

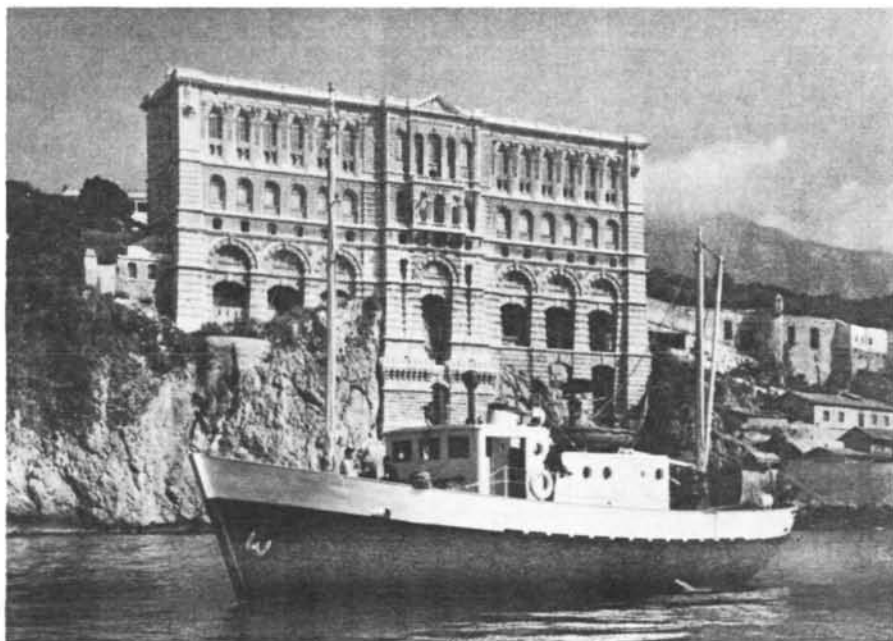
RADIOACTIVITY IN THE SEAS

INTERNATIONAL STUDY TO PREDICT FUTURE EFFECTS

Hewn within the solid rock on which stands the palace of Prince Rainier of Monaco, are laboratories of the International Atomic Energy Agency in which many of the mysteries of the ocean are being investigated. The specific purpose is to determine the existing radioactivity in water, plants and living inhabitants of the ocean with the object of predicting the effects of the increasing amounts of radiation which will arise from man-made causes. To achieve such an aim means detailed experiment and research into the sea's chemistry, its movements whether on the surface, at great depths or at the intermediate levels, the habits of its denizens together with their environmental responses, the effects of tides, wind and currents and a multitude of other factors which make up the comparatively young science of oceanography.

Above the laboratories is the Musée Océanographique with its collection of sea animals and an aquarium where hundreds of thousands of people a year see for themselves the almost unbelievable variety of creatures to be found in the Mediterranean, from a whale nearly 80 ft long to minute crustaceans. In the same building are the offices of Commandant Jacques Yves

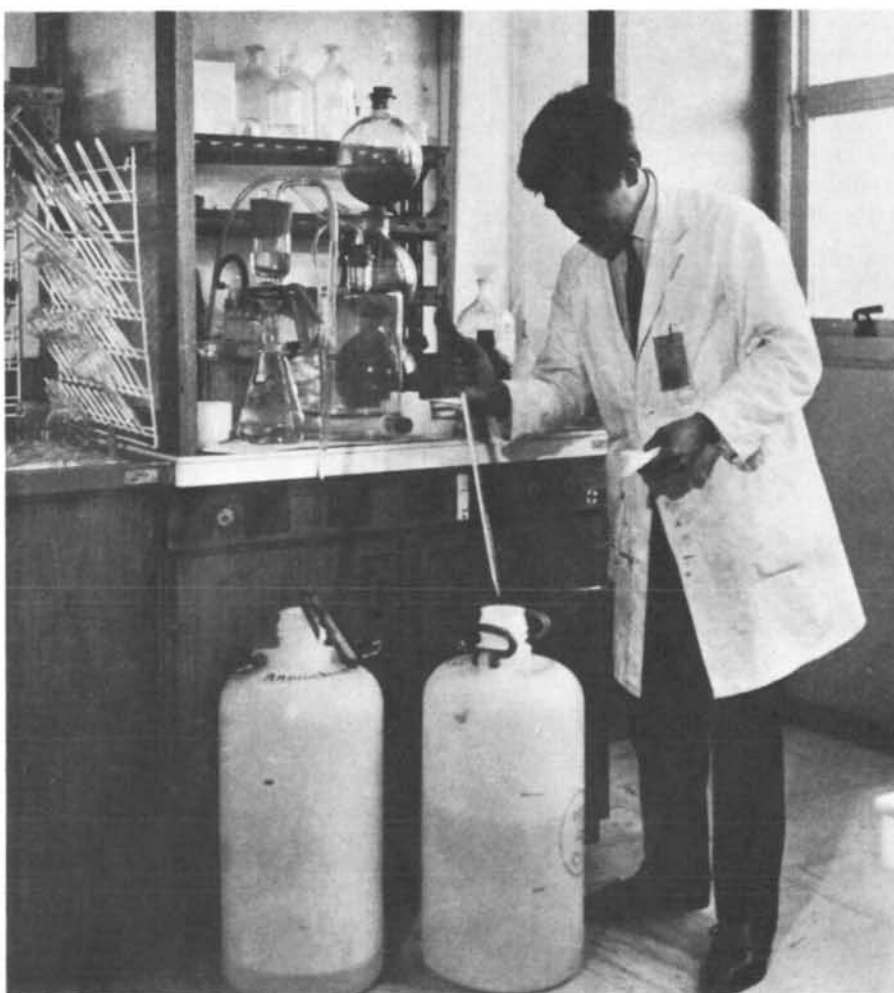
Musée Océanographique de Monaco and the small research vessel "Winnaretta Singer".



