Taking the Pulse of the Mediterranean

by Charles Osterberg

One outcome of the environmental movement of the last decade is an increased interest in the world's oceans. The oceans are viewed by some as the last asset of man, as yet unfouled, but threatened. These vast bodies of water occupy over two-thirds of the earth's surface, with a mean depth of 3,800 meters. It is apparent that there is enough water in the oceans to dilute enormous amounts of pollutants, but there is a strong feeling that the dilution capacity of the oceans is not infinite, and that the impacts of man, once started, could not be easily reversed.

A look at the seas and oceans on a world map quickly shows that the Mediterranean is one of the most vulnerable to the threat of pollution. Small, relatively shallow and separated from the Atlantic by a narrow sill at Gibraltar, the Mediterranean is almost an independent ocean in miniature. Along its shores are some of the most developed nations in the world, with all the pollutants that they generate. Across the surface move many ships, including an abundance of oil tankers. It seems evident that if the world's oceans are heading for trouble, the symptoms of the disease will first show up in the Mediterranean.

The staff at the International Laboratory of Marine Radioactivity in Monaco realized that they were favourably located to "take the pulse of the Mediterranean" and begin an enquiry into its health.

The first steps were natural enough, and the radioactivity of the Mediterranean was assessed (particularly plutonium) and the verdict was favourable. Practically all of the radioactivity in the water and sediments could be attributed to world-wide fallout from the nuclear tests of the 1960's. Unable to find enough radioactivity in the Mediterranean to work with in a meaningful way, the laboratory imported sediments from the Bikini-Eniwetok sites of the American thermonuclear tests, and sediments from the Irish Sea near the Windscale effluent pipe to do their experiments. Other experiments were carried out with relatively innocuous, short half-lived ^{237}Pu, made especially for the laboratory in Japan and in the USA. These experiments, designed to see how plutonium moves in the marine food chains of the Mediterranean, are still underway, but some results have already been published.

But the real feeling in Monaco was that if the Mediterranean were getting sick, radioactivity was not the culprit. Thus, we made a proposal to the United Nations Environment Programme (UNEP) to monitor the levels of chlorinated hydrocarbons and heavy elements in the Mediterranean. This report briefly discusses that work.

The *Winnaretta-Singer*, the ship available to the Monaco Laboratory on loan from the Musée Océanographique, is excellent for short trips, but has no facilities for housing a scientific

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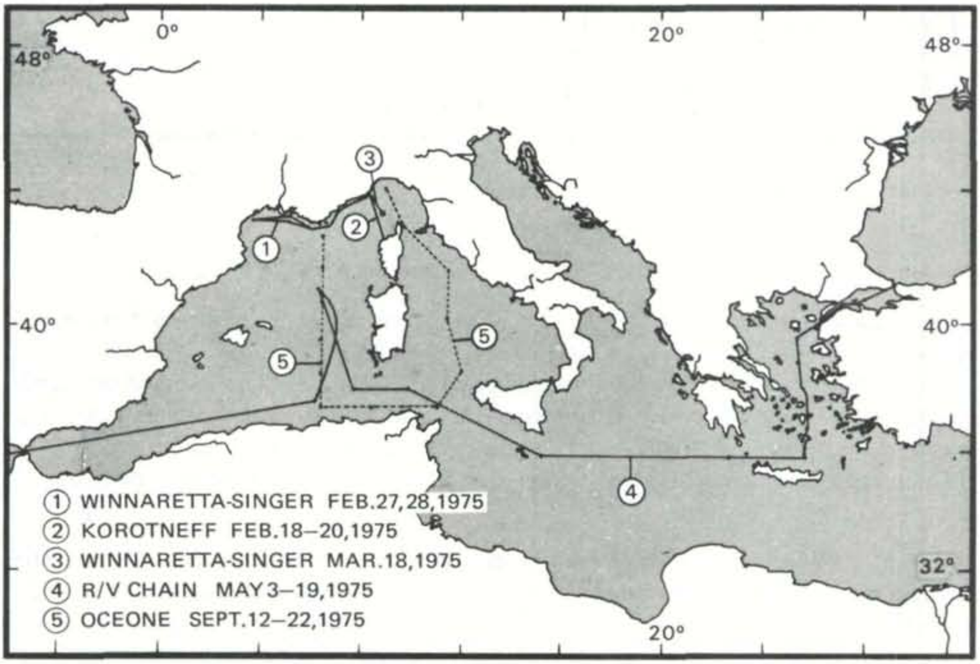
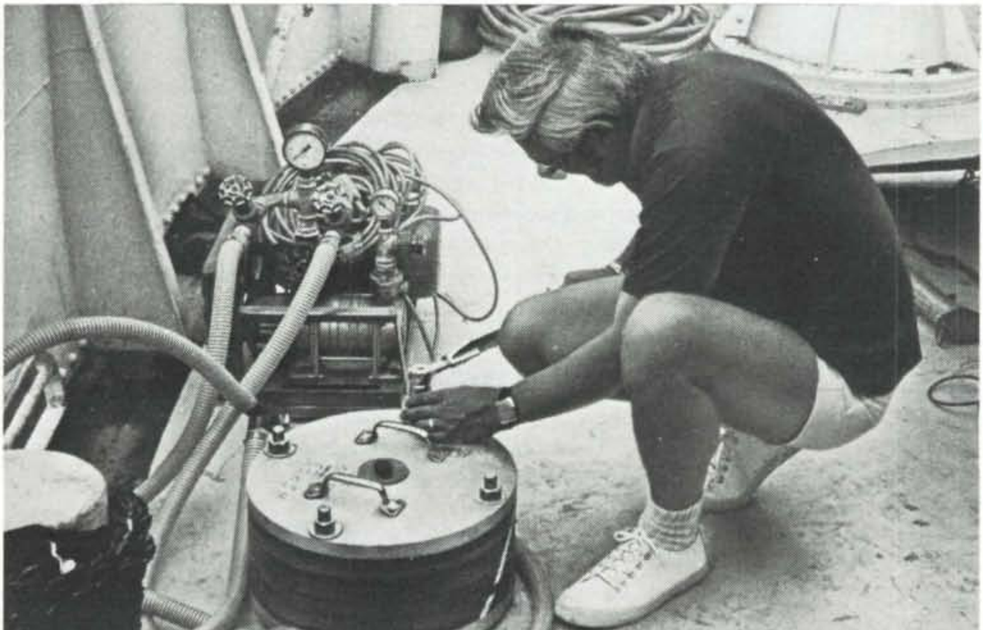


