THE DEATH OF THE OCEANS

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What I am going to tell you today may seem difficult to believe. Indeed, being an optimist, I find it hard to believe myself. But, being a scientist, I have tried to objectively analyze the data and have come to the following two conclusions: The first is that the oceans are beginning to die from chemical pollution; the second--and even more disturbing--is that NOTHING is being done about it; very few people know about it; -- no one is watching the world. This chemical contamination has begun to wipe out some species of oceanic birds. If left uncontrolled it will result in the death of the oceans.

This contamination is not only the very visible oil pollution we are hearing so much about these days. What I'm most concerned about, and what I want to discuss today, is the invisible contamination of the oceans by long-lived chemicals. For the remainder of this talk I want to discuss first the problem, and second, what can be done about it.

I fully realize th t this whole concept of oceanic contamination is difficult to imagine. Let's face it; when we talk of pollution of the seemingly endless oceans, we are really talking about global pollution. But in fact, there are already two well-documented examples of the chemical contamination of our entire planet.

The first was that resulting from Strontium^{90} (Sr^{90}) and other isotopes released during nuclear testing. How did it happen? First, this radioactive isotope was released into the atmosphere. There it was carried by global wind patterns all

over the earth to come down with rain and dust as radioactive fallout. Because Strontium is almost like calcium, it was concentrated by living organisms and thus got into our food. When we ate this contaminated food, the Sr^{90}, being like calcium, tended to concentrate in bone. Being radioactive, continued exposure to this radiation would have resulted in an increased incidence of cancer. Because of this global contamination by Sr^{90} and other radioactive elements, an international agreement was made to stop atmospheric nuclear testing.

The next example--which is still all too current--is the global pollution by DDT. How did this happen? First of all DDT is also a long-lived chemical--just as the half-life of Sr^{90} is 19 years, the half-life for DDT is between 10 and 30 years. Secondly, DDT is also released into the air during spraying or evaporates into the air after spraying. It too, is concentrated by living organisms and tends to increase in concentration higher up in the food chain.

How does it get to such high levels? First, it is fat-soluble, and even if present in minute amounts, the marine animals concentrate it--they literally scoop it up--from the water. Second, it is not easily metabolized. The organisms cannot break it down or excrete it. Thus, DDT gets into microscopic sea plants. The sea plants--with their DDT--are eaten by small fish. These fish--with their DDT--are eaten by still larger fish. Thus the DDT level gets higher and the highest levels are in those animals at the tops of food chains--such as the fish-eating birds.

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The reasons this contamination is of such concern is that DDT is a poisonous chemical--which, of course, is the reason it is used as an insecticide. The farmer assumes it stays in or near the field where he sprayed it. The contamination of the globe by DDT tells us that this is not the case.

Now, did anyone in any government realize the extent of this pollution? There were quite a few clues. First, DDT was found in Antarctic penguins; it was found in Arctic seals and whales as well as in Eskimos. In other words, in areas where it was never used. One would think that government agencies responsible for our welfare would have therefore looked at the oceans; but instead the bulk of government surveillance was with freshwater and terrestrial organisms.

Thus, the first solid evidence for the massive extent of this global pollution came from the laboratories of several university scientists, who looked beyond the immediate and more dramatic fish and bird kills. Through their investigations it has now become apparent that the oceans are heavily polluted with DDT. The most extensive survey has been made along the Pacific Coast. The basic--and most surprising--finding is that the contamination of the coastal ocean is as great--or greater--than many freshwater areas. For example, it has been highly publicized that Lake Michigan coho salmon are too heavily contaminated with DDT to be sold in interstate commerce. Similarly--and shockingly--Pacific coast jack mackerel can also no longer be canned for human consumption. The Food and Drug

Administration has essentially halted all canning of jack mackerel in southern California. This is the death of an entire fishery.

DDT has gotten away; it has escaped. What effects will this toxic chemical have? It has now been found that marine birds, which have the highest DDT concentration, cannot reproduce properly. Brown pelicans nesting in California are now making eggs whose shells are too thin--the chicks never hatch. Of two hundred nests examined last year on Anacapa Island, only two contained normal eggs. The rest were all squashed, dehydrated, dead. Thus, as the present adult generation dies off, they will not be replaced.

