

suspicions, so now I've tackled Dr. Caulk about it again. They took a picture Friday and there does seem to be trouble. He let me see the x-rays. It is the coracoid process of the scapula—the edge of it looks irregular and sort of eroded. For some reason Dr. Caulk seems rather puzzled—says he wants some of his associates to look at it and may want a picture from another angle, but on the whole he does feel it is a metastasis.

Well, all this brings questions in my own mind, which leaps to conclusions that may or may not be justified. Oh—the back trouble cleared up, but so slowly that Dr. Caulk had about decided it wasn't a metastasis. Treatment was begun just before Christmas and completed December 31. I was still in considerable pain in mid-January. Then rather rapid improvement set in and now it's OK. But now this bone deterioration in the shoulder makes me think all the more I had a metastasis in the spine. Dr. C. says not necessarily, but I think he's just trying to reassure me.

Barney, doesn't this all mean the disease has moved into a new phase and will now move more rapidly to its conclusion? You told me last year that it might stay in the lymph nodes for years, but that if it began going into bone, etc., that would be a different story. If this is the correct interpretation I feel I need to know. I seem to have so many matters I need to arrange and tidy up, and it is easy to feel that in such matters there is plenty of time. I still believe in the old Churchillian determination to fight each battle as it comes ("We will fight on the beaches—" etc.), and I think a determination to win may well postpone the final battle. But still a certain amount of realism is indicated, too. So I need your honest appraisal of where I stand.

Jane continues to give me courage. Kay told me of her question to the doctors: "Which of you is in charge of not giving up?" How like her! Well, I nominate you to that post. [. . .]

♪ 30 ♪

[1963]

The Pollution of Our Environment

IN EARLY 1963 Carson was invited to present the opening lecture to the Kaiser Foundation Hospitals and Permanente Medical Group in San Francisco at their annual symposium, but when the time neared for the October trip to the West Coast, Carson was debilitated from radiation treatment and frequently in pain. Nonetheless she made the trip, knowing that the symposium presented a unique opportunity to reach an influential audience.

Her official explanation for the cane she used to get on and off the stage was arthritis. The hushed and riveted audience of 1,500 physicians and health care providers did not seem to notice or care that she sat to deliver her hour-long lecture.

This was the first speech in which Carson publicly identified herself as an ecologist. Her message emphasized the links between species and their biological and physical environment, and the dynamic systems that govern the ecosystem.

There are reverberations of Silent Spring throughout this beautifully crafted speech, the last she gave. Carson expanded her criticism of a society that seldom evaluated the risks of new technology

before it was entrenched into social systems. She also included a final warning against making the sea a dumping ground for the "poisonous garbage of the atomic age."

♪ [. . .] I SUPPOSE it is rather a new, and almost a humbling thought, and certainly one born of this atomic age, that man could be working against himself. In spite of our rather boastful talk about progress, and our pride in the gadgets of civilization, there is, I think, a growing suspicion—indeed, perhaps an uneasy certainty—that we have been sometimes a little too ingenious for our own good. In spite of the truly marvelous inventiveness of the human brain, we are beginning to wonder whether our power to change the face of nature should not have been tempered with wisdom for our own good, and with a greater sense of responsibility for the welfare of generations to come.

The subject of man's relationship to his environment is one that has been uppermost in my own thoughts for many years. Contrary to the beliefs that seem often to guide our actions, man does not live apart from the world; he lives in the midst of a complex, dynamic interplay of physical, chemical, and biological forces, and between himself and this environment there are continuing, never-ending interactions. I thought a good deal about what I could say most usefully tonight on the subject assigned to me—"The Pollution of Our Environment." Unfortunately, there is so much that could be said. I am afraid it is true that, since the beginning of time, man has been a most untidy animal. But in the earlier days this perhaps mattered less. When men were relatively few, their settlements were scattered; their industries undeveloped; but now pollution has become one of the most vital problems of our society. I don't want to spend

time tonight giving a catalog of all the various kinds of pollution that today defile our land, our air, and our waters. I know that this is an informed and intelligent audience, and I am sure all these facts are known to you. Instead, I would like to present a point of view about pollution—a point of view which seems to me a useful and necessary starting point for the control of an alarming situation. Since the concept of the environment and its relation to life will underlie everything I have to say (and indeed, I think it is central to this whole symposium), I should like in the beginning to remind you of some of the early history of this planet.

