TURNING THE BLUE INTO BLACK: The Mediterranean Oil Pollution Problem

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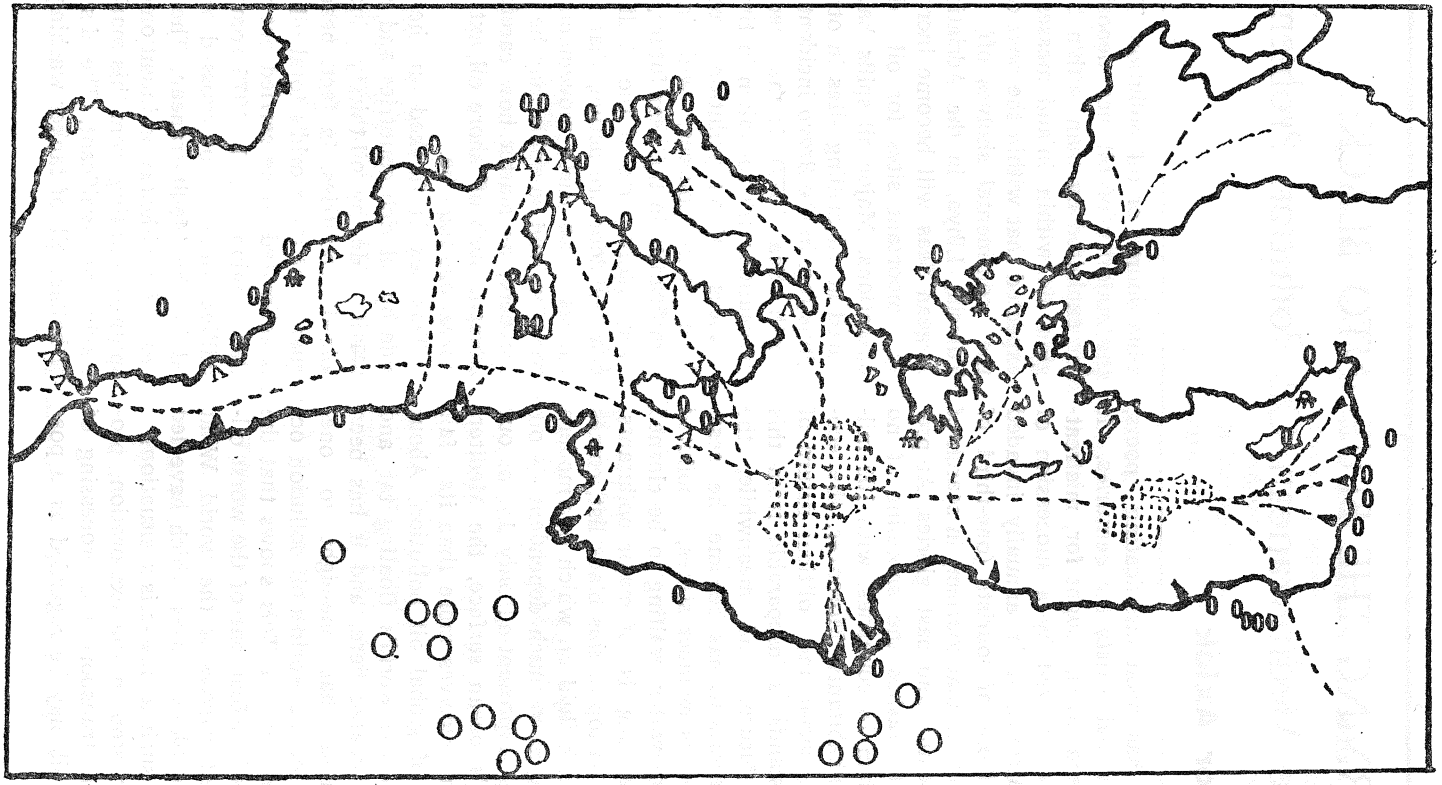
It has been intoxicating poets, writers and artists for centuries. It has been loved, fought for, mistreated and enjoyed by a succession of civilizations. It is annually invaded by millions of tourists (one-third of all international tourism) in search of fun, beauty and past glories. At present it washes the shoreline of no less than 18 countries, with 100 million inhabitants. Moreover, the economic, social and political future of our islands is inseparable from this sea's future. And meanwhile, the Mediterranean has become the cesspool of its member states, a polluted body of water, waiting to be cleaned from a long list of major pollutants. Right on top of this black list, comes that dark fluid on which our modern society is so much dependent — oil. Though representing only 1% of our planet's ocean surface, the Mediterranean receives more than its fair share of global oil pollution. About half of the world's floating tar and oil is located here, and it has been estimated that one-eight to one-fourth of the world's oil pollution occurs in this sea. This shows that the area is in effect one of the worst oil-polluted regions of the world. What are the likely causes which have led us to such a near-crisis situation?

