

CIESM - COMMISSION INTERNATIONALE POUR L'EXPLORATION
SCIENTIFIQUE DE LA MER MEDITERRANEE

Review of the scientific activities of the Members of the
Marine Radioactivity Committee with bibliography (1976-78)

by C. Triulzi (*)

As the President of the Committee I have taken care of the publication of the periodic report on the scientific activities of the MRC Members with related bibliography covering the years 1976-78 up to the CIESM Meeting held in Antalya (Turkey) (24 November-2 December 1978).

Two other reviews concerning the period 1972-74 (after the Monaco Pt. Meeting, 6-14 December 1974) and the period 1973-76 (after the Split Meeting (Yugoslavia), 22-30 October 1976) have been published in *Rapp. Comm. int. Mer Médit.* 23, 7, pp. 109-122 (1976) and 24, 3, pp. 107-158 (1977), respectively in the issues devoted to the Marine Radioactivity.

As in the past, on the basis of either the information already available or directly supplied by the Committee Members, who have been more actively engaged in researches or studies in the field of marine environmental radioactivity, it has been possible to obtain this report.

The members of the MRC are at present 80; the Countries or International Organizations they represent are 14.

The present paper reports in various sections the outlines of the scientific activities performed by each Member or Group or Laboratory starting from East to West of the Mediterranean Sea area: Israel (1), Turkey (2), Romania (3a and 3b), Greece (4), Yugoslavia (5), Italy (6a and 6b), Euratom CCR (7), Mona-

(*) CISE S.p.A. - POB 3986 - Milan (Italy)

co Principality (8), IAEA Labs. Monaco (9), France (10a, 10b and 10c) and USA (11).

Relevant bibliography is listed following an alphabetic Authors order; the quoted papers are denoted by analytical references at the end of each section.

1. ISRAEL

Fisheries Technology Unit, Ministry of Agriculture (Haifa) and Dept. of Nuclear Engineering - Technion, Institute of Technology (Haifa).

Studies and researches in the marine radioecology field, performed in co-operation by the FTU and NET, were concerned with the radiological impact of radioactive release from nuclear facilities into aquatic environment. The research was performed on the behaviour of fallout radionuclides, e.g. ^{90}Sr and ^{137}Cs in natural marine environment. Laboratory experiments were carried out on the uptake and loss of ^{65}Zn by the prawn, *Palaemon elegans*. Studies concerning ecological conditions of the eastern Mediterranean were carried out in the aim at describing the benthic ecosystem on the Israel continental shelf measuring temperature and salinity, and analyzing the edaphic conditions with the purpose of determining indicator species important for the understanding of the behaviour of radionuclides. In fact such a geographic area is a particular one, being inhabited by biota of Atlantic and Indo-Pacific origin, and characterized by high temperatures and salinities as well as low productivity. The constantly changing balance in the pelagic and benthic ecosystems of the subtropical Levant Basin is ascribable to the influx of species on the way of the Suez Canal. This results in the passage of radionuclides through a variety of food chains reaching finally invertebrates and fishes.

Bibl. Ref. Nos. 64, 128-131, 171, 172, 245.

2. TURKEY

Çekmece Nuclear Research and Training Center - Radioecological Laboratory, Radiobiological Department (Hava Alani, Istanbul)

The research activities of the Radioecological Laboratory in the field of marine radioecology (a) and conventional pollution (b) was developed in the past years as follows.

a) For radioecological investigations fresh water and marine fishes (gobies, *Proterorhinus marmoratus*, *Gobius melanostomus*; pike, *Esox lucius* and rudd, *Scardinius erythrophthalmus*), living in the Küçük Çekmece Lagoon, were chosen as test animals.

The accumulation of ^{65}Zn in such fishes was measured and compared. When concentration factors were calculated, it was found that marine fishes had a higher level of ^{65}Zn concentration than that of fresh water fishes.

The accumulation of ^{65}Zn either from water directly or from food and water pathway in goby (*P. marmoratus*) was also investigated and the concentration factors were calculated. The loss of ^{65}Zn in fish in field and laboratory conditions was also considered.

The loss of ^{65}Zn in postlarval rudd was followed in laboratory and in field experiments. It is concluded that the results obtained in field and laboratory trials cannot be compared in the case of the postlarval stage of the rudd fish. In another experiment the loss of ^{65}Zn in field and laboratory conditions in adult goby (*P. marmoratus*) was studied. The goby fishes were collected from the same area and the experimental conditions, as well as the dates of the beginning of the experiment were identical to those of the present experiment. It turned out from the results that goby fishes showed no significant differences in ^{65}Zn loss rates either in field or laboratory conditions.

b) In the field of pollution other than radioactivity, determination of LC 50 and estimates of safe level of LAS detergents for larvae of two fish species in the Küçük Çekmece lagoon were carried out.

Commercial LAS detergent mixture was less toxic than LAS to pipe fish larvae. The pipe fish larvae showed better tolerance to LAS detergent mixture at 20°C than at 10°C. The number of hatched larvae of goby was directly proportional to the concentration of LAS. The toxicity of the LAS was much less for the feeding sacfry of goby, when hatched in LAS contaminated medium. The conclusion is that the concentration at the discharge point must be no more than 3 ppm for the Küçük Çekmece lagoon. Moreover, the accumulation of a mixture of detergents and zinc in the goby *Proterorhinus marmoratus* PALL. was studied and the results are under analysis for publication.

3. RUMANIA

3a) Polytechnical Institute, Faculty of Chemical Engineering,
(Bucharest).

The main activities carried out in the laboratory of radiochemistry in the latest years or in progress are due to the study concerning the artificial radionuclides transport by the Danube river to the Black Sea and accumulation in biota and sediments. Radiochemical analyses and radiometric measurements have led to the identification of ten artificial radionuclides, among which ^{144}Ce , ^{125}Sb , ^{106}Ru , ^{137}Cs , $^{110\text{m}}\text{Ag}$, ^{65}Zn , ^{60}Co , having, however, very low activity. In view of obtaining some specific parameters that can characterize the radioactive pollution degree in the Danube river, the radionuclides carriers that is suspended matter, filtered water and bad load sediments, collected from many verticals of a named cross section under study, have been analyzed. The radiometric data have been correlated with the discharge and solid discharge of fixed verticals and with the average velocity variation with the slope flow and the average turbidity variation in the cross section. It has been possible to find out the "significant verticals" i.e. those present for at least 80% of the total radionuclides (at the same time, they have been detected in water and sediments). "Significative verticals" have been proposed in view of diminishing the number of water samplings and radiochemical laboratory analyses without lowering the accuracy of the measurements.

Moreover, the Danube water and Black Sea water and sediments have been investigated for total alpha, beta and gamma activities. In the algae *Enteromorpha l.* and *Cystossira b.*, ^{106}Ru , ^{137}Cs , ^{65}Zn were identified with low activities, as well as in the bottom sediments collected from different stations in the Black Sea.

More lately Mössbauer's spectroscopy has been applied to

study the iron chemical valency in the minerals of some rocks and sediments and ferro-manganese concretions of the Rumanian Black Sea shore.

Another analysis is in progress to establish the dilution capacity of the Danube river and to evaluate its radioactive discharge into the Black Sea.

3b) University of Bucharest; Faculty of Physics (Magurele, Bucharest).

Some researches on the marine radioactivity during the past four years were mainly concerned with the study of the transfer of radionuclides of sea water into sea-bottom sediments. The analysis of the electrokinetic behaviour and the determination of the zero point charge of some sediments of the Rumanian shore of the Black Sea were performed. The results of the analysis on the absorption capability of some radionuclides of the Black Sea in bottom-sediments were recently reported.

The determination of the uranium content in some sediments and in sea water samples was recently carried out, making use of a fission fragment trace analysis technique, as well as a study performed by means of Mössbauer's spectrometry.

Solide state track detectors were utilized in another research aimed at determining the uranium content in different marine samples.

Bibl. Ref. Nos. a): 30, 116-126, 159

b): 65-68, 75, 206, 247, 267-271

4. GREECE

Greek Atomic Energy Commission, Nuclear Research Center Democritos, Department of Chemistry, Radioanalytical Laboratory, (Athens)

Research work in the field of marine radioactivity during the past years was concerned with the following subjects:

- characterization of certain marine species as marine pollution indicators for certain elements of radioecological importance. Determination of Selenium, Chromium, Silver, Scandium, Iron, Zinc, Cobalt and Antimony, in Tunicates by instrumental neutron activation analysis and spectrometry. Determination of Vanadium in seven echinoderm species, sea water analysis and estimation of Vanadium concentration factors.
- Study on the present levels of Europium, Vanadium and Molybdenum in organisms of well defined food chains in order to get information on their possible biomagnification through food chains.
- Study on the distribution pattern of Cobalt, Silver, Selenium, Iron and Caesium, in otoliths of pelagic fish as a function of age and size. Specimens were collected from three sea areas of Greece. The fact that certain elements can be accumulated by individual tissue might be useful for the characterization of certain organs as indicators of some pollutants.

5. YUGOSLAVIA

Center for Marine Research, "Rudjer Boskovic" Institute
(Zagreb and Rovinj)

The research activities of the Laboratories Center in the field of marine radioactivity during the past years were concerned with the following topics:

- radioecological monitoring of the North Adriatic including gross beta activity measurements and gamma spectrometric analysis of organisms, sea water and some sediment samples;
- investigation of physico-chemical states where a certain radionuclide or trace metal occurs in the North Adriatic (zinc, ruthenium, cadmium, sodium, cesium) in connection with its biogeocycle in the marine environment;
- interaction of metal ions and ligands in solutions of very low concentrations; investigations of organic matter in marine environment, especially in muddy sediments and in suspended matter of the upper Adriatic and studies on sorption phenomena on sediments and suspended matter;
- interaction of certain radionuclides (e.g. ^{137}Cs , ^{65}Zn , ^{60}Co , $^{115\text{m}}\text{Cd}$) with representative marine organisms (fishes, mussels, crabs) including the transfer through the food chain; the influence of various biotic and abiotic parameters upon the investigated processes and mechanisms.

Other environmental researches from the aspects of analysing consequences of radioactive pollution include experimental studies and monitoring related to the siting of nuclear power plants.

Most of the Center activity was focused on the conventional pollution of the North Adriatic Sea area, and its influence on the ecological communities. Non-nuclear activities mainly concerned baseline studies of metals in sea water, sediments and biota (Cd, Hg, Pb, Cu, Zn), baseline studies of pesticides

in marine organisms, monitoring of the sanitary quality of coastal waters (coliforms, streptococs, BOD), studies of nutrient (nutrients, nitrates, phosphates, ammonia) and oxygen cycles, standard hydrographic surveys, thermal pollution and other studies on other important physical parameters.

6. ITALY

6a) University of Parma, Zoology Department, Radioecology Group (Parma).

The experimental study on the Taranto Gulf samples, aimed at determining natural and artificial radioactive baseline of the environment and at obtaining a preliminary characterization of such marine site has been performed, and is the subject of a special report (Indagine radioecologica alla foce del fiume Sinni e nel Golfo di Taranto - Final report of the research contract TRIMA-1 between CNEN and Parma University, 1976) available on request.

Suitable experimental devices have been set up and the optimal conditions of thorium, uranium and plutonium electro-deposition from environmental samples have been investigated with the cooperation of CISE (Milan); the contents of Th, U and Pu in the superficial layers of the Taranto Gulf sediments have been also determined. Recently, a study concerning the radioactive fallout (Parma station) has been started to follow its evolution both for gamma and for alpha emitters.

The Radioecology Group is at present engaged in determining the biogeochemical cycle of alpha emitters, mainly plutonium isotopes, in the marine environment around the Italian coasts, in order to improve the data relevant to the artificial radioactivity distribution in the various abiotic compartments (water, sediment) and biotic ones (plankton, fish, benthic organisms).

With the active collaboration of some researchers of CNEN (CSN-Casaccia Roma), some Pu isotopes measurements on such kind of samples collected from the Taranto Gulf have been obtained and the results have been published. Other radiochemical analyses on samples from the Tyrrhenian and North Adriatic Seas are now in progress. Analytical procedures for measurements of low amounts of plutonium, sea water, marine organisms, and sediments have been also studied in the frame

of such collaboration study.

Other sort of experimental work, performed with radioecological techniques, has then been carried out in the Zoology Department laboratories.

Thermobiology of marine organisms adapted to life in estuarine environments of the Po River Delta has been studied and the analysis of the trophic activity of the scavenger *Cyclope neritea* by using food labelled with a radiotracer has been continued.