I should like to speak of that strange and seemingly hostile environment that, nevertheless, gave rise to an event possibly unique in our solar system: the origin of life. Of course, our thoughts on this must be speculative; but nevertheless there is fairly wide agreement among geologists, astronomers, geochemists, and biologists about the conditions that must have prevailed just before life appeared on earth. They were, of course, very different from those of the present day. Remember, for example, that the atmosphere probably contained no oxygen; and because of that there could be no protective layer of ozone in the upper atmosphere. As a result, the full energy of the sun's ultraviolet rays must have fallen upon the sea; and there in the sea, as we know, there was an abundance of simple chemical compounds. These included carbon dioxide, methane, and ammonia, ready at hand for the complex series of combinations and syntheses that must have occurred. I shall not take time to describe the stages that presumably took place over long eons of time to produce, first, molecules capable of reproducing themselves; then some simple organisms, possibly resembling the viruses, and then doubtless much later organisms able to make their own food because of their possession of chlorophyll.

Rather than stressing these details, I want to suggest two general thoughts: (1) So far as our present knowledge goes, nowhere else in the solar system have conditions equally hospitable to life occurred. This earth, then, presented an environment of extraordinary fitness; and life is a creation of that environment. (2) No sooner was life created than it began to act upon the environment. The early virus-like organisms must have rapidly reduced the supplies of nutrients adrift in that primitive ocean. But more important was the change that took place as soon as plants began the process of photosynthesis. A by-product of this process was the release of oxygen into the atmosphere. And so, gradually, over the millions and billions of years, the nature of the atmosphere has changed; and the air that we breathe today, with its rich proportion of oxygen, is a creation of life.

As soon as oxygen was introduced into the atmosphere, an ozone layer began to form, high up; this shielded the earth from the fierce energy of the ultraviolet rays, and the energy needed for the creation of new life was withdrawn.

From all this we may generalize that, since the beginning of biological time, there has been the closest possible interdependence between the physical environment and the life it sustains. The conditions on the young earth produced life; life then at once modified the conditions of the earth, so that this single extraordinary act of spontaneous generation could not be repeated. In one form or another, action and interaction between life and its surroundings have been going on ever since.

This historic fact has, I think, more than academic significance. Once we accept it we see why we cannot with impunity make repeated assaults upon the environment as we now do. The serious student of earth history knows that neither life nor the physical world that supports it exists in little isolated com-

partments. On the contrary, he recognizes that extraordinary unity between organisms and the environment. For this reason he knows that harmful substances released into the environment return in time to create problems for mankind.

The branch of science that deals with these interrelations is Ecology; and it is from the viewpoint of an ecologist that I wish to consider our modern problems of pollution. To solve these problems, or even just to keep from being overwhelmed by them, we need, it is true, the services of many specialists, each concerned with some particular facet of pollution. But we also need to see the problem as a whole; to look beyond the immediate and single event of the introduction of a pollutant into the environment, and to trace the chain of events thus set into motion. We must never forget the wholeness of that relationship. We cannot think of the living organism alone; nor can we think of the physical environment as a separate entity. The two exist together, each acting on the other to form an ecological complex or an ecosystem.

