	?	?	?	?
Phorate I	1–2	high	high	?	moderate	2 months	yes	yes	yes
Phosdrin-see Mevinphos									
Phosphamidon S,I,A	16.5–23	high	moderate	high	high	3–5 days	yes	yes	yes
Pynamin-see Allethrin									
Pyrenone-see Piperonyl butoxide with pyrethrins									
Pyresin-see Allethrin									
Pyrethrins	1500	slight	**high**	**slight**	**minimum**	**contact**	**no**	**no**	**no**
Resitox-see Coumaphos									
Rothane-see DDD									
Rogor-see Dimethoate									
Ronnel I,A	1250–2630	**moderate**	**?**	**slight**	**moderate**	**2 months**	**no**	**no**	**no**
Rotenone I	50–75	**moderate**	**high**	**slight**	**minimum**	**1 month**	**(fish)**	**(water)**	**no**
SD 3562-see Bidrin									
Sevin-see Carbaryl									
Sodium arsenite						**long**			
Spectricide-see Diazinon									
Systox-see Demeton									
TDE-see DDD									

Tedion-see Tetradifon									
TEPP I		high	high	high	high	1–3 days	yes	yes	very
							trained operator only		
Tetradifon I,A	**14,700**	slight	moderate	slight	minimum	2–4 weeks	low	low	low
Thimet-see Phorate									
Thiodan-see Endosulfon									
Thiodemeton-see Disulfonon									
Tiguvon-see Fenthion									
Toxaphene I	80–90	moderate	high	moderate	minimum	long	yes	yes	low
Trichlorfon S,I	450–500	slight	moderate	high	minimum	1 week	(birds)	?	moderate
Trithion-see Carbophenothion									
Trolene-see Ronnel									
Vapona-see Dichlorvos									
Vapotone-see TEPP									
Zectran	**25–37**	**high**	**high**	**?**	**high**	**?**	**yes**	yes	**moderate**

I = Insecticide
A = Acaricide
F = Fungicide
S = Systemic