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SUMMARY REPORTS ON THE SCIENTIFIC RESULTS OF MED POL

Summary reports of participants in the Co-ordinated Mediterranean
Pollution Monitoring and Research Programme (MED POL)

PART I

RAPPORTS RESUMES DES RESULTATS SCIENTIFIQUES DU MED POL

Rapports résumés des participants au Programme coordonné
de surveillance continue et de recherche en matière de
pollution dans la Méditerranée (MED POL)

PARTIE I

GE.80-1016

Table of Contents/Table des matières

INTRODUCTION

This document contains the summary reports of research centres which have participated in the Co-ordinated Mediterranean Pollution Monitoring and Research Programme (MED POL).

The reports were edited by the specialized United Nations bodies to which they were submitted and are reproduced in the language in which they were originally written.

For convenience, the reports are arranged in order of the MED POL pilot projects and within these projects by countries in alphabetical order.

The names of the principal investigators and the research centres are indicated at the beginning of each summary report.

INTRODUCTION

Le présent document contient les rapports résumés des centres de recherche qui ont participé au Programme coordonné de surveillance continue et de recherche en matière de pollution en Méditerranée (MED POL).

Les rapports ont été édités par les organes spécialisés des Nations Unies auxquels les rapports ont été soumis et ils sont reproduits dans leur langue originale.

Pour plus de commodité, les rapports sont présentés dans l'ordre des projets pilotes du Programme MED POL et, dans le cadre de ces projets, ils sont classés par pays, par ordre alphabétique.

Les noms des chercheurs principaux et des centres de recherche sont indiqués en tête de chaque rapport résumé.

MED POL I : BASELINE STUDIES AND MONITORING OF OIL AND PETROLEUM HYDROCARBONS IN MARINE WATERS (IOC/WMO/UNEP)

MED POL I : ETUDES DE BASE ET SURVEILLANCE CONTINUE DU PETROLE ET DES HYDROCARBURES CONTENUS DANS LES EAUX DE LA MER (COI/OMM/PNUE)

Participating Research Centre: Fisheries Department
Ministry of Agriculture and
and Natural Resources,
NICOSIA
Cyprus

Principal Investigator: A. DEMETROPOULOS

Introduction:

The Fisheries Department has been carrying out pollution research and monitoring of oil in the Mediterranean since October 1976.

Area(s) studied:

The main areas of study are three, the Limmassol, Larnaca bay and Lara (Paphos).

(a) Limassol Bay: Faces south with cape Akrotiri sheltering the bay from westerly winds. On the bay is situated Limassol, a town of about 65,000 people and two commerical ports.

The coast is mainly sand or shingle beach where town or ports development has not affected it.

Freshwater inflow is limited to run off from winter rains entering the sea at various places.

On this coast there are mainly wine, spirit and soft drinks factories. These plus a slaughter house pollute the sea. The total amount of waste water entering Limassol bay from industries was about 194,000 tons for 1977.

Pollution load from industries as BOD_5 was estimated to be around 238 tons for 1976 and about 271 tons for 1977.

There is also some small-scale pollution from ships.

(b) Larnaca Bay: Faces south being reasonably protected from westerly winds.

The coast is sandy and shingle beach on the whole except for the town where the beach has been encroached upon by the construction of a commercial port and marina. Part of the old Larnaca town is also built on the sea and affects the coast.

Freshwater inflow is very limited to winter rains.

There is some very limited industrial and some oil pollution. The total amount of waste water from industries was about the same (62,000 tons) for

1976 and 1977. Pollution load as BOD_5 was the same (about 60 tons) for 1976 and 1977.

Some oil pollution exists from ship bilges in this area.

(c) Lara (Paphos)

This area is situated on the west coast of the Island. It is a rocky coast with occasionally continous beaches and gets the full effect of the westerly winds and waves generated over a considerable stretch. There is no habitation in the vicinity.

Freshwater inflow is very limited to winter rains, a small stream in the vicinity of the bay flows in winter only over limited periods.

There is no pollution apart from tar from the open sea and floating debris.

Material and methods:

(a) Oil slicks and other floating pollutants-observation

Observation of oil slicks and other floating pollutants was carried out by air (the Sovereign Base Areas' Royal Air Force and Cyprus Airways were contacted and requested to report oil slicks), at sea (fisherman have been contacted and requested to report oil slicks), on the coast (daily observations were carried out by the three district offices, at Limassol, Larnaca and Paphos).

(b) Floating particulate petroleum residues (tar balls)

Sampling of particulate petroleum residues was carried out using a neuston net. This net was made by this Department.

In each station the net was towed over a distance of one nautical mile (using standard procedures, 4 knots for 15 minutes therefore about 740 m^2 of sea surface is filtered to a depth of approximately 20 cm).

(c) Dissolved petroleum hydrocarbons in the surface water

Sampling procedure and analytical methods were according to the ones described in IOC Manuals and Methods No.7.

(d) Tar on beaches

The sampling area was an area of 6 metres along the beach and from backshore to low tide mark across the beach.

Since January 1978 the sampling method was changed. Four strips of one metre wide and five metres from one other were set up. The reason for this was to obtain greater statistical accuracy in the results.

Sampling was carried out every 9 and 10th days. Collected tar was measured as dry weight (g/m^2).

Results and their interpretation:

(a) Oil slicks and other floating pollutants-observations

In 1976 nine oil slicks were reported by the Larnaca district office, whereas in 1977 thirteen were reported. Up to November 1978 eleven oil slicks were reported from Larnaca; and five from Limassol.

(b) Floating particulate petroleum residues (tar-balls)

A cruise starting from Limassol port to Paphos covered a distance of about 34 miles. Nine stations were sampled. It was found that the amount of tar was higher in the stations situated in the Western part of Cyprus.

Four stations at Limassol bay were sampled twice (June and December 1978) for petroleum residues. Sampling at this station will continue on a monthly basis.

(c) Dissolved and dispersed petroleum hydrocarbons in the surface waters

No results are available for this part of the project. Work is planned to start later this year.

(d) Tar on beaches

Completed results covering the period from October 1976 to November 1978 are available for Ladies miles (Limassol) and Lara (Paphos) stations (tables 1 and 2). No completed results are available for Larnaca station due to staffing problems.

The amount of collected tar was higher for Lara (Paphos) than for Ladies mile (Limassol) station.

Relevant meteorological data (e.g. wind, surface water temperature, etc.) were obtained during the period of observation.

Interpretation of results:

(a) The reported oil slicks were of small size. The number of oil slicks has increased year after year.

(b) The higher quantities of petroleum residues at sea collected at the stations situated in the western part if Cyprus are in accordance with the high amounts of collected tar on this side.

The westerly winds blowing in this area must play an important role in these higher concentrations. The tar is transferred from the open to this area. (The area S.W. of Cyprus is open for the dumping of oil which reaches the shore assisted by the prevailing onshore winds in this area).

(c) The collected tar during the five months' period of 1978 was higher than for the same period in 1977 in the two stations. This difference might be due to higher oil transfer during 1978 and the consequential increase in pollution.

Another reason for this difference might be the different sampling procedure followed this year which is considered to be more accurate. The results are considered to be somewhat biased because the sampling method does not take into consideration the longshore drift of tar on the beach due to wave action.

In other words, what is measured is not the actual amount of tar deposed on the sampling strip from the open sea, but also that which moves along the beach and gets deposited on the sampling strip. Steps are being taken to calculate this.

Conclusion:

It is obvious that the results will give in a few years' time the trends regarding oil pollution or at least some aspects of it. At present there seems to be an increase in the tar deposited on our beaches from 1977 to 1978.

TABLE 1

LOCATION: LADIES MILE (LIMASSOL)

November 1977 - November 1978

Collected tar (g/m^2) per month with the percentage of the total of each season.

Month	Collected tar g/m^2	% of the total for each season	Type of tar
November 1977	16.2	-	Sandy
December 1977	35.5	23.6	Sandy
January 1978	31.8	21.1	Sandy
February	83.4	55.3	Sandy
Total for winter	150.7		Sandy
March	102	59.5	Sandy
April	34	19.8	Sandy
May	35.5	20.7	Sandy
Total for Spring	171.3	-	Sandy
June	23.0	59.1	Sandy
July	10.7	27.5	Sandy
August	5.2	13.4	Sandy
Total for Summer	38.9	-	-
September	20.7	41.6	Sandy
October	20.6	41.4	Sandy
November	8.4	17.0	Sandy
Total for Autumn	49.7		

TABLE 2

LOCATION: LARA (PAPHOS)

November 1977 - May 1978

Collected tar g/m^2 per month with the percentage of the total of each season.

Month	Collected tar g/m^2	% of the total for each season	Type of tar
November 1977	23.7	-	non-sandy
December 1977	230.6	37.5	non-sandy
January 1978	321.9	52.4	non-sandy
February	62.5	10	non-sandy
Total for Winter	614.0	-	
March	471.5	25.3	non-sandy
April	967.1	51.9	non-sandy
May	421.8	22.8	conquina
Total for Spring	1,860.4		
June	536.7	38.0	conquina
July	357.2	25.3	conquina
August	520.1	36.7	conquina
Total for Summer	1,414.0	-	-
September	221.8	27.8	conquina
October	93.7	11.8	conquina
November	481.2	60.4	conquina
Total for Autumn	796.7	-	-

TABLE 3

Additional results:

Oil slicks Larnaca	
Year	number
1976	11
1977	11 (up to September 1977)

Tar on beaches (g/m^2)

		Paphos	Limassol
1976	October	13.9	5.9
	November	257.5	4.5
	December	301.6	5.5
	Total	573.0	15.9
1977	January	158.9	23.7
	February		25.4
	March	132.0	31.4
	April		5.2
	May	33.4	1.1
	June		1.7
	July	14.1	5.8
	August		3.7
	September	8.9	27.4
	October		29.9
	Total	528.4	155.3

Participating Research Centre: Institute of Oceanography and Fisheries
Mediterranean Branch
ALEXANDRIA
Egypt

Principal Investigator: S.D. WAHBY

Introduction:

In view of the threat to coastal regions from pollution by petroleum hydrocarbons, and in view of the fact that Alexandria, which has a total population of 3 million increasing to about four million in summer, is the main summer resort of Egypt, the study of oil pollution along its beaches and coastal water became a necessity.

The shoreline of Alexandria exhibits typical features of a youthful shoreline. The shoreline between Mex and Mamaura extends more or less straight with slight undulations forming small embayments. It is characterized by being rocky in most places with narrow sand beaches, which are used as recreational sites especially in summer.

The hydrography of the Mediterranean water off the Nile Delta was studied by Hassan (1969). Coastal waters are cooler in autumn and winter and warmer in summer and spring than the off-shore waters. This may be attributed to the continental influence due to the presence of the shallow and broad continental shelf and embayment characterizing the Egyptian Delta.

The following table gives the average salinity and temperature values of Alexandria coastal waters for the years 1976-1977 (Wahby and Hanafy, unpublished).

	Jan.	March	May	July	Sept.	Nov.
			Salinity $^{o}/oo$:			
Nearshore	38.067	38.56	38.60	37.71	39.17	37.63
Offshore	38.511	38.57	38.57	37.74	39.47	37.63
			Temperature (°C):			
Nearshore	17.8	16.0	20.6	26.3	27.5	19.0
Offshore	17.2	16.0	20.2	26.0	27.5	19.2

In January and February the prevailing wind is mainly south-westerly. In April, May, June, July, August and September the wind is north-west. In October and November it is north-easterly and it becomes south-westerly in December. In January, February and March, the wind speed may exceed 22 knots.

Area(s) studied:

Four beaches were chosen for sample collection in the vicinity of Alexandria.

Material and methods:

Tar on beaches: Sampling started 27 February 1977, till January 1978. Starting from February to 20 March 1977 samples were collected along a longitudinal strip 6 metres in length running from the shore line inwards. The area of collection was thoroughly cleaned and staked out. Samples were collected every one and nine days. Sample analysis was performed by weighing the total amount of tar. If the tar balls were coated, totally or partially with sand and shell fragments, they were cleaned prior to weighing or dissolved in CCl_4 and evaporated.

Floating tar balls: These are collected by phytoplankton net from the surface from two zones (El-Max and West) in the vicinity of Alexandria. Collection of floating tar balls started in May 1977, and is being done as frequently as possible. An ordinary phytoplankton net (200 mesh) is used for collection. Tar balls are collected by hand, if sticky they are dissolved in CCl_4, evaporated and weighed.

Results and their interpretation:

Tar on beaches: The weight of tar per square metre, from 20 January to 27 February 1977, for one-day and nine-day accumulations are given in table 1. Weight of tar collected from an area of 1 m^2 from four stations every 15 days from April 1977 to January 1978 was measured. Results are given in table 2; more than one sample was taken from every station. Average monthly values (g/m^2/15 days) for four stations for the period April 1978 to April 1979 are given in table 3.

We noticed that the weight of tar in summer was less than that in winter. This is due to the inevitable cleaning of beaches in this season. The accumulation of tar proved to be correlated with wind strength and duration.

Floating tar balls: The results from May to November 1977 are given in table 4.

Samples collected from the western area of Alexandria have high tar content due to their vicinity to the main sources of oil pollution.

Conclusion:

This study on the accumulation of petroleum hydrocarbons on Alexandria beaches and adjacent waters is an important one from the point of view of the Institute of Oceanography and Fisheries as it represents a modern scope of study and affords chances for training in modern techniques.

It is the intention of the Institue to broaden the scope of study to cover the dissolved and dispersed hydrocarbons and to participate in any eventual follow-up to MED POL.

Table 1

Station		Nine days accumulation weight in grams		One day accumulation weight in grams
1	27-2-77	6	28-2-77	3.0
2		10		6.0
3		16		1.0
4		20		9.0
5		10		2.0
6		11		1.3
1	9-3-77	10.1	10-3-77	4.0
2		16.1		6.2
3		13.0		1.4
4		33.7		14.3
5		11.3		2.5
6		18.5		4.0
1	19-3-77	9.0	20-3-77	2.0
2		14.0		3.5
3		11.0		2.0
4		18.0		6.0
5		11.0		5.0
6		8.0		1.5

Table 2

(Average weight of tar $g/m^2/15$ days)

Month	Station	$g/m^2/15$ days	Month	Station	$g/m^2/15$ days
April	1	105	September	1	21.7
	2	48		2	41.5
	5	225		5	3.5
	6	118		6	1.0
May	1	90	October	1	80.0
	2	60		2	90
	5	100		5	140.0
	6	100		6	110.0
June	1	60	November	1	90.0
	2	33		2	90.0
	5	37		5	160.0
	6	33		6	128.0
July	1	66	December	1	320
	2	40		2	380
	5	40		5	115
	6	20		6	200
August	1	40	January 1978	1	290
	2	22		2300	
	5	26		5	100
	6	21		6	160

Table 3

Average monthly weight ($g/m^2/15$ days) of tar from four stations

	Month	$g/m^2/15$ days
1978	April	124
	May	87.5
	June	41
	July	41
	August	27
	September	21
	October	105
	November	117
	December	254
1979	January	212
	February	347
	March	202
	April	160
	May	110

Table 4

Weight of floating tar balls

Month	mg/m^3
May	0.3 - 0.2
July	1.06
August	0.07 - 0.15
November	0.08 - 0.05

Centre de Recherche Participant : Laboratoire de Chimie appliquée à l'expertise
Faculté de Pharmacie
MONTPELLIER
France

CHERCHEUR PRINCIPAL : C. Causse

Introduction :

Le Laboratoire de Chimie appliquée à l'expertise étudie principalement l'analyse des micropolluants dans l'environnement pour en favoriser l'inventaire. Parmi les travaux antérieurs intéressant le projet MED POL I, nous pouvons indiquer l'étude des résidus d'hydrocarbures dans les eaux des canaux et étangs de Camargue qui avait été réalisée en 1971, et celle des sédiments du plateau
continental languedocien.

Zone(s) étudiée(s):

- Zone de Port Vendres et Banyuls-sur-Mer
- Port-Vendres, petit port voyageurs et frêt maritime
- Banyuls, petit port pêche et tourisme
- Côte rocheuse des Pyrénées Orientales

La figure 1 montre la région étudiée et les stations.

Matériel et méthodes:

Des mesures étaient données par spectrophotométrie infra-rouge par une procédure adaptée d'après Beyron, Kusnitz et Rijnders (The Strichting Concave, 1968), en utilisant le standard API 733-58. Cet appareil mesures fondamentalement des alkanes, des alkènes et des aromates qui sont solubles dans ttrachloride de carbonique et qui absorbent des longueurs d'ondes de 3.38 - 3.42 et 3.50 um. La limite de détection est de 0.05 mg/l.

Résultats et leur interprétation:

Des valeurs en mg/l ont été données dans le Tableau 1 pour deux stations pour le période de novembre 1975 à mai 1978. Ces résultats doivent etre comparés à ceux obtenus dans d'autre regions pour pouvoir etre interprétés.

Tableau 1. Teneurs en hydrocarbures (en miligrammes par litre) pour la période novembre 1975 - mai 1978.

Rapport n°	Date prélèvement	Station n° 2	station n° 4
1	04 - 11 - 75	0,50	1,15
2	25 - 11	0,20	0,20
3	10 - 12	0,40	0,20
4	22 - 12	0,20	0,25
5	13 - 01 - 76	0,05	0,15
6	02 - 02	0,05	0,10
7	23 - 02	4,00	4,00
8	01 - 03	0,60	1,40
9	18 - 03	0,10	0,10
10	01 - 04	0,25	0,15
11	20 - 04	0,12	0,10
12	04 - 05	0,13	0,16
13	20 - 05	0,16	0,20
14	01 - 06	0,05	0,20
15	14 - 06	0,14	0,30
17	09 - 09	0,20	0,50
18	22 - 09	0,55	2,50
19	06 - 10	0,70	0,40
20	22 - 10	0,10	0,10
21	04 - 11	0,15	0,15
22	26 - 11	0,10	0,20
23	10 - 12	0,10	0,05
24	10 - 01 - 77	0,15	0,15
25	24 - 01	0,20	0,35
26	21 - 02	0,15	0,15
27	18 - 03	0,05	0,05
28	07 - 04	0,05	0,05
29	06 - 05	0,10	0,50
30	17 - 05	0,10	0,10
31	21 - 06 - 77	0,05	0,05
32	05 - 07	0,10	0,05
33	13 - 07	0,05	0,05
34	08 - 09	0,05	0,05
35	20 - 09	0,10	0,05
36	04 - 10	0,05	0,05
37	26 - 10	0,10	0,05
38	08 - 11	0,25	0,35
39	24 - 11	0,12	n.d.
40	06 - 12	5,00	0,75
41	19 - 12	0,13	< 0,05
42	01 - 02 - 78	0,80	1,05
43	15 - 02	0,30	0,95
44	28 - 02	0,75	2,50
45	14 - 03	0,20	0,25
46	04 - 04	0,20	0,20
47	27 - 04	0,20	0,30
48	13 - 05	< 0,05	0,20
49	23 - 05	< 0,05	< 0,05

Conclusions:

La surveillance bi-mensuelle des teneurs en hydrocarbures montre quelques teneurs relativement élevées dans 20% des cas.

A ces exceptions près, les teneurs observées se situent entre la limite de détection 0,05 mg/l et 0,25 mg/l.

La comparaison avec les taux observés par ailleurs devrait permettre de situer le degré de pollution de la zone étudiée.

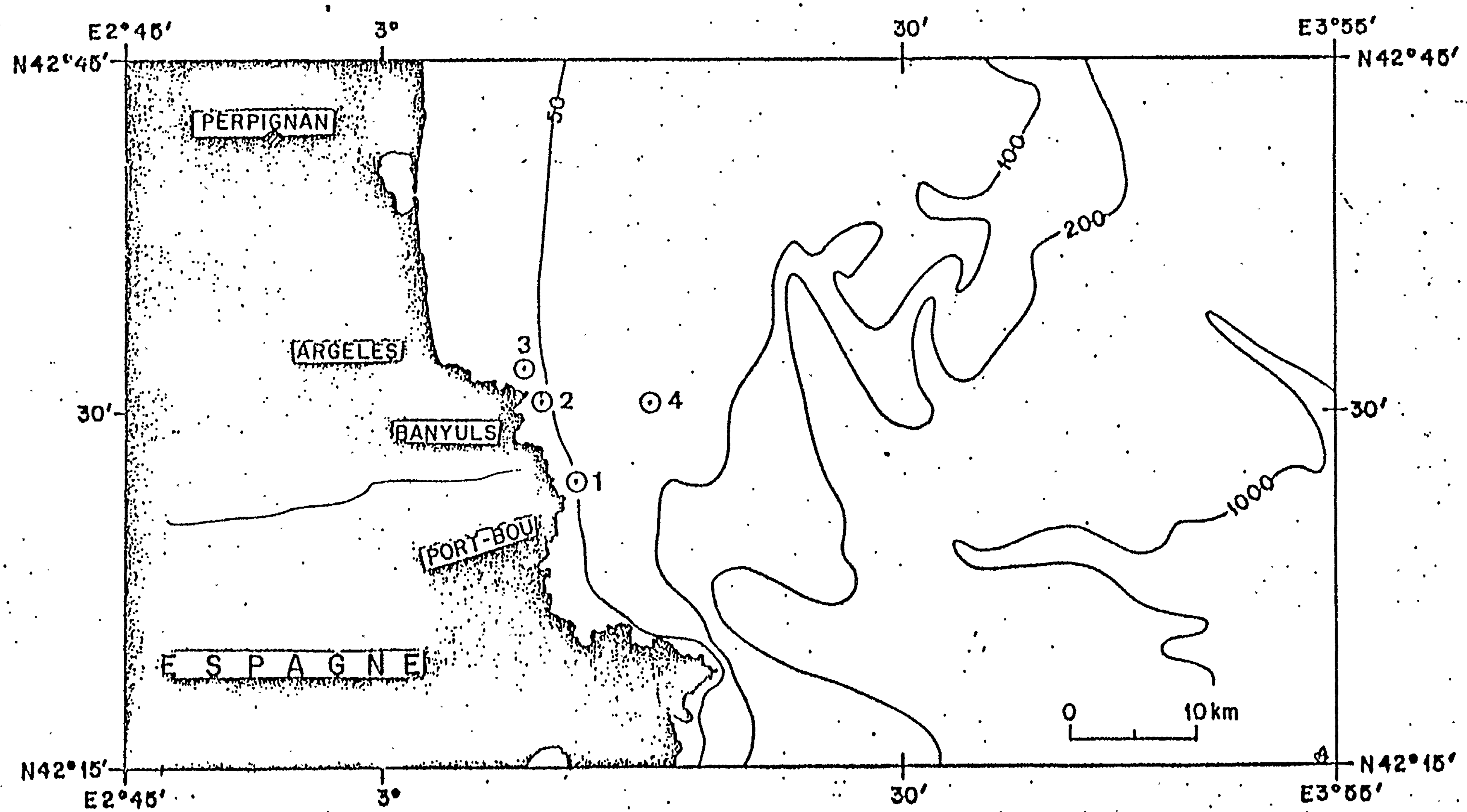


Fig.1 Areas studied off Banyuls-sur-mer. The four sampling stations.

Partcipating Research Centre: Radioanalytical Laboratory
Nuclear Research Centre "Demokritos"
ATHENS
Greece

Principal Investigator: N. MIMICOS

Introduction:

During 1975-1976 the Nuclear Research Centre "Demokritos" participated in a programme entitled "Study of the ecological response of phytoplankton to chronic oil pollution". This work was carried out in collaboration with the Hydrology Group of the Centre, and the main work of the laboratory was the determination of the concentration of petroleum hydrocarbons in sea-water.

Area(s) studied:

Figures 1-5 show the sampling station in the following areas:

- Patraikos Gulf (important industrial zone; ship traffic)
- Messiniakos Gulf (important harbour)
- Rhodos Island (important harbour, tourist centre)
- Kriti Island (important harbour, tourist centre)
- Lesvos Island (important harbour, tourist centre)

Material and methods:

For the first four areas we have chosen seven sampling stations, for Lesvos Island, six. All stations are about three miles offshore.

The sampling was carried out in co-operation with the Port Authorities following the sampling procedure as it is described in the relevant IOC publications. Three samples, for dissolved hydrocarbons determination, were collected at each sampling station at 1 m depth, using dark reagent bottles of 2.8 l capacity each.

For tar balls on beaches, one sampling point was chosen on a convenient beach in each of the above areas, except Lesvos Island, where two sampling points were chosen, as shown on the attached maps (indicated by T, in each case).

Initially the determination of the concentration of petroleum hydrocarbons was by infra-red spectrophotometry (P.E. Model 521). The results of these measurements were submitted to the Barcelona meeting (17-23 May 1976). Later, we continued the determination of petroleum hydrocarbons using ultra-violet spectrofluorimetry, as described in the IOC Manuals and Guides No.7 and its supplement, and in IOC Workshop Report No.10.

Results and their interpretation:

The results are given in table 1. These are given in ug/kg for the dissolved petroleum hydrocarbons. As far as the results of petroleum hydrocarbons are concerned it must be noted that we have not applied any clean-up procedure, so the given values do not represent obligatory real petroleum hydrocarbons concentrations.

List of publications:

- Ecological Responses of Phytoplankton on Chronic Oil Pollution. Environ.Pollut. (13) 1977.

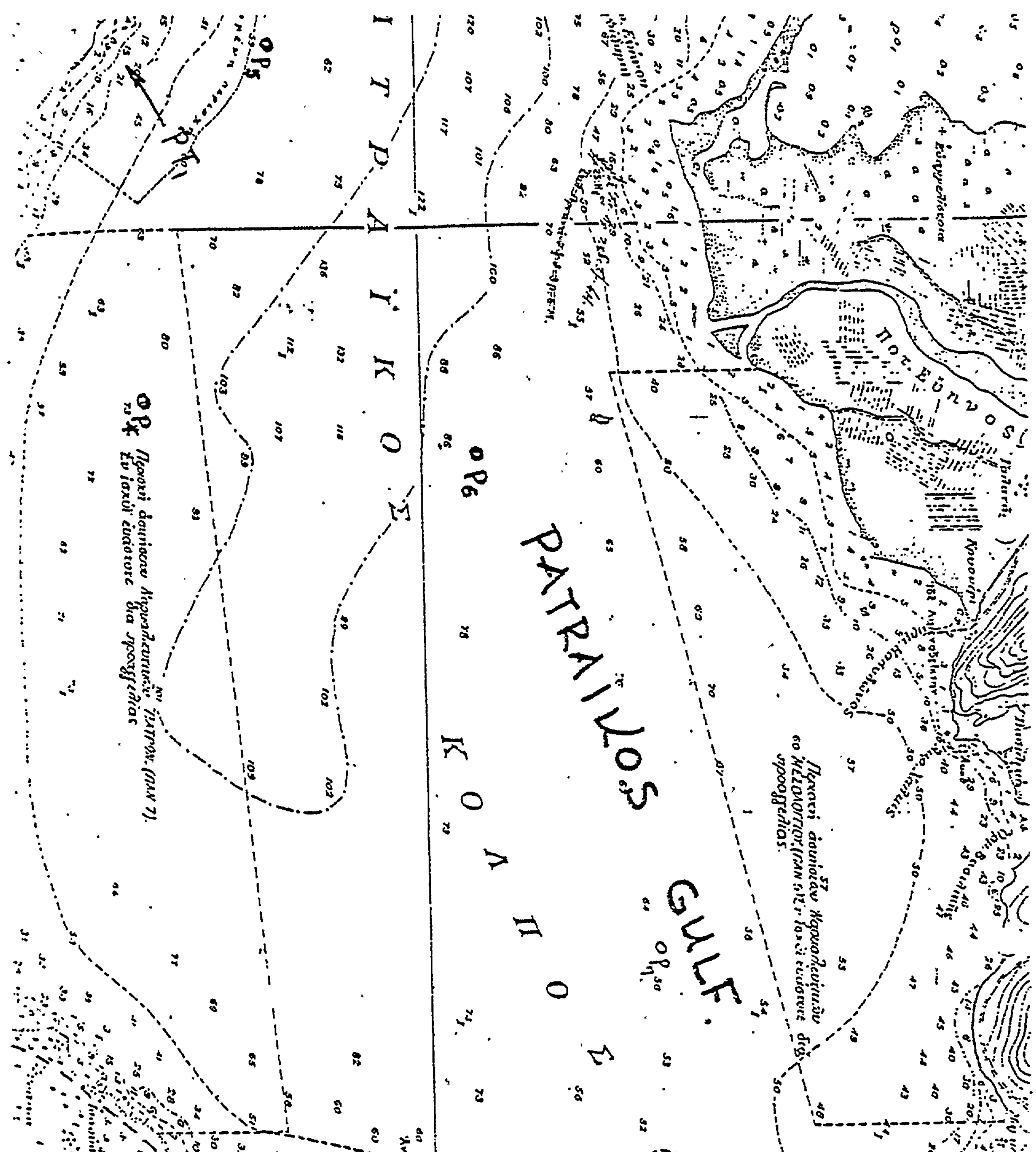
- A survey of petroleum hydrocarbons in Elefsis Bay, Aegean Sea and their effect on phytoplankton growth by L. Ignatiades and N. Mimico, presented in XXVth Congress and Plenary Assembly in Split 22-30 October 1976, Committee for Marine Pollution Fighting.

Table 1

Concentration of dissolved and sipersed petroleum hydrocarbons in sea-water at 1m depth expressed as ug/kg of chrysene units. (Mean of three separate samples after the clean-up procedure, as described in the IOC Manual and Guides No.7, has been applied).

			1.8.77	24.11.77	31.1.78	
Lesvos Island	L_1		1.7	2.7	1.5	
	L_2		0.8	3.2	1.3	
	L_3		2.5	1.4	1.2	
	L_4		2.5	2.4	1.9	
	L_5		1.0	1.5	2.7	
	L_6		1.2	3.0	3.1	
			4.7.77	8.11.77	25.2.78	6.7.78
Kriti Island	K_1		3.6	2.8	6.7	3.0
	K_2		2.8	3.7	3.0	2.5
	K_3		2.2	2.3	4.4	2.0
	K_4		4.4	2.2	2.5	1.1
	K_5		0.9	2.6	11.2	2.7
	K_6		2.8	3.2	6.6	2.1
	K_7		1.8	1.2	3.5	1.0
		15.5.77	6.10.77	15.1.78	21.4.78	
Rhodos Island	R_1	0.9	2.8	2.1	3.2	
	R_2	3.3	2.1	1.3	2.2	
	R_3	3.6	2.8	2.3	3.9	
	R_4	1.8	4.6	1.1	3.2	
	R_5	1.7	1.5	4.0	4.5	
	R_6	3.3	4.9	2.9	3.1	
	R_7	0.3	1.7	3.6	4.7	
		30.4.77	10.8.77	7.12.77	27.3.78	
Kalamata (Messiniakos Golf)	M_1	1.1	1.7	1.7	4.9	
	M_2	1.9	1.7	3.6	3.2	
	M_3	1.8	1.3	3.4	6.2	
	M_4	2.9	1.9	3.6	9.0	
	M_5	1.6	1.7	4.0	11.5	
	M_6	1.7	1.4	2.2	4.7	
	M_7	1.9	1.6	2.7	5.3	
Patraikos Gulf		13.3.77	5.9.77	+	20.2.78	
	P_1		10.3		1.3	
	P_2		9.6		1.3	
	P_3		9.5		1.4	
	P_4		15.3		2.1	
	P_5		14.0		1.1	
	P_6		3.6		2.3	
	P_7		14.5		3.8	

\+ No sampling owing to bad weather conditions


PATRAIKOS GULF
ΠΑΤΡΑΪΚΟΣ ΚΟΛΠΟΣ
FIG. 1

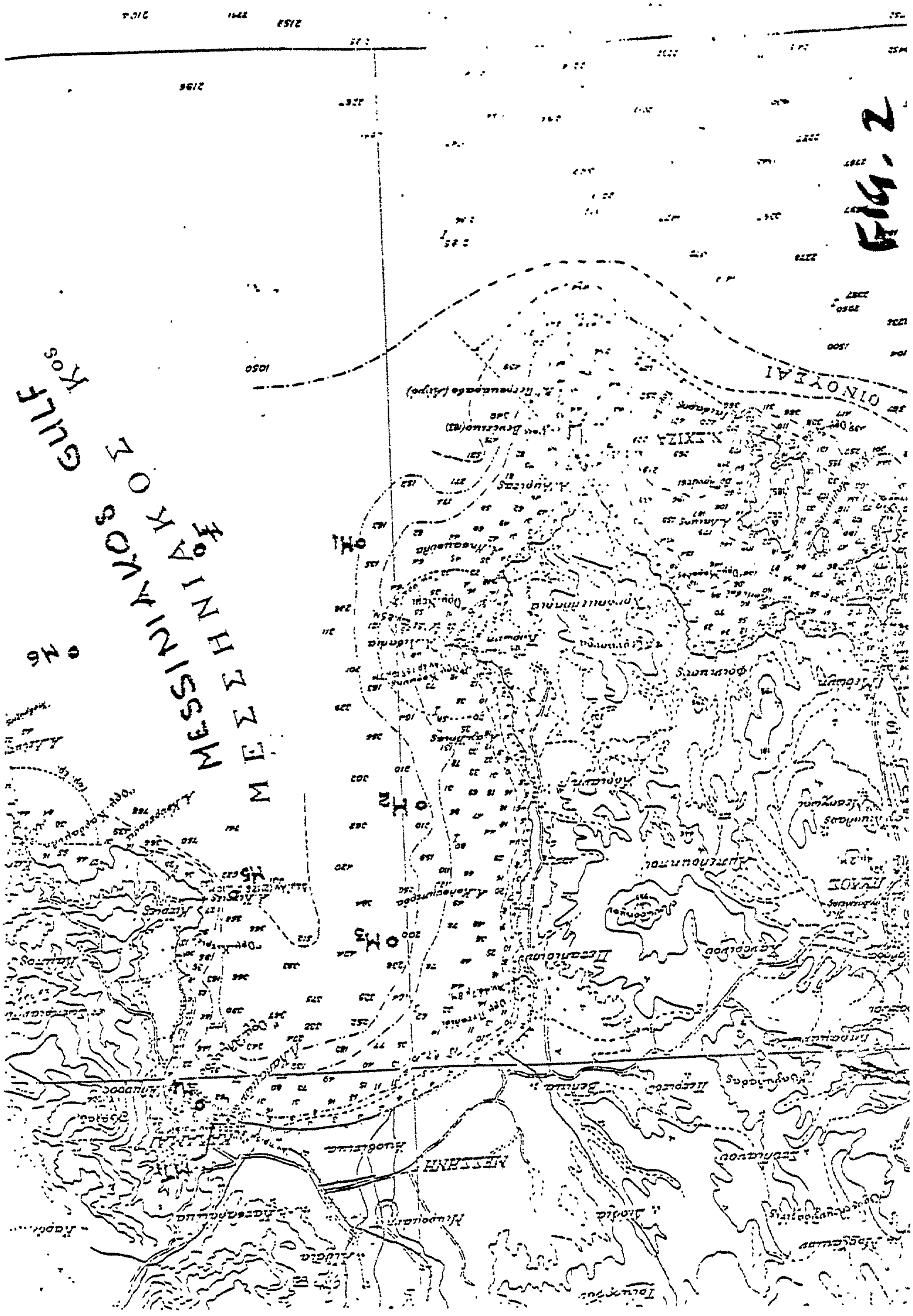


FIG. 2

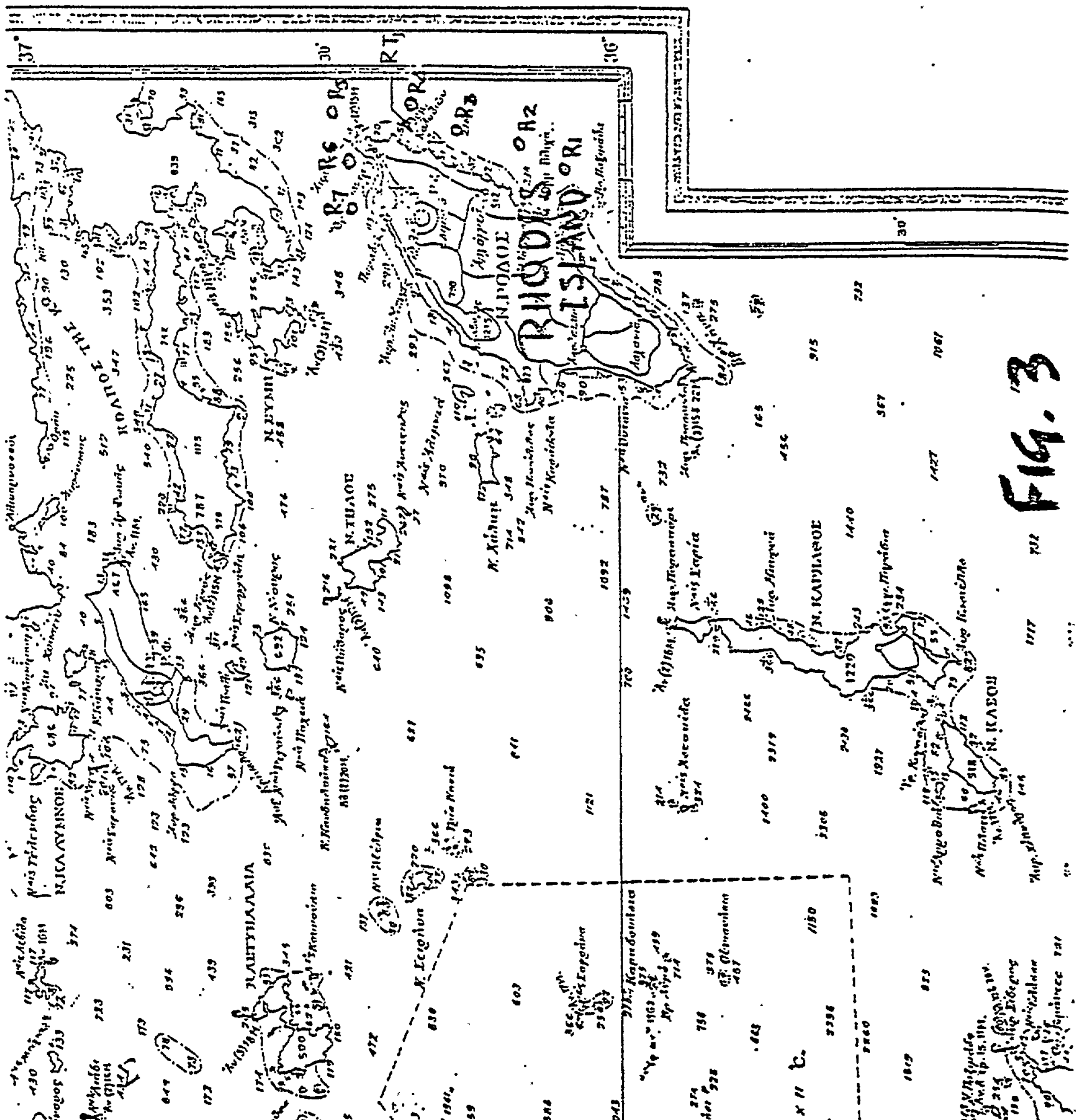

RHODES ISLAND
Ν. ΡΟΔΟΣ
Ν. ΚΑΡΠΑΘΟΣ
Ν. ΚΑΣΟΣ
Ν. ΤΗΛΟΣ
Ν. ΑΣΤΥΠΑΛΑΙΑ
Ν. ΚΑΛΥΜΝΟΣ
Ν. ΑΜΟΡΓΟΣ

FIG. 3

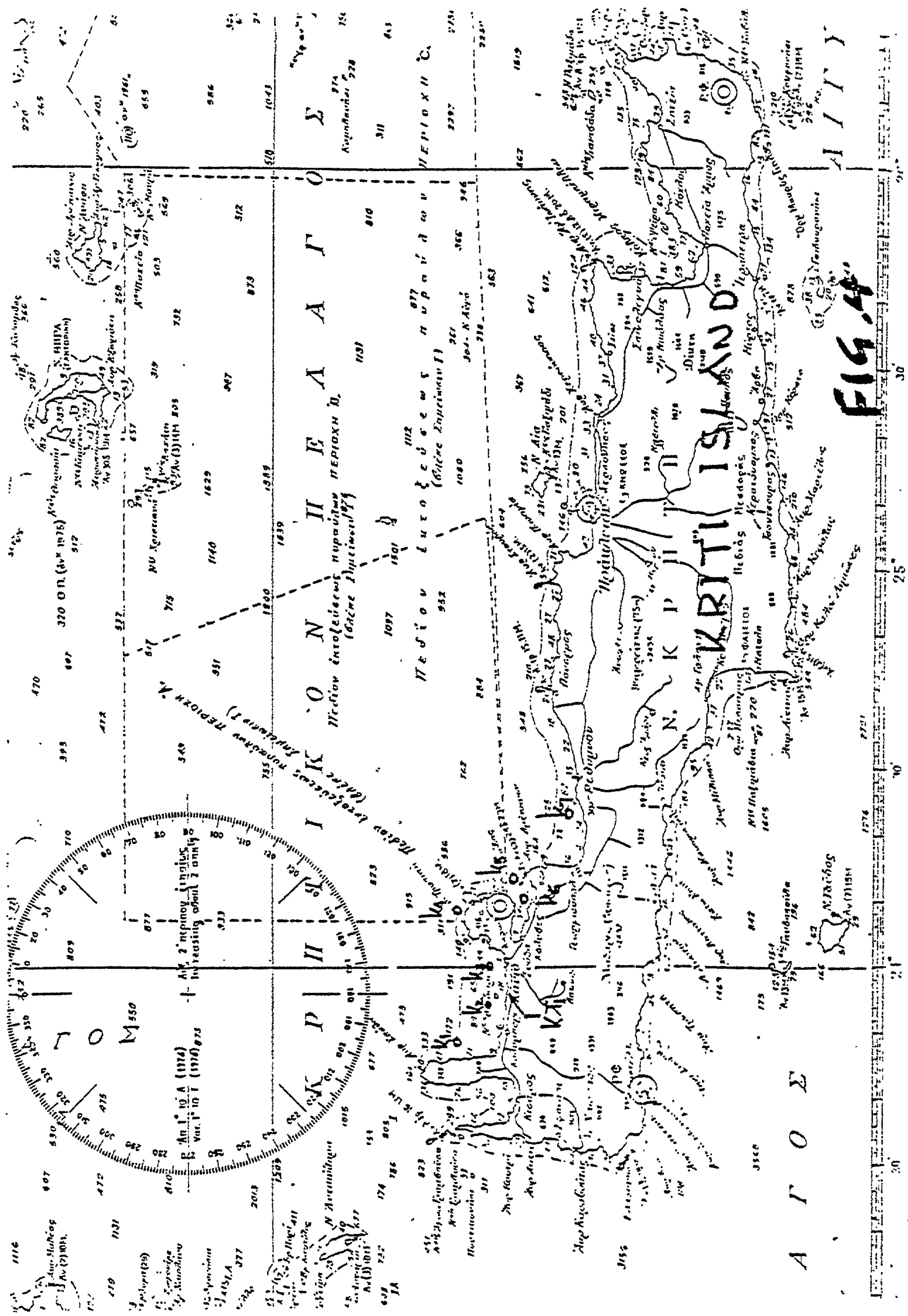


FIG. 4

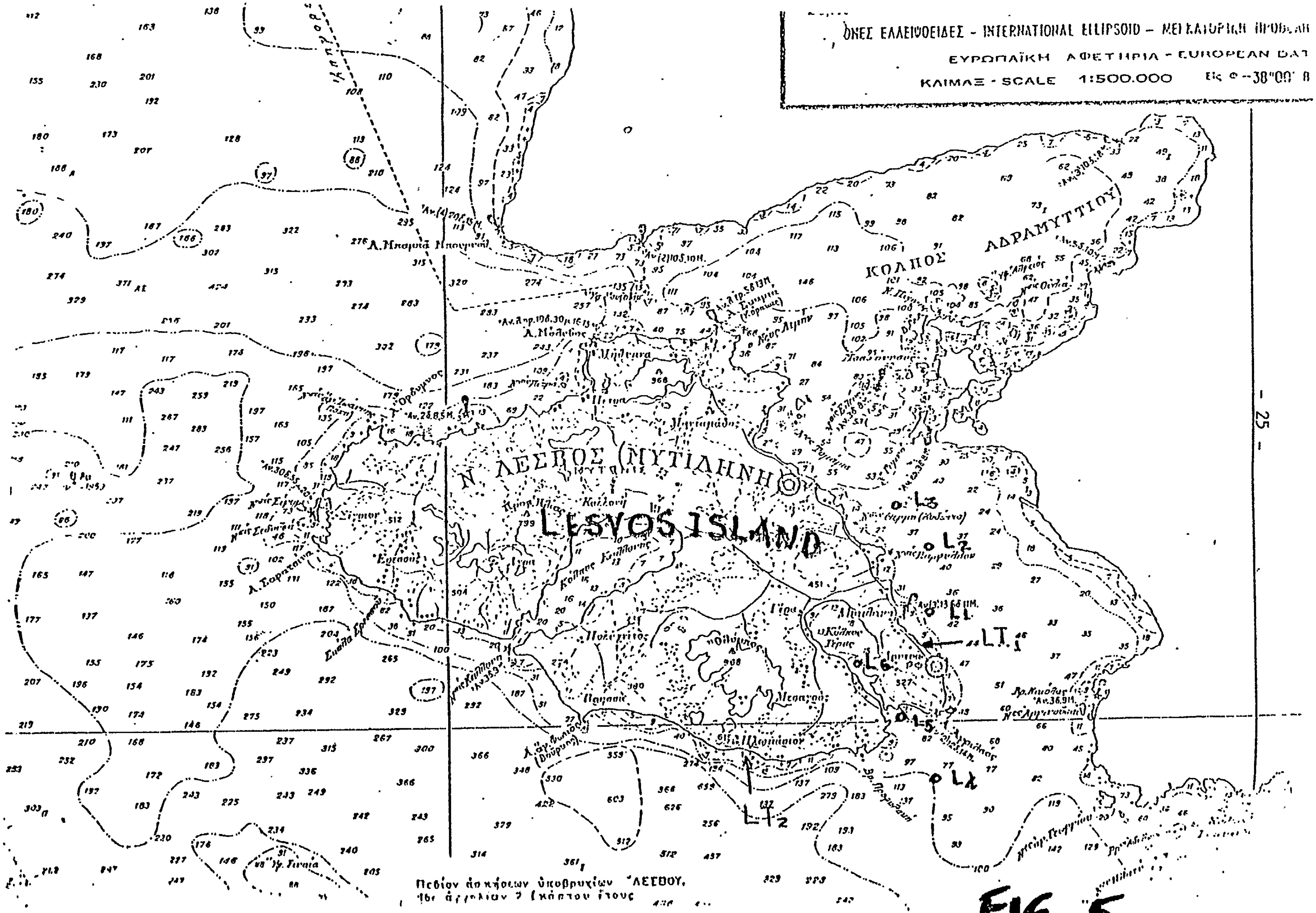

ΖΩΝΕΣ ΕΛΛΕΙΨΟΕΙΔΕΣ - INTERNATIONAL ELLIPSOID - ΜΕΡΚΑΤΟΡΙΚΗ ΠΡΟΒΟΛΗ
ΕΥΡΩΠΑΪΚΗ ΑΦΕΤΗΡΙΑ - EUROPEAN DAT
ΚΛΙΜΑΞ - SCALE 1:500.000
Ν. ΛΕΣΒΟΣ (ΜΥΤΙΛΗΝΗ)
LESVOS ISLAND
ΚΟΛΠΟΣ ΑΔΡΑΜΥΤΤΙΟΥ
L3
L2
L1
LT1
L6
L5
L4
LT2
Πεδίον ἀσκήσεων ὑποβρυχίων "ΛΕΣΒΟΥ.

FIG. 5.

Partcipating Research Centre: Laboratory of Organic Chemistry
University of Thessaloniki
THESSALONIKI
Greece

Principal Investigator: N.E. ALEXANDROU

Introduction:

Between October 1976 and April 1977 we started measurements on the extent of petroleum hydrocarbon contamination in Thessaloniki and Cavala harbours and Stryminicos Bay. In these places are located the most important industries in Northern Greece. These were continued for the period May 1977 to July 1979.

Area(s) studied:

The sampling sites in Thessaloniki and Cavala harbours and in Strymonicos Bay are shown in figure 1.

Material and methods:

Samples (one each) were taken from the above-mentioned areas from various stations and at three depths (0-5 cm, 1-10 m, 10-50 m). The determinations were made using the carbon tetrachloride extraction method and the oil content was measured using the infra-red method.

Infra-red spectra of carbon-tetrachloride-water extracts were measured in a 5 cm cell with quartz windows using a Perkin-Elmer Model 257 infra-red spectrophotometre. Spectra were scanned from 3.400-2.500 cm^{-1}. The C-H stretching band at 2.930 cm^{-1} was used for analysis. The absorptivity at this wavelength was calibrated with petroleum (fraction b.p. 150-200°). The straight line of the correlation diagram was obtained by measuring samples containing known weight of petroleum in distilled water. The accuracy in petroleum concentration is in the range of $\pm$0.2 mg/l.

For a preliminary examination, the carbon tetrachloride extracts of Thessaloniki harbour sea-water were evaporated and the whole residue was submitted to mass spectrometric examination. The mass spectra taken with a Hitachi-Perkin-Elmer-RMU-6L Spectrometre at 70 eV were very similar to the spectrum of the petroleum fraction (b.p. 150-200) used for calibration for oil determination. They mainly showed ion fragments differing by 14 mass units up to 278 m/e. This study is, however, under further consideration.

Results and their interpretation:

The results of the measurements are given in tables I, II and III, for the three areas, for the period October 1976 to April 1977.

Table 1

Oil concentration in Thessaloniki harbour water[a] (mg/l)

Station[b]	Surface (0-5cm)	Subsurface (1-10 m)	Subsurface (10-50m)
	1.5	2.6	2.5
	1.0	1.4	1.8
	1.6	2.5	2.1
	2.0	1.1	0.6
	1.3	0.1	0.6
	1.6	-	-

average value: 1.5 mg/l

Notes: a. all values given are average between 3-5 measurements
b. eash station consists of at least five sampling points.

Table 2

Oil concentration in Cavala harbour water[a] (mg/l)

Station[b]	Surface (0-5cm)	Subsurface (1-10 m)	Subsurface (10-50m)
	3.5	-	1.7
	2.7	3.1	2.0

average value: 2.6 mg/l

Notes: a. all values given are averages between 3-5 measurements
b. each station consists of at least five sampling points.

Table 3

Oil concentration Strymonicos bay water[a] (mg/l)

Station[b]	Surface (0.5cm)	Subsurface (1-10 m)	Subsurface (10-50m)
	0.9	1.1	0.9
	0.9	1.7	0.8

average value: 1.1 mg/l

Notes: a. all values given are averages between 3-5 measurements
b. each station consists of at least five sampling points.

No significant differences in the oil concentration between the three depths were observed. This indicates that the sampling error effectively obscures the expected variation in oil content due to sea currents and depths. Thus, all data can be pooled in each table to obtain the average oil concentration for the area under consideration.

These average values are 1.5 mg/l, 2.6 mg/l and 1.1 mg/l for Thessaloniki and Cavala harbours and Strymonicos Bay, respectively.

The oil concentration data for Thessaloniki and Cavala harbour and Strymonicos Bay for the period May 1977 to September 1978 are given in table IV. Average values for the oil concentration for each area are also given. However these average values show no significant change compared with the values obtained for the period October 1976-May 1977 (1.5, 2.6 and 1.1 mg/l for Thessaloniki and Cavala harbours and Strymonicos Bay, respectively).

The oil concentration data for Thessaloniki and Cavala harbours and Strymonicos Bay for the period November 1978 to July 1979 are given in tables V and VI. Average values for the oil concentration for each area are also given. The average value of 2.1 mg/l for the oil concentration in Thessaloniki harbour shows a considerable increase in oil concentration compared to the value of 0.8 mg/l obtained for the period May 1977 - October 1978. However, for the same period of time the variation in oil concentration in Thessaloniki Bay and Cavala harbours was insignificant (1.4 mg/l - 1.5 mg/l and 1.8 mg/l-1.6 mg/l, respectively). Finally, in Strymonicos Bay the oil concentration was doubled (1.4 mg/l - 2.9 mg/l). In any case, further studies are required to confirm the above data.

Table IV

Average oil concentration in Thessaloniki and Cavala Harbours and Strymonicos Bay water (mg/l)
The figures in parentheses indicate number of measurements

Harbour	Surface	0.5m	Average
Thessaloniki	0.9 (32)	0.7 (9)	0.8
Cavala	1.6 (14)	2.0 (4)	1.8
Strymonicos	1.1 (12)	1.7 (4)	1.4

Table V

Average oil concentration for each station in Thesslonìki and Cavala harbours and Strymonicos and Thermaicos Bay sea-water. Figures in parentheses indicate the number of measurements

Thessaloniki harbour

Station number	Surface	0.5 m	1 m	Average
ΘA	1.7 (6)	2.6 (2)	2.0 (4)	2.1
ΘB	1.5 (6)	1.9 (2)	1.8 (4)	1.7
ΘΓ	2.5 (6)	1.1 (2)	1.7 (4)	1.8
ΘΔ	3.0 (6)	1.5 (2)	1.7 (4)	2.1
ΘE	2.6 (4)	3.5 (2)	2.2 (4)	2.8
Cavala Harbour				
KA	1.4 (6)	0.7 (2)	0.9 (6)	1.0
KB	2.2 (6)	3.4 (2)	2.4 (6)	2.7
Strymonicos Bay				
ΣA	2.2 (6)	3.1 (2)	1.3 (6)	2.2
ΣB	3.4 (6)	6.4 (2)	1.0 (5)	3.6
Thermaicos Bay				
St. 153	1.0 (3)	1.5 (1)	2.3 (3)	1.6
St. 163	0.9 (3)	1.8 (1)	1.7 (3)	1.4

Table VI

Average oil concentrations in Thessaloniki and Cavala Harbours and Strymonicos and Thermaicos Bay sea-water.
The figures in parentheses indicate number of measurements

Harbour	Surface	0.5 m	1 m	Average
Thessaloniki	1.9 (22)	2.1 (10)	2.4 (20)	2.1
Cavala	1.3 (12)	2.0 (4)	1.6 (12)	1.6
Strymonicos	2.8 (12)	4.7 (4)	1.2 (11)	2.9
Thermaicos	2.4 (6)	1.6 (2)	0.5 (6)	1.5

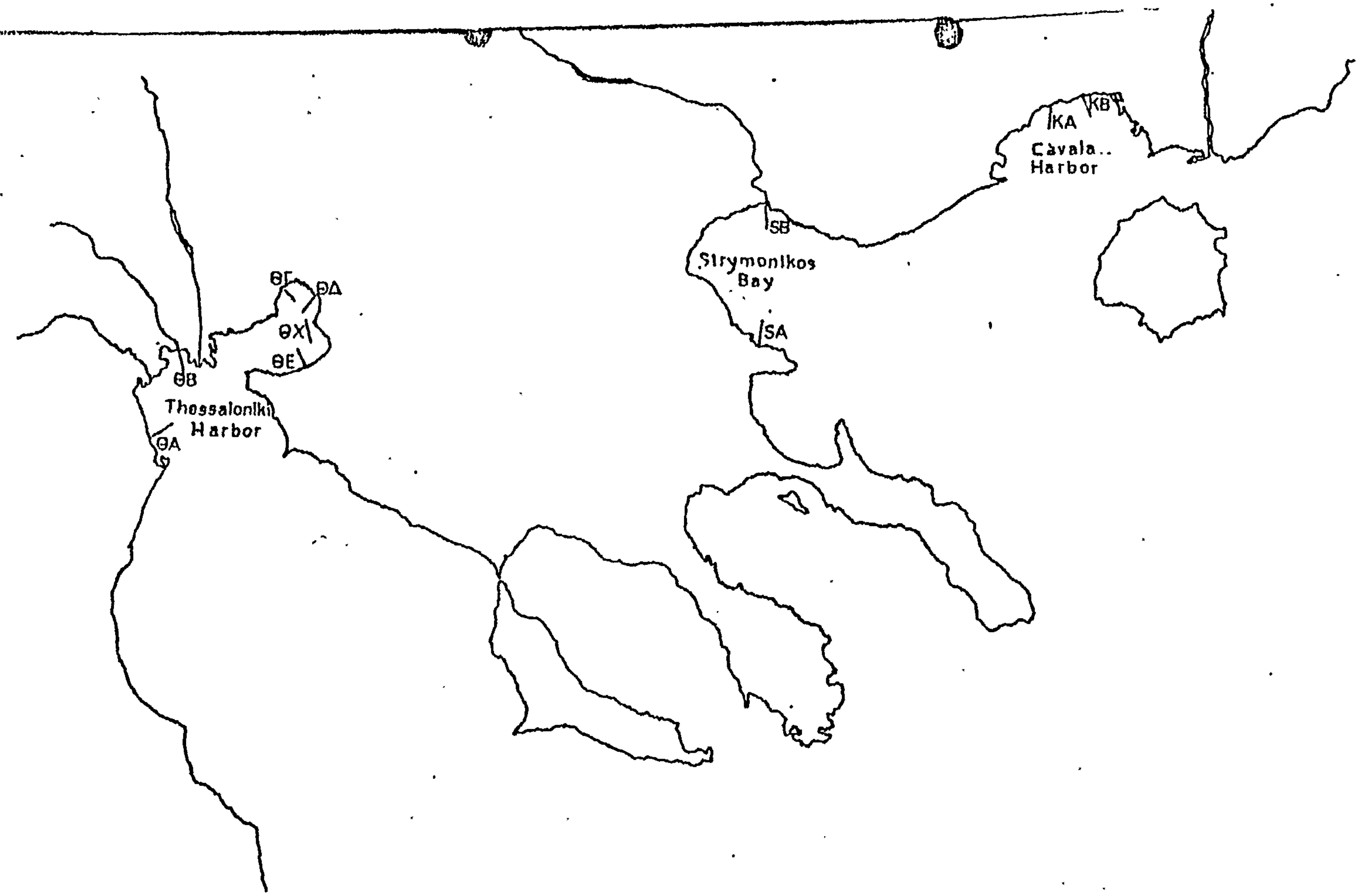


Figure 1. Sampling Stations

Participating Research Centre: Israel Oceanographic and Limnological Research Ltd., HAIFA Israel

Principal Investigator: O.H. Oren

Introduction:

The Mediterranean coast of Israel is a densely inhabitated area where there are many coastal industries and activities, including a continuous and relatively heavy traffic of ships.

Centres of maritime activities connected with the disposal of oil residues are:

Haifa Bay	- port, oil terminal (mainly fuel oil), petroleum industrial petrochemical plants, power stations;
Tel Aviv (including Ashdod area)	- port, power stations, refineries;
Ashkelon	- power station, oil port, loading terminal of the pipeline Eilat-Ashkelon.

All these centres can become sources of oil pollution, not only as a result of incidents and accidents, but also from regular activities.

In addition, there are several sewage outfalls: one of the biggest is the Tel Aviv domestic and industrial sewage pipeline, north of Tel Aviv; and there are smaller outfalls from other large cities. Several industrial outfalls are planned. The outfall discharges mineral oils from garages, fuel pumping stations, etc.

Area(s) studied:

The work comprises a study of tar-ball pollution on Israeli beaches, the oil pollution (as measured by the concentration of dissolved/dispersed hydrocarbons) along the Israeli coast and in the open sea of the Levant Basin.

Method and materials:

Tar on beaches: The collection of tar was carried out between spring 1975 until the winter of 1976 along the shore of six stations from El Arish in the south to Rosh Hanikka in the north. The collection was carried out every fortnight in duplicates.

Table 1 shows the mean quantities of tar along the beach and the relevant standard deviation.

Dissolved/dispersed hydrocarbons along the coast: This report reflects the state of oil pollution along the Israeli coast between August 1977 and March 1978; four cruises were carried out, and water samples from a depth of one metre were collected and analysed for dissolved oils. The sampling stations, with average concentrations, are shown in figures 2 - 5.

The sampling was generally carried out with the aid of the R/V Shikmona. This is a 120 ton, 25-metre-long trawler converted into a research vessel. The vessel has a crew of 8 with accommodation for 8 additional scientists. The ship has a cruising speed of 9 knots and an endurance of 21 days.

Samples for analysis were collected by the sid of a one gallon brown chemical reagent glass bottle suspended on a nylon rope in a nerosta wire cage weighted by a lead bottom. A buoy was attached to the cage on a one-metre-long rope to ensure that the sampling bottle collected was from exactly one metre below the surface of the sea.

Between 24 May and 16 June 1978, 29 water samples were collected off the National Oceanographic Institute at Tel-Shikmona, Haifa. About half the samples were surface samples, the other half being samples taken from one metre depth with the above-described sampler.

Dissolved/dispersed hydrocarbons in the Levant basin: We are reporting here on four cruises in the open Levant Basin:

1) 9 July - 16 July 1977

2) 10 October - 15 October 1977

3) 26 March - 3 April 1978

4) 27 June - 2 July 1978

The geographical locations of the sampling stations are shown, together with average concentrations, in figures 6-9. The samples were collected in the same way as described above and with the same R/V Shikmona.

Results and their interpretation:

Tar on beaches: The mean quantity of tar found was 3625 g/m of shore with a standard deviation of 2834 g. (see also table 1). Figure 1 shows that the quantity of tar decreased from spring 1974 to winter 1976, from 6107 g/m to 1344 g/m. From 1976 the quantity of tar increased to 4361 g, decreasing thereafter.

One of the reasons for the appearance of larger quantities of tar on the centrally located beaches of Israel is probably the transport of oil, the existence of oil loading and unloading ports, as well as in the area about 150 - 200 km off-shore (determined from the age of tar balls formed). The other reasons are the local meteorological conditions and ocean current regime.

Besides the two factors increasing beach tar, one has to take into account the factors causing its disappearance: one of the most important is the weathering of tar, its disintegration by wind and water action and sand abrasion.

Dissolved/dispersed hydrocarbons along the coast: The sampling stations are shown on the four maps attached (figures 2-5). During Cruise No.1, most of the samples were collected from the southern part of the coast, between Gaza and Tel-Aviv.

The southern oil port of Israel is situated in Ashkelon (station 3 on Cruises No.1 and No.3). During both cruises, the concentration of dissolved oils in this region was the highest (9.38 ug/l and 19.38 ug/l, respectively) except for Haifa Bay, where the second oil port of Israel is situated. Haifa Bay shows the highest values of dissolved oil (15.00 ug/l, Cruise No.1, and 15.63 ug/l, Cruise No.3) because of the great activity in this bay. Here, large quantities of bilges are released by ships awaiting unloading of various cargo, including oil: two extremely active harbours, Haifa and Kishon, are situated here. In addition, the extremely polluted Kishon river discharges into the bay, bringing wastes from the oil refinery and industrial sewage from the Haifa industrial area, the fishing harbour, the shipyard, etc.

Off Palmachim, a station south of Tel-Aviv, larger quantities of dissolved oils (12.50 ug/l, Cruise No.1, and 10.71 ug/l, Cruise No.3) were found. This may come from the urban and industrial sewage entering the sea nearby.

The largest quantities of dissolved oils were found during the present survey off a drilling raft in the Bardawil Lagoon (20.63 ug/l, Cruise No.2). Although the quantities of dissolved oils found are not large and critical, they truly indicate the state of pollution in locations where activities connectd with oil and shipping take place.

Off Tel Shikmona, on three occasions during the short sampling period (2 May - 16 June 1978), relatively large quantities of dissolved petroleum hydrocarbons were found. This may indicate either that some slight spillage or bilge spot reached the shore near the institute.

The quantities of oils found in samples taken from one metre depth varied very little from sampling day to sampling day. The largest quantity found was 7.5 ug/l.

The largest quantity of oil from surface samples was found on May 29th (more than 45.3 ug/l). The lowest quantity was 1.1 ug/l found on three occasions. During the rest of the sampling days, quantities of oil varied between 5.7 ug/l and 0.9 ug/l.

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Dissolved/dispersed hydrocarbons in the Levant Basin: Relatively large quantities of dissolved oils were found in the area between Cyprus and Crete, the area in which dumping of ballast and wash waters from tankers was permitted in the past and is probably still practised by many tankers. This was confirmed by a conversation with a First Officer serving on an oil tanker. One may conclude from this that illegal dumping of oily wastes is still taking palce in that area.

One should note that during Cruise No.3 and No.4, large quantities of dissolved petroleum hydrocarbons (40 ug/l) were found in the south of Cyprus at stations 15 and 20 on (Cruise No.3), and above 25 ug/l (Cruise No.4), practically in the same area.

Another area of relatively large quantities of dissolved oils was found in the southeast of Crete: above 40 ug/l, at station 40 on Cruise No.3.

The waters on the edges of the surveyed areas contain low quantities of dissolved oils (generally less than 10 ug/l).

In general, one could say that only small areas of the Levant Basin can be considered as slightly polluted by petroleum hydrocarbons, but if the rules and regulations adopted by the Mediterranean states are observed, one can obviously expect that in a few years the quantity of dissolved oils will diminish in the open sea, if no catastrophes occur.

TABLE 1

MEAN QUANTITIES OF TAR ON THE BEACHES OF ISRAEL IN GRAMMES PER 1 METRE OF COAST

COASTAL AREA	ROSH HANIKKA	ATLITH	BEITH YANAI	GA'ASH	ASKALON	EL ARISH
Mean quantity of tar g/m	3902	4388	4114	4186	3014	884
Standard deviation	2612	3185	3562	2493	2407	665

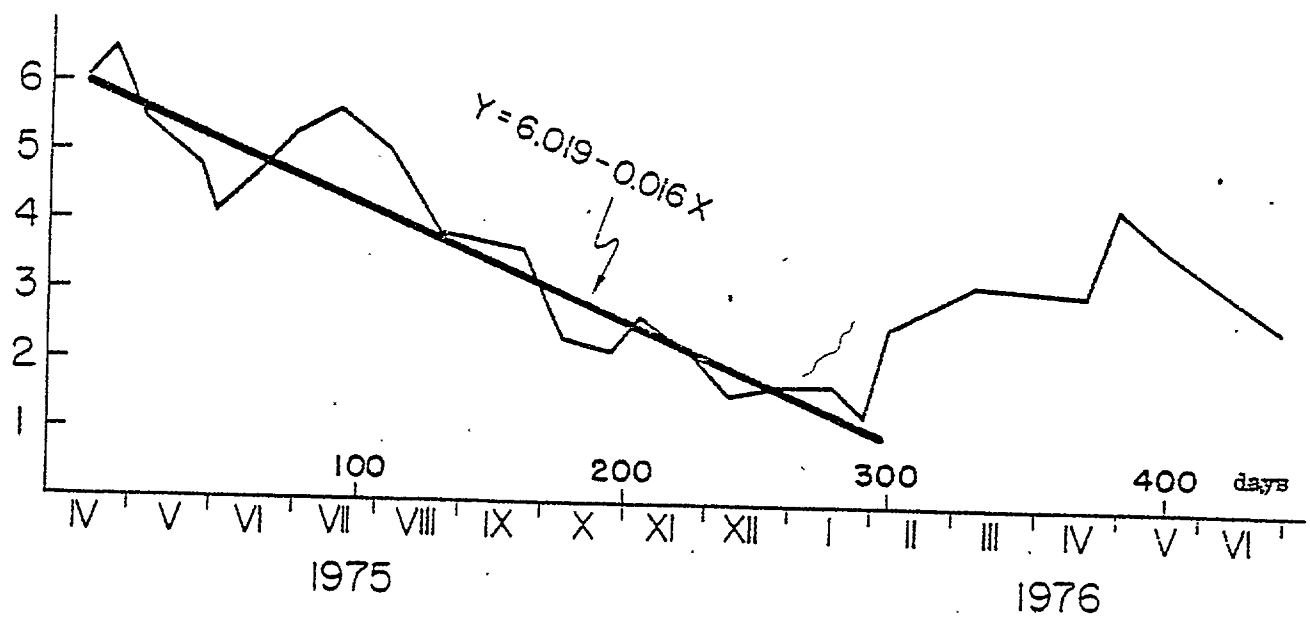


Fig. 1. Mean quantity of tar on Israeli coast of the Mediterranean as a function of time.