There is nothing static about an ecosystem; something is always happening. Energy and materials are being received, transformed, given off. The living community maintains itself in a dynamic rather than a static balance. And yet these concepts, which sound so fundamental, are forgotten when we face the problem of disposing of the myriad wastes of our modern way of life. We behave, not like people guided by scientific knowledge, but more like the proverbial bad housekeeper who sweeps the dirt under the rug in the hope of getting it out of sight. We dump wastes of all kinds into our streams, with the object of having them carried away from our shores. We discharge the smoke and fumes of a million smokestacks and burning rubbish heaps into the atmosphere in the hope that the ocean of air is somehow vast enough to contain them. Now,

even the sea has become a dumping ground, not only for assorted rubbish, but for the poisonous garbage of the atomic age. And this is done, I repeat, without recognition of the fact that introducing harmful substances into the environment is not a one-step process. It is changing the nature of the complex ecological system, and is changing it in ways that we usually do not foresee until it is too late.

This lack of foresight is one of the most serious complications, I think. I remember that Barry Commoner pointed out, in a masterful address to the Air Pollution Conference in Washington last winter, that we seldom if ever evaluate the risks associated with a new technological program before it is put into effect. We wait until the process has become embedded in a vast economic and political commitment, and then it is virtually impossible to alter it.

For example, surely it would have been possible to determine in the laboratory how detergents would behave once released into public water supplies; to foresee their nearly indestructible nature. Now, after years of use in every woman's dishwasher and washing machine, the process of converting to "soft" detergents will be a long and a costly one.

So our approach to the whole problem is shot through with fallacies. We have persisted too long in the kind of thinking that may have been appropriate in the days of the pioneers, but is no longer – the assumption that the rivers, the atmosphere, and the sea are vast enough to contain whatever we pour into them. I remember not long ago, I heard a supposedly able scientist, the director of one of our agricultural institutions, talk glibly about the "dilution of the pollution," repeating this magical phrase as though it provided the answer to all our problems. It does not, for several reasons.

One reason, as I expect Dr. Brown will tell us tonight, is that

there are entirely too many of us; and so our output of pollutants of all kinds has become prodigious. Another reason is the very dangerous nature of much of the present-day pollution. Substances that are highly capable of entering into biological reactions with living organisms. The third very important reason is that the pollutant seldom stays where we put it, and seldom remains in the form in which it was introduced.

Let us look at a few examples. The most serious problem related to modern synthetic pesticides, in my opinion, is the fact that they are becoming long-term, widespread contaminants of the environment. Some of them persist in soil for ten years or more, entering into what surely is one of the most complex and delicately balanced of all ecological systems. They have entered both surface and ground waters; they have been recovered not only from most of the major river systems but in the drinking water of many communities. Their importance as air contaminants is only beginning to be recognized. I remember this past summer there was a freak mishap in the State of Washington, which provided a rather dramatic illustration: a temperature inversion kept a very dangerous chemical, which was sprayed from the air, from settling on the crops that were being sprayed. Instead, the chemical remained in a drifting cloud for some hours and before the incident was over several cows had died of poisoning and some thirty people had been hospitalized. Then there was the incident in Long Island last winter, when several schools had to be closed because of dust from the potato fields – dust that was carrying insecticides and blowing through the screens of the school windows.

Less dramatic than those examples, but probably more important in the long run, is the fact, seldom remembered, that, for example, of all the DDT sprayed from the air less than half falls directly to the soil or to the intended target. The remainder is

presumably dispersed in small crystals in the atmosphere. These minute particles are the components of what we know as "drift," or the dispersal of pesticides far beyond the point of application. This is a subject of great importance and one on which few studies have been made. We don't even know the mechanics or the mechanisms of drift. We certainly need to find out.

A few months ago, wide publicity was given to a release purporting to show that only a very small percentage of the land surface of the United States is sprayed with pesticides in any year. I don't necessarily quarrel with the statement; it may or may not be correct. But I do quarrel very seriously with the interpretation, which implies that the pesticide chemicals are confined to very limited areas; to the areas where they are applied. There are a number of reports, from many different sources, which show how inaccurate that is. The Department of the Interior, for example, has records of the occurrence of pesticide residues in waterfowl, in the eggs of the waterfowl, and in associated vegetation in far arctic regions hundreds of miles from any known spraying. The Food and Drug Administration has revealed the discovery of pesticide residues in quite substantial amounts in the liver oils of marine fishes taken far at sea, fishes of species that do not come into inshore waters. How do those things happen? We do not know. But we must remember that we are dealing with biological systems and cyclic movements of materials through the environment.