Obviously the birds are getting this DDT from somewhere, and their source is fish. What effect is this DDT having on the fish? We don't know. Studies on freshwater trout show that low levels of DDT also result in reproductive failure, but by a completely different mechanism than in birds. We do not know whether fish in the ocean are also suffering from DDT toxicity. I am concerned, however, because so many of the ocean fisheries--especially off of California--are in a process of rapid decline. Thus, the sardine fishery--once the largest in the world--is gone. The pacific mackerel catch is drastically down, and has failed to reproduce properly for the past few years. The jack mackerel don't seem to be suffering from DDT, but the levels are so high they're unfit for human consumption. The anchovy is one of the most abundant coastal fishes. Although not too badly contaminated in northern

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California, the DDT levels in southern California anchovy are three times the FDA limit.

What are the main lessons from the DDT story? There are two: The first is that the oceans are the toilets of the world, and the second is that it is very easy to pollute them. Freshwater lakes and streams replace their water every few months or every few years. However, there is no plug in the bottom of the sea. Thus, any persistent chemicals released into the environment can--and are--ending up in our oceans. If they are toxic and are concentrated by organisms, these chemicals will become environmental hazards.

Okay, given these two examples of global pollution, one would think that national and international agencies would be monitoring the oceans, would be watching the world. Well, if anyone is, it's a well-kept secret. The fact is that there are no such agencies and that the only systematic programs of world-watching are presently coming from inadequately-funded university research.

What have these researchers found? First, as I already mentioned, DDT and its derivatives are being found all over the globe.

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Secondly, a group of industrial chemicals, chemically related to DDT, are also being found everywhere. These chemicals are known as polychlorinated biphenyls, or abbreviated as PCB's. They are used as electrical insulators, as cutting oils, and as plasticizers. Hundreds of millions of pounds of these chemicals have been produced and they have somehow escaped. Their concentrations are very high in organisms along the Atlantic and

Pacific coasts. In the North Sea off of England they are believed to have caused a very large bird kill last year, involving tens of thousands of birds. These are more birds than were killed by oil off of Santa Barbara! These compounds are toxic. It is not clear how they have escaped. Just as they have been found in wildlife, they are also found in ourselves, in humans, and in human milk.

Thirdly, the heavy metal, lead, may also be a problem. More than a half-billion pounds of lead are released each year into the air during the combustion of gasoline. This lead comes from the gas additive tetraethyl lead. It too is escaping into the world. Research from Caltech and the Scripps Institute of Oceanography has shown that large amounts of lead fallout are in snow in Greenland, and that the oceans contain very high lead concentrations near coastal cities, such as Los Angeles.

Lead is also poisonous. Like DDT, it too can be concentrated by marine organisms. Given these facts, is any governmental agency looking after our safety and examining the lead content in marine organisms? If they are, they are keeping it a secret.

Fourth, what about radioactive isotopes? This problem will become more severe in the future as nuclear reactors are developed. Who will look for global pollution by isotopes released by these reactors? What will happen to the results of their studies? If there is a danger, will anything be done?

I'll answer that. If we continue with our presently inadequate system of world-watching, little more will be done in the future than has been done in the past.

Obviously, something must be done to correct this situation, since the preceding examples show the ease with which the globe can be polluted. I would like to propose a four-point program. (1) First and most pressing is the establishment of an international commission or agency to watch the world. This agency has to be international, since this global pollution respects no national boundaries. Thus, the only manufacturer of the PCB's in the U.S. is Monsanto Chemical; but they are made by other chemical companies in Germany, France and Japan. Monsanto is apparently trying to find out how the PCB's are escaping and to provide substitutes. But will they? I don't know. Will responsible actions be taken by the other companies in Japan and France? Obviously some sorts of international controls are needed.

I propose that we consider the establishment of an environmental FDA (an environmental Food and Drug Administration). Such an environmental FDA should examine all persistent chemicals which are being produced and capable of being released into the environment. They must determine if they can be concentrated by organisms, such as is happening with DDT and the PCB's. Their data must be made public. This agency must have the authority to stop the manufacture or release of potential environmental chemicals.

An example of the need to examine all long-lived chemicals produced in large quantity can be seen in the detective story leading to the discovery of the global contamination by the PCB's. The PCB's were discovered by chance. They fortunately happen to be analyzed by the same methods used in DDT analysis. The PCB's just kept cropping up as unknown peaks on the graphs. What were these strange peaks? Were they an unknown insecticide? Were they some natural and unknown compound? Were they a new pollutant? Finally, through painstaking work here and in Sweden, they were identified as the PCB's.

Are there other unknown chemical contaminants which are escaping into the world? We were lucky to find the PCB's. Might there be others? We must establish some sort of international FDA now. We can't wait until 1972 when the United Nations begins to look at the global environment.