Each step in the exploration, production, transport and processing of crude oil may be regarded as a possible source of oil pollution. Though the majority of oil rich deposits so far exploited by man within this region, lie within inland masses, it is expected that within the next decade, the continental shelves off Spain, Tunisia, Libya, in the Adriatic, and Aegean Seas will become increasingly important sites for oil drilling operations. Major oil spills have occured at oil drilling sites in other regions (eg. in the *Bravo* incident in the North Sea, 1977). If the necessary precautions are not taken in time, the chances of oil pollution resulting from such sources, will increase significantly in the near future. Moreover, many parts of the Mediterranean sea floor are active, that is, volcanoes and earth movements are common, and so spills may be expected here, no matter how careful and efficient such off shore oil extraction operations may be.

This sea is flanked on the south side by oil rich countries and on the north side by oil-thirsty industrialized countries. In fact, nearly a quarter of the world's total oil traffic is estimated to be carried out within this region [2,3]. In 1975 some 350 million tonnes of oil crossed or landed in the Mediterranean. The chances of accidental or intentional oil spillage resulting from this marine oil traffic are significant. The discharge of ballast oil, of tanker washings and

PRODUCTION AND TRANSPORT OF OIL IN THE MEDITERRANEAN SEA
(Adapted from 'Le Bassin Mediterranéan," UNEP 1977)



of oily bilge water from tankers, is in fact one of the major source of oil pollution in the Mediterranean, resulting in the annual discharge of about 300,000 tonnes of oil in this sea (1972 estimate). In order to maintain adequate manouverability and propeller immersion, tankers have to load in sea water instead of crude oil in their storage tanks, during the return voyage. This ballast water, which becomes heavily polluted with oil remains in the tanks, has to be eventually unloaded, either in the sea, or in tank cleaning facilities at harbours (only about half of the 17 loading harbours have such faclities in the Mediterranean). Some 80% of the world's tanker fleet practise a procedure called 'Load on Top' (LOT) whereby oil is separated and collected from ballast sea water before its discharge. Unfortunately such procedures are rather lengthy and are only feasible when long distance journeys are involved. This LOT system cannot be used in the short distance shipping characteristic of the Mediterranean. Until recently, in fact, most ships discharged their ballast oil in one of two regions (see map) where such discharges were permitted by international law. Since January 1978 these two dumping zones have also been removed.

Only a small percentage of oil introduced in the marine environment is actually due to accidental damage to tankers. Nevertheless, accidents do happen and these were the cause of well publicised major oil spills which occurred in several parts of the world, especially in regions of heavy tanker traffic. In the Mediterranean, one of the regions of heaviest tanker traffic is probably to the southwest of Malta. The chances of major accidental oil spills occurring in this area are uncomfortably high. The likely effects of such major oil spills would be catastrophic both to our natural marine environment and to our tourist industry.

The oil refineries lining the Mediterranian coastline utilize large quantities of water during their normal processing of crude oil. Such water effluents may contain as much as 250 parts per million of dissolved oil and this is eventually dumped in the sea. About 20,000 tons of oil reach the Mediterranean annually via these sources [4]. Loss of oil from industrial complexes along the coast, as well as from small consumers such as yachts and other water crafts, may also contribute to such land-based oil discharges. These discharges, together with those due to trasportation are the major sources of oil pollution in our sea, leading to the familiar shorelines full of unpleasant tarry residues.