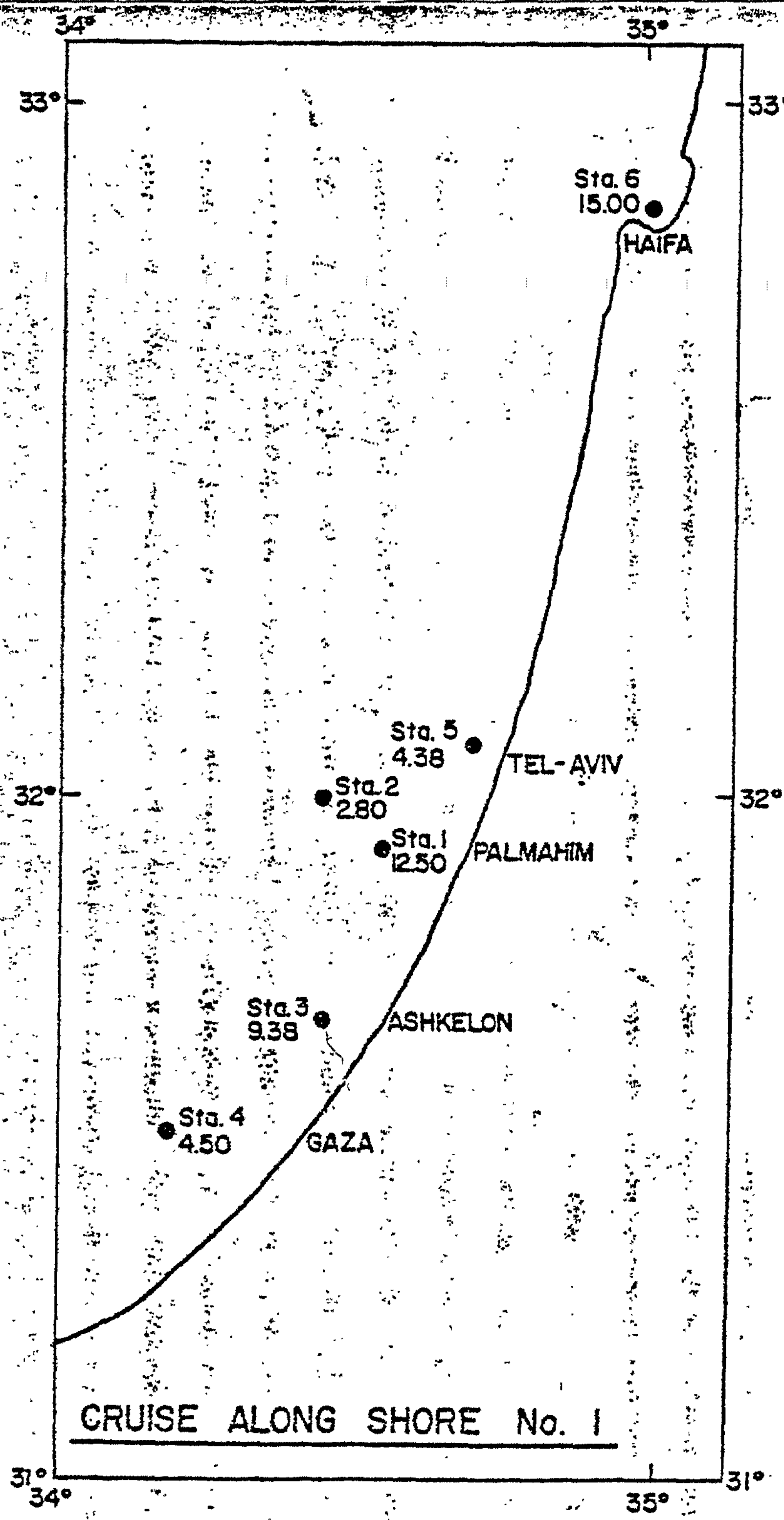

34°
35°
33°
33°
Sta. 6
15.00
HAIFA
Sta. 5
4.38
TEL-AVIV
32°
Sta. 2
2.80
32°
Sta. 1
12.50
PALMAHIM
Sta. 3
9.38
ASHKELON
Sta. 4
4.50
GAZA
CRUISE ALONG SHORE No. 1
31°
34°
35°
31°

Fig. 2

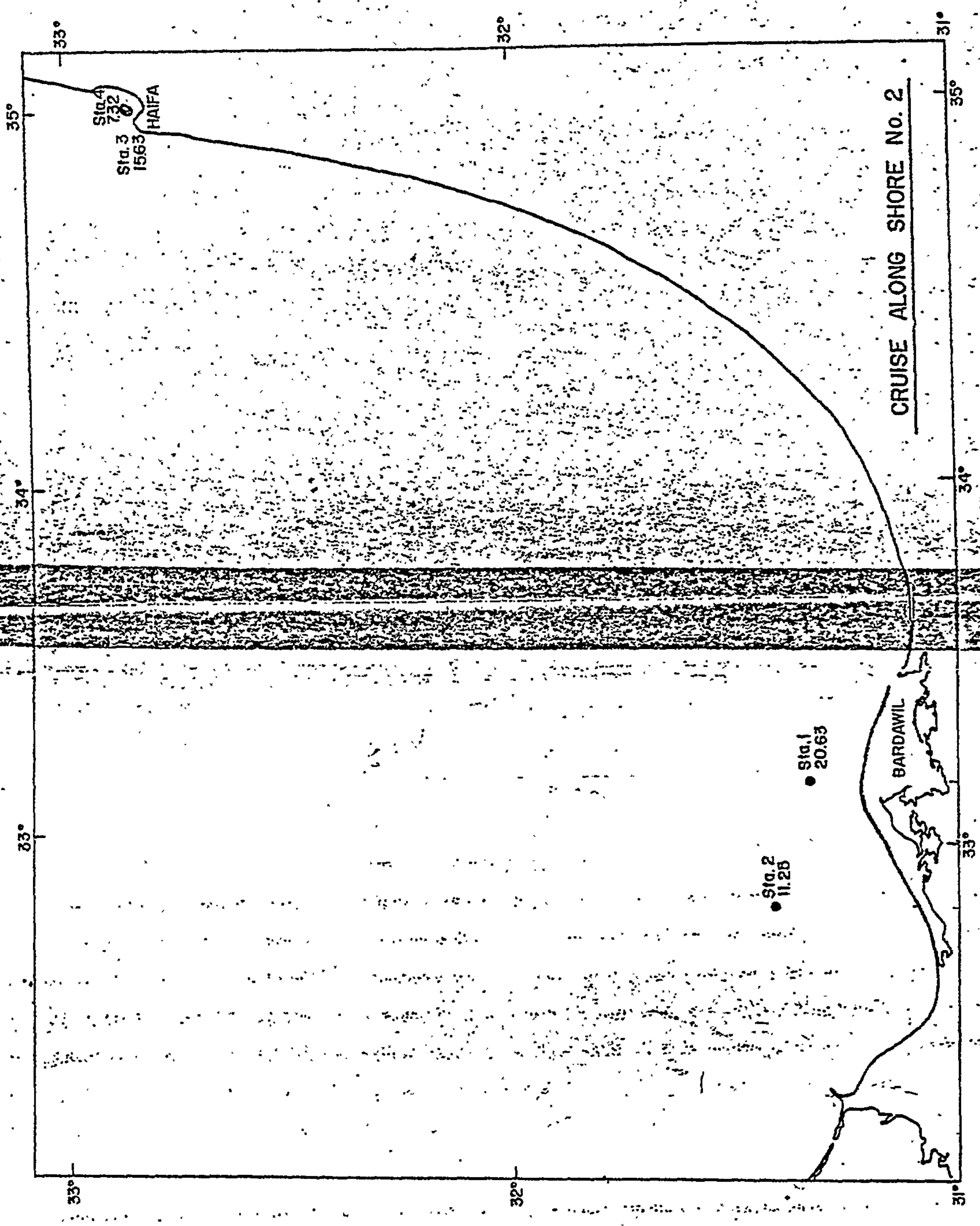

CRUISE ALONG SHORE No. 2
HAIFA
Sta.4 7.32
Sta.3 15.63
Sta.1 20.63
Sta.2 11.28
BARDAWIL
33°
32°
31°
35°
34°
33°

Fig. 3

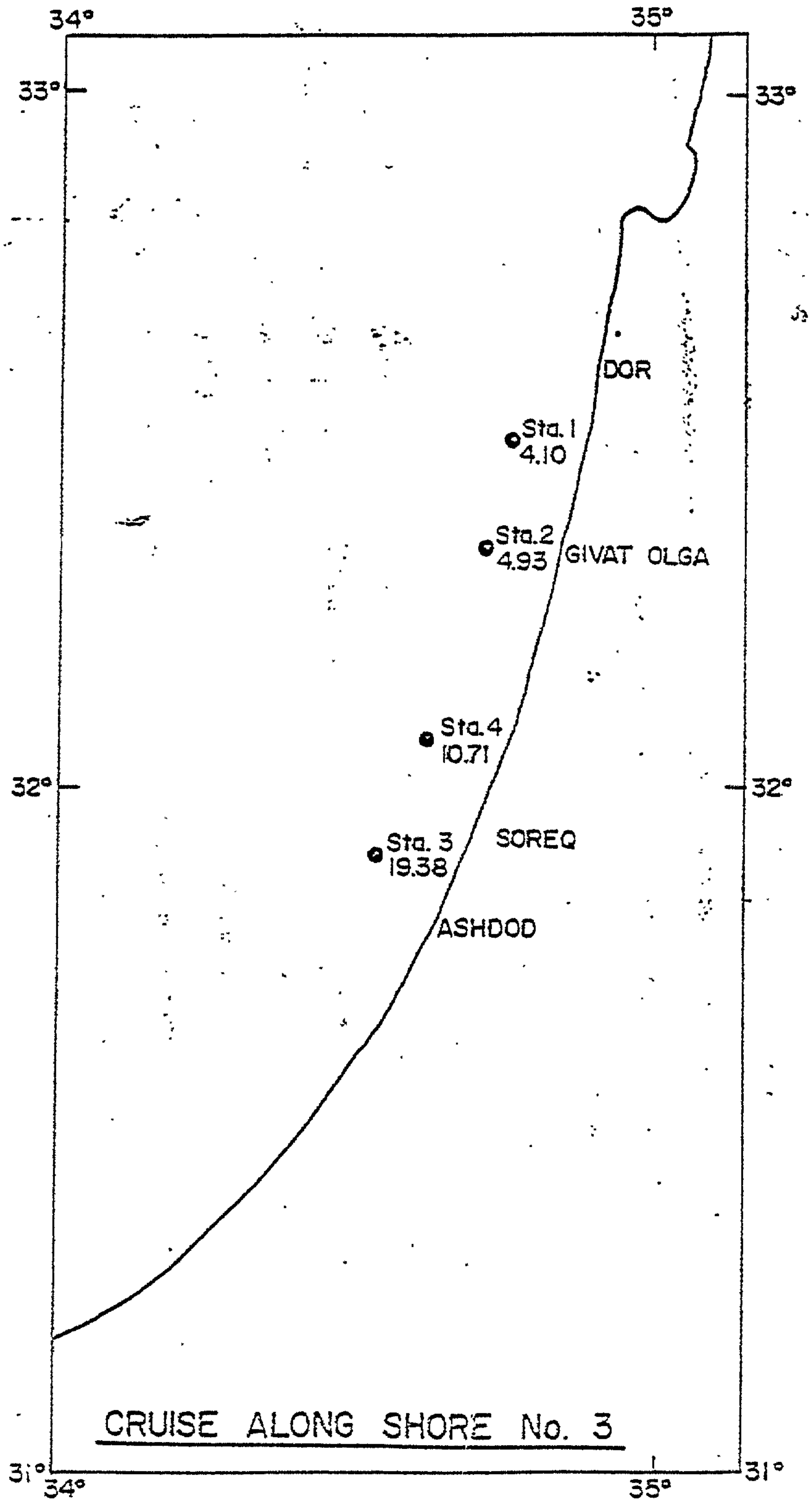

34°
35°
33°
33°
DOR
Sta. 1
4.10
Sta. 2
4.93
GIVAT OLGA
Sta. 4
10.71
32°
32°
Sta. 3
19.38
SOREQ
ASHDOD
CRUISE ALONG SHORE No. 3
31°
34°
35°
31°

Fig 4

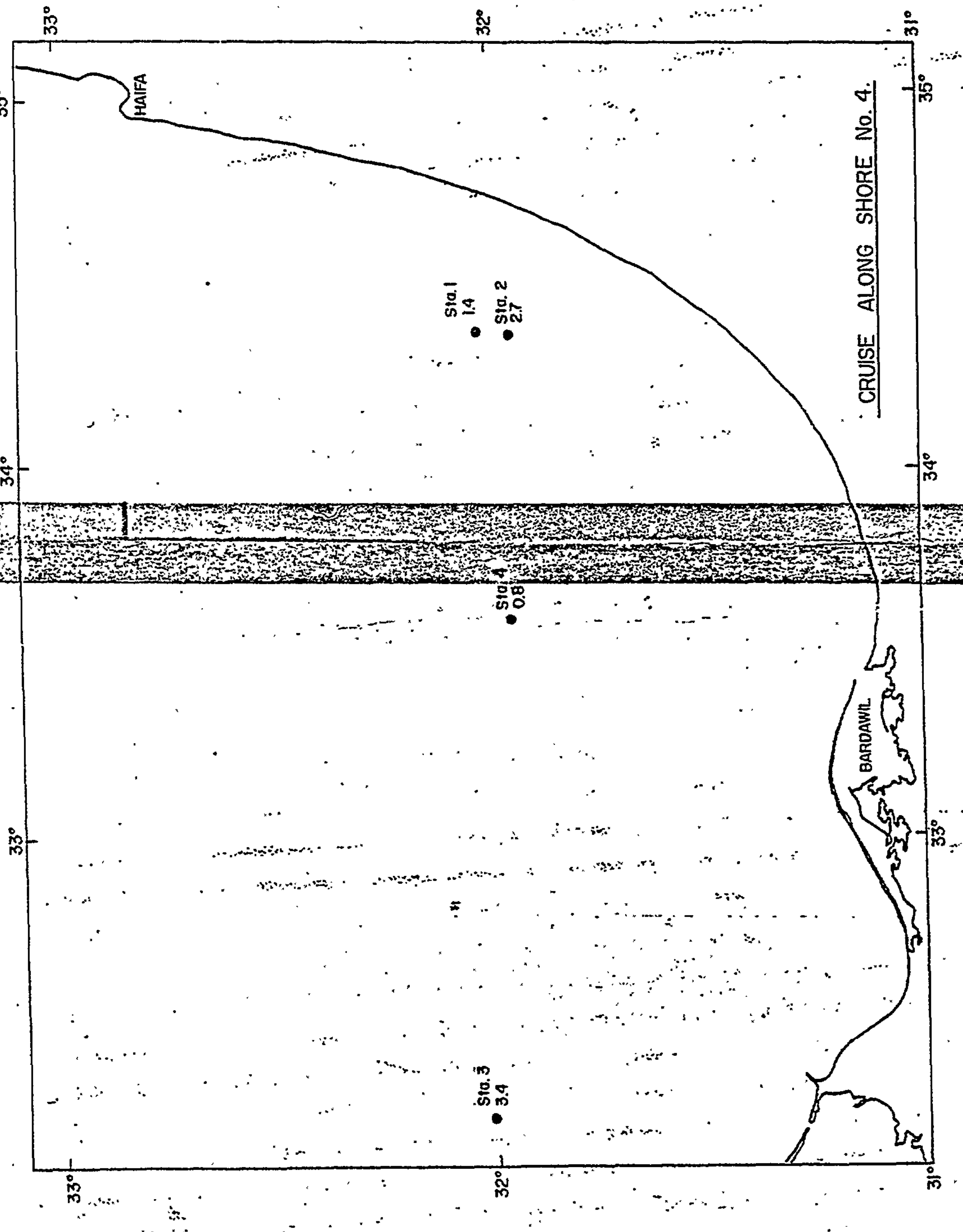

CRUISE ALONG SHORE No. 4.
HAIFA
BARDAWIL
Sta. 1
1.4
Sta. 2
2.7
Sta. 4
0.8
Sta. 3
3.4
35°
34°
33°
33°
32°
31°

Fig. 5

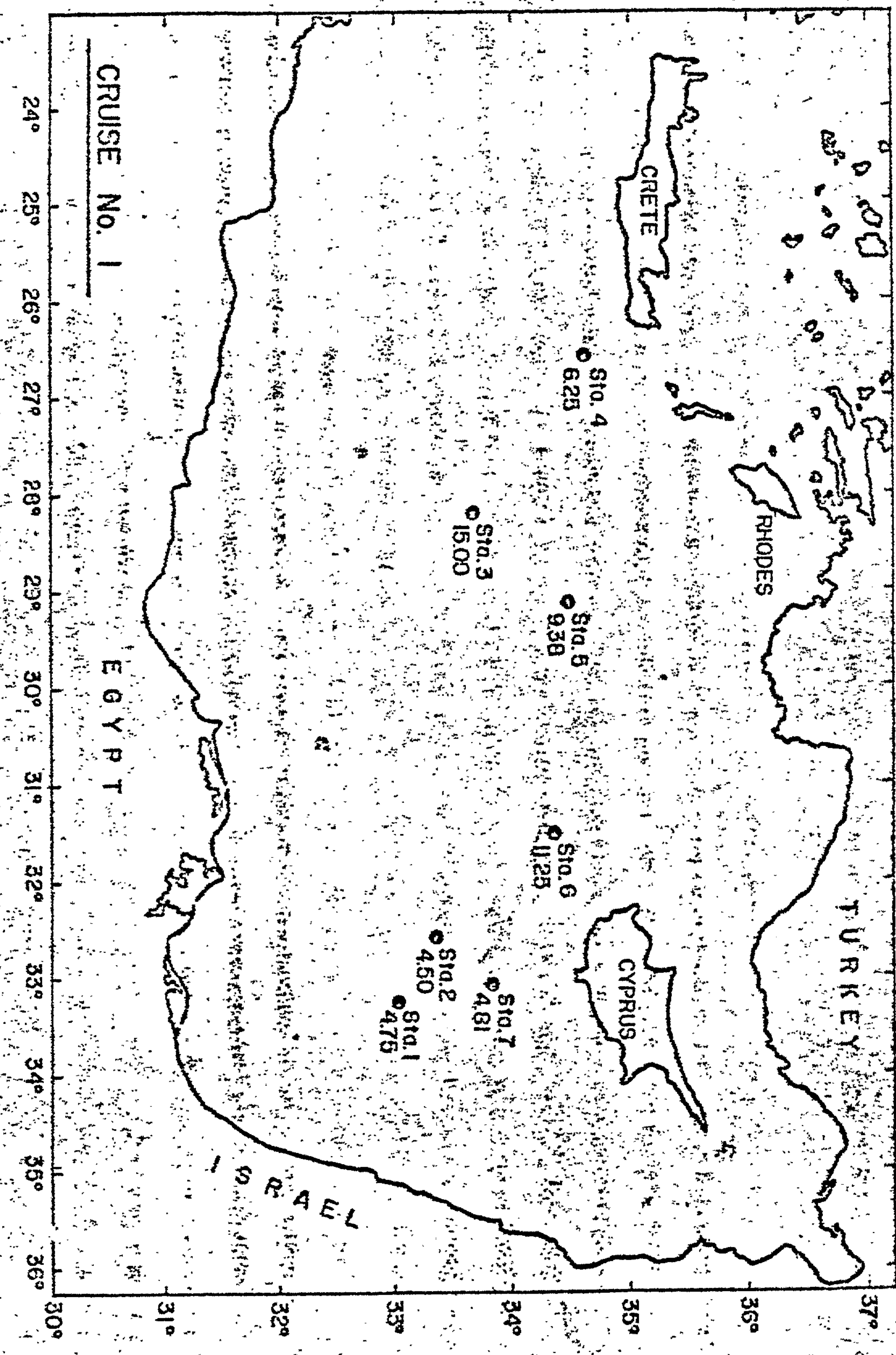


Fig 6

Cruise No 1

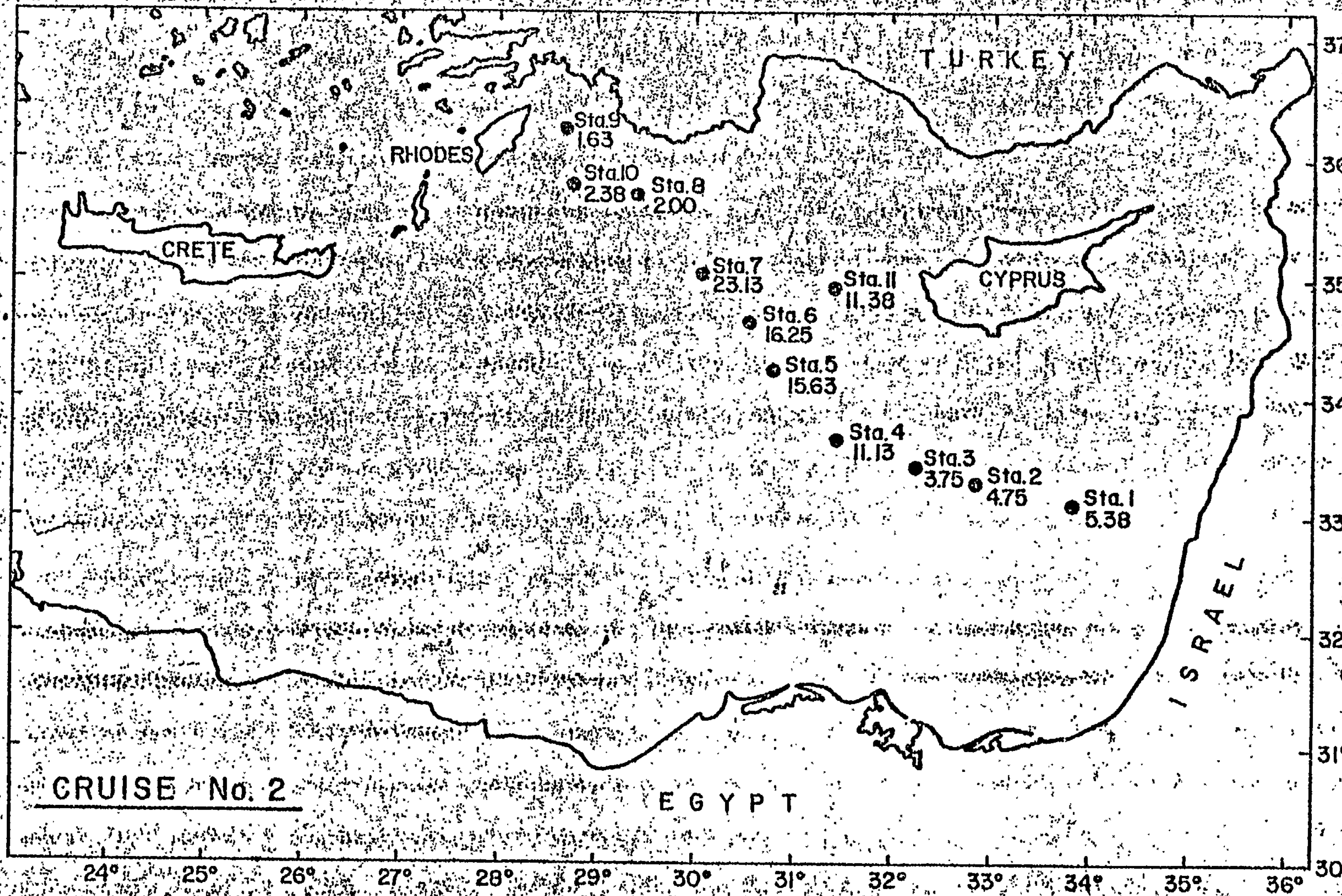

TURKEY
RHODES
CRETE
CYPRUS
ISRAEL
EGYPT
Sta.9
1.63
Sta.10
2.38
Sta.8
2.00
Sta.7
23.13
Sta.11
11.38
Sta.6
16.25
Sta.5
15.63
Sta.4
11.13
Sta.3
3.75
Sta.2
4.75
Sta.1
5.38
37°
36°
35°
34°
33°
32°
31°
30°
24°
25°
26°
27°
28°
29°
30°
31°
32°
33°
34°
35°
36°
CRUISE No. 2

Fig. 7

Cruise No 3

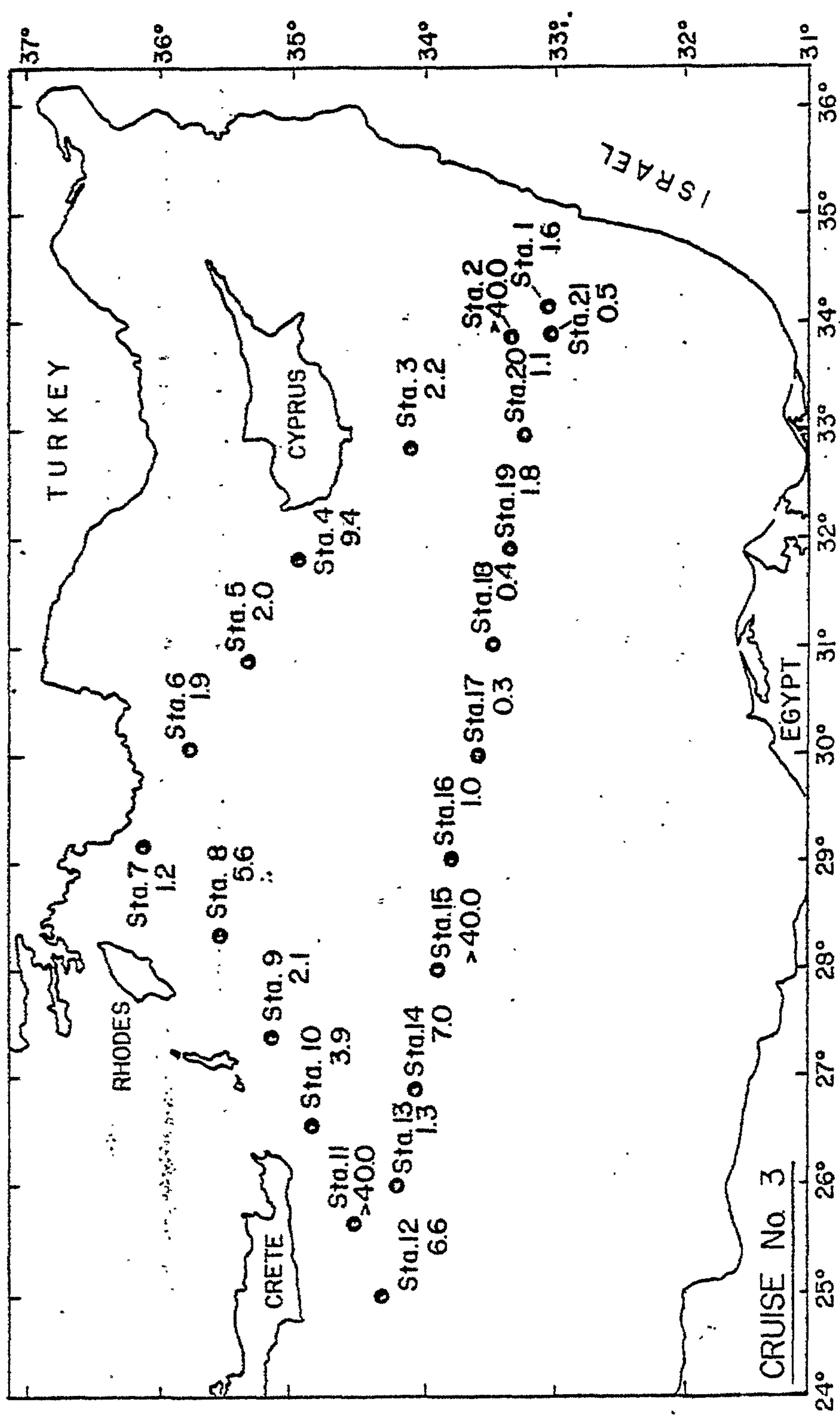


Fig 8

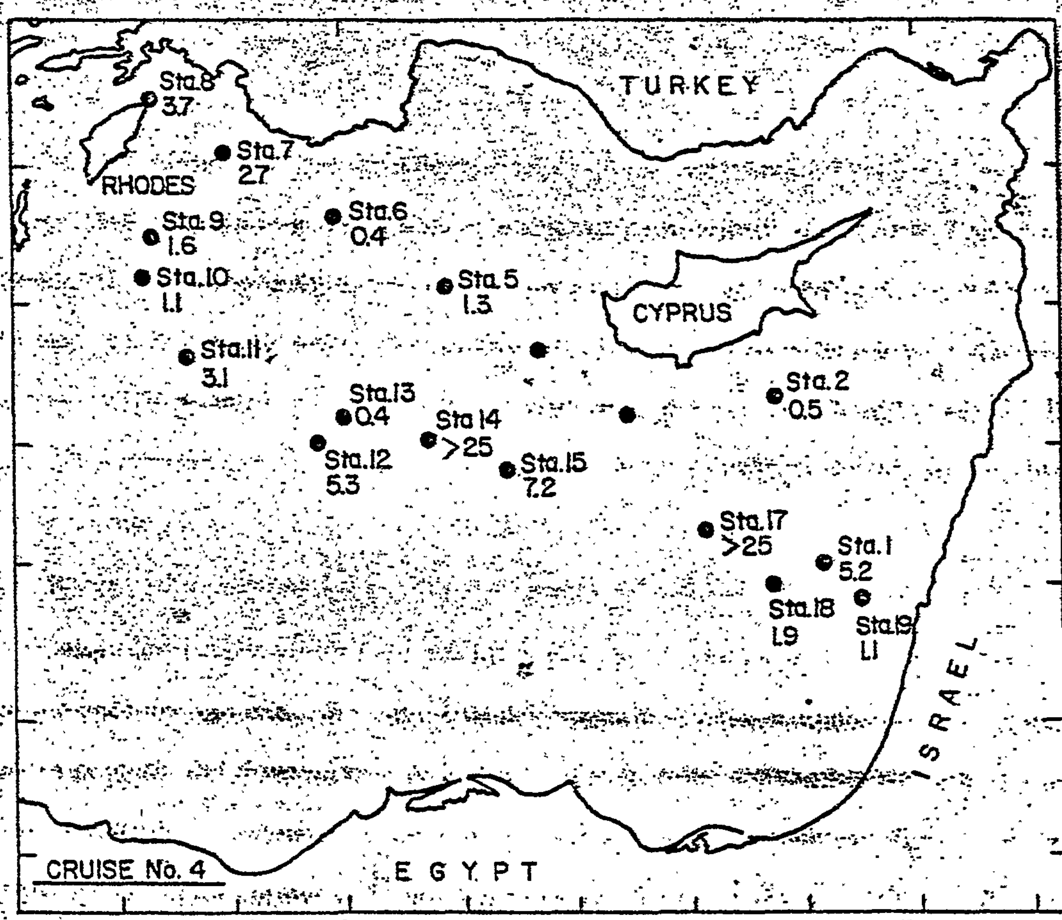

TURKEY
RHODES
CYPRUS
ISRAEL
EGYPT
CRUISE No. 4
Sta.8
3.7
Sta.7
2.7
Sta.6
0.4
Sta.9
1.6
Sta.10
1.1
Sta.5
1.3
Sta.11
3.1
Sta.13
0.4
Sta 14
>25
Sta.12
5.3
Sta.15
7.2
Sta.2
0.5
Sta.17
>25
Sta.1
5.2
Sta.18
1.9
Sta.19
1.1
37°
36°
35°
34°
33°
32°
31°
28°
29°
30°
31°
32°
33°
34°
35°
36°

Fig. 9

Partcipating Research Centre: Centre de Recherche marine
Conseil national de la Recherche scientifique
BEYROUTH
Liban

Principal Investigator: H.H. KOUYOUMJIAN

Introduction:

The Centre sampled tar on beaches from April 1977 till August 1978.

Area(s) studied:

Two principal zones were sampled: Ramlet al Baida to the south of Beirut, and Fidar, to the north. A third zone, Tripoli, was sampled three times. There are three sampling sites in each zone. Additional parametres were measured whenever possible (waves, winds, temperatures - air and sea - pH, salinity).

Material and methods:

The standard method was used. The data are shown in table 1.

Results and their interpretation:

The data generally suggest higher values in mid-summer, but are not adequate for firm conclusions.

Table 1

Average weights (from three samples) of tar on beaches (in g/m^2) for three stations, monthly, for the period April 1977 till August 1978.

Year/month		STATIONS Ramlet	Sidar	Tripoli
1977	April	1.4	0.6	0
	May	-	-	-
	June	-	-	-
	July	14.8	33.6	-
	August	11.0	0.5	-
	September	0	6.7	-
	October	0	0	-
	November	8.4	0	-
	December	2.9	0	-
1978	January	3.3	0.2	-
	Febraury	-	-	-
	March	1.4	0.5	-
	April	-	-	-
	May	0.8	0	0.4
	June	0.8	0	0.3
	July	-	-	-
	August	-	0	-

Partcipating Research Centre: The Old University
MSIDA
Malta

Principal Investigator: M.SAMMUT

Introduction:

Work on MED I started in April 1977. At first, owing to lack of equipment, only tar on beaches was measured.

Arrangements were made with Malta Armed Forces and the Regional Oil Combating Centre at Manoel Island to forward information regarding sightings of oil spills and other floating pollutants when these occur.

Measurement of floating tar particulates has not yet started. Our first attempts, at using the available neuston net were not successful because of the type of vessel we had available for sampling. A high-speed neuston net sampler (Derenbach and Ehrhardt, 1975) has been constructed, but presently we are having problems in using this neuston sampler because of frequent non-availability of boat and suitable land transport.

Meterological data is provided by the Meterological Office, Luqa.

Area(s) studied:

Oil spills and other floating pollutants: the whole of the Maltese coast is observed.

Tar on beaches: three areas are sampled:

Qawra: on the Northeasterly coast of Malta directly affected by Easterly and North Easterly winds;

Anchor Bay: on the Northeasterly coast of Malta, directly effected by Westerly and Northwesterly winds;

Marsaxlokk Bay: on the Southern coast of Malta, directly effected by Southerly and Southwesterly winds.

The shoreline is quite uniform in all three areas, straight at Qawra and Marsaxlokk Bay and slightly concave at Anchor Bay. The slope is gentle in all three areas. Substrate and shoreline are sand and gravel at Anchor Bay, sand at Qawra and muddy sand at Marsaxlokk Bay. A considerable quantity of Posidonia is deposited on all three areas especially during the winter months. There is a minimum of human activity at all three sites although some bathing is done in peak summer months. No land-based sources of heavy oil residues exist at these sites, however, slight spillage of diesel oil occurs at Marsaxlokk Bay, but this is not considered to have any significant influence on tar ball deposits on the beach.

Dissolved/dispersed hydrocarbons: Sampling sites are around the coast of Malta usually about 1 km from shore. The sites are:

	Latitude	Longitude
1. Off Grand Harbour	35 54'N,	14 33'E
2. Off Marsaxlokk Bay	35 49'N,,	14 33'E
3. Off Ghar Lapsi	35 48'N,	14 26'E
4. Malta Channel	36 00'N,	14 21'E
5. Off Qawra	35 58'N,	14 26'E

One major sewage outfall exists at Wied Ghammieq in the vicinity of Station 1. Another sewage outfall is in the vicinity of Anchor Bay. The Northern side of Malta, which has a gently sloping shoreline, is the most urbanized coastal area while the Southern side consists mainly of cliffs. There are no oil refineries on the Island and any 'oil' from land probably originates from sewage effluents. At times very small oil spills occur in harbours such as Grand Harbour, Marsamxett Harbour, Marsaxlokk Bay. Most of the oil on beaches is a result of tanker operations in the vicinity of Malta.

The sampling sites are shown in figure 1.

Methods and materials:

Oil slicks and other floating pollutants: the position and estimated area of each slick obseved is recorded.

Tar balls on beaches: three strips, 2 metres wide, running from the shoreline (in calm sea conditions) to the inner wave limit, were selected for each areas, depths were as follows:

Anchor Bay : 3 m

Qawra : 5 m

Marsaxlokk : 5 m

Each zone was thoroughly cleaned and staked out in April 1977. Sampling commenced after 14 days, and was continued at 14-15 day intervals.

The total amount of tar in each zone was weighed. In cases where the tar balls were coated (totally or partially) with Posidonia, this was removed prior to weighing.

Dissolved/dispersed hydrocarbons: measurement was by a Turner Model 430 ultra-violet spectrofluorimetre, after extraction of the sample by carbon tetrachloride, without clean-up. Besides the three main sites (off Grand Harbour, off Marsaxlokk, and the Malta Channel) two other sites (off Ghar Lapsi and off Qawra) were later included so as to assess the levels of dissolved/dispersed hydrocarbons all around the coast of Malta. A patrol boat of the Malta Armed Forces was used for sampling; our intention was always to sample on a monthly basis, but, this actually depends on weather conditions and availability of a boat. Triplicate samples are taken at each site, from a depth of 1 metre.

The intrcomparison exercise for dissolved/dispersed hydrocarbons organized by Dr. A. Zsolnay of Duke University, N.C., U.S.A., was carried out three times (October 1977, November 1977, February 1978). Results showed good precision and accuracy (Document IOC-WMO/MAPMOPP-11/12 Add.1. Washington D.C. February 1978).

Results and their interpretation:

Oil slicks: the observations are given in table 1. Oil slicks are small and infrequent.

Tar on beaches: Results for the three sites are shown in tables 2-4. The weight of tar has been calculated on the basis of daily accumulation since it has not always been possible to sample on the same day of each month. The relatively high standard deviation of the weight of tar collected on the same day from three strips at the same site indicates an uneven accumulation of tar on the beach. This variation could be due to the geographical characteristics of the beach as well as to the quality (size) of tar balls on each strip. Large tar balls (up to 20 kg) were sometimes seen at Anchor Bay but these tar balls were outside the sampling strip. The tar balls found are of various sizes varying from oil films to individual tar balls some 20 cm in diametre. The quality of the tar is mostly of the non-sandy and sandy types, with very little coquina being found. Preliminary tests have shown that the water content of the tar can be up to 19.5 per cent (w/w) and the debris 31 per cent (w/w).

There seems to be correlation between the prevailing wind direction and tar accumulation on beaches. The highest accumulation of tar is at Anchor Bay, which is exposed to prevailing westerly winds, whereas at Qawra and Marsaxlokk, where the wind is generally offshore, the quantity of tar is much lower, and in many instances no tar is deposited on the beach. More is deposited at Anchor Bay in autumn and winter than in spring and summer.

At Marsaxlokk Bay higher levels were found in June/July 1977 and January/February 1978. In the former two months this correlates with prevailing winds in the onshore direction. The tar accumulation for January/February 1978 (joint results) may not be representative of the whole beach, since at two strips no tar was found, while two large tar balls were found on the third strip. At Qawra there has been a consistent decrease in tar since July 1977 and no tar has been found since December 1977.

Results are shown in table 5. The most striking features of the results obtained so far are the low levels as well as the large variability (indicated by the standard deviation) in the results from samples collected at the same time and place. The levels indicate minimal presence of dispersed/dissolvd hydrocarbons in the coastal waters round Malta. Oil films on the water surface were never encountered at any of the sampling sites. It should be noted that samples from Grand Harbour contained 3.42 ug/l of dispersed/dissolved hydrocarbons.

The large variations could be due to uneven distribution of dissolved/ dispersed oil in the water column. A statistically significant temporal and spatial variation in the levels of dispersed/dissolved hydrocarbons in seawater round the coast of Malta is not apparent in view of the variability in sets of results.

A typical emission spectrum of the water extracts, compared to chrysene shows a maximum at around 340nm whereas chrysene has a maximum in the 380nm region (excitation 310nm) which indicates that the dispersd/dissolved oil is not of heavy type (e.g., crude oil or bunker oil) but rather a lighter type of oil such as diesel oil or a light fuel oil. However, fractionation of the oil due to preferential solubiliation of certain oil fractions cannot be excluded.

Conclusions:

Very few oil spills have been sighted round the coast of Malta and it is possible that a majority of oily residues are discharged at a fair distance from the Island and reach shore in the form of tar balls. The accumulation of tar on beaches seems dependent on the prevailing wind which in Malta is northwesterly. However, knowledge of surface water currents particularly in inshore waters and bays could provide useful information on the transport of tar balls particularly in view of the uneven distribution of tar on the beaches being sampled.

In our opinion, this exercise is only providing an indication of the deposition of tar on beaches since wave action may wash back some of the tar balls, water and debris are included in the estimation of tar, and the sampling zones may be representative of the whole beach.

The level of dispersed/dissolved hydrocarbons (expressed as Chrysene units) around the coast of Malta are low and no seasonal and/or temporal variations are observed. Although Chrysene may be a useful standard which would enable better comparison of results from different regions, it is considered doubtful whether chysene allows a good estimation of dispersed/ dissolved oil when its emission spectrum is so different from that of the water extracts.

Table 1

Observations of oil spills

Date	Position	Size	Action Taken	Remark
3.6.76	RTCI*	50ft sqr	mechanical removal and dispersion.	-
24.7.76	RTCI*	200 gallons	mechanical removal and dispersion.	-
19.1.78	33^{0} 57'N 15^{0} 31'E	Unspecified	None	Oil slick reported by an aircraft of RAF (Malta).
13.278	13 miles NNW of Luqa (Malta)	2sqr miles	Oil slick dispersed by Maltese authorities	Oil slick reported by an aircraft of RAF (Malta)

* Ricasoli tank cleaning installation.

(No oil slicks were ever observed during sampling trips).

No records of small oil spills that occur in harbours (Grand Harbour, Marsaxlokk Bay, Marsamxett, St. Paul's Bay) are available.

Table 2

TAR ON BEACHES (MALTA)

ANCHOR BAY

	Date	Predominant Wind Direction	$g/m^2/day$	S.D.*
	13/4/77	ONshore	10.0	6.9
A				
	27/4/77	ONshore	4.6	1.3
M				
	13/6/77	OFFshore	1.2	0.6
J/J				
	10/8/77	OFFshore	0.9	0.6
A				
	30/8/77	ONshore	2.8	1.6
S				
	5/10/77	ONshore	1.1	0.6
O/N				
	6/12/77	ONSHORE	6.4	5.1
D				
	3/1/78	ONshore	6.4	4.3
J/F				
	20/2/78	ONshore	7.4	4.4
M				
	10/4/78	ONshore	8.9	2.7
A				
	11/5/78	ONshore	0.9	0.8
M				
	8/6/78	ONshore	2.9	0.3
J				
	6/7/78	ONshore	1.0	0.3
J				
	8/8/78	ONshore	3.7	4.6
	12/9/78	ONshore	Fresh oil mixed with seaweeds could not be collected.	

* S.D. - Standard Deviation

Table 3

TAR ON BEACHES (MALTA)

MARSAXLOKK BAY

	Date	Predominant Wind direction	g/m^2 day	S.D.*
A	18/4/77	OFFshore	0.4	0.5
M	2/5/77	OFFshore	0.5	0.7
J	13/6/77	ONshore	1.0	0.4
J	8/7/77	ONSHORE	1.5	0.3
A	8/8/77	ONshore	1.2	0.6
S	1/9/77	Partly ON (rest OFF)	0.3	0.4
O/N	5/10/77	OFFshore	0	-
N	14/11/77	OFFshore	0.1	0.09
D	6/12/77	OFFshore	0.1	0.02
J/F	3/1/78	OFFshore	0.2	0.16
M	20/2/78	OFFshore	1.7	2.9
A	10/4/78	OFFshore	0.2	0.3
M	11/5/78	OFFshore	0	-
J	8/6/78	OFFshore	0	-
J	6/7/78	OFFshore	0	-
	8/8/78	OFFshore	0	-
	12/9/78	OFFshore	0	-

* S.D. - Standard Deviation

Table 4

TAR ON BEACHES (MALTA)

	Date	Predominant Wind direction	$g/m^2/day$	S.D.*
	18/4/77	OFFshore	0	-
A				
	2/5/77	OFFshore	0	-
M				
	16/6/77	ONshore	1.5	1.0
J				
	5/7/77	Alongshore	0.6	0.5
J				
	5/8/77	Alongshore	0.6	0.4
A				
	30/8/77	OFFshore	0.03	0.6
S				
	5/10/77	Alongshore	0.05	0.05
O/N				
	14/11/77	OFFshore	0.6	0.5
N				
	6/12/77	OFFshore	0	-
D				
	3/1/78	OFFshore	0	-
J/F				
	20/2/78	OFFshore	0	-
M				
	10/4/78	OFFshore	0	-
A				
	11/5/78	OFFshore	0	-
M				
	8/6/78	OFFshore	0	-
J				
	6/7/78	OFFshore	0	-
J				
	8/8/78	OFFshore	0	-
	12/9/78	OFFshore	0	-

* S.D. - Standard Deviation

Table 5

DISPERSED/DISSOLVED HYDROCARBONS IN THE COASTAL WATERS OF MALTA

Levels expressed as u/gl in terms of chrysene

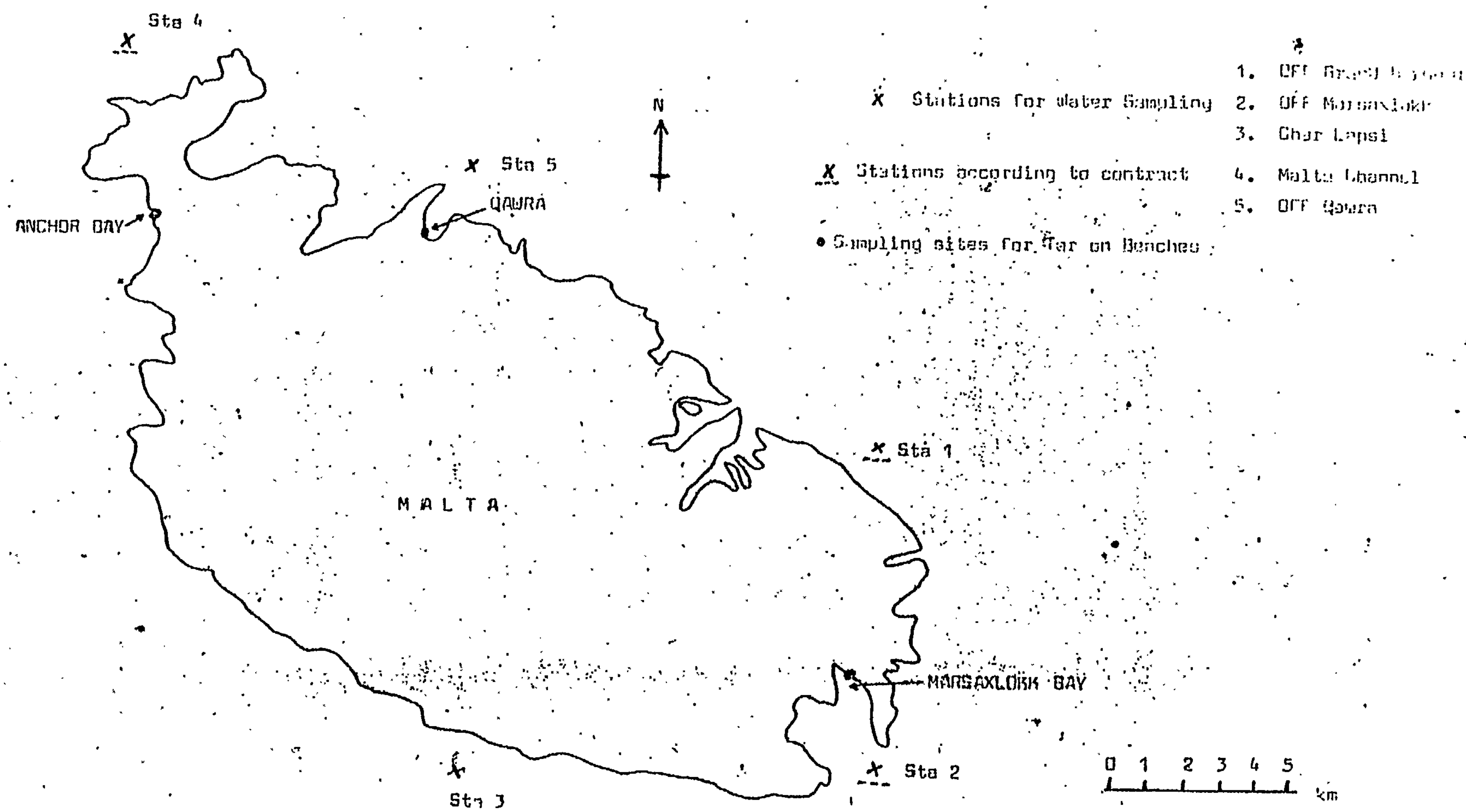
Date	Station 1 OFF Grand Harbour		Station 2 OFF Marsaxlokk		Station 3 OFF Ghar Lapsi		Station 4 Malta Channel		Station 5 OFF Qawra	
	π *	S.D. *	π	S.D.	π	S.D.	π	S.D.	π	S.D.
14/10/77	0.160	0.111	0.053	0.056			0.138	0.084		
11/11/77	0.064	0.02	0.078	0.023	0.070	0.043	0.074	0.020	0.052	0.020
29/12/77	0.097	0.047								
13/1/78	0.095	0.065								
6/3/78	0.048	0.002	0.292	0.201	0.256	0.290	0.050	0.019	0.216	0.276
30/3/78	0.038	0.040								
11/4/78	0.041	0.016	0.025	0.009	0.046	0.009	0.037	0.031	0.052	0.017
16/5/78	0.031	0.012	0.026	0.006	0.021	0.008				
11/7/78	0.042	0.008	0.065	0.014	0.027	0.008	0.039	0.006	0.032	0.009
20/9/78	0.032	0.010	0.050	0.027	0.116	0.113	0.023	0.006	0.022	0.004
	Inside Grand Harbour									
14/10/77	3.434	0.386								

* π Arithemetic mean of triplicating samples.

S.D. Standard Deviation

FIGURE 1

MAP OF MALTA SHOWING SAMPLING SITES FOR MED-I



CENTRO DE INVESTIGACION PARTICIPANDO EN EL PROYECTO : Instituto de Investigaciones Pesqueras
CADIZ
Espana

Investigador Principal: M. CALDERON

Introduccion:

La zona de la Bahia y Puerto de Cadiz ha sido el area estudiada hasta ahora por nosotros, mas adelante esperamos ampliar nuestro estudio a otras zonas de la costa gaditana, dentro de los 36º y 36º 50' de latitud N y entre los 5º 25' y los 6º 26' de longitud W.

Las fuentes contaminantes presentes en la zona son predominantemente aguas urbanas residuales no depuradas, procedentes de las poblaciones de Cadiz, Puerto Real, Puerto de Sta. Maria, Rota y las aguas fluviales, junto con su carga contaminante, del rio Guadalete y el rio San Pedro, este ultimo, aunque cano, aporta sin embargo agua dulce de los esteros. Los focos mas importantes de contaminacion industrial son los Astilleros de Matagorda y una fabrica de azucar cuyos residuos llegan a la Bahia a traves del rio Guadalete.

Area estudiada:

La zona de la Bahia y Puerto de Cadiz, asi como las estaciones de muestreo, se muestra en la Figura 1.

Materiales y metodos:

Todo el material utilizado de vidrio o teflon, es cuidadosamente lavado y posteriormente enjuagado con disolvente antes de ser utilizado. El disolvente empleado es eter de petroleo de punto de ebullicion inferior a 40ºC, este disolvente ha sido previamente purificado con el tratamiento adecuado para eliminar las trazas de aromaticidad.

Se tomaron muestras de agua superficial durante los anos 1976 y 1977, y luego en el ano 1978 se tomaron a 1 m de profundidad, todas en botellas de 1,3 l.

Para los anos 1976 y 1977 se practico una extraccion inmediata, en ampollas de decantacion de 2 l. de capacidad, con eter de petroleo (2 x 50 ml). Concentracion a 1-2 ml en evaporador rotario a temperatura de 40ºC y vacio a la trompa. Medida de la aromaticidad en espectrofluorimetro Perkin-Elmer MOD. MPF-3L. Creemos que la reproducibilidad del metodo es aceptable.

A partir del ano 1978 se ha seguido el criterio recomendado descrito en el documento IOC-WMO-UNEP/MED-MRM/3 Supp. 2. No obstante se ha introducido una modificacion en el metodo. Dado que el principal producto contaminante primario en la zona estudiada es el gas-oil marino, la intensidad de la fluorescencia de los extractos se determina a una excitacion de 295 nm, en lugar de la recomendada en el metodo, 310 nm, y la fluorescencia en la region de los 330 nm en vez de la de 360 nm. Se ha utilizado como patron gas-oil marino, usado como combustible por los barcos y que presenta caracteristica espectrofluorimetricas muy semejantes a las muestras estudiadas. El criseno dadas las caracteristicas espectrales que hemos empleado no ha sido utilizado como patron. En los casos de duda y como apoyo se ha utilizado en el analisis la tecnica de cromatografia gas-liquido.

Resultados y su interpretacion:

Manchas de petroleo : jirones o manchas de peliculas finas de petroleo de color irisado, son observados con relativa frecuencia procedente del trafico maritimo del puerto, aunque en cantidades absolutas no considerables.

Residuos solidos de petroleo flotantes: en el Puerto y Bahia de Cadiz no se observan normalmente residuos solidos flotantes de petroleo particulado, salvo cuando la marea es creciente y el viento de Poniente. Con viento de Levante el agua de la Bahia esta limpia.

En la orilla oriental del istmo gaditano se han observado con frecuencia cantidades apreciables de residuos solidos flotando o en la area, durante el ano 1977. En los meses transcurridos de 1978 la aparicion de residuos ha sido menos frecuente y en menor cantidad.

Residuos petroliferos disueltos y/o dispersos: en el Cuadro I, se dan los valores expresados en ug/l de los residuos petroliferos disueltos y/o dispersos en el agua del puerto y bahia de Cadiz en las ocho. Asimismo se dan los promedios anuales por estacion y la desviacion standard correspondiente para el ano 1976. Los niveles de contaminacion oscilan dentro de limites no alarmantes. Las estaciones E - 1 a E - 6, presentan unos indices de contaminacion minimos para zonas cercanas a un puerto. Las estaciones E - 7 y E - 8 dentro del puerto, presentan oscilaciones bruscas en el nivel de contaminacion. Esto es logico dado que depende del mayor o menor trafico maritimo existente, y de la apertura, o no, de un dique seco situado en las proximidades de la estacion E - 7.

En el Cuadro II, se indican los valores medios anuales expresados en ug/l de las estaciones estudiadas, junto con los estadisticos, desviacion normal (s) y numero de muestras para cada estacion, para los anos 1977 y 1978.

Los comentarios hechos con respecto a los resultados para el ano 1976 son validos para los anos 1977 y 1978. No obstante los promedios para 1978 son notablemente inferiores a los de 1977.

Los espectros de fluorescencia que se obtienen de los extractos organicos, procedentes de las muestras estudiadas, son analogos a los que presentan los hidrocarburos de petroleo contenidos en los gas-oil marinos envejecidos en mayor o menor grado. Asimismo los cromatogramas de los anteriormente citados extractos organicos corresponden a aquellos obtenidos para los gas-oil marinos con mayor o menor grado de envejecimiento.

Conclusiones:

De la observacion de los datos se duducen que los niveles de contaminacion oscilan dentro de limites no alarmantes. Consideramos que el contaminante original es principalmente gas-oil marino acompanado en parte y no siempre por fuel-oil marino y por aceite de motores quemado, aunque este ultimo en menor proporcion que el anterior.

CUARDRO I

Cont.

1976 Mes	E - 5	E - 6	E - 7	E - 8
Enero	17,07 - 13,61	13,59 - 12,80	35,82 - 42,08	3.858,44 - --
Febrero	8,75 - 51,74	10,73 - 12,77	58,56 - 13,88	29,88 - 33,20
Marzo	5,24 - 7,26	11,70 - 19,22	17,65 - 10,59	12,81 - 37,54
Abril	2,68 - 2,86	2,48 - 3,42	9,76 - 7,70	16,83 - 38,28
Mayo	0,48 - 0,61	0,89 - 0,81	2,66 - 2,85	25,06 - 38,74
Junio	1,71 - 4,04	4,77 - 4,17	5,33 - 7,65	13,11 - 10,31
Julio	1,15 - 1,78	1,93 - 1,81	15,72 - 6,76	15,18 - 16,91
Agosto	34,19 - --	39,30 - --	16,69 - --	91,53 - --
Septiembre	10,80 - 11,43	19,76 - 22,59	41,21 - 47,18	439,00 - 519,63
Octubre	18,62 - 19,20	30,37 - 25,22	43,78 - 1094,71	253,84 - 1126,44
Noviembre	35,91 - 35,91	49,38 - 21,80	55,15 - 35,91	109,01 - 69,26
Diciembre	25,60 - 19,82	25,04 - 24,02	668,33 - 763,09	204,18 - 193,25
$\bar{x}$, s	14,40 - 13,80	15,60 - 12,70	130,60 - 283,40	

CUARDRO I

Los valores de la concentracion (ug/l) de residuos petroliferos disueltos y/o dispersos en el agua en el puerto y bahia de Cadiz en 1976. Hay, en la mayoria de los casos dos valores cada mes, asi como los promedios anuales ($\bar{x}$) y las desviaciones standard (s) correspondientes.

E S T A C I O N

1976 Mes	E - 1	E - 2	E - 3	E - 4
Enero	31,46 - 16,48	6,80 - 8,24	10,51 - 9,09	23,52 - 10,74
Febrero	4,66 - 3,39	4,42 - 5,93	5,39 - 4,39	3,91 - 5,55
Marzo	11,25 - 5,18	6,07 - 11,70	4,90 - 5,91	5,62 - 9,36
Abril	1,64 - --	2,01 - 2,56	3,02 - 2,49	2,85 - 2,31
Mayo	0,97 - 0,82	1,46 - 0,52	1,23 - 0,90	0,81 - 0,56
Junio	1,33 - 1,63	1,28 - 1,33	0,85 - 1,28	1,59 - 1,11
Julio	1,37 - 1,07	6,50 - 3,86	1,41 - 1,22	3,11 - 1,81
Agosto	13,99 - --	7,68 - --	15,88 - --	12,38 - --
Septiembre	14,93 - 19,06	10,80 - 14,93	12,07 - 27,00	15,25 - 13,83
Octubre	28,78 - 15,63	56,11 - 24,62	11,01 - 11,01	16,52 - 17,45
Noviembre	20,52 - 21,16	18,60 - 19,24	39,12 - 37,20	26,93 - 20,52
Diciembre	23,69 - 108,30	9,53 - 16,28	16,23 - 17,76	146,82 - 15,23
$\bar{x}$, s	15,8 - 22,40	10,50 - 11,70	10,40 - 10,80	15,60 - 29,00

/....

CUADRO II

Promedios anuales (con sus correspondientes desviaciones standard y numero de muestras) para las concentraciones (en ug/l) de residuos petroliferos disueltos y/o dispersos en aguas superficiales del puerto y bahia de Cadiz en 1977 y 1978.

1977 Estaciones			1978 Estaciones		
E - 1	$\bar{x}$ =	12,8	E - 1	$\bar{x}$ =	2,6
	s =	11,63		s =	1,5
	n =	22		n =	8
E - 2	$\bar{x}$ =	15,3	E - 2	$\bar{x}$ =	3,7
	s =	11,5		s =	2,2
	n =	22		n =	8
E - 3	$\bar{x}$ =	20,9	E - 3	$\bar{x}$ =	5,5
	s =	33,9		s =	4,4
	n =	22		n =	8
E - 4	$\bar{x}$ =	9,0	E - 4	$\bar{x}$ =	3,8
	s =	3,4		s =	2,6
	n =	22		n =	8
E - 5	$\bar{x}$ =	25,4	E - 5	$\bar{x}$ =	4,2
	s =	48,7		s =	2,6
	n =	21		n =	8
E - 6	$\bar{x}$ =	15,01	E - 6	$\bar{x}$ =	3,9
	s =	14,6		s =	2,2
	n =	22		n =	8
E - 7	$\bar{x}$ =	96,1	- 7	$\bar{x}$ =	9,5
	s =	217,5		s =	8,2
	n =	22		n =	7
E - 8	$\bar{x}$ =	147,4	E - 8	$\bar{x}$ =	16,19
	s =	220,6		s =	26,0
	n =	22		n =	7

Por causas de fuerza mayor no pudieron realizarse los analisis correspondientes a los meses de Marzo - Junio en 1978.

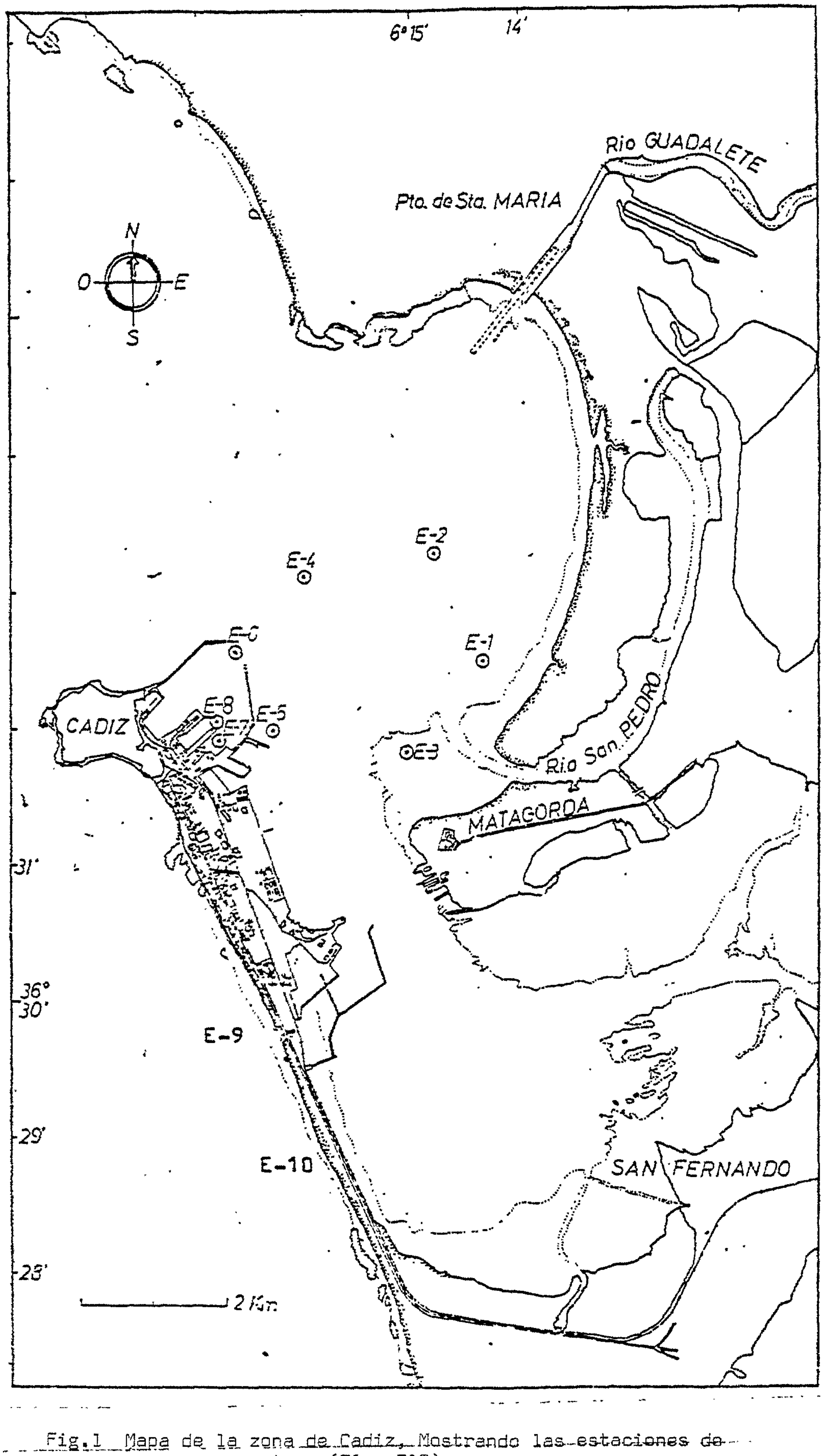


Fig. 1 Mapa de la zona de Cadiz, Mostrando las estaciones de noestreo (E1 - E10)

Partcipating Research Centre: Marine Science Department
Middle East Technical University
ERDEMLI-ICEL
Turkey

Principal Investigator: T.I. BALKAS

Introduction:

The hydrocarbons (aromatic) contents of seawater between Mersin and Akkuyu were investigated.

Area(s) studied:

This is shown in figure 1 (with the results: range of value obtained).

Material and methods:

Tar balls on beaches: samples were taken at a beach by the METU campus at Erdemli on 11 June 1977 (nine samples), 23 July 1977 (six samples), 25 June 1978 (seventeen samples), and at Akkuyu on 9 July 1978 (seven samples).

Dissolved/dispersed hydrocarbons: Samples were collected with special steel-framed samplers containing 2.5 l glass bottles. Sampling was repeated every three hours along the ship's track at a distance of approximately 5 km from the shore. Samples were taken at 1m depth. After the samples were taken, 25 ml of carbon tetrachloride was added to each sample, to avoid oxidation and degradation.

A Turner ultra-violet spectrofluorimeter Model 430 was used to analyze the samples.

Turkish crude oil, drilled in South-East Anatolia, was used as a standard to calculate the hydrocarbon content of the samples. The working standards were prepared within the range of 0.02 to 0.50 ppm, from a stock of 10 ppm. The crude oil originally consisted of 2 per cent aromatic hydrocarbon by weight.

Results and their interpretation:

Tar balls on beaches: the data may be summarized as follows:

Station	Date	Range g/m^2	Mean g/m^2
Campus	11-6-77	21.9 - 52.8	34.3
	23.7.77	4.8 - 52.6	27.9
	25.6.78	5.3 - 44.6	17.9
Akkuyu	9.7.78	2.5 - 24.4	12.4

Dissolved/dispersed hydrocarbons: the data are summarized in figure 1. High values (>725 ug/l) occur occasionally. In the vicinity of Mersin, an important port, such values would not be surprising.

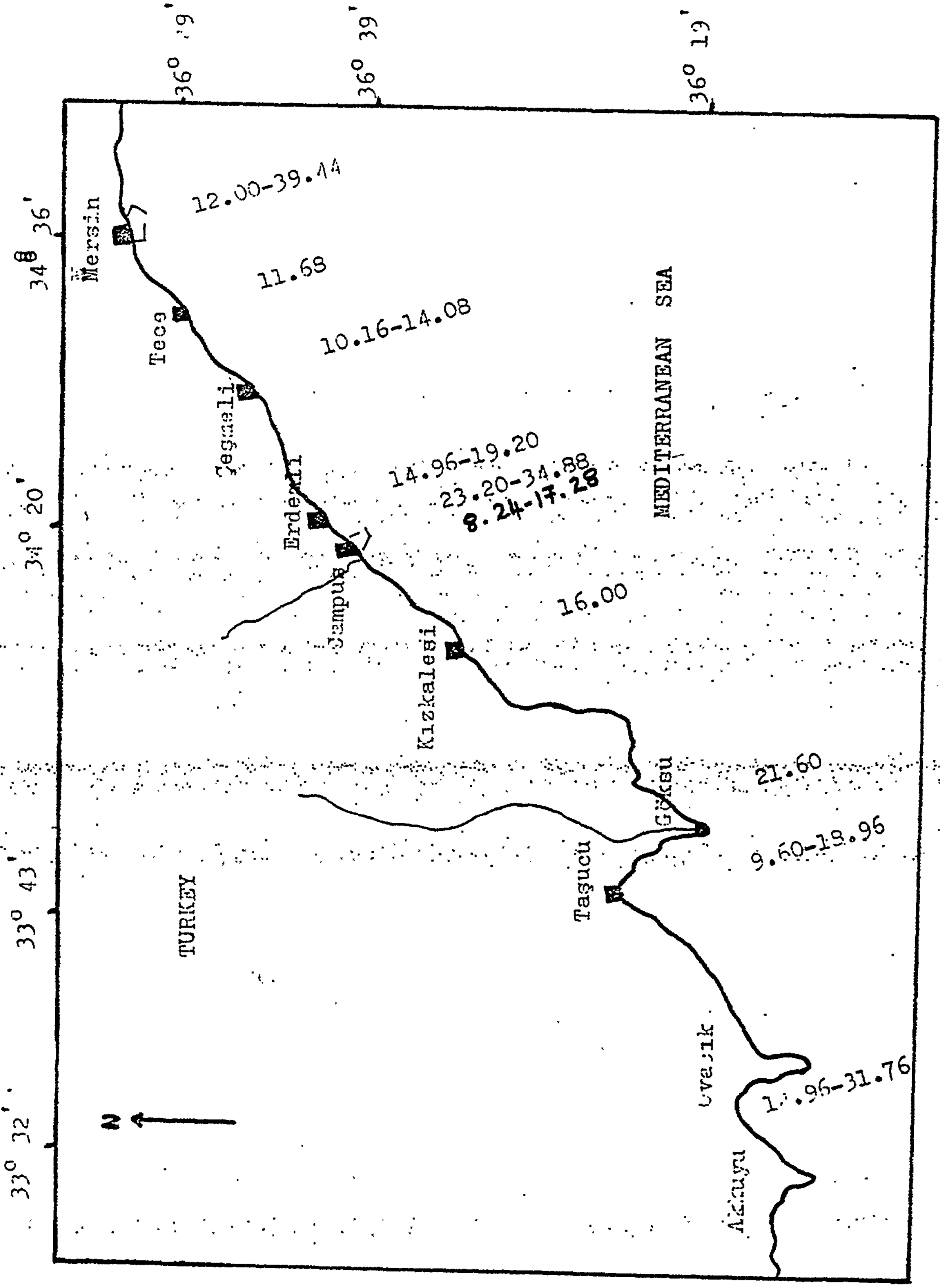

36° 39'
36° 19'
34° 20'
33° 43'
33° 32'
Mersin
Erdemli
Kizkalesi
Taşucu
TURKEY
MEDITERRANEAN SEA
N
12.00-39.44
11.68
10.16-14.08
14.96-19.20
23.20-34.88
8.24-17.28
16.00
21.60
9.60-18.96
.96-31.76

Fig. 1

Participating Research Centre: Centre for Marine Research
"Rudjer Boskovic" Institute
ZAGREB
Yugoslavia

Principal investigator: V. PRAVDIC

Introduction:

This report describes work done under the IOC/WMO/UNEP MED-I project. The field work was however, incorporated into a large environmental impact assessment study of Rijeka Bay which the Centre for Marine Research is excuting for a consortium of Yugoslav national and local authorities and the investment company constructing the Northern Adriatic Deep Water Oil Terminal. Authorization was given to use the data from these combined studies in the present report.

This project is using the same cruises and some of the same stations for sampling as the IOC/UNEP Pilot Project on Problems of Coastal Transport of Pollutants (MED-VI).

Area(s) studied:

The investigated area is the Bay of Rijeka (figure 1). The figure indicates the approximate locations and the distribution of sampling stations.

Material and methods:

Oil slicks and other floating pollutants: Observations were made randomly in the Bay of Rijeka during cruises and/or beach-tar sampling.

Tar on beaches: In the Bay of Rijeka it is difficult to chose a representative location for sampling; there is no real sandy beach in the whole bay, so a pebbled beach near Jelenscica had to be chosen. The slope of the beach changes under the combined action of wind and waves. On one side of the bay a town of approximately 200,000 inhabitants is located, and on the other an inaccessible island. Prevailing winds are onshore and accumulation of tar, if any, should be expected there. The beach was sampled ten times between 12 December 1977 and 9 April 1978.

Dissolved/dispersed hydrocarbons: Experimental procedures conformed with the instructions given in document IOC-WMO-UNEP/MED-MRM/3 sup.2 section D, p.12 ff. Calibration of the UV-spectrofluorimetre was done using Chrysene ("zur Synthese", Merck Darmstadt, W. Germany, Cat. No. 820 348), for the samples taken on cruise RIZA 7/77 (9-20 September 1977).

For the samples taken on four cruises of the R.V. "Vila Velebita' in June, September and December 1976, and March 1977, the following procedure was used:

The sea-water was collected with a 5-litre polyvinyl-chloride Van Dorn sampler. Bottom samples were collected at every station about 1 m above the bottom. Composite samples were obtained from three depths (at surface, 10-15 m, and 25-30 m);

The sea-water was transferred to well-rinsed 1 litre glass bottles for transportation to the laboratory, samples were conserved with copper sulphate solution. Maximum temperature of samplers during transportation did not exceed 15°C. The time between sampling and extraction varied from 24 to 36 hours;

As a solvent for the extraction, n-hexane of UV-spectrophotometric grade (Merck, W. Germany) was used. A sample of crude oil of Yugoslav origin with known concentrations of aromatic and aliphatic hydrocarbons was used for calibration purposes;

0.5 litre samples of seawater were extracted twice with 10 ml of n-hexane. For fluorescence measurements the aliquots of combined extracts were transferred into 1-cm quartz cells. Fluroescence measurements were performed on a Farrand MK-1 fluorescence spectrophotometre. With excitation at 310 nm and emission at 365 nm, response was linear for concentrations ranging from 0.001 to 1 ug/ml.

Results and their interpretation:

Oil slicks: only two slicks were observed in the period December 1977 to February 1978. This low frequency of observation is typical of the area studied.

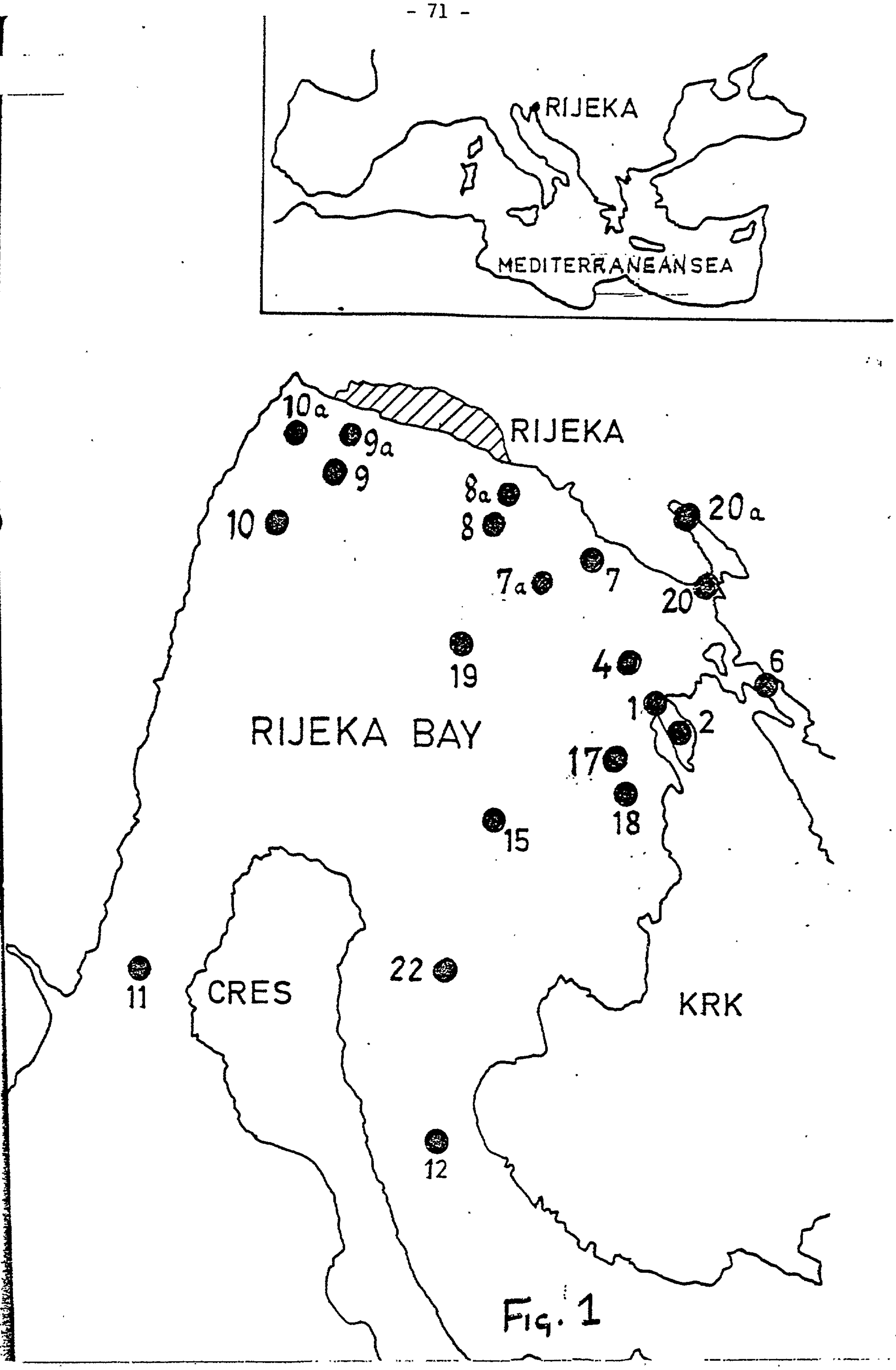
Tar on beaches: during the period December 1977 to April 1978, out of ten samples only two produced tar on the beach at Jelenscica; the values were 8.6 and 0.5 g/m^2.

Dissolved/dispersed hydrocarbons: Tables I-IV show the values obtained for the composite (C) and the bottom (B) samples taken at each station, for the concentration ($mg/l = 10^3$ ug/l) of dissolved/ dispersed hydrocarbons, determined by the ultra-violet fluorescence (UVF) method. Also shown are the values for the same samples by infra- red spectrophotometreic analysis (IR tot) of carbon tetrachloride extracts, and by similar analysis after running the sample through a column with chromotographic grade aluminum (IR nonpol).

Table V gives the measurements for samples from cruise RIZA 7/77 for UV-fluorescence only.

The observed differences for the four cruises for which the data are given in table I - IV, should be taken with some caution, since they are based on a rather small number of samples. No conclusion can be reached with regard to seasonal variation.

The results indicate that no significant differences exist between composite and bottom samples. The investigated area is relatively shallow, and mixing of surface water with deeper water should be a fast process, compared with the open sea. However, we consider that this "homogeneity" is rather the result of an unsuitable sampling method than a real state of homogeneity. In our sampling, special attention was paid to avoiding contamination of samples by oils from the ship, but it is possible that certain amounts of dispersed, particulate oil well adsorbed on the walls of the sampler when it passed from the surface to deeper water.


RIJEKA
MEDITERRANEAN SEA
10a
9a
9
10
RIJEKA
8a
8
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7a
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20
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4
6
1
2
RIJEKA BAY
17
18
15
11
CRES
22
KRK
12

Fig. 1

Table I.

Analyses samples collected during the cruise in June 1976

		mg/l		
Station *		UVF	IR_{tot}	IR_{nonpol}
R_1	C	0,050	0,5	0,4
	B	0,035	0,9	0,4
R_2	C	0,040	1,1	0,5
	B	0,028	0,8	0,2
R_6	C	0,014	0,4	0,3
	B	0,012	0,4	0,3
R_7	C	0,022	0,4	0,3
	B	0,018	0,4	0,3
R_{11}	C	0,023	0,4	0,3
	B	0,030	0,3	0,2
R_{12}	C	0,036	0,4	0,4
	B	0,018	0,3	0,2
R_{15}	C	0,010	0,3	0,2
	B	0,012	0,3	0,2
R_{17}	C	0,015	0,3	0,2
	B	0,013	0,2	0,2
R_{19}	C	0,010	0,2	0,1
	B	0,005	0,1	<0,1

* See figure 1 refers to Rijeka Bay.

Table II.

Analyses on samples collected during the cruise in September 1976

		mg/l		
Station		UVF	IR_{tot}	IR_{nonpol}
R_1	C	0,004	0,1	< 0,1
	B	0,002	0,3	< 0,1
R_2	C	0,002	< 0,1	< 0,1
	B	0,002	0,2	< 0,1
R_6	C	0,008	0,2	< 0,1
	B	0,006	0,1	< 0,1
R_7	C	0,002	0,5	0,1
	B	0,002	0,2	< 0,1
R_{11}	C	0,016	0,4	< 0,1
	B	0,004	0,4	< 0,1
R_{12}	C	0,010	0,2	< 0,1
	B	0,006	< 0,1	< 0,1
R_{15}	C	0,002	< 0,1	< 0,1
	B	0,004	0,1	< 0,1
R_{17}	C	0,010	0,1	< 0,1
	B	0,002	< 0,1	< 0,1
R_{19}	C	0,010	0,1	< 0,1
	B	0,001	< 0,1	< 0,1

Table III.

Analyses on samples collected during the cruise in December 1976

Station		mg/l		
		UVF	IR_{tot}	IR_{nonpol}
R_1	C	0,002	<0,1	-
	B	0,008	0,6	-
R_2	C	<0,001	<0,1	-
	B	0,001	0,2	-
R_6	C	0,002	0,6	-
	B	<0,001	0,2	-
R_7	C	0,012	0,5	-
	B	0,005	0,4	-
R_{11}	C	0,007	0,3	-
	B	0,004	0,3	-
R_{12}	C	0,003	<0,1	-
	B	0,002	<0,1	-
R_{15}	C	0,022	<0,1	-
	B	0,001	0,1	-
R_{17}	C	0,012	<0,1	-
	B	0,002	0,2	-
R_{19}	C	0,004	22	-
	B	0,006	56	-

Table IV.