Moreover, laboratory experiments on bioaccumulation of ^{85}Sr in the same mollusc in different combinations of temperature and salinity have been performed, with the aim at evaluating the relative importance of the two main pathways of uptake, water and food, on strontium kinetics.

Owing to their environmental approach, these experiments have been completed by ethological observations on the same scavenger and by the analysis of filtration activity of the filter-feeder *Mytilus galloprovincialis*.

Other investigations related to bioaccumulation processes and to radionuclide circulation in aquatic ecosystems are in progress on the Caorso nuclear site (BWR, 840 MWe), on the Po River.

6b) CNEN - Laboratorio per lo studio dell'ambiente marino
(Fiascherino, La Spezia)

Activities carried out in the past years concerned the following topics: chemical characterization and uptake by animal and vegetable organisms of stable elements and radioactive nuclides (^{65}Zn , ^{32}P , ^{137}Cs , ^{51}Cr ...), development of chemical automated analytical methods, effect of thermal pollution on phytoplankters, toxic effects of pollutants on selected species.

At present, part of the Laboratories activities have the purpose of determining gamma emitters and ^{90}Sr in fallout samples collected monthly (Fiascherino station) and of measuring ^{90}Sr and ^{137}Cs contents in sea water samples collected in five marine stations around the Italian coasts; other radioactivity determinations will be started in the future for the seasonal monitoring of selected fishes, typical molluscs and sediments.

Bibl. Ref. Nos. a): 1, 36, 46, 69, 127, 158, 184, 187, 216,
217, 221, 242-244, 252, 253, 259, 260
b): 37-43, 59, 115, 218, 239-241, 272

7. COMMISSION OF THE EUROPEAN COMMUNITIES, Joint Research Centre, Chemistry Division (Ispra Establishment, Italy)

The objective of the activities (1976-1978) connected with the long-term hazard evaluation, is the quantitative description of the behaviour of the actinides in terrestrial and aquatic environments following loss from a geological repository containing alpha-bearing wastes.

The experimental study areas include:

- problems related to the detection of different chemical species of actinides in water and sediments, specially in relation to their behaviour in very dilute solutions
- characterization of physico-chemical state of actinides in leached solutions from borosilicate glass
- development of laboratory systems which adequately simulate natural conditions.

Theoretical model study is being developed for the assessment of the distribution and associated hazard due to a long-term release of actinides into surface waters of a marine ecosystem. A compartment modelling concept is used which permits the identification of major components of the system. Critical group, critical pathway hazard assessment can be attempted such that dose rates to man can be evaluated.

8. MONACO PRINCIPALITY

Scientific Center of Monaco, Laboratory of Applied Radioactivity (Monaco Ville)

In addition to archaeological problems, the Laboratory is engaged in studying the chronology of sea level changes during the last 35000 years and related morphologic involvements in the Mediterranean western coasts, fluvial and marine sedimentations, chronology developments of barrier formations in the Rhone Delta and off-shore lines and coastal lakes.

In collaboration with the IAEA International Laboratory of Marine Radioactivity, a computation method to be used in gamma spectrometry (GeLi) has been performed and tested. The programme (FORTRAN) allows the automatic detection of photoelectric peaks, the determination of their areas, radionuclide identification and activity evaluation.

Other researches carried out at the Laboratory concern some determinations of ^{137}Cs and ^{14}C specific activities in sea water of the Ligurian Sea samples.

Two series of measurements were performed on 5 profiles in October 1975 and April 1976 in order to determine ^{14}C specific activity in the Ligurian Sea. These results, together with other obtained in the years 1962-67 and 1972 through a series of laboratory measurements could supply a mathematical model, which, making use of cosmogenic and thermonuclear ^{14}C as a tracer, proved to be rather convenient for the study of the vertical changes of water masses.

Chronostratigraphy by ^{14}C of marine sediments in Western Mediterranean constitutes the main part of the marine investigations of the Laboratory of Applied Radioactivity.

After a study of the Golfe du Lion, an investigation of the chronology of the Holocene transgression will be carried out on the Continental shelves of Ebre's Delta and of the Golfe de Gabes.

^{14}C method is also being applied to researches on recent tectonic submergences of shorelines in Western Crete.

9. IAEA, International Laboratory of Marine Radioactivity
(Monaco Principality)

Chemistry Group Activities

Transuranic Element Studies - Measurements of plutonium and americium isotopes were carried out on sea water and sediment samples collected from various parts of the Mediterranean Sea covered by several cruises in the period 1976-78. The vertical distribution of ^{238}Pu , $^{239+240}\text{Pu}$ and ^{241}Am were studied on several profiles in different Mediterranean basins. The differentiation of ^{241}Am from plutonium isotopes in the upper layers was confirmed. The consideration of the geochemical budget of plutonium in the profile indicated that the major part of the fallout delivery of plutonium is still in the water column.

Trace Element Studies - Measurements of copper, zinc, cadmium and mercury in off-shore Mediterranean waters have been carried out in order to obtain baseline levels of these heavy metals in the Mediterranean. The sea water samples were collected during several cruises conducted in 1976-78 and anodic stripping voltammetry was used for the analysis. Many coastal water samples were also analyzed in a similar manner. The results showed that, in general, the concentrations of these heavy metals in the open Mediterranean tend to be lower than or similar to those reported by other investigators for other oceanic waters.

Intercalibration programme - During the period 1976-78 the intercalibration programme on radionuclide and trace element measurements continued. For radionuclide measurements, the intercalibration exercise on 2 sediment samples (SD-B-2 and SD-B-3) was completed. With the support of UNEP the intercalibration exercises on the measurements of trace elements in marine biological materials also continued. Exercises on the oyster sample (MA-M-1), copepod sample (MA-A-1) and sea plant sample (SP-M-1) were completed in 1978 and that on fish sample (MA-A-2) is now in

progress. The results show that Mediterranean laboratories are, in general, performing satisfactory analytical work, compared with those in other areas.

Biology Group Activities

Heavy metal studies using radiotracers of arsenic and vanadium have been undertaken with marine zooplankton and a variety of benthic invertebrates. Emphasis has been placed on understanding the relative importance of the food and water pathway in their accumulation. The effect of temperature, salinity and stable element concentration on the accumulation of these metals has also been examined. In all cases flux parameters derived from radiotracer kinetic studies have been applied to natural concentrations of the element in the organism in an attempt to explain bioconcentration processes. In addition, parallel laboratory and in situ excretion studies using ^{74}As and ^{48}V have been performed in order to assess the degree to which laboratory experiments reflect metal flux processes taking place in nature.

The biogeochemical cycling of transuranic such as plutonium, americium and neptunium by a number of marine species has been examined. The gamma emitting isotopes, ^{241}Am and ^{237}Pu , have facilitated biokinetic studies by allowing whole body live counting of selected organisms. Studies on the bioavailability of transuranics to benthic species such as octopus, cuttle fish and starfish are now underway. Emphasis is placed on the ability of these species to assimilate transuranics ingested via the food chain and distribute them in their tissues.

Other studies are currently underway to establish the role of marine zooplankton in the vertical oceanic transport of alpha-emitting nuclides. Samples of euphausiids, copepods and their natural particulate products have been, or are being, analyzed for polonium, uranium, thorium, radium and plutonium. The data will be fit to a model which characterizes the verti-

cal transport of these nuclides by zooplankton particulate products. Additional data are being obtained on these radionuclides in sinking particulates. Sediment traps have been moored at depths of 100 meters in the Ligurian sea and left in place for intervals of two weeks. Samples which are comprised of fecal molts are analyzed for transuranics and polonium and levels are compared with those in freshly released fecal pellets of zooplankton. This information will be useful in determining how much of these nuclides reach the sediments and what fraction is remineralized back into the water column.

Samples of open Mediterranean plankton have been collected and analyzed for heavy metals as part of a Mediterranean baseline pollution study supported by UNEP.

Environmental Studies Group Activities

During the period 1976-1978 the major area of study covered:

- 1) baseline measurements of chlorinated hydrocarbons in water, biota and sediments collected from the open Mediterranean;
- 2) experimental studies on the transfer of PCBs from sediments to marine benthic organisms;
- 3) studies on the distribution of heavy metals in a population of marine neuston;
- 4) transfer of radionuclides between marine biota and their environment.

Studies on the combined effects of various types of pollutants, e.g. metals, chlorinated hydrocarbons, radionuclides, etc., were initiated. It is expected to broaden this line of research in the future. Considerable time was also devoted to reviewing current development in marine radioecology. These reviews were presented at several lectures given at the following institutions or at meetings: Lund University (Sweden, May 1976), Cadarache Nuclear Research Center (France, January 1977), Parma University (Italy, October 1977), XX Congress of AIFSPR (Bologna, Italy, October 1977), CNEN (Rome, Italy, October 1977), CNEN Laboratory for Radioactive Contamination of the Sea (Fia-

scherino, Italy, October 1977), IAEA - Panel on Methodology of studies of biological effects of ionizing radiations in marine ecosystems (Vienna, Austria, November 1977).

Bibl. Ref. Nos. 32-35, 60, 61, 70-74, 76-82, 84-99, 101, 102, 104, 114, 133-139, 151-156, 162, 176, 186, 189, 191, 194-195, 200, 224-233, 235-237, 249, 266, 273.

10. FRANCE

10a) CEA, Protection department - SERE (Fontenay-aux-Roses)

Les études et les recherches expérimentaux développés pendant les derniers 3-4 ans par les laboratoires de Radioécologie Marine du Centre de la Hague et de Radioécologie du CEN de Cadarache du Service des Etudes et Recherches sur l'Environnement peuvent être ainsi résumés.

1) Comportement physico-chimique des radionucléides dans l'eau et les sédiments marins.

Des efforts importants ont été consacrés à l'étude du comportement physico-chimique en eau de mer, du ruthénium-106 produit de fission rejeté dans le milieu par les essais de traitement de combustibles irradiés. On a constaté que l'évolution du ^{106}Ru se fait selon deux réactions concurrentes: d'une part formation de dérivés chlorés solubles, d'autre part hydrolyse aboutissant à la formation de polymères colloïdaux ou semi-colloïdaux. Une méthode basée sur l'utilisation de résines cationiques en milieu électrolytique a été mise au point pour étudier les propriétés des polymères et pour les éliminer de la fraction réellement soluble. Les diverses formes de ruthénium sont liées entre elles par des réactions d'équilibre qui déterminent les cinétiques de contamination des supports inertes (sédiments), ou vivants (algues, mollusques, etc.). On peut distinguer trois catégories de composés du ruthénium. Les formes A ont des propriétés d'adsorption élevée. Les formes B ne sont pas adsorbables directement, mais peuvent se transformer en formes A par déplacement d'équilibre. Les formes C sont des formes stables et non sorbables. Avant 1975, le ruthénium rejeté à La Hague était composé de 90% de formes A et de 10% environ de formes B. Dans les années ultérieures, on a trouvé 50% de formes A, 40% de formes B et quelques pour cent de formes C. Cette évolution est due à une modification

du procédé de traitement des effluents. Elle a été mise en rapport avec une contamination accrue de certaines algues, à contamination égale de l'eau de mer.

Une méthode de concentration et de dosage des nucléides contenus dans l'eau de mer a été mise au point. C'est ainsi que les radionucléides des cérium, cobalt, fer, ruthénium, zinc et zirconium ont été dosés dans l'eau de mer par préconcentration sur dioxyde de manganèse colloïdal à partir de grands volumes d'eau de mer, suivie d'une spectrométrie gamma à haute résolution. Cette technique permet de séparer, dans certains cas, les formes complexes et non complexes, ainsi que des formes plus ou moins oxydées. Le procédé a été adapté au dosage des nucléides non radioactifs, en couplant la préconcentration sur dioxyde de manganèse à différentes techniques de dosage, telles que l'absorption atomique, l'activation neutronique et la fluorescence X.

2) Transfert des nucléides aux organismes marins

Une étude des mécanismes de transfert du plutonium aux organismes marins a été effectuée. Ce travail a mis en évidence la relation existant entre le taux de concentration du plutonium chez des espèces marines végétales et animales et le niveau trophique de ces organismes. Cette relation fait apparaître une décroissance du taux de fixation du radioélément en rapport avec l'élévation du niveau trophique des espèces. Le contact direct eau de mer-espèces, mode essentiel de transfert chez les espèces marines appartenant aux niveaux trophiques inférieurs (producteurs et consommateurs primaires), apparaît comme une voie entraînant une importante fixation du plutonium. Par contre, le sédiment au contact duquel vivent certaines espèces ne semble pas constituer un vecteur essentiel de la contamination. Les relations trophiques entre espèces animales conduisent à supposer qu'il existe un transfert de plutonium par voie alimentaire, sans pour autant qu'il y ait concentration de ce radioélément le long de la chaîne allant des producteurs primaires aux consommateurs tertiaires. Par ailleurs, il a été constaté qu'il y

avait une relation entre le taux de fixation du plutonium et les structures calcifiées de certaines espèces marines, comparable à celle qui existe entre ce radioélément et le tissu osseux des mammifères terrestres.