The situation is worsened by the peculiar hydrographic characteristics of this sea. The Mediterranean contains some 3.7 million cubic kilometres of sea water, which is usually well oxygenated, but rather poor in nutrients such as nitrates, phosphates and silicates, needed by marine organisms. This has led some scientists to refer to this sea as 'blue but sterile' since low nutrients necessarily mean less fish and other marine life. In fact only areas under the Arctic ice and in the desert — like central and subtropical seas of the world's oceans are less productive per unit area [5]. Due to the high temperature of its surface waters, an

average of about 1.5 metres of water per year over the whole sea are lost through evaporation. To compensate for this loss, surface waters from the Atlantic (poor in nutrients) pour in the Mediterranean basin via the straits of Gibraltar. In effect, this means that the Mediterranean is replenished at a low rate and it takes 80 to 100 years to renew its water. This also means that any floating pollutant, like oil, tends to accumulate within this region and that dispersal of other pollutants is low. Moreover, cyclonic circulation of the surface waters is such that it tends to deposit any spilled oil on the shores or to accumulate it at certain exposed zones. In the Mediterranean, the deep waters are dependent for their oxygen supply on vertical mixing with surface waters mainly in three restricted regions — ie, the Provencal basin, the Northern Adriatic and the Aegean Sea. This means that the bottom sediments in such regions may well become polluted with crude oil floating on the surface. It has also been suggested that the oxygen content of the deep waters may diminish because of lack of oxygenation of surface waters due to the presence of oil slicks, though scientists seem to disagree about the validity of this argument [5, 6].

Crude oil itself is one of the most complex natural materials. Its chemical composition, physical properties and behaviour after being split, depends much on its source of origin. On spillage oil tends to spread over the water forming oil slicks. It will then start losing its more volatile and more toxic components via evaporation as well as solution in the water column. These volatile components include the lower aromatic and alkane hydrocarbons. Most of the dispersed oil is eventually removed from the sea by bacterial action. Reports have been made of widespread occurence of bacteria able to degrade oil at sea. However for such biodegradation to take place, large amounts of oxygen (1 litre of crude oil requiring all the dissolved oxygen in 320,000 litres of sea water) as well as the necessary nutrients must be present in the sea. Eventually split oil, after loosing its volatile constituents and after being partly biodegraded, will form tarry lumps which may eventually reach the coastline. such tar balls are persistent and highly resistant to further physical or biochemical degradation. The majority of beaches and harbours in the western Mediterranean are moderately or severely polluted with such tarry lumps. In some parts, fishing nets could no longer be used as they have become completely covered with tar [4].

The introduction of oil in the marine environment may have diverse and complex effects on sea life. These effects may be immediate and rather dramatic, or longterm and more subtle. The immediate toxic effects of fresh crude oil on various marine organisms have been well documented in the past few years [7, 8]. In general the greater the dispersion and emulsion of crude oil, the more evident are its toxic effects. These effects are especially significant on the coastline, where nearly all marine organisms are effected to varying extents. Young forms of marine animals are generally sensitive to oil. Thus Allen [9] has shown

that 0.5 ml of crude oil in 1ml of sea water will produce enough water soluble fractions to effect drastically, the cleavage and further development of fertilized eggs of sea urchins. Similar effects are reported in the case of many fish. Mechanical damage by crude oil on several organisms has also been extensively reported, especially on sea birds. Feathers have a great affinity for oil and oil penetrates or clogs the plumage, allowing water to enter the air spaces. As a result the bird gets heavier, swimming is impeded and flight becomes impossible. Large numbers of sea birds have died from drowning or exposure after encountering an oil slick. Also oiled birds' eggs usually fail to hatch. Oil may also penetrate into sea plants killing their growing points. However most oiled algae and seaweeds are capable of recovery.