Take, for example, some of the recent demonstrations of what happens when pesticides enter a natural food chain. They progress through it in a fashion that is really explosive. You have several examples here in the State of California, at the Tule Lake and Klamath National Wildlife Refuges. Water entering the refuges from surrounding farms is carrying in residues of insecti-

cides. These have now become concentrated in food chain organisms and in recent years have resulted in a heavy mortality among fish-eating birds.

Then, at Big Bear Lake in San Bernardino County, toxophene was applied to the lake at a concentration of only 0.2 of 1 part per million. But notice how it was built up. Four months later it was concentrated in plankton organisms at a level of 73 parts per million. Later, residues in fish reached 200 parts per million. In a fish-eating bird, a pelican, 1700 parts per million.

And at Clear Lake, not far from here, efforts to control the gnat population have had a long and a troubled history. Beginning in 1949, the chemical DDD was applied to the lake in very low concentrations. It was later picked up by the plankton, by plankton-eating fish, and by fish-eating birds. The maximum application to the water itself was only $1/50$ part per million; yet in some of the fishes the concentration reached 2500 parts per million. The western grebes which nested on the shore of the lake and are fish-eaters almost died out. When their tissues were analyzed they were found to contain heavy concentrations of the chemical. A very interesting phenomenon was that five years after the last application of the chemical, although the water of the lake itself was free of the poison, the chemical apparently had gone into the living fabric of the lake; all of the resident plants and animals still carried the residues and were passing them on from generation to generation.

One of the most troublesome of modern pollution problems is the disposal of radioactive wastes at sea. By its very vastness and seeming remoteness the sea has attracted the attention of those faced with the problem of disposing of the by-products of atomic fission. And so the ocean has become a natural burying-place for contaminated rubbish and for other low-level wastes of the atomic age. Studies to determine the limits of safety in this

procedure for the most part have come after rather than before the fact, and disposal activities have far outrun our precise knowledge as to the fate of these waste products.

If disposal of radioactive wastes at sea is to be safe, the material must remain approximately where it is put, or else it must follow predictable paths of distribution, at least until the decay of the radioactive substances has reduced them to relatively harmless levels. The more we know about the depths of the sea, the less do they appear to be a place of calm where deposits may remain undisturbed for centuries. There is far greater activity at deep levels than we formerly suspected. Below the known and charted surface currents there are others which run at their own speeds, in their own directions, and with their own volume. There are powerful turbidity currents that rush down over the continental margins. Even on the ocean floor, at great depths, moving waters are constantly sorting over the sediments, leaving the evidence of their work in ripple marks.

All of these activities, plus the long recognized upwelling of water from the depths and the opposite, downward sinking of great masses of surface water result in a gigantic mixing process. When we dump radioactive wastes in the sea we are introducing them into a dynamic system. But this transport by the sea is only part of the problem, because marine organisms also play an important part in concentrating and distributing radioisotopes. We still need to learn a great deal about the processes involved when radioactive materials are introduced, through fallout, into the marine environment. The studies that have been made reveal movements of great complexity between sea water and the hordes of plankton creatures, between the plankton and the organisms higher in the food chain, between the sea and the land and from the land to the sea.

The most important fact about this is that the marine organ-

isms bring about a marked distribution, both vertical and horizontal, of the radioactive contaminants. As the plankton make regular migrations, sinking into deep water in the daytime and rising to the surface at night, with the organisms go the radioisotopes they have absorbed, or that may adhere to them. As a result, the contaminants are made available to other organisms in new areas; and as they are taken up by larger, more active animals, they are subject to transport over long horizontal distances; migrating fishes, seals, and whales may distribute radioactive materials far beyond the point of origin.

All these facts have important meaning for us. They show that the contaminant does not remain in the place deposited, or in its original concentration, but rather becomes involved in biological activities of an intensive nature.