Analyses on samples collected during the cruise in March 1977

Station		mg/l UVF	IR$_{tot}$	IR$_{nonpol}$
R_1	C	< 0,001	0,1	<0,1
	B	< 0,001	< 0,1	<0,1
R_2	C	0,001	< 0,1	<0,1
	B	< 0,001	0,2	<0,1
R_6	C	0,520	0,3	<0,1
	B	0,290	0,4	<0,1
R_7	C	0,155	0,3	<0,1
	B	0,001	0,2	<0,1
R_{11}	C	< 0,001	0,4	<0,1
	B	< 0,001	0,3	<0,1
R_{12}	C	0,005	0,1	<0,1
	B	0,001	0,2	<0,1
R_{15}	C	0,002	< 0,1	<0,1
	B	0,001	0,3	<0,1
R_{17}	C	0,001	< 0,1	<0,1
	B	0,001	0,7	<0,1
R_{19}	C	0,720	0,3	<0,1
	B	0,060	0,2	<0,1

Table V

Analyses of samples collected during cruise RIZA 7/77 (9-20 September 1977)

Station*	UVF
R_1	3.3 1.7
R_4	1.8 0.5
R_6	0.7 0.1
R_7	0.2 0.1
R_{7a}	0.2 0.2
R_8	0.9 0.2
R_{8a}	0.9 0.2
R_{9a}	0.3 0.2
R_{10}	0.2 0.4
$R10_a$	0.4 0.4
R_{11}	0.1 0.1
R_{12}	0.1 0.1
R_{15}	0.1 0.1
R_{17}	0.4 0.4
R_{18}	0.3 0.3
R_{19}	0.2 0.1
R_{20}	2.5 2.4
R_{20a}	0.6 0.6
R_{22}	0.1 0.1

* See figure 1.

MED POL II : BASELINE STUDIES AND MONITORING OF METALS, PARTICULARLY MERCURY AND CADMIUM, IN MARINE ORGANISMS (FAO(GFCM)/UNEP

MED POL II : ETUDES DE BASE ET SURVEILLANCE CONTINUE DES METAUX, EN PARTICULIER DU MERCURE ET DU CADMIUM, DANS LES ORGANISMES MARINS (FAO(CGPM)/PNUE)

Centre de recherche participant: Centre de Recherches Oceanographiques et des Pêches
ALGER
Algerie

Chercheur principal: A. AISSI

Introduction:

Il n'y a pas eu d'activités concernant le programme MED POL avant le commencement de ce projet au Centre de recherches océanographiques et des pêches.

Zone(s) etudiee(s):

Les activités du projet pilote ont commencé vers la fin de 1976. Deux espèces ont été collectées tous les 3 mois sur les stations de la baie d'Alger, Zone III (fig. 1). La station I est située dans le port, derrière la grande jetée nord. Dans cette zone débouche le collecteur de l'Amirauté (eaux des égouts de la Casbah). La station II se trouve à proximité d'un site touristique de faible concentration urbaine. La salinité de l'eau est en moyenne de 37 ‰ et le gradient de température est de 14 à 24° C.

Matériel et méthodes:

Les organismes prélevés ont été la moule, Perna perna, et le rouget, Mullus surmuletus. L'échantillonnage, la préparation des échantillons et les analyses ont été menés selon FAO, Document technique sur les pêches, No. 158.

Résultats et leur interpretation:

a) Perna perna échantillonnée sur la station II (décembre 1976-mars 1978)
   Nombre des specimens analysés: 40
   Nombre d'analyses: 40
   Tissu analysé: partie molle

Métaux	Concentration en ug/kg poids frais	
	Minimum	Maximum
Hg(T)	20	160
Cd	30	160
Zn	840	19 600

b) Mullus surmuletus échantilloné sur la station II (décembre 1976 - juin 1978)
   Nombre de specimens analysés: 56
   Nombre d'analyses: 56
   Tissu analysé: filet

Métaux	Concentration en ug/kg poids frais	
	Minimum	Maximum
Hg(T)	20	156
Cd	30	306
Zn	970	3 400

Quelques variations saisonnaires des concentrations moyennes de Hg(T) et de Cd dans Perna perna et Mullus surmuletus ont été registrées en dessous de 100 ug/kg poids frais sur les stations I et II pendant tous les mois de 1977 avec une exception en mars (114 et 28 ug/kg poids frais respectivement).
Les concentrations (minimum, maximum et moyenne) de Hg(T) et Cd dans les mêmes espèces observées en janvier et mars 1978 sont les suivantes:

Nombre des spécimens analysés: 12
Nombre des analyses: 12

a) Perna perna échantillonnée sur la station I
Tissu analysé: partie molle

		Concentration ug/kg de poids frais			
		Minimum	Maximum	Moyenne	σ
janvier 1978	Hg(T)	50	80	65	± 11
	Cd	80	110	93	± 12
	Zn	2 700	3 800	3 217	±479
mars 1978	Hg(T)	90	100	97	± 5
	Cd	90	170	135	± 36
	Zn	2 100	3 700	2 917	±679

b) Mullus surmuletus échantillonné sur la station I
Tissu analysé: filet

janvier 1978	Hg(T)	50	80	65	± 12
	Zn	1 300	2 700	2 003	±472
mars 1978	Hg(T)	60	100	83	±
	Cd	80	100	95	± 8
	Zn	900	2 000	1 533	±463

Après examen des résultats on peut constater que:

- la teneur en métaux lourds chez les deux espèces étudiées est très faible comparativement aux concentrations des espèces se trouvant au large des côtes des pays industrialisés (1740 ug/kg de poids frais)

- le facteur de concentration est fonction du type de métal et il varie pour cet élément d'une zone à l'autre selon que l'on est dans une zone de très forte densité urbaine et industrielle ou de moindre densité.

La station I est à proximité du port d'Alger; elle reçoit donc le plus de matières polluantes mais l'effet de la présence d'un courant qui longe la côte de l'ouest en entraîne une répartition des éléments tout au long de cette baie.

La station II présente, malgré une faible pollution apparente, des résultats qui s'approchent de ceux de la station I.

Conclusions:

Les taux des métaux lourds trouvés dans les tissus de Perna et de Mullus sont relativement bas en ce qui concerne le mercure et le cadmium. Le taux de Zn se trouve plus élevé principalement dans Perna perna. On a remarqué que le taux de Hg et Cd reste faible, tandis que le Zn s'accumule surtout chez Perna perna; ceci est certainement dû au pouvoir filtreur de cet élément par la moule. Il est à noter, par ailleurs, que dans les deux stations de la baie d'Alger le taux de mercure et de cadmium sont plus ou moins rapprochés mais restent quand même à des niveaux très faibles. Néanmoins une surveillance continue s'avère nécessaire sur une longue période pour suivre l'évolution de ce phénomène.

Liste des publications:

Aissi, Abdelaiz. Recherche du zinc, du mercure et du cadmium dans les échantillons de Mytilus perna (Lamarck 1819) et de Mullus surmuletus (Linnaeus 1758) de la baie d'Alger. CIESM/PNUE Journées d'études "Lutte contre les pollutions marines", XXVIième Congrès, Assemblée plénière de la CIESM, Antalya, 24-27 novembre 1978.

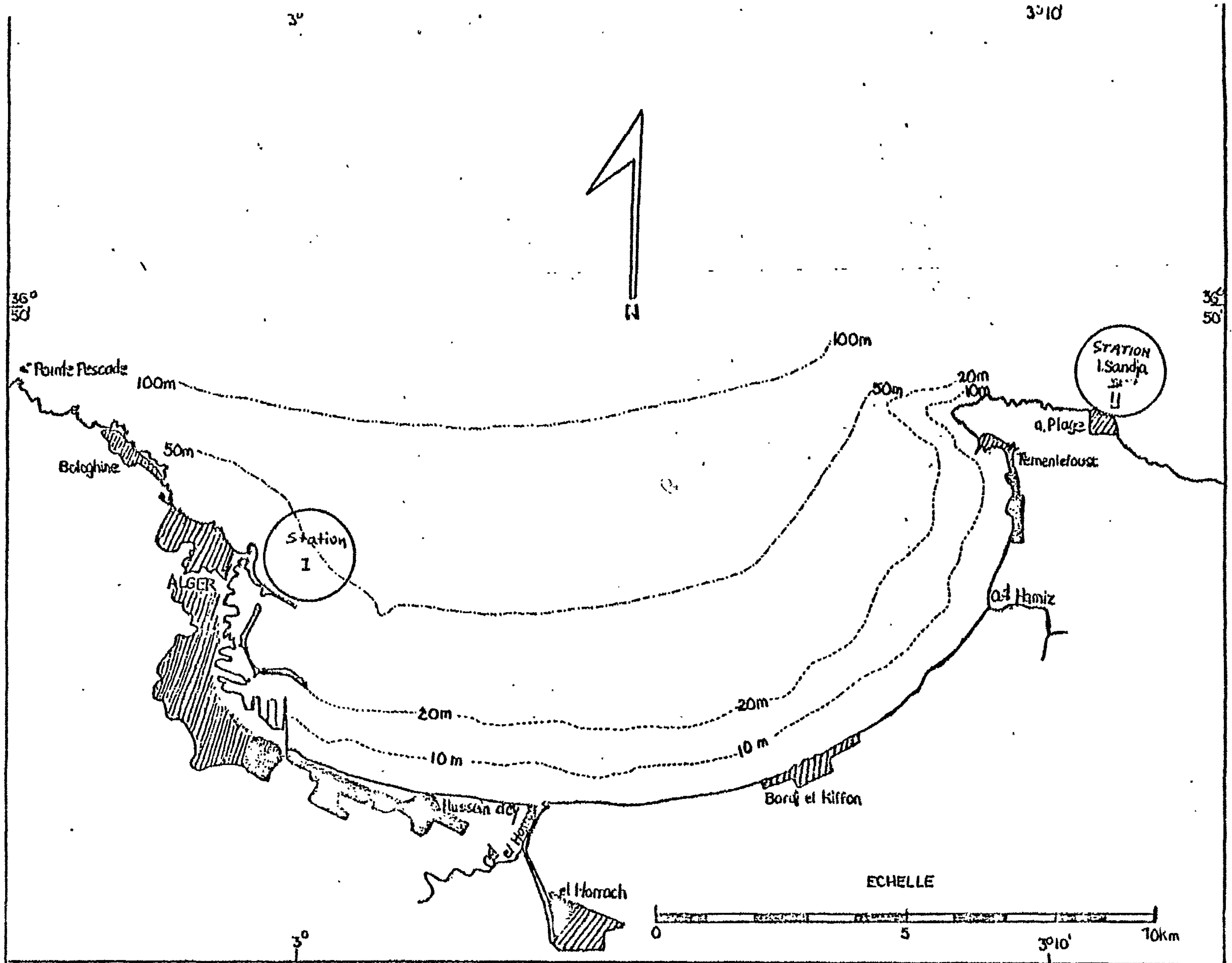


FIG.1 CARTE DE LA BAIE D'ALGER AVEC LES STATIONS DE PRELEVEMENTS D'ECHANTILLONS

Participating Research Centre: Fisheries Department
Ministry of Agriculture and Natural Resources,
NICOSIA
Cyprus

Principal Investigator: A. DEMETROPOULOS

Introduction:

Sampling of Mullus barbatus has been carried out since September 1976 in the following areas: Aktratiri Bay (Limassol Bay), Larnaca Bay and Paphos Area. The first two of them have mixed industrial settlements, including soft drink factories, wine factories, flour mill, cement factory and metallurgical plant for iron and copper ore. No analysis has been performed yet.

Participating Research Centre: Institute of Oceanography and Fisheries
Mediterranean Branch
ALEXANDRIA
Egypt

Principal Investigator: H. I. EMARA

The requested Summary Report has not been received.

Centre de recherche participant: Laboratoire Central d'Hygiene Alimentaire
Direction des Services Veterinaires
Ministère de l'Agriculture
PARIS
France

Chercheur principal: G. CUMONT

Introduction:

L'aspect pollution des produits de la pêche introduits en France a été envisagé au Laboratoire dès 1971 pour le mercure et depuis 1977 pour le cadmium. Le laboratoire dispose donc d'un grand nombre de données dont environ 10% concernant les poissons de Méditerranée.

La présentation de la plupart des résultats concernant les thons de Méditerranée a fait l'objet d'une communication lors de la réunion à mi-parcours à Dubrovnik (2-6 mai 1977).

Zone(s) étudiée(s):

Au cours de la deuxième moitié de 1977 et de la première moitié de 1978, Mullus barbatus et Thunnus thynnus ont été collectés sur la côte française, dans les golfes du Lion et de Gênes, dans le bassin occidental de la Méditerranée, au large des ports indiqués sur la carte, - (fig. 1), Zone II, sans que les zônes de pêche puissent être précisées. En effet, ne disposant pas d'un service local pour assurer l'échantillonnage soumis à l'examen, ceci a conduit à solliciter la participation bénévole des Services vétérinaires du littoral. Cette zone est le témoin d'une assez grande variabilité des caractéristiques physicochimiques (salinité 35 à 39 $^{o}/_{oo}$, pH 7,5 à 8,5 - RNO 1977), et biologiques surtout près du littoral (MES-DCO et DBO peuvent varier d'un facteur 1000).

Matériel et méthodes:

L'échantillonnage a porté sur Thunnus thynnus et Mullus barbatus, il n'a pu être dirigé comme il aurait été souhaitable qu'il le fût suivant les modalités indiquées par le projet pilote.

La plus grande masse des thons échantillonnés provient de l'inspection vétérinaire dans les ports de débarquement des bateaux de pêche français et dans les postes douaniers au moment des importations.

L'échantillonnage et le prétraitement, de même que les analyses finales par AAS ont été réalisés selon les normes du FAO, Document technique sur les pêches, No. 158.

Les analyses ont été réalisées suivant la technique décrite:
automatisation du dosage du mercure, technique de minéralisation appropriée - G. Cumont, M. Chevalier: Annales des Falsifications et de l'Expertise chimique. 1975, 726: 85-89.

Résultats et leur interprétation:

Les concentrations minimum, maximum et moyenne de Hg(T) et Cd chez Mullus barbatus et Thunnus thynnus de même que leur déviation normalisée pour la période indiquée figurent dans le tableau suivant.

Nombre total de spécimens analysés : non fourni
Nombre d'analyses: indiqué sur le tableau dans la collonne "n"
Tissu analysé: Filet

Epoque de l'échantillonnage	Espèce	n	Métal	Concentration ug/kg poids frais Minimum	Maximum	Moyenne	σ
2ème moitié de 1977	Mullus barbatus	29	Hg	30	1740	308	390
		27	Cd	trace	590	130	176
	Thunnus thynnus	28	Hg	370	2390	770	410
		27	Cd	20	590	88	115
1ère moitié de 1978	Mullus barbatus	26	Hg	40	670	140	142
		25	Cd	2	220	43	61
	Thunnus thynnus	33	Hg	480	1680	741	253
		33	Cd	12	425	68	101
2ème moitié de 1978	Mullus barbatus	19	Hg	40	570	175	134
		19	Cd	2	44	23	14
	Thunnus thynnus	5	Hg	270	1750	740	616
		71	Hg	130	6290	1337	1286
		5	Cd	4	59	19	23

Thunnus thynnus capturé dans les eaux du large de la Méditerranée.

Pour les données présentées dans ce tableau, il n'a pas été fourni de formulaires de renseignements.

Les précédents formulaires ont été complétés avec les codes conseillés sans que des renseignements sur les coordonnées géographiques puissent être fournis: les poissons ont été pêchés au large de la station indiquée, et en ne pouvant préciser que le mois de l'échantillonnage (carte jointe comportant les stations). A partir de la population très hétérogène des thons soumis au contrôle et donc d'un échantillonnage dû au hasard, nous observons que la population des thons de Méditerranée est plus abondamment représentée par des animaux de poids inférieur à 40 kg et de poids supérieur à 80 kg; les animaux de poids compris entre 40 et 80 kg sont très rares.

Les résultats de l'intercalibration sont disponibles pour Hg et Pb. Les résultats obtenus pour Cd ne peuvent être comparés à la moyenne AIEA qui est bimodale.

La valeur de l'Institut correspond à la moyenne basse.

Conclusions:

La surveillance de la contamination par le mercure des thons rouge (Thunnus thynnus) de la Méditerranée remonte maintenant à 7 années et porte sur un échantillonnage de 840 thons. La provenance de ces thonidés n'est pas toujours précisemment connue mais étant donné le mode de vie pélagique de ces poissons qui parcourent plusieurs dizaines de mille par jour, l'absence de coordonnées des lieux de pêche n'est pas un obstacle majeur à l'appréciation des résultats et à leur commentaires. Ces résultats confirment ceux qui ont été présentés antérieurement à savoir que:

- la contamination mercurielle de Thunnus thynnus d'origine méditerranéenne est 3 fois supérieure à celle du thon de même espèce d'origine atlantique et 4 fois supérieure à celle des thons "blanc": albacore, germon, listoa...;

- la relation teneur en mercure = f (âge du thon) n'est pas vérifiée et des thons de petites tailles peuvent présenter des concentrations élevées;

- le rapport méthylmercure/mercure total est plus faible que pour les poissons d'autre origine (observé sur les analyses réalisées antérieurement au contrat);

- les résultats du dosage de mercure recueillis sur le rouget présentent une large gamme et les moyennes calculées ont peu de signification comparées aux valeurs extrêmes observées (voir table);

- la contamination par le cadmium est moins importante et moins préoccupante que celle relevée pour le mercure si on compare les concentrations en cadmium et mercure dans les poissons aux doses hebdomadaires tolérables proposées par l'O.M.S. Cette contamination présente toutefois une dispersion proportionnellement aussi importante que celle du mercure, d'après les résultats (voir table) et cet échantillonnage est encore insuffisant pour tirer des commentaires aussi positifs que ceux que l'on peut formuler pour le mercure.

Liste des publications:

Cumont, G. et al. (1972). Contamination des poissons de mer par le mercure. Rev.Intern.Océanogr.Méd. 28: 95-127.

__________, Etude de la contamination par le mercure des poissons de mer et d'eau douce. Symposium International. Problèmes posés par la contamination de l'homme et de son milieu par le mercure et le cadmium. Commission des Communautés Européennes. Luxembourg: 295-307.

__________, Ubiquité du mercure dans l'environnement. Le mercure et l'environnement, Etude sur l'utilisation du mercure: ses émissions, ses effets biologiques et son contrôle. O.C.D.E.: 143-149.

__________, Bilan de la contamination des poissons de mer par le mercure à l'occasion d'un contrôle portant sur trois années. Premier Congrès International du mercure. Barcelone: 141-150 dans Ann.Hyg.L.Fr. Med. et Nut.

Anon., Bilan et examen critique du contrôle de la teneur en mercure des poissons de Méditerranée. Rapport Consultation Experts. Réunion FAO/GCPM-Dubrovnik, 2-6 Mai.

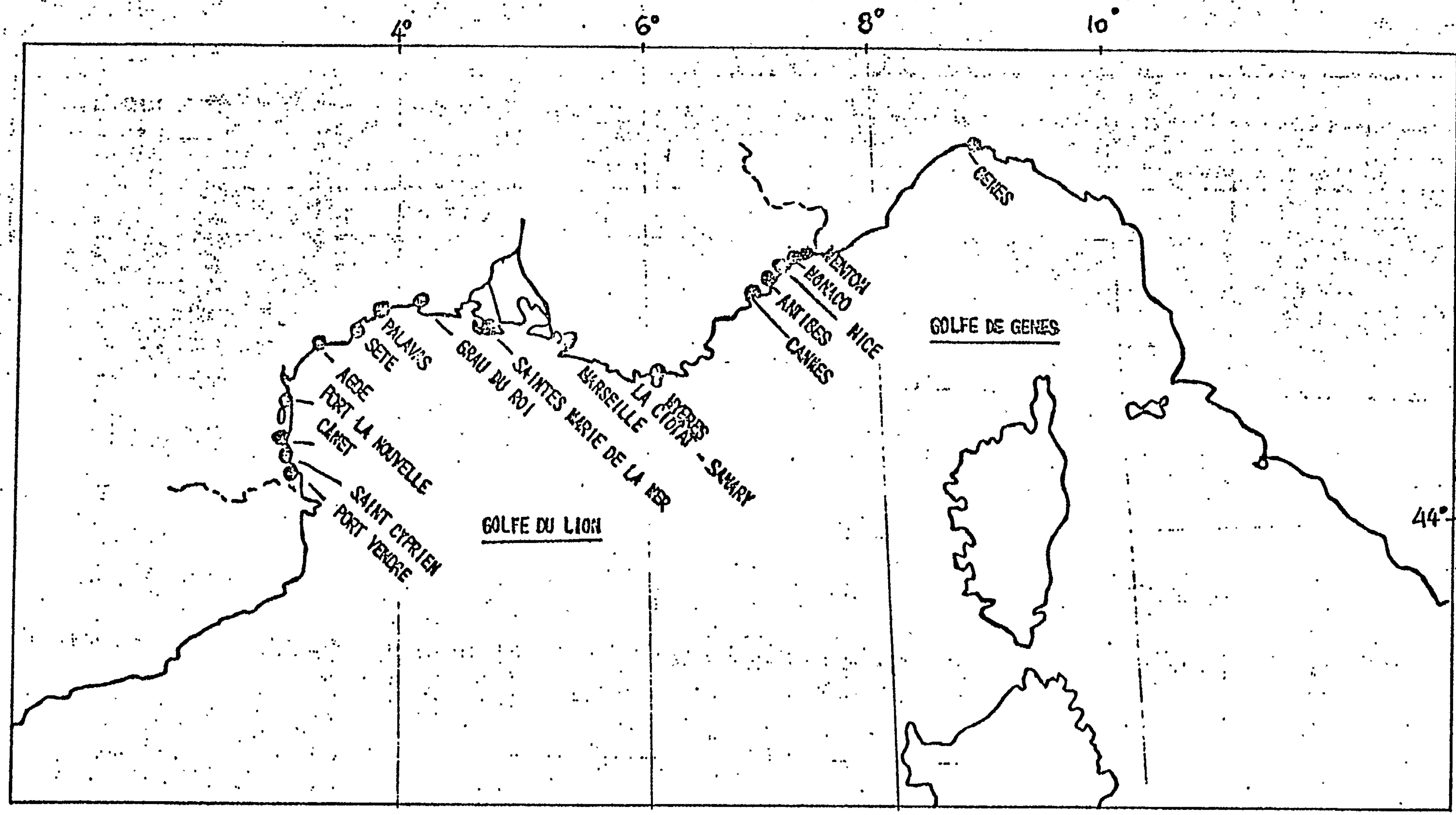


Fig. 1 Les lieux d'échantillonage dans le Golfe du Lion et le Golfe de Gênes

Centre de recherche participant: Laboratoire de Chimie Analytique et Toxicologie,
Universite de Montpellier
MONTPELLIER
France

Chercheur principal: S. BRUN

La rapport rèsumé demandé n'a pas été recu.

Centre de recherche participant: Institute Scientifiques et Technique des Peches Maritimes (I.S.T.P.M.), NANTES France

Chercheur principal: Y. THIBAUD

Introduction:

L'engagement de l'Institut dans les travaux concernant la pollution marine a commencé depuis le 5 décembre 1975.

Zone(s) étudiée(s):

Les stations déechantillonnage appartiennent à la Zone II de MED POL et sont indiquées dans la figure 1 et 2.

- Les zones de prélèvement de moules sont réparties tout le long du littoral méditerranéen français (de Banyuls à Toulon, voir figure 2). L'Institut n'a pas été en mesure de répéter l'échantillonnage de façon trimestrielle mais, dans l'ensemble, le nombre de prélèvements a été augmenté.

- Par rapport à l'année précédente l'échantillonnage, en un point de la côte, a porté sur deux espèces nouvelles: le crabe vert et la crevette grise (voir figure 1).

Pour les échantillons de poissons, la latitude et la longitude du lieu de pêche n'ont pu être connues avec précision, leur collecte se faisant aux ports de débarquement. Les zones approximatives de pêche sont indiquées sur la figure 2.

Matériel et méthodes:

Les espèces Mytilus edulis, Mytilus galloprovincialis, Mullus barbatus, Thunnus thynnus, Carcinus mediterraneus et Crangon crangon ont été collectées pour l'analyse.

La préparation des échantillons se fait selon la méthode suggérée par la FAO, Document technique sur les pêches, No. 158, en utilisant un réacteur en téflon après lyophilisation de l'a partie molle du spécimen. La technique AAS a été utilisé pour la détermination des taux de Hg(T), Cd, et Pb.

Résultats et leurs interprétations.

Les espèces Mullus barbatus, Mytilus edulis et Thunnus thynnus ont été échantillonées pendant la deuxième moitié de 1976 et analysées pour Hg(T), Cd et Pb. Les reultats sont résumés dans les tableux I et II.

a) Mullus barbatus (août 1976 - novembre 1976)

Nombre de spécimens analysés: 36
Nombre d'analyses: 7
Tissu analysé: filet

Nombre de spécimens analysés:

- 410 résultats ont été donnés pour Mytilus galloprovincialis mais les informations ne sont pas complètes;
- pour les autres espèces: informations non fournies

Tissu analysé: partie molle pour Mytilus galloprovincialis
Carcinus mediterraneus
Crangon crangon
filet pour Mullus barbatus
Muscle blanc pour Thunnus thynnus

Espèce	Métal	Nombre d' analyses	Concentration ug/kg poids frais Minimum	Maximum	Moyenne
Mytilus galloprovincialis	Hg(T)	39	13	610	74 ± 122
Mullus barbatus	Hg(T)	4	60	110	85 ± 21
Carcinus mediterraneus	Hg(T)	9	30	190	100 ± 61
Crangon crangon	Hg(T)	2	50	110	80 ± 30
Thunnus thynnus	Hg(T)	49	630	4240	1274 ± 850

Pas de données pour 1978.

Conclusions:

Cepandant les niveaux de contamination des coquillages varient de façon significative selon qu'ils se trouvent dans une région ostréicole (Etangs de Thau, de Leucate) ou dans une région industrielle (Rade de Toulon, golfe de Fos). Il n'est pas facile, pour le moment tout au moins, de donner une interprétation aux valeurs que nous avons obtenues étant donné que les teneurs en plomb et en cadmium concernant les organismes marins méditerranées dont nous avons connaissance sont relativement peu nombreuses, les dosages ayant été effectués surtour sur des organismes d'Atlantique ou de mer du Nord. D'une manière générale les teneurs en métaux lourds trouvés ici ne diffèrent pas beaucoup de celles trouvées dans les animaux pêchés dans les mers citées plus haut.

Citons un exemple de teneurs moyennes en plomb trouvées dans des moules de la mer du Nord: 2200 à 5800 par kg de poids sec selon 1966/1974 Pollution in Coastal Waters. (An Interim Report on Results of a Priority Programme of the German Research Society).

Les teneurs en plomb et cadmium dans le rouget-barbet sont un peu inférieures à celles trouvées antérieurement dans différents poissons (clupéidés, gadidés) mais ceci peut être dû à la petite taille des individus analysés ici.

Liste des publications:

Thibaud, Y. (1978). La présence des métaux lourds, de sélénium et d'arsenic dans le thon rouge de Méditerranée. Soumis aux quatrièmes journées d'études sur les pollutions marines en Méditerranée CIESM/PNUE. Antalya, 24-27 novembre 1978.

a) Mullus barbatus (août 1976 - novembre 1976)

Nombre de specimens analysés: 36

Nombre d'analyses: 7

Tissu analysé: filet

Métaux	Concentration µg/kg poids sec Minimum	Maximum	Moyenne	Pourcentage moyen d'H_2O	Concentration moyenne µg/kg poids frais
Hg(T)	380	1000	731 ± 276	76.1	175 ± 66
Cd	20	70	36 ± 17	76.1	9 ± 4
Pb	30	500	299 ± 145	76.1	72 ± 35

b) Mytilus edulis (juillet 1976 - septembre 1976)

Nombre de specimens analysés: 160 à 240 pour Hg(T)
240 pour Cd
160 pour Pb

Nombre d'analyses: 39

Tissu analysé: partie molle

Métaux	Concentration µg/kg poids sec Minimum	Maximum	Moyenne	Pourcentage moyen d'H_2O	Concentration moyenne µg/kg poids frais
Hg(T)	60	830	303 ± 208	81.4	56 ± 39
Cd	20	3200	575 ± 595	81.4	107 ± 111
Pb	100	3370	1010 ± 808	81.4	188 ± 150

c) Thunnus thynnus (juillet 1976 - décembre 1976)

Nombre de specimens analysés: 63 pour Hg(T)
44 pour Cd et Pb

Nombre d'analyses: 63 pour Hg(T)
44 pour Cd et Pb

Tissu analysé: muscle blanc

Métaux	Concentration µg/kg poids sec Minimum	Maximum	Moyenne	Pourcentage moyen d'H_2O	Concentration moyenne µg/kg poids frais
Hg(T)	1300	13800	4265 ± 1788	70.3	1267 ± 531
Cd	20	190	46 ± 34	69.6	14 ± 10
Pb	50	3900	521 ± 688	69.6	158 ± 209

Des échantillons de Mytilus galloprovincialis, Mullus barbatus, Carcinus mediterraneus, Crangon crangon et Thunnus thynnus ont été collectés et analysés pour Hg(T). Les résultats sont résumés dans le tableau suivant; les données ont été à l'origine rapportées sur les formulaires de renseignements.

Tableau I

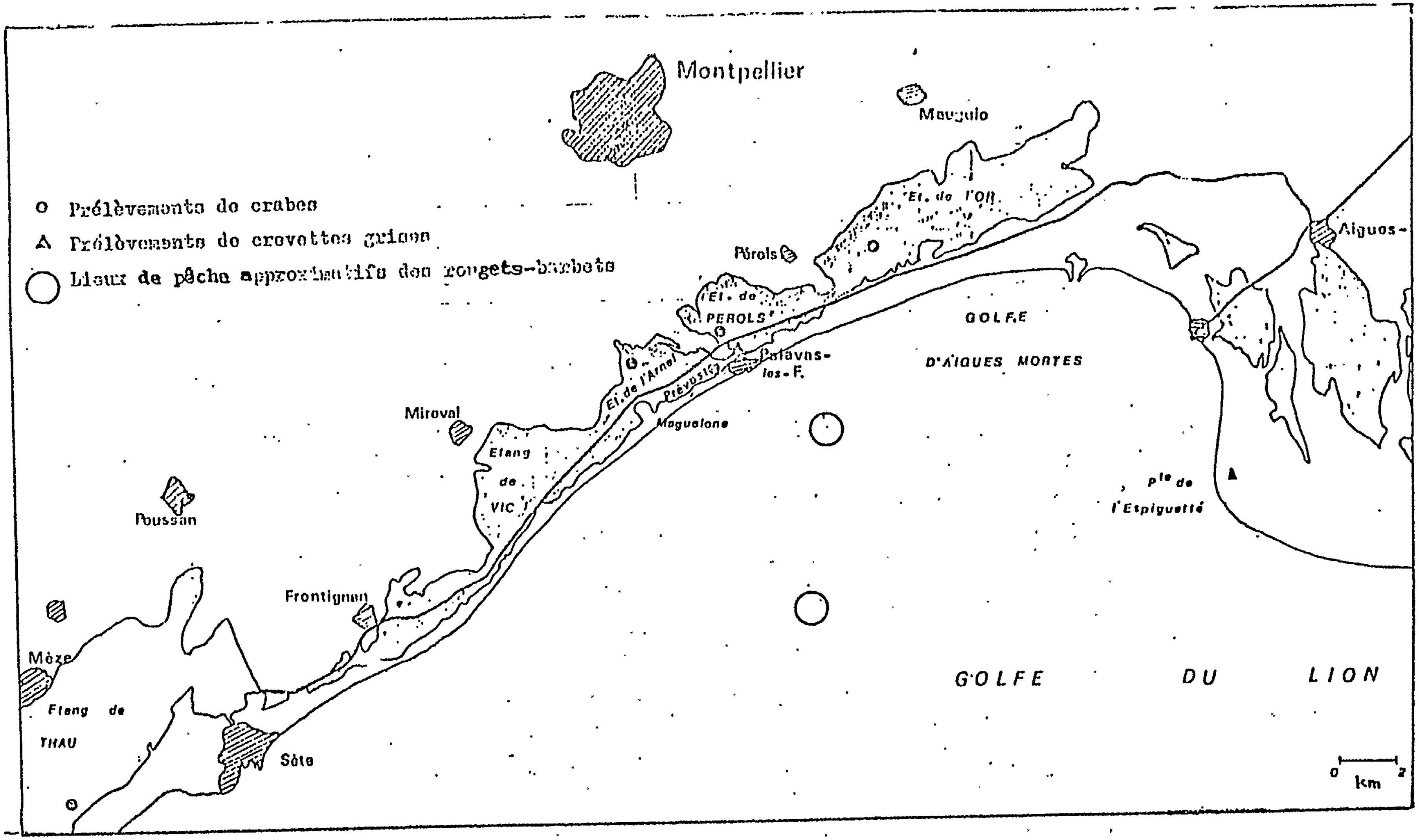


Fig.1 Les stations de prélèvement

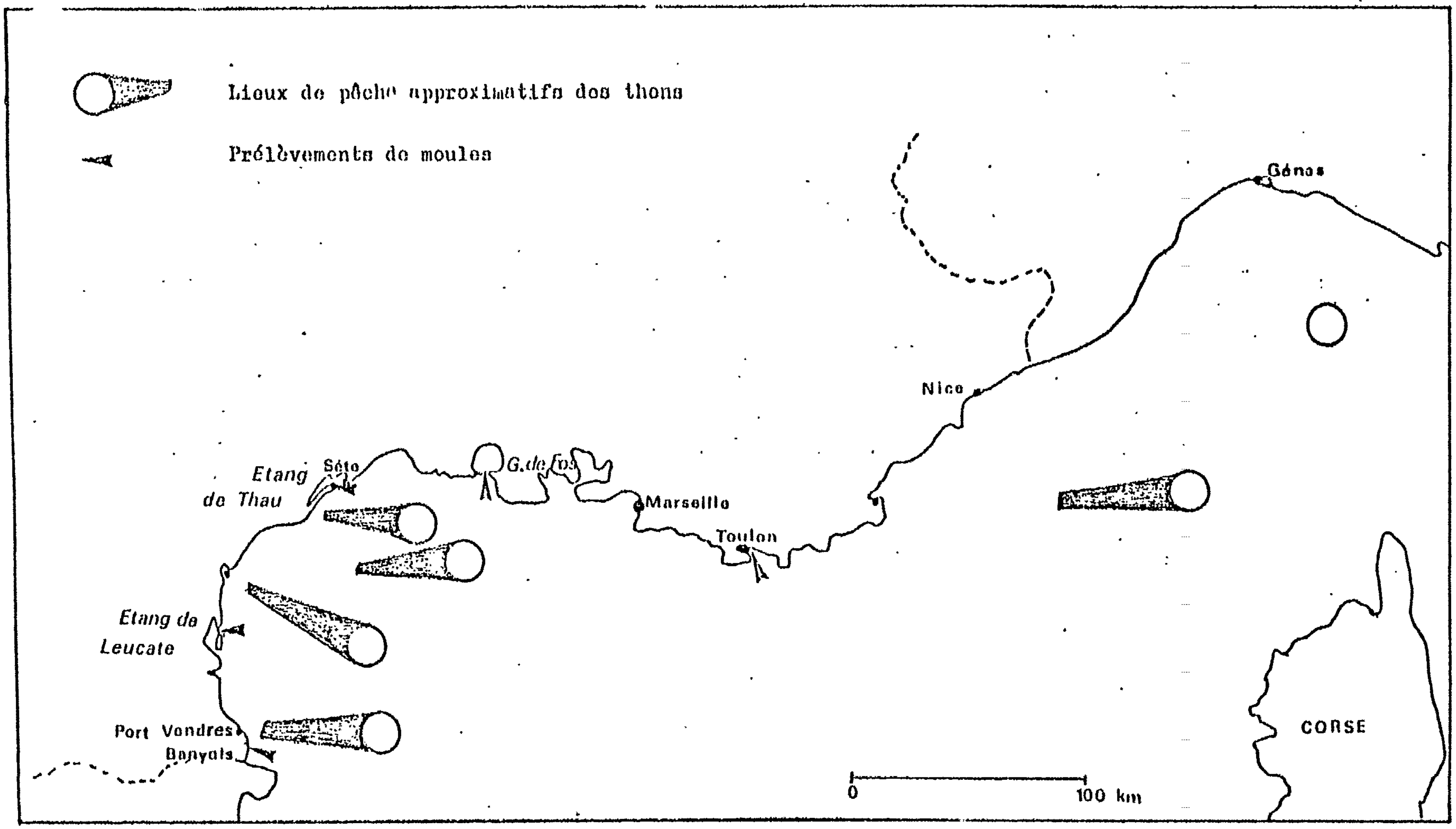


Fig 2: Côte occidentale de la Mediterranée avec les lieux de prélèvement de moules

Participating Research Centre: Institute of Oceanographic and Fisheries Research (IOKAE),
ATHENS
Greece

Principal Investigator: F. VOUTSINOU

Introduction:

The first trace metals determinations in sediments were carried out in October 1974.

Area(s) studied:

All the samples were taken in the Saronikos Gulf (Area VIII). The sampling stations are indicated in figure 1.

The shallowest water is in Elefsis Bay (about 30 m) and deepest near Epidavros where it exceeds 400 m. Temperatures of the water surface layer varied according to the season from 15 to 25 , and below 200 m depth it was between 14.5 to 15 . Salinity was around 38.5°/$_{oo}$. The content of dissolved oxygen is in surface layers near saturation; due to enhanced photosynthetic activity it is sometimes above saturation. The content of dissolved oxygen is slightly reduced at great depths and during the summer, in the central part of Elefsis Bay, is low or even absent.

Sampling area	Inorganic nitrogen ug-at/l	Phosphate	Silicate	Eutrophication
Elefsis Bay	9	0.6	5	maximal
near Piraeus harbour (metropolitan sewage outfall)	5	0.6	2	very high
south of sewage outfall	3.5	0.2	1.8	high
other stations in Saronikos Gulf	2.5	0.15	1.5	significant

The pollution, estimated through the effect on macrobenthic organisms, is maximal in Elefsis Bay (especially away from the shore due to anoxia), high in the sewage outfall zone, moderate southwards from sewage outfall and usually absent at the other sampling stations in Saronikos Gulf.

Material and methods:

Three species (Mullus barbatus, Parapenaeus longirostris and Mytilus galloprovincialis were sampled in the areas and analysed for the content of Cd, Cu, Zn, Pb and Mn. Parapenaeus longirostris, a crustacean of local economic importance was used instead of Xiphias gladius and Thunnus thynnus. The methods for sampling, sample preparation and analysis, proposed in FAO, Fisheries Technical Paper no. 158, were used.

Results and their interpretation:

The concentrations of each metal, which were determined separately in different species during the period from September 1975 until March 1978, are summarized in table 1, and are based on the respective LOG-FORMS provided. All concentrations are expressed in ug/kg F.W.

The average concentrations of Cd, Zn, Cu and Mn (expressed as ug/kg F.W.) determined during the above period in the three marine species, sampled in Saronikos Gulf (Area A, A_1, B, C - figure 1) are graphically presented in figures 2, 3 and 4 respectively. Figure 3 includes also some data on iron concentrations.

Cd concentration in:

a) Mullus barbatus: are from below the detection limit (40 ug/kg F.W.) up to 150 ug/kg F.W.

b) Parapaneus longirostris: are below the detection limit (40 ug/kg F.W.) and 50 ug/kg F.W.

c) Mytilus galloprovincialis: are with the exception of the value of 780 ug/kg F.W. determined in one sample, all around 120 ug/kg F.W.

Cu concentration in:

a) Mullus barbatus: varies in the range from 390 to 920 ug/kg F.W.

b) Parapenaeus longirostris: is about 10 000 ug/kg F.W. (mean value).

c) Mytilus galloprovincialis: varies in the range from 1 080 F.W. to 2 800 ug/kg F.W.

Zn concentration in:

a) Mullus barbatus: is close to 5 000 ug/kg F.W.

b) Parapenaeus longirostris: varies in the range from 10 000 to 17 000 ug/kg F.W.

Pb concentration in the analysed marine species could not be determined due to high detection limit of 600 ug/kg F.W.

Mn concentration averages in the analysed species are:

a) Mullus barbatus: 345 ug/kg F.W.

b) Parapenaeus longirostris: 580 ug/kg F.W.

c) Mytilus galloprovincialis: 2 395 ug/kg F.W.

In the above samples taken during 1978 the concentration of Fe and Pb were determined as well.

Conclusions:

Very low Cd concentrations were obtained in all species, except in Mytilus galloprovincialis. Zn and Cu concentrations were always well above the detection limit. Particularly high Zn and Cu concentrations were encountered in Mytilus galloprovincialis and in Parapenaeus longirostris, respectively.

In general, Parapenaeus longirostris and Mytilus galloprovincialis have higher content of metals than Mullus barbatus.

Owing to the limited number of analysed samples, at this stage it is difficult to determine significant differences between sampling areas and even more difficult between seasons.

The concentration range of investigated metals are similar to those found in fairly clean Mediterranean water (GFCM Report No.3, May 1978)

Table 1 - Concentrations of different metals analysed in the three species sampled from September 1975 to March 1978

Year	Metal	Species	Sampling period	Tissue analysed	Number of specimens	Number of analyses	Concentration µg/kg F.W. Minimum	Maximum	Average
1975	Cd	Mullus barbatus	September	Fillet	60	4	<40	40	
		Parapenaeus longirostris	September and December	Soft part	35	2	<40	<40	<40
		Mytilus galloprovincialis	December	Soft part	30	1			120 1)
1976	Cd	Mullus barbatus	March-December	Fillet	97	14	<40	130	
		Parapenaeus longirostris	March-June	Soft part	27	3	<40	50	
		Mytilus galloprovincialis	September	Soft part	20	1			780 1)
1977	Cd	Mullus barbatus	March-September	Fillet	42	9	<40	150	
		Parapenaeus longirostris	March-September	Soft part	54	6	<40	50	
		Mytilus galloprovincialis	June-October	Soft part	20	3	120	200	160 ± 40
1978	Cd	Mullus barbatus	January-March	Fillet	39	4	<40	120	
		Parapenaeus longirostris	March	Soft part	56	3	<40	<40	<40
		Mytilus galloprovincialis	January-March	Soft part	39	2	<40	110	

1) Only one value reported

<40 = below the detection limit

Table 1 (cont.) - Concentrations of different metals analysed in the three species sampled from September 1975 to March 1978.

Year	Metal	Species	Sampling period	Tissue analysed	Number of specimens	Number of analyses	Concentration µg/kg F.W. Minimum	Maximum	Average
1977	Cu	Mullus barbatus	March-September	Fillet	42	9	390	800	623 ± 146
		Parapenaeus longirostris	March-September	Soft part	54	6	6 300	35 400	16 133±12787
		Mytilus galloprovincialis	June-October	Soft part	20	3	1 300	2 800	1 883± 804
1978	Cu	Mullus barbatus	January-March	Fillet	39	4	600	920	783± 138
		Parapenaeus longirostris	March	Soft part	56	3	4 570	5 700	5 257± 603
		Mytilus galloprovincialis	January-March	Soft part	39	2	1 080	1 700	1 390± 310
1977	Zn	Mullus barbatus	March-September	Fillet	42	9	3600	6500	4900 ± 1021
		Parapenaeus longirostris	March-September	Soft part	54	6	9500	17200	12600 ± 2525
		Mytilus galloprovincialis	June-October	Soft part	20	3	24000	27000	25333 ± 1528
1978	Zn	Mullus barbatus	January-March	Fillet	39	4	4200	5500	4650 ± 592
		Parapenaeus longirostris	March	Soft part	56	3	14640	16500	15400 ± 976
		Mytilus galloprovincialis	January-March	Soft part	39	2	14200	32500	23350 ± 9150
1978	Mn	Mullus barbatus	January-March	Fillet	39	4	300	380	345 ± 37
		Parapenaeus longirostris	March	Soft part	56	3	400	800	580 ± 203
		Mytilus galloprovincialis	January-March	Soft part	39	2	2570	3300	2935 ± 516

<600 = below the detection limit

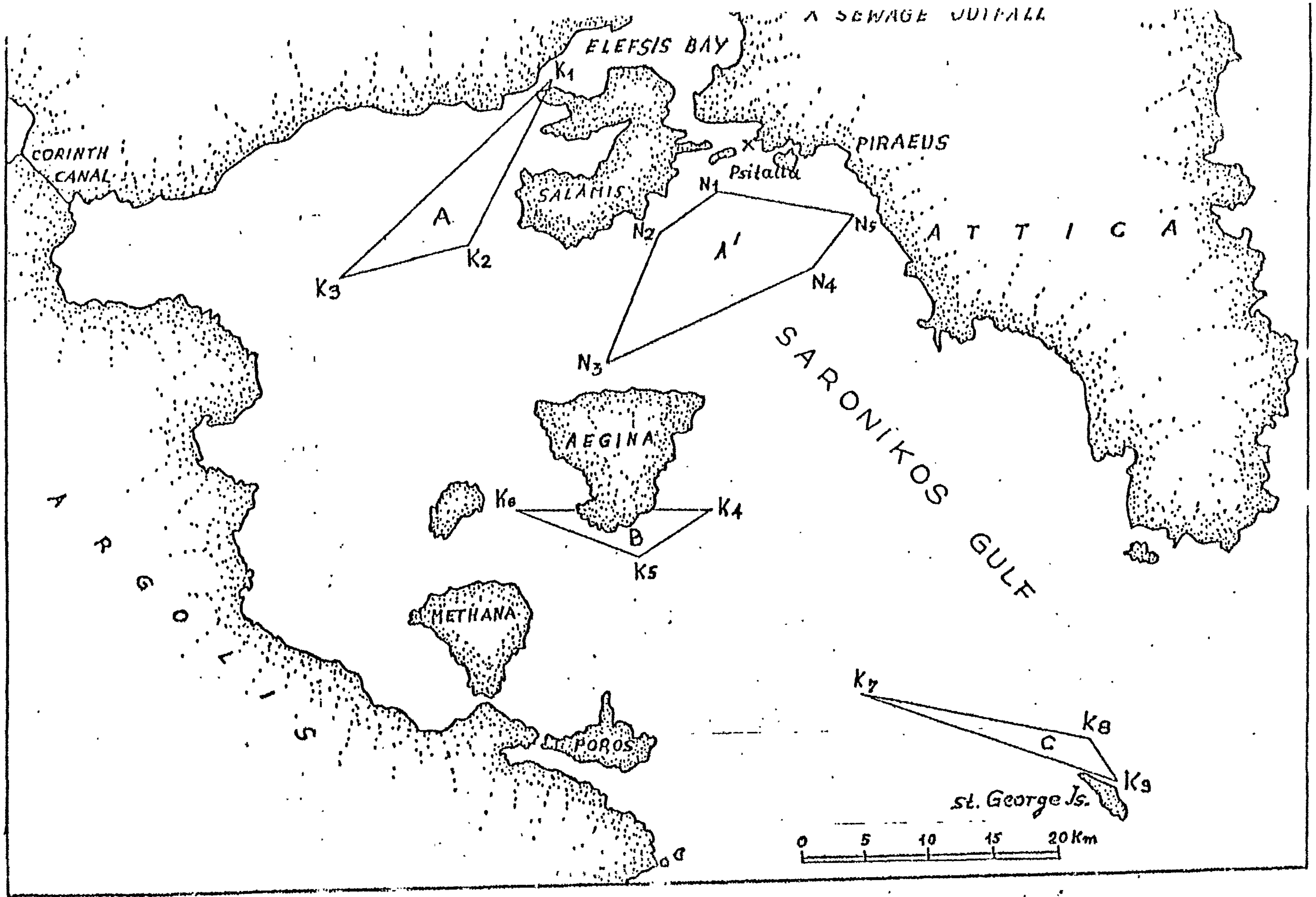


Fig. 1 Sampling sites in the Gulf of Saronikos

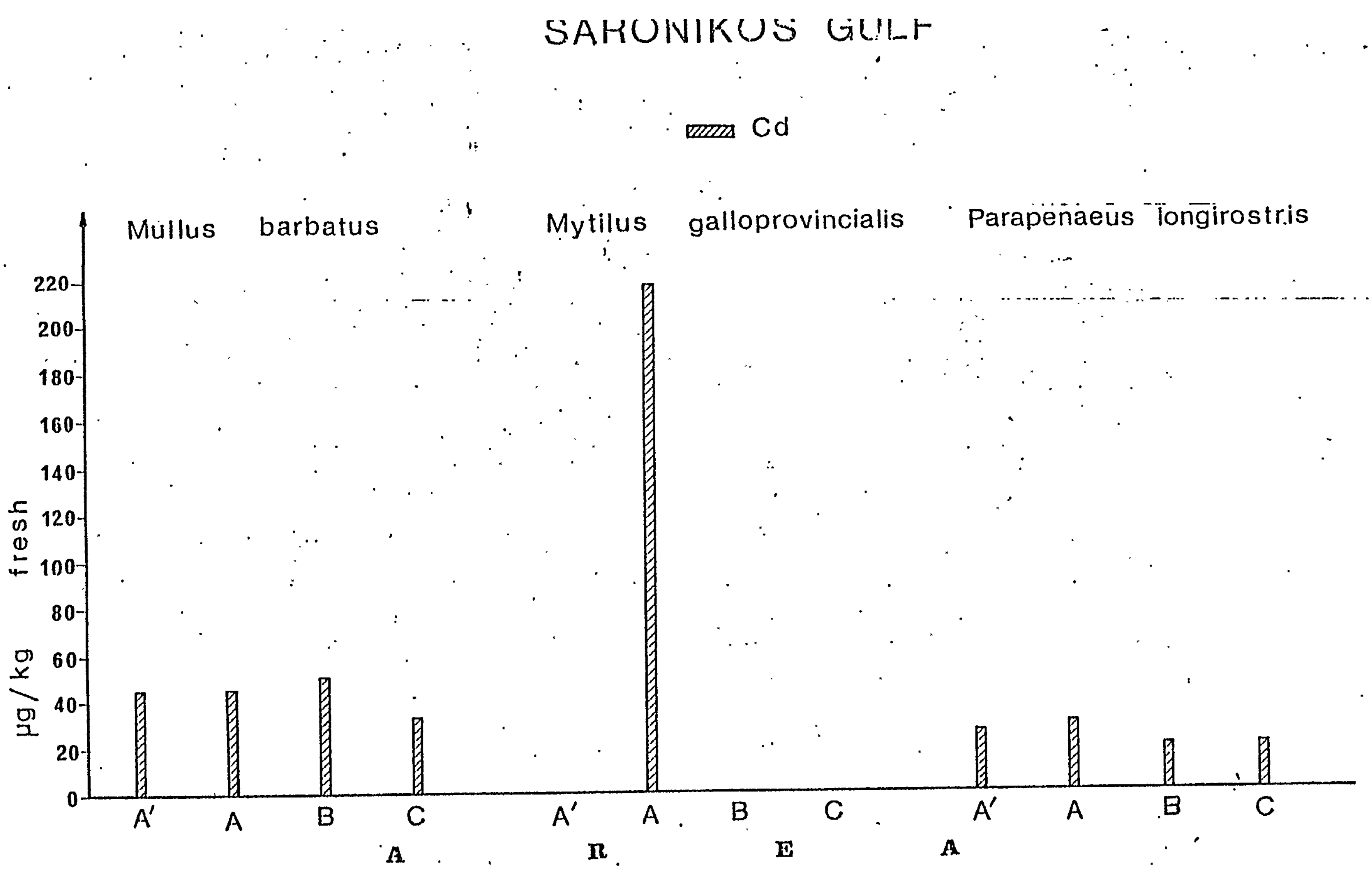


Fig. 2 Cadmium concentrations in selected species sampled in different sites

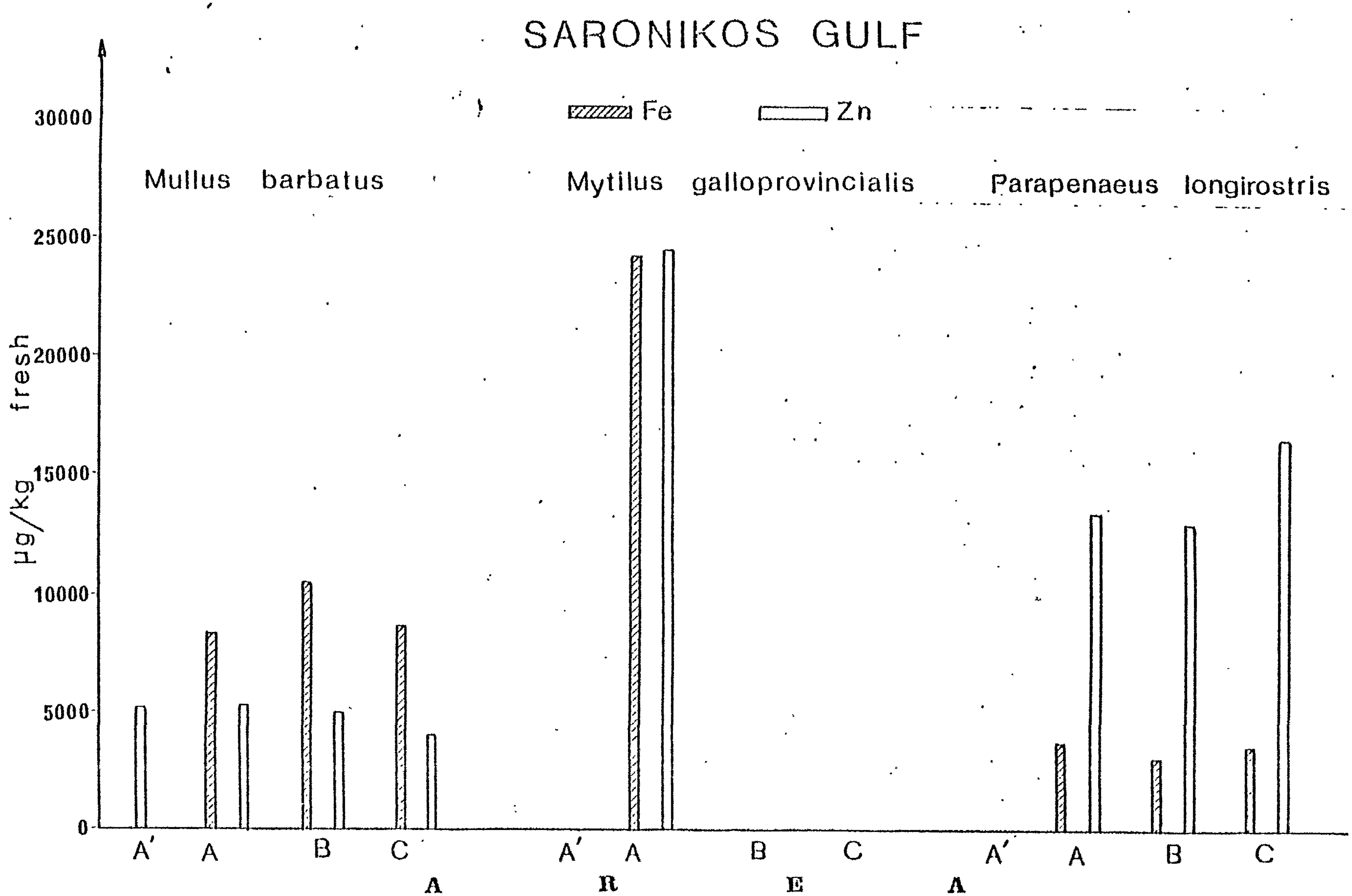


Fig. 3 Ferrum and zinc concentrations in selected species from different sampling sites

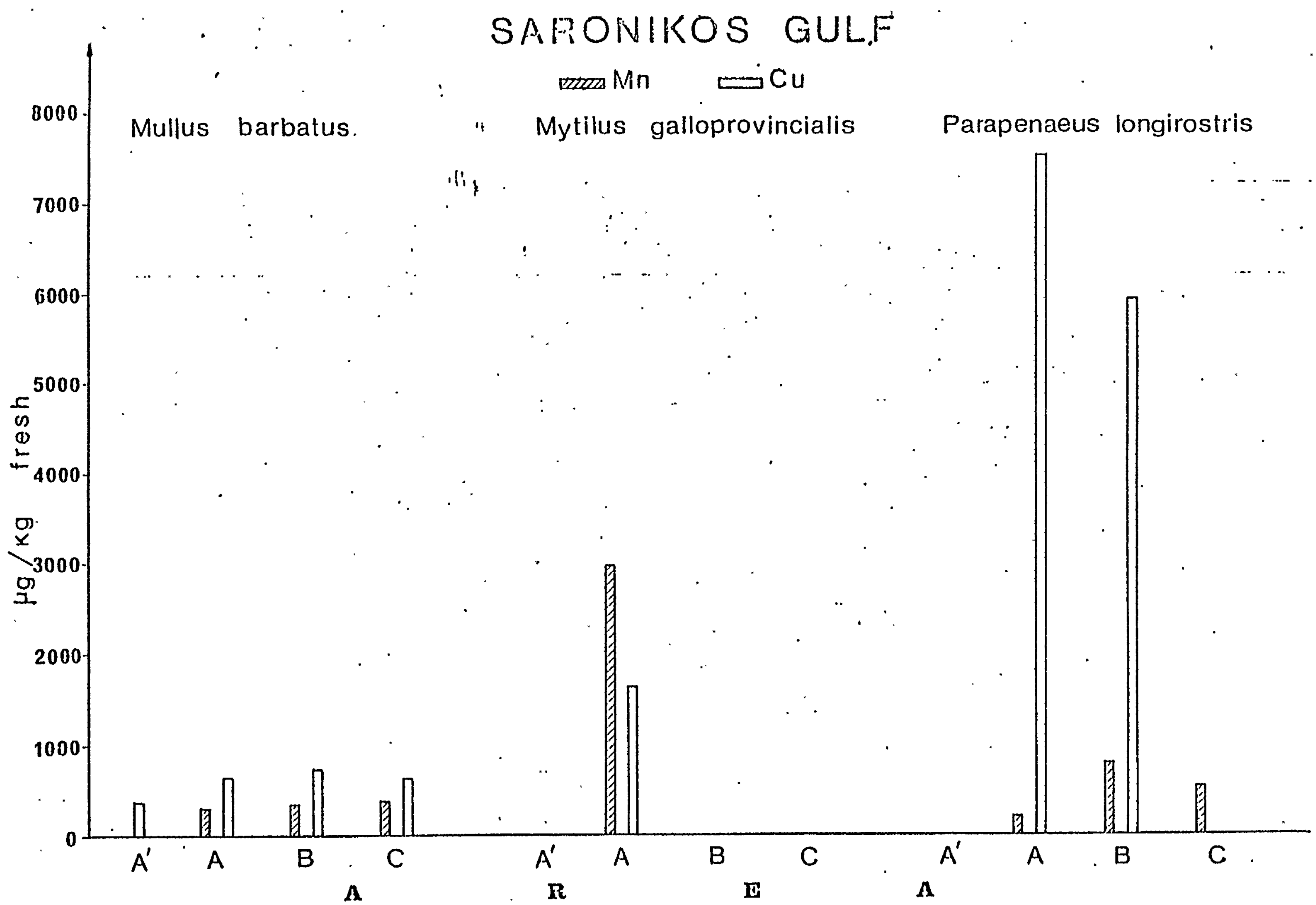


Fig. 4 Manganese and copper concentrations in selected species from different sampling sites

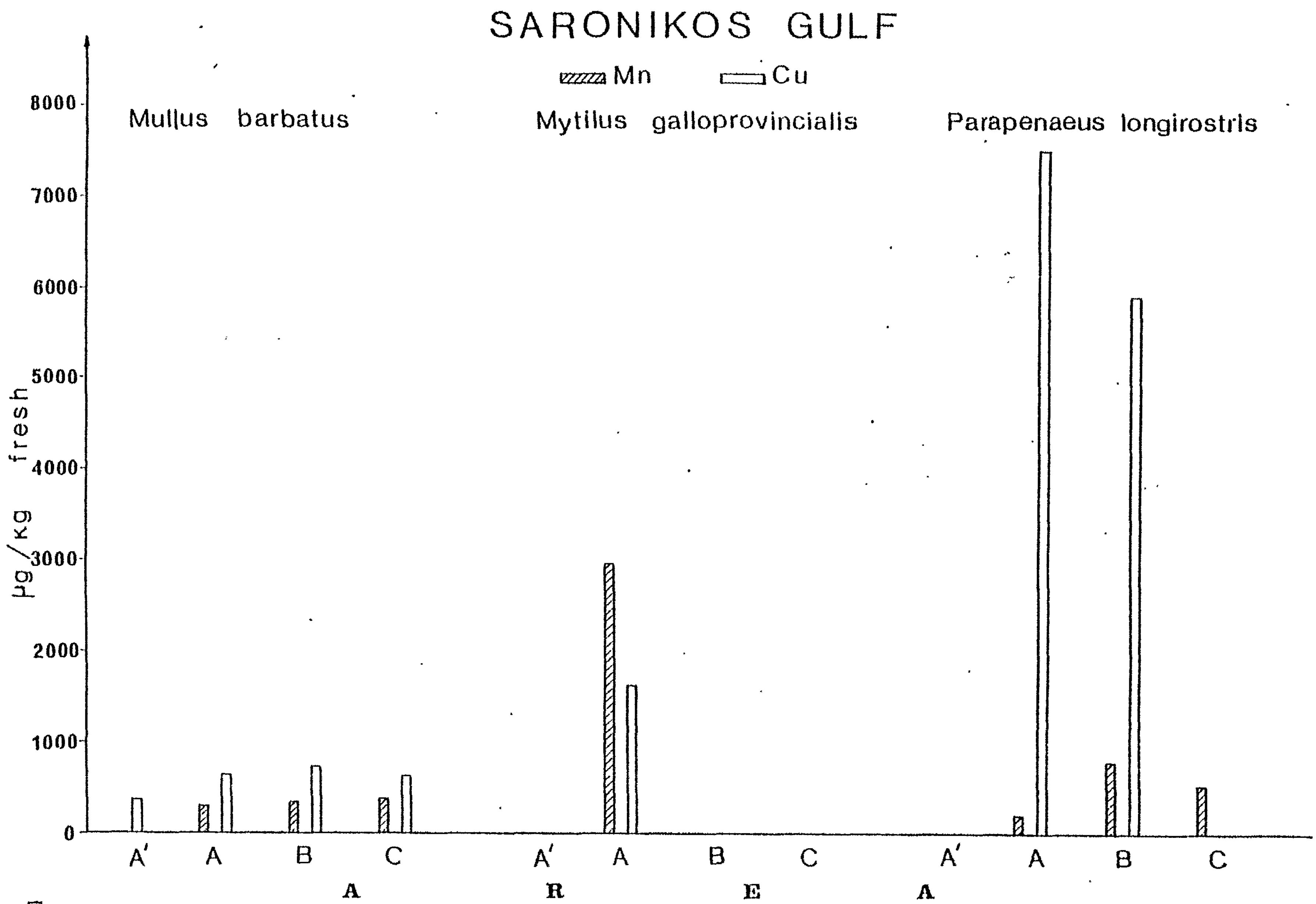

SARONIKOS GULF
Mn
Cu
Mullus barbatus
Mytilus galloprovincialis
Parapenaeus longirostris
μg/κg fresh
8000
7000
6000
5000
4000
3000
2000
1000
0
A′ A B C
A′ A B C
A′ A B C
A R E A

Fig. 5

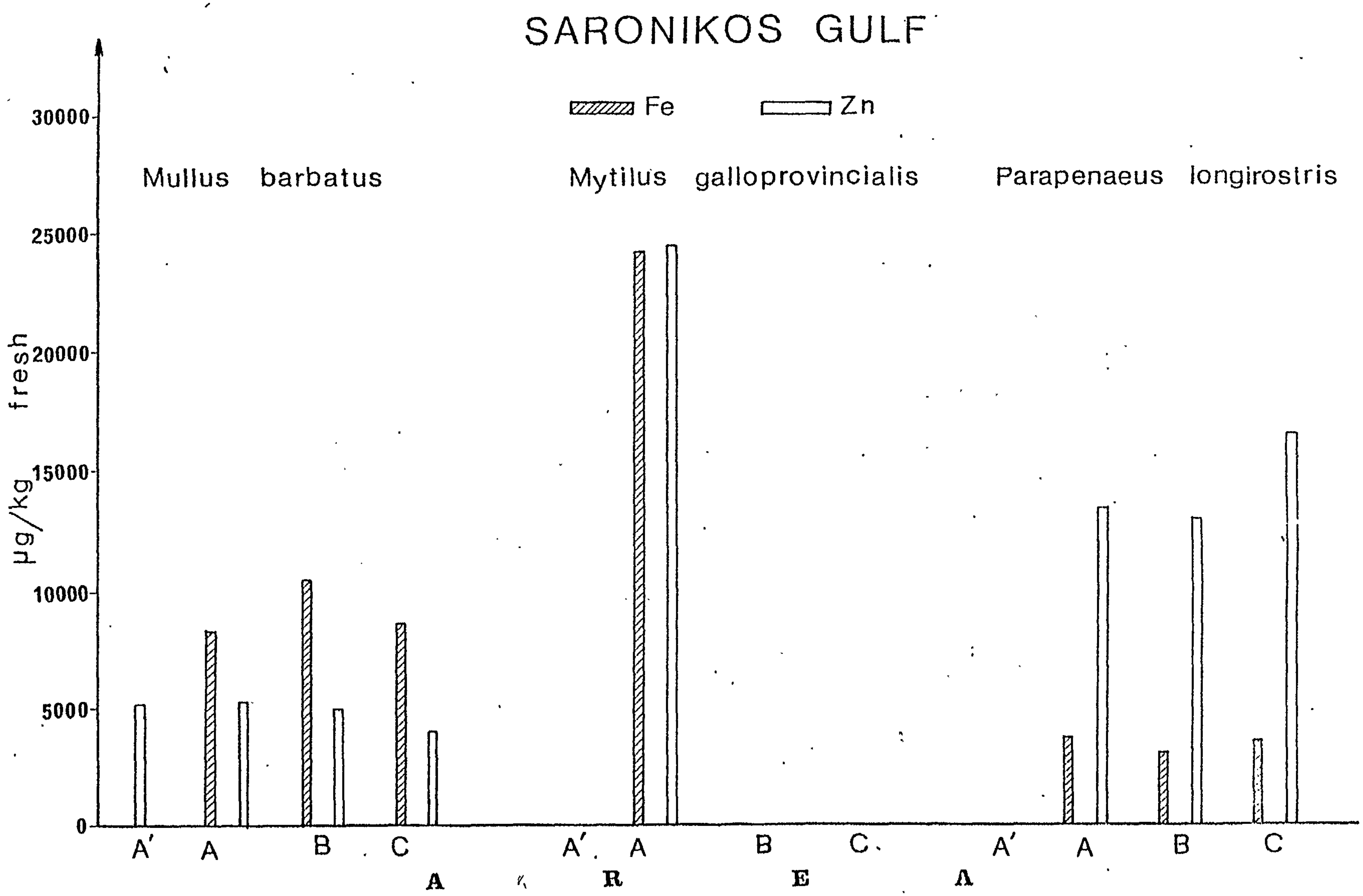

SARONIKOS GULF
Fe
Zn
Mullus barbatus
Mytilus galloprovincialis
Parapenaeus longirostris
μg/kg fresh
30000
25000
20000
15000
10000
5000
0
A′
A
B
C
A′
A
B
C
A′
A
B
C
A R E A

Fig. 6

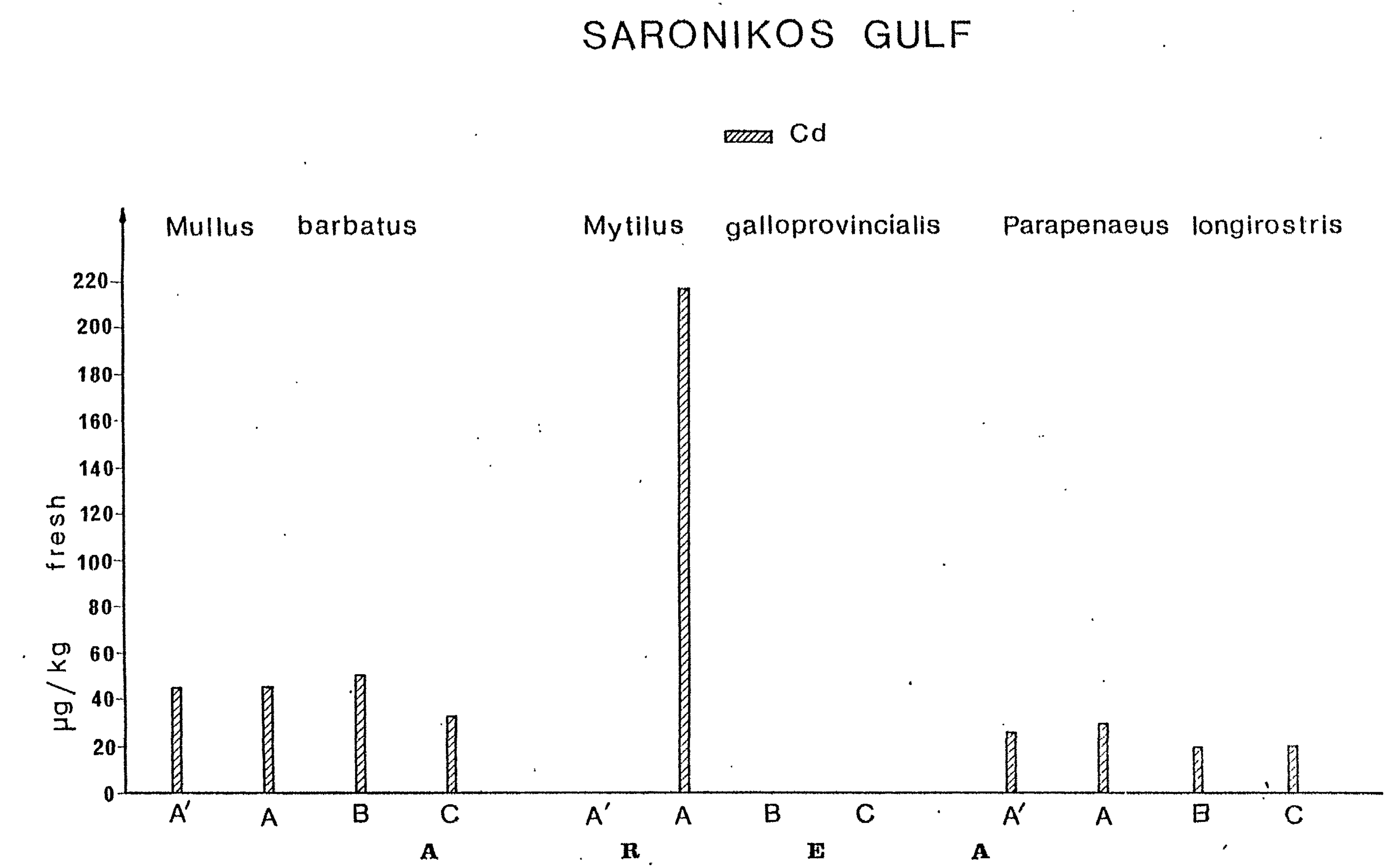

SARONIKOS GULF
Cd
Mullus barbatus
Mytilus galloprovincialis
Parapenaeus longirostris
µg / kg fresh
220
200
180
160
140
120
100
80
60
40
20
0
A′
A
B
C
A′
A
B
C
A′
A
B
C
A R E A

Fig. 7

Participating Research Centre: Radioanalytical Laboratory, Nuclear Research Centre "Demokritos", ATHENS Greece

Principal Investigator: A.P. GRIMANIS/C. PAPADOPOULOU

Introduction:

The Radioanalytical Laboratory has been carrying out research on trace elements in the marine environment since 1963 and has published 20 papers. Two publications have dealt with the concentrations of trace elements in three species of the edible fish Pagellus erythrinus, Sargus annularis and Gobius niger caught in the Aegean Sea.

Area(s) studied:

Saronikos Gulf, Aegean (Area VIII), has a surface of about 2900 km^2. Stream runoff into the Gulf, except during short period of heavy rainfall, is insignificant. The northern part receives domestic and industrial effluents. There is only a slight tide of about 50-60 cm. A sludge field, which has an elevated concentration of toxic and other trace elements, is found around the outfall. Circulation in the Gulf is predominately wind-driven and depends upon the prevailing wind direction; weak cyclonic or anticyclonic modes of circulations were established. Complete renewal of the waters takes about one month for the eastern part of the Gulf and about two months for the western part. Salinity and temperature ranges are from about 37,5 $^o/_{oo}$ to 38.9 $^o/_{oo}$ and 11 to 25.4 °C, respectively. Waters are homogeneous during the winter but in the summer a 30m-to-40m deep thermocline is formed.

Material and methods:

In previous work of the Laboratory, with the exception of As, high trace element concentrations were not found in the tissues of the three edible fish species P. erythrinus, S. annularis and G. niger, sampled from the northern part of the Saronikos Gulf.

In the present study Mullus barbatus and Parapenaeus longirostris were collected from four sampling stations, AA, A, B, and C (figure 1) where the depth of the water is between 80 and 120 m. The sediment in all stations is sandy mud. Specimens of Mytilus galloprovincialis were collected from point K1 at Station A.

Specimens of M. barbatus and P. longirostris were fished by bottom trawlers and those of M. galloprovincialis were collected from a mussel farm. Only one specimen of Ziphias gladius caught in the area southwest of Cyprus was analysed. Sample identification and preparation were made according to FAO, Fisheries Technical Paper No. 158. Samples were stored in deep-freeze for 4-10 weeks and then lyophilized. Subsequently, Instrumental Neutron Activation Analysis (INAA) was applied. For the determination of Hg and Zn fast radiochemical separations based on solvent extraction or iron exchange technique combined with NAA methods were used.

Results and their interpretation:

Trace elements Hg, Zn and Se have been determined in the muscle of Mullus barbatus and Parapenaeus longirostris as well as in the whole body of Mytilus galloprovincialis from Saronikos Gulf (figure 1).

Besides the mandatory metals Ag, Cr, Cs, Co, Fe, Rb and Sb were determined as well. One specimen of Xiphias gladius was also analysed for Hg, Zn and Se content.

The results of the analyses are summarized in tables 1, 2 and 3 for Hg, Zn and Se respectively for each of the following species: Mullus barbatus, Parapenaeus longirostris, Mytilus galloprovincialis, and Xiphias gladius and according to the sampling stations.

The results could be interpreted as follows:

Mullus barbatus

All Hg values found, ranging from 32 to 325 ug/kg F.W. are lower than the maximum permissible level for Hg in fish given by WHO (500 ug/kg F.W.) Mercury values found in samples taken at station C, during both years, are higher than those found in samples taken at other stations.