Une étude a par ailleurs été réalisée sur le transfert de quelques radionucléides (^{125}Sb , $^{110\text{m}}\text{Ag}$, ^{60}Co) à travers des chaînes alimentaires longues allant du producteur primaire à un mollusque et à un crustacé. Il a été constaté que les facteurs de transfert exprimant le rapport de l'activité d'un organisme à l'activité de l'eau, diminuent au fur et à mesure que l'on progresse dans l'échelle des êtres organisés. Autrement dit, les nucléides considérés ne sont pas focalisés dans les maillons supérieurs de la pyramide écologique. Cependant, les organismes étant toujours plus contaminés que l'eau dans laquelle ils vivent. Ces résultats sont à rapprocher des résultats similaires relevés par d'autres auteurs pour un grand nombre d'autres nucléides (à l'exception du césium 137).

3) Bilan radioecologique de l'impact des rejets en Manche

Une étude a été réalisée portant sur la répartition des radionucléides artificiels émetteurs gamma dans les sédiments littoraux de la Manche et de la mer du Nord pendant les années 1976-1977. Les principaux nucléides présents dans les sédiments de surface sont le ruthénium-106 (34 pCi/g) et le cérium-144 (30 pCi/g). On mesure aussi le césium-137 (2,3 pCi/g), le zirconium-95 (1 pCi/g), l'antimoine-125 (0,8 pCi/g). Les valeurs données entre parenthèses sont des valeurs moyennes, qui ne traduisent pas la variabilité rencontrée in situ. Les valeurs les plus élevées sont rencontrées à proximité de l'émissaire de La Hague et dans le golfe normand-breton. La contamination relativement importante de cette dernière zone est jusqu'à présent inexplicquée, compte tenu de ce que l'on sait des courants superficiels dans cette région. Les teneurs en ruthénium-106 et en cérium-144 sont fortement corrélées, et elles proviennent principalement des rejets de La Hague. Les autres nucléides peu-

vent provenir en proportion importante des retombées atmosphériques.

Une autre étude a porté sur la distribution du plutonium dans un certain nombre d'espèces marines: *Lichina pygmaea*, *Corallina officinalis*, *Corallina sanguinea*, *Balanus balanoides*. Ces espèces ont été prélevées sur le littoral de la Manche entre Brest et Honfleur. La teneur en plutonium marque un maximum au niveau de l'émissaire de La Hague, et diminue de part et d'autre du point de rejet pour atteindre des valeurs imputables aux retombées atmosphériques. Les valeurs atteintes à proximité de l'émissaire (zone d'Ecalgrain) sont de 5 à 10 fois plus élevées que les valeurs mesurées à Brest.

4) Applications non nucléaires

L'application des techniques nucléaires a permis en particulier, d'obtenir des renseignements précieux sur les déplacements des masses d'eau en Manche, ainsi que d'estimer les vitesses de sédimentation à partir de profils verticaux dans les carottes prélevées in situ.

10b) Centre des Faibles Radioactivités, Laboratoire mixte CNRS-CEA (Gif-sur-Yvette)

Some of the activities carried out at the Laboratory have been concerned with general theoretical approaches to the following topics.

- Evaluation of the efficiency of a marine gamma subassembly detector in the 0.5 to 1.5 MeV band for an infinite or semi-infinite radioactive and absorbing environment.
- Philosophical and mathematical classification of sampling and measurement methods for "in situ" and "in vitro" studies of the sea water radioactivity content.
- Algebraic study of simple tideless estuaries of the Mediterranean type for the evaluation of the diffusion into the sea

of a fluvial contamination. This study is at present underway.

10c) Université de Nantes, Institut des Sciences de la Nature, Laboratoire de Biologie Marine (Nantes).

Les activités dans le domaine de la radioactivité marine développées par les membres du Comité qui travaillent actuellement chez le Laboratoires de Biologie Marine ont continué sur le transfert du cobalt 60 dans les chaînes alimentaires (15, 19, 23, 28) envisageant les contaminations par l'eau et (ou) par la nourriture, l'élimination et l'organotropisme. Selon le même protocole expérimental nous avons cherché à quantifier le transfert de l'argent 110m dans une chaîne alimentaire marine benthique; les publications sont en partie sous presse. Nous avons entrepris le même travail pour deux chaînes alimentaires dulçaquicoles. Une méthode de calculs des doses d'irradiation a été mise au point.

Des synthèses bibliographiques ont été effectuées sur des problèmes de protection de l'environnement aquatique, sur le transfert des polluants radioactifs dans les chaînes alimentaires, sur l'influence du cycle d'intermue des Crustacés sur la radioécologie, sur l'influence de la température sur la radiocontamination.

Nous avons continué également l'étude de la toxicité subléthale de quelques métaux et l'exploitation mathématique des résultats.

Nous allons entreprendre des études in situ du transfert des métaux (Pb, Cd, Zn, Cu, ...) dans les chaînes trophiques estuariennes.

Bibl. Ref. Nos. a): 25-27, 47-49, 101, 102, 137-148, 160, 219
b): 173-175
c): 5-24

11. USA

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

The oceanic distributions of artificial radionuclides, mostly from worldwide weapons-testing fallout, have been underway for several years now at some laboratories of the Institution. These studies provide information both on the distributions and fates of these radionuclides and, through their various uses as oceanic tracers, about oceanic processes, e.g., water transport, particle settling and interactions with the marine biota.

These studies have shown that the information which is generated is applicable to predictions of the oceanic behaviour of future releases of artificial radionuclides, accidental or planned, from nuclear-related activities. Furthermore, a considerable fraction of this information is applicable to the understanding of the oceanic behaviour to be expected from a variety of pollutants from non-nuclear energy production, e.g. metals and organics.

Environmental Radioactivity Standards. The value and importance of quality control in analytical programs have been long recognized. Development and testing of several new standards have been carried out. These include several "natural matrix" standards for a program of the International Committee for Radionuclide Metrology ("blank" soil from Peru, contaminated fishmeal from the Irish Sea) and "spiked" fresh and seawater standards for DOE quality assurance programs.

Equipment Development

- Self-powered, filtration pump. This is a stream-powered device capable of filtering large volumes of water from any depth.
- Tripod corer. This is a structural modification of an earlier large diameter gravity corer permitting increased corin efficiency and improved surficial sediment recovery.

Mediterranean. Accumulating data show, relative to the oceans, much less vertical water column separation of plutonium from "soluble" nuclides, while ^{241}Am and ^{55}Fe are moved downwards faster through their suggested associations with particles of terrigenous origins.

Atlantic. Using the Deep Ocean Blank technique, the North Atlantic ^{137}Cs inventory in 1972 was found to be higher than predicted from overland fallout considerations, but uncertainty estimates bring the over-ocean delivery close to that predicted previously from overland measurements.

Pacific. Distributions and inventories of fallout nuclides in the Pacific appear to have been considerably affected by tropospheric fallout. Pacific distributions differ markedly from the Atlantic. There is striking evidence of plutonium-rich near-bottom water between 50°N and 20°N .

Non-Fallout Sources. The impact of European Nuclear fuel re-processing releases on the fallout tracer experiment has been found to be quite substantial and the rates and pathways of dispersal of nuclides from these sources studied.

^{55}Fe Sinking Rates. Discovery and correction of counter miscalibration points to earlier estimates of the rates of delivery of ^{55}Fe to marine sediments being underestimated by more than a factor of two.

The concentrations of transuranics and ^{137}Cs have been measured in samples of the blue mussel (*Mytilus edulis*) collected from a large number of coastal locations on the East, West and Gulf coasts of the U.S.A. This is part of the "Mussel-Watch" program which attempts to use *Mytilus* as a biological monitor of marine environmental quality in respect of metals, radionuclides and organic pollutants.

The distributions of transuranics and ^{137}Cs have been studied in various low-level nuclear waste dump sites off U.S. coasts, around several coastally-located nuclear power plants and one commercial nuclear fuel reprocessing center. These studies are directed towards the development of predictions of the behaviour of these radionuclides in the various locations from both present and future releases of radioactivity.

Bibl. Ref. Nos. 50-57, 83, 132, 150, 164-167, 170, 178-183, 248.

BIBLIOGRAPHY

- 1976÷1978 period -

- 1) ALBINI A., BONFANTI G., GIACOLETTO C. and TRIULZI C.,
1976 - Radioattività artificiale ricaduta a Segrate (Mi-
lano) nel periodo 1962-1973. Rapporto CISE-N-180.
- 2) ALOISI J.C., MONACO A., THOMMERET J. and THOMMERET Y.,
1975 - Evolution paléogéographique du plateau continental
languedocien dans le cadre du golfe du Lion. Rapp. Comm.
int. Mer Médit. 23, 4a, pp. 253-255.
- 3) ALOISI J.C., MONACO A., THOMMERET J. and THOMMERET Y.,
1975 - Evolution paléogéographique du plateau continental
languedocien dans le cadre du golfe de Lion. Analyse com-
parée des données sismiques, sédimentologiques et radio-
métriques concernant le Quaternaire récent. Revue de Géog-
raphie physique et de Géologie dynamique (2), Vol. XVII,
fasc. 1, pp. 13-22.
- 4) ALOISI J.C., MONACO A., PLANCHAIS N., THOMMERET J. & Y.,
1978 - The Holocene transgression in the golfe du Lion,
Southwestern France: Paleographic and Paleobotanical
evolution. Geogr. Phys. et Quaternaire XXXII, 2, pp. 145-
162, Québec.
- 5) AMIARD J.C., 1978 - Aspects sanitaires et écologiques des
pollutions radioactives dues aux installations nucléaires
littorales. In: Ecologie marine et Aménagement du Littoral,
2 Décembre 1977, Institut Océanographique, Paris, Oceanis,
IV.
- 6) AMIARD J.C., 1978 - Etude bibliographique de l'influence
de la température sur la radiocontamination des organismes
aquatiques. Rapport EDF E 31/78/n. 25 ARD E3D04, 82 p.
- 7) AMIARD J.C., 1975 - Interprétation d'une étude experimen-
tale du métabolisme du radiostrontium chez la Plié
(*Pleuronectes platessa* L.) à l'aide des analyses facto-
rielles. Rev. Intern. Océanogr. Méd. 39-40, 177-212.

- 8) AMIARD J.C., 1975 - Influence de divers facteurs écologiques sur l'accumulation du radiostrontium chez deux Téléostéens euryhalins: *Mugil auratus* Risso et *Pleuronectes platessa* L. Rapport CEA-R-4706.
- 9) AMIARD J.C., 1976 - Etude expérimentale de l'accumulation de l'antimoine 125 dans quelques biocoenoses marines. Rapp. Comm. int. Mer Médit., 23, 7, pp. 127-129.
- 10) AMIARD J.C., 1976 - Etude expérimentale de la toxicité aiguë de sels de cobalt d'antimoine, de strontium et d'argent chez quelques Crustacés et leurs larves et chez quelques Téléostéens. Rev. Int. Océanogr. Méd. 43.
- 11) AMIARD J.C. and AMIARD-TRIQUET C., 1975 - Expérience préliminaire à l'utilisation d'une chaîne trophique dans l'étude d'une pollution par le cobalt 60: Bilan après une ingestion unique. Water, Air Soil Pollut. 5 (2), 221-229.
- 12) AMIARD J.C. and AMIARD-TRIQUET C., 1976 - The different methods for studying the biological consequences of metallic pollutions in the aquatic environment. 1st World Congress of Environmental Medicine and Biology, 1-5 Juillet 1974, Paris, Elsevier Publ. Co., Amsterdam.
- 13) AMIARD J.C., 1976 - Les variations de la phototaxie des larves de Crustacés sous l'action de divers polluants métalliques: mise au point d'un test de toxicité subléthale. Mar. Biol., 34 (3), 239-245.
- 14) AMIARD J.C., HARDUIN J.C. and ODILON G., 1976 - Etude de l'influence d'une surcharge en chlorure de cobalt sur la composition en acides aminés libres de l'hémolymphe du Crustacé Décapode: *Carcinus maenas* L. Cah. Biol. Mar. Roscoff, 17 (3), 295-303.
- 15) AMIARD J.C., 1976 - Assimilation, excretion and distribution of cobalt 60 in the rat after daily ingestion of contaminated marine food products. Health Phys., 31 (4), 371-373.

