THE
POLLUTED
OCEAN (2)
R.A. PRIEST
THE POLLUTED OCEAN

THE MAJOR POLLUTANT FACTORS

As there are so many things that man puts into the ocean which have an adverse effect on it, I will endeavour to divide them into their different categories and describe each of them separately.

ORGANIC WASTES

The first pollution of the ocean was from organic waste during the Agricultural Revolution which brought about the establishment of permanent settlements.

As these settlements grew in size, less human and animal wastes were returned to the soil. This broke the natural cycle which maintains the productivity of the soil. Consequently, the soil began to lose its fertility and water retentive properties.

In fact, these early settlements started to pipe their wastes to the nearest body of water. It seems probable that most early civilisations felt the impact of soil infertility long before their rivers and lakes showed any signs of ecological imbalance.

CRIPPLING FAMINES

The Minoan, Roman and Greek civilisations all experienced crippling famines when their soil failed them. Likewise, the Maya civilisation of Central America was at the brink of collapse long before the Saniards did it for them.

Although their cities were surrounded by agricultural land, the fertility was robbed as food was taken into the town from where the wastes were never returned.

The Chinese civilisation is one of the few based on soil fertility conservation. They have returned their wastes to the soil for two thousand years. Few other societies have learnt from this example.

The Industrial Revolution served to heighten the problem. It centralised people into bigger and bigger cities, placing greater pressures on to agricultural land.

Eventually, man was forced to replace lost fertility by the use of inorganic fertilisers to increase or maintain the yield. The soil became addicted to inorganic fertiliser and more and more was required to keep the yield constant.

The annual consumption of inorganic nitrogen fertilisers has increased fourteen-fold in the USA in the past 25 years, while agricultural crop production has not even doubled over the same period.

As much as half of the inorganic nitrogen fertiliser which is applied to the land never reaches the plants, but is washed out into the nearest body of water. It is, therefore, not surprising that the nitrogen content of waterways in agricultural areas has increased alarmingly in the last two decades.

As well as increasing the amounts of inorganic fertiliser that he introduces into the ocean, industrial man has vastly increased his output of organic wastes. These wastes are produced by meatworks, laundries, breweries, dairies, sugar factories and other food processing plants.

SEWAGE TREATMENT

The effect of all these wastes on the ocean, which is where they eventually end, is no longer significant.

The increased quantities of organic wastes and inorganic fertilising elements produced by sewage treatment impose strong loads on water life. Both sea and fresh water ecosystems cope naturally with organic wastes by decomposing them and breaking them down to inorganic elements, but decomposition can only be achieved by the removal of oxygen from the water.

In a balanced system, the removal of oxygen is compensated by the oxygen produced by plants (photosynthesis) which are in turn fertilised by the products of decomposition.

The cycle is broken when large amounts of material ready for decomposition are introduced. Too much oxygen is removed for the animals which eat the plants to survive. Once fish and other organisms die off in large numbers they merely add to the decomposition already taking place.

The end result is nearly all life becomes extinct in areas where decomposition is rife.

This process is called over-fertilisation and leads to ecological imbalance. The complete process from over-fertilisation to excessive
decomposition is known as eutrophication and was first observed in fresh water bodies such as lakes. One of the great lakes, Lake Erie, is in a state of eutrophication and is regarded as being dangerously close to dying completely.

SEAS DYING TOO

What may come as more of a shock is that large bodies of open seawater and enclosed seas are showing the first signs of the eutrophication process.

The Baltic is one such sea and the coastal shelves of the industrialised nations are also affected.

The nursery grounds of many commercial fish species are being eliminated and highly productive ecosystems such as seaweed forests and estuaries are being relentlessly destroyed.

Forests of seaweed that are found on the continental shelves of much of the temperate zone can support many species of fish. Now they are frequently inhabited by a skeleton crew of worms nad bacteria acting out their role as decomposer organisms.

Estuaries are the spawning grounds of many of the fish we eat and they form the base of the food chain of approximately 60 per cent of the food we take from the sea. It is sad that these big rivers and their estuaries are also the sites used by man to build many of his cities and industries.

“RED TIDES”

An interesting sidelight to over-fertilisation are the so-called “red tides” caused by population explosions of certain red species of phytoplankton. They pose threats to fishing stock and human health.

Records show that a “red tide” occurred off the Florida Gulf coast in 1916. The next one occurred in 1932, then again in 1948. There were tides in 1952, 1953 and 1954, and then in every year from 1957 to the present time.

Other areas where they occur are Ceylon, Brazil and Spain.

They clog the gills of fish and the filters of shell fish and produce poisons which kill or paralyse animals.