Parapenaeus longirostris

In one sample the concentration of Hg was higher than the WHO maximum permissible level (570 ug/kg F.W.)

Mytilus galloprovincialis

The concentration of Hg varies in the range from 63 to 214 ug/kg F.W. with a mean of 149 ug/kg F.W.

Parapenaeus longirostris has the highest concentrations of Hg and Se, and intermediate concentrations of Zn. Mytilus galloprovincialis has the highest concentration of Zn and the lowest concentrations of Hg and Se. Mullus barbatus has intermediate concentrations of Hg, and Se and the lowest concentrations of Zn. The comparison without statistical analysis shows that concentrations of Zn and Hg in Mullus barbatus from Saronikos Gulf and in fish from areas other than the Mediterranean are comparable, in fact Hg is somewhat lower in Saronikos Gulf samples. Concentrations of Zn and Hg in Mytilus galloprovincialis from Saronikos Gulf are comparable to those in Mytilus edulis from areas other than the Mediterranean.

The results show that the increased domestic and industrial effluent input into the Saronikos Gulf, although it results in a highly eutrophicated ecosystem, has no measurable effect on the trace element concentrations in the three marine organisms monitored.

Conclusions:

Although Saronikos Gulf is highly influenced by the increased industrial and domestic wastes of the Greater Athens area and increased concentrations of trace elements have been found in sediments, the marine organisms monitored in the framework of this pilot project do not show any such effect.

As concluded from previous work, carried out at the Laboratory, fish do not necessarily reflect increased trace elements inputs. Nevertheless, it cannot be concluded that increased concentrations will not occur in other marine organisms. Continuous monitoring should be carried out in sensitive regions and ecological as well as biochemical factors should be taken into account.

List of Publications:

PAPADOPOULOU, C. and KANIAS, G.D. (1976). Trace element distribution in seven mollusc species from Saronikos Gulf. Adriatica 18/22: 365.

GRIMANIS, A.P. et al., (1978). Pollution monitoring of eleven trace elements in three marine organisms from Saronikos Gulf, Greece. Presented at the XXVIth Congress and Plenary Assembly of ICSEM, ICSEM/UNEP Workshop on Marine Pollution in the Mediterranean, Antalya.

Tabea 1

Metal	Species	Sampling station	Sampling period	Tissue analysed	Number of specimens	Number of analyses	Concentration µg/kg F.W. Minimum	Maximum	Average
Hg	*Mullus barbatus*	AA	Dec. 1975–June 1977	Fillet	51	5	40	276	124 ± 94
		B	Dec. 1975–Jan. 1978	Fillet	54	11	32	138	94 ± 34
		C	Jan. 1976–Jan. 1978	Fillet	39	7	167	325	264 ± 55
		A	March 1977–Jan. 1978	Fillet	7	2	52	76	64 ± 12
	Paraponaeus longirostris	AA	Dec. 1975–June 1976	Fillet	25	2	122	313	218 ± 96
		B	March 1976–Jan. 1978	Fillet	38	4	131	574	360 ± 186
		C	Jan. 1978	Fillet	9	1			115 1/
		A	March 1977–Jan. 1978	Fillet	36	4	110	506	239 ± 183
	Mytilus galloprovincialis	A	Dec. 1975–Oct. 1977	Whole body	58	3	63	214	149 ± 78
	Xiphias gladius	South-west of Cyprus	July 1976	Fillet	1	1			697 1/

1/ Only one value reported

Table 2

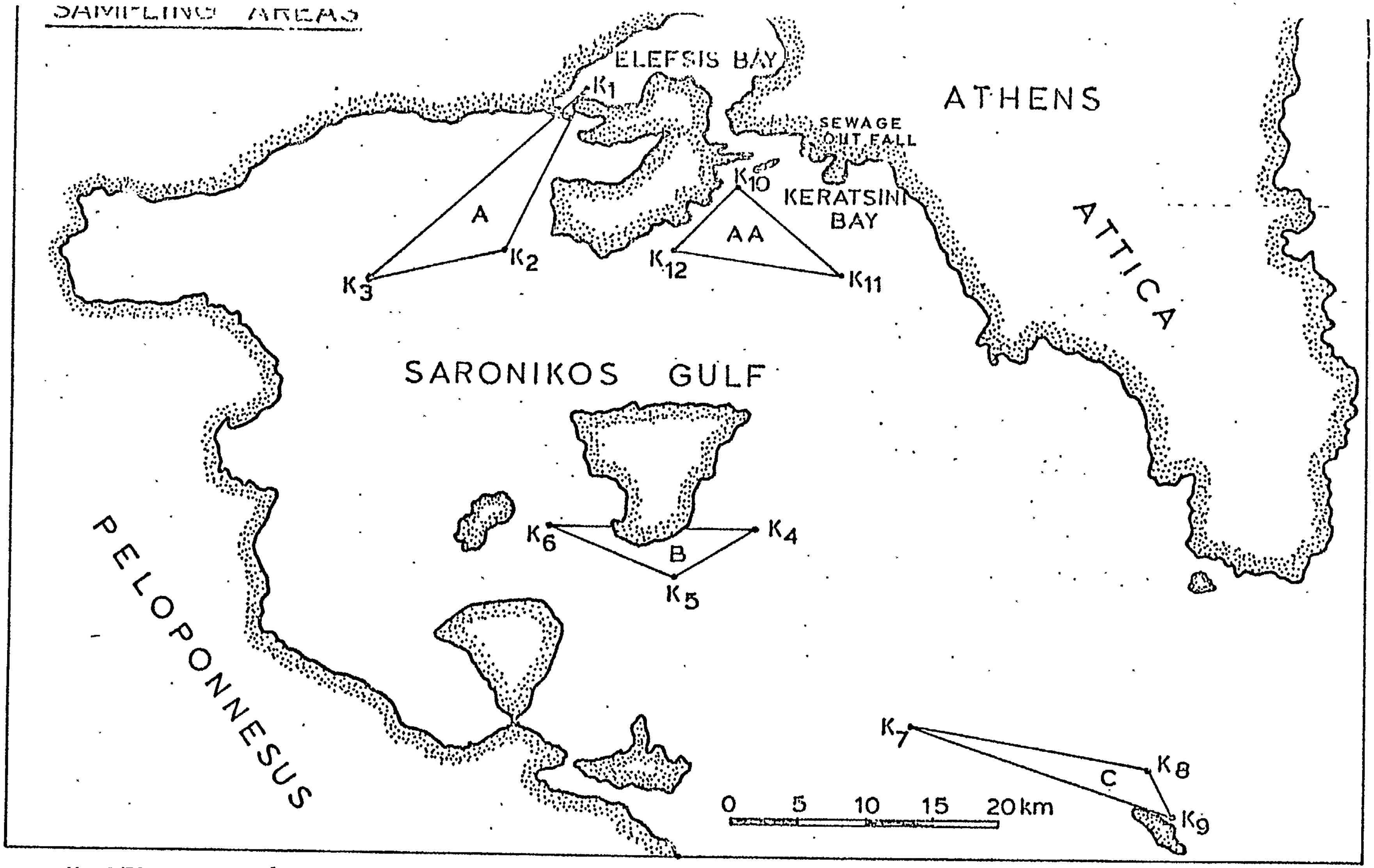
Metal	Species	Sampling station	Sampling period	Tissue analysed	Number of specimens	Number of analyses	Concentration µg/kg F.W. Minimum	Maximum	Average ± σ
Zn	*Mullus barbatus*	AA	Dec. 1975–June 1977	Fillet	51	5	2570	3700	3262 ± 479
		B	Dec. 1975–Aug. 1977	Fillet	43	10	2700	4400	3519 ± 430
		C	Jan. 1976–Jan. 1978	Fillet	39	7	2610	4050	3129 ± 551
		A	March 1977–Jan. 1978	Fillet	17	4	2800	3800	3225 ± 465
	Parapenaeus longirostris	AA	Dec. 1975–June 1976	Fillet	25	2	12300	14200	13250 ± 950
		B	March 1976–Jan. 1978	Fillet	47	5	4560	15200	10372 ± 4249
		C	Jan. 1978	Fillet	9	1			9700 1/
		A	June 1977–Jan. 1978	Fillet	28	3	3810	16700	10060 ± 6454
	Mytilus galloprovincialis	A	Dec. 1975–Oct. 1977	Whole body	64	4	11900	62500	33700 ±21050
	Xiphias gladius	South-west of Cyprus	July 1976	Fillet	1	1			4700 1/

1/ Only one value reported

Table 3

Metal	Species	Sampling station	Sampling period	Tissue analysed	Number of specimens	Number of analyses	Concentration µg/kg F.W. Minimum	Maximum	Average	σ
Se	*Mullus barbatus*	AA	Dec. 1975– June 1977	Fillet	51	5	333	583	486	± 103
		B	Dec. 1975– Aug. 1977	Fillet	54	11	380	612	476	± 65
		C	Jan. 1976– Jan. 1978	Fillet	39	7	460	651	554	± 60
		A	March 1977– Jan. 1978	Fillet	17	4	290	390	328	± 38
	Parapenaeus longirostris	AA	Dec. 1975– June 1976	Fillet	25	2	880	880	880	
		B	March 1976– June 1978	Fillet	47	5	1100	2060	1662	± 351
		C	Jan. 1978	Fillet	9	1			1810 1/	
		A	June 1977– Jan. 1978	Fillet	28	3	610	860	767	± 137
	Mytilus galloprovincialis	A	Dec. 1975– Oct. 1977	Whole body	64	4	310	550	405	± 107
	Xiphias gladius	South-west of Cyprus	July 1976	Fillet	1	1			620 1/	

1/ Only one value reported



K_1 37° 59.5 N / 23° 25.6 E	K_5 37° 39.5 N / 23° 30.75 E	K_9 37° 29.1 N / 23° 56.50 E
K_2 37° 53.2 N / 23° 22.0 E	K_6 37° 41.5 N / 23° 23.8 E	K_{10} 37° 55.45 N / 23° 33.85 E
K_3 37° 51.5 N / 23° 14.8 E	K_7 37° 33.2 N / 23° 42.5 E	K_{11} 37° 51.80N / 23° 38.50 E
K_4 37° 41.7 N / 23° 34.5 E	K_8 37° 31.1 N / 23° 55.0 E	K_{12} 37° 52 85N / 23° 30.20 E

Fig. 1 Sampling sites in Saronikos Gulf

Participating Research Centre: General Chemical State Laboratory, Division of Environmental Pollution Control
ATHENS
Greece

Principal Investigator: D.G. MARKETOS

Introduction:

Determination of heavy metals, particularly total mercury, in various species of fish exported to other countries have been performed for the last seven years, using the method of flameless atomic absorption spectrophotometry. Chemical analysis of industrial effluents and marine waters polluted by ships' fuel have also currently been performed.

Area(s) studied:

Saronikos Gulf, Aegean (Area VIII), figure 1, has a surface of about 2900 km^2 and the stream runoff into the Gulf is insignificant except during short periods of heavy rainfall. Keratsini Bay, the northern part of Saronikos Gulf, receives untreated domestic sewage and industrial effluents from the greater Athens area, through an outfall situated 100 m offshore at a depth of 30m. Sewage flow is about 350 000 m^3/days. Elefsis Bay, a semi-enclosed bay at the head of Saronikos Gulf, also receives industrial and domestic wastes, as well as waste from ships. The northern part of Saronikos Gulf is highly euthrophicated. Concentrations of nutrients are up to 15 times higher than in Aegean Sea waters. Consequently, primary production is greatly enhanced. The high biodegradable organic input from the Keratsini outfall has also resulted in low oxygen concentrations in the deep waters of several parts of Saronikos Gulf, especially Elefsis Bay. Conditions close to the outfall are toxic for benthic communities whereas to an extent of about 3 km benthos is highly eutrophicated. The discharge of wastes in Keratsini and Elefsis Bay has resulted in elevated concentrations of toxic and other trace elements in sediments of at least 100 km^2 of sea floor.

Material and methods:

Mullus barbatus, Parapenaeus longirostris and Mytilus galloprovincialis were regularly monitored for total mercury in four sampling stations in Saronikos Gulf, from September 1976 to January 1978. Samples of Xiphias gladius were collected in June 1976 from areas indicated in figure 2, and were also analysed for total mercury. The methods used for the analysis of the samples are those recommended in FAO, Fisheries Technical Paper No. 158, Chapter 6 (Analytical Procedures). The results of these analyses might not be reliable As the samples were transported to the laboratory at the room temperature.

Results and their interpretation:

In table the concentrations of Hg(T) determined in Mullus barbatus, Parapenaeus longirostris and Mytilus galloprovincialis are summarized according to the sampling stations A, B, C, AA. The position of these stations can be seen in figure 1.

a) Mullus barbatus Hg(T) concentrations in all samples were below and usually well below 500 ug/kg F.W. Maximum and minimum values were observed in June 1977 and in March 1977 respectively.

b) Parapenaeus longirostris Hg(T) concentration in six samples were well below 500 ug/kg F.W. Minimum value was observed in June 1977. In January 1978 (stations A, B and C), the concentrations were higher than 500 ug/kg F.W.

c) Mytilus galloprovincialis Hg(T) concentration in all samples were below 500 ug/kg F.W. Maximum and minimum concentrations were recorded in October 1977 and in January 1978, respectively.

The concentration of Hg(T) in Xiphias gladius sampled at four areas (figure 2) are summarized in table 2.

d) Xiphias gladius Hg(T) concentration in all samples seems to be rather low for this species. It could be due to a certain loss of mercury during the transportation from the collection area to the Laboratory, and also, the analysis was performed at ambient temperature. Therefore, this monitoring was discontinued.

The seasonal variation of Hg(T) concentration in Mullus barbatus, Parapenaeus longirostris and Mytilus galloprovincialis sampled at stations A, B, C, AA in Saronikos Gulf, is graphically presented in figure 3.

The concentration of Hg(T) is higher for Parapenaeus longirostris at stations B and C than at the station A. In Mullus barbatus and Mytilus galloprovincialis the values are comparable but lower than in Parapenaeus longirostris.

All mercury values (except 3 of them) found in the above three marine organisms are below the WHO maximum permissible concentration (500 ug/kg F.W.); therefore, no danger from human consumption is to be expected. Although increased concentrations of mercury were found in the sediments around Keratsini outfall these are not reflected in the marine organisms.

A brief comparison with bibliographic non-Mediterranean data shows that the results obtained for Mullus barbatus and Mytilus galloprovincialis are comparable with results reported for fish and Mytilus edulis, respectively.

Conclusions:

Total mercury was determined in 39 composite and individual samples (218 specimens) of four species. Thirty-four of these samples (Mullus barbatus, Parapenaeus longirostris and Mytilus galloprovincialis) were collected from four sampling stations in Saronikos Gulf from September 1976 to January

1978. Values found were usually well below 500 ug/kg of fresh weight, with the exception of two samples of Parapenaeus longirostris, where mercury concentrations found were about two times higher than the above limit. Due to the small number of the samples examined, seasonal variations were not identified. The remaining 5 samples (Xiphias gladius) were collected from four areas of Greek sea waters. The low values found (45 to 100 ug/kg of fresh weight) may be attributed to the fact that the samples were not transported to the Laboratory under refrigeration.

Publications:

Marketos, D.G. et al., (1978). Determination of total mercury in marine organisms (in Greek, with English abstract). Presented at the Seminar "Marine Pollution Research", Ministry of Co-ordination, Scientific Research and Technology Agency, 7-8 December 1978, Athens, Greece.

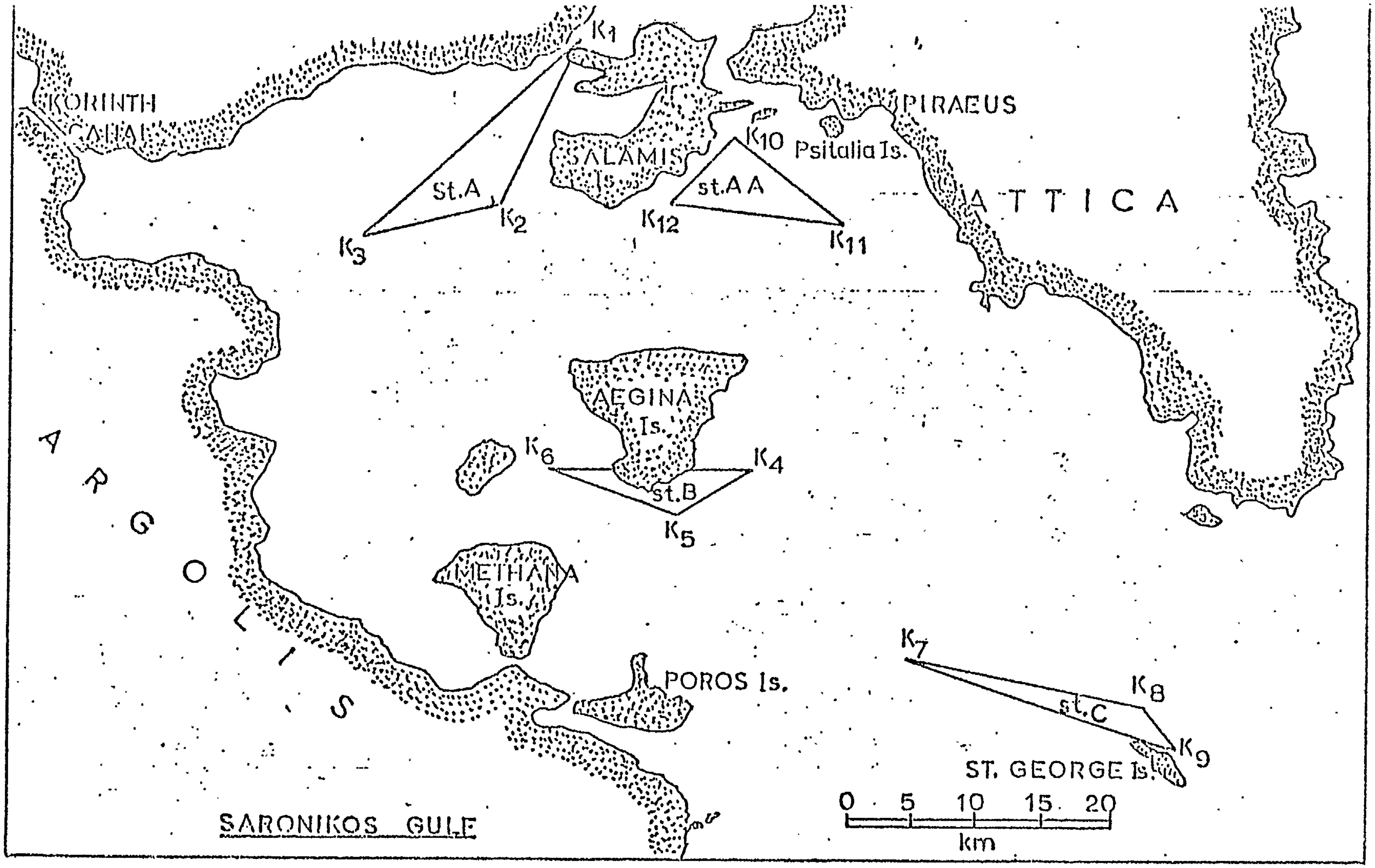
Table 1 - Sampling area: Saronikos Gulf

Metal	Specimen	Sampling stations	Sampling period	Tissue analysed	Number of specimens	Number of analyses	Concentration µg/kg F.W. Minimum	Maximum	Average	σ
Hg(T)	*Mullus barbatus*	A	Sept. 1976–Jan. 1978	White muscle	19	5	50	491	152	± 190
		B	Sept. 1976–Jan. 1978	White muscle	39	11	51	151	95	± 30
		C	Nov. 1976	White muscle	22	4	81	424	271	± 143
		AA	June 1977	White muscle	6	1			58 1/	
	Parapenaeus longirostris	A	March 1977–Jan. 1978	Soft part	36	4	114	545	231	± 210
		B	March 1977–Jan. 1978	Soft part	38	4	190	1195	484	± 479
		C	Jan. 1978	Soft part	9	1			908 1/	
	Mytilus galloprovincialis	A	April 1977–Jan. 1978	Soft part	44	4	44	378	252	± 144

1/ Only one value reported

Table 2

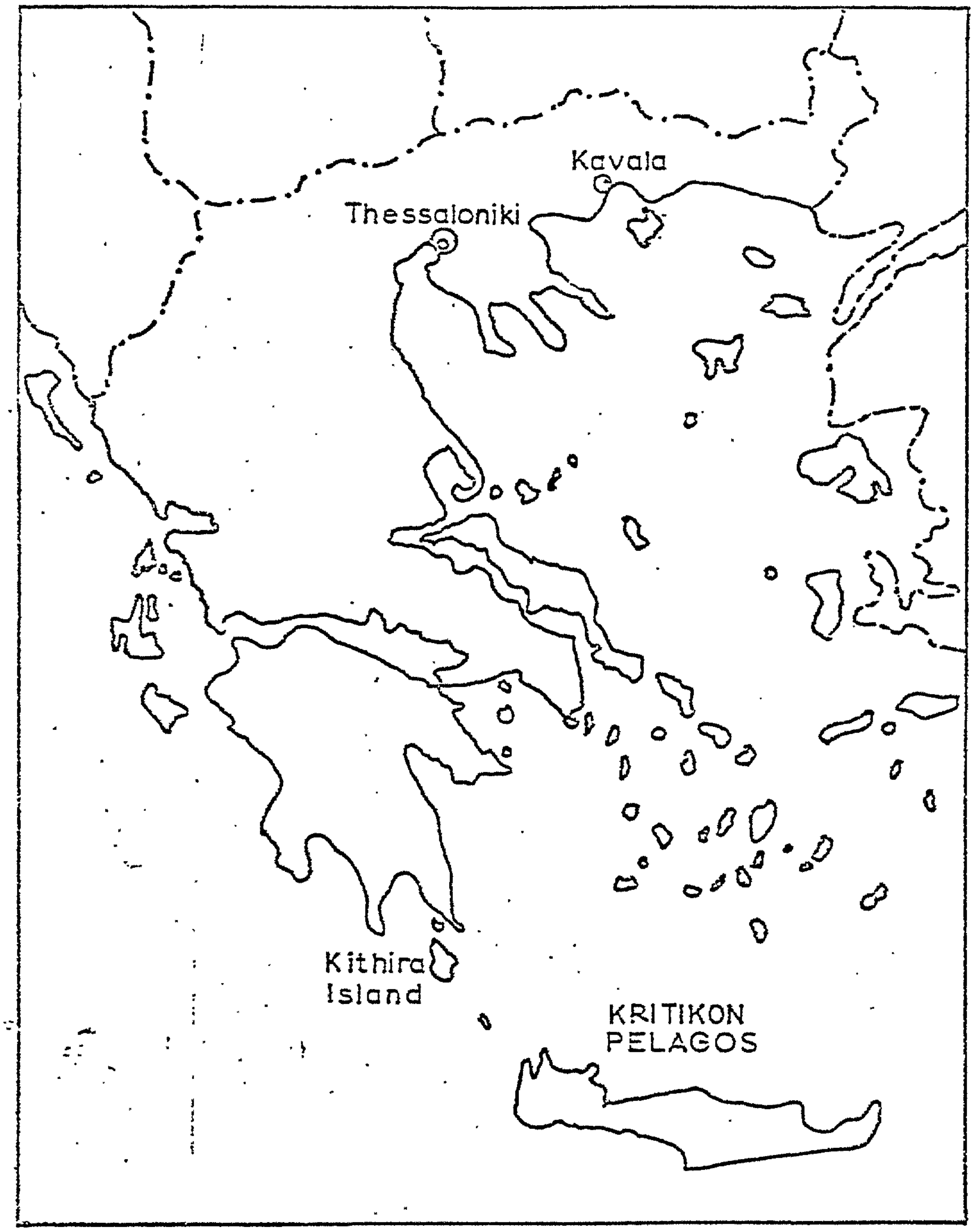
Metal	Species	Sampling stations	Sampling period	Tissue analysed	Number of specimens	Number of analyses	Concentration $\mu g/kg$ F.W. Minimum	Maximum	Average ± σ
Hg(T)	*Xiphias gladius*	South of Tessaloniki	June 1978	White muscle	1	1	45	100	74 ± 25
	Xiphias gladius	Kritikon Pelagos	June 1978	White muscle	1	1			
	Xiphias gladius	Near Kithira Island	June 1978	White muscle	1	1			
	Xiphias gladius	South of Kavala	June 1978	White muscle	2	2			



SAMPLING STATION	LAT		LONG	
	Degr.	Min	Degr.	Min.
A	37	55	23	20
B	37	40	23	29
C	37	31	23	19
AA	37	54	23	34

Fig. 1 Sampling sites in the Gulf of Saronikos

MAP OF GREECE



Sample	Sampling of areas
No.0035 :	South of Thessaloniki
No.0036 :	Kritikon Pelagos
No.0037 :	Near Kithira Island
No.0038 :	South of Kavala
No.0039 :	South of Kavala

Fig.22 Map of Greece

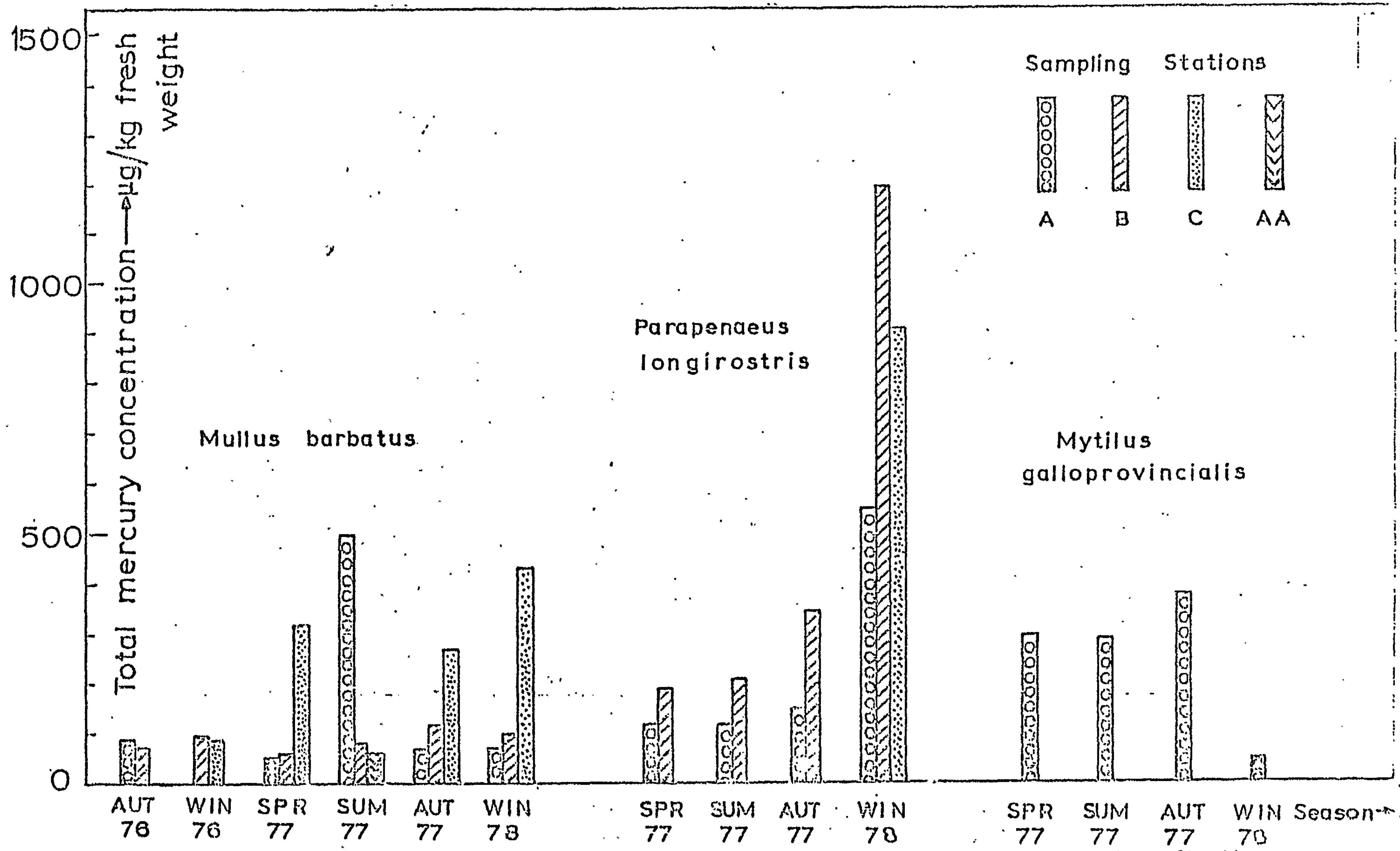


Fig.3. Seasonal and site variations of total mercury concentration in three marine organisms in Sarónikos Gulf from September 1976 to January 1978.

Participating Research Centre: Laboratory of Analytical Chemistry,
Faculty of Physics and Mathematics,
University of Thessaloniki,
THESSALONIKI,
Greece

Principal Investigator: G. VASILIKIOTIS

Introduction:

Since 1974 the Laboratory of Analytical Chemistry has been carrying out analysis of marine waters and sediments of Thessaloniki Gulf and waste waters discharged into it. Results obtained proved significant heavy metal concentrations near the sites where industrial wastewater and municipal sewage were discharged. Main subject was the investigation of mercury and lead distribution.

Area(s) studied:

The following areas of Northern Aegean Sea (Area VIII) were studied:

In Thessaloniki Gulf (part of Thermaikos Gulf, see fig. 1) the three sampling stations were located as follows: Th_1 in the vicinity of the industrial area, Th_2 in an area used extensively for fishing and Th_3 for recreation. Five sampling sites were chosen in the Kavala region (see fig. 2): St_1 and ST_2 are located in the harbour, St_3 near the fertilizer production plant, and St_4 and St_5 for comparative purposes in clearer sites.

In Strymonikos Gulf, in general considered as fairly unpolluted, the sampling stations S1 (in the North of a mixed sulfides deposit) and S2 (near the mouth of the Strymon River) were chosen, fig. 3.

Material and methods:

Sampling was done in September 1975 through December 1978. Specimens were collected by the Laboratory of Zoology (Prof. M. Katmoulas) and stored by deep freezing. In each analysis a composite sample was prepared and the destruction was performed by wet ashing with concentrated NHO_3 under reflux or in pressure decomposition vessels. Determination of heavy metals was performed with a PERKIN ELMER 403 Atomic Absorption Spectrophotometer. Each determination was carried out twice, the second being done by the standard addition technique and reported values represent their average. Determined metals were mercury, lead, and cadmium in the following marine organisms: Mytilus galloprovincialis, Mullus barbatus (principally), Thunnus thynnus and Xiphias gladius (rarely).

Results and their interpretation:

Table 1 gives results on ranges of concentration of heavy metals in the test organisms broken down to station level. Seasonal differences are not yet considered, apart from Mytilus, as all other species were only sampled occasionally.

Results achieved show that higher concentrations of heavy metals were observed in marine organisms collected from sampling stations near heavily populated or industrialized areas. Mytilus galloprovincialis is considered as an excellent indicator for the characterisation of the contamination level in an area around a sampling station. Other species are not so abundant so that data about their levels of contamination give only a general idea.

Table 1 - Heavy metal concentration in the mussel and some bony fish in different sampling sites of the Northern Aegean Sea.

Species	Station	Specimens analysed	Tissue Code 1/	Range of heavy metal concentrations (µg/kg F.W.) Hg(T) 3/	Cd 2/	Pb 2/
Mytilus galloprovincialis	Th_1	59	01	4.0-177.0	(43)10.0-283.0	160.0-1756.0
	Th_2	75	01	(70)4.0- 53.0	(51) 5.0-403.0	(65)196.0-5640.0
	S_1	38	01	12.0- 28.0	(25) 8.0- 19.0	86.0- 207.0
	S_2	19	01	9.0- 16.0	(14)27.0- 60.0	55.0- 92.0
	St_1	23	01	76.0-282.0	10.0-208.0	3302.0-4244.0
	St_2	72	01	40.0-920.0	(56)15.0-109.0	(64) 73.0-4779.0
	St_3	62	01	4.0-108.0	(41)29.0-143.0	81.0-3399.0
	St_4	70	01	(61)4.0- 84.0	(46)34.0-274.0	227.0-8260.0
	St_5	23	01	22.0- 33.0	(12) 9.0- 23.0	(17) 75.0- 86.0
Thunnus thynnus thynnus	Th	2	31	50.0- 62.0	(1) 283.0	197.0- 426.0
	S	3	31	72.0-890.0	(2)119.0-215.0	159.0- 560.0
	St	1	31	86.0	168.0	551.0
Xiphias gladius	Th	2	31	410.0-755.0	76.0-148.0	126.0-358.0
Mullus barbatus	Th	22	31	62.0-407.0	(20) 58.0-210.0	(16)187.0-861.0
	St	10	31	56.0-177.0	(8) 27.0-158.0	41.0-816.0
	S	19	31	14.0-194.0	(14) 58.0-204.0	73.0-308.0

Numbers in brackets refer to reduced numbers of specimens analysed

1/ Tissue code: 01 = soft parts (whole body without carapace or shell)
31 = fillet

2/ Data represent mean values from 1 to >10 specimen per sample, error not given.

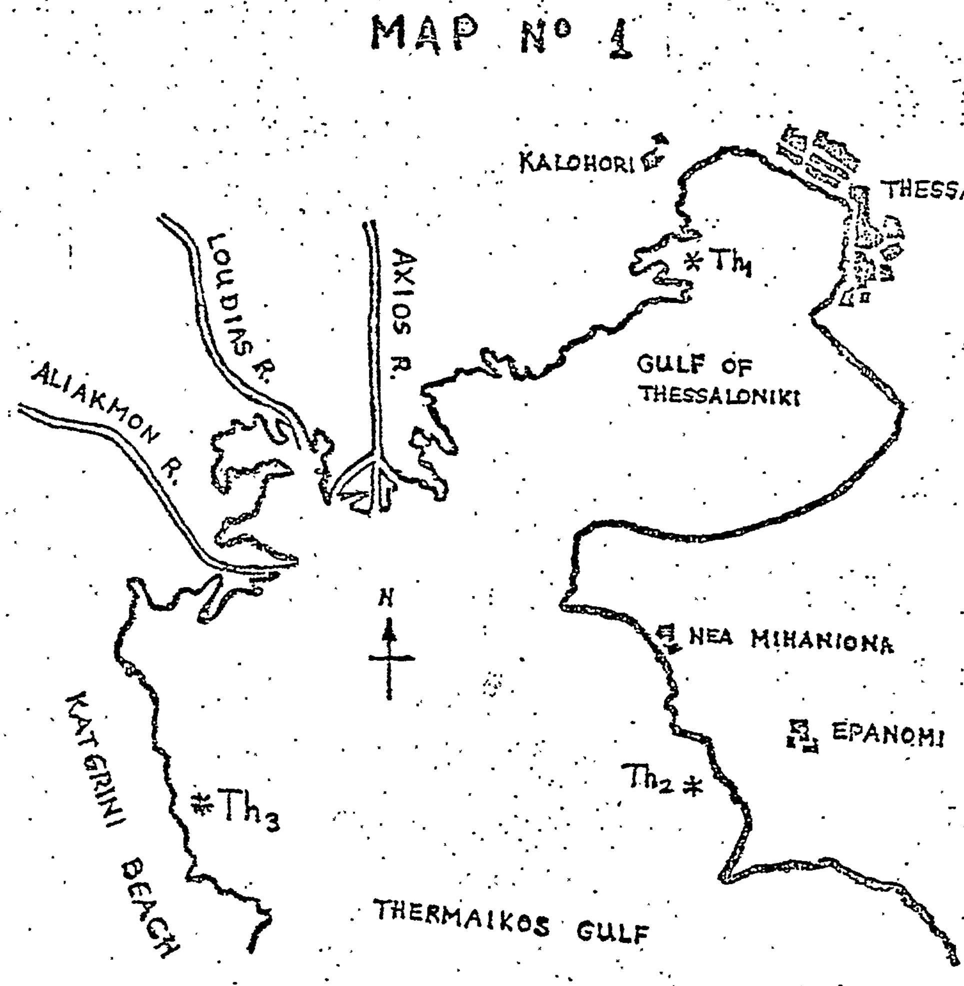
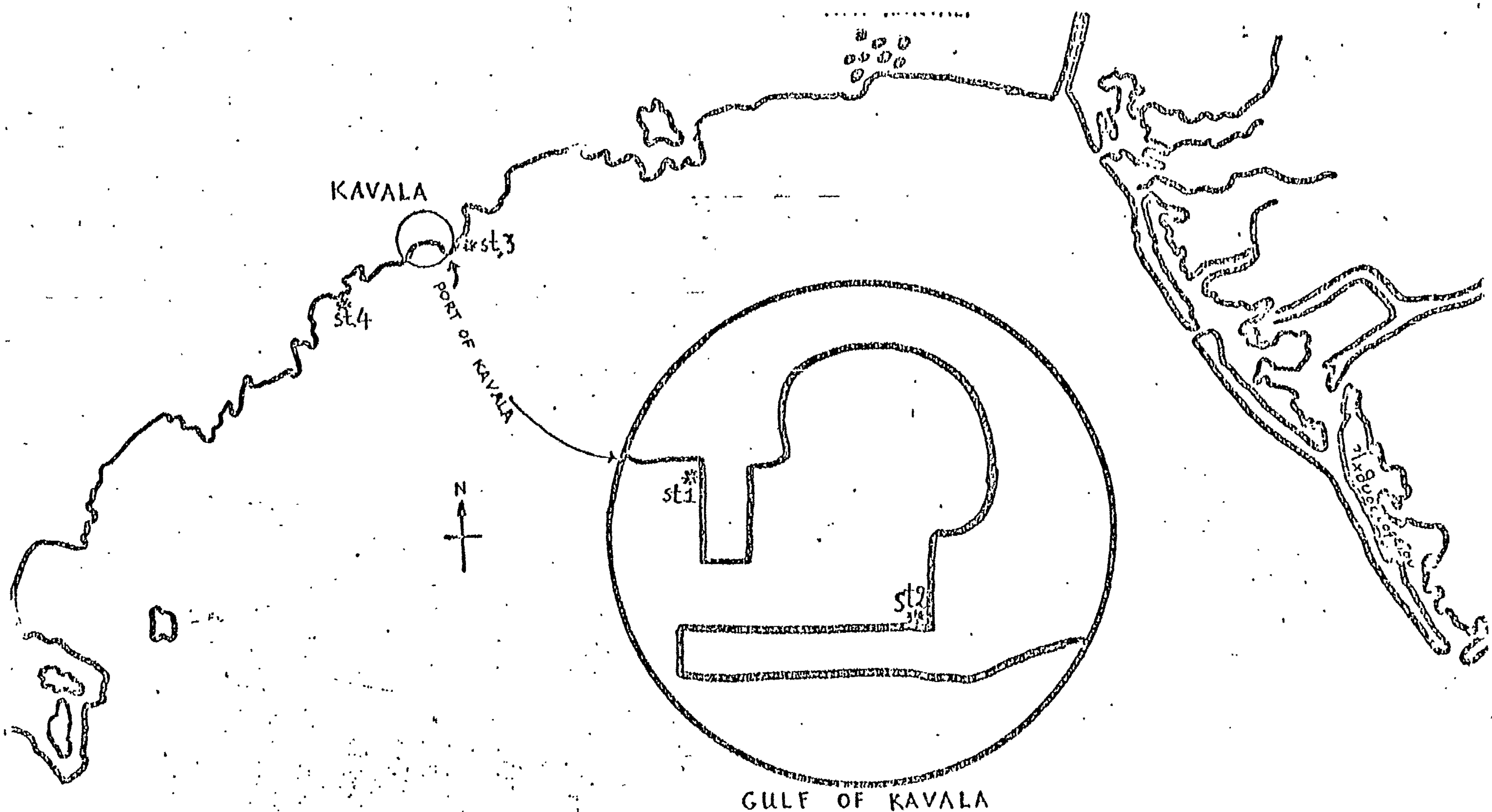


Fig. 1 Sampling sites in Thermaikos and Thessaloniki Gulfs (Stations Th_1, Th_2, and Th_3)



Note: Point St_1 was found to be an azoic area since winter 1975 when close to this point the disposal of domestic sewage started. For this reason no more samples were taken thereafter.

Fig. 2 Sampling sites in the Gulf of Kavala (Stations St_1, St_2, St_3, and St_4)

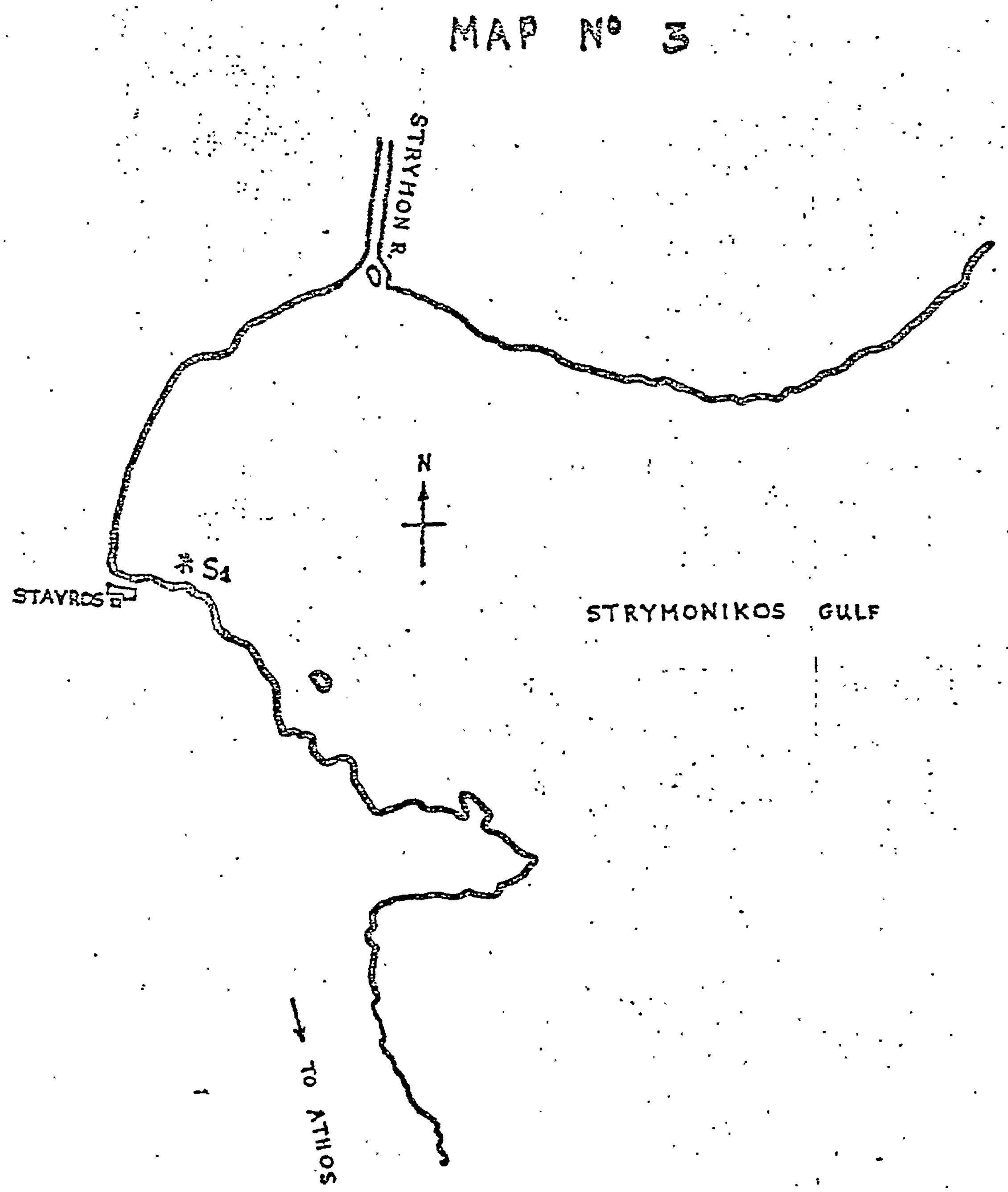


Fig. 3 Sampling site in Strymonikos Gulf (S_1)

Participating Research Centre: Israel Oceanographic and Limnological Research Ltd., HAIFA, Israel

Principal Investigator: O.H. OREN

Introduction:

Previous studies on the mercury content in fish along the Israeli Mediterranean coast were done by Yannai and Sachs (1978). Roth and Hornung (1977) investigated the heavy metals (Cd, Pb, Zn, Ni, Cr) in fish, sediments and water from the same area.

Area(s) studied:

The results given below refer to sampling carried out in six stations: Haifa Bay (HB), Tira (T), Netanya (N), Tel Aviv (TA), Palmahim (P) and Ashquelon (A), shown in figure 1., S. Levantin, Area X. Fish were sampled from five stations along the coast. The mollusc Donax trunculus was sampled at one station in Haifa Bay, where some of the heavy industry areas are concentrated. The Tel-Aviv sampling station is situated near the most densely populated area. The fish collected off Palmahim for TAHAL Water Planning for Israel Ltd. project on "Abnormalities in Fishes off Palmahim" were used for additional study.

No physical and chemical characteristics of the sampling stations were reported.

Material and methods:

From the mandatory species only two, i.e. Mullus barbatus and Mullus surmuletus, have been analysed and the concentration of Hg(T), Cd, Pb, Cu, Zn and Ni was determined. Besides that, in Donax trunculus, Saurida unosquamis, Trachurus mediterraneus, Upeneus moluccensis, Boops boops, Pagellus erythrinus, Sphyraena spyraena Hg(T), Cd, Pb, Cu, Zn, Ni were analysed while in Merluccius merluccius, Pagellus acarne, Sphyraena chrysotaenia and Chelidonichthys lucernus the concentration of Hg(T) was determined.

Sample treatment was in accordance with FAO Fisheries Technical Paper No 158. Each sample was done in triplicate; blanks were run with each batch of samples. A Coleman Mercury Analyser System (MAS-50) was used for the determination of total mercury concentration. The concentrations of Cd, Pb, Cu, Zn and Ni were measured on a Varian, Model 1200 AAS.

Results and their interpretation:

The mean concentrations of Hg(T), Cd, Pb, Cu and Zn (mandatory metals) in two mandatory fish species Mullus barbatus and Mullus surmuletus are summarized in table 1. Mullus barbatus was sampled in the period from October 1975 till March 1978, and Mullus surmuletus once in October 1976.

Table 1

Concentrations (ug/kg F.W.) of different metals in two mandatory species. The number of specimens in the sample is shown in parenthesis.

Species and length range cm	Total Hg (ug/kg)	Cd (ug/kg)	Pb (ug/kg)	Cu (ug/kg)	Zn (ug/kg)
Mullus barbatus 9.5 - 22.2	120 (504)	35 (306)	355 (306)	879 (306)	4370 (306)
Mullus surmuletus 12.0 - 16.0	90 (9)	26 (9)	501 (0)	350 (9)	2910 (9)

Additionally, the concentration of Hg(T) in 10 non-mandatory fish species and in one mollusc were reported; for seven of them the concentration of Cd, Pb, Cu and Zn are also given. The results for non-mandatory fishes are summarized in table 2.

The following data were obtained on Donax trunculus.

Number of specimens: 331; Number of analyses: 11; Tissue analysed: muscle; Number of stations: 10 samples from Haifa Bay, taken from November 1975 to February 1978;

Hg(T) ranges between 54 and 909 ug/kg. Maximum value was observed in October 1977 and the minimum value in February 1978. Cd ranges between 42 and 95 ug/kg F.W. Pb ranges between 731 and 2957 ug/kg F.W.; Cu ranges between 1928 and 5865 ug/kg F.W.; Zn 82144 ug/kg found in the sample from June.

Fish

The variations in the mercury levels along the five sampling stations were not significant, even though some of the areas sampled are polluted by industry. For Mullus barbatus the concentrations of Hg(T) were observed in the range from 28 to 475 ug/kg F.W. in all stations and for all the seasons (from March 1974 till March 1978). For Mullus surmuletus only one composite sample was analysed and the concentration of 86 ug/kg F.W. found is well below the permitted level of WHO. No increase in mercury concentrations was observed by comparing our data with those from 1974 of Yannai and Sachs (1978), table 3. It can be seen from this table that most of the fish sampled in 1974 were bigger and the mercury levels were higher; probably mercury level increases with the size range.

Concerning the other trace elements, there were no significant differences in the amounts of the metals among the species, except for Upeneus moluccensis, which seems to show an increase in almost all the elements listed.

Comparing present data with those Roth and Hornung (1977) for the same region and the same species collected in 1974, no increase in any of the metals studied was observed. It appears likely that the levels recorded in this study do not constitute a health hazard. To get a clear picture of the whole coastal area, further work will be required to establish the levels of heavy metals in the shore fish species as well.

Molluscs

The high values of the metals in the Donax trunculus can be explained in relation to the high pollution of the area. As no data in the literature on heavy metals in Donax trunculus was available, no comparison of the obtained values could be made.

List of publications:

ROTH, I. and HORNUNG, H. (1977). Heavy metal concentrations in water, sediments and fish from the Mediterranean coastal area, Israel. Environ. Sci. Technol. 11 (3): 265

ROTH, I. and HORNUNG, H. (1977). The concentration of heavy metals in streams and estuaries in the central and northern area of Israel. Selected Papers on the Environment in Israel, No. 5, Environmental Protection Service, Ministry of the Interior, Jerusalem, pp. 1-22.

RAMELOW, G. and HORNUNG, H. (1978). An investigation into possible mercury losses during lyophilization of marine biological samples. Atomic absorption Newsletter 17 (3): 59.

HORNUNG, H. and ZISMANN, L. Mercury in commercial fishes of the Israel Mediterranean coast. In preparation.

Species	Range length (cm)	Total Hg (µg/kg)	Cd (µg/kg)	Pb (µg/kg)	Cu (µg/kg)	Zn (µg/kg)	Ni (µg/kg)
Saurida undosquamis	12.3 - 31.3	150 (144)	12 (41)	510 (41)	452 (41)	3910 (41)	276 (41)
Merluccius merluccius	17.5 - 25.0	100 (13)	-	-	-	-	-
Trachurus mediterraneus	13.0 - 26.4	110 (49)	49 (10)	401 (10)	701 (10)	6027 (10)	198 (10)
Upeneus moluccensis	8.9 - 20.6	470 (138)	45 (13)	455 (13)	1150 (13)	6730 (13)	205 (13)
Boops boops	14.8 - 19.8	160 (12)	53 (9)	190 (9)	700 (9)	4820 (9)	49 (9)
Pagellus acarne	13.5 - 16.2	220 (5)	-	-	-	-	-
Pagellus erythrinus	9.7 - 20.7	200 (126)	22 (25)	393 (25)	835 (25)	5820 (25)	209 (25)
Sphyraena chrysotaenia	20.6 - 26.7	330 (8)	-	-	-	-	-
Sphyraena sphyraena	21.9 - 31.0	190 (19)	35 (2)	260 (2)	1010 (2)	6350 (2)	75 (2)
Chelidonichthys lucernus	17.0 - 18.5	90 (4)	-	-	-	-	-

Table 2. - The concentration (µg/kg F.W.) of heavy metals, in some non-mandatory species of economic importance for the area.

	Saurida undosquamis	*Merluccius merluccius*	*Mullus barbatus*	*Upeneus moluccensis*	*Sphyraena sphyraena*
Present survey (mean values)	150	100	120	470	190
Size range (cm)	12.3 - 31.3	17.5 - 25.0	9.5 - 22.2.	8.9 - 20.6	21.9 - 31.0
1974 sampling (mean values) Yannai and Sachs, 1978	316	230	187	437	360
Size range (cm)	20.2 - 33.5	19.2 - 47.0	11.0 - 16.0	14.5 - 17.5	31.5 - 40.5

Table 3. - Comparison of mercury levels (µg/kg F.W.) in the same species (1974 and 1975-1978)

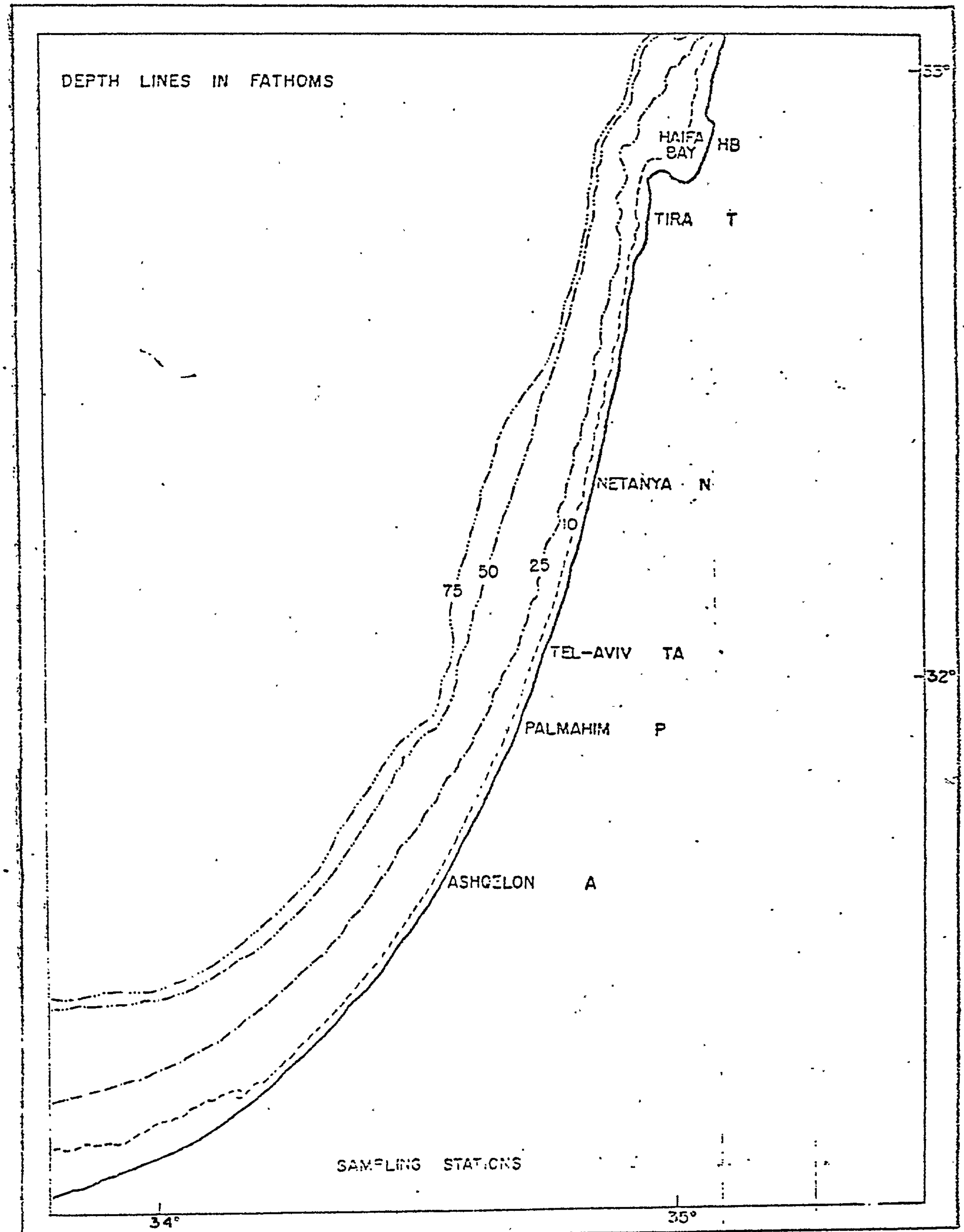


Fig. 1   Sampling sites

Participating Research Centre: Institute of Hydrobiology and Fish Culture,
Institute of Comparative Anatomy,
University of Siena
SIENA
Italy

Principal Investigator: A. RENZONI

Introduction:

Since 1971 the Laboratory has been doing research in the field of pollution and many data have been obtained from fresh-water fishes and mussels. Since 1973 the research has been focussed mainly on mercury levels in marine organisms.

Area(s) studied:

The sampling areas include a section of North-Western (Area II) and Thyrrhenian Sea (Area IV). The organisms have been collected in six areas of the open sea (T, S) and in four areas of rocky shores (M), shown in figure 1.

No physical, chemical or biological characteristics of the stations were reported.

Material and methods:

The following mandatory species were analysed: Mullus barbatus (T_1, T_2 and T_3) and Mytilus galloprovincialis (M_1, M_2, M_3 and M_4).

As non-mandatory species Nephrops norvegicus was sampled at S1, S2 and S3 and Engraulis encrasicolus at T_1, T_2 and T_3.

The analytical methods used were similar to those suggested in FAO, Fisheries Technical Paper, No. 158.

Results and their interpretation:

The concentrations of Hg, Cd, Pb, Cu, Mn and Zn in two mandatory species, Mullus barbatus and Mytilus galloprovincialis at each sampling station have been studied and the following minimum and maximum mean values (ug/kg F.W.) have been recorded for the above species and for all stations (numbers in brackets represent the number of specimens):

Metal	Mytilus galloprovincialis		Mullus barbatus	
Hg	73(14)	1 784(13)	110(17)	2 812(5)
Cd	60(7)	300(3)	5(10-18)	
Pb	100(7)	12 700(3)	100(3-23)	
Cu	888(4)	5 175(4)	241(16)	495(10)
Mn	1 200(1)	15 833(3)	160(5)	769(16)
Zn	18 000(2)	51 667(3)	3 020(5)	5 344(9)

The seasonal variations of these concentrations have also been studied.

In two non-mandatory species, Nephrops norvegicus and Engraulis encrasicolus, the concentrations of Hg, Cd, Pb, Mn and Zn were analysed and the seasonal dependence reported. Below are shown only cumulative data, e.g. minimum and maximum values of metal concentrations for the whole period under study.

Engraulis encrasicolus - Number of specimens: 115; Number of analyses: 690; Sampling stations: T_1, T_2 and T_3; Sampling period: from Fall 1976 to Fall 1978; Tissues analysed: muscle

Metals	Concentration(in ug/kg F.W.) Minimum	Maximum
Hg	10	400
Cd	<5	
Pb	<100	
Cu	120	650
Zn	1 450	18 700
Mn	60	1 800

Nephrops norvegicus

Number of specimens: 225; Number of analyses: 960; Sampling station: S_1, S_2, and S_3; sampling period: from Winter 1976 to Fall 1980.

Metals	Concentration(in ug/kg F.W.) Minimum	Maximum
Hg	15	2 400
Cd	<5	
Pb	<100	
Cu	215	11 100
Zn	1 350	19 300
Mn	30	3 850

In figure 2 the correlation between the mercury and selenium body burden and body weight were graphically presented for Mullus barbatus sampled at the station T_2. While positive correlation can be found for mercury there is less evidence for selenium.

In figure 3 the positive correlation can be observed between mercury body-burden and body weight for Xiphias gladius sampled in the entire area.

From a careful analysis of the data the following comments can be made:

a) the concentration of the trace elements in the species analysed is at the background level, except for mercury and, in a few cases, for lead;

b) high mercury body-burden has been observed in most of the benthic species; among the pelagic species, the levels found in tuna are quite high, whereas those in anchovies, though not too high, are somewhat higher than the levels obtained from specimens collected in Atlantic waters. Background levels, or slightly higher, have been found in the mussels collected in the four sampling areas of the Tuscany coast;

c) lead has been found in very low concentrations in all samples and in all stations, with the exception of the mussels in two sampling areas. However the concentration of this element in the two areas is far below that reported in literature for areas where industrial and/or mining activities are, or were, under way;

d) no seasonal variations in the concentrations of the elements have been observed so far for any species at any stations;

e) differences in accumulation according to sex have only been observed in Nephrops norvegicus (with females showing higher concentrations of mercury than males of the same size); Mullus barbatus does not seem to follow the same pattern; Mytilus galloprovincialis were analysed in tissue pools;

f) in relation to age different mercury concentration has been observed in the muscle tissue of Mullus barbatus, Thunnus thynnus and Nephrops norvegicus.

Conclusions:

With the data obtained, these conclusions can be made:

a) out of the six elements analysed only mercury seems to require more attention;

b) in the two benthic species (Mullus barbatus and Nephrops norvegicus) and in the large pelagic one (Thunnus thynnus), the mercury concentration in the muscle is almost always higher than the established legal limits;

c) the fact that some sampling stations are located in a cinnabar-rich region should be taken carefully into consideration when trying to determine and localize the amount of the natural and anthropogenic sources of contamination.

List of publications:

Renzoni, A. (1976). Influenza di sostanze tossiche su organismi marini. Archo.Oceanogr. Limnol. 3: 189-99

_________, et al., Mercury concentration in Mediterranean marine organisms and their environment: natural or anthropogenic origin. Paper presented at the second Intern.Mar.Poll., Dubrovnik, October 1977.

_________, Mercury body-burden in Atlantic and Mediterranean pelagic fish Contribution presented at the Joint ICSEM/UNEP Workshop on Pollution in the Mediterranean, XXVIth Congress, Plenary Assembly, Antalya, 24-27 November 1978.

_________, Comparison between the mercury concentration in tuna from Atlantic and Mediterranean. Paper presented at the Joint ICSEM/UNEP Workshop on Pollution in the Mediterranean, XXVIth Congress, Plenary Assemby, Antalya, 24-27 November.

Bernhard, M. and A. Renzoni (1979). Mercury concentration in Mediterranean marine organisms and their environment: natural or anthropogenic origin? Paper presented at the 2nd Intern.Marine Pollution Symposium, Dubrovnik, October. To be published in Thalassia, Yugoslavica.

Renzoni, A. et al., (1978). Concentrzioni di metalli in tracce in organismi del Mar Tirreno. Relazione al X Congresso della S.B.M., Ancona, Italy.

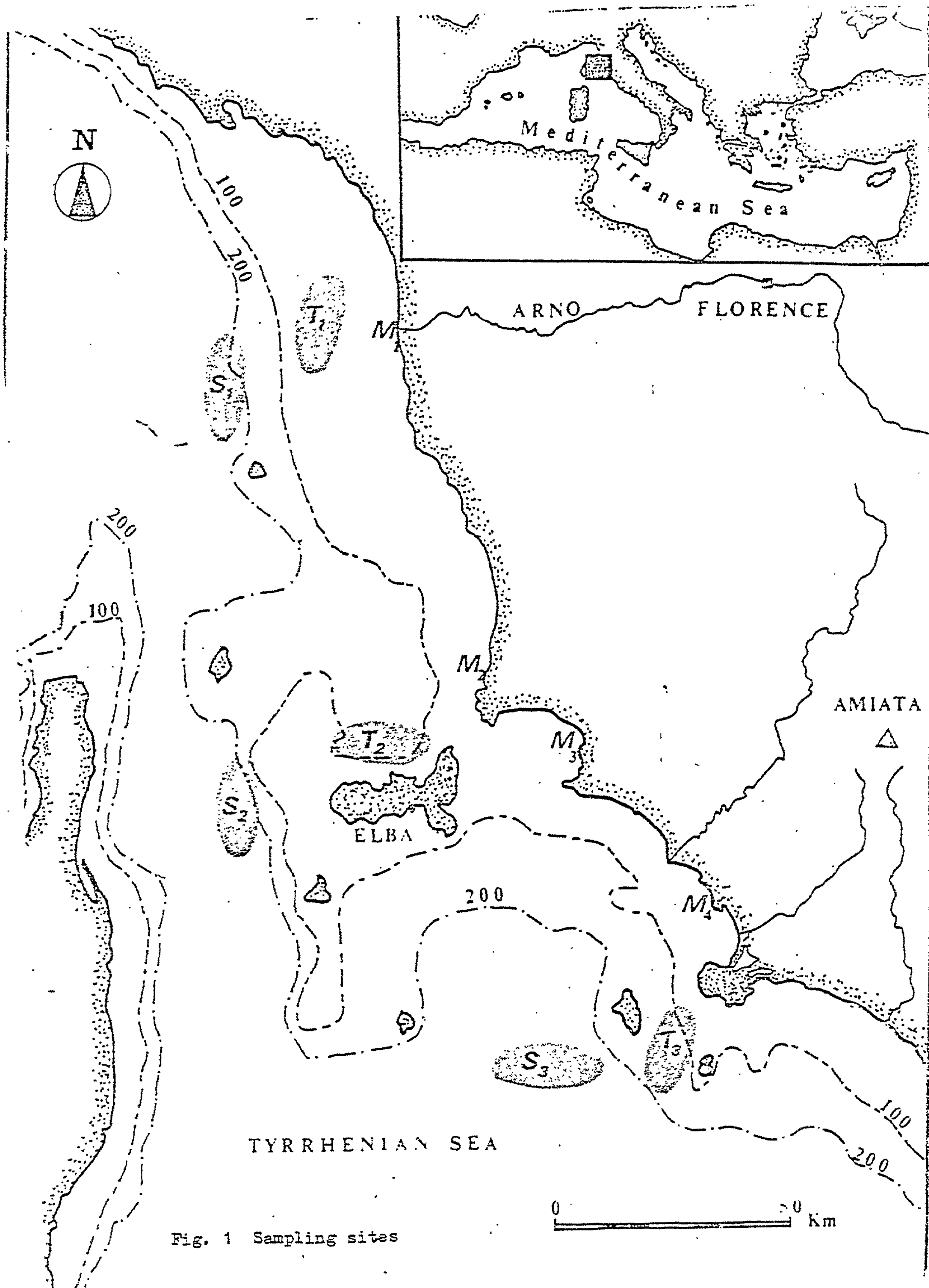


Fig. 1 Sampling sites

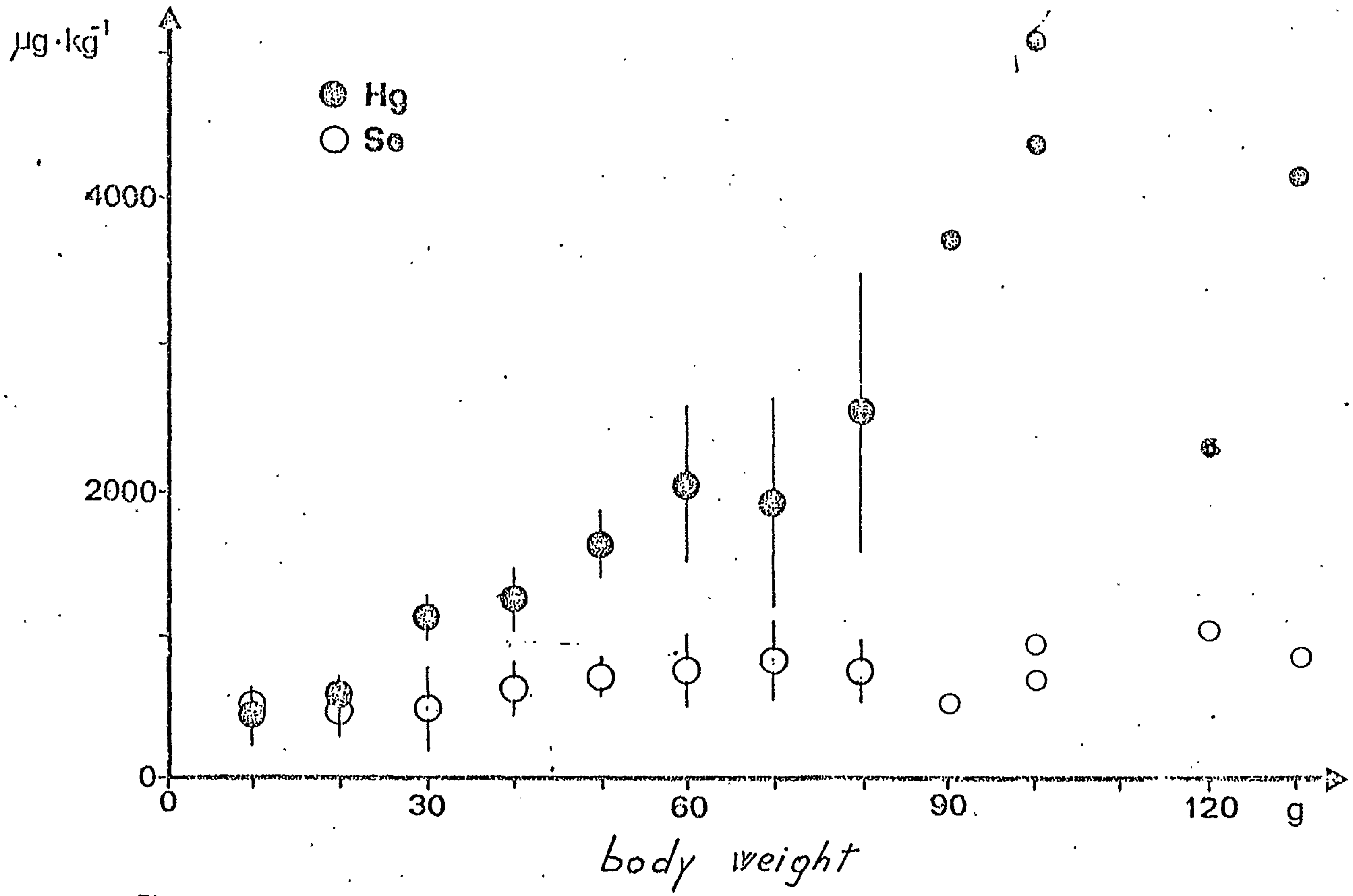


Fig. 2 Correlation between Hg and Se body burden and body weight in <u>Mullus barbatus</u>

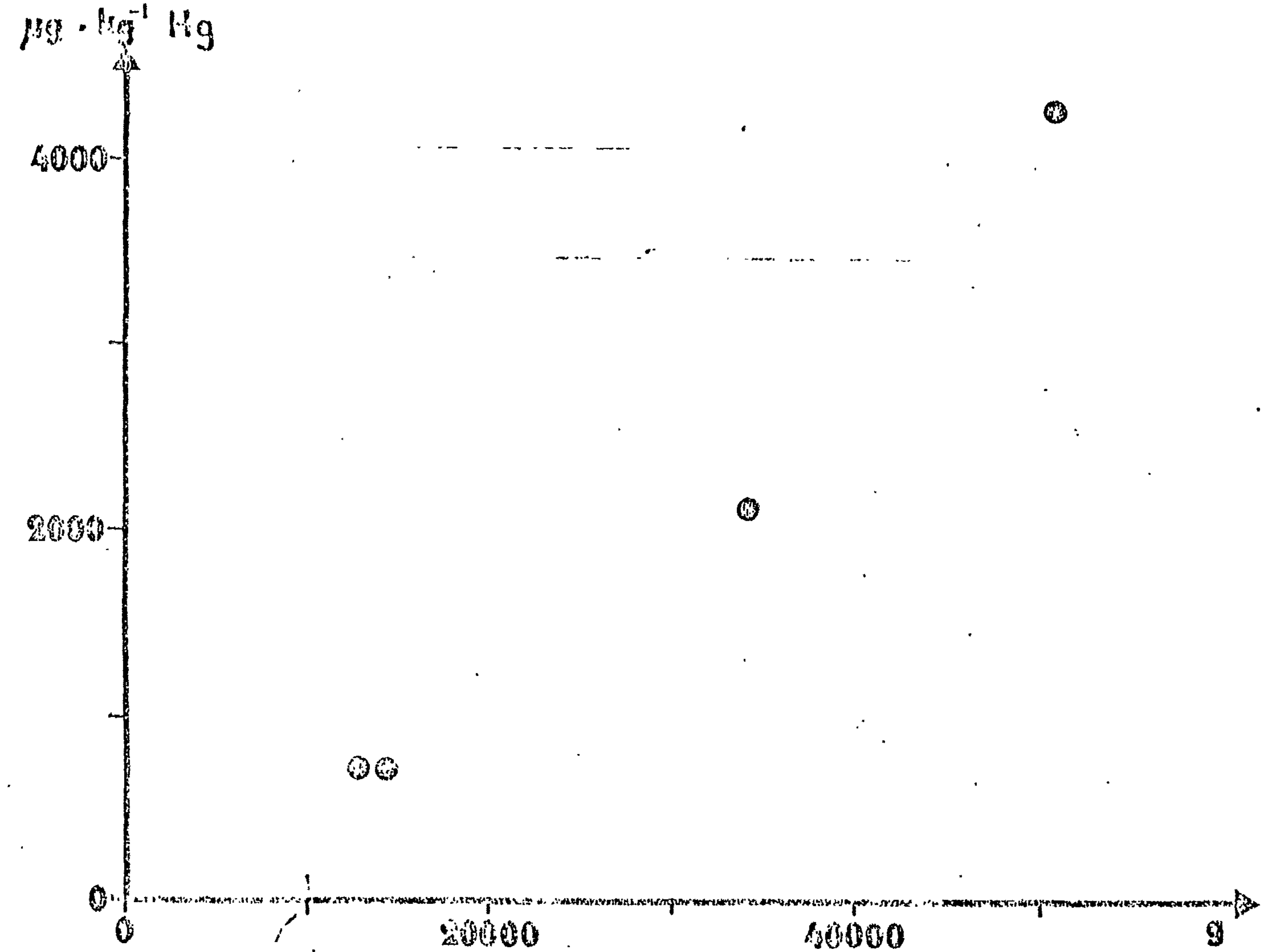


Fig. 3 Correlation between Hg body burden and body weight for *Xiphias gladius*

Participating Research Centre: Marine Comtamination Laboratory - CNEN
FIASCHERINO,
Italy

Principal Investigator: A. BRONDI (From August 1977 to February 1979)
M. BERNHARD (From February 1979)

The requested Summary Report has not been received in time. According to the available information the following can be summarized.

From the summer of 1975 to the autumn of 1976 more than 750 specimens of 36 different marine species were collected in selected areas of the Mediterranean Sea and the Atlantic and analysed for mercury content.

Area(s) studied:

No map with sampling areas has been supplied. The main sampling areas are: Gulf of La Spezia (Area II), coastline of Venice and Ancona (Area V), but the samples were collected as well at Maddalena (Sardinia), Isle of Farrignona and Trapani (Sicily), Chioggia and Dubrovnik (Area V), Tanger and Ceuta (Area I).

Material and methods:

Applied procedure was in agreement with the proposed one in FAO, Fisheries Technical Paper No. 158. Instrument and pretreatment errors (variation) were also estimated from replicates of analytical determination of pretreatments. The coefficient of variance between instrumental determinations ranged from 2.5 to 10 per cent; 10 of 13 replicates showed less than 4 per cent variation.

Results and their interpretation:

Mercury concentration was determined in mandatory species Mullus barbatus, (Mullus surmuletus), Mytilus galloprovincialis. The samples which were taken during the period from October 1975 to July 1976 are summarized in table 1. Delay in the installation of the AAS postponed the analysis of elements other than mercury. Most organisms were analysed individually rather than pooled in order to determine the variation between individuals from the same sample. Mercury determination was completed for edible tissue.

