

and yet that is clearly not the way in which we are going to live in the future. So we are really faced with a problem of understanding enough about our environment, its physical side and its biological side, so that we can most efficiently use the resources that are available to us.

Philosophically it seems to me that we have considered all of these resources as essentially "free" in the past and there were no constraints against the dumping of waste—and by wastes I mean those things that are not useful to us at a particular point in time or in a particular concentration or in a particular place or in a particular form—wherever was most convenient. With certain very toxic materials, we now have changed this philosophy so that it is very much the other way around. In the handling of pesticides, for example, the responsibility rests with industry or the proponent of a particular use, to demonstrate that the use will be both advantageous for the purpose for which it is intended and equally that it will not be disadvantageous to other uses of resources. We have not yet expanded this philosophy to many other pollutants. The nuclear energy business is one other example. Here there were all sorts of possibilities of escapes of materials into the environment and we could foresee enough difficulty that we exercised, relatively speaking, extreme care in the way we handled it. The result has been that we have learned to handle nuclear energy so as to achieve maximum benefits with a minimum of disadvantages.

One of the issues raised by your Research Management Advisory Panel relates to the appropriateness of considering direct effects on people as the principal measure of pollution. I submit that it is inappropriate. I think quite clearly that man is the center of the universe and all our activities are oriented around him. But it isn't just the physical needs—the need for food and oxygen and water and these sorts of things we must be concerned with. Rather it is all of the things that man needs, directly and indirectly. It is conceivable that we might be able eventually to take the separate elements that occur in the universe and combine them into substances which we can use for human food by some means other than using green plants as the basic mechanism. At the present time, however, we totally depend upon green plants for serving this need. The first thing they do is capture energy from the sun and convert this into plant materials. In the process, they release oxygen, take up carbon dioxide from the atmosphere, take up minerals from the soil and so on. These plants in turn are fed on by other living organisms, or if they die without having been eaten by an animal of some sort, then some of the micro-organisms in turn break them down into smaller pieces and eventually the nutrients are put back into the cycle.

It seems to me that we depend on these services and we best be sure that those things we do to the environment do not seriously disrupt these functions.

There are some other things living organisms do that concern me. From our point of view they are sort of inadvertent things that we would really prefer that they not do. In the process of cycling both energy and nutrients they also are able to, and in fact do, pick up some of the heavy metals, some of the relatively persistent and resistant organic compounds and pass these on—in some cases with no changes and in some cases with extensive changes through metabolic