In the presence of chronic low level oil pollution (such as is often the case in the Mediterranean) several long term subtle sublethal effects on sea life are reported, which may lead to more far reaching ecological damage. Thus respiratory functions of fish, and shellfish are effected even by very low concentrations of oil. Fish gills are irritated by dispersed oil and secrete copious thick mucus which may interfere with their normal functioning leading to sickness, unbalance in the body water and salts and eventual death. During stormy weather or when an oil slick is treated with detergents, small oil droplets are formed which may be ingested by filter-feeding marine organisms such as mollusces, leading to tainting. Fish are also known to be thus effected and reports of inedible oil-tainted fish caught in and around the Mediterranean harbours are common. In France, Spain, Tunisia Yugoslavia and Israel, commercial fish and shell fish tainted with oil are becoming a common occurrence. Furthermore it is now known that several oil fractions are chemically quite stable and may persist and become incorporated in marine food webs, possibly leading up to man himself. It is known that crude and refined oils contain many compounds which are carcinogenic to mammals or man, including polynuclear aromatic hydrocarbons (PNAH). It is as yet unclear whether such dangerous compounds are in fact incorporated and accumulated in marine food webs. Other sublethal effects of oil on marine organisms may include interference with subtle integrative mechanisms utilizing pheromones (chemical messengers), by blocking body receptors or by mimicking natural stimuli.

Recent research carried out at the University of Malta show that on exposure to water soluble fractions of oil, there occurs a reduction in the adhesive properties of tube feet and a decrease in the normal spine reaction response to local mechancal stimuli of a local sea urchin, *Paracentrotus lividus*. Also, when the littoral snail *Monodonta turbinata* was exposed to various forms of crude oil a rather curious 'inversion effect' was reported. Animals thus effected turned upside down, stand on their shell with foot fully extended, but without attempting to righten themselves up. In the natural normal state, this snail is found grouped in clusters on exposed rocky shores, presumably as an adap-

tation to withstand heavy wave action. The normal animal also tends to make a number of excursions across the sea water level each day, so that it is alternatively immersed and emersed. All these normal behavioural patterns are severely altered in the presence of crude oil, and these effects may reduce the normal chances of survival of this species [10].

Reduced species diversity of habitats exposed to chronic low level oil pollution have been reported in several Mediterranean oil harbours and refinery sites [4]. Thus the bay of Muggia in Italy was known in the past for its extraordinary colourful diversity of animal and plant life. Ever since it became the site of a huge complex of oil refineries, only about ten marine species, which are resistant to oil are left. Any reduced species diversity of a particular habitat renders it ecologically less stable.

In an effort to clean up and control oil pollution, several methods have been devised and are employed by Mediterranean states. These include, retrieval of oil by specially designed crafts, sinking and dispersing of oil by the use of detergents. Some of these control measures may themselves be harmful to sea life, especially in the case of oil dispersants. Others merely result in a displacement of the pollutants. Much effort is being made to devise efficient and harmless control measures.

The questions now are whether the Mediterranean nations will realize in time the extent of the damage being done by oil and other pollution to this sea, and whether they are willing to forget political differences and unite in a common effort to protect their common heritage. Recent developments in regional co-operation are indeed heartening. In Barcelona, in February 1976, a Mediterranean Action Plan was devised comprisng poltical, legal, scientific and economic measures in an effort to protect this sea. This action plan which is being co-ordinated by the United Nations Environmental Programme, also involves two pilot monitoring projects: one devoted to the study of the actual state of oil pollution in the Mediterranean, while the other deals with the problems of the coastal transport of pollutants.

Several Mediterranean research centres (including one at the University of Malta) are also actively participating in this plan in an effort to study the effects of pollutants on the marine ecosystem. On the legislative side, at the Barcelona Conference, the majority of the Mediterranean states adopted a Convention on the Marine Environment as well as two protocols, including one dealing with combatting oil pollution. As a result, a Regional Oil Combating Centre was set up in Malta to facilitate co-operation in this field. In fact a major role is being played by our country in the field of international co-operation as regards such common environmental problems. At many international gatherings, it is now a common sight to see marine scientists and diplomats from Turkey and Greece and from Arab countries and Israel working side by side to help solve our sea's environmental problems, while their compatriots have been at war. Maybe, only when facing a common crisis will the

people of the Mediterranean be able to strive to make out of this sea, a clean realize their common heritage and sea of peace.

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