Besides mandatory species the concentration of mercury was determined in the following: Portunus sp, Peneaus kerathurus, Squilla mantis, Eledone sp, Octopus vulgaris, Sepia officinalis, Raja asterias, Loligo vulgaris, Sardina pilchardus, Engraulis encrasicols, Maena maena, Boops boops, Belone belone, Merluccius merluccius, Phycis blennoides, Scomber japonicus, Scomber scombrus, Trachurus trachurus, Trachurus mediterraneus, Sarda sarda, Atherina sp, Crenilabrus tinca, Uranoscopus scaber, Scorpaena scrofa, Scorpaena porcus, Diplodus anularis, Oblata melanura, Trachinus draco, Pagellus acarne, Pagellus erthrinus, Serranus scriba, Solea vulgaris. These species were sampled in selected areas of the Mediterranean and the Atlantic.

Samples of Penaeus, Sepia and Mullus barbatus show side variations of Hg concentration between individuals, but this is most strikingly illustrated by the Isle Tino sample of Mullus barbatus (March 1976) with a mean of 205 ug/kg F.W. and a range of values from 39 to 763 ug/kg F.W. Samples of Sepia, Octopus (arms), Mullus barbatus, Sardina pilchardus and Crenilabrus tinca had relatively high values. Marked differences existed between areas for samples of Mytilus, Mullus and Crenilabrus.

The concentrations of Cd, Cu and Pb in sea water samples were also determined. In addition to heavy metals analysis in marine organisms, concentrations of cadmium, copper and lead in coastal waters of the Liguraian and Tyrrhenian Seas were investigated at 225 stations. The concentrations were high in very clear water, and low in areas rich in algae or suspended particulates. It is suggested that studies should be made to describe the distribution and the fate of metals associated with algae, sediment and suspended particulates. The average concentrations in sea water were 0.02, 1.0 and 0.02 g/l for cadmium, copper and lead respectively. Cadmium levels are similar to those previously reported for the Northwest Basin and the North Adriatic, while lead is in order of magnitude lower than in the north Adriatic.

A few preliminary Hg(T) determinations were carried out in the sea water samples taken from La Spezia and concentrations from 0.004 to 0.015 ug Hg/l were found. In table 2 the comparison of the mercury concentrations in some mandatory marine species from the Mediterranean and other European Seas has been made. The concentrations refer to ug/kg F.W.

Conclusions:

From these preliminary results it can be seen that high values were associated with both high trophic level predators and filter feeders with increased consumption of particulate matter with absorbed metals.

List of publications:

STOEPPLER, et al., Comparative studies on metal levels in marine biota, I. Mercury in marine organisms from Central and Western Mediterranean Sea and the Strait of Gibraltar (Internal Report, without data).

STOEPPLER et al., Mercury in Marine Organisms of the Mediterranean and Other European Seas. XXVth Congress and Plenary Assembly C.I.E.S.M. Split (22-30 October 1976). Thalassia Jugoslavica, in press.

NURNBERG, H.W. et al., Applications of Palarography and Voltammetry to Marine and Aquatic Chemistry. III. Determination of Levels of Toxic Trace Metals Dissolved in Sea Water and Inland Waters by Differential Pulse Anodic Stripping Voltammetry. Thalassia Jugoslavica, in press.

STOEPPLER, M. and BACKHAUS, F.(1978) Pretreatment Studies with Biological and Environmental Materials. I. Systems for Pressurized Multisample Decomposition. Fresenius Z. Anal. Chem. 291 (1978); 160-120.

STOEPPLER, M. and MATTHES, W. (1978). Storage behaviour of Inorganic Mercury and Methylmercury Chloride in Sea Water, Anal. Chim. Acta, 98, 389-392.

MATTHES, W., FLUCHT, R. and STOEPPLER. (1978). Beitrage zur automatisierten Spurenalyse. III Eine empfindliche automatisierte Methode zur Quicksil erbestimmung in biologischen und Umweltproben, Fresenius Z., Anal. Cehm., 291 (1978) 20-26.

Species	Number of Specimens	Mercury values mean	range	Length (cm) $\bar{x}$	range	Weight (g) $\bar{x}$	range	Sampling area and data
Mullus barbatus	1o	2o5	37-766	12,7	1o,8-15,3	4o,8	23,8- 75,2	Tino/Carrara 3.76
	1o	221	72-38o	13,5	12,3-16,o	45,5	34,4- 73,6	Portovenere 3.76
	5	2o4	164-243	14,o	13,2-14,5	58,3	46,8- 64,o	Sardinia 2.76
	1o	69	45-125	12,7	11,5-14,o	35,5	27,4- 47,3	Carrara 1o.75
	5	72	43-122	15,1	14,o-16,5	58,3	46,2- 76,o	Lerici 5.76
	5	123	51-218	13,9	13,o-14,5	4o,2	31,9- 55,2	Lerici 5,76
	5	2o9	115-331	11,9	1o,5-13,5	24,4	17,3- 32,8	Lerici 6.76
	1o	241	89-557	13,4	1o,5-17,o	48,8	18,7- 92,4	Tunis 5.76
	21	8o	21-192	9,8	8,5-12,5	18,4	9,9- 35,2	Carrara 4.76
	1o	247	8o-4o3	15,7	13,5-2o,5	78,3	45,5- 139,5	Maddalena 6.76
Mullus surmuletus	1o	28o	5o-615	16,o	12,5-21,5	77,3	36,7- 168,5	Tanger 7.76
	8	148	58-319					Maddalena o7.75
	6	91	68-1o9	14,8	14,o-15,5	51,o	42,2- 62,2	Trapani 6.76
	4	281	187-393	18,4	16,5-21,5	117,5	75,2- 212,52	Ceuta 7.76
Mytilus galloprovincialis	10	160	120-216	5,2	4,8- 5,7			Maddalena 2.76,
	7	42	22- 71	4,9	4,7- 5,0	4,5	3,4- 5,3	Palmaria 6.76,
	7	46	13-227	4,8	4,3- 5,0	3,8	2,3- 4,5	Palmaria 6:76,
	25	63	42- 93	6,0	4,0- 8,0			La Spezia 4.76,
	30	25		(composite sample)				Tino/Carrara
Xiphias gladius	2	1259	621-179o					Trapani 6.76

Table 1. Mercury concentration in mandatory species.
The concentration is expressed in ug/Kg F.W.

Table 2 - The comparison of Hg concentrations in some mandatory species from different sea:

Species	MEDITERRANEAN SEA (n)	MEDITERRANEAN SEA ($\bar{x}$)	MEDITERRANEAN SEA (range)	ATLANTIC (n)	ATLANTIC ($\bar{x}$)	ATLANTIC (range)	NORTH SEA (n)	NORTH SEA ($\bar{x}$)	NORTH SEA (range)
Mytilus galloprovincialis	79	67	13-227				86	84	25-206
Mullus barbatus	81	159	21-766	20	260	50-615			
Mullus surmuletus	14	119	58-319	4	281	187-393			

Participating Research Centre: Centre for Radiochemistry and Activation Ananlysis - CNR
University of Pavia
PAVIA
Italy

Principal Investigator: E. ORVINI

The requested Summary Report has not been received.

Centre de recherche participant: Gruppo Ricerca Oceanologica, Istituto di Chimica Generale, Universita di Genova,
GENOVA
Italy

Chercheur principal: R. CAPELLI

Introduction :

En 1976 on a entrepris l'étude et la détermination des métaux dans les crustacés et les poissons ainsi que l'étude de l'accumulation des éléments dans les divers organes (Capelli et al., 1977). Durant cette période le G.R.O.G. a adhéré au projet pilote et, suite à cette adhésion, l'attention du groupe s'est portée vers les espèces bio-indicatrices de pollution. Le fait que les deux projets (l'autre était programmé par le C.N.R.) aient porté leur choix sur les mêmes animaux nous a permis de réduire notablement les frais.

Zone(s) étudiée(s):

L'échantillonnage a été effectué de Punta del Mesco (Riviera est) jusqu'à Savone (Riviera ouest), c'est-à-dire dans le golfe de Gênes, partie nord de la mer Tyrrhénienne (Zone II).

Matériel et méthodes:

L'attention du Centre s'est tournée vers les espèces qui avaient été choisies dans les deux programmes (F.A.O. et C.N.R.) en tant que bio-indicatrices de pollution.

Espèces obligatoires: Mullus barbatus et Mytilus galloprovincialis
Expèces facultatives: Engraulis encrasicolus, Nephrops norvegicus et Sarda sarda.

La préparation des échantillons a été effectuée conformément aux instructions du Manuel des méthodes de recherche sur l'environnement aquatique, troisième partie (FAO, document technique sur la pêche, No. 158, 1977). Les métaux suivants ont été déterminés : Hg, Pb, Cd, Cu, Mn, Cr et Zn. Environ 400 analyses, soit 3500 déterminations ont été effectuées de 1977 à 1978.
La détermination de la teneur en Hg total a été effectuée au moyen de la spectrophotométrie sans flamme. Afin de réduire les possibilités d'erreurs on a estimé opportun d'utiliser la méthode des additions.

En outre, pour éliminer les erreurs dues à l'absorption moléculaire, on a employé une lampe à deutérium.

Actuellement le groupe est en train de mettre au point la méthodologie pour la détermination du méthyl-mercure; il est prévu, dans un proche avenir, d'étendre la recherche à d'autres éléments, comme As, Se, etc.

Résultats et leur interprétation:

Les résultats obtenus au cours de la période décembre 1976 - décembre 1978 sont résumés dans les tableaux I, II, III, IV, V et VI. Dans ces tablaux, on a reporté la valeur moyenne pour chaque année avec l'intervalle trouvé (valeur minimum et maximum) et la valeur moyenne avec la déviation normalisée de toutes les mesures effectuées.

En examinant les résultats (encore en cours d'élaboration) on peut mettre en évidence certaines indications de caractère général:

a) Pour ce qui concerne les métaux, les données ne semblent pas démontrer une différence substantielle entre les concentrations constatées dans les organismes prélevés à l'est et à l'ouest de Gênes.

b) Les moules récoltées près de l'Ile des pétroliers (à deux milles au large de Gênes-Pegli) montrent des valeurs semblables à celles du promontoire de Portofino. On a estimé opportun d'examiner aussi des moules plus près de la zone industrielle afin d'étudier l'effet de la distance de la côte du point de vue de la pollution.

c) Pour les moules la concentration en mercure total est du même ordre de grandeur que celle qu'a trouvée Freman et al. (1974) sur les côtes canadiennes de l'Atlantique (0.04 mg/l de chair égouttée) et celle qu'a trouvée Alzieu et al., dans les moules provenant du littoral de la Manche et de l'Atlantique (0.066 mg/l de chair égouttée).

d) En ce qui concerne les anchois on a remarqué pour l'année 1978 une diminution très nette de la teneur en mercure total, alors que la teneur des autres métaux reste à peu près sans changement. Il est donc utile de poursuivre l'échantillonnage de cette espèce pendant au moins encore une année afin de contrôler si cette tendance est fortuite ou correspond à une réelle diminution. Il serait opportun de disposer des valeurs concernant la quantité de phytoplancton et de zooplancton de façon à pouvoir mettre en relation cette évolution de la teneur en mercure en comparaison de la plus ou moins grande quantité d'aliment disponible.

e) Pour les rougets et les langoustines également, la teneur moyenne en mercure est inférieure à la limite prévue par la législation italienne. En outre on peut remarquer que durant ces deux dernières années il n'y a pas eu de variations notables dans les concentrations des métaux.

f) Une mention spéciale peut être faite pour la pélamide, organisme marin proposé par la FAO et le CNR comme organisme pouvant substituer le thon. Sur ce poisson ont été effectuées différentes analyses et mesures, aussi bien sur le filet que sur les divers organes. D'après les premiers résultats que nous avons obtenus, on peut constater une forte accumulation de mercure à mesure que la taille augmente et une teneur différente en métaux dans les parties blanches et rouges du poisson. Cette différence est particulièrement sensible pour le cuivre et pour le zinc. Pour le mercure aussi on note une teneur différente selon le type de chair pris en considération. Ce fait doit être rappelé au moment de la préparation de l'échantillon pour analyse, car en certain cas cela peut faire varier d'une façon appéciable la valeur finale.

g) La teneur en Cd et Pb trouvée dans les poissons est inférieure à la limite que permet de révéler la méthode analytique que nous employons (A.A.S. dans la flamme air-acétylène).

Conclusions:

Durant ces deux années d'étude a été effectuée une première recherche sur la teneur en métaux dans des organismes marins de la mer ligurienne (Golfe de Gênes). Il est difficile de fixer le degré actuel de pollution de cette zone, car aucune recherche systématique de ce genre n'a été faite précédemment dans cette partie de la mer ligurienne. Il serait donc très dangereux de tirer des conclusions sur le degré de pollution en prenant comme terme de comparaison des organismes de même type pêchés dans d'autres mers. Une réponse ne pourra être donnée que si dans quatre ou cinq ans une étude est faite avec les mêmes modalités d'échantillonnage et d'analyse que celles qu'on vient de faire. Ainsi sera-t-il possible de contrôler si durant cette période une amélioration s'est manifestée dans cette zone, ou non. En même temps il serait opportun d'effectuer une étude géo-chimique des sédiments afin de connaître l'influence de ceux-ci sur la teneur en métaux des organismes benthique et d'avoir une évaluation de l'influence de l'apport naturel comparé à l'apport d'origine humaine.

Liste des publications:

Capelli, R.V. Contardi and G. Zanicchi (1976). Studio sulla presenza di metalli pesanti in organismi marini (Mytilus galloprovincialis). Communicazione H_3, Atti IX Conv. Naz. Ass. Chim. INORG. Marina del Cantone, 20/25-9/1976.

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__________ (1976). Sali nutritivi e rapporto O/N:P. IIIièmes Journées d'études sur la pollution marine, Split, C.I.E.S.M., 175-181.

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Frache, R. et al. (1976). The Determination of Heavy Metals in the Ligurian Sea I. The Distribution of Cu, Co, Ni and Cd in Surface Waters, Marine Chemistry 4: 365-375.

Capelli R., Franchi A. et Zanicchi, G. Résultats obtenus au cours de la première année d'études sur le contenu en métaux dans les organismes marins de la mer de Ligurie. Présenté à CIESM/PNUE IVième Congrès, Assemblée Plénière, Antalya, 24-27 novembre 1978.

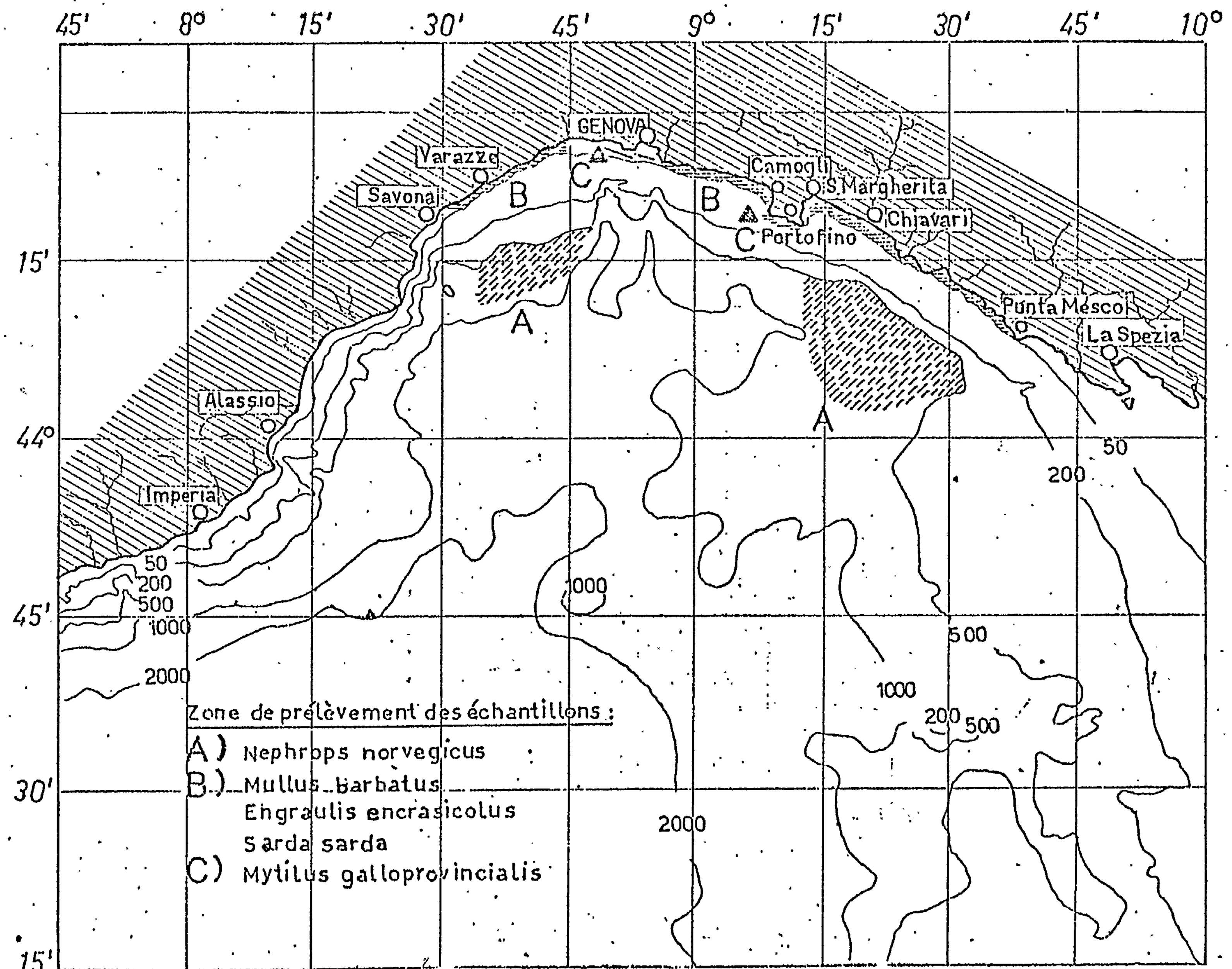

Fig. 1 Zone de prélèvement des échantillons

<u>Tableau I</u> Concentrations des métaux dans le filet - <u>Mullus barbatus</u>

Année	Hg	Cd	Pb	Cu	Mn	Zn
1977	260 (94 ÷ 400)	< 80	< 300	670 (520 ÷ 1300)	550 (290 ÷ 970)	5800 (2400 ÷ 9500)
1978	270 (41 ÷ 610)	< 80	< 300	500 (360 ÷ 600)	335 (290 ÷ 380)	3870 (2840 ÷ 4900)
$\bar{X} \pm 1\sigma$	260 ± 150	-	-	670 ± 298	440 ± 200	5300 ± 1900

<u>Tableau II</u> Concentrations des métaux dans le partie molle - <u>Mytilus galloprovincialis</u>

Année et lieu	Hg	Cd	Pb	Cu	Mn	Zn
1977 Portofino	30 (24 ÷ 38)	< 250 (80 ÷ 394)	< 1000	870 (500 ÷ 1500)	900 (630 ÷ 1200)	26900 (20200 ÷ 34000)
1077 Genova	19 (14 ÷ 24)	200 (180 ÷ 214)	< 900	1080 (750 ÷ 1430)	-	23570 (20200 ÷ 29400)
1978 Portofino	20 (17 ÷ 27)	< 250 (80 ÷ 280)	1080 (1030 ÷ 1150)	1090 (930 ÷ 1350)	690 (670 ÷ 1100)	19280 (15600 ÷ 22800)
1978 Genova	18 (17 ÷ 19)	200 (150 ÷ 280)	-	960 (880 ÷ 1100)	2400 (2300 ÷ 2600)	26200 (21600 ÷ 28700)
$\bar{X} \pm 1\sigma$	25 ± 7	220 ± 60	-	970 ± 255	1490 ± 760	24400 ± 5300

Golfe de Gênes (Espèces facultatives,; concentrations en µg/kg P.H.)

<u>Tableau III</u> Concentrations des métaux dans le filet – *Engraulis encrasicolus*

Année	Hg	Cd	Pb	Cu	Mn	Zn
1977	150 (97 ÷ 196)	< 80	< 300	1050 (880 ÷ 1390)	540 (478 ÷ 620)	20900 (16800 ÷ 25800)
1978	65 (21 ÷ 128)	< 80	< 300	1240 (1010 ÷ 1450)	495 (330 ÷ 592)	18400 (15700 ÷ 21000)
$X \pm \sigma$	92 ± 55	–	–	1200 ± 190	515 ± 67	19390 ± 2660

<u>Tableau IV</u> Concentrations des métaux dans le muscle caudal – *Nephrops norvegicus*

Année	Hg	Cd	Pb	Cu	Mn	Zn
1977	680 (570 ÷ 770)	140 (90 ÷ 200)	–	5180 (3970 ÷ 6000)	1478 (900 ÷ 2160)	14500 (12000 ÷ 16000)
1978	550 (370 ÷ 680)	< 80	–	6080 (3400 ÷ 8300)	1300 (229 ÷ 1840)	12300 (7700 ÷ 15900)
$X \pm \sigma$	625 ± 115	–	–	5530 ± 1500	1418 ± 527	12800 ± 2320

<u>Tableau V</u> Concentrations des métaux dans le filet - <u>Sarda sarda</u>

Année poids (gr)	Hg	Cd	Pb	Cu	Mn	Zn
1977 1050 gr	490	< 80	< 300	1280	340	5500
1977 1500 gr	821	< 80	< 300	1410	250	7500
1977 2100 gr	980	< 80	< 300	1060	230	2600

<u>Tableau VI</u> Concentrations des métaux dans les muscles blanc et brun - <u>Sarda sarda</u>

Année poids (gr)	Hg	Cd	Pb	Cu	Mn	Zn
1978 800 gr muscle blanc	228	< 80	< 300	865	-	3500
1978 800 gr muscle brun	300	< 80	< 300	4290	520	6230
1978 1250 gr muscle blanc	340	< 80	< 300	575	195	6900
1978 1250 gr muscle brun	380	< 80	< 300	3770	370	9600
Erreur estimée %	6	-	-	6	8	10

Participating Research Centre: Station for Marine Biology,
Institute of Zoology and Comparative Anatomy, University of Messina
MESSINA
Italy

Principal Investigator: L. MOIO

Introduction:

Since 1973 the problem of pollution has been faced and a series of analyses on the concentration of heavy metals in the waters of some Italian coastal areas performed. In 1976 studies on the concentration of heavy metals in tissues of some marine organisms began, in the framework of a research programme sponsored by the National Research Council (CNR) and the MED POL programme.

Area(s) studied:

The areas where specimens have been sampled include zones along the coasts of Sicily and Calabria, Area IV and VI (figure 1). The general physico-chemical features were studied by other investigators of this centre but the data are not reported. The samples were taken in areas where commercial fishing is practised employing professional gear and methods.

Material and methods:

The following mandatory species were sampled: Mullus barbatus, Mytilus galloprovincialis and Thunnus thynnus. Additionally, some non-mandatory species like Engraulis encrasicolus and Nephrops norvegicus were sampled as well. The sample preparation was performed according to the methods recommended in FAO, Fisheries Technical Paper, No. 158. The samples were kept in deep freeze. First, the biological parameters, useful for statistical purposes, were taken; then at least 10 specimens of the same size were used for analyses. From these samples muscular parts were removed and the fillets of the same weight prepared. Using the mechanical homogenizer, at controlled speed, a homogeneous substance was made. Two grams of this substance were heated with HNO_3 ("suprapure") until a complete digestion of the organic substance was achieved. The complete digestion was subdivided into two periods: predigestion at ambient temperature, and digestion at a temperature of 100°C for three hours. The nitric solution, obtained after the digestion, was brought up to the required volume with redistilled deionised H_2O and analysed by the atomic absorption spectrophotometric procedure without flame using atomic absorption spectrophotometric equipment (Perkin-Elmer 306) fitted with graphite furnace HGA 76 and with an accessory for the determination of the mercury with cold vapours.

Results and their intrepretation:

The comparison of the concentrations of mercury determined in mandatory species in two sampling Areas (IV and VI) is given in table 1.

The range of concentrations (minimum and maximum) of Hg, Cd and Pb determined in mandatory and non-mandatory species for sampling Areas IV and VI is summarized in table 2.

The maximum concentrations of Hg, Cd and Pb in analysed species are presented in figure 2.

It can be seen that the accumulation of the trace metals in investigated species is generally homogeneous in different areas and it does not reach critical levels. Particularly Hg concentration does not exceed the level of 399 ug/kg F.W. which is lower than the legally permitted level of 700 ug/kg F.W. Higher values were found in organisms near the sea bottom: M. barbatus (330 ug/kg F.W.) and M. norvegicus (360 ug/kg F.W.) while other species (with the exception of M. galloprovincialis which is a scarce accumulator of Hg) are hardly representative of limited areas. The samples of Thunnus thynnus present the highest concentration (399 ug/kg F.W.), which is relatively low for this species. This could be related to the fact that only young specimens of 6620 g were analysed and there is no comparison with larger specimens. In particular for T. thynnus the relationship to fishing areas cannot be found due to the migratory nature of this species.

The highest concentration of Cd was found in N. norvegicus (111 ug/kg F.W.) followed by M. galloprovincialis (52 ug/kg F.W.), M. barbatus (51 ug/kg F.W.), E. encrasicolus (11-40 ug/kg F.W.) and T. thynnus (21 ug/kg F.W.).

The levels of Pb encountered in M. galloprovincialis show that this species accumulates this metal considerably (960 ug/kg F.W.) with the highest value being in the samples fished during the month of April, but decreasing in the following month. N. norvegicus also concentrates Pb notably (900 ug/kg F.W.), particularly in the Milazzo zone. The Pb values found in other species are within acceptable levels: M. barbatus (233 ug/kg F.W.), E. encrasicolus (391 ug/kg F.W.) and T. thynnus (291 ug/kg F.W.).

Conclusions:

The comparison of the areas 1 and 3 (figure 2) has shown a possible correlation between industrial settlements (refineries and factories related to the transformation of chemical products derivatives) and the pollution level detected in the sampled organisms. The area of the coast of Calabria (area 4), opposite the zone of St. Eufemia can be indicated as the less industrialized and according less affected by pollution phenomena.

Species	Sampling area	Year	Sampling period	Tissue analysed	Number of specimens	Number of analyses	Concentration µg/kg F.W. Minimum	Maximum
Mullus barbatus	VI	1976	November	Fillet	40	2	47	128
		1977	January	Fillet	18	2	230	330
			March	Fillet	20	2	120	128
			September	Fillet	20	2	138	139
			December	Fillet	20	2	218	254
		1978	January	Fillet	20	2	270	310
	IV	1976	December	Fillet	20	2	120	170
		1977	February	Fillet	20	2	130	140
			March	Fillet	20	2	60	70
			May	Fillet	20	2	145	153
			September	Fillet	20	2	158	163
			November	Fillet	20	2	153	155
			December	Fillet	39	4	231	308
		1978	March	Fillet	20	2	242	259
Mytilus galloprovincialis	VI	1976	November	Soft Part	30	2	40	48
		1977	January	Soft Part	40	2	35	39
			March	Soft Part	40	2	45	50
			September	Soft Part	40	2	90	96
		1978	January	Soft Part	40	2	95	115
			March	Soft Part	40	2	120	146
Thunnus thynnus	VI	1976	November	Fillet	2	2	60	76
		1977	September	Fillet	5	5	189	346
		1978	January	Fillet	6	2	355	399
Thunnus thynnus	IV	1977	January	Fillet	2	2	90	100
			September	Fillet	3	3	189	254
			November	Fillet	1	1		184*
			December	Fillet	6	2	312	336

*only one value reported

Table 1. Mercury concentration in mandatory species.

Table 2 The range of concentrations (minimum and maximum) for sampling areas IV and VI in all analysed species.

The range of concentrations (ug/kg F.W.)

Species	Hg	Cd	Pb
Engraulis encrasicolus	53–230	11–40	43–391
Mytilus galloprovincialis	35–146	24–52	165–960
Mullus barbatus	47–330	5–51	30–233
Nephrops norvegicus	59–360	13–111	145–900
Thunnus thynnus	60–399	9–26	40–291

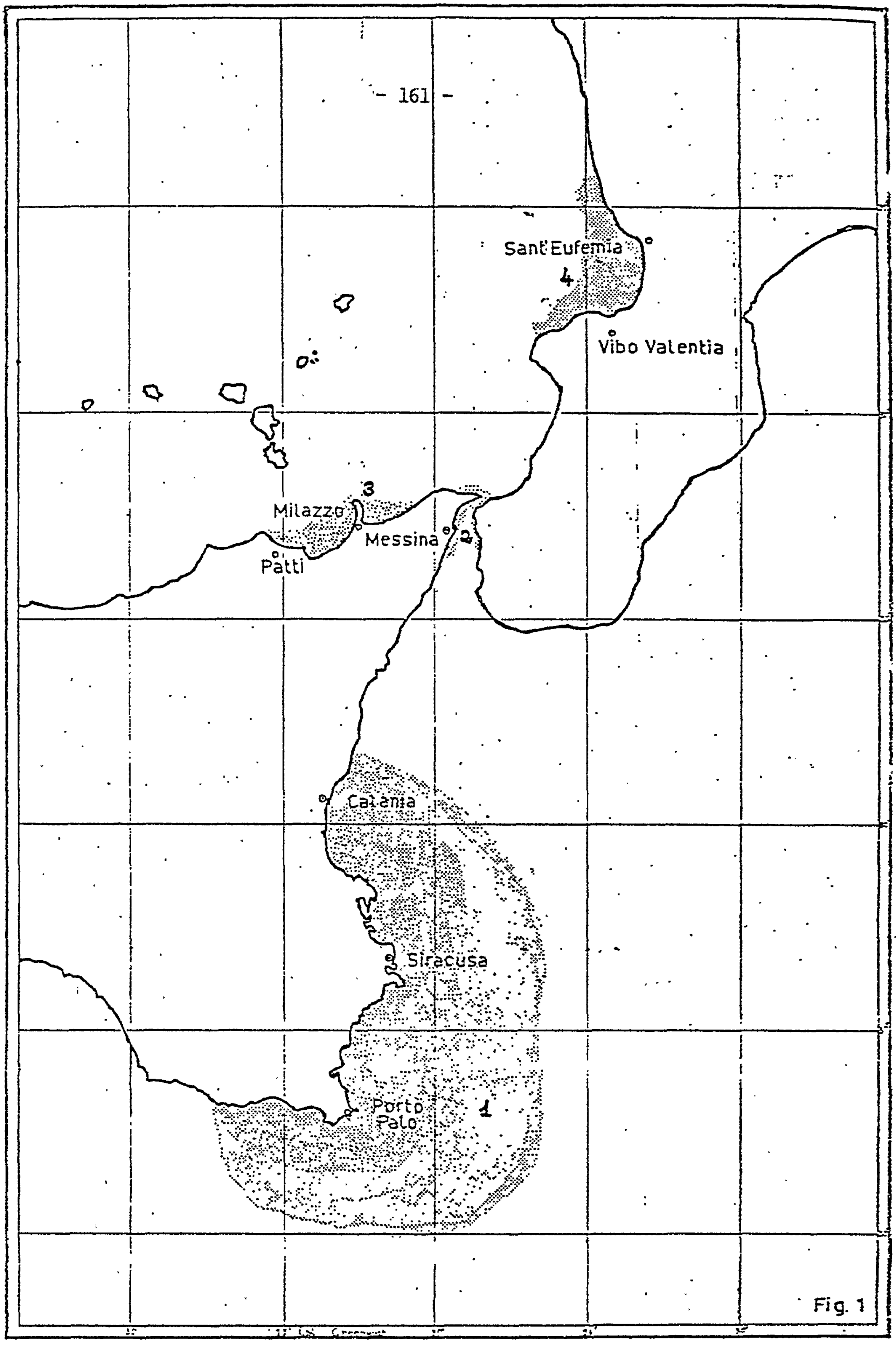

Fig. 1 Sampling sites

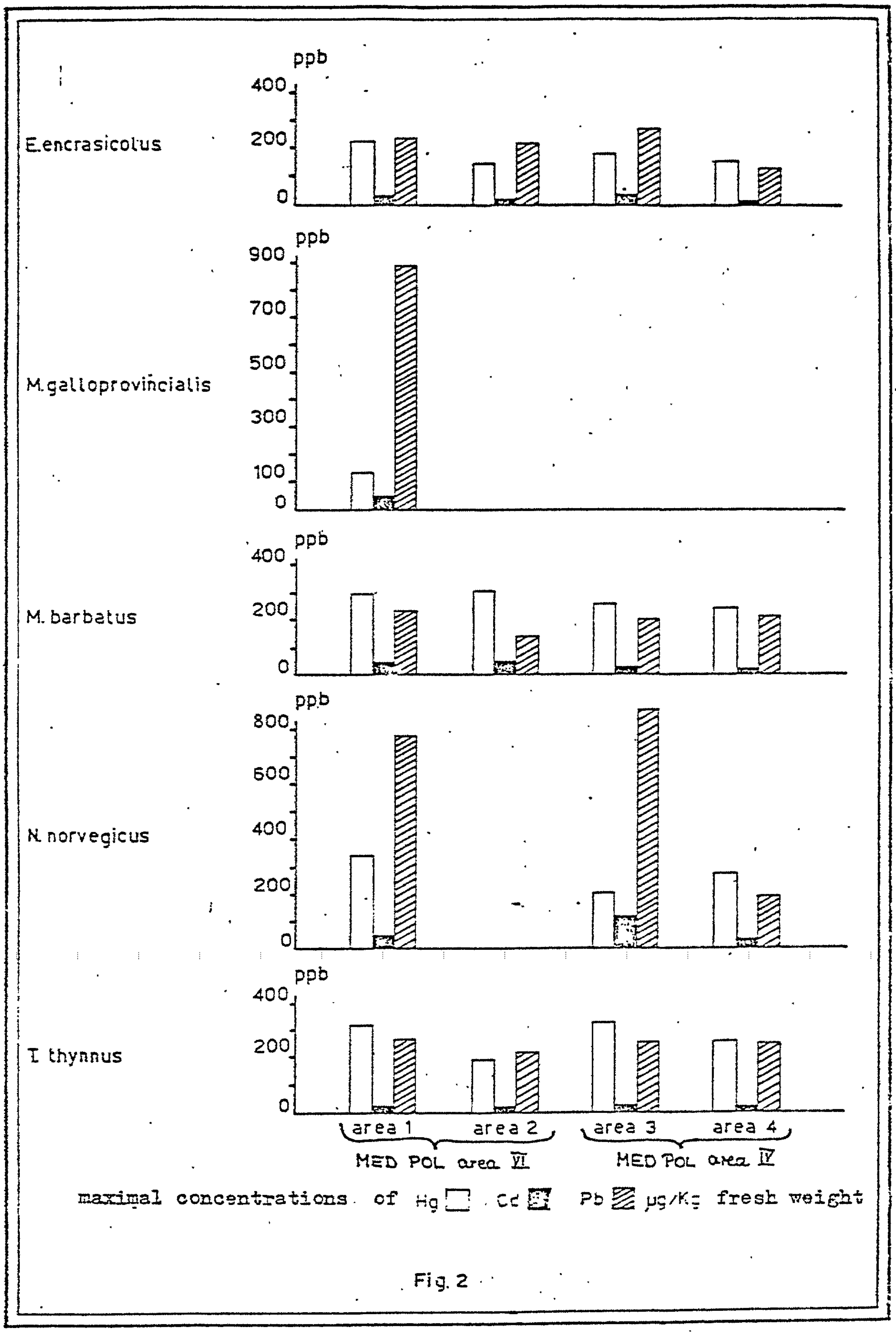

Fig. 2 Maximal concentrations of mercury, cadmium and lead (µg/kg F.W.) in selected species sampled from different areas

Participating Research Centre: Marine Research Centre, National Council for Scientific Research,
BEIRUT
Lebanon

Principal Investigator: H.H. KOUYOUMJIAN

Summary Report has not been received.

Participating Research Centre: The Old University
Department of Chemistry,
MSIDA,
Malta

Principal Investigator: A. STORACE

Introduction:

In the past the Department had not carried out monitoring work such as programmed under this pilot project. The Principal Investigator had some previous experience in flame AAS and other analytical methods like spectrophotometry and potentiometry. Instrumental faults during most of the period February 1977 - January 1978 delayed the start of the programme.

Area(s) studied:

The sampling sites are indicated in figure 1 with A (between the points 1 and 2), G and L: Central Mediterranean (Area VII). Mullus barbatus, Trachurus mediterraneus and Merluccius merluccius were sampled seven kilometers off the coast between the points 1 and 2, indicated on the map as area A. Two samples of Mullus barbatus are from the area G and the samples of Lithophaga lithophaga from the area L.

Material and methods:

Basically the methods indicated in FAO, Fisheries Technical Paper No. 158 were followed for handling the specimens, but slight modifications were made taking into consideration: (a) information available in literature, (b) levels of pollutants in the sample and (c) the instruments' responses. While the confidence limits have been calculated according to the above-mentioned paper, the standard error formula was taken from Davies and Goldsmith.

Results and their interpretation:

The concentrations of Hg (T), Cd, Cu, Mn, Zn and Pb determined in the mandatory species Mullus barbatus at two different sampling areas A and G are summarized in the following tables I and II.

Conclusions:

The number of results is not enough to assess seasonal or site variations. The calculation limits reveal the difficulties involved in obtaining satisfactory results. This may be due to the instruments, the digestion procedure, the operator's ability, or a combination of all these factors. Perhaps, peak areas, rather than peak heights, would give more consistent results. These difficulties have to be taken into account if maximum levels in the organisms are recommended in future.

TABLE I

Sampling period : September and December 1976.

Total number of specimens in the samples : 12

Number of analyses : 2

Tissued analysed : Fillet

Sampling area	Metal	Concentration µg/kg F.W. Minimum	Maximum
G	Hg(T)	195	280
	Cd	14	21
	Cu	870	2700
	Mn	130	500
	Zn	4200	5800

Sampling period : September 1976 till June 1978

Total number of specimens in the samples: 36

Number of analyses : 7

Tissue analysed: Fillet

Sampling area	Metal	Concentration µg/kg F.W. Minimum	Maximum	Average	
A	Hg(T)	32	260	124	+85
	Cd	11	49		
	Cu	360	1650	751	+422
	Mn	100	580		
	Zn	2700	5800	4279	+958
	Pb*	210	520		

* 3 analyses only

TABLE II

The range of concentrations of trace matels insome non-mandatory marine species are as follows:

a) Trachurus mediterraneus

Sampled : September and December 1976

Number of samples : 5

Tissue analysed: Fillet

Metals	Concentration (µg/kg F.W.) Minimum	Maximum
Hg (T)	80	995
Cd	15	160

b) Merluccius merluccius

Sampled : December 1976

Number of samples : 6

Number of analyses : 1

Tissue analysed : Fillet

Metals	Concentration (µg/kg F.W.)
Hg	220
Cd	98
Cu	1070
Mn	160
Zn	8670

c) Lithophaga lithophaga

Sampled : March 1978

Number of samples : 12

Number of analyses: 2

Tissue analysed : soft part

Metals	Concentration (µg/kg F.W.) Minimum	Maximum
Hg (T)	184	290
Cd	311	690
Cu	3400	5140
Mn	2500	3780
Zn	131000	160000
Pb	32700	40000

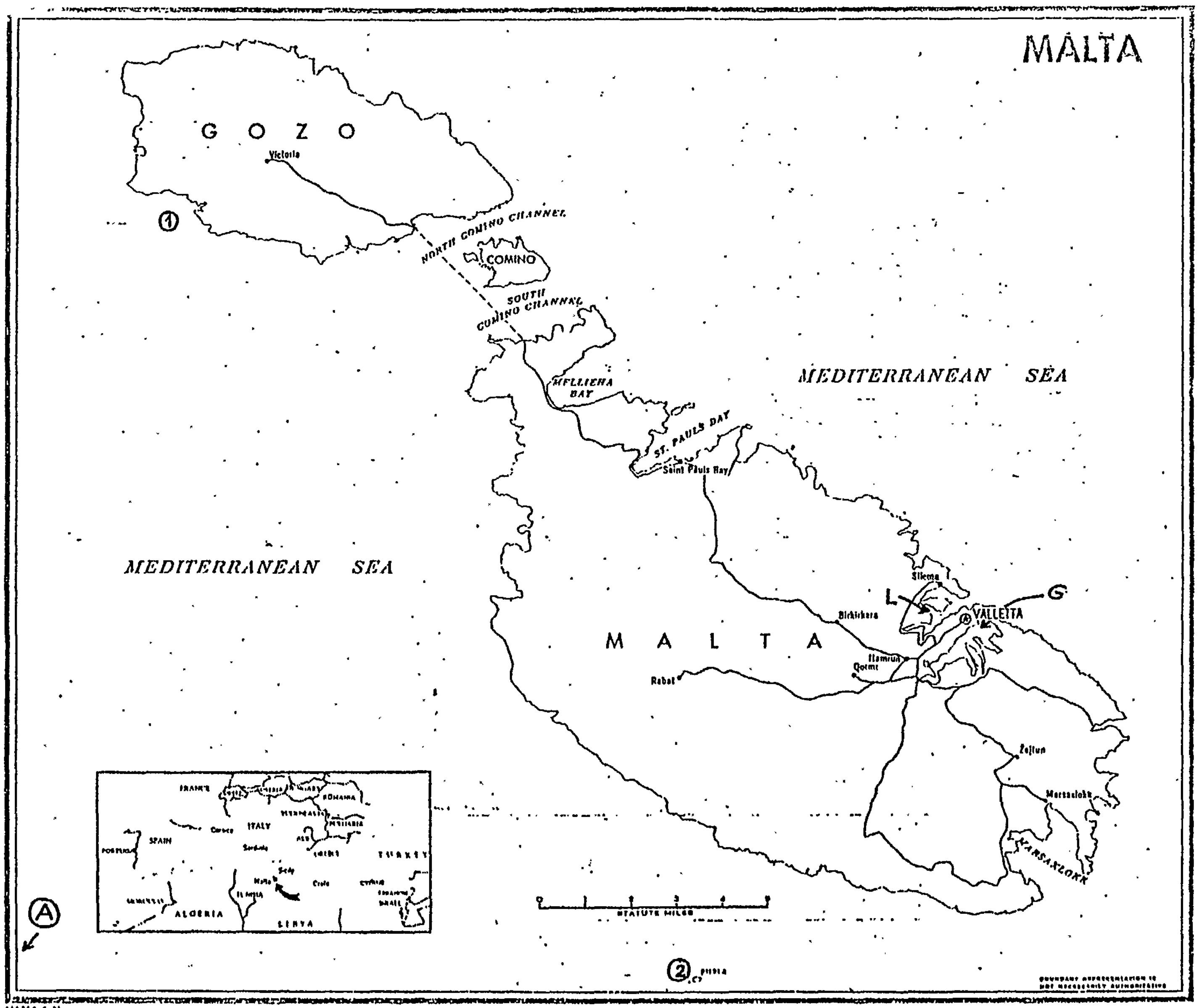

Fig. 1 Sampling sites in Malta

Centre de recherche participant: Institute des Peches Maritimes,
CASABLANCA
Maroc

Chercheur principal: H. IDRISSI

Le rapport resumé demandé n'a pas été recu.

Participating Research Centre: Instituto de Investigaciones Pesqueras, BARCELONA, Spain

Principal Investigator: A. BALLESTER

Introduction:

No data about the past activities of the Institute.

Area(s) studied:

The samples were taken along the Catalonian coast from Cabo Creus to Cabo de Tortosa in the following localities: Planassa, Lloret, Forbiasa, Poble nou, Llobregat, Capets, Barcelona, Montgat, San Salvador, Malgrat Carrameta, Les Quaranta, Castell Defels, Garraf, Ampurias, Fanals, Ametlla de Mar, Aeropuerto, Les Garotes, La Boadella, Can Ferrer, La Malica, Castell de Long, Can Pera Negre, La Rocasa Terra, Pallets, Badalona, Sot de la Breca, Estartit Blanes, Altea, Palamos, Castellon Plana, La Escala, Area II (figure 1).

Material and methods:

Sampling was performed in the period from June 1975 to May 1978. The following mandatory species were collected: Mytilus edulis, Mullus barbatus, Mullus surmuletus and Thunnus thynnus. The following non-mandatory species were also collected: Patella vulgaris, Venus galina, Venus mercenaria, Tapes decussatus, Todarodes sagittatus, Octopus vulgaris, Aristeus antenatus, Nephrops norvegicus, Merluccius merluccius, Gadus poutassou, Lophius piscatorius, Conger conger, Pagellus erythrinus, Pagellus acarne, Phycis blennoides, Sardina pilchardus, Scomber scombrus, Scyliorhinus canicula, Helicolenus dactylopterum, Geleus melanostomus. The samples were prepared according to FAO, Fisheries Technical Paper No. 158. The analysis of the samples were carried out by (Perkin-Elmer 503) techniques.

Results and their interpretation

The range of concentrations of Hg, Cd, Pb, Cu and Zn in mandatory and non mandatory species, sampled in the period from June 1975 till May 1978 at the indicated sampling sites (figure 1) is summarized in table 1. The concentrations are presented in ug/kg F.W.

Species	Number of specimens	Number of analyses	Minimum and maximum concentration in µg/kg F.W.				
			Hg (T)	Cd	Pb	Cu	Zn
Mytilus edulis	104	44	100–200	100	–	1000	23000
Mullus barbatus	316	54	100–3400	100	–	300–400	3000–7700
Mullus surmuletus	35	7	100–500	0	–	700	2300–8100
Thunnus thynnus	9	9	200–2600	0 – 100	–	–	4500–5800
Patella vulgaris	?	?	–	–	–	–	–
Venus galina	90	3	100	400	–	–	15000
Venus mercenaria	60	3	100	200	–	–	17000
Tapes decussatus	60	4	100	0	–	17500	3300
Todarodes sagittatus	3	3	–	0	–	–	1200
Octopus vulgaris	2	2	100–200	–	–	–	–
Aristeus antenatus	180	33	100–10000	–	–	–	7800–13500
Nephrops norvegicus	54	9	0	0	300	1100	10000–14000
Merluccius merluccius	142	3.8	100–900	0	300	400	2900–8300
Gadus potassou	166	31	100–300	0 – 100	400	100–1900	2600–8600
Lophius piscatorius	84	32	300–1500	0 – 100	300	300–800	2100–7500
Conger conger	2	2	300	–	–	–	6300
Pagellus erythrinus	71	29	100–900	0 – 100	–	100–500	3900–6500
Pagellus acarne	8	2	–	–	–	–	6000
Phycis blennoides	30	5	200	–	–	–	6000–17000
Sardina pilchardus	139	25	100–800	0.0–0–2	–	1500–4600	7400–10900
Scomber scombrus	30	5	100–500	–	–	–	3700
Scyliorhinus canicula	17	7	2200	–	1 7	–	100–12000
Helicolenus dactylopterus	?	?	300	–	–	–	8000
Galeus melanostomus	3	3	1300	–	–	–	5300

Table 1. Range of concentrations of Hg, Cd, Pb, Cu and Zn in mandatory and non-mandatory species

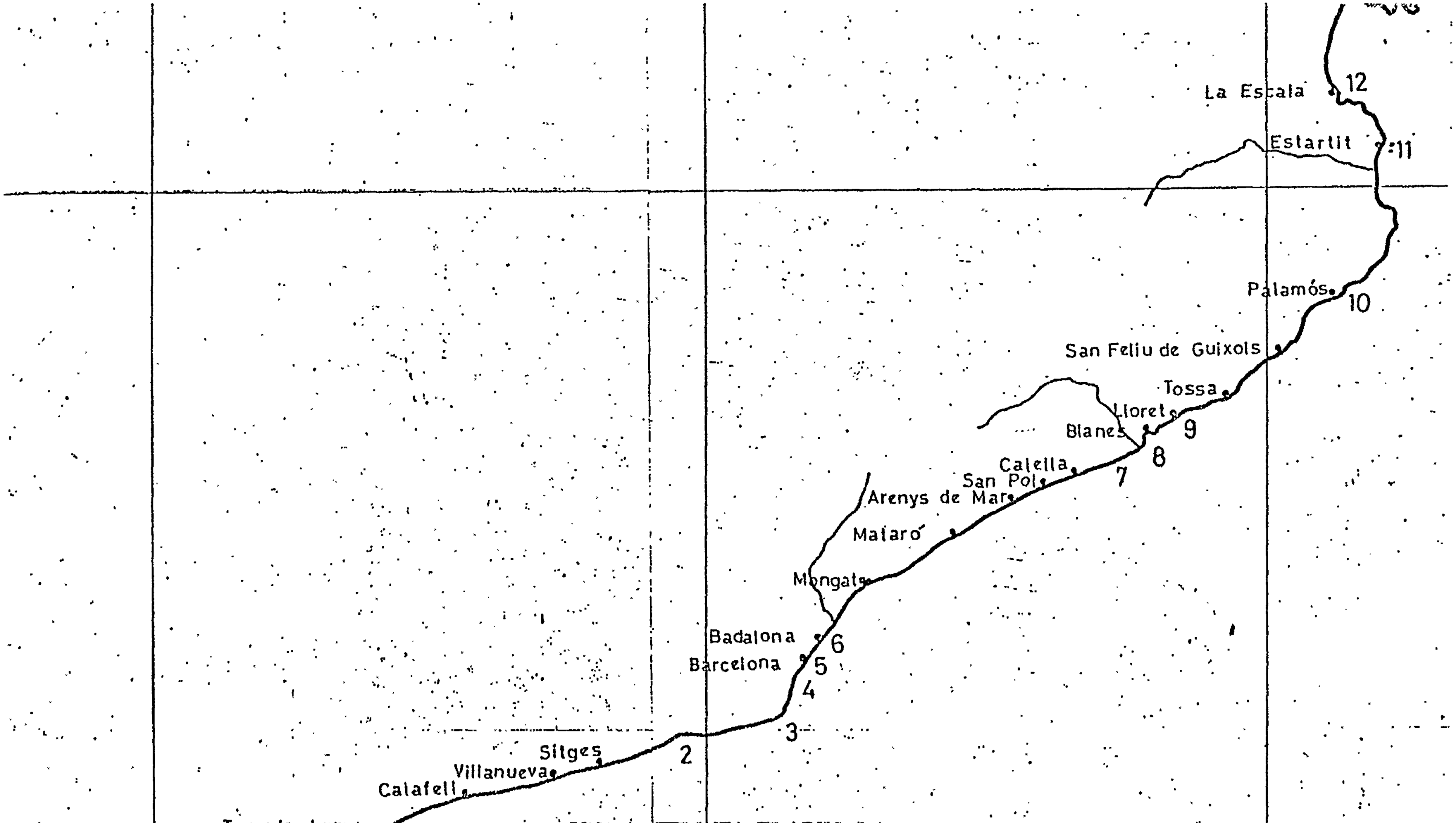

Fig. 1 Sampling sites

Centre de recherche participant: Institut National Scientifique et Technqiue d'Oceanographie et de Peches (INSTOP), SALAMBO Tunisie

Chercheur principal: A.H. SALEM

Introduction:

Il n'a pas été apporté de données sur les activités antérieures du Centre de recherche.

Zone(s) étudiée(s):

Le golfe de Tunis (Area IV) est situé à la limite nord-est de l'Afrique du nord. Il s'tend entre 1010' et 115' de longitude est et 3643' et 3710' de latitude nord. Il se présente comme une grande baie largement ouverte vers la mer au nord et étranglée au sud. (voir carte, fig. 1). La température dans l'ensemble du golfe correspond aux températures moyennes du bassin occidental de la Méditerranée et varie entre 13°C et 28°C. La salinité de l'eau varie autour de $37^{o}/_{oo}$. Au niveau des deux stations de collecte des échantillons de Mullus barbatus, le fond est sablo-vaseux et riche en débris coquilliers et en algues.

Matériel et méthodes:

Le spectrophotomètre atomique (Varian) a été fourni et installé en mars 1978. Les échantillons de Mullus barbatus et Mytilus galloprovincialis ont été récoltés fin 1978 et début 1979 sur les lieux indiqués à la figure 1. L'échantillonage, le traitement de l'échantillon et les analyses ont été faits selon les recommandations de la FAO, Document technique sur les pêches, No. 158.

Résultats et leur interpretation:

Les gradients de concentration en Hg(T), (ug/kg P.F.) déterminés chez Mullus barbatus et Mytilus galloprovincialis sont présentés au tableau 1, selon les lieux et périodes d'échantillonnage.

Espèce	Stations d'échantillonnage	Periode d'échantillonnage	Tissu analysé	Nombre de spécimens	Nombre de analyses	Concentration Hg(T) µg/kg P.F. Minimum	Maximum
Mullus barbatus	Korbous	Février 1979	Filet	12	2	124	133
	Korbous	Mars 1979	Filet	6	1	123[1)]	
	Gamart	Mars 1979	Filet	12	2	83	162
Mytilus gallo-provincialis	Gamart	Novembre 1978	Partie molle	18	3	27	46
	Canal Navigation	Janvier 1979	Partie molle	20	2	24	41
	Rades	Février 1979	Partie molle	30	3	∅	41
	Rades	Mars 1979	Partie molle	20	2	31	47

1) Une valeur seulement a été fournie.

Tableau I. Gradients et concentrations en Hg chez M. barabatus et M. galloprovincialis

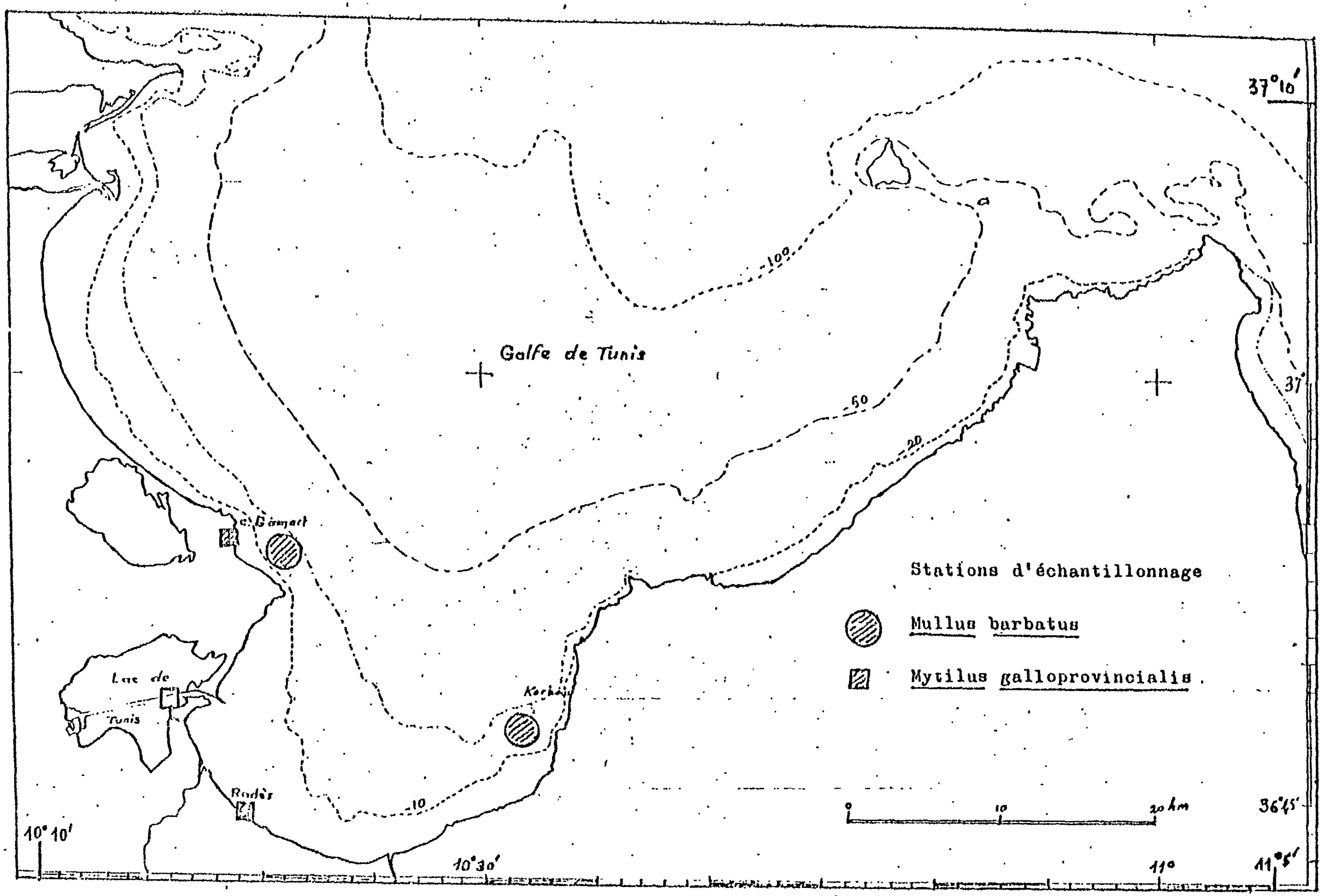

Fig. 1 Stations d'échantillonnage

Participating Research Centre: Hydrobiological Research Institute,
Faculty of Science,
University of Istanbul,
ISTANBUL,
Turkey

Principal Investigator: I. ARTUZ

Introduction:

No data were reported on the past activities of the Institute.

Area(s) studied:

Samples have been collected from the following sampling sites: Ayvalik, Edremit, Foca, Canakkale, Bandirma, Istanbul and Bospours (Areas VIII and IX).

Material and methods:

The following mandatory and non-mandatory species were samples in the period from June 1977 to June 1978 and analysed for Hg(T) content: Mullus barbatus, Mytilus galloprovincialis, Carcinus mediterraneus, Trachurus mediterraneus, Parapenaeus longirostris, Temnodon saltator, Pagellus erythrinus, Maena smaris, Diplodus anularis, Merluccius merluccius and Trigla sp. Sampling, sample treatment and the analyses were done according to the procedures recommended in FAO, Fisheries Technical Report No. 158.

Results and their interpretation:

The concentration of Hg (T) in mandatory species and further in non mandatory ones sampled at five sampling sites is summarized below.

Mandatory species
Sampling period: June 1977 to June 1978
Total number of species in the sample: 60
Number of analyses: 6

Species	Tissue analysed	Concentration in ug/kg F.W.			
		Minimum	Maximum	Average	σ
Mullus barbatus	Whole body	200	235	216	± 13
Mytilus galloprovincialis	Soft Part	134	170	154	± 17

Non-mandatory species
Sampling period: June 1977 till June 1978
Total number of species in the sample: 60
Number of analyses: 6

Species	Tissue analysed	Concentration in ug Hg(T)/kg F.W. Minimum	Maximum	Average	σ
Parapenaeus longirostris	Whole body	248	352	281	± 36
Merluccius merluccius	Whole body	778	850	823	± 26
Pagellus erythrinus	Whole body	210	228	219	±7
Trachurus mediterraneus	Whole body	320	365	342	± 16

Participating Research Centre: Middle East Technical University, Marine Science Department, ERDEMLI-ICEL Turkey

Principal Investigator: T. I. BALKAS

Introduction:

The establishing of the Marine Science Department conincided approximately with the beginning of the MED POL project. With the transfer of the Department to Erdemli in June 1977, the activities of the Department were expanded. The results obtained up to September 1977 were presented in interim reports. Further results are included in this summary report.

Area(s) studied:

The original agreement specified 20 sampling sites. These were later reduced to 5 (R, C, S, M, T) including Mersin Area, Area IX, figure 1. In the first phase of the work some of the specimens were collected also at Gemlik in the sea of Marmara (Area XII) and at Izmir in the Aegean Sea (Area VIII). The sea water temperature varies between 16.5°C and 29°C and the salinity is relatively high (minimum 37.8 and maximum 39.2 $^{o}/_{oo}$). Thermal stratification generally begins in March and water starts to become well mixed in October, where the thermocline during stratification, on the average, is at a depth of 60 meters.

The wind system, of the area is rather complicated; accordingly, the current system is also rather complex. The currents have two main components: one of them is the high frequency 24 h component which is due to land breeze, sea breeze, and the second one is the low frequency component which varies between 3 to 10 days, and the two are possibly related to cyclonic disturbances.

The nutrient content, and hence the productivity of the area, are relatively low. There is not much available information about the chemistry and biology of the area. Mersin area (figure 1) can be considered as a hot point, since many industrial plants (i.e. Petrochemical, Agrochemical, Textile, etc.) and a big busy harbour are located in this area. As a reult of the development of the local agriculture, also many insecticides and pesticides are used.

Material and methods:

The following mandatory species were analysed: Mytilus galloprovincialis, sampled at Izmir (Area VIII) and Gemlik (Area XII), Mullus barbatus and Mullus surmuletus (Area IX). Thunnus thynnus and Xiphias gladius were not available. The species selected for study were not limited only to those specified in the project document. A wide range of non-mandatory species, particularly those of local importance, such as: Penaeus kerathurus, Portunus pelagicus, Mugil auratus, Mugil cephalus, Mugil capito, Sardinella maderensis, Pagellus acarne, Pegusa lascaris, Boops salpa, Upeneus molluccensis and Pomatomus saltator, were also analysed. Samples taken near the shore were collected with gill nets. Other samples were taken by trawl. The samples collected with gill net were immediately brought to the laboratory and after identification stored at -40°C in a freezer. The trawl samples were first kept in an ice chest and later also deep-frozen. Sample preparation was effected following the FAO, Fisheries Technical Paper No. 158, using either Uniseal or Groteklaes decomposition vessels. The analyses were carried out with different AAS models, by cold-vapour technique (Department's own design), by flame methods, in a few cases by a pulse nebulization technique developed in the laboratory, and also by flameless AAS.

Results and their interpretation:

The results for Mytilus galloprovincialis, Mullus barbatus and Mullus surmuletus are shown in table 1. The ranges of trace metal concentrations found in non-mandatory species are presented below:

a) Penaeus kerthurus
   Number of specimens: 2
   Number of analyses: 14
   Tissue analysed: Soft body

Metals	Concentration (ug/kg F.W.)	
	Minimum	Maximum
Hg	17	22
Cd	21	67
Zn	-	12600
Cu	2200	2610
Mn	130	350

b) Portunus pelagicus
   Number of specimens: 1
   Number of analyses: 2
   Tissue analysed: pincer and abdomen
   Maximum values observed (ug/kg of fresh weight) G/
   in one specimen only were: Hg 11 and Zn 3930.

c) Mugil auratus
   Number of specimens: 3
   Number of analyses: 20
   Tissue analysed: muscle

Metals	Concentration (ug/kg F.W.)	
	Minimum	Maximum
Hg	1	27
Cd	7	80
Zn	2500	6000
Cu	290	610
Mn		840

d) Mugil cephalus
Number of specimens: 1
Number of analyses: 1
Tissue analysed: muscle

Metals	Concentration (ug/kg F.W.)
Hg	160
Zn	3080

e) Sardinella maderensis
Number of specimens: 2
Number of analyses: 6
Tissue analysed: muscle

Metals	Concentration (ug/kg F.W.)	
	Minimum	Maximum
Hg	22	49
Cd	4	26
Cu	350	435

f) Pagellus acarne
Number of specimens: 1
Number of analyses: 6
Tissue analysed: muscle
Concentration observed (ug/kg of fresh weight): Hg 102; Zn 650; Cu 390.

g) Pagellus sp.
Number of specimens: 1
Number of analyses: 4
Tissue analysed: muscle
Concentration observed (ug/kg of fresh weight): Hg 102; Zn6050; Cu 390

h) Pegusa lascaris
Number of analyses: 3
Tissue analysed: muscle
Concentration observed (ug/kg of fresh weight) in one specimen only was: Hg 13; Zn 4300.

i) Boops salpa
Number of analyses: 4
Tissue analysed: muscle
Minimum value observed (ug/kg of fresh weight) in one specimen only was: Hg 3
Maximum values observed (ug/kg of fresh weight) in one specimen only were: Hg 17; Zn 4620.

j) Upeneus moluccencis
Number of specimens: 1
Number of analyses: 3
Tissue analysed: muscle
Maximum values observed (ug/kg of fresh weight) in one specimen only were: Hg 110; Cd 40 and Cu 723.

k) Pomatomus saltator
Number of specimen: 1
Number of analyses: 3
Tissue analysed: muscle

Concentration observed (ug/kg of fresh weight):

Cd	26 - 86
Cu	510 - 910
Pb	420 - 750
Zn	5600 -19500

The mercury levels in the fish caught from the Eastern Mediterranean coast are very low. No significant local differences were found in the mercury levels in fish collected from the Seyhan Delta and METU campus areas. The number of fish analysed are not sufficient to draw any conclusion about the dependence of Hg concentration on size.

The mercury concentration in fish collected from the Eastern Mediterranean coast of Turkey is similar to the mercury concentration in similar fish from other places, such as the Atlantic and the Australian Seas. This finding is therefore opposed to the theory which states that the mercury concentrations in fish living in the Mediterranean Sea is higher than the mercury concentration in the same fish living in other areas.

The mean concentration of zinc in fish from different sampling areas showed no significant differences: i.e. the average zinc concentrations of Mullus surmuletus from the Seyhan Delta, Soli and METU campus are 3.5, 3.7 and 4.0 ug/gr (wet weight) respectively.

It has also been observed that copper and cadmium concentrations increase with the size of mussels collected near Gemlik (Sea of Marmara). However more data is needed to be conclusive.

Trace metal concentrations in Mugil spp. Upeneus moluccensis and Mullus barbatus were compared with published results from different seas. Trace metal levels in Mugil spp. show no significant differences from the Australian Seas, the N.W. Atlantic and the Atlantic coast of Spain. The muscle tissues of Upeneus moluccensis living in Israeli coastal waters contain higher zinc and copper levels. It can also be observed that Mullus barbatus from Israeli waters have higher levels of copper and cadmium.

Conclusions:

The absence of abnormally high levels of trace metals in analysed fish and the differences existing between the levels found in these areas and the ones in the other areas do not necessarily indicate that the areas with low levels are not locally polluted. In fact the levels of trace metals may not be reflected in the edible muscle tissue of fish exposed for a short period of time. However, according to the available information, the coastal areas of northwestern Mediterranean have not been significantly polluted by trace metals, with the exception of point sources.

List of publications:

RAMELOW, G. and BALKAS, T.I. (1977). Determination of Trace Metals in Fish Tissue by Flame Atomic Absorption Spectrometry Using a Discrete Nebulization Technique. Anal.Lett. 10,(9), pp. 733-742.

RAMELOW, G., TUGRUL, S., OZKAN, M.A., TUNCEL, G., and BALKAS, T.I. (1978) The Determination of Trace Metals in Marine Organisms by Atomic Absorption Spectrometry. Int. J. of Environ. Anal. Chem., 5, pp. 125-132.

BALKAS, T.I., SALIHOGLU, I., TUNCEL, G., TUGRUL, S. and RAMELOW, G. (1978), Trace Metals and Organochlorine Residue Content of Mullidae Family Fishes and Sediments in the Vicinity of Erdemli (Icel), Turkey. XXVI Congress and Plenary Assembly, Antalya, Nov. 24 - Dec 2, 1978.

Species	Sampling area	Sampling period	Tissue analysed	Concentration µg/kg F.W. (The number of analysis is indicated in brackets)					
				Hg	Cd	Cu	Pb	Zn	Mn
Mytilus galloprovincialis	Gemlik	August 1976	Soft Part	20-50 (4)	70-400 (3)	750-2650 (4)	480-610 (4)		
	Izmir	January 1977	Soft Part			1200-1800 (3)		9200-23700 (3)	
Mullus barbatus	Mersin	January 1977	Fillet	60-90 (3)	20 (1)	200-680 (2)	120 (1)	6400-7400 (2)	220 (1)
	METU Campus	January 1978	Fillet	20-78 (3)		222-691 (6)		3360-5600 (11)	
Mullus surmuletus	Soli	August 1977	Fillet	16-41 (2)	3-135 (2)	383-2680 (2)		702 (1)	
	Seyhan Delta	August 1977	Fillet	15-16 (2)	7-12 (2)	323-428 (2)		3070-3900 (2)	330 (1)
	METU Campus	January 1978	Fillet			540 (1)		3110-5200 (3)	
		February 1978				419 (1)		4330 (1)	
		March 1978	Fillet	0.4-34 (2)		495-719 (2)		3020-5110 (8)	

Table 1. Hg concentrations in mandatory species.

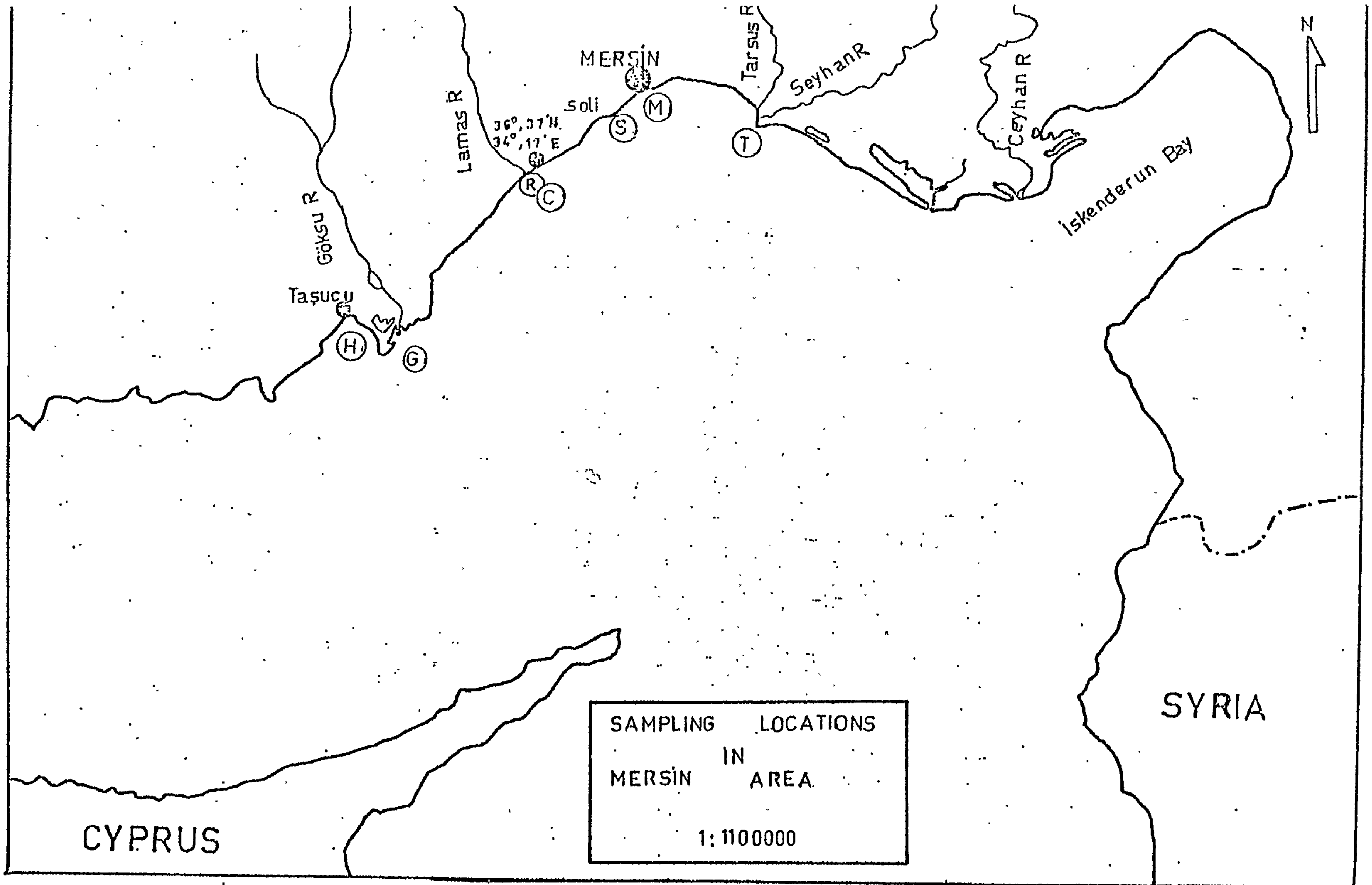

Figure 1 Sampling sites in Mersin area

Participating Research Centre: Institute of Hydrobiology,
Faculty of Science,
Ege University,
IZMIR,
Turkey

Principal Investigator: H. UYSAL

Introduction:

Trace elements are usually present in sea water and can be selectively concentrated in marine organisms (Papadopoulou and Kanias, 1976). Due to increased pollutant inflow into Izmir Bay the studies on concentrations of some trace elements have been carried out since 1970 (Uysal, 1973; Geldiay and Uysal, 1975 and 1976).

Area(s) studied:

Within the framework of the pilot project the pollution studies started (1977) in Izmir Bay and along the Aegean coast (Area VIII) at the following sites: Ayvalik (1), Aliaga (2), Izmir (3), Cesme (4), Bodrum (5) and Saroz Bay (6) as shown in figure 1.

The Aegean coast is very extensive and there are plenty of bays and estuaries. Many metals enter these areas through rivers, coastal erosion, and atmospheric fallout (Riley and Chester, 1971). A further increase in levels of metals is also caused by industrial effluents, domestic sewage and agricultural runoff (Geldiay and Uysal, 1975). For these reasons the inner bay and harbour waters are now heavily polluted. The waters outside these bays are much less polluted; although an increase in pollution may occur in the near future. In addition, the Aegean coast might be affected by the polluted sea water coming from other parts of the Mediterranean Sea, through water circulation.

Material and methods:

Samples of the following mandatory and non-mandatory species were studied: Mullus barbatus, Mullus surmuletus, Thunnus thynnus, Mytilus galloprovincialis, Mugil spp., Penaeus kerathurus, Palaemon spp. and Carcinus mediterraneus.

Thunnus thynnus was the only species sampled at the sampling site No. 6 (Saroz Bay), and Mytilus galloprovincialis could not be found southwards of Izmir. The rest of the analysed species were taken at the above-mentioned sampling sites.

Mytilus galloprivincialis, Mullus spp., Mugil spp. and Carcinus mediterraneus were sampled in the period from July 1977 to July 1978. Penaeus kerathurus in the period from July 1977 to November 1978 and Thunnus thynnus thynnus only once in May 1977.

Samples were transported in thermoisolated boxes, with ice in plastic containers and kept in deep freeze. The preparation of samples for analyses was made according to FAO, Fisheries Technical Paper No. 158. For digestion of samples, decompositon vessels (closed Teflon crucible in a steel block) and hot plate with thermostatic control were used. The analyses were performed with Varian Techtron Atomic Absorption Spectrophotometer (Model 1250). The determination of the total mercury (Hg T) in biological samples was made by flameless determination in open system (Parker 1972). Cold Vapour Technique and Varian Techtron Model 64 (As/Se/Hg Analysis kit) were also used.

Results and their interpretation:

The mean concentration of some trace metals (ug/g F.W.) found in different species sampled at the five stations during the above-indicated periods are summarized in table 1.

The concentrations of Fe, Co and Cr were also reported. In general zinc and lead concentrations were higher than others (FAO, Circ. Gen.Fish.Counc.Mediterr., 7 May 1978 and FIR:PM 77/7, April 1977) and the concentrations changed according to the different areas.