Shell fish which are not killed build up high concentrations of the poison and can kill men who eat them, while sea spray containing tide phytoplankton can harm man on contact, causing irritations of the skin, mouth and throat.

The red tide, however, is only one of the results of dumping sewage into the sea that is harmful to man.

The area around New York City has been found to be rich in micro-organisms harmful to man. More than 45 strains of virus, including those which cause polio and meningitis, have been found off the New Jersey coast.

It has been found that the organic content of sewage acts as a protective coating so that viruses live longer and are more likely to contaminate water used by humans for recreational purposes.

NO EASY ANSWER

Having understood the problems associated with the dumping of organic wastes and inorganic fertilisers into the sea, how do we deal with it?

The answer isn’t easy.

One or two enlightened localities have come to realise that wastes are indeed wastes if they are not returned to the soil and hence to the natural cycle to which they belong.

The return would be cheapest to effect in developing countries where domestic wastes are not mixed with synthetic detergents and other household items. It might pay to follow the example set by China, where most pig, sheep and human excrement is returned to fertilise the soil.

In industrial nations, it is possible to treat all animal and industrial organic wastes in this fashion, but human wastes could only be treated if toilets were redesigned. And this is unlikely to happen until fresh water shortages are sufficient to make the flushing of gallons of water an unreasonable act.

Any failure by the world’s nations to face the threat of over-fertility in the oceans is a threat to the world’s food supplies, to health and to recreational amenities.
The next pollutant we shall deal with is chlorinated hydrocarbons, or the stuff you spray on your garden to kill weeds or bugs.

One you may have heard of is DDT.

Just as the soil becomes addicted to artificial fertilisers, so does the user of these chemicals.

The sustained use of biocides nearly always causes the “pest” involved to develop into resistant forms. Bigger and bigger doses have to be applied to keep it down. At the same time, those creatures which would naturally keep the pest down, are often wiped out.

Okay, let’s talk about the one we all know about - DDT.

The most common method of application is spraying, from the ground or the air. Right away, only a fraction gets to the insects it is intended for; the rest is wafted away and deposited in the soil.

Scientists generally agree that, once there, it is non-biodegradable (i.e. it cannot be broken down into harmless elements by living things). Therefore, it is around for anything up to 50 years.

The important thing is that some gets to the sea by evaporation, and the rest gets there by running off into the nearest body of water.

We must remember that, in the end, the sea has to handle everything.

Recent calculations indicate that as much as a quarter of the annual production of DDT compounds (81,300 tons in 1963 in the US alone) ends up in the ocean. The overwhelming majority of this is introduced to the sea by precipitation, which means that it is not only confined to coastal waters but is distributed evenly throughout the surface layer of the world, including the polar seas.

DDE takes longer than DDT to break down (possibly decades) and is not known to be broken down by any marine organism. DDE enters plankton directly through their porous cell walls. Once stored, the compounds are slow to leave and this organism gradually builds up a strong concentration of it.

Concentration increases as one looks at organisms further up the food chain. For instance, from plankton to small fish, to bigger fish, to fish eating birds and, finally, to predatory birds which eat the fish eating birds. These latter birds were found to be carrying around massive doses of DDE.

Laboratory tests have shown that the effects of DDE compounds on living organisms are adverse growth, reproduction and mortality patterns. But by far the greatest shock was to discover that DDE inhibits marine photosynthesis in phytoplankton which is essential to all other marine life.

If the manufacture and use of DDT compounds was stopped tomorrow, the quantity in the environment is so great that it could still be doing its damage a decade from now.

In fact, the damage to the oceans might well be greater in a few years’ time when residues held in lakes and other surface waters are finally released to seawater.

Pollution of the ocean by oil has had more publicity focused on it than that by any other substance.

This is undoubtedly due to the number of major disasters involving super tankers that have occurred during the past decade.

But accidental spills of this nature represent less than 10 per cent of the two million metric tons of oil that man introduces directly into the ocean every year. The other 90 per cent results from the normal day-to-day operations of tankers, other ships, refineries, petrochemical plants and offshore oil wells and from the disposal of industrial oils.

In addition to the oil dumped directly into the sea, another ten million tons arrive via the rivers and the atmosphere.
Thor Heyerdahl’s report that tar globules derived from dumped oil are to be found right across the Atlantic has since been confirmed by scientists trawling plankton nets in the surface waters of the ocean. Tar globules constituted, on an average, over 20 per cent of the material collected.

VARYING EFFECTS

The effects of oil pollution depend on whether the pollutant is crude oil or fuel oil.