It is surprising, then, that so little thought seems to have been given to the biological cycling of materials in one of the most crucial problems of our time: the understanding of the true hazards of radiation and fallout. There have been situations in the news in recent months that are perfect illustrations of our lack of application of the ecological understanding that we have. I think one of the best examples of what I mean is taking place now in the arctic regions in both eastern and western hemispheres. Only two or three years ago it was reported that both the Alaskan Eskimos and the Scandinavian Lapps are carrying heavy burdens of both Sr^{90} and Ce^{137} . This is not because fallout is especially heavy in these far northern regions; indeed, it is lighter there than in areas of heavier rainfall somewhat farther south. The reason is that these native peoples occupy a terminal position in a unique food chain. This begins with the lichens of the arctic tundras; it continues through the bones and the flesh of the caribou and the reindeer, and at last ends in the bodies of the natives, who depend heavily on these animals for meat. Be-

cause the so-called "reindeer moss" and other lichens receive nutrients directly from the air, they pick up large amounts of the radioactive debris of fallout. Lichens, for example, have been found to contain 4 to 18 times as much Sr^{90} as sedges, and 15 to 66 times the Sr^{90} content of willow leaves. They are long-lived, slow-growing plants; so they retain and they concentrate what they take out.

Cesium¹³⁷ also travels through this arctic food chain, to build up high values in human bodies. As you remember, cesium has about the same physical half-life as Sr^{90} , although its stay in the human body is relatively short, only about 17 days. However, its radiation does take the form of the highly penetrating gamma rays, thus making it potentially a hazard to the genes. About 1960 it was reported that Norwegians and also the Finnish and Swedish Lapps were carrying heavy body burdens of Ce^{137} . Then, during the summer of 1962, a team from the Hanford Laboratories in Washington went up into the arctic and measured the levels of radioactivity in about 700 natives in 4 different villages above the arctic circle. They found that the averages for Ce^{137} were about 3 to 80 times the burden in individuals who had been tested at Hanford. In one little village, where caribou is a major item of diet, the average burden of Ce^{137} was 421 nanocuries;* the maximum burden was 790. The counts for 1963, which extended over a wider geographic area in Alaska, are said to have been still higher.

This situation almost certainly existed from the beginning of the bomb tests; yet somehow it does not seem to have been anticipated, or at least it was not widely discussed and acted upon, though the Scandinavian countries have been rather active in their investigations.

*One billionth (10^{-9}) of a curie, a unit of radioactivity.

Another example which has become familiar to many of us in recent months is provided by radioactive iodine. This must always have been an important constituent of fallout, so we wonder why its significance has been largely ignored until very recently. Probably the answer lies in its very short half-life, which is only about 8 days, and in the assumption that decay would have rendered it harmless before it could affect human beings. But the facts, of course, are otherwise. Radioactive iodine is a component of the lower atmospheric fallout and so, depending upon weather conditions it may reach the earth so early that much of its radioactivity is retained. Its distribution may be spotty, also, because of wind, rain, or other weather conditions. So we have the occurrence of the so-called "hot spots."

But we are not primarily concerned with the amount of radioactive iodine on the ground. It is not believed that we absorb significant amounts through the skin or even by inhalation. What is important is the entrance of this material into the food chains. From that point the route to the human body is short and direct. From contaminated pasture grass to the cow, from fresh cow's milk to the human consumer; and once in the body, the iodine finds its natural target, the thyroid gland. It follows that small children, with their small thyroids and their relatively large intake of milk, are endangered more than are adults.

Only a few years ago, it was declared by a scientist testifying before the Committee on Atomic Energy that radioiodine from worldwide fallout is not a problem of concern to humans, and it is not expected that it will become a problem in the future. At the time this prediction was made, there was no national system for sampling. Most of the sampling done since then seems to have suffered from various defects. For example, data on milk supplies for large cities have little meaning, because such milk is a mixture of collections from various areas and the occasional

high levels of contamination are easily obscured. Until the summer of 1962 no attempt seems to have been made to collect fallout data and milk contamination data at the same place and time. It appears also that much of the monitoring data reported by the AEC refers to measurements of gamma-ray intensity from the ground, or of beta radioactivity near the ground or in the air. However, as we have seen, what is important is not the radioactive source outside the body, but the entrance of the radioactivity into the food chain and so into the human body.