Cousteau, the man who has devised means by which men have lived on the sea-bed for long periods studying the possibility of fish "farming". Here too are the laboratories of Monaco's own Marine Radioactivity Research. The connection between all of them is that oceanography, like the sea itself, is an entity in which the study of any single aspect has a bearing on all others.

In most people's minds, Monaco is associated with holidays and pleasure, but the Principality and its rulers have made important contributions to this specialized branch of science. One of the most recent is the Scientific Centre founded by Prince Rainier in 1960 to encourage international collaboration and a laboratory of applied radioactivity was established at the same time.

Processing water samples for trace analysis.



In the following year the International Atomic Energy Agency (IAEA), now consisting of 96 nations pledged to the development of the peaceful uses of atomic energy, entered into an agreement with the Oceanographic Institute and the Government of Monaco for a programme of research into the effects of radioactivity in the sea.

Under the agreement IAEA designated a scientist to take charge of research and provided the necessary staff and funds for equipment and operation. The Monaco Government undertook to assist in providing the means for research, laboratories, additional scientific, administrative and technical staff by an annual contribution, while the Oceanographic Institute agreed to place the technical installations of its Museum at the disposal of the IAEA as far as was possible under its own research programme.

Historically this followed in the tradition established by Prince Albert I of Monaco, one of the great pioneers of the study of the seas and founder of the Oceanographic Institute.

Dr. Joachim Joseph, Federal Republic of Germany, a Master of Science in mathematics, physics and geophysics, Dr. rer. nat. in oceanography of the University of Leipzig, Regierungsdirektor in the German Hydrographic Institute of Hamburg (of which he is head of the Oceanographical Department and from which he is seconded) directs the programme of the IAEA Centre. It is guided by a Council consisting of M. Arthur Crovetto, Minister Plenipotentiary of the Monaco Government, Professor Henry Seligman, Deputy

Counting planktonic animals.



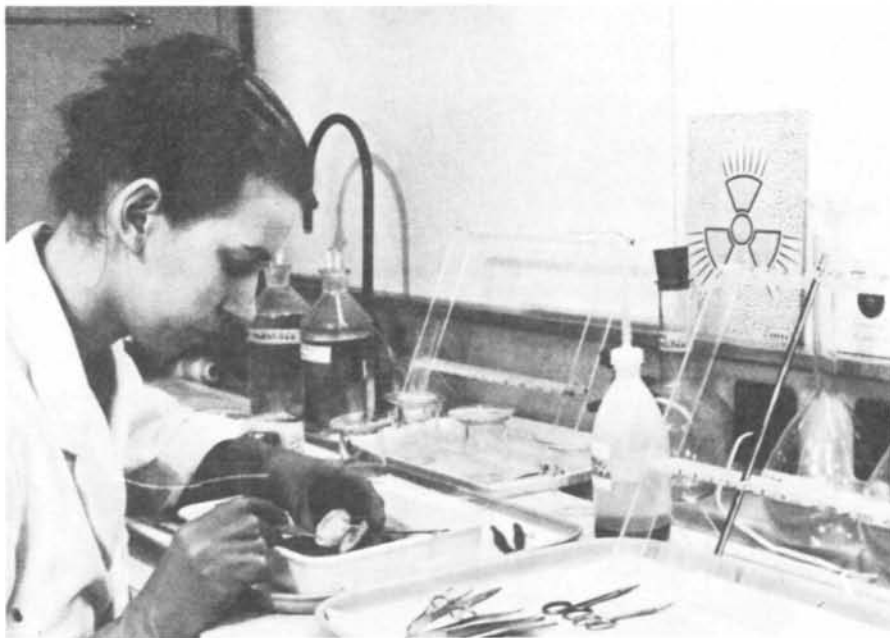
Director General of IAEA for Research and Isotopes, and Commandant Jacques Yves Cousteau. Valuable technical assistance is given by Dr. Jean Thommeret, head of the "Laboratoire de radioactivité appliquée" of Monaco.