- 16) AMIARD-TRIQUET C. and AMIARD J.C., 1976 - La pollution radioactive du milieu aquatique et ses conséquences écologiques. Bull. Ecologie 7 (1), pp. 3-32.
- 17) AMIARD-TRIQUET C. and AMIARD J.C., 1976 - Influence du mode de contamination sur l'élimination du cobalt 60 par *Scrobicularia plana* da Costa (Mollusque Bivalve) et *Carcinus maenas* L. (Crustacé Décapode). Cah. Biol. Mar. Roscoff 17 (1), 1-8.
- 18) AMIARD-TRIQUET C. and AMIARD J.C., 1976 - L'organotrophisme du ^{60}Co chez *Scrobicularia plana* et *Carcinus maenas* en fonction du vecteur de contamination. Oikos 27 (1), 122-126.
- 19) AMIARD J.C. and PAGES J., 1976 - Comparaison de trois variantes d'analyse factorielle sur des données biologiques. Note CEA-N-1888, 26 p.
- 20) AMIARD J.C., 1976 - Impact des installations nucléaires françaises sur l'environnement aquatique. Vie Milieu, 26 (2B), 319-340.
- 21) AMIARD J.C. and AMIARD-TRIQUET C., 1977 - Health and ecological aspects of cobalt 60 in a seawater food chain typical of an intertidal mud-flat. Intern. J. Environmental Studies, 10, 113-118.
- 22) AMIARD J.C., 1978 - Etude comparative de différents tests de toxicité d'un sel métallique vis-à-vis d'un Crustacé Décapode. IIIe Journées Etud. Pollutions, XXVe Congrès-Assemblée Plénière de la C.I.E.S.M., Split, 22-23 oct. 1976, 75-78.
- 23) AMIARD J.C., 1978 - Contribution à l'étude de l'accumulation et de la toxicité de quelques polluants stables et radioactifs chez des organismes marins: l'antimoine, l'argent, le cobalt et le strontium chez des Mollusques, des Crustacés et des Téléostéens. Thèse de Doctorat d'Etat, Université P. et M. Curie (Paris 6), 4 mars 1978, 150 p. Rapport CEA-R-4928, 138 p.

- 24) AMIARD J.C., 1978 - Exemples de calculs de doses d'irradiation reçues par des organismes en milieu expérimental contaminés par divers radionucléides. 1. Cas de cultures de *Dunaliella bioculata* contaminées par ^{51}Cr et ^{109}Cd . Rev. Intern. Océanogr. Méd., 51-52.
- 25) ANCELLIN J. and FRAIZER A., 1976 - Le plutonium en milieu marin. Revue générale nucléaire, vol. 3, pp. 223-227.
- 26) ANCELLIN J., 1977 - Radioécologie marine: quelques aspects de recherches appliquées à la protection. Bull. ing. sc. et tech., 222, pp. 11-16.
- 27) ANCELLIN J., 1978 - La pollution radioactive en milieu marin, in "La pollution des eaux-marines". Ouvrage collectif présenté par J.M.PERES, pp. 67-77, Gauthier-Villars ed., Paris.
- 28) AVOGADRO A., MURRAY C.N. and DE PLANO A., 1979 - Laboratory experimental development for the study of Transuranic migration in Porous Media. In CEC-NEA Workshop on the Migration of Long-Lived Radionuclides in the Geosphere, Brussels, 29-31 January 1979.
- 29) BALLESTER A.N. and NEDWED C.R., 1977 - Landsat-1 MSS data as a tool to study marine phenomena. Rapp. Comm. Int. Mer Médit. 24, 3, 103-106.
- 30) BARB D., DIAMANDESCU L., MORARIU M., GEORGESCU I.I., 1978 - Mössbauer and chemical analyses of some sediments from the Romanian shore of the Black Sea. International Mössbauer Congress, Kyoto (Japan), Aug. 1978, J. Phys. (1979) - Colloc. C2, Suppl. No. 3, pp. 445-448.
- 31) BAZILE F., RENAULT-MISKOVSKY J. and THOMMERET J., 1976 - Sur la présence d'un niveau littoral du Würm récent (Würm III) dans la région d'Aigues-Mortes. Comptes Rendu de l'Académie des Sciences, Paris, t. 282, série D, pp. 1149-1150.
- 32) BEASLEY T.M., HEYRAUD M., HIGGO J.J.W., CHERRY R.D., FOWLER, S.W., 1978 - Po^{210} and Pb^{210} in zooplankton fecal pellets. Mar. Biol. 44, pp. 325-328.

- 33) BEASLEY T.M. and FOWLER S.W., 1976 - Plutonium and americium: Uptake from contaminated sediments by the polychaete *Nereis diversicolor*. Mar. Biol. 38, pp. 95-100.
- 34) BEASLEY T.M. and FOWLER S.W., 1976 - Plutonium isotope ratios in polychaete worms. Nature, vol. 262, No. 5771, pp. 813-814.
- 35) BENAYOUN G. and FOWLER S.W., 1976 - Accumulation and retention of selenium in marine organisms. Rapp. Comm. int. Mer Médit. 23, 7, pp. 79-80.
- 36) BEDULLI D., MEZZADRI M.G., PARISI V., POLI P., 1977 - Thermobiology of estuarine molluscs. Atti Soc. ital. Sci. nat. Museo civ. Stor. nat. Milano, 118 (2), 185-197.
- 37) BERNHARD M., BRUSCHI A. and MOLLER F., 1975 - Use of compartmental models in radioecological laboratory studies. IAEA Panel "Design of Marine Radioecological Experiments" IAEA, Vien (in press).
- 38) BERNHARD M., CAGNETTI P. and ZATTERA A., 1975 - Processi di diluizione di contaminanti in un ambiente marino. Atti Conv. Interparlam. Italo-Yugoslavo.
- 39) BERNHARD M., GOLDBERG E.D. and PIRO A., 1975 - Zinc in sea water: an overview 1975. In "The nature of sea water", E.D. Goldberg (ed.) Physical and Chemical Science Report 1, Dahlem Workshop, Berlin, pp. 43-68.
- 40) BERNHARD M. and ZATTERA A., 1975 - I maggiori contaminanti dell'ambiente marino. Estratto da Ingegneria Ambientale - Inquinamento e depurazione n. 3, pp. 186-287.
- 41) BERNHARD M. and ZATTERA A., 1975 - Radiotracer experiments with phytoplankton. In "Design of Marine Radioecological Experiments", IAEA, Technical Reports series N. 167, Vienna, pp. 35-62.
- 42) BERNHARD M. and ZATTERA A., 1976 - The role of chemical speciation in the uptake and loss of elements by marine organisms. Presented at the Symposium "Interaction between water and living matter". G.G. Polikarpov (Ed.), September 1975, Odessa.

- 43) BERNHARD M. and ZATTERA A., 1975 - Major pollutants in the marine environment. In: Proc. 2nd Intern. Congr. on Marine Contamination and Disposal of Wastes into the Sea, ed. by Jenkins, pp. 195-300, Pergamon Press, Oxford.
- 44) BIGAZZI G. and FORNACA-RINALDI G., in press - La méthode de "trace de fission" pour la mesure de la concentration d'uranium dans l'écosystème marin. (XXVI CIESM, Antalya, 1978). Rapp. Comm. int. Mer Médit. 25-26.
- 45) BOISSON M., HUGUES G. and RAPPAIRE G.L., 1977 - Activité en radiocarbone de l'eau de mer Ligure (1975); résultats préliminaires. Rapp. Comm. int. Mer Médit. 24, 3, pp. 45-47.
- 46) BONFANTI G., 1977 - Determinazione di radionuclidi gamma emettitori ricaduti a Segrate (Milano) nel triennio 1974-1976. Rapporto CISE-N-184.
- 47) BOVARD P., GRAUBY A. and FRAIZIER A., 1977 - Les transferts radioactifs: enseignement tirés de l'observation in situ. 7e Colloque International d'Océanographie, Nice.
- 48) BOVARD P. and GUEGUENIAT P., 1978 - Application de techniques nucléaires à l'étude de l'environnement marin. Colloque de l'Union des Océanographes de France, Brest.
- 49) BOVARD P. and GRAUBY A., 1977 - Bilan des recherches sur les transferts dans le milieu naturel. IVE Congrès International I.R.P.A., Paris, pp. 263-265.
- 50) BOWEN V.T., LIVINGSTON H.D. and BURKE J.C., 1976 - Distributions of transuranium nuclides in sediment and biota of the North Atlantic Ocean. In: Transuranium Nuclides in the Environment, pp. 107-120 (IAEA, Vienna).
- 51) BOWEN V.T., 1976 - Distributions of transuranic nuclides in the oceans; possibilities for their cycling. In: International Union of Geodesy and Geophysics Proces-Verbaux No. 14. IAPSO XVI General Assembly at Grenoble, France, August-September 1975, pp. 143-144 (abstract).

- 52) BOWEN V.T., 1976 - Report of transport and dispersion panel. In: Proceedings of the Workshop, November 12-14, 1975. Battelle Seattle Research Center, Seattle, Washington (ERDA-76/134) pp. 50-62.
- 53) BOWEN V.T., 1977 - Radioecology and Energy Resources. Proc. of the Fourth National Symposium on Radioecology, May 12-14, 1975. (A Review). In: The Quarterly Review of Biology 52 (3), 320.
- 54) BOWEN V.T., 1978 - Natural matrix standards. Environment International 1, pp. 35-39.
- 55) BOWEN V.T. and LIVINGSTON H.D. - Radionuclide distributions in sediments of marine areas used for dumping solidified radioactive wastes. To be submitted to Marine Pollution Bulletin.
- 56) BOWEN V.T. and BURKE J.C. - The sea bottom in the OECD/NEA solid waste dumping site. To be submitted to Marine Pollution Bulletin.
- 57) BOWEN V.T., 1976 - Non-USA disposal of radioactive waste in the oceans: past and ongoing. Testimony presented at Subcommittee on Energy and the Environment, Washington, D.C., July 1976.
- 58) BRANICA M., 1977 - Sea Research in the Frame of "The Project of the Protection of Human Environment" in the Yugoslavia Adriatic Region. III Journées Etude Pollutions (XXV CIESM, Split 1976).
- 59) BRANICA M., BERNHARD M. and PIRO A., 1975 - Zinc in sea water: determination of physical chemical states of zinc in sea water. Marine Chemistry (in press).
- 60) CHERRY R.D., HIGGO J.J.W. and FOWLER S.W., 1978 - Zooplankton faecal pellets and element residence times in the ocean. Nature, Vol. 274, pp. 246-248.
- 61) CHERRY R.D., FOWLER S.W., BEASLEY T.M. and HEYRAUD M., 1975 - Polonium-210: its vertical oceanic transport by zooplankton activity. Marine Chemistry, 3, 2, pp. 105-110.

- 62) CHESSELET R., 1975 - Deep ocean suspended matter chemistry. *Thalassia Jugosl.* 11, 1/2, 135.
- 63) CORTECCI G., NOTO P. and OZTURGUT E., 1976 - Tritium profiles in the Eastern Mediterranean basin. *Rapp. Comm. int. Mer Médit.*, 23, 7, pp. 85-86.
- 64) CROSS F.A., RENFRO W.C. and GILAT E., 1975 - A review of methodology for studying the transfer of radionuclides in marine foodchains. In "Design of Radiotracer Experiments in Marine Biological Systems". IAEA - Technical Reports Series No. 167, pp. 185-210, Vienna.
- 65) DANIS A., in press - On the nature and distribution of the fissionable element impurities in minerals and soils. 9th Intern. Conf. on Solid State Nuclear Track Detectors, München, 1976.
- 66) DANIS A., in press - Several considerations on radio-colloidal and pseudo-radiocolloidal state of the fissionable element solutions. 9th Intern. Conf. on Solid State Nuclear Track Detectors, München, 1976.
- 67) DANIS A. and VOLJIN V., 1977 - Détermination de la teneur de l'uranium dans les échantillons de sédiments et d'eaux marines par la méthode des traces de fragments de fission. *Rapp. Comm. int. Mer Médit.* 26, 3, pp. 69-71.
- 68) DANIS A. and VOLJIN V., 1978 - Determination of Uranium Content in Marine Samples using the Solid State Track Detector. *Journal Nuclear Track Detection*, Pergamon Press.
- 69) DELLE SITE A., IANELLI S., MARCHIONNI V., TRIULZI C., in press - Preliminary results on $^{239+40}\text{Pu}$ and ^{238}Pu in some environmental samples of the Taranto Gulf (XXVI CIESM) *Rapp. Comm. int. Mer Médit.* 25-26.
- 70) DONAGHAY P.L. and SMALL L.F., in press - Food selection capabilities of an Estuarine copepod, *Acartia clausi*. *Mar. Biol.*
- 71) DUURSMA E.K., 1975 - Radioactive tracers in estuarine chemical studies. In: *Estuarine Chemistry*, J.D. Burton and P.G. Liss (Eds.) London Academic Press (in press).