In the summer of 1962, the Utah State Department of Health began to make its own evaluation of this problem and quickly decided that a hazardous situation existed. All of the five bomb tests carried out in Nevada in July 1962 had carried radioactive iodine into Utah. As exposures began to exceed the yearly radiation protection guide, the state recommended protective measures. Of course, for radioactive iodine, these are very simple: cows may be transferred to stored feed; contaminated milk may be diverted to processing plants for use in ways that will assure an appropriate lapse of time before it is consumed. Knapp, of the AEC's Division of Biology and Medicine, made other observations in Utah, examining single samples of milk rather than dealing in averages, or in composite samples. And these studies bore out the contention that high levels of radioactive iodine were occurring in certain areas. The Utah situation is probably not unique. A few months ago the Committee for Nuclear Information testified before the Joint Committee on Atomic Energy and declared that a number of local populations, especially in Nevada, Utah, Idaho, and probably other communities scattered throughout the continental United States, have been exposed to fallout of medically unacceptable proportions, especially in the cases of children who drink fresh, locally produced milk. The evidence provided by the Committee, as well as that

collected in the recently released Knapp report, would seem to support this conclusion. Yet as recently as May of this year the Public Health Service stated that I^{131} doses from weapons testing have not caused undue risk to health.

My reason for reviewing these facts, which I am sure are familiar to most of you, is simply to emphasize that we have not yet become sophisticated enough to view these matters as the ecological problems [. . .] they are. Of course there are various ways of studying the problem; there are various angles from which it must be approached, and what I am suggesting does not necessarily preclude other approaches. But I think that the ecological aspect of it must be considered. We must remember that we have introduced these things into dynamic systems that comprise our environment, and it is not enough to monitor the entrance of the contaminant into the environment at that single point. We must be prepared, with the best understanding of all concerned—the physician, the biologist, the ecologist—to follow the contaminants through whatever path they take, through physical and biological systems. This demands more extensive studies than any that have been undertaken, more comprehensive monitoring programs, and more realistic evaluations.

In my opinion, we have been too unwilling to concede the possibility of hazard or of the actual existence of hazard. We have been too unwilling to give attention to the preparation of countermeasures to cope with the hazardous situations when they do arise. Perhaps not now, but perhaps in the future that will arise. Indeed, a report to the Surgeon General by the National Advisory Committee on Radiation in 1962 revealed that except in the case of I^{131} , no effective countermeasures exist. In the climate of euphoria that is generated by repeated assurances that all is well, there is little public support and there is little

money for the kind of research that needs to be done. I, for one, would like to see the public considered [. . .] capable of hearing the facts about the hazards that exist in the modern environment. I should like to have them considered capable of making intelligent decisions as to prudent and necessary measures that ought to be taken.

Currently, in this specific area of radiation hazards, I think there is a certain danger that we will feel that the recent test ban treaty makes the whole fallout problem obsolete. This, in my opinion, is not true. The longer-lived isotopes will remain in the upper atmosphere for years to come, and we are still destined to receive heavy fallout from past tests. Another very important point is that underground tests have been known to produce atmospheric contamination through venting in the past, and they will almost certainly continue to do so.

The third point is that environmental contamination by radioactive materials is apparently an inevitable part of the atomic age. It is an accompaniment of the so-called "peaceful" uses of the atom as well as of the testing of weapons. This contamination will come about occasionally by accidents, and perpetually by the disposal of wastes.

Underlying all of these problems of introducing contamination into our world is the question of moral responsibility—responsibility, not only to our own generation, but to those of the future. We are properly concerned about somatic damage to generations now alive; but the threat is infinitely greater to the generations unborn; to those who have no voice in the decisions of today, and that fact alone makes our responsibility a heavy one.