Dr. Joseph asserts that knowledge concerning the effects of radioactivity in the sea is no less important than the question of pollution by oil, which caused the setting up of the International Oil Convention, and must be approached in the same way. The very fact that there are different opinions of what can be done in disposal of waste means that there is insufficient knowledge based on scientific observation and exact work, and the only answer is to be given time to establish the laws governing the effects of such disposal.

The work which has to be done falls under four main headings. The first of these is the physical problem of transport, or distribution, of radioactive material in space and time. The laws governing this vary with sea areas. There are variations, as an example, between the tidal currents of the North Sea and the wind currents of the Mediterranean or the great flows such as the Gulf Stream in the Atlantic and the equatorial currents of the oceans. Only by establishing constants can extrapolations be made on which to base predictions for the future.

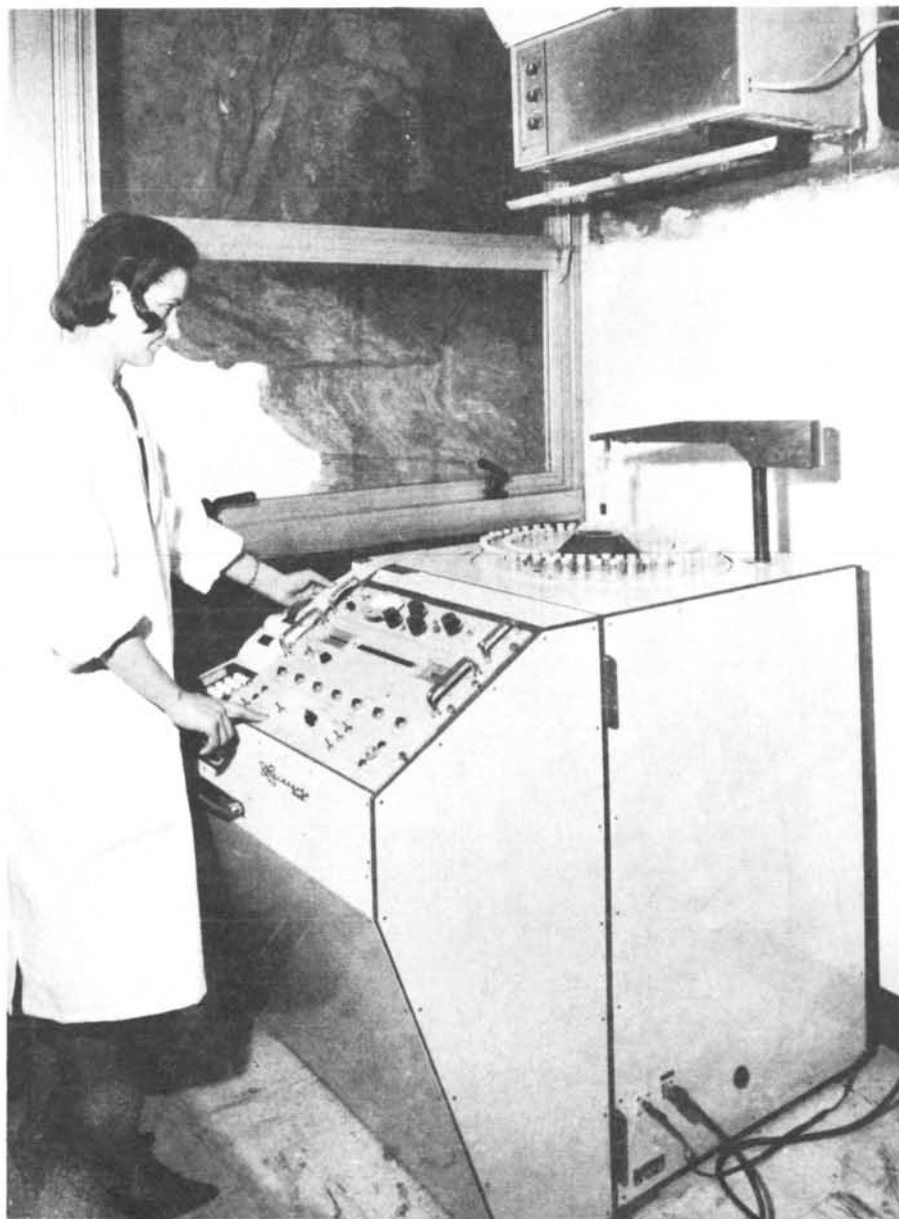
Second comes the chemistry of the sea, its chemical and molecular effects on matter which enters it and the consequential relationship in the sea water to the marine organism cycle. Much valuable work has already

Dissecting molluscs.



been accomplished in studying chemical effects on some of the main metallic elements found in radioactive waste and certain characteristics have been established. Iron, for example, is easily precipitated but manganese and cobalt stay in solution for a long time; between them come zinc, chromium and cerium. Experimentation is complex, concerning both organic and in-

Automatic sample changer.