- 72) DUURSMA E.K., 1976 - Role of pollution and pesticides in brackishwater fish and shrimp culture in Indonesia. FAO Fish. Techn. Paper, (in press).
- 73) DUURSMA E.K., DAWSON R. and ROS VICENT J., 1975 - Competition and time of sorption by various radionuclides and trace metals by marine sediments and diatoms. *Thalassia Jugosl.* 11, 1/2, 47.
- 74) DUURSMA E.K. and PARSI P., 1976 - Distribution of plutonium-237 between sediment and sea water. *Rapp. Comm. int. Mer Médit.*, 23, 7, pp. 159-160.
- 75) DULIU O., VOLJIN V., in press - The EPR investigation of the sorption process by the marine sediments. (XXVI CIESM, Antalya 1978) *Rapp. Comm. int. Mer Médit.* 25-26.
- 76) EDWARDS L.L. and OREGIONI B., 1975 - Extraction and concentration of copper by anodic stripping from a mercury thin film electrode. *Anal. Chem.* 47, 2315.
- 77) EDWARDS L.L. and OREGIONI B., in press - Mercury thin film electrodeposition techniques for flameless atomic absorption. Determination of copper in sea water. *Rapp. Comm. int. Mer Médit.* 23, 7, pp. 59-60.
- 78) ELDER D.L., FOWLER S.W. and POLIKARPOV G.G., in press - Remobilization of Sediment-associated PCBs by the worm *Nereis diversicolor*. *Bull. Environ. Contam. & Toxicology*.
- 79) ELDER D.L. and VILLENEUVE J.P., 1977 - Polychlorinated biphenyls in the Mediterranean Sea. *Mar. Poll. Bull.*, 8, 1.
- 80) ELDER D.L., 1976 - Polychlorinated biphenyls in N.W. Mediterranean coastal waters. *Mar. Poll. Bull.*, 7, 4.
- 81) ELDER D.L. and FOWLER S.W., 1977 - Polychlorinated biphenyls: penetration into the deep ocean by zooplankton faecal pellet transport. *Science*, 197 No. 4302, pp. 459-461.
- 82) ELDER D.L., FOWLER S.W. and POLIKARPOV G., in press - Remobilization of Sediment-associated PCBs by the worm *Nereis diversicolor*. *Bull. Environ. Contam. and Toxicology*.

- 83) FARMER J.G., BOWEN V.T., NOSHKIN V.E. and GAVINI M.B., 1976 - Long-lived artificial radionuclides in Lake Ontario. I. Supply from fallout, and concentrations in lake water, of plutonium, americium, strontium 90 and cesium 137. Submitted to Limn. & Oceanogr.
- 84) FOWLER S.W., POLIKARPOV G.G., ELDER D.L., PARSI P., VILLENEUVE J.P., 1978 - Polychlorinated biphenyls: Accumulation from contaminated sediments and water by the polychaete *Nereis diversicolor*. Mar. Biol. 48, 303-309.
- 85) FOWLER S.W. and BENAYOUN G., 1976 - Influence of environmental factors on selenium flux in two marine invertebrates. Mar. Biol. 37, 59-68.
- 86) FOWLER S.W. and BENAYOUN G., 1976 - Selenium kinetics in marine zooplankton. Mar. Science Comm. 2, 1.
- 87) FOWLER S.W. and BENAYOUN G., 1976 - Accumulation and distribution of selenium in mussel and shrimp tissues. Bull. Environ. Contam. Toxic. 16, 3.
- 88) FOWLER S.W. and BEASLEY T.M., 1977 - Plutonium and americium in fish. Nature, 265 No. 5592, pp. 384.
- 89) FOWLER S.W. and GUARY J.C., 1977 - High absorption efficiency of ingested plutonium in crabs. Nature, 266 No. 5605, pp. 827-828.
- 90) FOWLER S.W. and ELDER D.L., 1978 - PCB and DDT residues in a Mediterranean pelagic food chain. Bull. Environ. Toxicol. vol. 19, No. 2, pp. 244-249.
- 91) FOWLER S.W., GUARY J.C., HEYRAUD M. and LA ROSA J., 1977 - Assimilation of plutonium in selected marine invertebrates. Rapp. Comm. int. Mer Médit., 24, 3, pp. 19-22.
- 92) FOWLER S.W. and HEYRAUD M., 1976 - Flux of plutonium through Marine Biota. Rapp. Comm. int. Mer Médit., 23, 7, pp. 161-162.

- 93) FOWLER S.W., HEYRAUD M. and BEASLEY T.M., 1975 - Experimental studies on plutonium kinetics in marine biota. In: Impacts of Nuclear Releases into the Aquatic Environment, pp. 157-177, IAEA, Vienna.
- 94) FOWLER S.W., 1977 - Trace elements in zooplankton particulate products. *Nature*, Vol. 269 No. 5623, pp. 51-53.
- 95) FOWLER S.W., LA ROSA J., HEYRAUD M. and RENFRO W.C., 1976 - Effect of different radiotracer labelling techniques on radionuclide excretion rates in marine organisms. *Rapp. Comm. int. Mer Médit.*, 23, 7, pp. 125-126.
- 96) FOWLER S.W., LA ROSA J., HEYRAUD M. and RENFRO W.C., 1975 - Effect of different radiotracer labelling techniques on radionuclide excretion from marine organisms. *Marine Biol.* 38, 297-304.
- 97) FOWLER S.W. and OREGIONI B., 1976 - Trace metals in mussels from the N.W. Mediterranean. *Mar. Pollut. Bull.* 7 (2), pp. 26-29.
- 98) FOWLER S.W. and SMALL L.F., 1975 - Procedures involved in radioecological studies with marine zooplankton. In: "Design of Radiotracer Experiments in Marine Biological Systems". *Tech. Rep. Ser. N. 167*, pp. 63-84, IAEA, Vienna.
- 99) FOWLER S.W., HEYRAUD M. and LA ROSA J., 1978 - Factors Affecting Methyl and Inorganic Mercury Dynamics in Mussels and Shrimp. *Mar. Biol.* 46, (3), pp. 267-276.
- 100) FRAIZIER A. and GUARY J.C., 1976 - Recherche d'indicateurs biologiques appropriés au contrôle de la contamination du littoral par le plutonium. In: "Transuranium nuclides in the environment". IAEA, Vienna, 679-689.
- 101) FRAIZIER A. and GUARY J.C., 1977 - Diffusion du plutonium en milieu marin: étude quantitative effectuée sur des espèces marines du littoral de la Manche, de Brest (Pointe St. Mathieu) à Honfleur. *Rapport CEA-R.4822*, 16 pages, and in "Proc. of the IVth International Congress of the International radiation protection association" Paris, 24-30 avril 1977, Vol. 2, 247-250.

- 102) FRAIZIER A., MASSON M. and GUARY J.C., 1977 - Recherches préliminaires sur le rôle des aérosols dans le transfert de certains radioéléments du milieu marin au milieu terrestre. *Journal de recherches atmosphériques* 1, 49-60.
- 103) FRIGNANI M., FRASCARI F., GIORDANI P., GUERZONI S., MARABINI F. and POLETTI R., 1976 - Heavy metal distribution related to sedimentological features in bottom sediments of the Adriatic sea between Ancona and Po river delta. *III Journées Etud. Pollutions*, pp. 81-83, Split (CIESM).
- 104) FUKAI R., BALLESTRA S. and MURRAY C.N., 1976 - Preliminary results of intercalibration of radionuclide measurements on a large volume seawater sample. *Rapp. Comm. int. Mer Médit.*, 23, 7, pp. 151-152.
- 105) FUKAI R., BALLESTRA S. and VAS B.D., in press - Distribution of Cesium-137 in the Mediterranean Sea. A preliminary report (XXVI CIESM, Antalya 1978) *Rapp. Comm. int. Mer Médit.*, 25-26.
- 106) FUKAI R. and HUYNH-NGOC L., 1975 - Chemical forms of zinc in sea water - problems and experimental methods. *J. Oceanogr. Soc., Japan*, Vol. 31, 179-191.
- 107) FUKAI R. and HUYNH-NGOC L., 1975 - Copper, zinc and cadmium in coastal waters of the northwestern Mediterranean. *Mar. Pollut. Bull.*, 7, 9.
- 108) FUKAI R. and HUYNH-NGOC L., 1976 - Direct determination of mercury in sea water by anodic stripping voltametry with a graphite electrode. *Anal. Chem. Acta* 83, 375.
- 109) FUKAI R. and HUYNH-NGOC L., 1976 - Distribution of some heavy metals in the waters along the French coast of the Mediterranean. *Rapp. Comm. int. Mer Médit.* 23, 7, pp.49-50.
- 110) FUKAI R. and MURRAY C.N., 1975 - Results of plutonium intercalibration in seawater and seaweed samples. *Tech. Rep. N. 169*, IAEA, Vienna, p. 107.
- 111) FUKAI R. and MURRAY C.N., in press - Results of plutonium intercalibration and seaweed samples. *Reference Methods*

for Marine Radioactivity Studies. Determination of Transuranic Elements and some other Radionuclides in Marine Environmental Samples. IAEA Tech. Report N. 169.

- 112) FUKAI R., OREGIONI B. and VAS D., 1978 - Interlaboratory Comparability of Measurements of Trace Elements in Marine Organisms: Results of the Intercalibration Exercise on Oyster Homogenate. *Oceanol. Acta*, Vol. 1, 391-396.
- 113) FUKAI R., STATHAM G. and ASARI K., 1976 - A rapid method for strontium-90 analysis by HDEHP solvent extraction: application to large volume sea water samples. *Rapp. Comm. int. Mer Médit.* 23, 7, pp. 149-150.
- 114) FUKAI R., BALLESTRA S. and HOLM E., 1976 - Am-241 in Mediterranean surface waters. *Nature*, 264, pp. 739-740.
- 115) GALLI C. and ZATTERA A., in press - Accumulation of caesium by some marine phytoplankters. (XXVI CIESM, Antalya 1978) *Rapp. Comm. int. Mer Médit.*, 25-26.
- 116) GEORGESCU I.I., 1976 - Instrumental neutron activation analysis and chemical composition of the sediments collected at 30 m and 200 m depth on the floor of the Black Sea. *Rapp. Comm. int. Mer Médit.* 23, 7, pp. 87-88.
- 117) GEORGESCU I.I., BARB D. and DIAMANDESCU L., 1976 - Mössbauer Spectroscopy applied to the study of some sediment samples from the Black Sea. *Rapp. Comm. int. Mer Médit.*, 23, 7, pp. 37-38.
- 118) GEORGESCU I.I., BARB D., DIAMANDESCU L., MORARIU M. and DEMETRESCU M., 1977 - Chemical and Mössbauer analysis of some sediment samples of the Romanian shore. *Rapp. Comm. int. Mer Médit.* 24, 3, pp. 95-97.
- 119) GEORGESCU I.I., CIOVICA N., DEMIAN N., BUTUCEANU E. and BARAN Gh., 1977 - Experimental research concerning the radionuclides transport in Danube river delta. *Rapp. Comm. int. Mer Médit.*, 24, 3, pp. 49-50.