I recently read some calculations made by Professor H. J. Muller. His general conclusion was that the amount of somatic damage from radiation as it is distributed today is far less than

the damage which this same radiation, received and transmitted by the present generation, will inflict upon posterity. His further conclusion was that hereditary damage should be the chief touchstone in the setting of permissible or acceptable dose limits. But apparently we have a long way to go and much enlightenment to gain before any agreement can be reached on standards of this kind.

The question of genetic damage from harmful elements in the environment is one that particularly interests me. Elsewhere I have made the suggestion that pesticide chemicals should be viewed with great suspicion as possible agents of genetic damage to man. This suggestion has been challenged by some on the grounds that there is no proof that these chemicals are having such an effect. I don't believe we should wait for some dramatic demonstration before making a thorough study of the potential genetic effect of all chemicals that are widely introduced into the human environment. By the time such a discovery is made otherwise, it will be too late to eradicate them. Some of the chemicals that are now in use as herbicides and insecticides do have mutagenic effects on lower organisms. Others have the ability to cause chromosome damage or a change in chromosome number, and as you know this type of chromosomal abnormality may be associated with a wide variety of congenital defects in man, including mental retardation. I think we should test the pesticide chemicals on several of the organisms that reproduce rapidly and so lend themselves to genetic experiments. If the chemicals then prove mutagenic, or otherwise disruptive of genetic systems in a variety of test organisms, then I think we should withdraw them from use. I am not impressed with the argument that they might not have similar effects in man. After all, the science of genetics was founded when an obscure Austrian monk performed some experiments on garden peas; and

the basic hereditary laws he discovered have proved generally applicable in both plants and animals.

Again, another fact of far-reaching significance, that influences in the external environment can cause mutations, was discovered by Professor Muller in experiments on an insect; yet few doubt its applicability to man. Indeed, one of the most striking phenomena in biology is the basic similarity of genetic systems throughout the living world. Yet again and again, in this whole field of environmental influences in relation to life, and this includes our theme of pollution and its impact on life, we meet a strange reluctance to concede that man is, himself, susceptible to harm. It may be admitted freely, for example, that an agricultural chemical entering a river could kill thousands of fish; but it will be denied that this chemical could do any harm to the person who might drink the water. Reports of the decimation of whole populations of birds are shrugged off with the thought that it can't happen to us. If we carry this view to its logical conclusion, it would make a mockery of all the elaborate testing, involving millions of laboratory animals; yet I have been astonished to discover how frequently it crops up, if not stated directly, then at least as the implied basis for an official point of view or decision, or perhaps more often for the lack of any decisive action. I wonder sometimes whether this attitude may not have a deep significance which is relative to our theme tonight. It seems to me to imply a sort of rejection of our past—a reluctance or an unreadiness to accept the fact that man, like all other living creatures, is part of the vast ecosystems of the earth, subject to the forces of the environment.

As I look back through history I find a parallel. I ask you to recall the uproar that followed Charles Darwin's announcement of his theories of evolution. The concept of man's origin from pre-existing forms was hotly and emotionally denied, and the

denials came not only from the lay public but from Darwin's peers in science. Only after many years did the concepts set forth in *The Origin of Species* become firmly established. Today, it would be hard to find any person of education who would deny the facts of evolution. Yet so many of us deny the obvious corollary: that man is affected by the same environmental influences that control the lives of all the many thousands of other species to which he is related by evolutionary ties.

I find it quite fascinating to speculate what hidden fears in man, what long-forgotten experiences, have made him so loath to acknowledge first, his origins and then his relationship to that environment in which all living things evolved and coexist. The Victorians at last freed themselves from the fears and superstitions that made them recoil in shock and dismay from Darwinian concepts. And I look forward to a day when we, also, can accept the facts of our true relationship to our environment. I believe that only in that atmosphere of intellectual freedom can we solve the problems before us now.

Thank you.