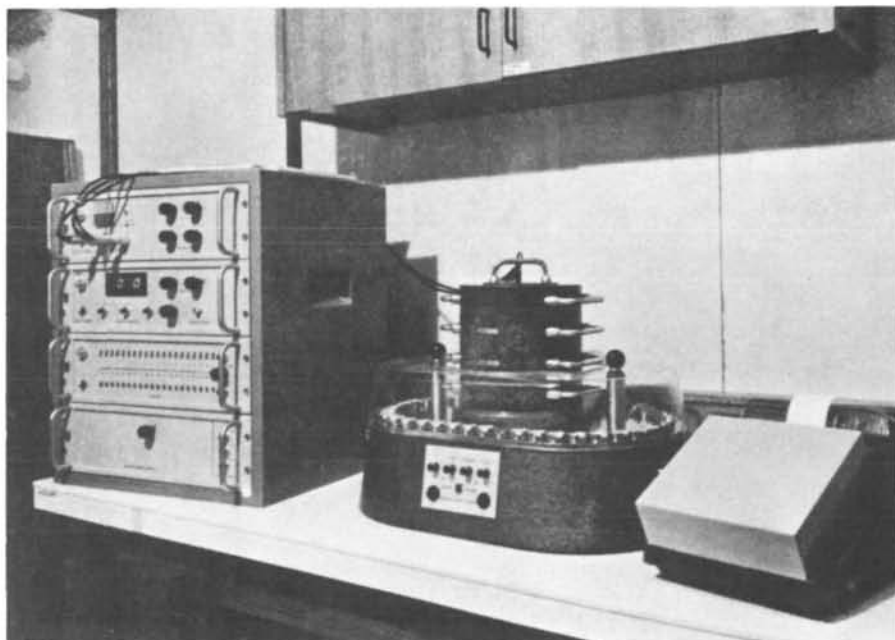
organic composition and involving the chemistry of sediments as well as sea water, and the distribution of elements in marine organisms. Nevertheless, there is a probability that predictions will be possible such as the amount of radioactive material from a given quantity of waste which may be found in a tunafish - or any other form of seafood.

Thirdly comes the study of fish and sea animals arising from the fact that these are the real concentrating factors for radioactivity, particularly as it is likely to affect man. This is related to the chemical forms of radioisotopes accumulated, because if it can be established that elements in certain chemical forms are rejected by fish a great advance will have been made towards reducing dangers by indicating methods of disposal.

Finally, there has to be an examination of the migration of radioisotopes in the sea bed dependent on the nature of sediments and interactions between sediments and water masses with the aim of determining constants from which these effects can be described and predicted. The ultimate aim of all the work is to reach the stage of being able to forecast with accuracy the pattern of behaviour of radioactivity in all circumstances, whether from steady disposal of waste or unexpected occurrences such as the bursting of a waste container or even an accident to a nuclear vessel.

With only four or five scientists available at a time, helped by a few scientific assistants, and with only limited use of boats despite the generous efforts of Commandant Cousteau, the task is obviously formidable and a

Automatic beta counter.



survey of the full ecology of sea organisms must take many years. There are, however, hopes that eventually a research vessel may be acquired and there is also excellent collaboration with other organizations throughout the world. In the Mediterranean there are close connections with the Laboratory set up for similar studies by the Comitato Nazionale per l'Energia Nucleare of Italy, and the Institut Ruder Boskovic of Yugoslavia. The Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée has a special committee dealing with marine radioactivity of which Dr. Joseph is Chairman and on which there are 37 members. Some useful equipment has been made available by the Commissariat à l'Energie Atomique of France. Beyond this area there are ties with the International Council for Exploration of the Seas, with the countries around the North Sea which have oceanographic centres, with USSR and Israel, and with others doing similar work in other ocean areas.

As with all the work of the IAEA there is no secrecy in the laboratories and all information is freely available to the whole world. The laboratory is truly international in character and its staff has included workers from Finland, France, Germany, Greece, Israel, Italy, Japan, the Netherlands, Sweden, Tunisia, USSR, UK, USA and Vietnam.