- 120) GEORGESCU I.I., DEMIAN N. and BUTUCEANU E., 1977 - On the radioactivity of water and sediments collected in Danube river delta and Romanian Black Sea shore. Rapp. Comm. int. Mer Médit., 24, 3, pp. 47-48.
- 121) GEORGESCU I.I., SALAGEAN M. and LUPAN S., 1976 - On the identification of some neutron induced nuclides in Black Sea water. Rapp. Comm. int. Mer Médit., 23, 7, pp. 157-158.
- 122) GEORGESCU I.I., SALAGEAN M. and LUPAN S., 1976 - Instrumental neutron activation analysis and chemical composition of the sediments collected at 200 m depth on the floor of the Black Sea. Rapp. Comm. int. Mer Médit., 23, 7, pp. 87-88.
- 123) GEORGESCU I.I., SALAGEAN M. and MANOLESCU L., 1976 - Sur la radioactivité artificielle de la région lagunaire du Razelm jusqu'au Sud du port Constanza de la mer Noire. Rapp. Comm. int. Mer Médit., 23, 7, pp. 165-166.
- 124) GEORGESCU I.I., DEMIAN N., BUTUCEANU E. and BANU C., 1978 - On the radioactivity of Danube water and sediments during 1977. Rev. Roum. Phys., Vol. 23, N. 6, pp. 653-659.
- 125) GEORGESCU I.I., FLOREA J. and BARAN GH., 1978 - Distribution of ten artificial radionuclides in the cross section of the Danube river, at mile 34 during 1976. Rev. Roum. Sci. Techn. Méc. Appl., Vol. 23, N. 6, pp. 953-960.
- 126) GEORGESCU I.I., BARB D., DIAMANDESCU L., MORARIU M. and DEMETRESCU M., 1977 - Chemical and Mössbauer analyses of some sediment samples of the Romanian shore. Thalassia Jugosl. 13, pp. 173-178.
- 127) GHERSINI G., 1976 - Ricerca e messa a punto di metodologie per la determinazione della radioattività artificiale nell'ambiente. Atti del Convegno "Metodologie Analitiche Avanzate", SCI, Roma (29 settembre-1 ottobre 1976), 87-89.
- 128) GILAT E. and SHAFRIR N.H., 1975 - Kinetics of passage of radioelements through subtropical marine environment and biota influencing the human food chain. Rep. to Public

- Health Service, U.S. Government, Research contract: BDPEC--RH-IS-1, 161 pp., Technion, Haifa.
- 129) GILAT E., 1975 - The accumulation of radionuclide zinc-65 in benthic marine Invertebrates. Proc. of the Sixth Sci. of the Israel Ecological Society, Tel-Aviv, pp. 96-104.
- 130) GILAT E., LAICHTER Y. and SHAFRIR N.H., 1975 - Behaviour of caesium-137 in the marine environment. In "Impacts of Nuclear Releases into Aquatic Environment". IAEA-SM-198:18 pp. 63-67, Vienna.
- 131) GILAT E., in press - Research activities in marine radioecology (XXVI CIESM, Antalya 1978) Rapp. Comm. int. Med. Médit., Vol. 25-26.
- 132) GOLDBERG, EDWARD D., BOWEN V.T., FARRINGTON W.J., HARVEY G., MARTIN J.H., PARKER P.L., RISEBROUGH R.W., ROBERTSON W., SCHNEIDER E. and GAMBLE E., 1978 - The Mussel Watch. Environmental Conservation 5(2) pp. 1-25.
- 133) GUARY J.C. and FOWLER S.W., in press - Uptake from water & tissue distribution of Neptunium-237 in Crabs, Shrimp and Mussels. Mar. Pollut. Bull.
- 134) GUARY J.C. and FOWLER S.W., 1977 - Biokinetics of ^{237}Np in mussels and shrimp. Mar. Sci. Commun. Vol. 3(3) pp. 211-229.
- 135) GUARY J.C. and FOWLER S.W., 1977 - Accumulation et rétention de ^{237}Np chez deux invertébrés marins. Rapp. Comm. int. Mer Médit., 24, 3, pp. 27-31.
- 136) GUARY J.C. and FOWLER S.W., in press - Elimination et répartition du ^{241}Am et du ^{237}Pu chez la moule *Mytilus galloprovincialis* dans son environnement naturel (XXVI CIESM, Antalya 1978). Rapp. Comm. int. Mer Médit., Vol. 25-26.
- 137) GUARY J.C., MASSON M. and FRAIZIER A., 1976 - Etude préliminaire, in situ de la distribution du plutonium dans différents tissus et organes de *Cancer pagurus* (Crustacea:Decapoda) et de *Pleuronectes platessa* (Pisces:Pleuronectidae), Marine Biology, Vol. 36, n. 1, pp. 13-17.
- 138) GUARY J.C. and FRAIZIER A., 1977 - Etude comparée des teneurs en plutonium chez divers mollusques de quelques sites littoraux français. Marine Biology, 41, 263-267.

- 139) GUARY J.C. and FRAIZIER A., 1977 - Influence of trophic level and calcification on the uptake of plutonium observed, in situ, in marine organisms. *Health Phys.*, 32, pp. 21-18.
- 140) GUEGUENIAT P., 1976 - Rôle des paramètres physico-chimiques dans la contamination expérimentale de sédiments marins par le ^{60}Co . *Rapp. Comm. int. Mer Médit.*, 23, 7, pp. 137-139.
- 141) GUEGUENIAT P., BARON Y. and AUFFRET J.P., 1976 - Note sur l'évolution de la radioactivité artificielle dans les sédiments de la Manche pendant les années 1971-1975 (Rapport CEA) R-4739.
- 142) GUEGUENIAT P., CARBONIE M. and GERMAIN P., 1976 - Contamination de sédiments marins par le ^{137}Cs en fonction de leur composition en argiles et en carbonates. *Rapp. Comm. int. Mer Médit.*, 23, 7, pp. 133-135.
- 143) GUEGUENIAT P., GANDON R., HEMON G. and PHILIPPOT J.Cl., 1976 - Méthodes de mesures d'éléments à l'état de traces dans l'eau de mer par activation neutronique et absorption atomique. Cas particulier des isotopes stables de produits de fission. Colloque International sur l'étude des techniques nucléaires pour la détection des polluants, IAEA, pp. 369-382.
- 144) GUEGUENIAT P., 1977 - Etude du transfert des radionucléides dans l'eau et les sédiments marins. *Bull. Inf. Sc. et Tech.*, 222, pp. 17-23.
- 145) GUEGUENIAT P. and GANDON R., 1977 - Le Ruthénium. Cas particulier du devenir d'un radionucléide dans le milieu marin. *Ive Congrès International I.R.P.A. Vol. 2*, pp. 257-258.
- 146) GUEGUENIAT P., GANDON R. and LUCAS Y., 1975 - Determination of radionuclides of Ce, Co, Fe, Ru, Zn and Zr in seawater by preconcentration of colloidal manganese dioxide. Application to the determination of low-level ruthenium 106. In: "Reference methods for marine radioactivity studies II." IAEA, Technical Reports Series n. 169, pp. 137-145.
- 147) GUEGUENIAT P., GRAUBY A., GANDON R. and BARON Y., 1977 - Etude de quelques aspects du comportement de l'Antimoine 125 et de son isotope stable dans le milieu marin. *Rapp.*

Comm. int. Mer Médit., 24, 3, pp. 55-59.

- 148) GUEGUENIAT P., AUFFRET J.P. and BARON Y., in press - Etude de la répartition des radionucléides artificiels dans les sédiments littoraux de la Manche et de la Mer du Nord pendant les années 1976-77. Oceanologica Acta.
- 149) HADZISTELIOS I. and PAPADOPOULOU C., 1977 - Radiochemical determination of Europium by GeLi detector in biological tissues. J. of Radioanalytical Chemistry, Vol. 36, pp. 427-434.
- 150) HARDY E.P., LIVINGSTON H.D., BURKE J.C. and VOLCHOK H.L., 1978 - Time pattern of off-site plutonium contamination from Rocky Flats Plant by lake sediment analyses. U.S. Dept. of Energy, Environmental Quarterly Report EML-342, pp. I-123-I-146.
- 151) HEYRAUD M., FOWLER S.W., BEASLEY T.M. and CHERRY R.D., 1976 - Distribution of ^{210}Po in marine zooplankton. Rapp. Comm. int. Mer Médit., 23, pp. 123-124.
- 152) HEYRAUD M., FOWLER S.W., BEASLEY T.M. and CHERRY R.D., 1976 - ^{210}Po in euphausiids: A detailed study. Mar. Biol. 34 (2), pp. 127-136.
- 153) HIGGO J.J.W., CHERRY R.D., HEYRAUD M. and FOWLER S.W., 1977 - Rapid removal of plutonium from the oceanic surface layer by zooplankton faecal pellets. Nature, 266, No. 5603, pp. 623-624.
- 154) HOLM E. and FUKAI R., 1977 - A method for multi-element alpha-spectrometry of actinides and its applications to environmental radioactivity studies. Talanta, Vol. 24, pp. 659-664.
- 155) HOLM E. and PERSSON R.B.R., in press - Pu-241 in Swedish raindeer lichens by a radiochemical procedure. Health Physics.
- 156) HOLM E. and PERSSON R.B.R., 1977 - Pu-241 and Am-241 in the environment. 4th Meeting IRPA 25-29 Apr. 1977 Paris.
- 157) HOPPENHEIT M. and MURRAY C.N., in press - Some Observations on the Uptake and Effects of Americium 241 on a Brackish-Water Amphipod. (XXVI CIESM. Antalia 1978). Rapp. Comm. int. Mer. Médit. Vol. 25-26.

- 158) IANELLI S. and TRIULZI C., 1977 - Elettrodeposizione di Th, U, Pu a livello di campioni ambientali. Atti del XX Congr. Naz. AIFSPR, 161-168.
- 159) IORGULESCU A., IORGULESCU St. and ROGALSKI I., 1976 - The radioactivity of the lower Danube between 1970-1974. Rapp. Comm. int. Mer Médit., 23, 7, p. 167.
- 160) IZUMO Y., ANCELLIN J., GUEGUENIAT P. and FRAIZIER A., 1977 - Données sur le transfert en milieu marin du ruthénium par voie alimentaire. Rapp. Comm. int. Mer Médit., 24, 3, pp. 33-36.
- 161) JELISAVCIC O., 1977 - Effects of elevated concentrations of Ca, Zn and Cd in sea water on the accumulation of ^{137}Cs in *Mytilus galloprovincialis* Lam. Rapp. Comm. int. Mer Médit. 24, 3, pp. 23-26.
- 162) JENNINGS C.D., 1977 - Vertical distribution of ^{55}Fe in the Ocean. Rapp. Comm. int. Mer Médit., 24, 3, pp. 51-54.
- 163) KECKES S., 1975 - Techniques for evaluating lethal and sub-lethal effects of pollutants that occur in the marine environment. Proc. GESAMP V, Doc. 2/3, 5.
- 164) KUPFERMAN S.L. and LIVINGSTON H.D., in press - A procedure for independently estimating blanks and uncertainties of measured values of ^{90}Sr and ^{137}Cs concentrations in the Atlantic Ocean. Submitted to J. Marine Res.
- 165) KUPFERMAN S.L., LIVINGSTON H.D. and BOWEN V.T., in press - A mass balance for ^{137}Cs and ^{90}Sr in the North Atlantic Ocean. Submitted to J. Marine Res.
- 166) KUPFERMAN S.L. and BOWEN V.T., 1977 - Comparison of ^{137}Cs concentrations measured after in situ absorption with those determined by bulk water analyses or calculated from ^{90}Sr analyses. Limn. & Oceanogr. 21(3): 467-473.
- 167) KUPFERMAN S.L., LIVINGSTON H.D., BOWEN V.T. and AARKROG A., in press - Radioactive effluent from Windscale as a perturbation of the fallout tracer experiment in the North Atlantic Ocean. Submitted to J. Marine Res.