(2) Secondly, we must make international treaties or establish international agencies regulating the types of cargoes which can ply the oceans. Basically, such regulations are no different than those governing transport of explosives over bridges. Such agencies would never have allowed construction of the present generation of supertankers, or at the least would have postponed their use until methods were available to prevent oil spills. Santa Barbara will be like nothing if one of these supertankers goes down. The amount of oil in one of these supertankers is about 20 times that released at Santa Barbara. Furthermore, since the release would occur at one time, the effects could be even more disastrous.

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Even more frightening, however, are the present chemical tankers being built for transporting liquid chemicals. These tankers can carry millions of pounds of such chemicals as sulfuric acid, phenol, and aniline. As there are no laws against bulk transport of biological poisons, these tankers might also be used for carrying pesticides or herbicides. Recall the chain of events last year following the loss of one sack of insecticides on the Rhine River. A trail of dead fish extended almost 100 miles from Germany into the Netherlands. Consider the catastrophe if a tanker goes down that is loaded with herbicides or pesticides. The statistics are against us. In the three years before the tanker Torrey Canyon sank in the English Channel, tankers were involved in an average of two accidents per week, and one in ten resulted in oil spillage. Do we have to wait for a Texas City disaster before we begin to regulate international shipments of oil and such poisonous chemicals as herbicides and pesticides? The oceans are too small and our chemical technology too powerful to allow unregulated transport of such powerful poisons.

Ladies and gentlemen, there are almost no laws, other than those of economic expediency, governing the types of cargoes transported on the oceans. If we don't institute such laws, how can we expect anything less than the death of the oceans?

(3) The third part of this program is support of research leading to technology which does not result in long-lived contaminants. This must come from both the universities and private industry. Both basic and applied research are needed.

Unfortunately, the universities are presently in a very difficult situation as regards basic research. On the one hand are a vocal minority concerned about the harmful effects of technology. They have transposed these fears to all basic and applied research. They scream "no basic research, no applied research--all research ends up as ultimately destroying the environment." On the other side is the Federal Government which says "we have technological problems--let's cut the basic research and increase appropriations for applied research."

This philosophy will get us nowhere. Basic research is the cornerstone of new technologies. As an example, let's examine the alternatives to DDT and other long-lived pesticides. What is available? One of the most promising and exciting are a class of chemicals known as juvenile hormones. These are insect hormones which prevent the growth of noxious insects. Their discovery resulted from basic research on how caterpillars change into butterflies. It is the sort of basic research that some newspaper columnists like to make fun of. Imagine what good copy it is to ask "Why is the U.S. Government spending all this money on how caterpillars turn into butterflies?". Yet this was money incredibly well-spent. This research into caterpillar biology and embryology was basic or non-mission oriented research. No one said "go find an insect hormone which can be used as a pesticide." No one even knew if there were such hormones, much less if they were suitable as pesticides. This research, which has provided the most promising method of insect control in years, simply originated from the curiosity about how

caterpillars can achieve that incredible transformation of a seemingly warty worm into a beautiful butterfly.

We also need more basic research into forms of energy production which will not contaminate the globe. I am extremely concerned about our emphasis and dependance on nuclear energy for electric power. The problem of storing the enormous amounts of radioactive waste may prove insurmountable and we may irreversibly contaminate the globe.

We need more basic research into non-contaminating forms of energy conversion, such as solar energy. If you'll pardon the pun, is this "pie in the sky." Probably not. Again--as with the caterpillar story--the significant breakthrough will come from basic research in physics, chemistry, and biology--from research in the area of photochemistry.

In summary, I have pointed out the danger of chemical pollution in the oceans and I have indicated that no one is watching the world. We now have ample warning that, if left unchecked, the death of the oceans will result. Coal miners used to take canaries down into the mines with them to warn about carbon monoxide poisoning. When the canaries keeled over, they knew they were in trouble and better leave fast. The oceans have also shown us their canaries. These are the pelicans not reproducing because of DDT and North Sea birds dying because of PCB's. Can we afford to wait for greater irreversible tragedies?

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As an immediate solution we need first the immediate establishment of an international environmental FDA to prevent the release of long-lived chemicals into the environment; second, we require treaties and agencies to regulate the types of cargoes which sail the seas; finally, as both an immediate and long-term solution, we need more basic and applied research leading to alternatives to our contaminating technology.

These are not insurmountable problems. As I have pointed out today, our chemical technology is so powerful as to have polluted the globe and to have begun the destruction of the oceans. Surely, knowing this, our response can also be powerful enough to prevent such an occurrence.

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