In the case of crude oil, shellfish are rendered unpalatable, their growth and feeding slow down and they may slowly starve to death if their filters become sufficiently clogged.

Fish can be affected in many ways, ranging from cancers of the skin to disequilibrium.

Oil spills are also particularly dangerous to birds. Sea birds are easily killed by oil pollution because, once their plumage is oiled, they cannot fly and are doomed to drown or starve.

Most of Britain’s coastal birds are in decline and reports come in from all over the world of species faced with extinction. The Cape of Good Hope receives so much regular oil pollution that the jackass penguin is faced with imminent extinction.

Carcinogens, which are cancer causing agents, have been found in crude oil. It is possible that they are passed on to man when he eats fish and other seafood contaminated with oil.

CONTROL EFFORTS

Attempts to control the influx of oil into the seas are being made. They are, however, mainly concentrated on preventing spillage from the routine operations of tankers and are motivated on the theory that lost oil is lost money.

The immediate post war problem of leakage through loose rivets has been solved by the advent of all welded construction. The main problem still remains with ballasting and tank cleaning.

Having never served on a tanker myself, no doubt some old tanker hands will correct me if I am wrong, but during return voyages, the tanks have to be washed out and, as their total surface area amounts to some acres, it is not surprising that these cleaning operations remove a fair weight of oil. Actually, it is approximately 0.3 per cent of the original cargo.

It has been common practice in the past to discharge this waste oil over the side. However, a real breakthrough has been achieved in the problem of tank cleaning - the load-on-top system.

In this system, the oily water resulting from tank cleaning is put into a settling tank where the oil and water separate out, and the separated water is slowly removed.

DISPOSAL PROBLEM

That leaves only the problem of disposing of the recovered oil. One would assume that, with the price of oil being what it is, that problem would be solved but this is not so.

The greater weight than that of a completely empty tanker means extra port dues, the customs then charge for importing the oil and the company chartering the vessel may be loath to mix the waste oil with a new load. The answer is, of course, to dump it at sea.

The majority of oil companies have facilities for receiving this waste oil at their terminals, so the culprits are really the flag-of-convenience, independently-owned tankers whose owners are solely concerned with maximising profits from each voyage.

We must bring these people into line and also ensure that every terminal has on-shore facilities for taking waste oils. Only then will the load-on-top system really prove effective.

LITTLE RESEARCH

As much as these measures may be welcome, the major problem still remains - the indirect influx into the sea of millions of tons of oil.

This enormously important area is disgracefully under-researched and consequently very little can be done to control it.

Any successful method of dealing with oil pollution must rapidly do one of two things -
remove the oil or break it down into harmless chemical elements.

Removing the oil is being tried by spotting slicks from planes, containing them by using booms and then pumping them into empty tankers. This method has not proven to be entirely successful due to the time factor involved. By the time the booms and the tanker get there, the slick is likely to have dispersed.

The other development is the creation of mixed cultures of micro-organisms which eat up oil and reduce it to basic organic chemical elements that can be used as nutrients by other living things in the sea.

Unfortunately, as we have already seen with the examples of eutrophication and de-oxygenation caused by organic wastes, the introduction of large quantities of nutrients into the sea is not necessarily a good idea.

The whole subject was well summarised in an editorial published by the *Marine Pollution Bulletin*:

"The fact is that, even after a decade of serious investigation, great publicity and much international and national legislation, we still have very incomplete ideas about oil pollution. What we have discovered is that the solution to one problem raises new problems and that changing technology constantly changes the nature of the problems. If this is true of our best known pollutant in the sea, we cannot expect that problems of pollutants we have only just discovered will be solved at the stroke of a pen. We have a long haul in front of us and the sooner that is realised the better. Let us hope there is time."
RADIOACTIVE WASTE

The radioactive wastes released so far by man into the marine environment probably amount to less than 3 per cent of the background radiation from cosmic rays, radioactive rocks and certain substances in the human body (especially potassium).

The argument put forward in some quarters is that our contribution is so small and that living organisms are somewhat accustomed to natural radiation that we should not worry too much. However, there is a serious doubt as to the wisdom of this theory.

Marine and other organisms have adapted over a period of millions of years to a fairly narrow range of radioactive substances from a limited range of places where they are present at fairly constant levels.

Man has suddenly introduced a whole new range of radioactive materials and is releasing them at comparatively high levels in areas that have received little radiation before.

Radiation has a profound effect on living cells and marine organisms are probably among those most easily affected. Because they are sheltered by seawater from much natural radiation, they are less accustomed to it than terrestrial organisms. Marine food chains are also longer and more concentrative than land ones, so the odds on a dangerous dose are that much greater.