Seasonal variations of the mean concentration (ug/g F.W.) of some trace metals in different species sampled at the five stations during previous indicated period are as follows:

Species	Seasons	Hg	Cd	Cu	Pb	Mn	Zn
Mullus spp	Spring	0. 408	2.7	10.1	19.1	10.8	39.5
	Summer	0. 278	1.6	5.3	13.0	3.7	9.1
	Autumn	0. 208	1.6	6.2	26.9	11.7	33.5
Mugil spp	Spring	0. 170	2.9	6.5	21.3	9.9	41.3
	Summer	0. 230	1.3	5.3	8.6	4.9	8.1
	Autumn	0. 170	1.9	8.8	22.7	8.7	37.2
M. gallo-	Spring	0. 160	3.1	9.6	19.7	8.4	64.3
provinci-	Summer	0. 140	1.2	6.1	11.8	6.2	57.0
alis	Autumn	0. 220	2.7	8.9	20.5	11.4	58.1
Panaeus	Spring	0. 090	1.8	4.6	10.5	6.1	31.5
kerathu-	Summer	0. 210	1.1	8.8	11.3	6.0	18.7
rus	Autumn	0. 160	2.0	7.0	31.7	9.8	59.3
Carcinus	Spring	0. 220	2.9	15.4	22.0	12.1	80.1
mediter-	Summer	0. 174	2.1	13.5	12.1	14.1	35.1
raneus	Autumn	0. 360	2.6	16.9	42.5	29.3	49.4

The metal concentrations in C. mediterraneus, M. galloprovincialis and Penaeus spp. are higher than in other species.

In general all the species have lower metal concentration in summer, which increases during the other seasons; but there is no high variation except for iron, chromium and mercury.

Conclusion:

As can be seen from the tables, the mean concentration of trace metals in animals studied have varied according to (a) the species, (b) season of the year, and (c) area (see also Papadopoulou and Kanias, 1976; Geldiay and Uysal, 1975; Bertine and Goldberg, 1972; Bryan and Uysal, 1978). The metal concentrations in C. mediterraneus, M. galloprovincialis and Penaeus spp. are higher than in other species. In general iron, zinc, and lead concentrations are higher than those of other metals. A lower concentration was found during the summer period but it rose during the remaining seasons.

List of publications:

UYSAL, H., (1973) The distribution of some trace elements in M. galloprovincialis (Lamarck) in different localities. Scientific Reports of the Faculty of Science, Ege University, No. 165.

GELDIAY, R. and UYSAL, H., (1975). Comparative behaviour of toxic metals in marine ecosystems. International Atomic Energy Agency, Vienna.

GELDIAY, R. and UYSAL, H., (1976). Accumulation and distribution of trace metals and radionuclides in marine organisms (particularly in Tapes decussatus L.) in the Izmir Bay area, Turkey. International Atomic Energy Agency, Vienna.

BRYAN, W.G. and UYSAL, H., (1978). Heavy metals in the burrowing bivalve Scrobicularis plans from the Tamar Estuary in relation to environmental levels.

UYSAL, H., Accumulation and distribution of heavy metals in some marine organisms in the Bay of Izmir and in Aegean Coast; XXVI Congress and Plenary Assembly of ICSEM, Joint ICSEM/UNEP Workshop on Pollution of the Mediterranean, 24 Nov - 2 Dec 1978, Antalya.

Species	Area	Hg	Cd	Cu	Pb	Mn	Zn
Mullus sp.	Ayvalik	0.203	1.6	4.9	13.2	6.5	20.4
	Aliağa	0.294	1.8	9.0	22.9	7.8	36.6
	Izmir	0.187	2.9	6.9	11.6	4.9	22.3
	Çeşme	0.244	1.4	5.7	16.8	8.1	18.9
	Bodrum	0.307	2.3	7.4	21.7	8.6	13.6
Mugil sp.	Ayvalik	0.383	1.8	9.0	15.8	6.5	24.7
	Aliağa	0.139	1.6	6.3	17.1	5.2	37.9
	Izmir	0.135	1.7	5.7	12.5	8.4	19.8
	Çeşme	0.124	1.4	5.1	13.3	8.1	18.1
	Bodrum	0.218	2.8	6.3	17.9	7.3	17.8
T.thynnus	Saroz Bay	0.802	0.9	7.9	24.7	5.1	28.1
M. gallo-provincialis	Ayvalik	0.187	1.1	10.6	13.8	8.0	56.0
	Aliağa	0.167	2.0	6.3	15.6	9.9	75.3
	Izmir	0.148	2.0	6.0	18.4	6.8	48.0
Penaeus kerathurus	Ayvalik	0.100	1.0	6.4	14.1	7.3	21.4
	Aliağa	0.154	1.4	6.7	24.8	8.6	51.9
	Izmir	0.222	1.5	8.4	14.2	5.7	29.7
	Bodrum	0.148	1.5	7.5	10.7	5.1	22.6
Palaemon	Aliağa	0.143	2.1	23.8	9.5	27.4	26.2
	Çeşme	0.128	4.5	23.4	12.9	54.8	22.6
C. mediterraneus	Ayvalik	0.213	2.7	18.8	26.7	22.7	56.4
	Aliağa	0.204	1.7	13.0	20.2	8.5	51.9
	Izmir	0.177	2.4	16.3	14.4	21.7	61.4
	Çeşme	0.295	3.4	6.4	12.4	7.8	24.0

Table 1. Mean concentrations of some trace elements (ug/g F.W.) at five stations.

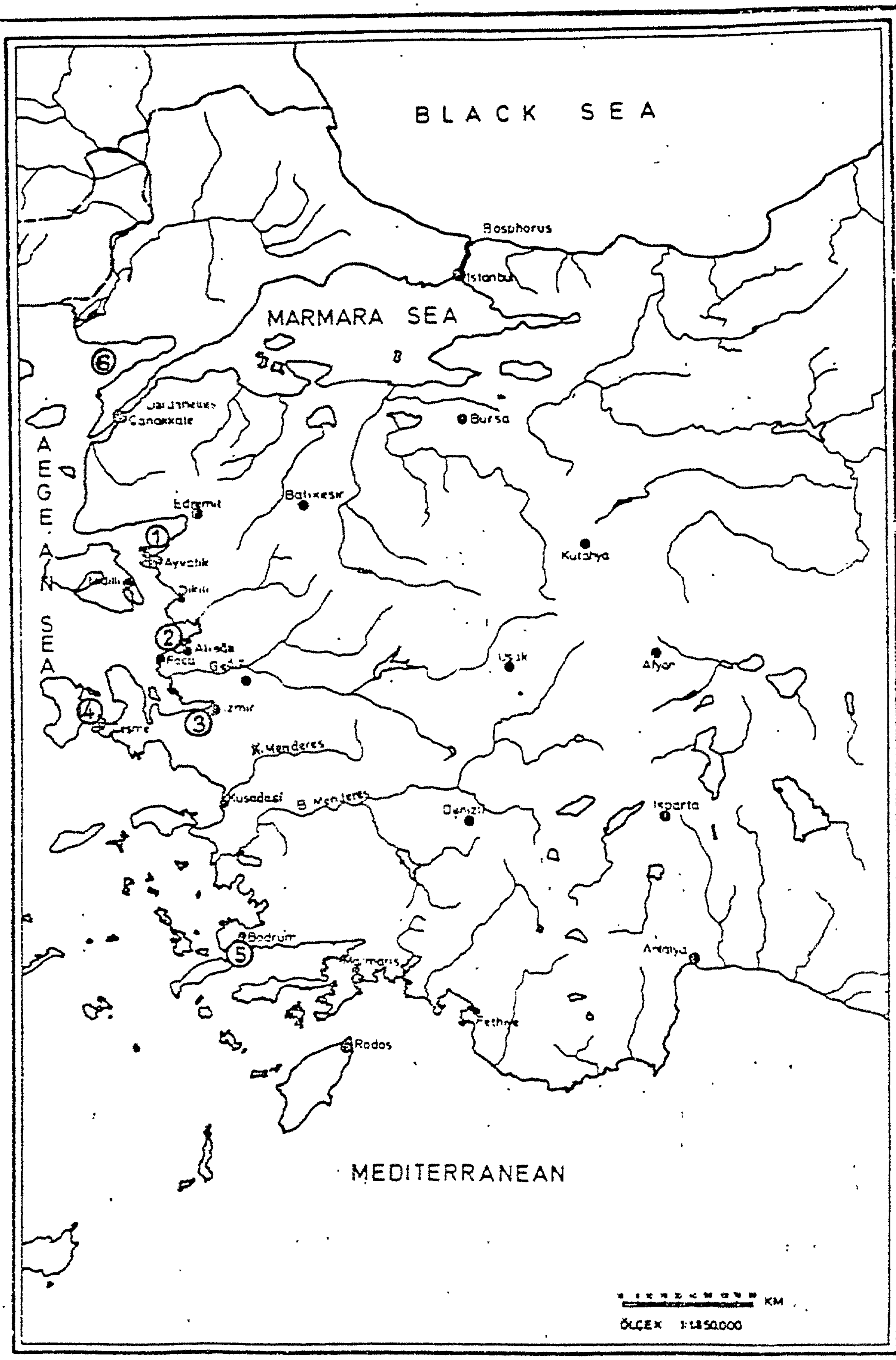

Fig. 1 Sampling sites in the Aegean Sea

Participating Research Centre: Laboratory for Trace Element Analyses, Department of Physics and Mathematics, University of Rijeka, RIJEKA, Yugoslavia

Principal Investigator: V. VALKOVIC/A. LJUBICIC

Introduction:

No data were reported about the past activities of the Research Centre.

Area(s) studied:

Marine species were sampled in the northern Adriatic Sea (Rovinj, Limski Kanal, Rabac and Omisalj) belonging to Area V.

Material and methods:

Samples of Mytilus galloprovincialis were taken in March 1977 and have been analysed as composite samples on Cu, Zn, Pb, as mandatory metals, and Fe, As, Br and Sr as non-mandatory ones. The composite samples of Mullus barbatus, Sardina pilchardus and Sepia officinalis were taken at the same time (March 1977). but were analysed later due to the failure of the Si(Li) X-ray detector. Thunnus thynnus were not availale in that area. The concentration of trace elements in the above species was measured using X-ray fluorescence induced by a radioactive 109 Cd source. Samples were dried at low temperature and glued on the kepton foil with perspex-aceton solution.

Results and their interpretation:

Mandatory species:
(a) Mytilus galloprovincialis

Total number of specimens in the samples: 48
Total number of analyses: 28
Tissue analysed: Soft part
The range of mandatory and non-mandatory trace metal concentrations (minimum and maximum) is reported in ug/g D.W.:

Metals	Minimum	Maximum
Cu	< 10	< 10
Zn	43	178
Pb	< 22	80
Fe	68	220
As	4	15
Br	110	158
Sr	9	13

(b) Mullus barbatus

Total number of specimens in the samples: 24
Total number of analyses: 14
Tissue analysed: not reported
Concentrations are reported in ug/g D.W.

	Trawling grounds of Rovinj-Area 1	Trawling grounds of Rabac-Area 2
Fe	52 ± 5	151 ± 7
Cu	< 10	< 10
Zn	78 ± 3	32 ± 3
As	10 ± 3	4 ± 2
Br	84 ± 2	56 ± 2
Pb	31 ± 3	< 22

Non-mandatory species:

(a) Sardina pilchardus

Total number of specimens in the samples: 24
Total number of analyses: 14
Tissue analysed: not reported
Concentrations reported in ug/g D.W.

	Trawling grounds of Rovinj-Area 1	Trawling grounds of Rabac-Area 2
Fe	65 ± 6	196 ± 6
Cu	< 10	< 10
Zn	96 ± 3	54 ± 3
As	9 ± 2	4 ± 1
Br	105 ± 2	98 ± 2
Sr	23 ± 3	6 ± 1
Pb	35 ± 4	< 22

(b) Sepia officinalis

Total number of specimens in the samples: 24
Total number of analyses: 14
Tissue analysed: not reported
Concentrations reported in ug/g D.W.

	Trawling grounds of Rovinj-Area 1	Trawling grounds of Rabac-Area 2
Fe	34 ± 4	184 ± 8
Cu	< 10	< 10
Zn	118 ± 3	42 ± 3
As	12 ± 3	5 ± 3
Br	94 ± 2	108 ± 2
Sr	6 ± 1	4 ± 1
Pb	40 ± 4	< 22

In June 1978, samples of Mytilus galloprovincialis were taken from three different stations: R1: Rovinj, R2: Limski kanal, R3: Rabac. At the same time samples of Mullus barbatus were taken from area 2 (trawling grounds of Rabac) and analysed as composite samples for Fe, Cu, Zn, As, Br, Sr and Pb. Results of these analyses are as follows:

	Mytilus galloprovincialis			Mullus barbatus (Area 2)
Elements	R1	R2	R3	
	(Concentrations in ug/g D.W.)			
Fe	51 ± 6	108 ± 7	180 ± 8	168 ± 6
Cu	< 10	< 10	< 10	< 10
Zn	115 ± 3	32 ± 3	45 ± 3	42 ± 3
As	3 ± 1	3 ± 1	11 ± 2	6 ± 2
Br	98 ± 2	127 ± 4	102 ± 3	84 ± 2
Sr	4 ± 1	6 ± 1	8 ± 1	19 ± 2
Pb	< 22	< 22	< 22	< 22

Participating Research Centre: Institute for Oceanography and Fisheries,
SPLIT,
Yugoslavia

Principal Investigator: L. STOJANOSKI

The requested summary report has not been received.

Participating Research Centre: Centre for Marine Research,
"Rudjer Boskovic" Institute,
ZAGREB/ROVINJ
Yugosalvia

Principal Investigator: M. BRANICA

Introduction:

For more than 15 years the Centre has gained experience in the development and application of electro-analytical procedures and neutron activation analysis (NAA) of trace elements in sea water and marine organisms. During the period 1973-1976 preliminary work on the sea water analyses was also performed.

Area(s) studied:

For the purpose of the pilot project, samples were taken from two areas (Area V) Rijecki Zaljev (5 stations) and the west Istrian coast (2 stations).

Material and methods:

In March, June, September and December 1977 and March and June 1978 analyses of sea water and marine organisms (Mytilus galloprovincialis, Mullus barbatus, Sardina pilchardus and Sepia officinalis) were made. In December 1978 additional analyses were performed on samples of sea water and Mytilus galloprovincialis collected at 2 stations in Rijecki Zaljev and 2 stations along the West Istrian coast. Sampling and sample storage followed the procedure proposed in FAO Fisheries Technical Paper No. 158. The AAS provided through MED POL was not utilized for these analyses. The analyses of samples were done as follows: the destruction of organic matter was performed by "Wet procedure" with nitric acid and hydrogen peroxide (in open Kjeldahls); after mineralisation, samples were analysed for heavy metals (except Hg) by electroanalytical procedures; at the beginning, ASW method was applied with hanging mercury drop electrode (HMDE), then rotating glassy carbon thin film mercury electrode (RGCE) and at the end (the best combination) differential pulse anodic stripping voltametry (DPASV) with glassy carbon thin mercury film electrode system with efficient mixing of electrolyte (TMFE-Mix). The neutron activation analyses were performed on the dried samples without destruction of organic matter. Details of analytical procedures used are described in published papers (see list of publications).

Results and their interpretations:

The following metals were analysed in sea water and in mandatory and alternative species:

a) Sea water
Number of analyses: 80

Metals	Concentration (ug/l sea water)			
	Minimum	Maximum	Average	Method used
Cd	< 0.05	0.35	0.07	ASV
Pb	< 0.05	1.6	0.3	ASV
Cu	< 0.05	3.5	0.5	ASV
Zn	1.2	50	11	ASV
Zn	10	61	23	NAA

b) Mytilus galloprovincialis
Number of samples: 228
Number of analyses: 52
Tissue analysed: soft part (applied factor F.W./D.W. = 8.0)

Metals	Concentration (ug/kg F.W.)		Method used
	Minimum	Maximum	
Hg(T)	10.6	37.5	NAA
Cd	25	400	ASV
Pb	62	3500	ASV
Cu	163	3400	ASV
Zn	2500	70000	ASV
Zn	15800	37500	NAA
Se	1300	2160	NAA

c) Mullus barbatus
Number of specimens: 46
Number of analyses: 19
Tissue analysed: fillet-white (applied factor F.W./D.W. = 4)

Metals	Concentration (ug/Kg F.W.) Minimum	Maximum	Method used	Composite samples of 10 homogenized specimens Minimum	Maximum
Hg(T)	79	110	NAA		
Cd	7.5	225	ASV	0.8	50
Pb	1100	3200	ASV	25	75
Cu	150	2600	ASV	150	320
Zn	2300	17500	ASV	2000	5000
Zn	11300	100000	NAA		
Se	610	5150	NAA		

d) Sardina pilchardus
Number of specimens: 24
Number of analyses: 12
Tissue analysed: Fillet-white (applied factor F.W./D.W. = 4)

Metals	Concentration (ug/kg F.W.) Minimum	Maximum	Method used
Cd	7.5	250	ASV
Pb	10	4400	ASV
Cu	375	3850	ASV
Zn	3250	22500	ASV

e) Sepia officinalis
Number of specimens: 4
Number of analyses: 2
Tissue analysed: Fillet-white

Metals	Concentration (ug/kg F.W.) Minimum	Maximum	Method used
Hg(T)	160	200	NAA
Cd		650	NAA
Zn	23000	29000	NAA
Se	1800	3000	NAA

LOG-FORMS for all these analyses were not provided. The values reported for sea water taken from sampling areas, are higher than for the open ocean waters. This could be mainly due to land washoff and partly to secondary contamination (sampling, storage and pre-treatment procedure). During the last few years increased attention has been paid to handling the samples, which brought the values to a lower level. The oscillating results of heavy metals' contents in marine organisms could also be interpreted accordingly. Very consistent and significant lower results of Cd, Pb and Zn by analyses of composite samples (10 specimens of Mullus barbatus) were also observed. Surprisingly high values of heavy metals were found in Mytilus galloprovincialis living in an area well protected from waste water inflow (Limski kanal). It seems that such areas, where the concentration of heavy metals is elevated because of the natural geochemical cycles of these microconstituents, are favourable to shellfish farming. For these reasons it is hard to make a distinction between heavy metals brought by the natural cycles and those due to anthpogenic activities.

The results of the sea water and Mytilus galloprovincialis samples taken in December 1978 are in the range of the previously reported concentrations. In the recent period, the AAS provided by UNEP-FAO gives reproducible results for Cd and Pb and their intercomparison will be reported later. Due to the change of pollution sources in Rijeka Bay, the Institute has to revise the proposed sampling programme.

Conclusions:

The values obtained are within acceptable limits when compared with those from other areas. It is worthwhile mentioning that high concentrations of some heavy metals were found in unpolluted areas (probably due to high exchange rate in the biogeochemical cycles already mentioned).

List of publications:

BRANICA, M., Development of methods for rapid detection of trace metals in sea water - Proceedings of Symposium on Marine Pollution Research, Gulf Breeze, 27-29 January 1976, pp. 114-119

BILINSKI, H., KOZAR, S. and BRANICA, M., Absorption of heavy metal traces on particulate matter in sea water. Colloid and interface Sc., V: 211-31

SIPOS, L., et al. Applications of polarography and voltammetry to marine aquatic chemistry. IV. A new voltammetric method for study of mercury traces in sea and inland waters. J. Electroanal. Chem. 77: 263-69

MAGJER, T., and BRANICA, M., A new electrode system with efficient mixing of electrolyte. Croat. Chem. Acta: 49: 51-5

BRANICA, M., NOVAK, D.M., and BUBIC, S., Application of anodic stripping voltammetry to determination of state of complexation of traces of metal ions at low concentration levels. Croat. Chem. Acta, 49: 539-47.

SIPOS, L., et al., Subtractive anodic stripping voltammetry with rotating mercury coated glassy carbon electrode. J. Electroanal. 87: 347-52

RASPOR, B. et al., The chelation of Cd with Nta in sea water as a model for the typical behaviour of trace metal chelates in natural waters. Sc. Total Environment 9: 87-109

BUBIC, S., SIPOS, L. and BRANICA M., Cruises of RV "Vila Velebita" in the Kvarner region of the Adriatic Sea. V. Electroanalytical determination of ionic zinc, cadmium, lead and copper in sea water. Thalas. Jugosl. (in press)

SIPOS, L. et al., A new voltammetric method for the simultaneous determination of Cu and Hg in sea water. Rapp. Comm. Int. Mer. Medit. (in press)

RASPOR, B., Cadmium concentration levels and speciation in natural waters. In Biogeochemistry of cadmium edit. J.O. Nriagu, Wiley, London (in press)

Participating Research Centre: Marine Biology Station,
PORTOROZ
Yugoslavia

Principal Investigator: S. GOMISCEK

Introduction:

The Station has been studying the monitoring of the distribution of potentially toxic elements in sea-water, sediments, plankton and selected larger biota (fish, mussels etc.) since 1973; however the analyses were performed by collaborating laboratories of the University of Ljubljana, the Chemical Institute "Boris Kidric" and Nuclear Institute "Josef Stefen". Samples were collected in open waters of the Adriatic and particularly along the shores of its northern part. Results were partly published, and a selection of unpublished results was provided in the 1st Progress Report (28 April, 1977).

Area(s) studied:

Sampling sites were located in the Bay of Strunjan which served as an area free from local pollution sources and in the Bay of Koper which is heavily polluted by sewage discharges and some industrial wastes and also influenced by the river Rizana. In addition, the fish sampling was performed in open waters off the Bay of Piran, serving as a reference area. The mussels were collected all along the North Adriatic coast and at the "super-clean" location (Island of Jabuka), figure 1.

Material and methods:

All samples were collected, preserved and prepared for analyses according to the techniques suggested in the FAO, Fisheries Technical Paper No. 158. The following two series of samples were collected: during February, May, July and November 1977 several samples of Mytilus galloprovincialis (and of Upogebia littoralis) were collected regularly as programmed from both "clean" (Strunjan) and "polluted" (Koper) areas, yielding in total 16 samples and about 300 specimens of all principal growth classes. Unfortunately the samples of Mullus barbatus were available only in the winter and summer seasons since the species is quite rare with this area with muddy bottoms. Samples collected during autumn 1976 were used mainly for development of methods, calibrations and training, and results were therefore not reported.

Several samples of Mytilus galloprovincialis were taken on the shores of Istria. In addition, the reference samples from presumably very little polluted inshore and offshore waters of the Middle Adriatic (island of Jabuka) were also collected. To obtain reference samples, samples were collected in an area influenced by discharges of petrochemical industry.

In most of the localities mentioned, the samples were collected twice, during summer and autumn in 1976 and 1977, while at reference stations only during 1978.

All samples were analysed for mercury and cadmium by AAS, partly at the Chemical Institute "B. Kidric" using Perkin-Elmer systems and partly at the MBS Portoroz using FAO/UNEP purchased Varian CRA and Hg Systems. Preparation of samples and analytical procedures used were according to the FAO, Fisheries Technical Paper No. 158. Many samples were checked for Hg concentrations and selected samples analysed also for Se, As, Cu, Zn, Mn and Sb by NAA at the Nuclear Institute "J. Stefan" by the methods described by Kosta L. et al., 1978.

Results and their interpretations:

In tables 1 and 2 the concentration ranges of the trace metals Hg (T), Cd, Cu, Zn and Se determined in the mandatory species Mullus barbatus and Mytilus galloprovincialis are summarized according to the sampling sites and periods of sampling. In the vicinity of a petrochemical industry a value of 7000 ug/kg fresh weight of mercury was obtained in Mytilus galloprovincialis (sample No. 74) while in the clean offshore reference area the highest concentration in the same species was 45 ug/kg F.W.

At this stage it is difficult to give significant interpretations and conclusions of the work performed. However, some obvious findings can be anticipated:

- accumulations of selected elements in muscular tissue of sampled fish (Mullus barbatus) are found to be within the "normal" ranges, except in such samples that are under direct influence of mercury discharges and where the detected levels were between 200 - 300 p.p.b. Levels for copper are also somewhat high;

- the results obtained are not sufficient to demonstrate any seasonal or other variations;

- for the mussel (Mytilus galloprovincialis,) which seems to be an ideal indicator organism, there is a good deal of information available and the following preliminary observations can be given: The concentrations of mercury are relatively low and uniform in the whole North Adriatic as well as of course in the southern reference areas. The mean concentration of mercury in mussels is 600 p.p.b, reaching also 1,600 p.p.b. The highest value found in the mussels taken in the vicinity of a PVC industrial plant was 7000 p.p.b., the lowest offshore of the Middle Adriatic (Island of Jabuka 20 p.p.b.).

List of publications:

KOSTA, L., RAVNIK, V., BYRNE, A.R., STIRN, J., DERMELJ, M., STEGNAR, P., (1978). Some trace elements in the waters, marine organisms and sediments of the Adriatic by Neutron Activation Analysis. Journal of Radioanalytical Chemistry, 44:317-32.

at different sampling sites along the coast of S.R. Slovenija.

Sampling site	Sampling period	Range of concentration µg/kg F.W. (number of analysis indicated in brackets)			
		Hg (T)	Cd	Cu	Zn
off Piran	February 1977	98 - 98 (2)		140-160 (2)	2330 - 2900 (2)
	May 1977	192 (1)	234(1)		
	November 1977	120 - 390 (3)	20-30(3)		

As concentration between 14450 and 16600 µg/kg F.W.

Sb concentration 1 µg/kg F.W.

Table 1. The concentration range (minimum and maximum) of Hg(T), Cd, Cu, Zn in Mytilus galloprovincialis (soft part) sampled in diffent sites of the Adriatic during 1977 and 1978.

Table 2 The concentration range (minimum and maximum) of Hg (T), Cd, Cu, Zn, and Se in *Mytilus galloprovincialis* (soft part) sampled in different sites of the Adriatic during 1977 and 1978.

Sampling site	Sampling period	Range of concentration µg/kg F.W.; No of analyses in brackets				
		Hg (T)	Cd	Cu	Zn	Se
Koper	February 1977	40 (1)		1550 (1)	30700 (1)	330 (1)
Strunjan	"	40 (1)		1340 (1)	65200 (1)	910 (1)
Koper	May 1977	198 (1)	372 (1)			
Strunjan	"	61 (1)	122 (1)			
Koper	July 1977	40 – 131 (4)	120 – 122 (2)			460 – 940 (2)
Strunjan	"	40 – 175 (3)	205 – 427 (2)			123 (1)
Koper	November 1977	169 (1)	220 (1)			
Strunjan	"	48 – 80 (3)	213 – 244 (3)			

As-concentration 2800 and 4600 µg/kg F.W.; Sb-concentration 18 and 23 µg/kg F.W.

Sampling site	Sampling period	Hg (T)	Cd	Cu	Zn	Se
Mid Adriatic (Inshore)	November 1977	70 – 128(4)	208 – 243 (2)	1090 (1)	25200(1)	950 – 1240 (2)
Vicinity of petrochemical industry	"	2320 –7000(4)	159 – 186 (2)			900 – 1750 (2)
Island Jabuka reference area	June 1978	26 – 45 (3)		600–1070(2)	8130–9390(2)	

As-concentration 6530 and 11340 µg/kg F.W. Sb-concentration 12 and 49 µg/kg F.W.

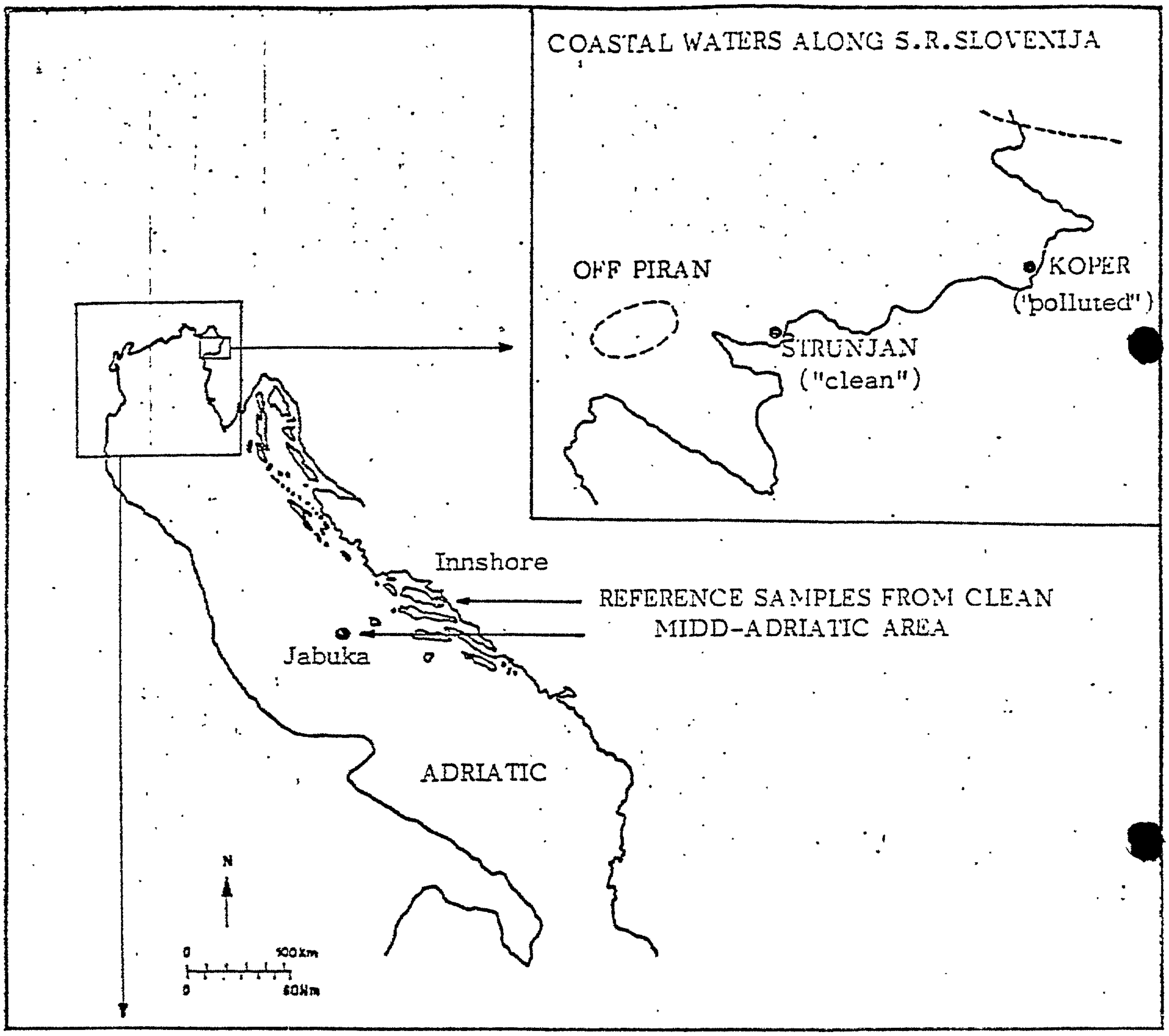

Fig. 1 Sampling sites for the monitoring of metals

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Intergovernmental Review Meeting of
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Barcelona, 11 - 13 February 1980

SUMMARY REPORTS ON THE SCIENTIFIC RESULTS OF MED POL

Summary reports of participants in the Co-ordinated Mediterranean Pollution Monitoring and Research Programme (MED POL)

PART II

RAPPORTS RESUMES DES RESULTATS SCIENTIFIQUES DU MED POL

Rapports résumés des participants au Programme coordonné de surveillance continue et de recherche en matière de pollution dans la Méditerranée (MED POL)

PARTIE II

GE.80-1017

Table of Contents/Table des matières

Page/Page

INTRODUCTION

This document contains the summary reports of research centres which have participated in the Co-ordinated Mediterranean Pollution Monitoring and Research Programme (MED POL).

The reports were edited by the specialized United Nations bodies to which they were submitted and are reproduced in the language in which they were originally written.

For convenience, the reports are arranged in order of the MED POL pilot projects and within these projects by countries in alphabetical order.

The names of the principal investigators and the research centres are indicated at the beginning of each summary report.

INTRODUCTION

Le présent document contient les rapports résumés des centres de recherche qui ont participé au Programme coordonné de surveillance continue et de recherche en matière de pollution en Méditerranée (MED POL).

Les rapports ont été édités par les organes spécialisés des Nations Unies auxquels les rapports ont été soumis et ils sont reproduits dans leur langue originale.

Pour plus de commodité, les rapports sont présentés dans l'ordre des projets pilotes du Programme MED POL et, dans le cadre de ces projets, ils sont classés par pays, par ordre alphabétique.

Les noms des chercheurs principaux et des centres de recherche sont indiqués en tête de chaque rapport résumé.

MED POL III : BASELINE STUDIES AND MONITORING OF DDT, PCBS AND OTHER CHLORINATED HYDROCARBONS IN MARINE ORGANSIMS (FAO(GFCM)/UNEP)

MED POL III : ETUDES DE BASE ET SURVEILLANCE CONTINUE DU DDT, DES PCB ET DES AUTRES HYDROCARBURES CHLORES CONTENUS DANS LES ORGANISMES MARINS (FAO(CGPM)/PNUE)

Participating Research Centre: Institute of Oceanography and Fisheries
Mediterranean Branch,
Alexandria
Egypt

Principal Investigator: M. M. Abbas Aly

The requested Summary Report has not been received.

Centre de recherhche participant: Laboratoire de chimie appliquée a l'expertise, Faculté de pharmacie, Université de Montpellier, MONTPELLIER
France

Chercheur principal: R. METRES

Introduction:

Le laboratoire, créé en 1962, possède le personnel qualifié et le matériel voulu pour l'analyse de micro-polluants halogénés du milieu marin. Il a également mis au point les méthodes officielles de recherches des résidus de pesticides (Journal officiel de la République française, 3 décembre 1978; Arrêté du ler octobre 1968) et a ralis diffrentes analyses sur les rsidus de pesticides dans des fruits et des légumes français et tropicaux.

Zone(s) étudiées(s):

Les spécimens ont été recueillis sur quatre stations (fig. 1) dans la zone de Banyuls-sur-mer, Méditerranée nord-ouest (Zone II).

Matériel et méthodes:

Les espèces utilisées pour les analyses ont été Mullus barbatus, Mytilus galloprovincialis, Carcinus mediterraneus et zooplancton. Les échantillons ont été préparés et extrait au solvent selon la méthode décrite dans la FAO, Document technique sur les pêches, No. 158, et les analyses réalisées selon la méthode décrite dans Trav.Soc.Pharm. Montpellier (1976) 36:43-58; elles comportent la purification de l'extrait par une première chromatographie sur florisil avec élution par le mélange acétone-eau (80/20) et une séparation primaire des hydrocarbures chlorés en deux fractions:

a) celle renfermant les hydrocarbures halogénés non-oxygénés (par exemple PCB, HCH, DDT, etc.);

b) celle renfermant les hydrocarbures halogénés oxygénés (endrine, dieldrine, etc.). Cette séparation a été réalisé par élution sélective sur une collone de florisil.

L'analyse par chromatographie gazeuse utilisant des détecteurs à capture d'électrons Ni 63 a été réalisée sur deux colonnes avec différentes phases stationnaires en vue de vérification.

Résultats et leur interprétation:

Le tableau 1 est un résumé des résultats contenus dans les différents tableaux individuels présentés. Les constituants, à part les PCBs, n'ont pas toujours été détectés dans les échantillons examinés.

Les observat.c..s suivantes ont été faites:

Moules
- présence constante de DP 5 entre 0,2 et 0,5 mg/kg
- présence inhabituelle de DP 4 le 18.10.1977 simultanément à une presence inhabituelle de DDT.

Crabes
- présence notable de lindane en mai et juin 1977 seulement
- présence constante de DP 5 entre 0,3 et 3,2 mg/kg
- présence inhabituelle de DP 4 le 18.10.1977 simultanément à une
- présence anormale de DDT

Rouget barbet
- traces soutenues de lindane et de DDE
- présence constante de DP 5 entre 0,2 et 9,5 mg/kg
- présence inhabituelle de DDT les 17.10 et 20.12.1977

Zooplancton
- présence continue de DDT entre 0,1 et 0,2 mg/kg
- présence continue de DP 5 entre 0,8 et 3,0 mg/kg
- présence de DP 6 le 25.8.1977

Conclusions:

La pollution légère de l'environnement aquatique paraît maintenue par des rejets sporadiques des hydrocarbures halogénés qui se traduisent par de fortes teneurs momentanées.

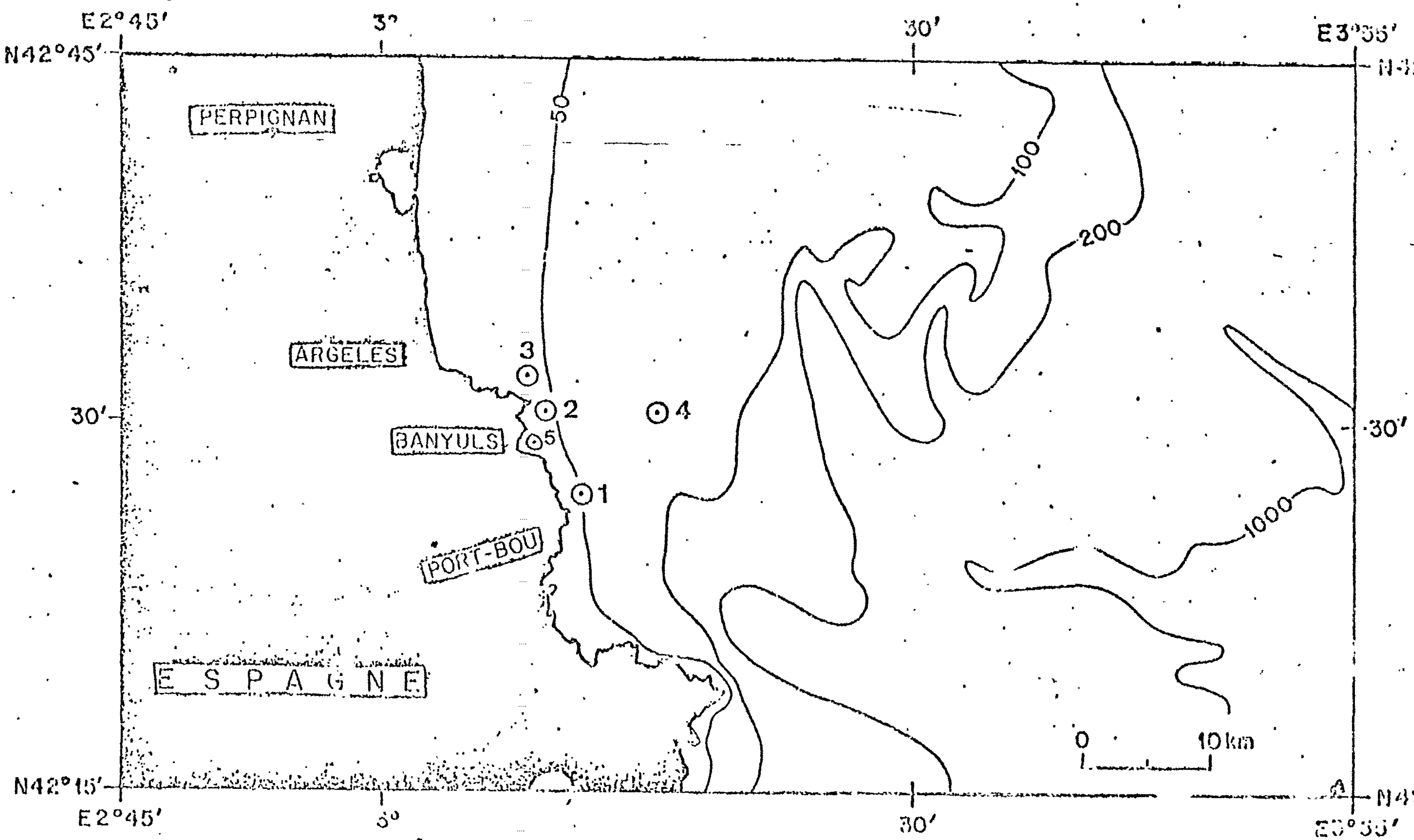


Fig. 1 Les stations de recueil

	Mytilus galloprovincialis	*Mullus barbatus*	*Carcinus mediterraneus*	*Zooplancton*
No. d'échantillons	10	12	10	4
No. d'individus	72	68	85	-
PCBs:				
valeurs extrêmes	200-1200	30-9500	300-3600	800-22000
moyen	414.5±307	1661±3328	1448±1365	6950±10065
ΣDDT:				
valeurs extrêmes	nd-190	nd-120	nd-151600	90-170
moyen	27.5±63	30.9±36	15701±47780	130±34
ΣBHC:				
valeurs extrêmes	nd-20	nd-20	nd-36	nd
moyen	3.4±6.2	3.65±5.8	7.9±13.7	

Tableau 1 - Résumé des résultats rélatifs aux concentrations de PCBs, ΣDDT et ΣBHC dans différentes espèces (µg/kg poids frais).

Centre de recherche participant: Institut scientifique et technique des pêches maritimes (I.S.T.P.M.),
NANTES
France

Chercheur principal: C. Alzieu

Introduction:

L'Institut travaillait dejà dans ce domaine avant la mise en route du projet pilote MED POL.

Zone(s) étudiée(s):

Mytilus galloprovincialis a été recueillie tout le long de la côte française de la Méditerranée, de Banyuls à Toulon, (fig. 2) Zone II. Les autres espèces collectées en vue d'analyse ont été Thunnus thynnus, Carcinus mediterraneus, Mullus barbatus et Crangon crangon (voir fig. 1 pour la localisation exacte des stations).

Matériel et méthodes:

Les échantillons sont préparés selon les recommendations de la FAO, Document technique sur les pêches, No. 158 et puis lyophilisés.

La méthode d'analyse comprend l'extraction des lipides à l'hexane, la purification par H_2SO_4 concentré, la séparation des PCBs, des DDTs sur colonne de gel de silice (5% H_2O) puis l'analyse par chromatographie en phase gazeuse avec détecteur à capture d'électrons Ni-63.

Résultats et leur interprétation:

Le Tableau 1 montrant les concentrations de DDT et de PCB trouvées dans les différentes espèces analysées est une compilation des résultats fournis dans les formulaires d'enregistrement.

Conclusions:

Les concentrations les plus élevées s'observent dans Thunnus thynnus.
Les niveaux de contamination des coquillages varient de façon significative selon qu'ils se trouvent dans une région ostréicole (Etang de Thau, de Leucate) ou une région industrielle (Rade de Toulon, golfe de Fos).

Liste de publications:

Alzieu, C. et Duguy (1978). Contamination des dauphins bleus et blancs de Méditerranée (Stenella coeruleoalba) par les composés organochlorés présenté aux quatrièmes journées d'étude sur la pollution marine en Méditerranée CIESM/PNUE, Antalya, 24-27 novembre 1978.

Espèce \ Composé	ΣDDT	PCBs
Mytilus galloprovincialis		
n = 32		
valeurs extrêmes	18.6 - 195.2	23.6 - 750
moyen	54.8	118.5
Thunnus thynnus (chair blanche)		
n = 21		
valeurs extrêmes	6.3 - 3275	74 - 6239
moyen	806	1307
Carcinus mediterraneus		
n = 9		
valeurs extrêmes	19.1-104.7	42.5 - 271
moyen	53	117
Mullus barbatus		
n = 4		
valeurs extrêmes	43.5 - 89.9	200 - 266
moyen	63.8	241
Crangon crangon		
n = 2		
valeurs extrêmes	18.3	30 - 35
moyen	18.3	32.5

Tableau 1. Concentrations, valeurs extrêmes et moyens de ΣDDT et des PCBs (en µg/kg de poids frais).

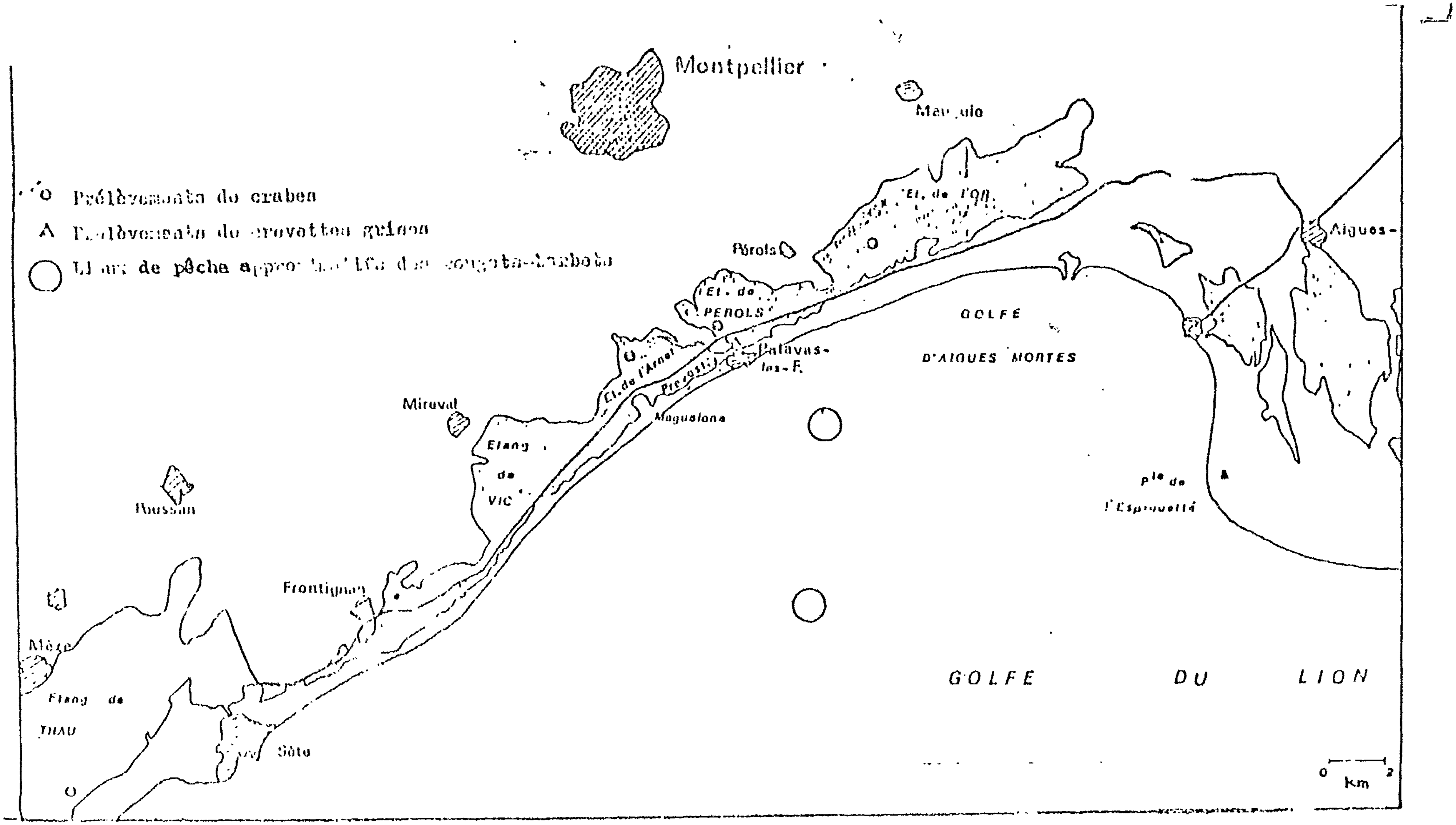


Fig.1 Les stations de prélèvement

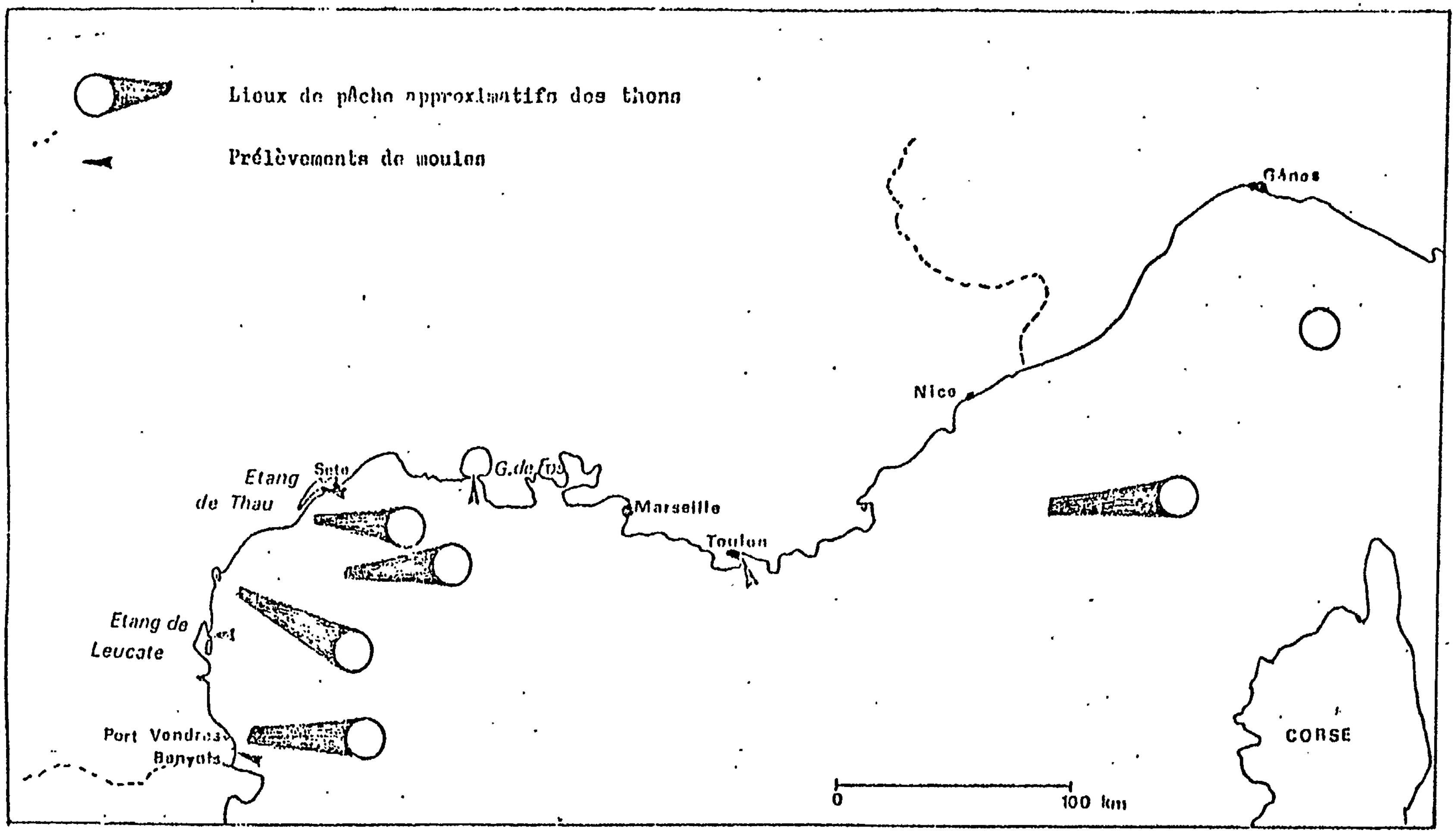


Fig 2: Côte occidentale de la Mediterranée
avec les lieux de prélèvement de moules

Participating Research Centre: Institute of Oceanographic and Fisheries Research (IOKAE), ATHENS Greece

Principal Investigator: J. SATSMADJIS

Introduction:

Analysis of chlorinated hydrocarbons started at the Institute in late 1975.

Area(s) studied:

All samples were collected from the Saronikos Gulf, Aegean (Area VIII), figure 1.

The water characteristics of the gulf are as follows: temperature generally varies between 15°C and 25°C and salinity around 38.5 °/₀₀, dissolved oxygen values are in general near saturation except in Elefsis Bay where sometimes oxygen levels can be very low, or even down to zero.

Saronikos Gulf is polluted by the sewage of Athens' greater area and by many industries situated mainly around Elefsis Bay.

Material and methods:

The following three species were collected for analysis: Mullus barbatus, Parapenaeus longirostris and Mytilus galloprovincialis.

The first two were bottom trawled, the last one collected by hand. The specimens were kept in deep freeze and then prepared and anlysed fresh or lyophilised. The analytical method resembled that of Holden and Marsden (J. Chromat. 40, 481, 1969). The hexane extract, cleaned up on an alumina column, went through a silica gel column, to give six fractions, processed on a TRACOR 222 gas chromatograph provided with a Nickel-63 electron capture detector. Peak heights only were measured and compared with those of standards.

Results and their interpretation:

All data collected since the beginning of the project and up to September 1978 are listed in the Log-Forms. All concentrations are expressed as ug/kg on a fresh weight basis (F.W.). No correction factor was applied as this was not found necessary, based on the intercalibration exercise.

The following summary table and the histogram (figure 2) give the mean values of the constituents by species and by area.

Species	Area	PCBs	ΣDDT	ΣBHC	Heptachlor epoxide	Dieldrin	Endrin
Mullus barbatus	NI	470	220	5.6	0.3	17	0.4
	N^2+N^3	200	73	6.9	0.2	3.0	1.8
	B	38	31	5.0	0.11	1.17	0.82
	C	74	74	3.3	0.5	1.2	1.4
Parapenaeus longirostris	N^2+N^3	27	2.8	0.72	0.14	0.28	0.3
	A	9.0	3.8	1.0	0.05	0.33	0.15
	B	20	3.3	0.55	0.08	0.39	0.32
Mytilus galloprovincialis	A	58	8.0	3.8	0.03	1.8	0.75

The following observations can be made:

a. PCBs and DDT predominate in all samples.

b. Mullus barbatus exhibits much greater concentrations than the other two species.

c. Aldrin, heptachlor and heptachlor epoxide were not always detected and then only in very small quantities.

d. The highest concentrations observed for the major constituents were: PCBs 1100, DDT 390, Dieldrin 50, BHC (all isomers) 10 and eldrin 2.2 ug/kg F.W. (All found in Mullus barbatus).

e. The areas rank as follows (by order of decreasing pollution): NI (around the sewage outfall), N^2+N^3 (adjacent to and south NI), A, B, and C, the last one showing differences of no statistical significance, owing to insufficient data.

f. No significant differences were found between seasons, although there is an indication that spring values are the highest.

g. No comment is possible on differences between sexes, because of lack of data.

h. In the sewage outfall area, there was a perfect relationship between lipids (EOM) on the one hand and PCBs, DDE, DDD and ΣDDT on the other. For DDT, the correlation coefficient was 0.88.

i. The ratios of PCBs to ΣDDT and of DDD to ΣDDT were higher in the areas near the sewage outfall than those further away.

j. The residue levels seems to increase with the length of the fish and the lipid content, but the number of data for each area were not enough for reliable conclusions.

k. The data for M. barbatus are comparable to those found by other workers while those which concern Mytilus and Parapenaeus seem to be lower.

Conclusions:

The total concentration of chlorinated hydrocarbons in Mullus barbatus does not usually exceed 1 ppm, even when it comes from the sewage outfall zone. It quickly drops to around 0.1 ppm when the sampling site is at least 20 km further, with the probable exception of the Elefsis Bay.

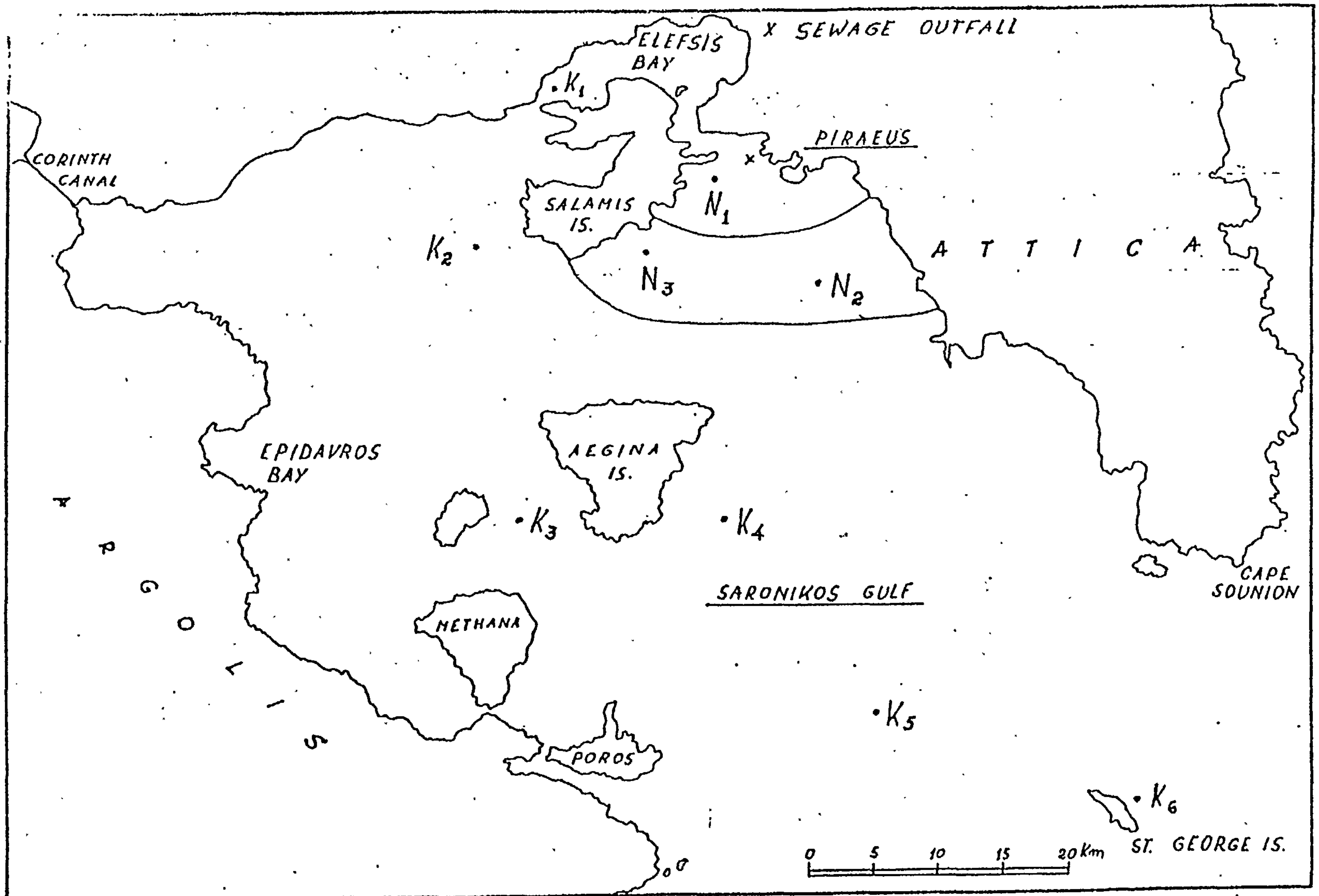
Parapenaeus longirostris and Mytilus galloprovincialis contain amounts 5 to 30 times smaller than Mullus barbatus, taking into account the degree of pollution of the sampling area.

Hence, none of these three marine organisms coming from the Saronikos Gulf presents a health hazard to the consumer.

List of publications:

SATSMADJIS, J. and GABRIELIDES, G.P. (1977). Chlorinated hydrocarbons in striped mullet (Mullus barbatus) of Saronikos Bay. Thalassographica 1: 151-154

__________, (1979). Observations on the concentration levels of chlorinated hydrocarbons in a Mediterranean fish. Marine Pollution Bulletin, April 19, vol.10, n.4.



K_1	37° 59,5 B/23 25,6 A	13 m		
K_2	37° 53,2 B/23 22,0 A	112 m		
K_3	37° 41,5 B/23 23,8 A	60 m		
K_4	37° 41,7 B / 23° 34,5 A	190 m	N_1	37° 55,8 B 23° 34,7 A 50 m
K_5	37° 33,2 B / 23° 42,5 A	135 m	N_2	37° 51,3 B 23° 40,7 A 66 m
K_6	37° 29,1 B / 23° 56,5 A	120 m	N_3	37° 53,0 B 23° 30,6 A 86 m

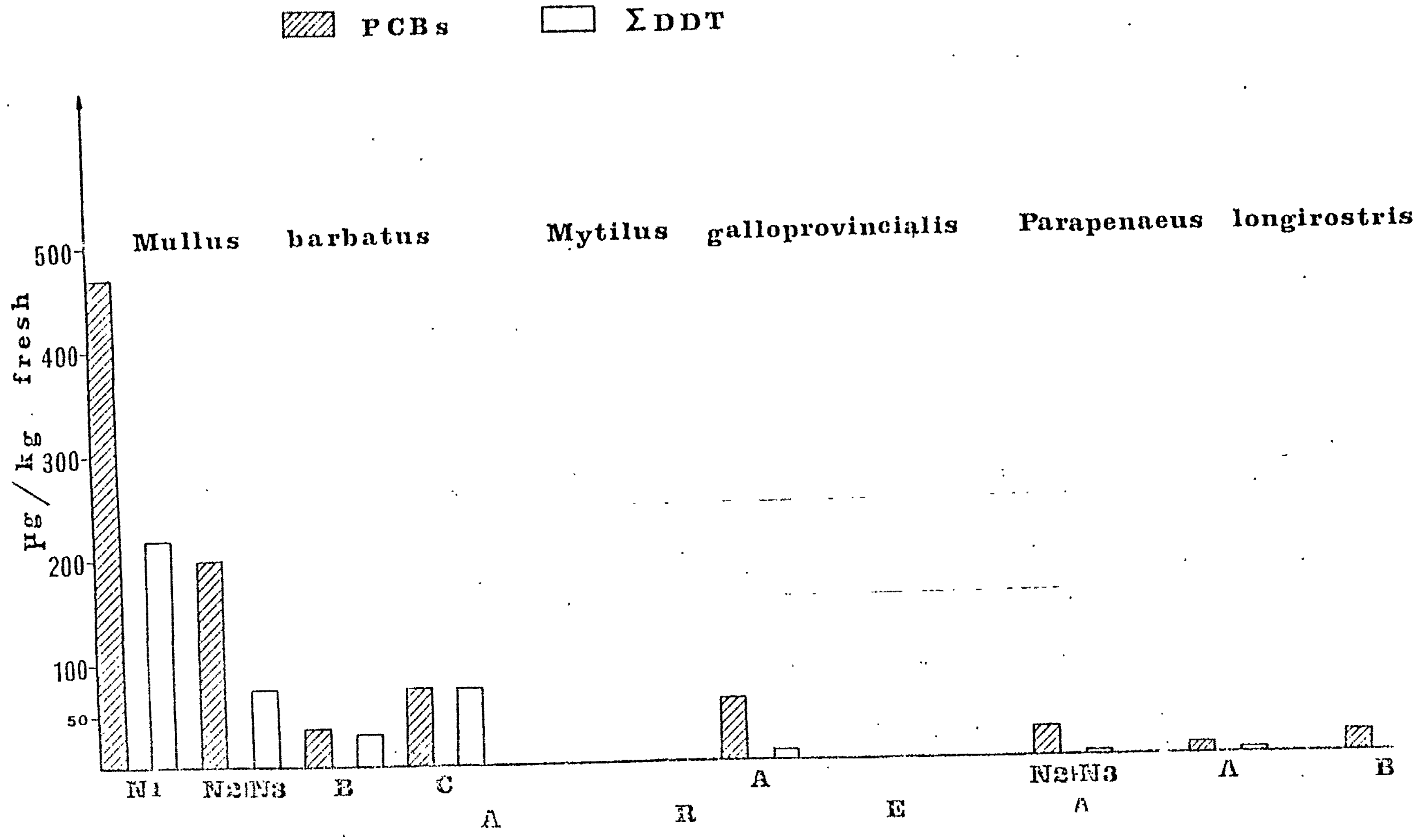
Fig. 1

Fig. 2

SARONIKOS GULF

PCBs and ΣDDT

(Mean values by species)



Participating Research Centre: Department of Food Hygiene, Faculty of Veterinary Medicine, Aristotelian University of Thessaloniki,
THESSALONIKI
Greece

Principal Investigator: S.D. KILIKIDES

Introduction:

Activities related to the pilot project started in 1971 with analysis of organochlorine pesticides in food, fats and milk.

Area(s) studied:

Samples were collected from Thermaikos Gulf, Strymonikos Gulf, and Kavala Gulf, North Aegean (Area VIII), figure 1. All three gulfs are characterized by shallow waters and have proved to be an excellent environment for shellfish cultivation. The main polluting sources of Thermaikos Gulf are the sewage outfall of the Thessaloniki industrialized west coast area and agricultural effluents in its eastern part. Strymonikos and Kavala Gulfs are polluted by agricultural effluents and the city's sewage outfall.

Material and methods:

The species Mytilus galloprovincialis, Mullus barbatus, Thunnus thynnus and Xiphias gladius were collected for analysis in the three above gulfs and at six sampling sites: Th1, Th2, S1, S2, St1 and St2 (figure 1). Samples were stored in deep freezer 1-2 months prior to analysis. They were treated with sodium sulfate (anhydrous) and then extracted by Soxhlet apparatus using petroleum ether (bp 40-60°C). The extractable organic matter was treated by Johnson's method J.A.O.A.C. 48 (1965) 668, and Jansen et al., (1973). Natl.Swed.Env. Prot.Brd. (4E): 7.

In analyzing fish and shellfish for organochlorinated pesticides and PCBs, gas chromatography was used. For this purpose a gas-chromatographic equipment, Hewlett Packard, model 7400 and another one, Varian, were used. The former was equipped with ECD, tritium and the latter with ECD, Ni 63.

Hewlett-Packard: Glass column 6' x 1/4' packed with 15 per cent QF-1 and 10 per cent DC-200 on Chromosorb 80-100 mesh. The temperature was 210°C for the oven and 220°C for the inlet and the detector. Flow rate of carrier gas (Nitrogen) was 10 ml/min.

Varian: The glass column, 200 cm x 6, 35 mm x 2 mm, packed with same liquid phase as with Hewett-Packard. Inlet and detector temperatures were 30° C and that of oven 210°C. Flow rate carrier gas (Nitrogen) was 14 ml/min. All other conditions were the same as in the above case.

Results and their interpretation:

Tables 1, 2 and 3 present the mean values of each determined hydrocarbon (ug/kg F.W. weight sample), the species, the number of the examined samples and the number of times in per cent of each constituent detected in the samples. This is referred to as positiveness.

All other species were found polluted by PCB's and DDT, except M. galloprovincialis where the positiveness was 89 per cent. The examined marine organisms were also found polluted by BHC as follows: M. barbatus 83 per cent, M. galloprovincialis 37 per cent, and T. thynnus 25 per cent. Aldrin was detected only in M. galloprovincialis (figure 2).

From tables 1 and 2 it can be seen that the concentrations of organochlorinated pesticides (DDT and others) in marine organisms (M. galloprovincialis and M. barbatus), found in areas polluted by agriculture cutlet (e.g. Kavala Gulf) are higher than in other areas. M. galloprovincialis, for example, taken from sampling site ST1 (industrial area), were found more polluted by PCB's (mean value 397,6 ug/kg F.W.), than the samples taken from ST2 (agriculture area) with mean value 212,4 ug/kg F.W. In figure 3 the values of each pollutant in the marine organisms are comparatively presented in histograms. Finally, marine organsims from higher trophic levels (e.g. Thunnus thynnus), were found more polluted than the organisms from the lower trophic levels (e.g. M. galloprovincialis) as shown in figure 4.

TABLE 1

CHLORINATED HYDROCARBONS IN *Mytilus galloprovincialis*
(μg/kg fresh weight)

CHLORINATED HYDROCARBONS	THERMAIKOS GULF (30 samples)	STRYMONIKOS GULF (9 samples)	KAVALA GULF (29 samples)	N.AEGIAN SEA (68 samples)
DDE	6.4 (93)*	9.4 (89)	14.0 (90)	9.8 (89)
DDD	4.1 (80)	11.2 (89)	9.4 (79)	8.1 (79)
DDT	5.2 (80)	7.0 (78)	11.5 (83)	7.8 (82)
ALDRIN	3.0 (26)	Ø (Ø)	7.1 (48)	5.8 (31)
BHC	2.2 (33)	2.3 (78)	0.8 (28)	1.8 (37)
TOTAL PESTICIDES	20.9	29.9	42.8	33.3
PCB's	305.0 (93)	321.0 (44)	243.8 (90)	280.4 (85)
TOTAL	325.9	350.9	286.6	313.7

(*) Positiveness per cent.

TABLE 2

CHLORINATED HDROCARBONS IN *Mullus barbatus*
(μg/kg fresh weight)

CHLORINATED HYDROCARBONS	THERMAIKOS GULF (7 samples)	STRYMONIKOS GULF (7 samples)	KAVALA GULF (5 samples)	N.AEGIAN SEA (19 samples)
DDE	49.5 (86)*	53.5 (86)	96.5 (100)	66.2 (100)
DDD	14.1 (71)	15.0 (86)	65.8 (60)	31.6 (86)
DDT	21.5 (71)	15.1 (86)	64.2 (80)	33.6 (86)
ALDRIN	Ø (Ø)	Ø (Ø)	Ø (Ø)	Ø (Ø)
BHC	14.8 (71)	5.5 (57)	2.2 (60)	7.6 (83)
TOTAL PESTICEDES	99.9	89.1	228.7	139.0
PCB's	204.0 (100)	85.3 (100)	110.0 (100)	138.3 (100)
TOTAL	303.9	174.4	338.7	277.3

(*) Positiveness per cent.

TABLE 3

CHLORINATED HYDROCARBONS IN MARINE ORGANISMS FROM N. AEGIAN SEA
(μg/kg fresh weight)

CHLORINATED HYDROCARBONS	*Mytilus galloprovincialis* (68 samples)	*Mullus barbatus* (19 samples)	*Xiphias gladius* (2 samples)	*Thunnus thynnus* (4 samples)
DDE	9.8	66.2	194.3	601.4
DDD	8.1	31.6	92.8	323,2
DDT	7.8	33.6	205.3	315.1
ALDRIN	5.8	Ø	Ø	Ø
BHC	1.8	7.6	2.4	36.8
TOTAL PESTICIDES	33.3	139.0	494.8	1276.5
PCB's	280.4	183.3	363.7	2613.0
TOTAL	313.7	277.3	858.5	3889.5

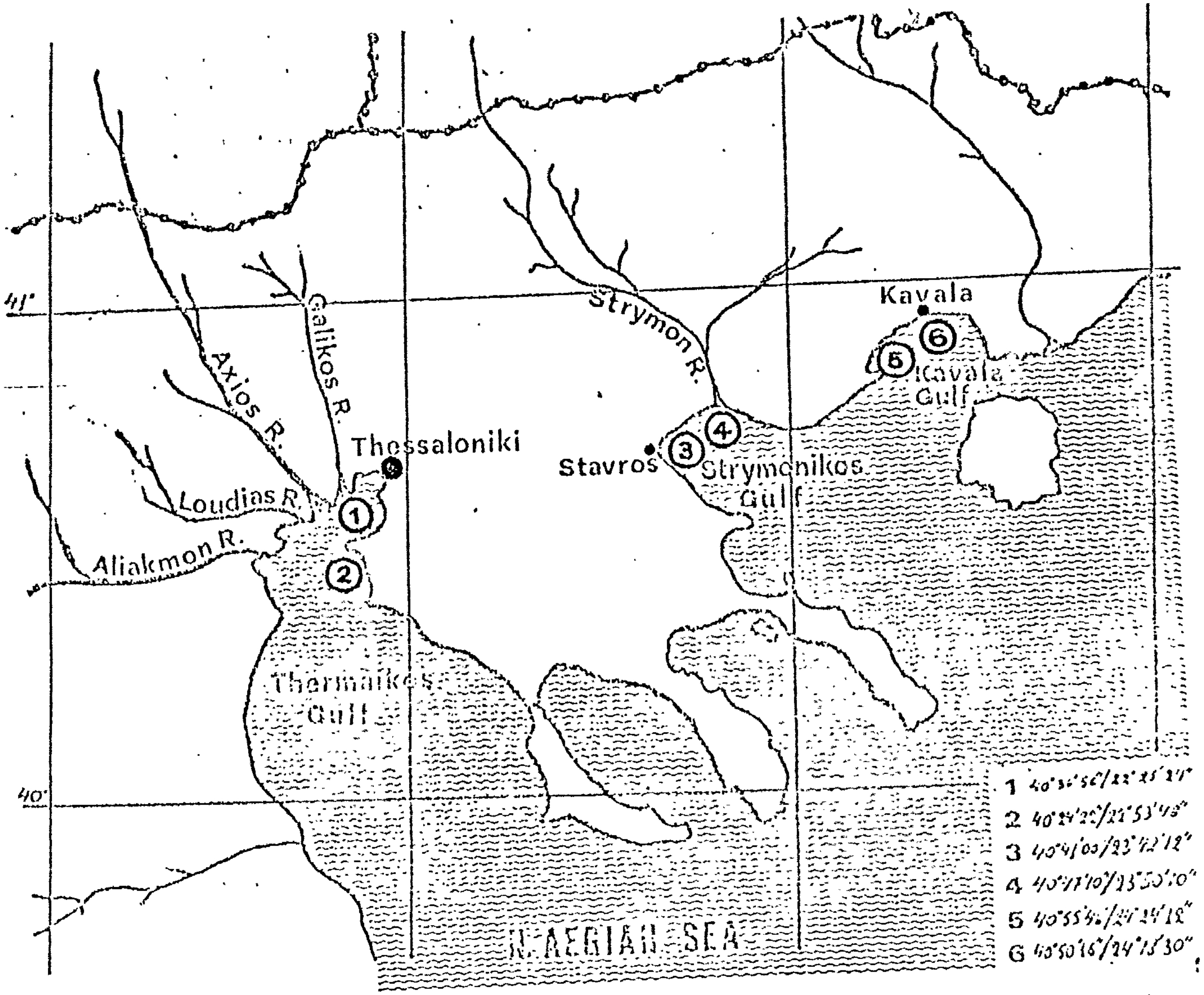


FIG. 1

Sampling areas in Thermaikos Gulf, Strymonikos Gulf, and Kavala Gulf

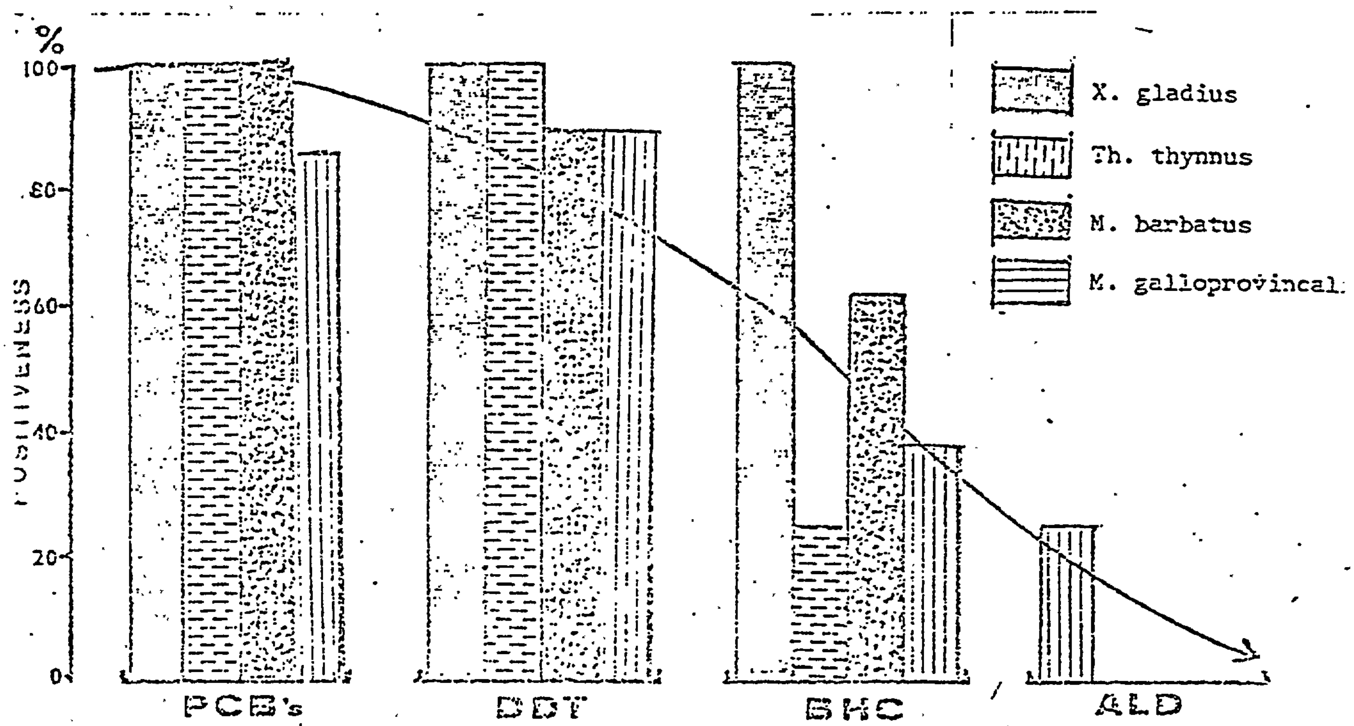

%
POSITIVENESS
100
80
60
40
20
0
PCB's
DDT
BHC
ALD
X. gladius
Th. thynnus
M. barbatus
M. galloprovincal.