Figure 1: Cruises on the Mediterranean by staff members of the IAEA Monaco Laboratory.

Figure 2: Dr. Thomas Beasley, former director of the Monaco Laboratory, works on a device which removes radioactivity from sea water by filtration and ion absorption.



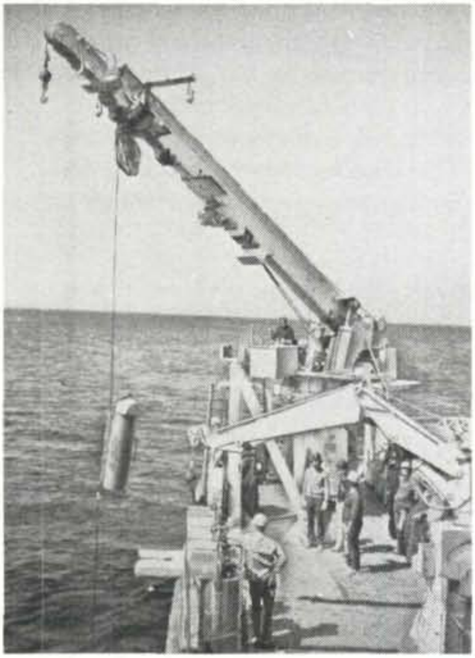


Figure 3: A large Gerard bottle goes down to take samples for the measurement of PCB's in the water.

Figure 5: Lang Huynh-Ngoc, foreground, helps attach a bottle to get water samples for heavy element analyses. When not at sea, Lang is an expert on polarography.

Figure 4: Jean-Pierre Villeneuve adjusts the air sampler, which is used to measure the input of airborne pollutants into the Mediterranean.

crew on longer cruises. Clearly, something larger was needed to cover the full expanse of the Mediterranean. Fortunately, a Woods Hole ship working in the area made room for our crew, and most of the open ocean measurements were made on the *R. V. Chain.* In addition, to fill gaps and repeat some measurements, permission was kindly given to use the *Korotneff,* a University of Paris ship based in Villefranche. A private vessel, the *Oceone* was also chartered for 10 days. While coverage of the area near Monaco was fairly heavy, measurements of the far eastern and far western Mediterranean were light. Plans are being made to further study these areas.

Three sets of studies were carried out by the Monaco group to assess the current levels of pollutants in the Mediterranean:

1) Radioactivity
2) Chlorinated hydrocarbons (DDT's and polychlorinated biphenyls)
3) Heavy elements.

As stated earlier, measurements showed that radioactivity in the ocean off Monaco is quite low, indicating that there are no major sources of radionuclides reaching the open ocean other than fallout. Measurements were made (Figure 2) by pumping hundreds of liters of sea water through a multi-disc absorption bed, developed by Battelle-Northwest Laboratories of Richland, Washington, USA. This system has been somewhat modified at Monaco.

Polychlorinated biphenyls (PCB's) and DDT's must be collected in special, non-plastic bottles. Since the amount of water needed for a sample is large (up to 55 litres), the Gerard 200-litre bottle (Figure 3) was used. (Unfortunately, after rendering yeoman service one of our large bottles was lost on one of our cruises, and it remains somewhere on the bottom). Water was collected at various depths down to 4000 metres (a deep spot in the south Ionian Sea). Once brought to the surface, the water was passed through a glass column containing Amberlite XAD-2 resin, which has an affinity for PCB's. After a full 40 to 55 liters of water has been passed through the resin, the resin is sealed and returned to the laboratory. There, after extraction from the resin, heat is used to vapourize the PCB's in a gas chromatograph, where they are identified and measured.