Problems come from 'ionising radiations'. These are invisible electromagnetic waves and sub-atomic particles which travel at very high speeds and have the ability to penetrate living tissue.

In their passage through the tissue, they knock electrons off atoms and cause the water to become charged and therefore chemically active. This activity is usually incompatible with the normal functioning of the cell in which it occurs.

The very smallest doses of radiation cause changes to cells and large doses can kill them almost instantaneously.

All radioactive substances decay, turning into stable non-radioactive forms as they lost matter or energy, in the form of ionising radiation. The rate of decay is expressed as the 'half life' of a substance - that is, the time taken for half its radiation to be released. Half-lives vary considerably from a few seconds to millions of years.

NUCLEAR WEAPONS

The first large-scale human release of radioactivity to the environment came from the use and testing of nuclear weapons.

When a nuclear device is exploded above or on the surface of the earth, large quantities of radioactive dust are blown into the upper atmosphere. The portion of that dust which slowly drifts back to earth is known as fallout.

More than 200 different radioactive materials can be released in one explosion and their distribution is difficult to predict. It is thought, however, that more fallout per unit area is deposited over the oceans than over the land masses.

Direct entrance of fallout into the ocean is irrelevant, considering that fall-out which finds itself on land ends up in the ocean anyway - it is slowly leached off land surfaces into seawater.

Much of the river borne material is deposited in the sediments of estuaries, due to the chemical processes induced when seawater meets fresh water.

A technical report on an underground test carried out on the Alaskan island of Amchitka in 1970 suggested that radioactive materials would take six years (until this year) to reach the ocean. Once it has reached the ocean, the radioactive waste will remain above maximum permissible levels for as long as 66 years.

Nuclear weapons are not the sole source of radioactive releases into the sea. The increasing use of nuclear reactors to generate power, together with the wastes they produce, are an ever-growing headache.

Nearly all reactors are at present situated on the coast or on a large body of water connected to the ocean and routinely release small quantities of radioactivity to the marine environment.

Another problem associated with nuclear reactors is the disposal of the radioactive residue that cannot be processed for re-use and is extracted in solid form.
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This solid waste is usually placed in steel and concrete containers and dumped in deep oceanic trenches in the mistaken belief that the ocean’s depths are immobile. But, in fact, there are earthquake shockwaves which pass through the sea floor and the water as well as powerful sub-surface currents.

A United Nations publication, “Marine Pollution - Potential for Catastrophe,” points out that “no one expects the containers to last forever, even those who make them”.

An interesting side effect of nuclear reactors is the use of water in their cooling systems. This water is returned to its source after use many degrees warmer than when it entered the system. The many reactors lining the banks of the Rhine have raised the temperature of that river to a level where even the hardy fish which have survived the toxic poisons can no longer survive there. In fact, the Rhine gets the prize for being the filthiest river in the world.

MUCH TO COME

Much of the radioactivity released to the environment has yet to reach the ocean. It awaits the whims of the winds, the leaching activity of fresh water and the destruction of containers.

Marine organisms are as effective at building up high concentrations of radioactive elements as they are with chemical toxins. Oysters gathered 250 miles from any nuclear source have been found with 200,000 times more radioactive zinc than the surrounding ocean.

The major obstacle to safe controls on the release of radioactive wastes may well be that the very mentality which has led to the horrific abuse of nuclear power for military ends and to the worship of enormous centralist power generation schemes is exactly the sort of mentality that is least susceptible to subtle considerations of facts about oysters.

INDUSTRIAL WASTES - INCLUDING HEAVY METALS

As unlikely as it may seem, man is affecting the composition of seawater by his industrial activities.

The natural controls, which have kept the composition of seawater constant for millions of years, have been upset by a sudden massive input of heavy metals such as lead.

Unfortunately, as we have already seen, marine organisms have a knack of concentrating just about everything we put into the ocean - and heavy metals are no exception.

The usual disastrous results occur higher up the food chain. All heavy metals have been found, when present in high levels, to retard growth and to increase the mortality of a wide range of marine animals.

Mercury is an extremely valuable heavy metal and consequently is not thrown away haphazardly. Nonetheless, one third of the 10,000 tons produced in the world annually finds its way into the oceans.

Marine organisms can concentrate mercury much more effectively than other heavy metals and it is highly toxic in very low concentrations. These two factors together are lethal to all living matter. Incredibly low levels, well below those commonly accepted as safe for drinking water, have been found to retard the growth of marine phytoplankton and to inhibit photosynthesis. By the time it reaches man, the concentrations can be high enough to kill.