FIG. 2

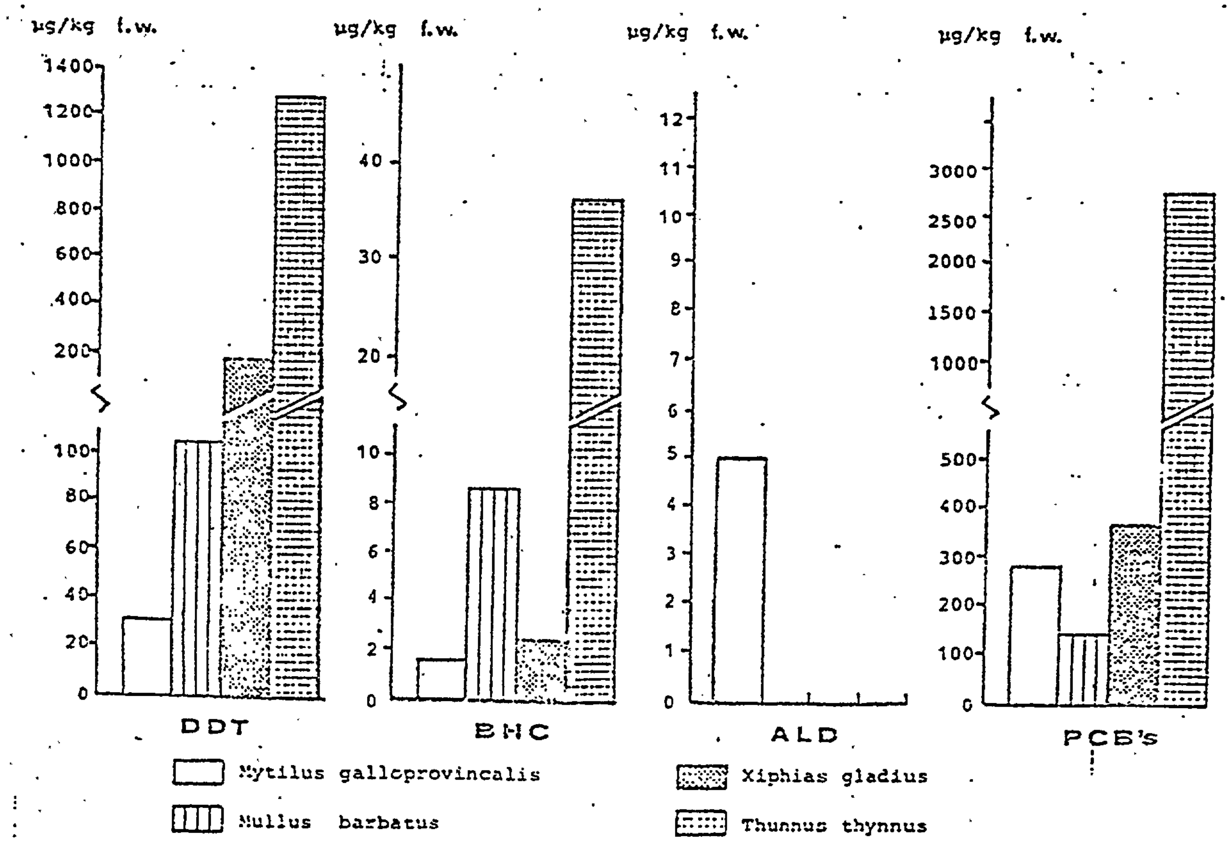

µg/kg f.w.
DDT
BHC
ALD
PCB's
Mytilus galloprovincalis
Mullus barbatus
Xiphias gladius
Thunnus thynnus

FIG. 3

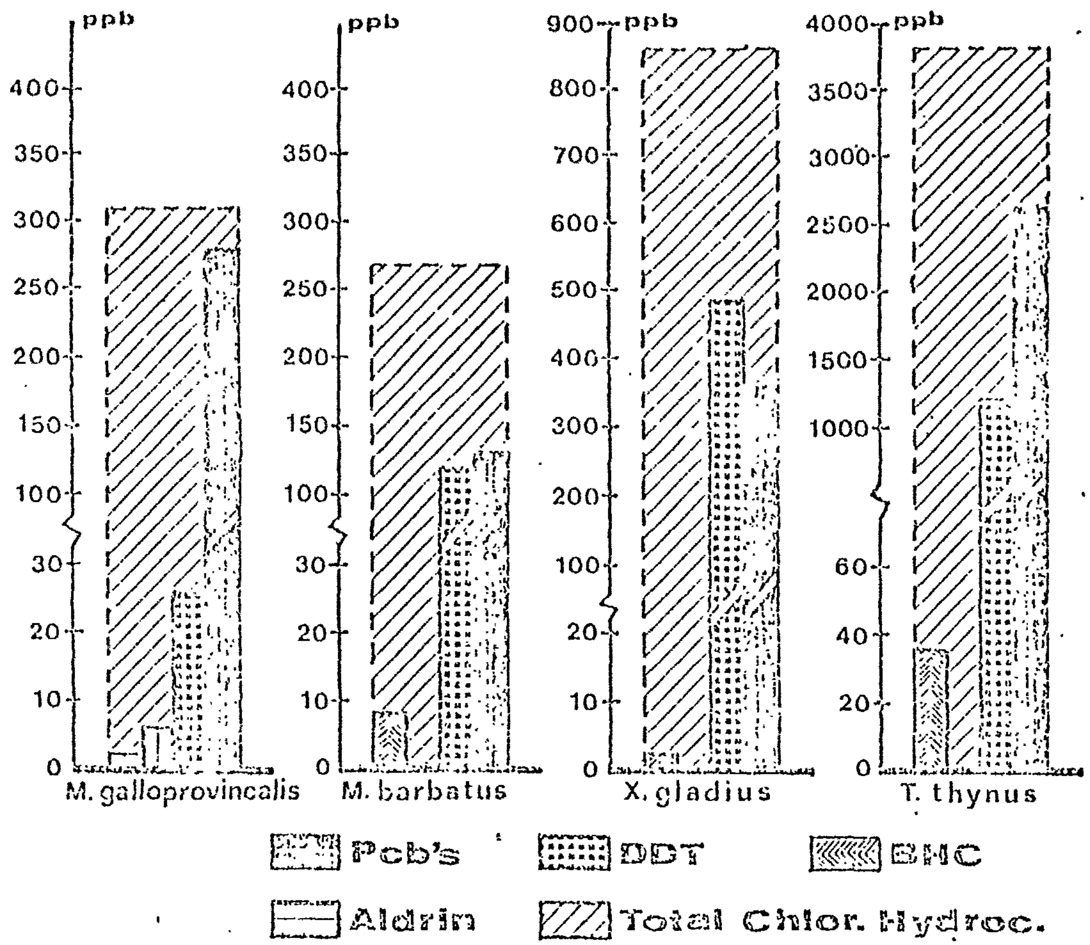


FIG 4

Pesticide concentrations in ppb in 4 selected test species

Participating Research Centre: Laboratory of Analytical Chemistry, Faculty of Physics and Mathematics, University of Thessaloniki
THESSALONIKI
Greece

Principal Investigator: G. VASILIKIOTIS

The requested Summary Report has not been received.

Centre de Recherche Participant: Institut phytopathologique "Benaki"
ATHENES
Grece

Chercheur Principal: N. ADAM

Introduction:

Des recherches concernant la pollution des eaux de rivière et des lacs, ainsi que des produits agricoles, ont été faites dans le passé.

Zone(s) étudiée(s):

La zone de surveillance continue et de recherche est le golfe de Saronicos, Egée (Zone VIII). La figure 1 indique la localisation des stations d'échantillonnage A, B, C, et AA.

Matériel et méthodes:

Les trois espèces suivantes ont été analysées: Mullus barbatus, Parapenaeus longirostris et Mytilus galloprovincialis. Les tissus ont été homogénéisés et extraits au n-hexane. Du H_2SO_4 concentré a été ajouté pour purification avant analyse par chromatrographie en phase gazeuse avec détecteur à capture d'électrons Ni 63. L'hydrolyse alcaline a été utilisée dans un but de confirmation et les pics des PCBs ont été quantifiés un par un.

Résultats et leur interprétation:

Le tableau 1, qui montre les valeurs moyennes et les déviations normalisées des PCBs et ΣDDT par espèce et zone, a été préparé d'après les données fournies dans les formulaires de renseignements. Les concentrations extrêmes trouvées dans chaque espèce sont les suivantes:

Mullus barbatus Nombre des échantillons: 23
Nombre des individus: 120

ΣDDT a varié de 8 ug/kg de poids frais avec une valeur extrême de 335 ug/kg de poids frais tandis que les extrêmes des PCB ont varié de 0 à 95 ug/kg de poids frais avec une exception (toujours dans le même échantillon) de 950 ug/kg poids frais.

Parapenaeus longirostris Nombre des échantillons: 15
Nombre des individus: 155

valeurs extrêmes ΣDDT 5-15 ug/kg de poids frais
valeurs extrêmes PCBs: 51-80 ug/kg de poids frais

On peut également faire les observations suivantes:

a) les concentrations les plus élevées de Σ DDT et PCBs ont été trouvées dans la zone AA·

b) les concentrations des PCBs sont plus élevées que celles de $\sum$ DDT.

c) les échantillons dans lesquels on a trouvé de hautes concentrations de polluants ont aussi une haute concentration de matière organique extractible (M.O.E.);

d) pour Mullus barbatus c'est en été qu'on a trouvé les concentrations les plus basses de polluants et de M.O.E.;

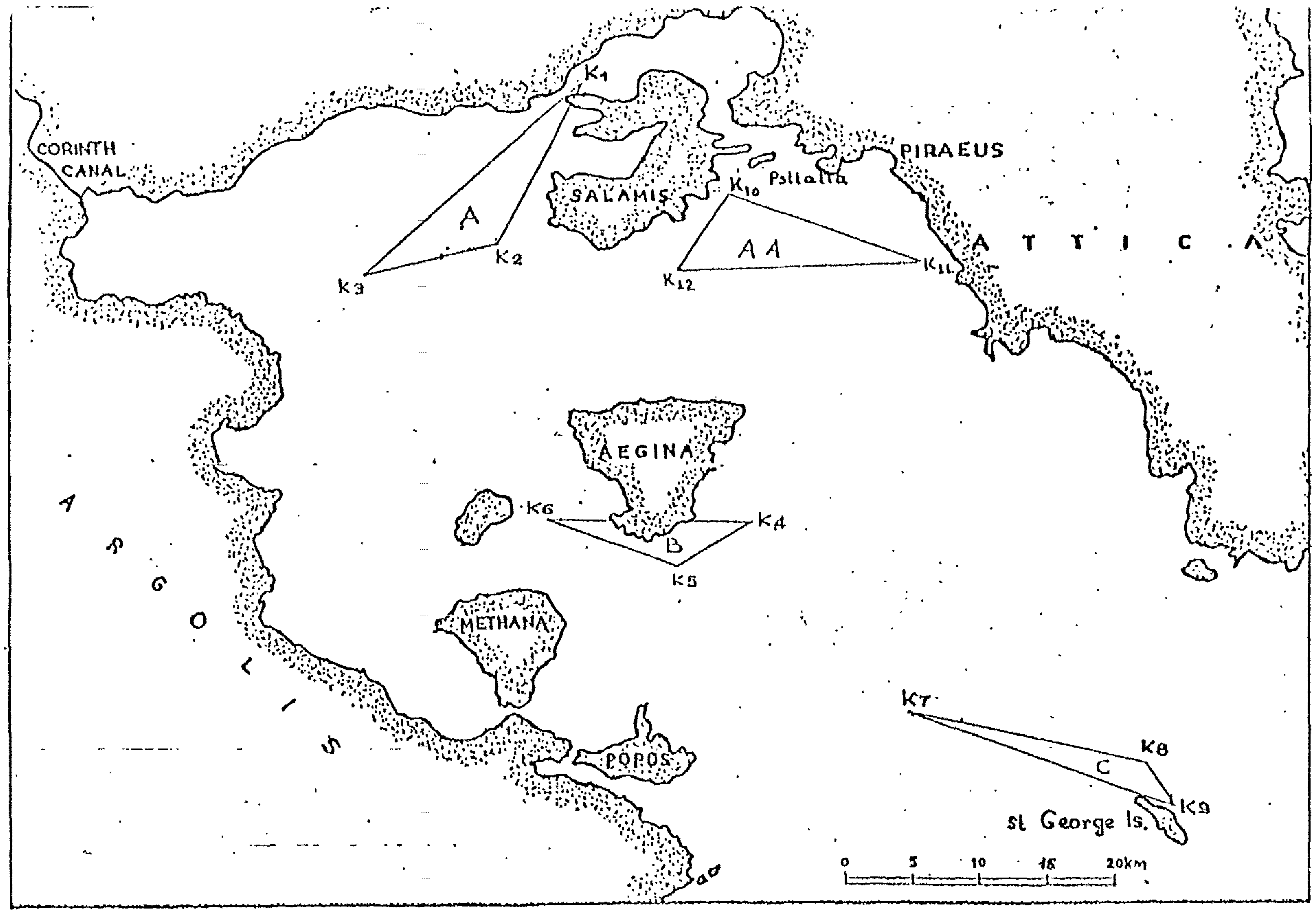
e) pour Parapenaeus longirostris on n'a pas observé de différences significatives entre les zones et les valeurs de 1976 ont été plus élevées que celles de 1977.

Conclusions:

a) En général les résultats des dernières analyses de la période janvier 1976 -janvier 1978 montrent un abaissement des concentrations globales en DDTs ainsi qu'en PCBs. Certainement un nombre plus élevé d'échantillons pourrait amener à des conclusions plus concrètes.

b) D'après les résultats obtenus jusqu'à ce jour, on estime que l'échantillonnage doit être étudié de nouveau pour qu'on puisse mieux suivre et interpréter la pollution.

c) Les résultats sont encourageants pour continuer la surveillance, afin d'avoir une image de la pollution plus proche de la réalité.



K_1 37° 59,5 B / 23° 25,6 A	K_5 37° 39,5 B / 23° 30,75 A	K_9 37° 29,1 B/23° 56,5 A
K_2 37° 53,2 B/ 23° 22,0 A	K_6 37° 41,5 B/ 23° 23,8 A	K_{10} 37° 55,45 B/23° 33,85 A
K_3 37° 51,5 B/ 23° 14,8 A	K_7 37° 33,2 B/ 23° 42,5 A	K_{11} 37° 51,80 B/23° 38,50 A
K_4 37° 41,7 B/ 23° 34,5 A	K_8 37° 31,1 B/ 23° 55,5 A	K_{12} 37° 52,85 B/23° 30,20 A

Fig. 1 Les stations d'échantillonage dans le Golfe de Saronicos

Tableau 1 - Valeurs moyens μg/kg poids frais et déviations normalisées des PCBs et de ΣDDT par espèce et par zone

Zone / Espèce		AA	A	B	C
<u>Mullus barbatus</u>	n	4	4	6	9
	PCBs	288±443	32±13	31±30	44±28
	ΣDDT	119±146	15±6	24±13	46±21
<u>Mytilus galloprovincialis</u>	n	-	6	-	-
	PCBs	-	64±10	-	-
	ΣDDT	-	9±5	-	-
<u>Paraponaeus longirostris</u>	n	2	7	5	1
	PCBs	22.5±3.5	19±17	8.4±7	6
	ΣDDT	4.5±2	5.7±5.4	2±0.8	1

Participating Research Centre: Israel Oceanographic and Limnological Research Ltd. (IOLR),
HAIFA
Israel

Principal Investigator: R. RAVID

Introduction:

No other information, apart from that included in the Log-Forms was provided. As could be observed from these forms, the following species were analysed in S. Levantin research area (Area X):

Mullus barbatus, Saurida undosquamis, Upeneus molusensis, Parapenaeus longirostris, Carcinus mediterraneus, Pagellus erythrinus, Pagellus acarne, Boops boops, Boops salpa, Trachurus trachurus, Trachurus mediterraneus, Maena maena, Sphyraena sphyraena, Diplodus anularis, Merluccius merluccius, and Trigla lucerna.

The ranges of the concentrations of chlorinated hydrocarbons found in various species are shown in table 1 prepared, using the data provided in the Log-Forms.

Species \ Compound	Values in µg/kg of fresh weight				
	ΣDDT	PCBs	ΣBHC	Dieldrin	Aldrin
1. *Mullus barbatus* (37)	2.9 - 82.9	nd - 283.7	nd - 954.6	0 - 5.5	0 - 28.5
2. *Saurida undosquamis* (13	5.1 - 67.9	31 - 1190	nd - 220	0 - 9.9	0 - 19.0
3. *Upeneus mollucensis* (9)	3.1 - 106.1	16.7-800	nd - 332	0 - 1.5	0 - 1.9
4. *Parapaneaus longirostris* (9)	nd - 3.4	nd - 18.6	nd - 125.6	0 - 1.1	0 - 2.2
5. *Pagollus erythrinus* (9)	4.9 - 45.0	41 - 994	nd - 444	0 - 1.3	0 - 22.2
6. *Pagellus acarne* (1)	4.5	63.6	6.0	nd	3.0
7. *Boops boops* (3)	nd - 2.4	18.7-55.3	nd - 8.4	nd	nd
8. *Boops salpa* (2)	0.6 - 21.6	5.9-55	3.8 - 4.8	nd	0.5-1.6
9. *Trachurus trachurus* (1	14.2	59	1.4	nd	nd
10. *Trachurus mediterraneus* (2)	8.1 - 14.1	13.9-90.6	nd - 35.8	nd	nd
11. *Maena maena* (5)	8.9 - 40.1	6.9-253.7	nd - 500	nd - 1.4	0 - 10.2
12. *Carcinus mediterraneus* (9)	1.3 - 8.4	nd - 108.5	1.6 - 270	nd - 9.8	0 - 6.5
13. *Sphyraena sphyraena* (3)	19.2 - 162	79.8-478.4	9.3 - 73.8	nd - 0.9	0.2 - 2.7
14. *Diplodus annularis* (1)	14.4	686.8	88.5	2.7	2.3
15. *Merluccius merluccius* (2)	7.1 - 21.0	23.8-70.3	8.3	nd	nd
16. *Trigla lucerna* (3)	3.9-104.5	62.2-538.9	81 - 510	0 - 3.4	0 - 25.4

Table 1. Ranges of concentrations of chlorinated hydrocarbons in various species. The number in brackets after the name of each species denotes the number of analyses (samples).
ΣDDT = DDE + DDT + DDD   ΣBHC = BHC + Lindane   Zero figures were taken as zero values.

Participating Research Centre: Laboratory of Hydrobiology and Fish Culture,
Institute of Comparative Anatomy
University of Siena
SIENA
Italy

Principal Investigator: A. RENZONI

Introduction:

There was no activity before the present research started.

Area(s) studied:

The monitored area includes two sections of the northern Tyrrhenian Sea (Area II and Area III). The organisms have been collected in six areas of their open waters and in four areas of their rocky shores (see figure 1).

Material and methods:

The material consists of the following species: Mullus barbatus, Mullus surmuletus, Nephrops norvegicus, Engraulis encrasicolus, Mytilus galloprovincialis.

The analytical methods are similar to those reported in FAO, Fisheries Technical Paper, No. 158. Other details are reported below:

Analyses have been performed either with one specimen or with composite samples. Samples were homogenized i.e. a similar amount of material for each specimen of the same size was taken. The material to be analysed (soft part of mussel, or muscle tissue of other animals) has been freeze-dried (residual water 2 - 5 per cent of the dry weight) and ground to powder. Two grams of such material was soxlet-extracted for eight hours with 250 cm^3 of n-hexane (Pestanal). The material was concentrated in a rotary evaporator, for the evaluation of the E.O.M., at a temperature not higher than 50°C. After the adding of sulfuric acod (1.5 cm^3) for cle,anup the hexane extract (10 cm^3) was treated with Florisil. Separation of PCB's from organochlorine insecticides was performed on a silica gel column. For identification of substances two columns were used (DC 200 10 per cent with Gas Chrom Q BW-DMCS 100- 120 mesh and for control QF 1 at 5 per cent with Chromosorb W AW-DMCS 80-100 mesh). Analyses have been completed with a Gas-Chromatograph equipment Perkin- Elmer, Mod. F 22, equipped with ECD (Ni 63). The amount of DDT has been obtained adding the values of pp'DDT, pp.DDD and pp'DDe. PCB's were evaluated in comparing them with the commercial available substances AROCLOR[r] 1254 and 1260 of the Monsantr Company. All data are expressed as ug/kg F.W.

Results and their interpretation:

Data presented in LOG-FORMS and in table 1 indicated that although they have been obtained by analysing only few specimens (for the moment), they already show a trend. The available values do not allow the evaluation of possible sex and age differences but certainly indicate that the contamination of the biota (and evidently also of the sea) around the Archipelago of Toscana in the Tyrrhenian Sea (Central) is relatively high in coastal areas and in a lower degree in the open waters (Compare data on Norwegian lobsters and red mullet in table 1).

A careful evaluation of these preliminary results also shows that a certain difference of contaminant concentration in the various organisms analysed occurs between animals collected in the northern section of the area and those collected in the southern portion.

The results obtained for PCB's seem to be in agreement with what has been foreseen by the research centre at the beginning of the project due to higher density of the industry in the northern part of the area. The recorded DDT concentrations, although they are not much higher with respect to other Mediterranean areas were not expected.

Table 1

Species	Station / Season of 1978	E.O.M.	PCB	DDE	DDD	DDT
Engraulis encrasicolus	T_1 Summer	1.77	470	59.5	22.2	59.7
	T_2 Summer	1.73	217	39.2	20.7	30.5
	Fall	1.90	110	26.5	14.0	26.5
	T_3 Fall	1.30	40	8	2	5
Mytilus galloprovincialis	M_3 Spring	0.92	420	17	16	17
	Fall	0.80	260	12	5	11
	M_4 Spring	0.96	32	6	4	6
	Fall	0.81	26	5	1	7
	M_1 Spring	0.81	80	8	8	6
	Summer	1.01	230	26	16	21
	Fall	0.81	193	23	18	21
	Winter	0.86	180	21	13	32
	M_2 Spring	0.88	60	3	5	9
	Fall	0.94	70	4	2	5
	Winter	0.81	50	2	1	1
Nephrops norvegicus	S_1 Spring	0.43	16.6	2.8	<1	1
	Summer	0.50	20.0	3	<1	<1
	Fall	0.35	28.7	5.5	<1	2.0
	S_3 Spring	0.30	27.0	3.0	<1	4.0
	Summer	0.40	16.7	2.6	<1	<1
	Fall	0.40	42.5	5.8	1.4	2.8
	Winter	0.26	220.0	5.2	1.0	2.9

Table 1 (cont.)

Species	Station / Season of 1978	Sex	E.O.M.	PCB	DDE	DDD	DDT
Mullus surmuletus	S_1 Spring	M	1.97	86	11.8	1.7	6.0
	Spring	F	1.90	90	9.5	2.0	5.5
Mullus barbatus	T_3 Spring	M	1.6	160	27	6	12
	Summer		2.1	100	19	2	12
	Fall		1.7	170	56	20	49
	Spring	F	1.4	230	35.0	6.1	25.0
	Summer		1.7	80	11.5	1.5	6.5
	Fall		1.9	90	21.1	7.0	22.0
	T_2 Summer	M	1.74	405	51.3	7.9	22.4
	Fall		2.18	190	30.0	9.0	25.0
	Winter		1.57	3087	75.2	53.2	74.5
	Summer	F	1.83	267.7	327	6.0	12.1
	Fall		2.05	70.0	29.0	6.0	25.2
	Winter		1.38	419.0	19.1	7.9	23.0
	T_1 Spring	M	1.92	350	22	7.6	18.6
	Summer		1.78	1291	48	70.0	141.4
	Fall		1.60	160	24	12.0	24.0
	Spring	F	2.0	1500	31	42	50
	Summer		1.6	280	19	9	25
	Fall		1.8	85	12	5	14

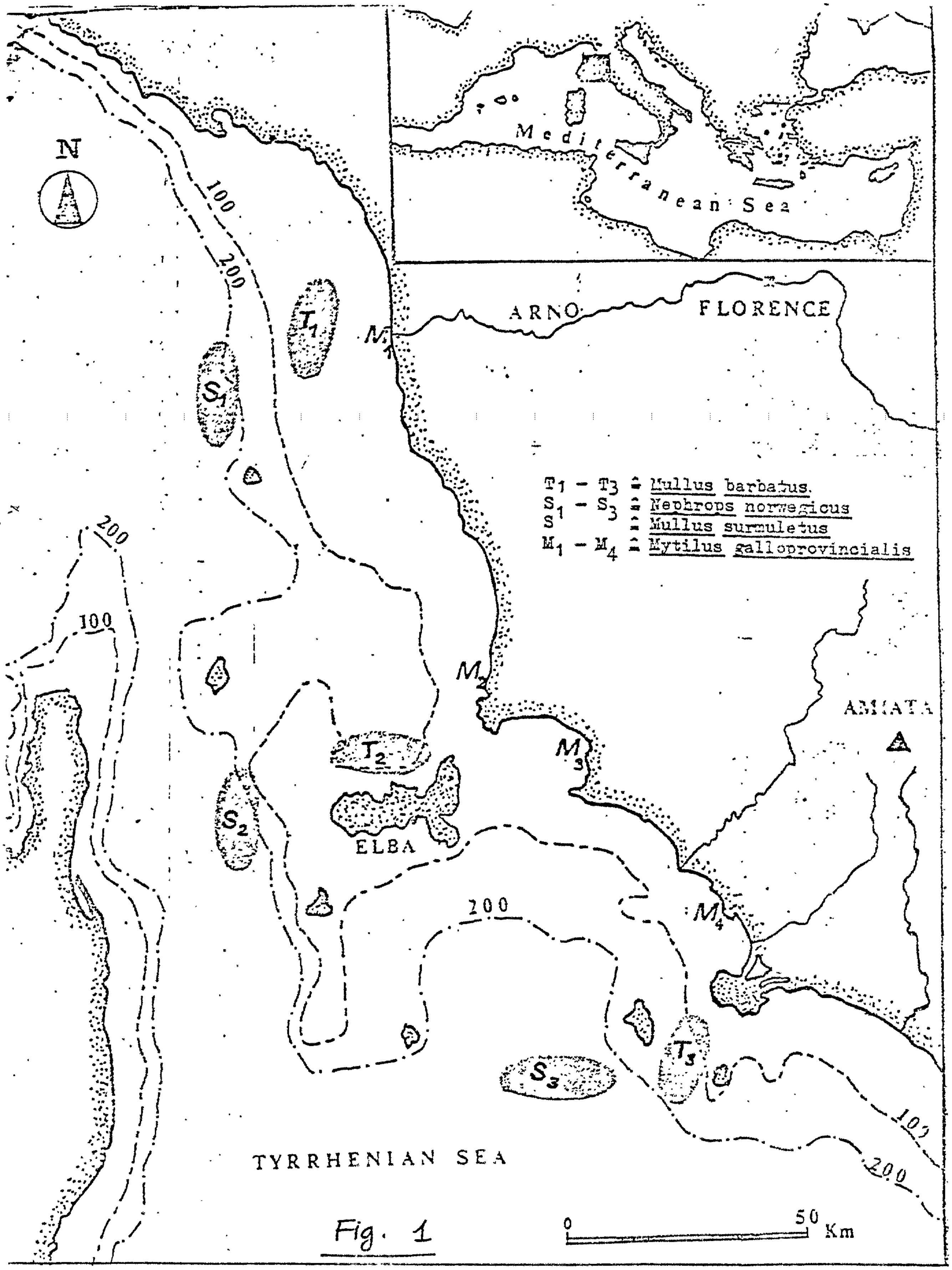

N
Mediterranean Sea
ARNO
FLORENCE
100
200
T1
S1
M1
T1 – T3 ≙ Mullus barbatus.
S1 – S3 ≙ Nephrops norwegicus
S ≙ Mullus surmuletus
M1 – M4 ≙ Mytilus galloprovincialis
M2
M3
M4
T2
S2
ELBA
T3
S3
AMIATA
TYRRHENIAN SEA
0
50 Km

Fig. 1

Participating Research Centre: Institute of Marine Biology - CNR, VENICE Italy

Principal Investigator: V.U. FOSSATO

Introduction:

As from 1972 the Institute has had a laboratory equipped for gas chromatographic analysis of organic pollution in marine waters and organisms. At first, field and laboratory experiments were carried out to study the uptake and loss of petroleum hydrocarbons by mussels; subsequently, a systematic survey on levels of oil pollution in the Lagoon of Venice using the mussels as a biological tool was then undertaken and is now completed. In the second half of 1975 the activities were extended to include the analysis of chlorinated hydrocarbons in organisms collected from the Lagoon of Venice and the Adriatic Sea (from Trieste to Ancona) in the framework of the pilot project (MED POL III) and the national programme for monitoring of chlorinated hydrocarbons in edible marine organisms.

Area(s) studied:

Two sampling areas were chosen in the Adriatic Sea far from direct pollution sources: the first, shown in figure 1, is located in the Gulf of Venice (upper Adriatic); the second, shown in figure 2, is located in the central Adriatic Sea near Ancona (Area V).

In the Gulf of Venice the annual variation of temperature, related to the shallow water, is on the average, 8.8°C to 28.3°C. The salinity, which varies between 29.8 ‰ and 38.2 ‰, is influenced by the thermal stratification and the rivers' inflow. Mussels (Mytilus galloprovincialis) and crabs (Carcinus mediterraneus) are present in this area throughout the year, while mullets (Mullus barbatus) are absent in the cool season.

The second sampling area was selected about twelve miles south-east of Ancona and three miles from the coast, where an artificial park has already been situated for some years. Although this area is far from industrial and river inflows, it is influenced by a current descending along the Italian coast, which receives and dilutes the fresh waters from the Northern Italy. Some samples from La Spezia were also analysed (Area II).

Material and methods:

The samples collected for analyses were Mytilus galloprovincialis, Mullus barbatus and Carcinus mediterraneus.

Sample preparation was done according to the procedures recommended in the FAO, Fisheries Technical Paper No. 158.

Extraction of the chlorinated hydrocarbons was accomplished by refluxing an aliquot of the freeze-dried sample in a Soxhlet apparatus for eight hours with n-hexane. The solvent was removed by evaporation under vacuum and the extractible organic matter (EOM) was weighed. Coextracted substances were removed using the general method of partitioning between n-hexane and acetonitrile, then PCBs were separated from DDT and its metabolites (DDD and DDE) by chromatography on silica gel column, according to the procedure of Snyder and Reinert, Bull.Environ.Contam. Toxicol. 6 (1971): 385-390.

Quantitative analysis was done using a 5750 Hewlett-Packard gas chromatograph, equipped with a Ni 63 electron capture detector. Details on the analytical method are given by Fossato and Craboledda, Arch.Oceanogr.Limn. 19 (in press).

Results and their interpretation:

Chlorinated hydrocarbon values reported (table 1) are for analyses of organisms sampled between June 1976 and June 1978. Results indicate that PCB residues predominate at all stations regardless of season. The PCB Arocolor 1260 was not reported in Mytilus samples, being only a small percentage of total PCB, but it was present in significant quantities in other specimens. Aroclor 1260 and 1254 were present in approximately equal amounts in Mytilus, while in Carcinus the ratio was about 1 : 2.5. Of the three fractions of DDT, DDD was usually the smallest one. With notable exceptions, DDT was the major fraction in Mytilus and Mullus, while its metabolite DDE was usually more abundant in Carcinus.

In all samples, measurable amount of BHC (α, β and γ isomers) were determined, while aldrin and dieldrin were present in minor quantities or in traces.

On the basis of the whole data, it seems that the amounts of organochlorine compounds accumulated by the specimens analysed were related to their lipid content; for instance, the following series of increasing levels of chlorinated hydrocarbons (Carcinus <Mytilus <Mullus) reflect the increasing lipid (EOM) content of three specimens, and indeed a moderately significant correlation (r = 0.53 - 0.72) was observed between the concentrations of lipids and PCBs in Mullus and Carcinus. However, there was no evidence for such relationship with BHC and DDT and conflicting results were obtained for Mytilus.

Samples of Sardina pilchardus and Engraulis encrasicolus from the Gulf of La Spezia have also been analysed, and showed values comparable to those found in Mullus barbatus from the same area, although their lipid content was about half of Mullus. Evidently also the food and the physiology of various organisms highly influence their accumulation capability.

Conclusions:

In order to place the findings of this survey in proper perspective, it should be pointed out that the sampling stations were located in coastal waters far from polluted areas (lagoons, ports, river mouths, industrial areas) to obtain results which could be used to characterize the levels of pollutants in the open sea. In the Adriatic Sea no significant differences were observed between levels of chlorinated hydrocarbons in organisms collected offshore Venice and Ancona: however, in the framework of the national programme for monitoring of chlorinated hydrocarbons in marine organisms, higher concentrations were determined in mussels collected inside the Lagoon of Venice (Fossato & Craboledda 1978) and near the mouths of Adige and Po rivers (Fossato & Craboledda 1979).

The concentration of organochlorine compounds determined in specimens sampled in the Gulf of La Spezia were also much higher than those collected offshore Venice and Ancona. These findings are in agreement with previous data on levels of DDT and PCBs in some organisms from the northwestern Mediterranean coast and with the preliminary results obtained in the framework of the national programme (P.F. Oceanography, Sub-project: Marine Pollution 1978).

List of publications:

FOSSATO, V.U. and CRABOLEDDA, L. (1978). Chlorinated hydrocarbons in mussels Mytilus sp, from the Laguna Veneta. Archo.Oceanogr.Limnol. 19 (in press).

________, (1979). Idrocarburi clorurati (BHC, DDT, PCB) in organismi marini campionati nell'Adriatico centro-settentrionale fra giugno 1976 e giugno 1978. Convegno scientifico nazionale del progetto finalizzato oceanografia e fondi marini, CNR, Roma, 5-7 March 1979 (in press).

P.F. OCEANOGRAPHIE, sub-project: Pollution marine, CNR: Monitorage de l' etat de la pollution marine le long des cotes italiennes avec l'emploi des indicateurs biologiques. XXVIe Congres Assemblee pleniere de la CIESM, Antalya, 24 novembre - 2 decembre 1978 (in press).

	Samples No.	wet weight / dry weight	EOM % wet wt	Σ BHC	Σ DDT	Σ PCB
Mytilus galloprovincialis						
Venice	9	5.76 ± 0.30	1.73 ± 0.18	1.3 ± 0.3	12.9 ± 1.8	43 ± 5
Ancona	9	5.29 ± 0.21	1.97 ± 0.16	1.7 ± 0.5	20.4 ± 2.1	65 ± 9
La Spezia	5	5.75 ± 0.65	1.75 ± 0.25	1.0 ± 0.2	21.1 ± 6.2	120 ±48
Mullus barbatus						
Venice	5	3.74 ± 0.17	6.58 ± 0.98	5.5 ± 1.0	26.4 ± 3.3	136 ± 20
Ancona	10	4.16 ± 0.17	4.60 ± 0.79	3.7 ± 0.8	44.1 ± 7.3	131 ± 18
La Spezia	7	4.07 ± 0.24	4.64 ± 1.10	1.9 ± 0.6	81.4 ±26.1	665 ± 409
Carcinus mediterraneus						
Venice	8	4.51 ± 0.26	0.36 ± 0.05	0.8 ± 0.2	6.1 ± 1.4	75 ± 15
Ancona	7	4.62 ± 0.23	0.36 ± 0.03	0.7 ± 0.2	6.6 ± 2.3	[illegible] ± 14

Table 1. Chlorinated hydrocarbons content (means ± SD, µg/kg wet weight) of some marine organisms collected near Venice, Ancona and La Spezia from June 1976 to June 1978.

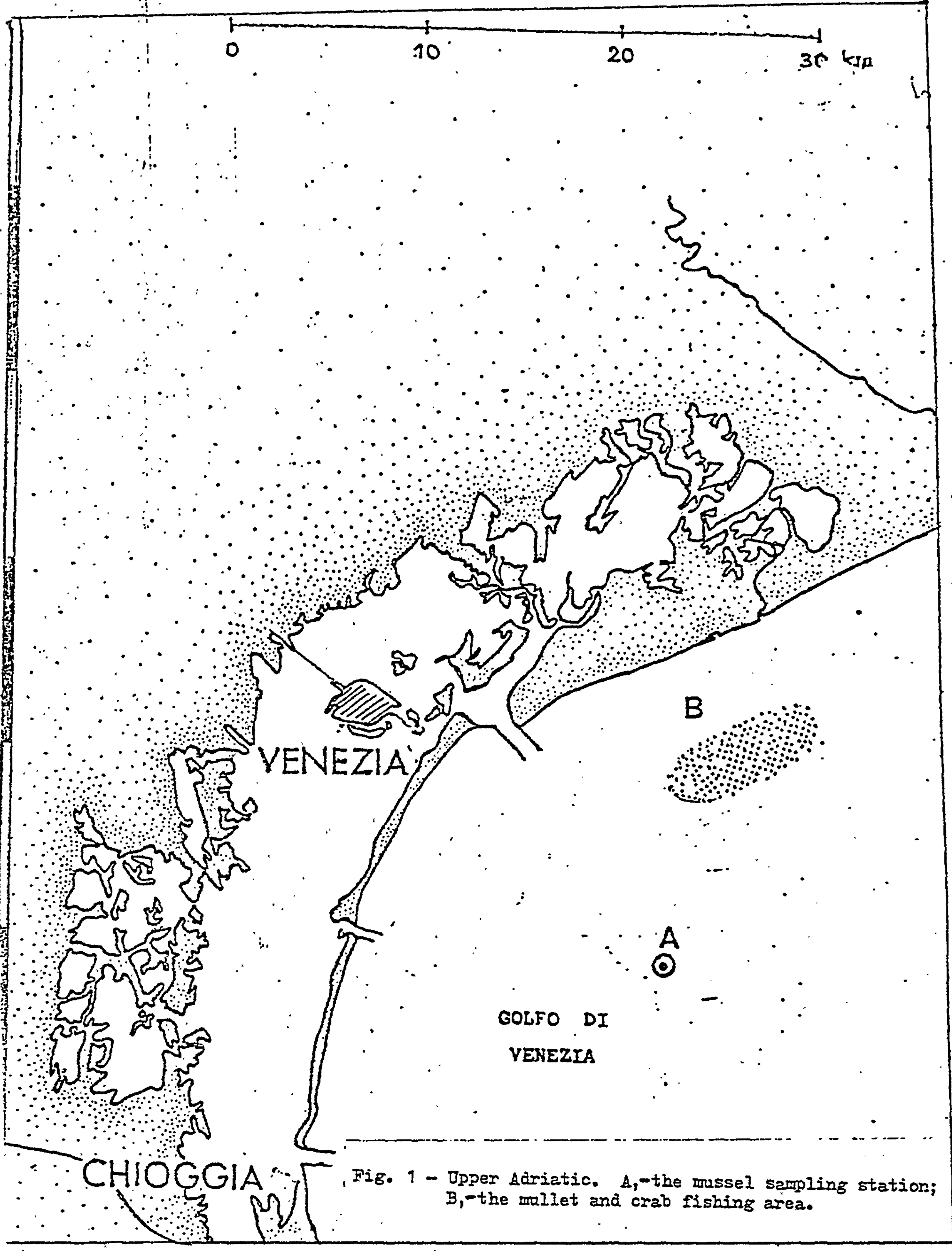


Fig. 1 - Upper Adriatic. A,-the mussel sampling station; B,-the mullet and crab fishing area.

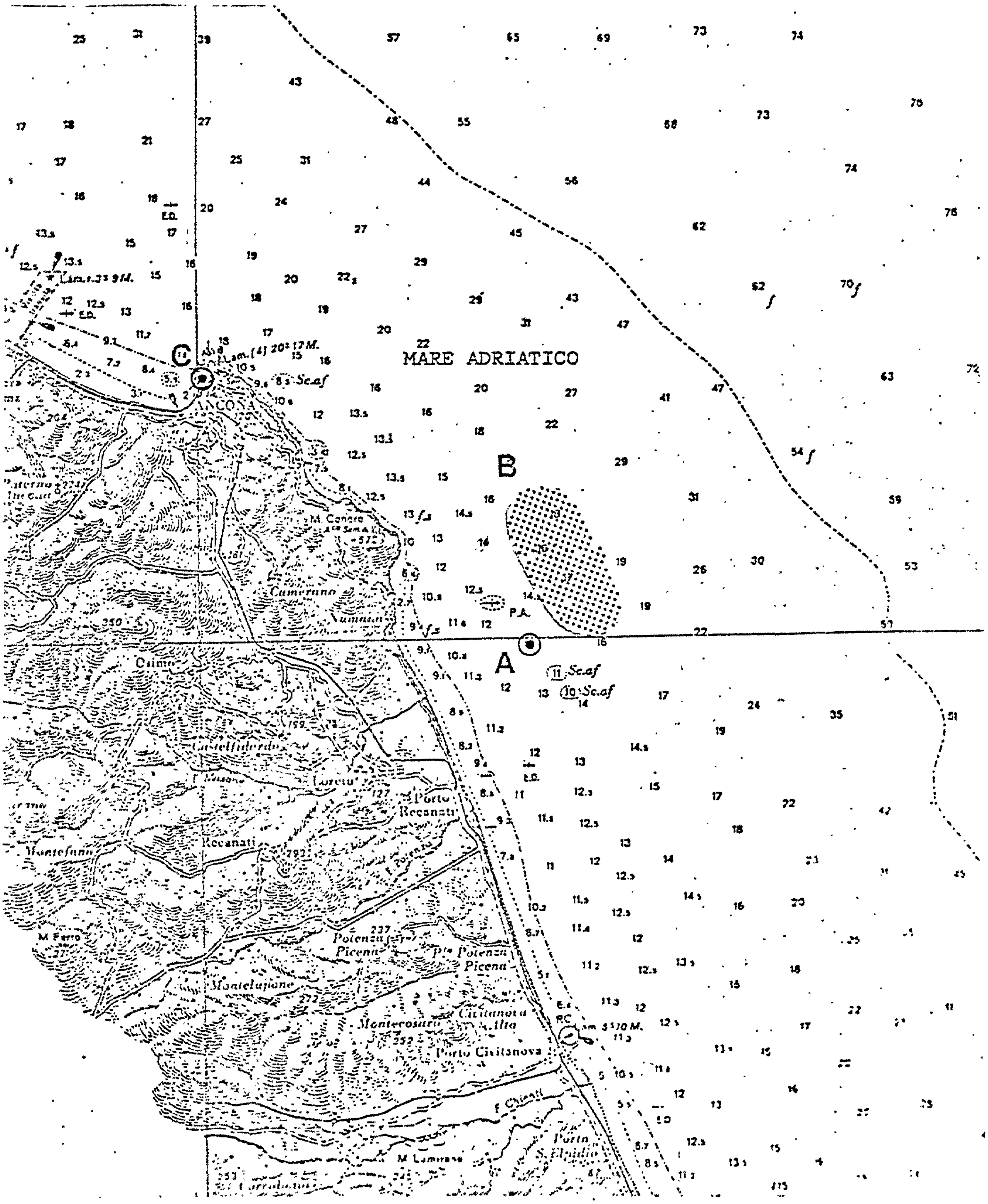


Fig. 2. [illegible] Adriatic. A, the mussel sampling station; B, the mullet fishing area; C, the crab sampling station.

Participating Research Centre: Marine Research Cenre, National Council for Scientific Research, BEIRUT Lebanon

Principal Investigator: H.H. KOUYOUMIJIAN

Introduction:

A Varian gas chromatograph was delivered to the Institute in June 1978 but due to the political situation in the country its installation was delayed.

In the meantime samples of Mullus barbatus, Penaeus kerathurus and Patella coerulea are being collected from the Tripoli and Jounieh fishing zones.

Participating Research Centre: The Old University
MSIDA
Malta

Principal Investigator: J.V. BANNISTER

The requested Summary Report has not been received.

Centre de Recherche participant: Institut Scientifique des pêches maritimes,
CASABLANCA
Maroc

Chercheur principal: H. IDRISSI

Introduction:

Les échantillons de Mullus barbatus, Mytilus galloprovincialis, Mytilus edulis et Parapenaeus longirostris ont été récoltés dans la mer Alboran (Zone I) et dans l'Atlantique (Zone XI) et conservés sous congélation en l'attente de leur analyse. Comme l'Institut n'a pas pu acheter le chromatographe en phase gazeuse qu'il avait prévu, le PNUE et la FAO ont décidé de le lui fournir.

Participating Research Centre: Instituto de Investigaciones Pesqueras, BARCELONA Spain

Principal Investigator: J.M. FRANCO (From July 1976 to February 1978) A. BALLESTER (From February 1978)

Introduction:

There is no information about the previous work of the Institute in this field.

Area(s) studied:

For the pilot project the species Mullus barbatus, Mytilus edulis, Carcinus mediterraneus and Sardina pilchardus were collected from the vicinity of Barcelona and Castellon, North-western (Area II), figure 1, throughout the year 1976. No data is available for the period 1977. Mytilus edulis and Pagellus bogaraveus were the only two species collected between April and September 1978.

Material and methods:

The samples were homogenized with blender and then soxhlet extraction applied according to FAO, Fisheries Technical Paper No.158. For clean-up purposes the destructive method (FAO, Fisheries Technical Paper No.137) was used. The gas chromatographic determination was carried out on a 1.82 m long (4 mm o.d.) column packed with 10 per cent DC-200 on Gas-Chrom Q (80-100 mesh size). The detector was EDC type, where the electrons' source was Ni-63 foil.

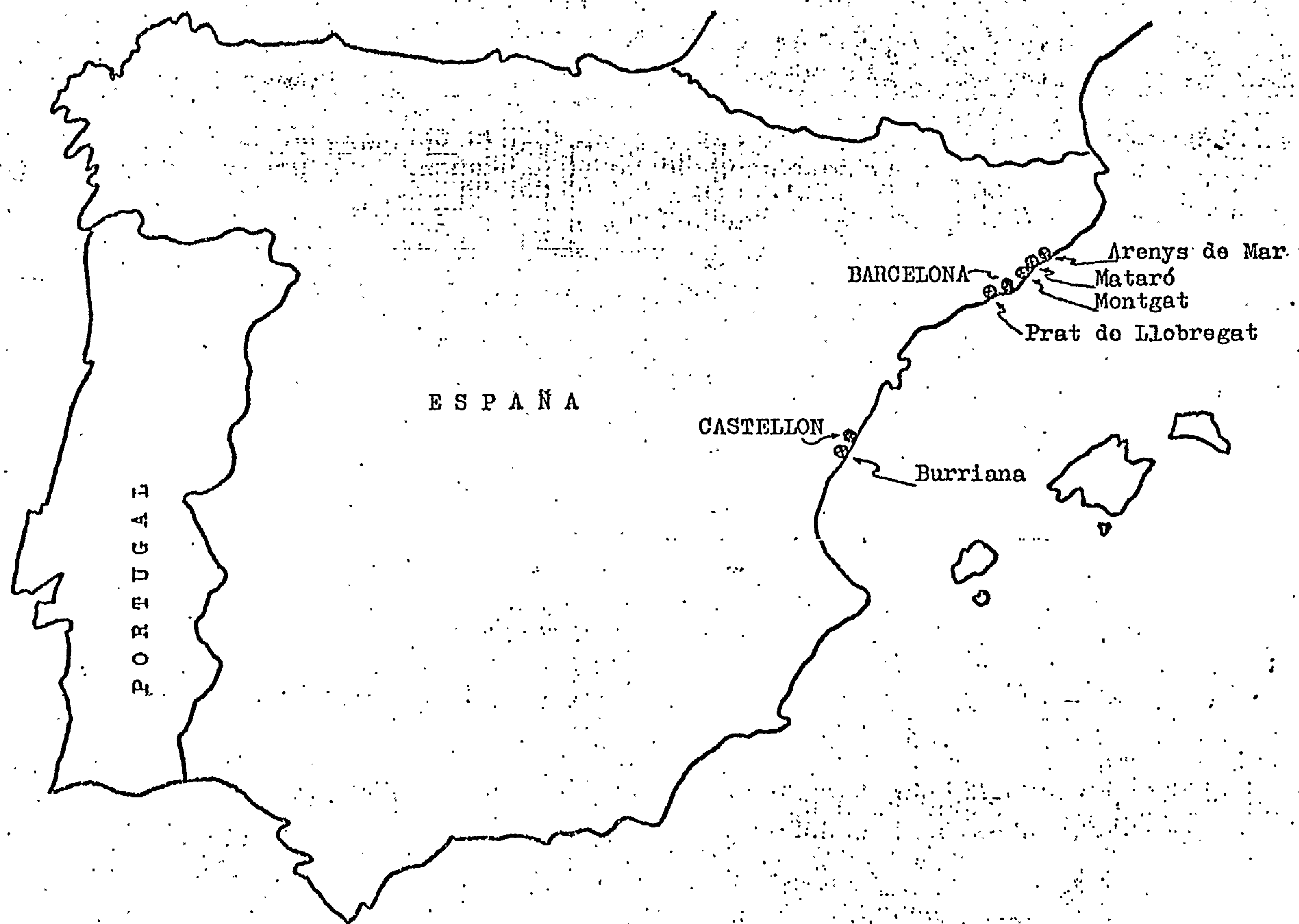
Results and their interpretation:

Acoding to the data submitted the residues looked for were DDT, DDD, DDE, and PCBs and the results are as follows:

Species	Area	Number	Number	Tissue	Concentrations of	
Mullus barbatus	Castellon	48	5	Muscle	55 - 156	170 - 710
	Barcelona	24	3	Fillet	183.4 - 690	660 2250
Mytilus edulis	Barcelona	n.d.	n.d.	n.d.	53.9 - 297.2	182.7 - 422.7
	Castellon	n.d.	n.d.	n.d.	2.2 - 177	68 - 670
Carcinus mediter-rancus	Barcelona	16	2	n.d.	117.9 - 137.5	960 - 1250
	Castellon	57	5	n.d.	40.4 116	1130 - 1513
Sardina pichardus	Barcelona	28	3	Fillet	510 - 560	880 - 1600
	Castellon	54	5	Fillet	164 - 880	519 - 1280
Pagellus bogareveo	Castellon	n.d.	n.d.	n.d.	148.5 - 138.5	

Conclusions:

Relatively high concentration of chlorinated hydrocarbons was found both in waters of sampling areas and in all analysed species.



<u>Fig. 1</u> Sampling areas near Barcelona and Castellon

Centre de Recherhce Participant: Institut National Scientifique et Technique d'Oceanographie et de peche (INSTOP), SALAMMBO Tunisie

Chercheur principal: H.A. SALEM

Introduction:

L'Institut a acheté un chromatographe en phase gazeuse sur fonds gouvernementaux ainsi qu'il a été rapporté en mai 1979 et les analyses commenceront aussitôt que possible.

Participating Research Centre: Hydrobiological Research Institute,
Faculty of Science,
University of Istanbul
ISTANBUL
Turkey

Principal Investigator: I. ARTUZ

Introduction:

Sampling started in June 1977 from the North Aegean (Area VIII), the Sea of Marmara and partly from the Bosporus (Area XII).

From the Log-Forms provided it was found that the following species were sampled: Carcinus mediterraneus, Parapenaeus longirostris, Mytilus galloprovincialis, Merluccius merluccius, Mullus barbatus, Pagellus erythrinus, Pomatomus saltator, Maena smaris, Trachurus mediterraneus and Diplodus sargus.

The samples were prepared following the procedure recommended in the FAO, Fisheries Technical Paper No. 158.

The compounds analysed were aldrin, DDT, DDE, DDD and dieldrin and the PCBs were not reported. As the Log-Forms were not completed properly it was not possible to analyse the results fully. However, it could be seen that aldrin values varied from 0 to 116 ug/kg F.W., DDT from 8 to 22 ug/kg F.W., DDE from 18 to 82 ug/kg F.W., DDD from 2 to 120 ug/kg F.W., and dieldrin from 5 to 96 ug/kg F.W.

Participating Research Centre: Middle East Technical University,
Marine Science Department
ERDEMLI-ICEL,
Turkey

Principal Investigator: I. SALIHOGLU

Introduction:

Previous experience of this type of work is not reported.

Area(s) studied:

Monitoring and research area: N. Levantin (Area IX).

Sampling locations are shown in figure 1.

There is not much available information on the chemistry and biology of the area. The ranges of sea water temperature and salinity in the area were from 16.5 to 29°C and from 37.8 to 39.2 $^{\circ}/_{oo}$ respectively. Thermal stratification was found during the summer months. Nutrient content and consequently productivity are quite low.

Many industrial complexes exist in the Mersin area as well as a big busy harbour. Inland, agriculture activities consume a large quantity of insecticides and pesticides.

Material and methods:

The selection of some species was made according to the pilot project document. These species were Mullus barbatus, Mullus surmuletus and Upeneus mollucensis (Mullidae). The other two species studied were Parapenaeus longirostris and Carcinus mediterraneus. Among the selected species Mugil auratus, Penaeus kerathurus and Lithophaga lithophaga, which are the alternative species of Mullus barbatus, Parapenaeus longirostris, and Mytilus galloprovincialis respectively, were also included. Boops salpa, Callinectes sapidus and Patella coerulea were also studied since they have high commercial value in the area.

The sampling and preservation of the specimens, sample preparation and analysis of samples were done according to the recommendations given in FAO, Fisheries Technical Paper No.158. However, some of the samples were analysed with the "Cold-acetic acid-perchloric and acid digestion", and "Sulfuric acid clean-up" methods.

Results and their interpretation:

A summary of the results is given in table 1. PCBs values are not given for all samples. As can be seen, the highest concentrations of ΣDDT appear in Mugil saliens and Mullus barbatus.

An attempt was made (figure 2) to correlate Σ DDT with the length of the species and a good correlation (within experimental error) was found only for Mugil auratus and Callinectes sapidus.

Primary analysis of the data showed no significant season or area variation within a single species (except PCB content of Patella coerulea).

The Σ DDT values for Mullus barbatus are comparable to those found by Satsmadjis and Gabrielides, Thalassographica 1, 151 (1972) and by Mestres, FAO/GFCM Circ. No.7, but those for Mugil auratus and Mugil saliens are, on the average, half of those reported by Relevante & Gilmartin, Inv.Pesq. 39, 491 (1975) for the North Adriatic.

PCBs, aldrin, BHC, dieldrin, heptachlor and heptachlor epoxide were found in minimal concentrations in all samples.

Conclusions:

Σ DDT was found to be the predominant chlorinated hydrocarbon.

List of publications:

SUNAY, M. et al., (1978) Determination and distribution of organochlrine residues and heavy metals in tar balls, XXVI Congress and Plenary Assembly, C.I.E.S.M. Antalya.

BALKAS, T.I. et al. Trace metals and organochlorine residue content of Mullidae family fishes and sediments in the vicinity of Erdemli (Icel), Turkey.

Species	(n)	ΣDDT			PCBs		
		Max.	Min.	Mean	Max.	Min.	Mean
Mullus barbatus	17	251	2	105	52	T	9
Mugil saliens	12	237	T	130	77	T	17
Upeneus mollucensis	2	86	44	67	-	-	-
Mugil auratus	5	72	20	37	-	-	-
Peraeus kerathurus	10	65	25	41	-	-	-
Carcinus mediterraneus	7	58	1	30	-	-	-
Mullus surmuletus	2	34	21	27	-	-	-
Callinectes sapidus	2	22	5	13	-	-	-
Parapenaeus longirostris	4	17	3	10	3	T	2

Table 1 - Minimum, maximum and mean values of ΣDDT and PCBs analysed in different species and presented in µg/kg F.W.

DDT values are shown in decreasing order of accumulation
(T = in traces)

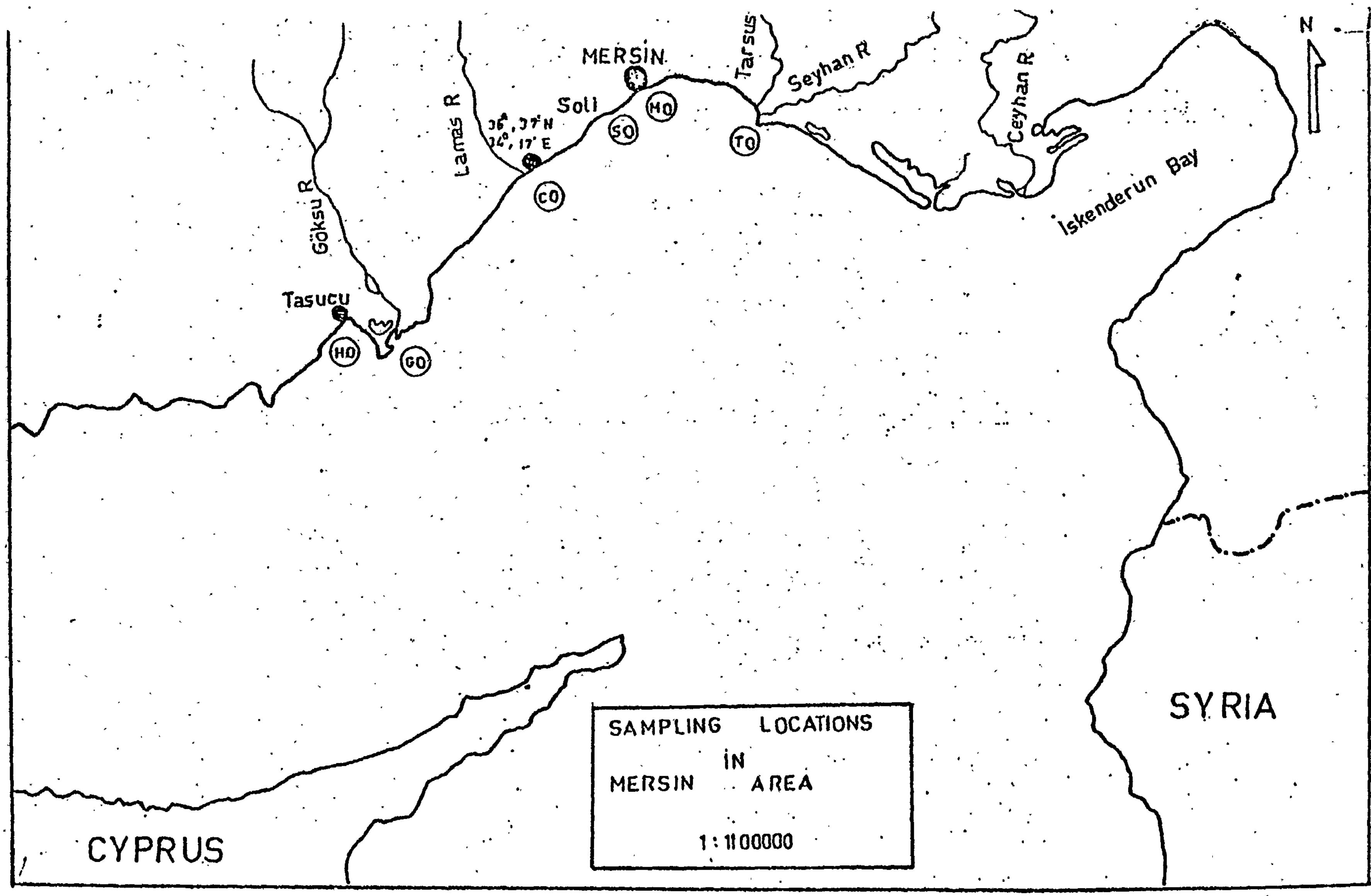


Figure 1 Sampling locations in Mersin area

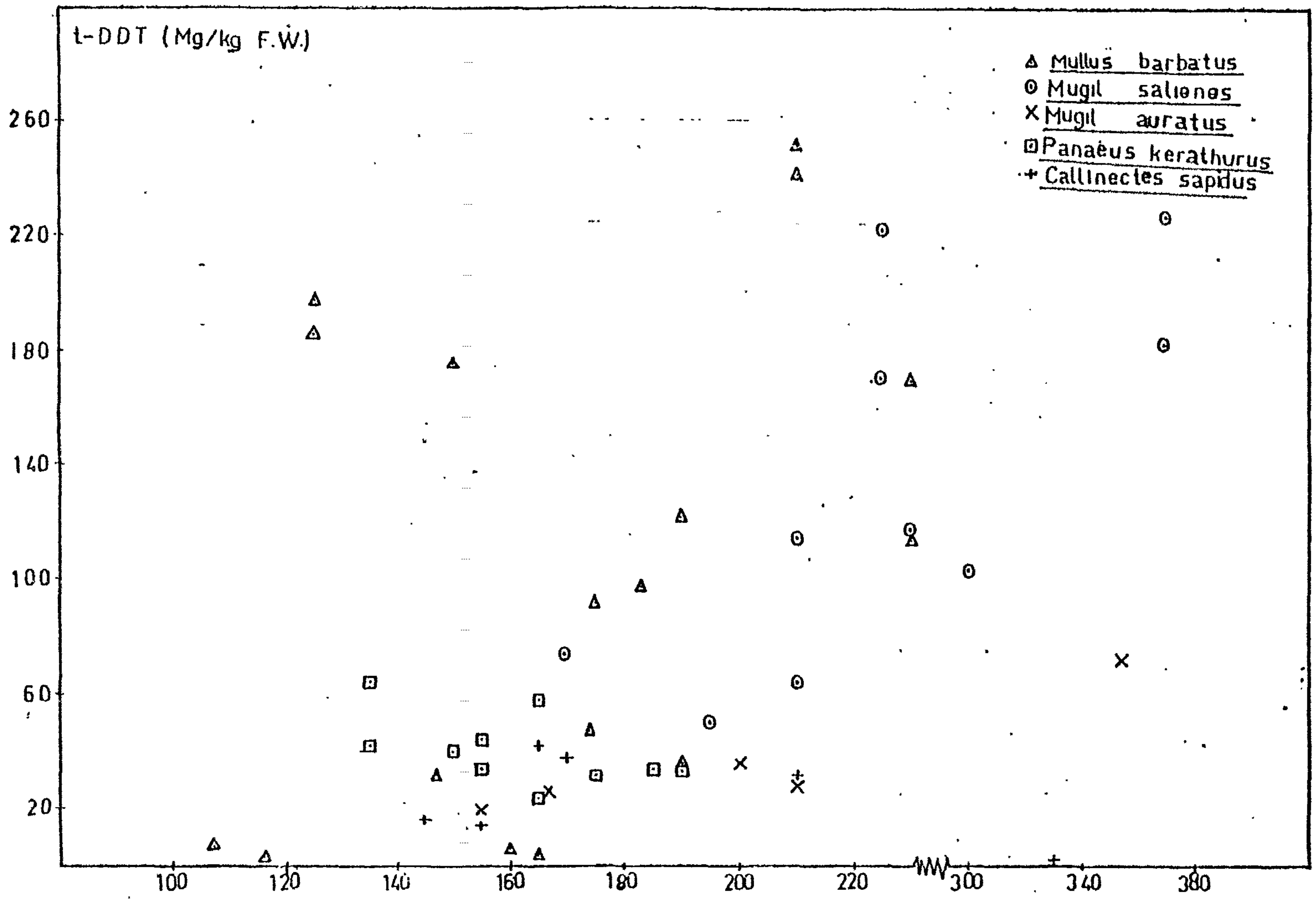


Figure 2 Total DDT-concentrations (mg/kg fresh weight) in various species

Participating Research Centre: Institute for Oceanography and Fisheries,
SPLIT
Yugoslavia

Principal Investigator: T. VUCETIC

Introduction:

The Institute is taking part in this pilot project to contribute to a better understanding of the pollutant concentrations in the marine biota of the area which was never investigated before.

Area(s) studied:

Monitoring and research area is East Central Adriatic (Area V) and sampling stations are located in three important industrial and agricultural areas, namely Zadar, Split and Ploce (figure 1) with a reference station in the open sea (Blitvenica).

Material and methods:

Sampling started in March 1979 and usually included Mullus barbatus, Mytilus galloprovincialis, Portunus depurator, Pachygrapsus marmoratus, Xantho hydrophilus, Carcinus maenas (mediterraneus), zooplankton and sediments, but Portunus, Pachygrapsus and Xantho were not always available.

The samples were prepared as described in FAO, Fisheries Technical Paper No. 158. The analytical procedure included homogenisation, extraction with petrolether, filtration through a column of anhydrous Na_2SO_4 and clean-up on an alumina column. PCBs were separated from the organochlorine insecticides using a minature silica gel column. In the EC chromatograph analysis, mirex was used an an internal standard.

Results and their interpretation:

Results are provided for Mullus barbatus, Mytilus galloprovincialis, Carcinus maenas and zooplankton.

The ranges of Σ DDT, PCBs and dieldrin shown below are for the above species and for all areas together:

	Mullus barbatus	Mytilus galloprovincialis	Carcinus mediterraneus	Zooplankton
Σ DDT	0.5 - 50.0	4.9 - 31.2	0.5 - 18.3	0.5 - 4.4
PCBs	1.0 - 497.0	6.0 - 179.0	1.0 - 340.0	6.4 - 25.8
Dieldrin	0 - 3.1	0 - 2.2	0.1 - 1.7	0.1

In table 1 are presented the mean values of the above chlorinated hydrocarbons by species and by area. From this table the following observations can be made:

Zadar area (A^1) - In Mytilus high PCBs values were observed but rather low DDT concentrations. DDT in Mullus was higher than in Mytilus but the reverse is true of PCBs.

Split area (A^2) - The highest values of Σ DDT and PCBs were observed in Mullus and the lowest in Zooplankton.

Ploce area (A^3) - Samples collected near the delta of Neretva river presented higher concentrations than those collected from the SE coast of the Hvar island.

Blitvenica (A^4) - reference area - The concentrations of Σ DDT, PCBs and dieldrin in Mullus barbatus were not the lowest as one would expect and this might probably be attributed to contamination during sampling as the specimens were taken from commercial catches.

Conclusions:

The average values of all the data from the Central Adriatic (East Coast) seem to be among the lowest in the Mediterranean Sea.

Mullus barbatus (fillet)
Total No. of analyses: 22

	Area	Dieldrin	≤DDT	PCBs
A_1	Zadar	0,43	20,0	51,9
A_2	Splitska vrata	0,8	16,9	81,8
A_2	Kaštela bay	1,6	33,6	257,6
A_3	O. Hvar Sucúraj	0,15	5,5	6,4
A_3	Ploče	1,2	18,7	112,8
A_4	Blitvenica	1,3	19,4	59,5

Mytilus galloprovincialis (soft part)
Total No. of analyses: 13

	Area	Dieldrin	≤DDT	PCBs
A_1	Biograd	0,5	7,8	93,0
A_2	Kaštela bay	0,8	13,5	58,1
A_3	Sućuraj	0,25	21,5	69,9
A_3	Veliki Ston	0,5	7,3	6,9

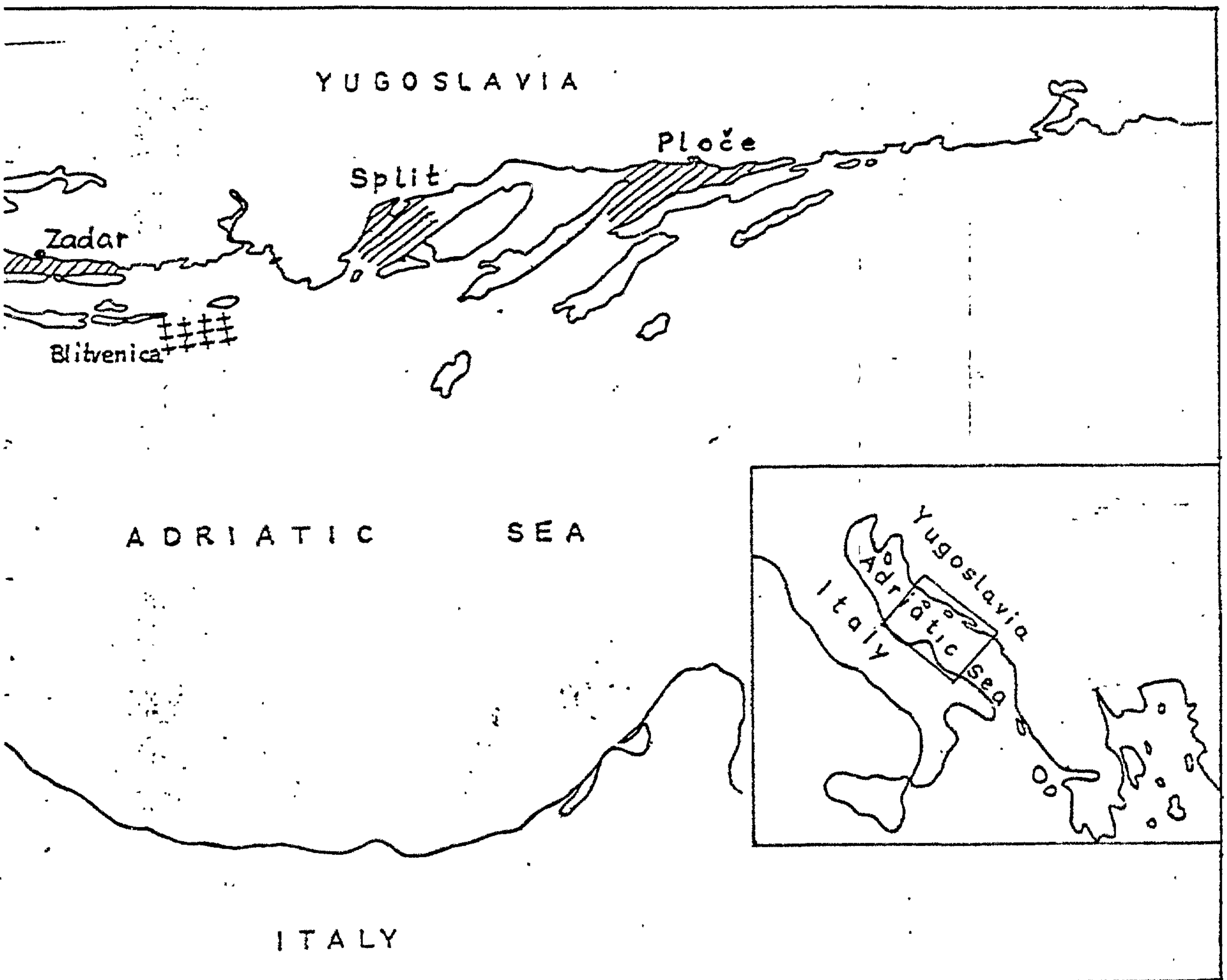
Carcinus maenas (pincer)
Total No. of analyses: 4

	Area	Dieldrin	≤DDT	PCBs
A_2	Split	0,8	6,2	170,4

Zooplankton (total)
Total No. of analyses: 5

	Area	Dieldrin	≤DDT	PCBs
A_2	Split	0,1	2,2	14,0

Table 1. Mean values of ≤DDT, PCBs and dieldrin by species and by area. Concentration in µg/kg, wet weight (F.W.)



Name and characteristic of area: 1. Zadar, 2. Split, 3. Ploče } neritic ////// ; 4. Blitvenica - open sea ‡‡‡‡

Fig. 1 Sampling sites in the Middle Adriatic (Area V)

Participating Research Centre: The Biological Institute
DUBROVNIK
Yugoslavia

Principal Investigator: D. VILICIC

Introduction:

The monitoring of chlorinated hydrocarbons relevant to MED POL programme in South Adriatic coastal waters started in September 1976.

Area(s) studied:

The samples were taken from three areas, (figure 1), i.e. at the mouth of the Neretva river (highly productive lowland covered by orchards, vegetables and flowers), in the Mali Ston Bay (the end of the Neretva channel with oyster and mussel beds), and near the town of Dubrovnik (affected by different kinds of pollution).

Material and methods:

Biota samples were collected and prepared for the analyses using procedures recommended by FAO, Fisheries Technical Paper No.158. The following species were taken for samples: Mullus surmuletus, Merluccius merluccius, Mytilus galloprovincialis, Ostrea edulis, and Xantho hydrophilous. Zooplankton was collected using a 250 g net with copper bucket. Sediment samples were also collected.

The method used for the analysis of biota included homogenization and extraction with petrolether, filtration through a column of anhydrous Na_2SO_4, clean-up on alumina column (Holden & Marsden 1969; J. Chromat 40, 481), separation of PCBs from organochlorine insecticides on a miniature silica gel (Picer & Ahel, 1978. J.Chromat. 150, 119), and EC chromatographic analysis. Mirex was used as an internal standard.