To better understand the input of PCB's into the ocean from the air, concurrently when water samples were being taken, an air sampler is also operated (Figure 4). It runs for 4 to 5 hours trapping PCB's on a special filter which is also analysed by gas chromatography.

The results of this study are being published (Marine Pollution Bulletin, 1977) but it can be said that the data are not much different than that for the Atlantic Ocean and Saragasso Sea. The western Mediterranean is clearly higher in PCB's than the eastern Mediterranean, but not unduly so.

Less can be said about the trace or heavy elements because the patterns are so variable. For these substances, samples must be collected in a non-metallic bottle to avoid contamination (Figures 5 and 6). Smaller sample sizes suffice, and the water can be brought back to the laboratory for analysis. Atomic absorption spectrometry is used to detect and measure most trace elements. Because biological material is usually high in trace elements, it is easily analysed. For the lower levels that appear in seawater, chemical preconcentration prior to analysis by spectrometry is necessary. For some four or five metals, polarographic

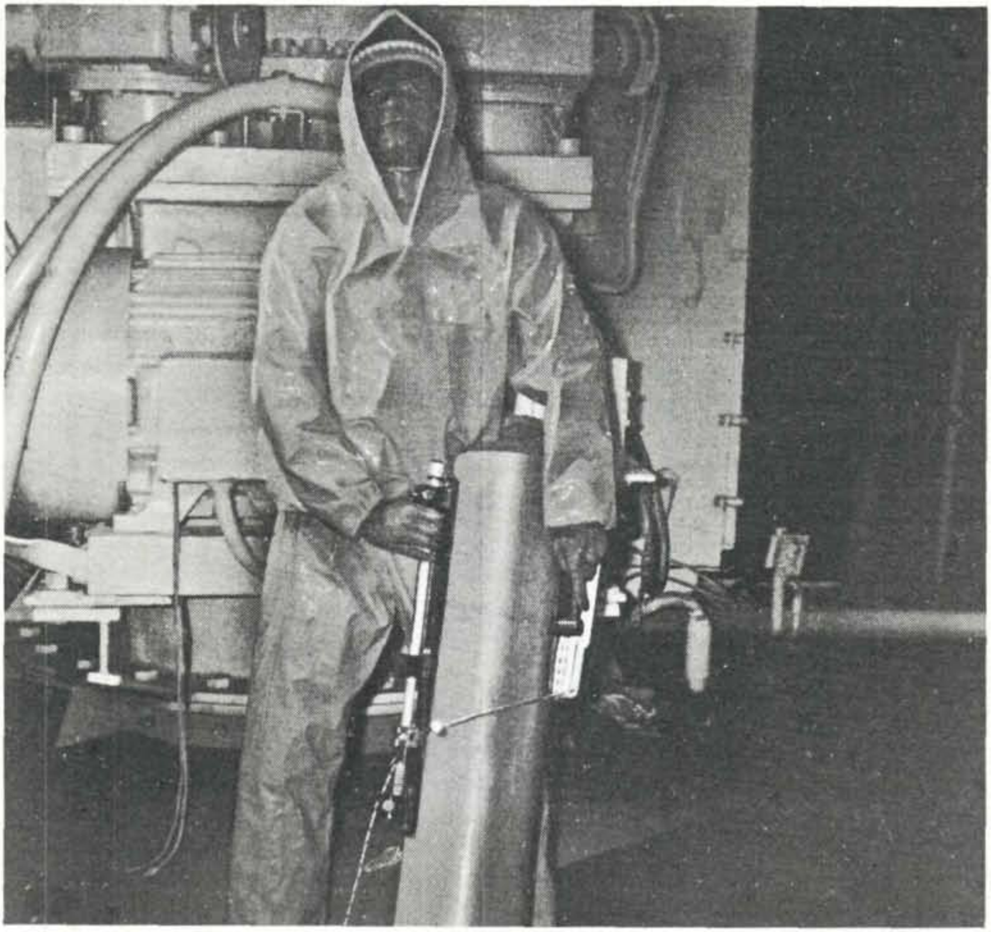


Figure 6: It's wet working on the "fantail", so Dr. Dan Elder (in charge of the PCB project) wears the customary oilskins while he handles a bottle for collecting water samples for heavy element analyses.

techniques can be used directly for their measurement in seawater. A new polarograph for Monaco is on order to accelerate this portion of the project.

Much of 1975 was spent at sea, and most of 1976 was spent in the laboratory analysing results and writing them up. Recently the Monaco Laboratory was awarded a new major UNEP contract to continue work on pollutants in the Mediterranean and their effects on marine communities (and vice versa). Thus 1977 is shaping up as another year with a great deal of sea duty, mostly in the eastern and far western Mediterranean.

The work to date has gone a long way toward defining the baselines of certain pollutants in the Mediterranean. The new programme will continue this work, but it also places a greater emphasis on the processes and mechanisms of removal and transport of pollutants. Not until these are understood can much be said about the future of the Mediterranean — or the Atlantic and the Pacific. So far, it appears, the Mediterranean is not as badly off as we might have expected from its geography.