MERCURY POISONING

The worst instance of mercury poisoning occurred in 1956 at Minamata Bay, Japan. Of the 116 cases officially recorded, 43 died and the rest have still not recovered.

The poison affected the central nervous system, causing numbness of the limbs and lips, defective sight, ataxia (failure of muscular co-ordination) and slow, slurred speech.

A clue to the source of the mercury came from the local cats which had shown signs of poisoning long before the humans and were jumping into the sea to drown.

Investigation showed that the bay’s fish and shellfish, eaten by both the cats and their owners, were heavily contaminated with mercury.

The source was traced to a chemical company situated on the bay which denied
any responsibility, refused to submit waste water for analysis and refused to give information about its production processes.

A court case, instigated by the families of the victims, still drags on to this day.

A similar episode occurred at the mouth of the Agamo River in 1965.

A disturbing factor is that fish protein concentrates, which were mentioned previously as a promising source of protein for third world countries, have been found to contain high levels of mercury.

It has been found in mackerel, herring, cod, alewife, Atlantic herring, Californian anchovy, gulf menhaden and ocean pout.

Although not fatal to fish, mercury is definitely fatal to man.

BIGGEST THREAT

Cadmium is the heavy metal which poses the biggest threat to marine life. Japan has once again led the world with 500 deaths so far from “itaitai” (cadmium poisoning).

Once inside the body, cadmium builds up in the liver and kidneys. It also concentrates in the bones (replacing the chemically similar calcium) and, when this happens, the bones become so brittle that a cough will break them.

The culprits this time are zinc smelting works. Those of our comrades on Lake boats can think about it next time they visit Risdon with a load of zinc concentrate.

Zinc smelting produces cadmium wastes which are then discharged, in the case of Risdon, into the river or the harbour.

In Japan, it unfortunately finds its way into rice paddies and is incorporated into the food of the local populace.

Little research has been done to determine the extent to which cadmium has affected marine life, but fish caught in the Bristol Channel had much higher levels of cadmium than expected. The zinc smelter responsible has completely ceased production.

Copper is a heavy metal which does not often occur in high concentrations in the sea but, when it does, it can have spectacular effects.

The most dramatic case occurred in March, 1965, off the Dutch coast. Industrial copper sulphate had been poured into the sea, increasing the natural concentration of copper in seawater over a hundred times.

Instead of quickly dispersing, as the dumpers had hoped it would do, the copper-enriched water travelled in a coherent mass which wrought havoc as it moved along the coast.

One hundred thousand dead fish were found washed up and many more were observed swimming around in an uncoordinated fashion. Whole mussel beds were wiped out and some species of plankton died in large numbers.

Green oysters made unpalatable by the large concentrations of copper they contain have also been reported from various parts of the world.

ONLY A FRACTION

Other heavy metals such as zinc, nickel and silver, although as yet only found in local concentrations, are still a source of potential danger.

Heavy metals are, however, only a fraction of the half million substances dumped each year by industry.

Just to sum up, the following are some figures from the first governmental survey on the dumping of industrial wastes carried out by the US in 1968. The report showed that 48 million tons of wastes were dumped in the oceans around the US in 1968 and that $29 million was spent to achieve it.

A study of the North Sea, made in the same year, showed that the Dutch alone poured in 3,600 tons of sulphur dioxide each year. The West Germans were found to be dumping 375 tons of sulphuric acid and 750 tons of iron sulphate per day and 200,000 tons of gypsum plus 600 tons of polyethylene per year.

The American survey indicated that the dumping had increased four-fold in the previous 20 years and showed no signs of abating.

That was in 1968, eight years ago, so we can only speculate on the amounts being dumped now.
WHAT ANSWER?

In these articles, I have endeavoured to do nothing more than to encourage an awareness among our membership of what is happening to the oceanic environment.

It is incredible that so little attention has been paid to the enormous damage we have done and are doing to life in the seas.

During the research I carried out for this article, I read many books and various publications on the subject*. One thing which I noticed they all had in common was that none of them provided any long-term solutions to the problem.

In fact, my conclusion is that, apart from stop-gap measures, there probably aren’t any as yet.

One of the biggest hopes is the international biological programme. Unfortunately, its work is hampered by lack of adequately trained researchers and finance.

Most governments appear to be more concerned with economic problems than environmental ones. The U.S. government, for example, spends thousands of millions of dollars on oceanographic research of a depressingly limited nature - a nature determined entirely by military needs.

The military also employs a far too great proportion of the limited number of oceanographers and marine biologists available.

You and I earn our living by the sea. We are closer to it than a vast majority of the world’s people and we can do something. Next time you are about to dump that garbage over the side, just think about it first!