- 168) KUZMIC M., JEFTIC Lj. and POLICASTRO A.J., 1977 - Modelling of Jet-Type surface thermal discharge at Urinj site. Rapp. Comm. int. Mer Médit., 24, 3, pp. 83-84.
- 169) LABEYRIE J., LALOU C., MONACO A. and THOMMERET J., 1976 - Chronologie des niveaux eustatiques sur la côte du Languedoc de -33.000 ans B.P. à nos jours. Comptes Rendus de l'Académie des Sciences, Paris, t. 282, série D, pp. 349-352.
- 170) LABEYRIE L.D., LIVINGSTON H.D. and BOWEN V.T., 1976 - Comparison of the distributions in marine sediments of the fallout derived nuclides ^{55}Fe and $^{239, 240}\text{Pu}$: a new approach to the chemistry of environmental radionuclides. In Transuranium Nuclides in the Environment, pp. 121-137 (IAEA, Vienna).
- 171) LAICHTER Y., 1973 - Low level gamma spectrometry for the detection of the passage of radionuclides in the marine environment. Technion-Ph.D. Thesis, 116 pp. (in Hebrew).
- 172) LEWIS S.R. and SHAFRIR N.H., 1971 - Low level Ge(Li) gamma-ray spectrometry in marine radioactivity studies. Nuclear Instruments and Methods. Vol 93, pp. 317-332.
- 173) LAPICQUE G., 1977 - Measurement Methods in Sea Water and Organisms. VII International Colloquium on Medical Oceanography. Measurement of radioactive contamination of the Sea. CERBOM.
- 174) LAPICQUE G., 1977 - Presentation d'une formulation generale de calcul du rendement d'une sonde pour la detection "in situ" d'un émetteur gamma en milieu infini. Rapp. Comm. int. Mer Médit., 24, 3, pp. 61-64.
- 175) LAPICQUE G., in press - Evaluation du taux de disparition d'un polluant soluble ou d'un traceur dans un estuaire sans courant de marée (XXVI CIESM, Antalya 1978) Rapp. Comm. int. Mer Médit. Vol. 25-26.
- 176) LA ROSA J., 1976 - A simple system for recovering zoo-plankton fecal pellets in quantity. Deep-Sea Res., 23, pp. 995-997.
- 177) LEGOVIC T., KUZMIC M., JEFTIC Lj. and PATTEN B.C., 1977 -

- A Model of the Adriatic Regional Ecosystem (MARE). Rapp. Comm. int. Mer Médit., 24, 3, pp. 79-81.
- 178) LIVINGSTON H.D., BOWEN V.T. and BURKE J.C., 1977 - Fallout radionuclides in Mediterranean sediments. Rapp. Comm. int. Mer Médit. 24, 3, pp. 37-40.
- 179) LIVINGSTON H.D., CASSO S.A., BOWEN V.T., BURKE J.C., in press - Soluble and Particle-Associated Fallout Radionuclides in Mediterranean Water and Sediments (XXVI CIESM, Antalya 1978) Rapp. Comm. int. Mer Médit. Vol. 25-26.
- 180) LIVINGSTON H.D. and BOWEN V.T., 1976 - Contrasts between the marine and freshwater biological interactions of plutonium and americium. U.S. Energy Research and Develop. Admin., HASL Environmental Quarterly, HASL-315, pp.I-157 - - I-172.
- 181) LIVINGSTON H.D. and BOWEN V.T., 1976 - In Environmental Toxicity of Aquatic Radionuclides: Models and Mechanisms. Americium in the marine environment - relationships to plutonium. Morton V. Miller and J. Newell Stannard, Editors. (Ann Arbor Science Publishers) pp. 107-130.
- 182) LIVINGSTON H.D. and BOWEN V.T., 1977 - Windscale effluent in the waters and sediments of the Minch. Nature 269: 586-588.
- 183) LIVINGSTON G.D. and BOWEN V.T., in press - Plutonium and ^{137}Cs distribution patterns in coastal sediments of the Northwest Atlantic Ocean. Earth and Plan. Sci. Letters.
- 184) MANGIA A., MEZZADRI M.G. and TRIULZI C., 1977 - Th, U and Pu isotopes in the upper layer sediment of the Taranto Gulf (Ionian Sea). Rapp. Comm. int. Mer Médit., 24, 3, pp. 41-44.
- 185) MANGINI A. and SIGL W., 1977 - Allogenic uranium in Ionian-Sea sapropels. Rapp. Comm. int. Mer Médit, 24, 3, pp. 75-77
- 186) MARCHAND M., VAS D. and DUURSMA E.K., 1976 - Levels of PCBs and DDTs in mussels from the N.W. Mediterranean Coast. Mar. Poll. Bull. 7, 4.

- 187) MEZZADRI M.G. and TRIULZI C., 1976 - On the ^{90}Sr carried by the Po river into the North Adriatic Sea in the 1962-1972 period. Rapp. Comm. int. Mer Médit., 23, 7, pp. 169-171.
- 188) MLADINIC G., 1977 - Dynamic of Oxygen exchanges through the sea surface. Rapp. Comm. int. Mer Médit., 24, 3, pp. 99-102.
- 189) MURRAY C.N. and FUKAI R., 1975 - Absorption-desorption characteristics of plutonium and americium with sediment particles in the estuarine environment. Studies using plutonium-237 and americium-241. Impacts of Nuclear Releases into the Aquatic Environment. IAEA, Vienna, p. 179.
- 190) MURRAY C.N. and MEINKE S., 1976 - Influence of soluble sewage material on adsorption desorption behaviour on cadmium, silver and zinc sediment/freshwater/sediment-sea water systems. Journal Oceanogr. Soc. Japan.
- 191) MURRAY C.N. and FUKAI R., 1975 - Reference Methods for Marine Radioactivity Studies. II - Determination of Transuranic Elements; Radioruthenium and some Other Radionuclides in Marine Environmental Samples. IAEA Technical Report n. 169.
- 192) MURRAY C.N. and AVOGADRO A., 1978 - Effect of a Long-Term Release of Plutonium and Americium into an Estuarine-Coastal Ecosystem. II - Chemical Speciation and Environmental Factors. (XXVI CIESM, Antalya 1978) Rapp. Comm. int. Mer Médit. Vol. 25-26.
- 193) MURRAY C.N., MURRAY L. and RILEY J.P., in press - The freezing point lowering of seawater, Hanbook of Marine Sciences, ed. F.G.W. Smith.
- 194) MURRAY C.N. and STATHAM G., 1976 - Application of a Solvent Extraction Procedure Using Di-2-Ethylhexyl Phosphoric Acid (HDEHP) for the Separation of some Transuranic Elements in Environmental Samples. Deutsche Hydrographische Zeitschrift, 29.2, pp. 69-75.
- 195) MURRAY C.N. and RENFRO W., 1976 - Uptake of Plutonium from Seawater and Sediment by a Marine Polychaete Worm. J. Oceanogr. Soc. Japan 32.6, pp. 249-252.

- 196) MURRAY C.N. and KAUTSKY H., 1977 - Plutonium and Americium Activities in the North Sea and German Coastal Regions. *Estuar. Coast. Mar. Science*, 5, pp. 319-329.
- 197) MURRAY C.N. and EICKE H.F., 1977 - German Coastal Survey, a Comparison of the Distribution and Behaviour of Cesium and some Transuranic Isotopes. *Deutsche Hydrographische Zeitschrift*, 30, 1, pp. 1-8.
- 198) MURRAY C.N., HOPPENHEIT M. and RADE H., 1978 - Accumulation of ^{243}Am in Selected Brackish and Marine Invertebrates. *Helgoländer Wiss. Meeresunters.*, 31, pp. 34-54.
- 199) MURRAY C.N., KAUTSKY H., HOPPENHEIT M. and DOMIAN M., 1978 - Actinide Activities in Water Entering the Northern North Sea. *Nature*, 276, pp. 225-230.
- 200) MURRAY C.N. and FUKAI R., 1978 - Environmental Measurements of $^{239+240}\text{Pu}$ in the Northern Mediterranean Sea. *Estuar. Coast. Mar. Science* 6, pp. 145-151.
- 201) MURRAY C.N. and AVOGADRO A., in press - Effect of a long Term Release of Plutonium and Americium into an Estuarine - Coastal Sea Ecosystem. I. Development of an Assessment Methodology Health Physics.
- 202) MURRAY C.N., KAUTSKY H. and EICKE H.F., in press - Transfer of Actinides from the English Channel into the Southern North Sea. *Nature*.
- 203) MUSANI L. and KONRAD Z., in press - The Interaction of ^{51}Cr and EDTA in Sea Water and NaCl Solutions. (XXVI CIESM, Antalya 1978) vol. 25-26.
- 204) MUSANI L., VALENTA P., NURNBERG H.W., KONRAD Z. and BRANICA M., in press - Interaction of some toxic metals and humic acid of marine sediment origin in sea water (XXVI CIESM, Antalya 1978) vol. 25-26.
- 205) MUSANI L. and KONRAD Z., 1977 - Interaction of ^{90}Sr - ^{90}Y and some other radionuclides with Na-alginate in sea water and 0,55 M NaCl solutions. *Rapp. Comm. int. Mer Médit.* 24, 8, pp. 77-80.

- 206) NISTOR C., VOLJIN V., FILOTI G. and SPINU V., 1978 - Analyse of Marine Samples using the Mössbauer Spectrometry (in russian). Presented on the 3rd Congress Application of Nuclear Physics Methods in Scientific and Technological Problems, Dubna (USSR).
- 207) PAPADOPOULOU C., KANIAS G.D. and MOIRATOPOLOU E., 1976 - Stable elements of radioecological importance in certain echinoderm species. Rapp. Comm. int. Mer Médit. 23, 7 pp. 81-83 and Marine Pollution Bull., August 1976.
- 208) PAPADOPOULOU C. and KANIAS G.D., 1977 - Tunicate species as marine pollution indicators. Marine Pollution Bulletin 1977, Vol. No. 10, pp. 229-231.
- 209) PAPADOPOULOU C. and MORAITOPOULOU-KASSIMATI E., 1977 - Stable elements in skeletal formations of fish species from Greek waters. Rapp. Comm. int. Mer Médit., 24, 3, pp. 65-68.
- 210) PAPADOPPULOU C. and HADZISTELIOS I., 1977 - Radiochemical determination of Europium and application of the method in marine samples. Rapp. Comm. int. Mer Médit., 24, 3, pp. 89-93.
- 211) PAPADOPOULOU C. and KANIAS G., 1976 - Trace element distribution in seven Mollusk species from Saronicos Gulf. Symp. on the Eastern Mediterranean, Acta Adriatica, XXVIII, n. 22, 367.
- 212) PAPADOPOULOU C., KANIAS G. and HADZISTELIOS I., 1976 - Radiochemical determination of Chromium in Biological materials by ion-exchange. Jour. of Radioanalytical Chem., Vol. 31, N. 2, pp. 389-396.
- 213) PAPADOPOULOU C. and KASSIMATI E., 1977 - Stable elements in skeletal formation of fish species from Greek Waters. Thalassia Yugoslavia, Vol. 13.
- 214) PAPADOPOULOU C., KANIAS G. and KASSIMATI E., 1978 - Zinc content in otoliths of Mackerel from the Aegean. Marine Pollution Bulletin Vol. 9, No. 4, pp. 106-108.
- 215) PAPADOPOULOU C. and HADZISTELIOS I., in press - Vanadium concentration factors of echinoderm species from Saronicos Gulf. (XXVI CIESM, Antalya 1978), Rapp. Comm. int. Mer Médit.

Vol. 25-26.

- 216) PARISI V., MEZZADRI M.G., BEDULLI D. and POLI P., 1977 - Thermal pollution studied by radioecological techniques. Rapp. Comm. int. Mer Médit., 24, (3): 85-88.
- 217) PARISI V. and MEZZADRI M.G., in press - Thermal pollution in brackish water environments: an experimental model. Ateneo Parmense, Acta nat., 15.
- 218) PERONI C.N., 1976 - Results about the transfer of ^{32}P to copepods through contaminated bacteria. Rapp. Comm. int. Mer Médit., 23, 7, pp. 143-144.
- 219) PESRET F., 1976 - Fixation de radionucléides sur des carbonates en milieu marin. Rapp. Comm. int. Mer Médit., 23, 7, pp. 131-132.
- 220) POKRIC B. and PUCAR Z., in press - Electrophoretic and Tyndallometric studies on the hydrolysis of Lead(II) in aqueous solutions. J. Inorg. Nucl. Chem.
- 221) POLI P., PARISI V., MEZZADRI M.G. and BEDULLI D., in press - Trophic behaviour and thermobiology of estuarine Molluscs in an experimental model. Part I: filtration activity in *Mytilus galloprovincialis*. Part II: exploratory activity in *Cyclope neritea*.
- 222) PIRAZZOLI P. and THOMMERET J., 1977 - Datations radiométriques d'une ligne de rivage à + 2,50 m, près de Aghia Roumeli, Crète, Grèce, C.R. Acad. Sc. Paris, 284, D, pp. 1255-1258.
- 223) PLANCHAIS N., PASQUIER L., COUR P. and THOMMERET J.Y., 1977 - Essai de Palynologie côtière appliquée au remplissage flandrien de Palavas (Hérault). C.R. Acad. Sc. Paris, 284, D, pp. 159-162.
- 224) POLIKARPOV G.G., 1978 - Effects of ionizing radiations on aquatic organisms (chronic irradiation). Alcuni Aspetti di Radioecologia. AIFSPR, XX Congresso nazionale, Bologna 1977, 25-46 (In English).
- 225) POLIKARPOV G.G., 1978 - Experimental methods for radioecological investigations with developing fish eggs. IAEA

- (Technical Report Series), 1977.
- 226) POLIKARPOV G.G., OREGIONI B., PARCHEVSKAYA D.S. and BENAYOUN G., 1978 - Body burden of chromium, copper, cadmium and lead in neustonic copepod *Anomalocera patersoni* (Pontellidae) collected from the Mediterranean. Paper submitted to Mar. Biol. Jour.
- 227) POLIKARPOV G.G., 1977 - Development of marine radiation hydrobiology. - *Gidrobiologicheskij zhurnal (USSR)*, vol. 13, No. 5, 57-66 (In Russian).
- 228) POLIKARPOV G.G., 1977 - La contamination radioactive des écosystèmes aquatiques. In: SFRP - Séminaire de radio-écologie, l'impact des installations nucléaires sur l'environnement, Cadarache, 31 janv. - 4 fév. 1977, S.I, SFRP, 5 p. (In French).
- 229) POLIKARPOV G.G., 1977 - Accumulation of radionuclides by hydrobionts and its consequences. In: *Okeanologia. Biologia okeana*, Vol. 2. *Biologicheskaya structura okeana*. M.E. Vinogradov, ed., Nauka, Moscow, 331-33 (In Russian).
- 230) POLIKARPOV G.G. and RISIK N.S., 1977 - Studies of processes of concentration and action of radioactive and chemical substances in marine hydrobiological systems. In: *Investigations of biological resources and their conservation in south seas*. Naukova dumka, Kiev, 58-63 (In Russian).
- 231) POLIKARPOV G.G. and RISIK N.S., 1977 - Radiochemoecology of the Black Sea. (*Radiokhemoekologia Chernogo morja*). Naukova dumka, Kiev, 231 pp. (In Russian).
- 232) POLIKARPOV G.G., ZESENKO A.Ja., EGOROV V.M. and NAZAROV O.B., 1976 - Radioecological principle of study of dynamics of suspended organic substance in pelagic zone of seas and oceans. *Visnik AN Ukr, RSR*, No. 12, 70-75 (In Ukrainian).
- 233) POLIKARPOV G.G., 1976 - Interaction between water and living matter (Symposium of the working subgroup of International Association of Geochemistry and Cosmochemistry in Odessa). *Visnik AN Ukr, RSR*, No. 5, 97-100. (In Ukrainian).

- 234) PUCAR Z., 1976 - Determination of stability constants by high voltage electrophoresis: radionuclide-sea water-complexing agent systems. *Thalassia Jugosl.* 7, pp. 153-155.
- 235) RAPAIRE J.L., BALLESTRA S. and FUNEL J.L., 1976 - Dépouillement per ordinateur de spectres gamma obtenus avec un détecteur Ge(Li). *Rapp. Comm. int. Mer Médit.* 23, 7, pp. 153-155.
- 236) RENFRO W.C. and BENAYOUN G., 1975 - Sediment worm interaction: transfer of ^{65}Zn from marine silt by the polychaete worm. *Nereis diversicolor*. 4th Nat. Symp. on Ecology Radioecol. (Corvallis) May 1975, pp. 271-276.
- 237) ROSVICENT J., COSTA YAGUE F., PARSI P., STATHAM G. and DUURSMA E.K., 1975 - The ease of release of some trace metals and radionuclides being sorbed for prolonged periods by marine sediments. *Bull. Inst. Esp. Oceanogr.*
- 238) A. SALTELLI, AVOGADRO A. and BERTOZZI G., 1979 - Assessment of Plutonium Chemical Forms in Groundwater. In CEC-NEA Workshop on the migration of Long-Lived Radionuclides in the Geosphere, Brussels, 29th-31st January 1979.
- 239) SCHULTE E.H., 1975 - The influence of algal concentration and temperature on the filter activity of *Mytilus edulis*. *Marine Biology*, 30, 331-341.
- 240) SCHULTE E.H., 1976 - The laboratory culture of the palaemonid prawn *Leander squilla* (L.). In: Proc. of the 10th European Symposium on Marine Biology. G. Persoone (Ed.), Sept. 1975, Ostende.
- 241) SCHULTE E.H., 1976 - Preliminary experiments on the uptake of Zn by *Leander squilla* larvae. *Rapp. Comm. int. Mer Médit.* 23, 7, p. 141.
- 242) SCHREIBER B., 1975 - Plankton and sediment; first and last step of the radioactivity diffusion in the Sea. *Ciência e Cultura*, 27, 197-206.
- 243) SCHREIBER B., DELLE SITE A. and TASSI PELATI L., in press - Plutonium isotopes determinations in some plankton and sea water samples around Italian coasts. Paper submitted to *Accad. Naz. dei Lincei* (Roma).

- 244) SCHREIBER B. and TRIULZI C., 1975 - Radioanalisi di substrati marini. Atti del Convegno "La determinazione di radionuclidi in campioni ambientali e materiali biologici", CNEN, Roma (1974), pp. 328-245.
- 245) SHAFRIR N.H, LAICHTER Y. and GILAT E., 1971 - Fast qualitative and quantitative determination of environmental radioactivity by Ge(Li) gamma spectrometry. In "Rapid Methods for Measuring Radioactivity in the Environment". IAEA-SM-148/63, pp. 291-300, Vienna.
- 246) SKRIVANIC A., 1977 - A contribution to chemical oceanography of the Adriatic Sea. Rapp. Comm. int. Mer Médit. 24, 8, pp. 81-83.
- 247) SKRIVANIC A., VUCAK Z. and NOZINA I., 1977 - A new aspect of marine Chemistry in relation to dynamics of the Adriatic Sea. Rapp. Comm. int. Mer Médit. 24, 8, pp. 85-88.
- 247) SIRBU M., 1976 - On the determination of alpha, beta and gamma activity of some biota of the Black Sea. Stud. Cerc. Fiz. 28, No. 10 pp. 1053-1056 (Translated from Romanian).
- 248) SCHNEIDER D.L., LIVINGSTON H.D. and BOWEN V.T., 1978 - Detection and measurement of curium in the marine environment. Presented at the Symposium on Analytical Methods in Oceanography, New England Regional Meeting, American Chemical Society June 1978.
- 249) STATHAM G. and MURRAY C.N., 1976 - Radiochemical separation of plutonium, americium and curium from environmental samples, by solvent extraction. Rapp. Comm. int. Mer Médit., 23, 7, pp. 163-164.
- 250) STROHAL P., 1975 - The determination of radionuclides in marine sample. Atti Convegno Determinazione di Radionuclidi in campioni ambientali e materiali biologici, CNEN, CSN Casaccia (Roma, 1974), pp. 300-312.
- 251) STROHAL P., HULJEV D., LULIC S. and PICER M., 1975 - Antimony in the marine environment. Estuarine and Coastal Marine Science, 3, pp. 119-123.

- 252) TASSI PELATI L., TRIULZI C. and VANNINI W., in press - Evoluzione delle ricadute radioattive a Parma da ottobre 1977 a febbraio 1979. Ateneo P.se, Acta naturalia.
- 253) TASSI PELATI L., TRIULZI C. and MEZZADRI M.G., 1975 - Radioattività nel Mare Mediterraneo, Ateneo P.se, Acta nat., 11, 171-179.
- 254) THOMMERET J., THOMMERE Y. and HUGUES G., 1976 - Quelques mesures de carbone-14 et de cesium-137 en mer Ligure. Rapp. Comm. int. Mer Médit., 23, 7, pp. 173-176.
- 255) THOMMERET J. and THOMMERET Y., 1978 - ^{14}C Datings of some Holocene sea levels on the North coast of the island of Java (Indonesia). Modern Quaternary research in Southeast Asia, 4, pp. 51-57. AA. Balkema Publishers, Rotterdam.
- 256) TOPCUOGLU S., 1976 - Accumulation and loss of ^{65}Zn in different fish species from the Küçük Cekmece lagoon. CNAEM-R-169.
- 257) TOPCUOGLU S., in press - The loss (in field and under laboratory conditions) of ^{65}Zn by the postlarval rudd. *Scardinius erythrophthalmus* L. (CNAEM rep.).
- 258) TOPCUOGLU S., in press - The accumulation and loss of ^{65}Zn in goby (*Proterothinus marmoratus* PALL) and the effect of detergents on the accumulation (CNAEM rep.).
- 259) TRIULZI C., 1977 - Review of the scientific activities of the Members of the Marine Radioactivity Committee with bibliography (1976-1978). Rapp. Comm. int. Mer Médit. 24, 3, pp. 105-158.
- 260) TRIULZI C., ALBINI A. and CATTANEO C., 1975 - Metodo per la determinazione dei principali prodotti di fissione e di attivazione in campioni di sedimento fluviale. Atti Convegno Determinazione di radionuclidi in campioni ambientali e materiali biologici. CNEN-CSN Casaccia (Roma, 1974), pp. 72-84.
- 261) UNLU M.Y., 1976 - Comparison of ^{65}Zn loss-rate of *Mytilus galloprovincialis* determined in field and laboratory conditions. Rapp. Comm. int. Mer Médit. 23, 7, pp. 145-148.
- 262) UNLU M.Y. and TOPCUOGLU S., 1977 - Determination of LC 50 and

- estimation of safe level of LAS detergents for larvae of two fish species in Küçük Cekmece lagoon. CNAEM-R-171.
- 263) UNLU M.Y., in press - Effect of radioecological characteristics of certain area on derivation of working limits for radioactivity emissions from Nuclear Power Plants. (CNAEM rep.)
- 264) UNLU M.Y. and FOWLER S.W., in press - Factors affecting the flux of arsenic through the mussel *Mytilus galloprovincialis*. Mar. Biol. Jour.
- 265) UMEZU T., 1976 - Mesures préliminaires de teneurs en tritium sur le site de la Hague. Mémoires de la Société des Sciences Naturelles et Mathématiques de Cherbourg. Tome 55, pp. 9-16.
- 266) VILQUIN A., FOWLER S.W. and RENFRO W.C., 1975 - Procedures for radioecological studies with marine benthic invertebrates. In: "Design of Radiotracer Experiments in Marine Biological Systems". Tech. Rep. Ser. N. 167, pp. 107-119, IAEA, Vienna.
- 267) VOLJIN V., DULIU O.G. and DANIS A., 1979 - Some considerations concerning the content of trace elements in water and sediments of Black Sea. Work accepted to presentation on the 3rd Congress IWRA (International Water Resources Association) to be presented at Mexico City, 23-27 april 1979.
- 268) VOLJIN V. and GAVRILAS M., in press - Etude de la diffusion simultanée de quelques radionucléides dans les sédiments du fond de la mer Noire par la méthode de spectrométrie- γ .
- 269) VOLJIN V. and DANIS A., in press - Détermination de la teneur de l'uranium dans l'eau marine et dans les échantillons de sédiments de la mer Noire par méthode des traces de fragments de fission. Thalassia Iugoslavica.
- 270) VOLJIN V. and OLTEANU M., 1976 - Point de charge zéro de quelques sédiments de la zone du littoral roumain de la mer Noire. Rapp. Comm. int. Mer Médit., 23, 7.
- 271) VOLJIN V., ZAMFIR E. and BLIDARU M., 1975 - Some considerations concerning the sorption capacity of several radionuclides of the Black Sea water in sediments on the Black Sea botton. Proc. 2nd World Congress International Water Resources

Association IWRA New Delhi, Vol. V, pp. 335-345.

- 272) ZATTERA A., BERNHARD M. and GALLI C., 1975 - Radiotracer experiments with benthic algae. In: "Design of Marine Radioecological Experiments", IAEA, Tech. Rep. serie N. 167, Vienna, pp. 85-105.
- 273) WRENCH J., FOWLER S.W. and UNLU M.Y., in press - Arsenic Metabolism in a Marine Food Chain. Mar. Pollut. Bull.
- 274) ZORE A., 1976 - Water renewal in the Basins along the Eastern coast of the Adriatic Sea. III Jour. Etud. Pollut. (Split) CIESM (1976) pp. 225-227.
- 275) ZORE A., 1976 - Oceanographic research in anticipation of expected construction of nuclear power plant near Zadar. III Jour. Etud. Pollut. (Split) CIESM (1976) pp. 227-230.

Cet ouvrage tiré à 500 exemplaires
a été achevé d'imprimer sur les presses
de l'Imprimerie Nationale de Monaco
le 10 octobre 1979.