Results and their interpretation:

It was assumed that the results presented on the Log-Forms are on a fresh-weight basis and that the decimal point was observed. Based on this assumption table no.1 was prepared which shows the maximum, minimum and mean concentration of $\leq$ DDT, PCBs and dieldrin for the species analysed. The results for 8 samples of zooplankton were as follows:

Compound	Range	Mean
	Concentrations (ug/kg F.W.)	
Σ DDT	2.6 - 9.5	5.6
PCBs	29.2 - 266.0	85.8
Dieldrin	0.1 - 1.5	0.4

The ΣDDT and PCB values for Mytilus galloprovincialis and for the sediments are also presented in figure 1 as geometrical means but on a dry weight basis. Similarly figure 2 shows the distribution of the same compounds in the various organisms in a histogram form.

Concentrations of Σ DDT in biota samples are very low, sometimes (e.g. in Mali Ston Bay) even lower than those found in W. Mediterranean. PCB concentrations are relatively high in the vicinity of Dubrovnik probably due to ship-repairing and paint-work carried on there.

Conclusions:

Significant concentrations of PCBs were observed in the Gruz Harbour area and in Rijeka Dubrovacka probably due to the presence of industry. The concentrations of DDT are rather low compared to the rest of the Mediterranean.

List of publications:

PICER, M. and AHEL, M. Separation of polychlorinated biphenyls from DDT and its analogues on a miniature silica gel column. J. Chromatogr. 1978, 150: 119-127.

TABLE 1. Concentration of DDT, PCBs and dieldrin
(μg/kg F.W. in various species)

Species		Mytilus galloprovincialis	Mullus surmuletus	Ostrea edulis	Merluccius merluccius	Xantho hydrophilus
No of analyses (samples)		24	5	7	4	10
Total no. of specimens		236	27	63	19	76
Tissue analysed		soft part	fillet	soft part	fillet	fillet
ΣDDT	Range	0.7-13.1	0.7-25.0	2.1-13.7	1.8-19.4	3.0-17.3
	Mean	5.2	10.6	4.6	10	7.9
PCBs	Range	4.7-450.0	5-120	5 - 30	5 - 52.8	7.5-242.4
	Mean	87.9	42.5	12.1	24.2	92.7
Dieldrin	Range	0.1-1.9	0.1-2.0	0.1-2.0	0.1-0.7	0.1-8.5
	Mean	0.5	0.4	0.5	0.4	2.6

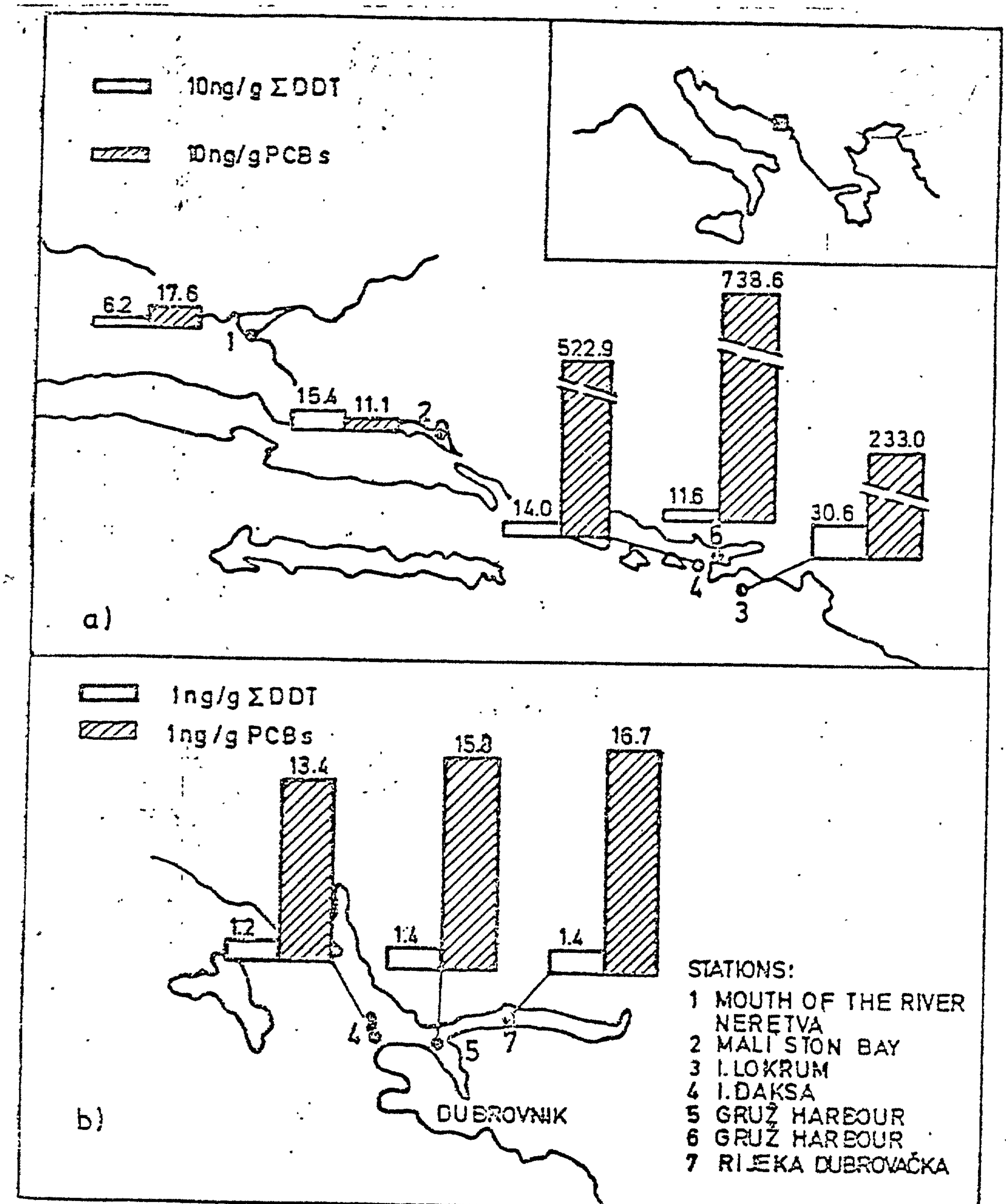


FIG.4 Sampling stations and concentrations of total DDT and PCBs in *Mytilus galloprovincialis* (a), and in sediment samples (b), expressed graphically as geometrical means on dry weight basis.

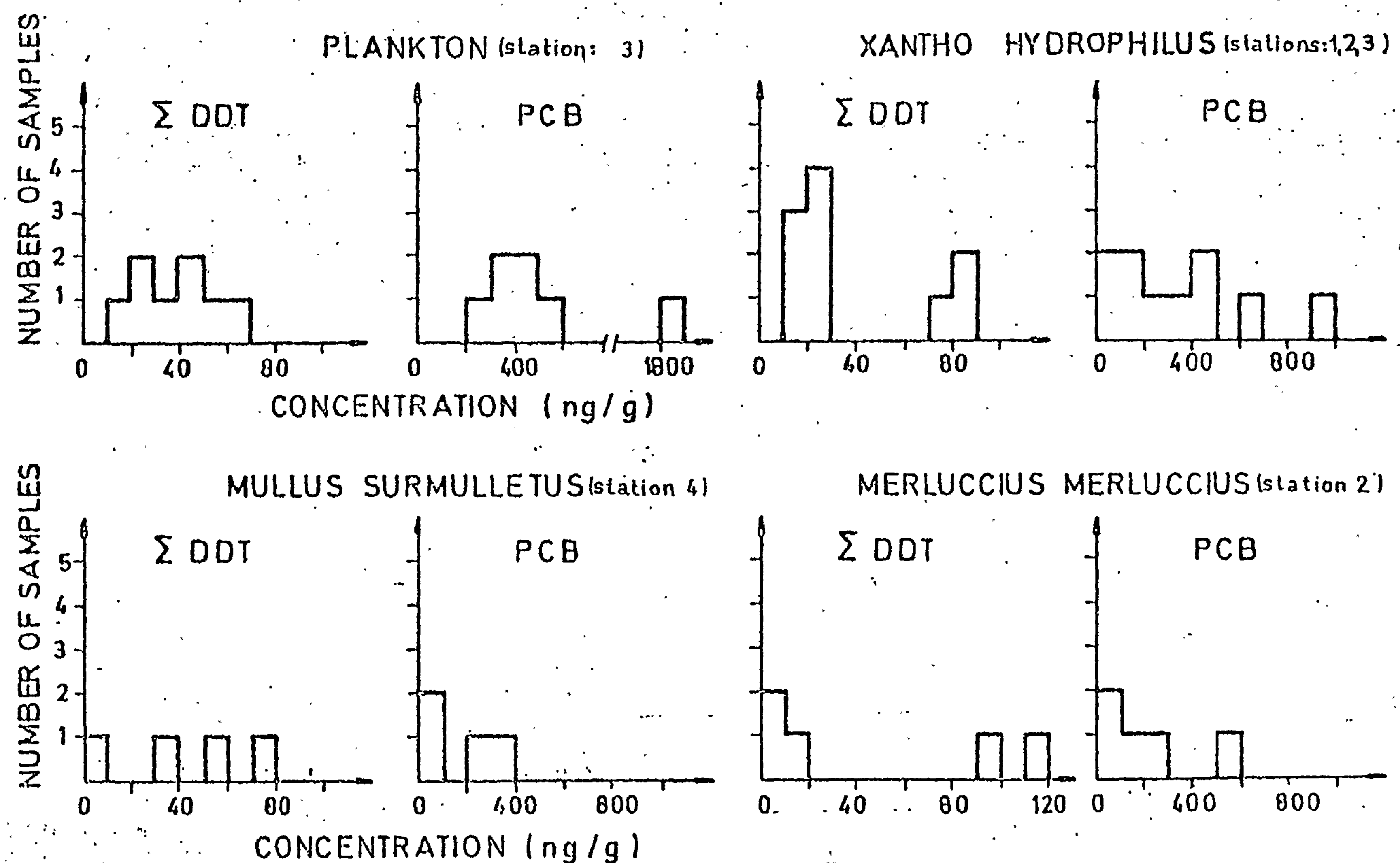


Fig. 2 Distribution of total DDT and PCBs concentrations in tested organisms expressed on dry weight basis.

Participating Research Centre: Centre for Marine Research, "Rudjer Boskovic Institute", ZAGREB/ROVINJ Yugoslavaia

Principal Investigator: N. SMODLAKA

Introduction:

The analysis of chlorinated hydrocarbons in biota, sediments and seawater started at the Zagreb laboratories in 1974 while preliminary analyses in seawater began in Rovinj in 1973. Now both laboratories work together on MED III pilot project.

Area(s) studied:

Samples were collected form various stations on the West Istrian coast and in Rijeka Bay, Adriatic (Area V). Figure 1 and 2.

The chemical and biological characteristics of the west Istrian coast are typical for oligotrophic areas but sometimes more eutrophic conditions appear due to the influence of the Northern Adriatic rivers. It is a shallow area not exceeding 40 m in depth with well-defined stratification in summer and complete mixing during winter.

Rijeka bay is somewhat deeper (up to 70 m) with the same characteristics as the west Istrian coast but it is influenced by a large industrial city.

Material and methods:

The major species analysed was Mytilus galloprovincialis but some analyses on the following species are also reported:

Ostrea edulis, Patella coerulea, Monodonta turbinata, Trisopterus minutus capelanus, Merluccius merluccius, Boops boops, Mullus barbatus, Mugil auratus, Pagellus erythrinus and Oblada melanura.

Some zooplankton, seawater (including surface film) and sediments were also collected for analysis.

The analytical procedure for the marine organisms included homogenization, extraction with petroleum ether, filtration through a column of anhydrous Na_2SO_4, and clean-up on an alumina column. PCBs were separated from the organochlorine insecticides on a miniature silica gel column prior to gas chromatographic analysis using an electron capture detector and Mirex as an internal standard.

Results and their interpretation:

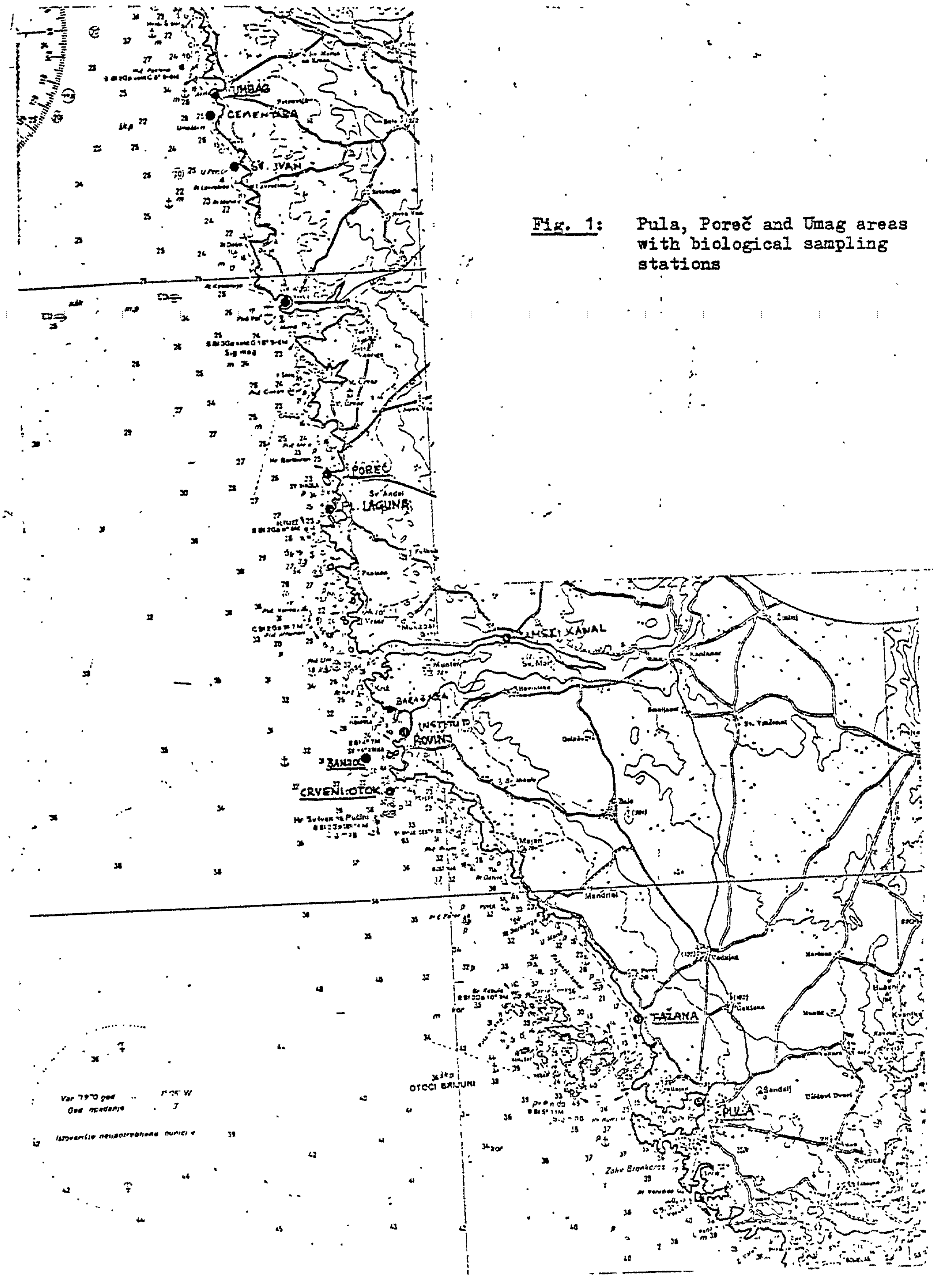
Table 1 shows the corrected analytical results for Mytilus galloprovincialis by area. The range, the mean and the number of samples are also included. Table 2 is a summary of the corrected data for all species analysed. The mean values for $\leq$ DDT and PCBs in Mytilus (table 1) from the west Istrian coast are somewhat higher compared to the Rijeka bay samples. The reason could be the higher local pollution and also the influence, although seasonal, of the Po river.

Zooplankton $\leq$ DDT values are probably lower because the correction factor is high (21.27).

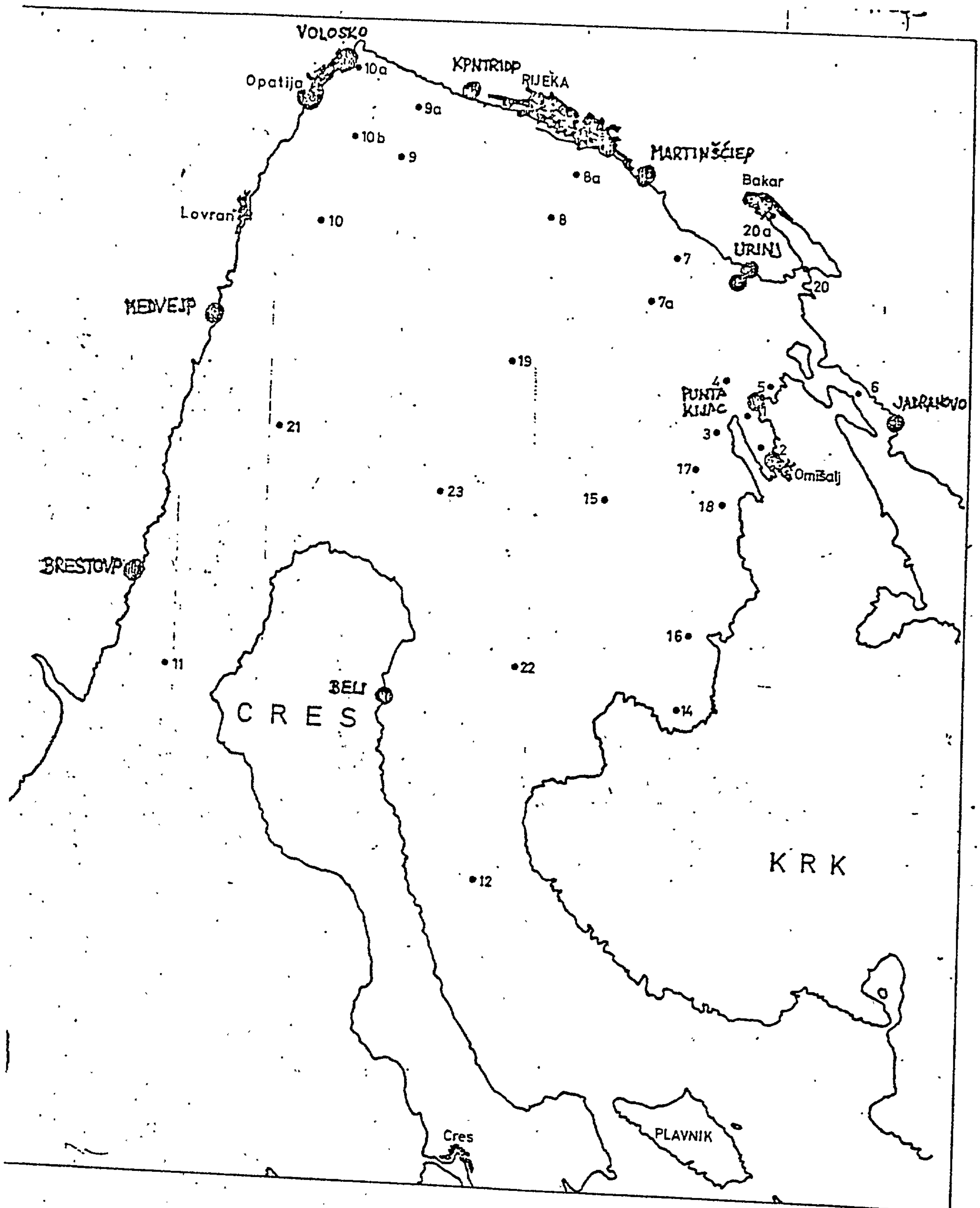
Most of the results for chlorinated hydrocarbons in sea water lie beyond the analytical sensitivity of the method (for DDT 0.05 ng/l and for PCBs 0.1 ng/l).

Sediment sampes from Pula area show a significantly higher concentration of DDT and especially PCBs than those from Porec area.

Generally, values were higher in areas polluted by industrial effluents.



<u>Fig. 1:</u> Pula, Poreč and Umag areas with biological sampling stations



g. 2 Rijeka Bay with bilogical sample stations

Table 1. Polychlorinated hydrocarbons concentrations analysed in *Mytilus galloprovincialis* (μg/kg F.W.)
(corrected data)

Correction factor		0,85	1,56	1,13	1,06	71	1,23
Pollutant		DDT	TDE(DDD)	DDE	DDT	DIEL	PCBs
Pula area	range	<0,4 - 63,8	<0,16 - 33,9	<0,1 - 14,9	<0,7 - 97,2	<7,1 - 142	<6,2 - 193,0
	$x \pm \sigma_{n-1}$	12,0 ± 18,6	8,9 ± 9,8	5,5 ± 4,5	26,2 ± 27,7	13,5 ± 41,2	82,4 ± 76,6
	n	12	12	12	12	12	12
Rovinj area	range	<0,4 - 18,3	0,6 - 6,2	0,3 - 2,9	3,0 - 29,8	<7,1 - 28,4	<6,2 - 55,4
	$x \pm \sigma_{n-1}$	4,4 ± 5,7	2,3 ± 1,6	1,1 ± 0,7	8,4 ± 8,5	4,3 ± 9,2	8,0 ± 17,5
	n	10	10	10	10	10	10
Poreč area	range	<0,4 - 85	0,5 - 41,8	0,7 - 17,0	1,0 - 116,3	<7,1 - 42,6	<6,2 - 179
	$x \pm \sigma_{n-1}$	19,7 ± 21,7	13,3 ± 12,9	7,0 ± 5,1	40,2 ± 32,9	9,2 ± 16,3	70 ± 63,2
	n	14	14	14	14	14	14
Umag area	range	<0,4 - 2,6	<0,16 - 1,4	2,3 - 5,4	2,1 - 5,5	<7,1 - 92,3	41,8 - 63,2
	$x \pm \sigma_{n-1}$	0,85± 1,4	0,5 ± 0,8	3,1 ± 2,1	4,2 ± 1,8	42,6 ± 46,9	51,4 ± 10,8
	n	3	3	3	3	3	3
Rijeka area	range	<0,4 - 68,6	<0,16 - 6,2	<0,1 - 46,6	<0,7 - 129,2	<7,1 - 42,6	0,0 - 148,8
	$x \pm \sigma_{n-1}$	4,8 ± 12,8	1,7 ± 1,9	2,6 ± 8,7	2,4 ± 8,2	5,0 ± 14,2	30,4 ± 43,7
	n	28	28	28	28	28	28

Table 2. Polychlorinated hydrocarbons concentrations analysed in different species (corrected data)

	Species	No. of analyses	Σ DDT		PCB	
			Correction factor	range µg/kg F.W.	Correction factor	range µg/kg F.W.
1	Patrela coerulea	1	1,06	10,6	1,23	< 5,3
2	Monodonta turbinata	1	1,06	9,8	1,23	< 5,3
3	Trisopterus minutus capelanus	2	0,97	6,2-14,2	3,63	< 4,9
4	Merluccius merluccius	2	0,97	7,51-136,5	3,63	9,7-46,6
5	Boops boops	1	0,97	15,2	3,63	29,1
6	Mullus barbatus	1	0,97	59,9	3,63	14,6
7	Mugil auratus	2	0,97	159,7-827,6	3,63	116,4-1028,2
8	Pagellus erythrinus	1	0,97	10,5	3,63	4,7
9	Oblada melanura	1	0,97	90,0	3,63	24,3
10	Mytilus galloprovincialis	67	1,06	<0,7-129,2	1,23	0,0-193,0
11	Ostrea edulis	1	1,06	5,1	1,23	21,3
12	Zooplankton	13	21,47	<15-60,1	1,25	<6,3-168,8

All samples are from Rijeka Bay except No. 11.

Mytilus galloprovincialis includes samples from all areas.

Participating Research Centre: Marine Biological Station,
Institute of Biology,
University of Ljubljana,
PORTOROZ
Yugoslavia

PRINCIPAL INVETIGATOR: J. CENCELJ

Introduction:

MBS has been occupied with the monitoring of chlorinated hydrocarbons in sediments, plankton and selected biota (fish, mussels, etc.) since 1973 but analyses were performed by the collaborating laboratories of the Agricultural Institute of S.R. Slovenija, Ljubljana. The results have been partly published but a selection of the unpublished ones have been incorporated in the previous reports for the MED III pilot project.

Area(s) studied:

Monitoring and research area: Adriatic (Area V), figure 1. Sampling sites are locatd in the Bay of Strunjan (clean area) and in the Bay of Koper (polluted area), both areas found along the coast of S.R. Slovenija (North Adriatic). Samples were also collected in the Middle Adriatic (Jabuka Island) considered as a reference area. In addition, samples were collected from experimental fields in the Lagoon of Strunjan polluted by ordinary municipal sewage, in order to get some information on the types and quantities of residues accumulated in organisms and sediments.

Material and methods:

Only Mytilus galloprovincialis was sampled and used for analysis. Samples were prepared according to the FAO, Fisheries Technical Paper No. 158 but with some modifications. Both hot and cold extraction methods were used. In the first case, extracts were not cleaned by passing them through a florisil column and eluting with 6 per cent and 15 per cent diethyl ether in petrol ether. In the latter case, extracts were treated with NaCl solution in separatory funnels and instead of passing them through florisil, the concentrated H_2SO_4 destruction method was used.

Ethanolic KOH hydrolysis was used for identification purposes.

The samples were finally injected on a VARIAN Ni-63 ECD gas chromatograph using a 1.5 per cent OV-17/1.95 per cent OV-210 ft glass column.

Recovery percentages were 95 per cent for DDT and 90 per cent for PCBs.

Results and their interpretation:

Results are reported only for Mytilus galloprovincialis
Coast of Slovenija
Number of samples: 5
Total number of specimens in samples: 17
Tissue analysed: soft part

Compound	Concentration ug/kg F.W.) Minimum	Maximum	Mean
Σ DDT	Traces	1672	351
PCBs	25	2622	655

The highest Σ DDT value was found in the port of Koper and that for PCBs in the port of Piran while the lowest values for both were found in Savudrija. A sample near Jabuka Island in the Middle Adriatic gave values equal to 21 ug/kg and 88 ug/kg of F.W. for DDT and PCBs respectively.

In the experimental lagoons at Strunjan, Σ DDT varied from 47 to 191 ug/kg F.W. while PCBs averaged about ug/kg F.W. In this case the presence of aldrin and β-BHC were also reported.

Conclusions:

1. The highest concentrations of both Σ DDT and PCBs were found in mussels growing in areas polluted by mixed sewage, industry and port waste waters such as the inner Bay of Koper. (DDT 1672 ug/kg, PCBs 505 ug/kg).

2. The concentrations of Σ DDT and PCBs were found to be low in mussels from areas away from urban or industrial pollution.

3. By using artificially polluted lagoons, it was possible to demonstrate that domestic sewage alone can give rise to high levels of Σ DDT, PCBs and aldrin in biota living in polluted lagoons as compared to those growing in lagoons used as blanks.

List of publications:

STIRN, J. (1974). Pollution problems in the Adriatic Sea - an interdisciplinary approach. Rev.Inst.Oceanogr.Med. 35-36 (1974), 21-78.

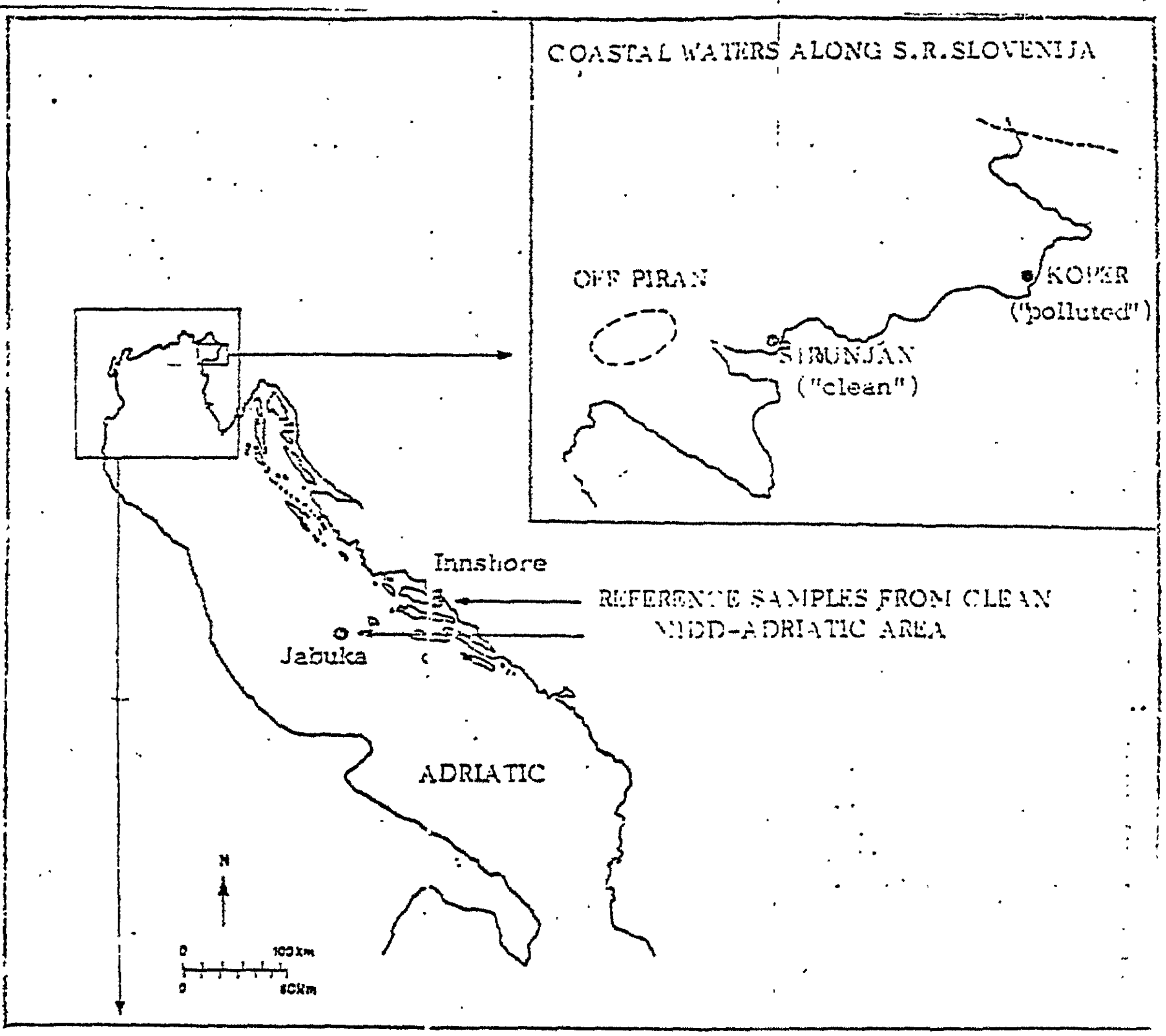


Fig. 1 – Sampling localities in the Northern Adriatic (Area V)

MED POL IV : RESEARCH ON THE EFFECTS OF POLLUTANTS ON MARINE ORGANISMS AND THEIR POPULATIONS (FAO(GFCM)/UNEP)

MED POL IV : RECHERCHE SUR LES EFFETS DES POLLUANTS SUR LES ORGANISMES MARINS ET LEURS PEUPLEMENTS (FAO(CGPM)/PNUE)

Participating Research Centre: Institute of Oceanography and Fisheries
Mediterranean Branch,
ALEXANDRIA
Egypt

Principal Investigator: H.H. SALEH

Introduction:

The requested Summary Report has not been received.

Centre de Recherche Participant: Station marine d'Endoume et centre d'oceanographie
MARSEILLE
France

Chercheur principal: G. BELLAN

Introduction:

Les recherches effectuées à la Station marine dans le cadre du projet pilote ont débutées en 1969 et se rattachent, pour l'essentiel à l'action de détergents, issus de la pétroléochimie, sur des Invertébrés marins. Soixante-dix produits (anioniques, non ioniques et cationiques) ont été choisis, représentant les principales familles chimiques commercialisées. Des Polychètes, des Mollusques, des Echinodermes représentatifs de différents niveaux trophiques ou de niveaux de pollution globale préalablement définis avaient été choisis. Les expériences ont été d'abord conduites en "milieu statique" (avec renouvellement ou non de ces milieux). Un système de "flux continu" est maintenant opérationnel.

Matériel et méthodes:

Utilisation d'une salle à température constante et réglable; de thermostats (et cryostats). Expérience effectuée pour l'ensemble en milieu "statique" avec renouvellement périodique des solutions tests, à intervalles réguliers lors d'expériences de longue durée (supérieure à 96h). Développement récent d'un système de flux continu avec prochainement, pompes microdoseuses automatiques.

Résultats et leur interprétation:

Trois objectifs ont été choisis:

Objectif A:

Action de synergie ou d'antagonismes salinité-détergents sur deux Polychètes Scolelepis fuliginosa et Capitella capitata.

La toxicité des détergents vis-à-vis des Polychètes marines, indicatrices de pollution, Scolelepis fuliginosa et Capitella capitata, peut donc être accentuée (effet synergique) ou atténuée (effet antagoniste) par des salinités inférieures ou supérieures à la salinité normalement subie par les espèces étudiées, récoltées dans le secteur de Cortiou. Elle est accentuée par les salinités infranormales de 18°/oo, 20°/oo, 22°/oo et par les salinités supranormales de 50°/oo, 48°/oo, 46°/oo (et 44°/oo pour les Scolelepis fuliginosa). Elle peut être atténuée par les salinités de 25°/oo, 30°/oo et 42°/oo.

L'existence de l'un ou de l'autre de ces deux phénomènes dépend, outre la salinité du milieu:

1) du degré de toxicité du détergent:

Pour Scolelepis fuliginosa, les salinités de 25°/₀₀, 30°/₀₀, et 42°/₀₀ qui sont des salinités non létales, atténuent la toxicité des détergents moyennement toxiques (Beycostat LP4A, Laural LS, Néopon lam., Syntaryl A990). Elles acceptent la toxicité des détergents faiblement toxiques (Ultraphos 11, E 7252). La salinité peu ou non létale est donc synergique avec les altéragènes ayant un degré de toxicité fort et ceux ayant un degré de toxicité faible. Elle a une réaction plutôt antagoniste avec les altéragènes de toxicité moyenne.

2) de la concentration de détergent contenue dans le milieu:

La salinité réagit différemment avec la toxicité du détergent, suivant que ce dernier se trouve en forte, moyenne ou faible concentration (proportionnellement à son degré de toxicité), par exemple, pour Scolelepis fuliginosa, en 48 h, le Beycostat LP4A manifeste vis-à-vis de la salinité de 20°/₀₀, un antagonisme à faible et forte concentration et une synergie à moyenne concentration.

3) de la composition chimique du détergent (structure moléculaire):

liée au degré de toxicité de l'altéragène.

4) des réactions physiologiques des animaux:

Les Polychètes manifestent un phénomène de résistance physiologique à la toxicité des détergents fortement toxiques qu'ils "détectent" plus rapidement, cette résistance physiologique se faisant par activation de l'osmorégulation et/ou par ralentissement du métabolisme.

5) de la durée d'action de détergent dans le milieu:

La toxicité des détergents vis-à-vis des Polychètes étudiées peut être atténuée par la salinité dans les premières 48 h et accentuée au bout de 96 h.

Objectif B:

Action de détergents sur la séquence de développement de l'oursin Paracentrotus lividus. Les résultats essentiels sont regroupés dans le tableau 1. On notera l'allongement des stades du développement notamment au moment de l'apparition de la membrane de fécondation (F), de la première division cellulaire (D), de la gastrulation (G) et de l'échinopluteus (E). L'effet est nettement fonction du contact des larves avec les détergents. Si au début (stade F), les effets peuvent être faibles, ceux-ci s'accélèrent très vite et deviennent toujours importants au stade E. L'effet des produits varie notablement de l'un à l'autre. On a noté aussi des malformations létales. On a constaté des polyspermies retardatrices, des blocages au stade blastula, des exogastrulations et des malformations des baguettes chez l'Echinopluteus.

Objectif C:

Les études ont été conduites avec les Mollusques Tapes aureus et Mytilus galloprovincialis et les r sultats acquis, demandent à tre confirms définitivement par d'autres expériences:

1) tant avec les détergents qu'avec les métaux lourds, une augmentation de température entraîne, en règle générale, un accroissement de la sensibilité des espèces (synergie, additivité positive).

2) l'abaissement de la salinité du milieu expérimental de 30°/₀₀ à 25°/₀₀ entraîne une diminution de la sensibilité des espèces (antagonisme, additivité négative).

3) toutes autres conditions expérimentales étant identiques, les mortalités chez Tapes aureus sont identiques que l'on utilise un circuit ouvert ou que l'on renouvelle périodiquement le milieu expérimental. Chez Mytilus galloprovincialis, on note une augmentation de la sensibilité aux agents polluants en milieu périodiquement renouvelé par rapport au circuit ouvert.

Objectif supplémentaire:

Action de détergents, à long terme, sur le développement de l'Isopode valvifère Idotea balthica basteri. Il a été mis en évidence, avec 7 détergents sur 8, au bout de 12 semaines la castration des mâles, les cellules germinales étant bloquées au niveau de la prophase, les chromosomes apparaissant soit raccourcis et épaissis, soit amassés en forme de croissant. Il y a donc blocage de la spermatogène soit par action directe sur les cellules germinales, soit indirectement et on pourrait alors envisager une action au niveau de la glande androgène qui chez les Péracarides joue un rôle considérable dans la formation des produits génitaux. Chez la femelle d'Idotea baltica, par contre, il n'a pas été remarqué d'altérations au niveau histologique sur la reproduction. Des études à caractère plus strictement biochimique (utilisant l'électrophorèse) sont en cours. Les premiers résultats de ces études seront fournis dans le prochain rapport.

Liste de publications:

Bellan, G., Kaim-Malka, R., Ladjal, A., Stora, G., et Tahvildari-Damoui, S., Etude de différentes modalités de l'action de détergents sur des espèces marines. Présenté aux IVèmes journées d'Etudes sur les pollutions marines en Méditerranée, CIESM/PNUE, Antalya, 24-27 novembre 1978.

Kaim-Malta, R.A., Action in vitro des détergents non ioniques sur l'isopode valvifère Idothea balthica basteri. Présenté à la VIème Réunion des carcinologistes de langue française.

TABLEAU 1

C E 50 % : concentration permettant que 50 % de l'effectif testé atteigne le stade considéré dans le temps normal

Paracentrotus lividus

		F	D	G	E
	Temps normal pour l'achèvement du stade	3 mn	90 mn	24 h	48 h
	Pourcentage de réussite (témoin)	99,5	98,5	98	95
C E 50 % non ioniques	Nonyl phénol 936	41,8	2,2	2	1,4
	Alcool Oxo 431	64,2	0,9	0,7	0,3
	Cesulsol DB 817	70,6	3,3	0,9	0,2
	Ethomeen C 25	57,7	4,4	2,8	0,3
	Pluronic L 61 R	100	20	15	10
CE 50 % anioniques	Hexaryl L30	19,8	20	17	8,3
	Laural 729	24	23,8	19,8	3,6
	Ester d'alcool oxyakilé	25,1	3,7	1,8	1,7

Centre de Recherche participant: Laboratoire de Zoologie et Musee, Universite d'Athens, ATHENES Grece

Chercheur principal: M. MORAITOU-APOSTOLOPOULOU

Introduction:

Le laboratoire réalise différentes recherches sur la systématique et l'écologie du plancton et s'est intéressé à l'étude des communautés planctoniques, particulièrement, dans les zones polluées du golfe de Saronikos.

Matériel et méthodes:

L'idée de base, pour la participation au projet pilote, était l'étuude des effets des métaux lourds (Cd et Cu) sur deux populations différentes de copépodes Acartia clausi; l'une vivant dans une baie polluée (la baie d'Elefsis dans le golfe de Saronikos), l'autre dans une baie relativement propre (non polluée). Ces deux populations présentaient d'intéressantes modifications morphologiques: ceux vivant dans la baie polluée montraient en particulier un phénomène d'adaptation aux polluants testés.

Résultats et leur interprétation:

Les résultats aux tests de toxicité aux métaux - exprimés par la DL_{50}, 48 h - indiquent une différence significative dans la tolérance au cuivre et au cadmium, entre les deux populations. La DL_{50}, 48 h de la population adaptée à la pollution (celle de la baie), était supérieure à celle de la zone non-polluée.

Métaux	Zone non-polluée	Zone polluée
Cu (18°C)	0.034 $\pm$ 0,0044	0.082 $\pm$ 0,0026
Cd (14°C)	1.20 $\pm$ 0,028	1.50 $\pm$ 0,030

DL_{50}, 48 h (ug/l) de Cu et Cd de A. clausi (femelles matures)

De la même façon, l'activité nutritionelle, la longévité et fécondité des animaux de la zone non-polluée montraient une réduction progressive dans l'échelle de concentration de cuivre utilisée (de 0,001 à 0,01 mg/l). La population d'Acartia adaptée à la pollution, semble plus résistante à des doses subléthales de cuivre.

Concentration de Cu (mg/l H_2O)	Taux d'ingestion (cal./copépode/24h)		Oeufs produits (en 3 jours)		Oxygène consommé (102 ug/copépode/20h)	
	zone non-polluée		zone non-polluée		zone non-polluée	
0	25 600	25 550	5,25	3,12	0,010	0,006
0,001	24 950	14 440	6,0	1,0	0,018	0,009
0,0025	--	--	7,06	--	--	--
0,005	12 290	3 065	--	0,28	0,022	0,019
0,01	--	--	5,69	--	0,0305	0,024

Tableau 1. Taux d'ingestion, oeufs produits, oxygène consommé (nombres moyens) d'Acartia clausi sous différentes concentrations de cuivre.

Conclusions:

La résistance d'organismes marins, aux métaux lourds, semble résider dans une adaptation favorable mais les organismes résistants contiennent de hautes concentrations de polluants qui peuvent être transmises à des prédateurs non-adaptés et aussi à l'homme.

Liste de publications:

Moraitou-Apostolopoulou, M., (1978). Acute toxicity of copper to Acartia clausi (Copepoda, Calanoida). Marine Pollution Bulletin, Vol. 9, pp. 278-280.

Some effects of sub-lethal concentrations of copper on the marine copepod Acartia clausi (an experimental study).

Temperature and adaptation to pollution as factors influencing the acute toxicity of Cd to the planktonic copepod Acartia clausi.

Moraitou-Apostolopoulou, M., et Verriopoulos, G., Différenciation morphologique entre deux populations d'Acartia clausi (Copepoda) provenant des biotopes différant à l'état de pollution.

Centre de Recherche participant: Institut Phytopathologique "Benaki", ATHENES Grece

Chercheur principal: R. FYTIZAS

Introduction:

Le laboratoire de Toxicologie des Pesticides s'occupe depuis 1965 des recherches sur la toxicité des pesticides.

Matériel et méthodes:

Mugil cephalus, Murex brandaris et Pagurus sp. étaient maintenus dans un aquarium de 70 l d'eau de mer naturelle. Un herbicide (le Paraquate) et deux insecticides organophosphorés (le Diméthoate et le Fenthion) étaient testés. Tous les essais de toxicité ont été réalisés en milieu statique. Les paramètres suivants ont été étudiés:

a) pour le Paraquate: toxicité aigue, chronique, effets sur organes et tissus, accumulation et sélectivité du produit toxique pour les différents tissus, ainsi que la cinétique du produit toxique dans le milieu d'expérimentation et

b) pour les esters phosphorés: toxicité aigue et leur activité anticholinestérasique dans le sang et le cerveau de Mugil cephalus.

Résultats et leur interprétation:

a) Cinétique du Paraquate dans le milieu d'expérimentation

D'après le tableau 1, le Paraquate, ajouté au récipient d'expérimentation (verre, eau de mer), est absorbé immédiatement par les parois du récipient (en quantités qui varient selon le cas (de 2/3 à 3/4). Cet équilibre se maintient pendant 24 heures, l'eau et le toxique étant renouvellés au bout de ce temps. Il est évident que le polluant actif est de beaucoup inférieur (en quantité) à la quantité initiale.

b) Toxicité

Les temps létaux 50 (TL_{50}) de trois organismes testés (M. cephalus, M. brandaris et Pagurus sp.) étaient à différentes concentrations du Paraquate. De ces données on constate que bien que le poisson soit plus sensible que les deux autres organismes après une exposition de courte durée à la dose de 10 p.p.m., il est moins sensible qu'eux aux doses plus faibles mais répetées. Pour les doses répetées, Pagurus sp. s'est révélé l'espèce la plus sensible. Des doses chroniques (1, 0,1 et 0,05 p.p.m.) celle de 1.0 p.p.m. fut létale pour les trois organismes, les deux autres étant dépourvues d'effet létal même après une durée d'exposition de trois mois.

c) Accumulation

D'après les données figurant dans les tableaux 2 et 3, l'accumulation du Paraquate est beaucoup plus grande dans le tractus digestif et la peau que dans les ovaires ou les muscles. Des trois espèces, les petits crustacés accumulent des quantités de Paraquate plus considérables que les deux autres espèces, fait probablement dû à la sensibilité élevée de ces organismes aux expositions répétées.

d) Effet d'une exposition aigue aux esters organophosphorés à l'activité cholinestrasique dans le sang et le cerveau de M. cephalus.

Le but de ce travail est la recherche des critères de l'intoxication autres que la mortalité. Comme on peut constater des données figurant dans le tableau 4, la matière la plus convenable pour la réalisation d'un essai anticholinestérasique est le cerveau. La moyenne de l'activité cholinestérasique (delta pH) dans le cerveau du poisson non traité est égale à 2,336 unités, pour une incubation de deux heures. Pour le sang, le delta pH arrive à peine à 0,278 unités.

Les deux insecticides ont provoqué une inhibition de la cholinestérase du sang dès le premier quart d'heure d'exposition, arrivant à réduire son activité de 12 à 32 pour cent.

Dans le cerveau, l'inhibition est plus tardive mais beaucoup plus prononcée (inhibant à 78 ou 87 pour cent l'activité cholinestérasique).

Conclusions:

L'herbicide étudié, quoique pourvu d'une toxicité modérée, présente pour les organismes mmrins un danger réel à cause de son pouvoir de se fixer en quantités considérables aux organismes à tégument chitineux; ces organismes jouent d'ailleurs un rôle important dans la chaîne trophique.

Les esters organophosphotés, par contre, ont une toxicité élevée; ils s'hydrolysent, pourtant, facilement dans le milieu marin. Un test facile et rapide pour la détermination du niveau d'un polluant (comme les esters organophosphorés) serait la mesure de l'activité anticholinestérasique du polluant dans le cerveau des poissons.

Quantités initiales (mg/l)	Quantités détectées après:				
	10 mn	1h	4h	6h	24h
10	—	2,45 ± 0,05	2,55 ± 0,05	2,66 ± 0,06	2,53 ± 0,04
5	1,32 ± 0,07	1,38 ± 0,04	1,38 ± 0,05	1,48 ± 0,04	1,63 ± 0,12
1	0,33 ± 0,04	0,43 ± 0,03	0,50 ± 0	—	0,52 ± 0,04

Tableau 1 - Equilibre du Paraquate dans les aquaria (eau de mer)

Organes	Quantités détectées (en µg/g)
Muscles	0,192 ± 0,067
Ovaires	0,230 ± 0,141
Peau	4,742 ± 1,784
Tractus digestif	6,083 ± 1,789

Tableau 2 - Accumulation et sélectivité du Paraquate dans différents tissus de *Mugil cephalus* après une exposition à 1 p.p.m. pendant 15 jours.

Concentrations (en p.p.m.)	Quantités détectées (en µg/g)	
	M. brandaris	*Pagurus* sp.
10	2,82	—
5	2,24	14,632
2,5	—	9,208
1	1,46	3,115

Tableau 3 - Accumulation du Paraquate dans le corps entier de *Murex brandaris* et de *Pagurus* sp. après une exposition à différentes concentrations pendant 3 jours.

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olluant testé	Concentration de la solution (en mg/ l)	Durée d'exposition (en h)	delta pH[1]		delta pH par rapport au témoin	
			dans le sang	dans le cerveau	dans le sang	dans le cerveau
émoins	0	0	0,278	2,336	-	-
méthoate	3,0	1,5	0,192	2,332	0,69	0,99
"	6,0	2,0	0,192	2,330	0,69	0,99
"	6,0	36,0	0,176	0,301	0,63	0,13
"	20,0	0,5	0,245	1,337	0,88	0,57
athion	2,5	24,0	0,131	0,514	0,47	0,22
"	5,0	1,0	0,074	2,295	0,27	0,98
"	5,0	2,0	0,122	2,329	0,44	0,99
"	10,0	0,2	0,189	2,332	0,68	0,99

) Différence de pH après deux heures d' incubation à 37°C

Tableau 4 - Inhibition de l'action cholinestérasique dans le sang et le cerveau *Mugil cephalus* après une intoxication aux esters organophosporés.

Participating Research Centre: Israel Oceanographic and Limnological Research Ltd., HAIFA, Israel

Principal Investigator: T. SHIMONY

Introduction:

The requested Summary Report has not been received.

Participating Research Centre: Biological Research Laboratories, Institute of Evolution,
HAIFA
Israel

Principal Investigator: E. NEVO

Introduction:

The objectives of this project are to study the direct effects of known pollutants on the genetic structure of several marine organisms by introducing various levels and kinds of pollutants into controlled systems maintained in the laboratory. Previous studies conducted by the Institute concerning changes in the gene pool of the barnacles under in situ conditions have indicated the influence of pollutants on natural selection. However, the amounts and nature of this selection by particular pollutants still remain unknown. It is hoped that by means of critically designed studies, such as the present one, light will be shed on the cause-effect relationship of pollutants to changes in the biotic system.

Material and methods:

Palaemon elegans is a widespread East Atlantic decapod also common along the Mediterranean coasts. The biology including morphology, sex ratio, reproduction and behaviour of this species is well known. It constitutes one of the common elements of the marine community of rocky shores and lagoons, and selects heterogeneous environment (spatially and temporally). As such, it is expected that P. elegans will contain a high degree of genetic variability and therefore be suitable for this study.

P. elegans was collected from tidal rock pools along the Mediterranean coast of Haifa. Care was taken to collect repeatedly along a small defined area so that population sources could be considered constant. The animals were then kept for a few days in a community aquarium so as to acclimate them to the laboratory conditions before being distributed into the experimental aquaria.

Three aquaria of about 100-litre capacity were filled with sea water pumped from a 30-m deep marine well. The first aquarium served as a control while 1 687 (18 ppm) Berol 716 detergent and 4 mg (0.036 ppm) $HgCl_2$ were introduced separately into the other two.

All aquaria were outfitted with an airstone and a glass wool filter. Sixty P. elegans of random sizes were placed in each aquarium. The animals were fed with Artemia salina nauplii, and temperature, salinity and pH measured daily. After eight days the remaining animals were counted and frozen at -80°C until later analysed. Repetitions of this procedure were and are being made.

Soft tissues of whole animals were homogenized in distilled water and studied by horizontal starch gel eletrophoresis (Selander, 1971). After initial screening of 30 enzyme systems, the following gene loci were scored: esterases (five loci), peptidases (two loci), hexokinase, phosphoglucomutase, phosphoglucoisomerase, glutamate oxaloacetate transaminase (two loci) and malic enzyme.

Results and their interpretation:

Two trials of mercury induced selection and one of detergent-induced selection have been run to-date. Electrophoretic analysis has been carried out on one set of the mercury and control survivors. Of the 60 individuals introduced into the two aquaria, 50 survived in the control while only 26 survived in the mercury-polluted aquarium. Electrophoresis was run on 30 and 26 individuals from the control and mercury aquaria, respectively.

Eight loci were found to be monomorphic (Est-1, 2, 3, 4, 5; Pept-1, 2; HK), three slightly polymorphic (PGI, GOT, ME) and only one enzyme locus highly polymorphic. At present, no significant trends have been found suggesting directional selection on the sytem studied. The paucity of the data, of course, prevents sophisticated statistical analysis at the present time. Further replications and electrophoretic analyses remain to be carried out before positive conclusions may be reached. In addition, similar experiments remain to be conducted on other organisms, particularly Balanus amphitrite.

List of publications:

NEVO, E., SHIMONI, T. and LIBNI, M. (1977). Thermal selection of allozymes polymorphisms in barnacles. Nature, 267: 699-701.

________, Pollution selection of allozyme polymorphisms in barnacles. Experientia (in press).

Participating Research Centre: Institute of Marine Biology - CNR
VENICE
Italy

Principal Investigator: L. DALLA VENEZIA

Introduction:

Since 1975 this research centre has been working on short-and long-term effects of pollutants on copepods of genus Tisbe. These organsims were chosen since they are easily cultured in the laboratory and have a short life cycle.

Material and methods:

The proposed research consists of two parts: first, copepods of one or more species of Tisbe will be treated with chlorinated hydrocarbon pesticides at different concentrations, in order to determine the LC50 of the pollutants. The mortality at different stages of the life cycle and in both sexes will be registered. Secondly, a sub-lethal concenration of the same pollutant will be used for long-term experiments. Two populations of the same species of Tisbe will be kept: the one in polluted sea water, the other in clean sea water, as control, for several generations. Then the number of eggs, the hatching percentage, the length of the life cycle under both conditions will be determined. For this kind of experiment aquaria for rearing copepods, analytical balance (Givertini) and microscopes (Wild or Zeiss) will be used. As for analytical analysis of the pesticides concentration (by gas chromatographic technique) the specific competence of the research group of Dr. V.U. Fossato (working in pilot project MED III) is required.

Conclusions:

The pilot project started only in July 1978. No results have been reported yet.

List of publications:

Copepods of genus Tisbe have already been used in this research centre for experiments on pollution, at first of domestic detergents, then of petroleum. Results of this research have been published in the following papers:

DALLA VENEZIA, L. and FOSSATO, V.U. (1977). Characteristics of oil suspension of Kuwait oil and Corexit 7664 and their short-and-long-term effects on Tisbe bulbisetosa. Mar Biol., 42: 233-7.

__________, Risposta alle variazioni di salinita di Tisbe bulbisetosa, dopo esposizione ad inquinamenta da petrolio. Atti IX Congresso S.I.B.M. Ischia, Maggio 1977 (in press).

Participating Research Centre: Group for Oceanographic Research - Genova,
University of Genova,
GENOVA
Italy

Principal Investigator: M. ORUNESU

The requested Summary Report has not been received.

Participating Research Centre: The Old University
MSIDA
Malta

Principal Investigator: L.J. SALIBA

Introduction:

Activities relevant to the pilot project were commenced in 1972 and included:

a) Research on effects of heavy metals salts (copper, lead, iron and zinc) on acclimation and tolerance of Artemia salina.

b) Research on effects of oil dispersants and dispersant/heavy metal (copper and mercury) mixtures on Artemia salina.

c) Miscellaneous research and investigational work on toxicity of pollutants (various) to selected marine organisms.

Material and methods:

Three experimental designs were used:

1 - Acute toxicity experiments

2 - Sub-lethal effects

3 - Biochemical effects

Results and their interpretation:

Acute toxicity experiments:

Experiments were performed with mercury and cadmium salts. 24 h LC_{50} values for mercury salts ranged from 1.3 to 1.8 ppm and 48h LC_{50} values from 0.78 to 0.9 ppm for Arbacia lixula. As far as Strongylocentrotus lividus is concerned, the 24h LC_{50} values ranged from 1..3 to 1.5 ppm and 48h LC_{50} values from 0.4 to 0.8 ppm.

For mercury sulfate experiments with Monodonta articulata the 24h LC50 value was 8 ppm and 48h LC_{50} value 6 ppm. For mercury chloride and acetate the values were well over 10 ppm.

The figures obtained for cadmium salts in experiments with all above-mentioned species were higher.

Similar experiments (24h and 48h LC_{50}) for chloride, acetate and sulfate of mercury and cadmium were made also with Leander (Palaemon) serratus. Preliminary experiments on acute toxicity of Artemia salina (adults and larvae) on exposure to oil dispersants was commenced.

Sublethal effects:

Several experiments were conducted with the algae Phaeodactylus tricornutum. The growth is much affected with concentration of 25 ppm of various cadmium salts. The chlorophyll a production level was severely affected in concentration of mercury as low as 0.1 ppm while the toxicity of cadmium salts was much lower. Retraction into the shell of M. articulata and M. turbinata is one of the first symptoms of toxicity of mercury or cadmium but snails died if retained in test solutions.

Mortality and retraction into the shell observed in M. turbinata:

	Hours of exposure					
	24	48	72	96	120	144
	D*+ R**	D + R	D + R	D + R	D + R	D + R
Mercuric Sulphate						
1 ppm	0+25	0+35	0+45	10+35	30+25	45+5
3 ppm	0+65	0+30	0+45	5+50	35+25	40+15
10 ppm	60+40	75+25	100+0	100+0	100+0	100+0
Mercuric Chloride						
1 ppm	0+30	0.25	0+25	5+35	10+25	25+9
3 ppm	0+90	0+80	0+90	25+65	50+40	80+10
10 ppm	25+75	25+75	30+70	50+50	85+15	90+10
Mercuric Acetate						
1 ppm	0+5	0+15	5+5	5+0	5+0	5+0
3 ppm	10+80	10+85	20+80	45+45	75+15	85+5
10 ppm	20+80	20+80	30+70	55+45	70+30	90+10

* D = deaths
**R = snails retracted

Oxygen consumption decreases significantly with the progressive rise of concentration of all three salts.

Gregarious behaviour was affected in M. turbinata and reduction of mobility in S. lividus observed under crude oil exposure.

In A. salina a definite depression of the hatching rate and inhibitory effect on growth rate was recorded if exposed to mercury and cadmium salts. Similar results were obtained with surface and sunken oil exposures.

Biogeochemical effects:

Aldrin, Dieldrin and DDT show no effect on oxygen transport in Murex trunculus (animal having haemocyanin as its oxygen carrier).

The effect of Permethrin on the muscle enzymes of fish species Boops boops, Coryphaena hippurus and Mugil cephalus was studied in vitro. On the average the Permethrin raised the maximum velocity of the enzymes pyruvate kinase (PK) and malate dehydrogenase (MDH) and suppressed the maximum velocity of succinate dehydrogenase (SDH) and cytochrome oxydase (COX). There was no effect on lactate dehydrogenase (LDH).

Conclusions:

Both mercury and cadmium exert a highly toxic effect on several invertebrate species under Mediterranean conditions. Sublethal concentrations exert behavioural and related effects at comparatively low levels, and results recorded with Artemia salina, Arbacia lixula, and Monodonta articulata offer a very good indication that reliable bioassay techniques can be developed to detect the presence of these metals at low concentrations in sea water. This of course cannot be specific, as other substances might have the same effects.

The effect of oil, both from the crude material itself, and from its water-soluble fractions, has been to show to exert significant behavioural effect on littoral organisms, thus accentuating the threat to marine life even from small routine spills.

Centre de Recherche Participant: Instituto de investigaciones pesqueras
BARCELONA
Espana

Chercheur principal: R. ESTABLIER

Introduction:

Le laboratoire s'est d'abord intéressé à l'accumulation de métaux lourds dans des organismes marins des côtes espagnoles. Les recherches ont été poussées jusqu'à l'étude, à l'extrémité de la chaîne, de l'accumulation du mercure dans les cheveux de populations humaines consommant normalement ou beaucoup de poissons.

Matériel et méthodes:

Les caractéristiques du milieu expérimental (salinité, pH, température, etc.) ont été rigoureusement contrôlées, de même que les concentrations de polluants.

Résultats et leur interprétation:

Deux types d'expériences ont été conduites:

1) toxicité létale
2) accumulation et effets histopathologiques

1) <u>toxicité létale</u>

Une étude a été menée sur les stades larvaires de *Penaeus kerathurus*. Le tableau ci-dessous exprime les Cl_{50} 24 h (mg/l) pour différents types de polluants.

	CH_3HgCl	Hg ($HgCl_2$)	Cd ($CdCl_2.H_2O$)	Cu ($CuSO_4.5H_2O$)
Nauplius	0,0054	0,0052	0,937	0,103
Protozoea I	0,0046	0,0082	--	0,077
Protozoea II	0,0049	0,0075	1,305	0,081
Protozoea III	0,0035	0,0047	1,270	0,107
Mysis I	0,0071	0,0098	1,270	0,098
Mysis II	0,0098	0,0092	1,230	0,092
Mysis III	0,0071	--	--	--
Post-larvae (P1-P3)	0,0220	--	1,640	--
Post-larvae (P4-P6)	0,0469	--	4,890	1,470

On a aussi étudié l'action des métaux lourds sur des larves de Sepia officinalis et Sparus auratus (CL_{50} 24 h, mg/l)

	$Hg(HgCl_2)$	CH_3HgCl	$Cd(CdCl_2.H_2O)$	$Cu(CuSO_4.5H_2O)$
S. officinalis	0.237-0.280	0.17-0.19	6.0-8.0	0.17
S. aurata	0.35		2,80	0.27

L'éclosion des oeufs de Sepia officinalis est très perturbée pour des concentrations de 0,4 à 0,8 ug/l de Cd et de 80 à 160 ug/l.

2) Accumulation et hystopathologie

Divers poissons Halobathrachus didactylus, Dicentrachus labrax, Mugil auratus, Sparus aurata et la crevette Penaeus kerathurus ont été retenus en tant qu'animaux tests. Les taux d'accumulation suivants ont été trouvés dans divers organes de poissons (en mg/kg de poids humide).

	pylore	muscle	sang	rein	rate	foie	intestin
H. didactylus							
$HgCl_2$ (0,1 mg/l - 35j)			3,69	39,84	37,50	70,86	
$CdCl_2H_2$ (50 mg/l - 96h)		0,15	1,20	12,79		5,21	39,05
D. Labrax							
$HgCl_2$ (0,1 mg/l - 62j)				176.50	125	329.25	
M. auratus							
$HgCl_2$ (0,10 mg/l - 56j)	20,90					101,23	19,70
CH_3HgCl (0,008 mg/l - 45j)	11			16,72	19,10	28,90	
S. aurata							
$CuSO_4.5H_2O$ (0,20 mg/l - 77j)					20	8,92	2,36

Conclusions:

Chez Penaeus kerathurus on a trouvé des taux moyens d'accumulation de Cd($CuCl_2.H_2O$) dans hépatopancreas et muscle de respectivement 319.64 et 6.92 mg/kg de poids humide. De très nombreuses altérations tant cytohématologiques qu'histologiques au niveau de l'appareil digestif et excréteur ont été remarquées.

Liste de publications:

Gutierrez, M., Establier, R. et Arias, A., Acumulacion y efectos histopatologicos del Cadmio y del Mercurio en el Sapo (Halobatrachus didactylus). Investigacion Pesquera (en prensa).

Establier, R., Gutierrez, M. et Arias, A., Acumulacion y efectos histopatologicos del Mercurio inorganico y organico en la Lisa (Mugil auratus). Investigacion Pesquera (en prensa).

Establier, R., Gutierrez, M. et Rodriguez, A., Acumulacion de Cadmio en el musculo y hepatopancreas del Langostino (Penaeus kerathurus) y alteraciones histopatologicas. Investigacion Pesquera (en prensa).

Gutierrez, M., Establier, R. et Arias, A., Acumulacion y efectos del Mercurio inorganico en la sangre del Robalo (Dicentrachus labrax). Investigacion Pesquera (en prensa).

Establier, R., Gutierrez, M. et Arias, A., Acumulacion del mercurio inorganico a partir del agua de mar por el Robalo (Dicentrachus labrax L.) y sus efectos histopatologicos. Investigacion Pesquera (en prensa).

Participating Research Centre: Hydrobiological Research Institute,
Faculty of Science,
University of Istanbul
ISTANBUL
Turkey

Principal Investigator: I. ARTUZ

The requested Summary Report has not been received.

Participating Research Centre: Department of Biological Oceanography and Institute of Hydrobiology, Faculty of Science, Ege University, BORNOVA/IZMIR, Turkey

Principal Investigator: Dr. H. Uysal

Introduction:

City wastes entering Izmir bay have created an alarming situation in relation to marine environment quality.

This work deals with the accumulation and toxicity test of trace metals in Mytilus galloprovincialis and Paracentrotus from Izmir bay and Aliaga bay.

Material and methods:

Experimental stations were chosen according to their different degree of pollution. During field experiments, environmental conditions of these stations were as follows: in Izmir bay: temperature 21°C - 27°C; salinity 36.3 - 39.4 °/₀₀; oxygen contents 0.70 - 6.2 mg/l; pH 7.3 - 8.3, and transparency 0.37 m - 4.05 m. In Aliaga bay: temperature 21°C - 2° C; salinity 38 - 40 °/₀₀; oxygen 5.0 - 6.9 mg/l and pH 8.0 - 8.3. There are seasonal changes especially concerning the temperature and oxygen content; the changes of other parameters are not appreciable. M. galloprovincialis were collected from non-polluted waters of Izmir bay from which 10 control animals were analysed for their trace metals. Then 100 animals, about 50-60 mm in size, were put in each cage and placed in polluted (sewage outfall and industrial discharges) and non-polluted areas (figure 1) of Izmir bay and in the oil-polluted area of Aliaga bay during the most sensitive season of the year for these animals. Ten samples were taken out from each cage and analysed at 15-day intervals. Decomposition vessels (closed teflon crucible in a steel block) and hot plate with thermostatic control for wet digestion of samples have been employed. Wet digestion samples diluted with tri-distilled water and assayed using Varian Techtron Model 1250 Atomic Absorption Flame Spectrophotometer. For the determination of total mercury (Hg T) in biological samples an AAS (Parker 1972) has been used for flameless Hg determination in open system. Cold vapour technique and Varian Techtron Model 64 As/Se/Hg analysis kit were also employed.

Results and their interpretation:

Only preliminary information can be given on the concentrations of trace elements in M. galloprovincialis at different localities during a period of one month (table 1).

Furthermore, information is provided on natural mortality of M. galloprovincialis in net cages during an experimental period of two months in different temperatures (table 2).

Table 2 - Monitoring of dead mussels (Mytilus galloprovincialis) during a field cage experiment

Date of sampling	Sea water temperature	Stations 1	2	3	4	5	6
22.5.1978	21°C	0	0	0	0	0	0
8.6.1978	25°C	2	2	2	4	2	2
26.6.1978	26°C	10	45	50	30	4	4
23.7.1978	27°C	CL	33	28	36	-	10

Further comparative experiments will be carried out in the laboratory using larvae of sea urchins (Paracentrotus lividus) and M. galloprovincialis.

List of publications:

UYSAL, H. (1973). The distribution of some trace elements in Mytilus galloprovincialis Lamarck in different localities. Scientific Reports of the Faculty of Science, Ege University, No.165.

UYSAL, H. (1978). The effects of some pollutants on Mytilus gallprovincialis Lam. and Paracentrotus lividus Lam. in the Bay of Izmir and Aliaga. Presented at the Joint ISCEM/UNEP Workshop on Pollution of the Mediterranean, XXVI Congress, Plenary Assembly of ICSEM, Antalya, 24 - 27 November 1978.

Locality	Sampling date	Dry %	Cu	Mn	Zn	Fe	Pb	Co	Cr	Cd	Hg
R. Paşa Fishery (Control stock)	22.6.78	27.4	7.3	8.3	29.8	26.9	13.4	7.2	4.4	1.3	0.120
Inciralti (1)	9.6.78	26.4	10.6	8.1	69.1	26.8	4.1	8.9	6.5	3.4	0.243
	28.6.78	28.5	15.7	7.9	28.8	19.6	7.3	8.9	4.2	2.2	0.104
	13.7.78	Cage lost									
Mektupçu (2)	9.6.78	28.1	7.6	10.9	40.3	20.6	8.7	12.0	2.4	5.0	0.272
	2[illegible].6.78	25.3	8.1	7.2	48.6	16.3	9.9	4.0	6.4	2.0	0.111
	13.7.78	All died									
Passaport (3)	9.6.78	27.3	6.9	4.7	49.8	23.2	9.4	9.4	11.2	3.4	0.154
	28.6.78	25.9	7.1	7.8	47.0	13.6	8.6	4.0	4.0	1.1	0.113
	13.7.78	All died									
Naldöken (4)	9.6.78	26.8	8.5	3.5	42.6	22.1	10.8	13.2	6.2	3.9	0.186
	28.6.78	26.9	7.4	7.4	39.7	20.4	9.6	2.8	16.4	1.7	0.124
	13.7.78	27.8	4.5	2.8	49.1	19.1	10.0	2.5	8.5	1.1	0.100
Aliağa (5)	9.6.78	19.8	8.8	5.4	43.0	35.2	7.8	4.9	7.8	2.1	0.175
	28.6.78	18.5	6.5	7.3	53.1	39.6	10.2	8.0	16.0	1.5	0.109
	13.7.78	17.2	8.5	6.7	48.7	33.1	8.6	4.9	4.9	1.1	0.100
Aliağa (6)	9.6.78	24.2	10.0	13.6	59.8	37.2	12.7	7.3	15.4	1.9	0.163
	28.6.78	25.4	7.1	3.4	52.8	19.4	9.4	3.8	10.4	1.7	0.136
	13.7.78	2[illegible].7	3.3	5.2	44.1	17.8	9.5	2.4	6.2	1.0	0.071

Table 1. Concentrations of trace elements in *M. galloprovincialis* at different localities during the period of a month. (ug/g w.w.)

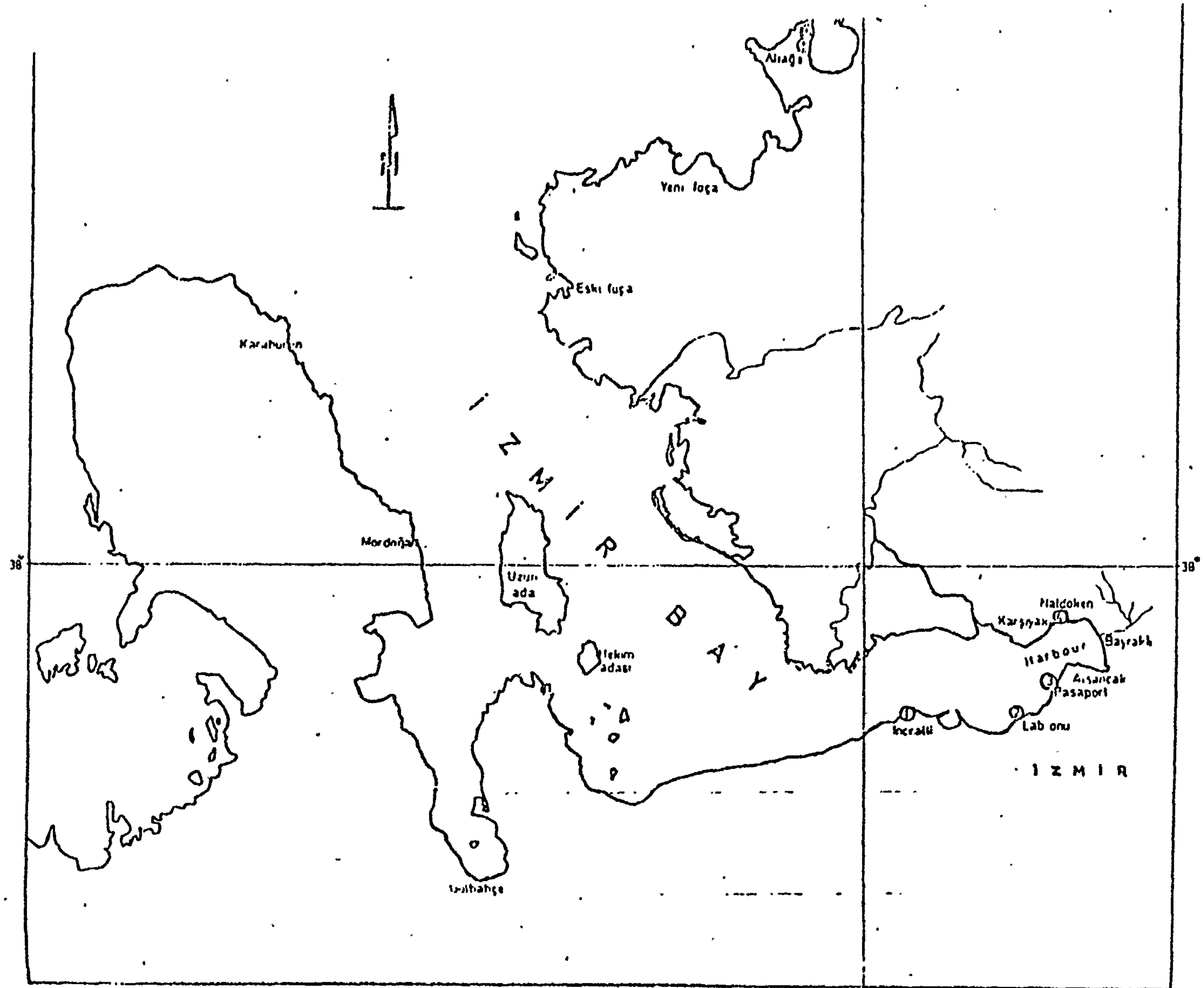


Fig. 1 Izmir Bay and Aliaga Bay with experimental station (1 – 6).

Participating Research Centre: Institute of Oceanography and Fisheries SPLIT Yugoslavia

Principal Investigator: R. MUZINIC

Introduction:

The previous studies were restricted to some observations on the effects of lead on the enzyme activity of the erythrocytes in Scyliorhinus canicula.

Results and their interpretation:

The following experiments were conducted, two of them in close collaboration with laboratories participating in the same pilot project, Instituto de Investigaciones Pesqueras, Cadiz (Spain), and the Old University of Msida, (Malta):

a) Effects of cadmium ($CdCl_2$) on survival of juvenile Mugil auratus. 10 Mugil (length range 31 to 62 mm and weight range 0.43 to 3.30 g) were used with 4 concentrations ranging from 18 mg/l to 100 mg/l (plus a control). Some results are shown below.

Hours	Control	Cumulative number of dead fish			
		Concentrations (mg/l)			
		18	32	56	100
8 h					1/10
24 h		1/10	10/10		10/10
96 h	0	4/9	10/10		
120 h	0	6/9			

b) Effects of mercury on 6 individuals of Halobatrachus didactylus (length range 260-310 mm). Long-term exposure with 100 ug/l concentration of Hg was conducted. The number of erythrocytes and the quantity of haemoglobin and haematocrit were determined. Some cytonaematological alterations were observed.

c) DDT effects on enzyme activities of young Mugil cephalus. Observations were carried out with 6 enzymes (Lactate dehydrogenase, succinate dehydrogenase, malate dehydrogenase, fumarase, - hydroxybutirate dehydrogenase and cytochrome, oxidase from liver and 4 lactate dehysrogenase, succinate dehydrogenase, malate dehydrogenase and fumarase) from muscles. In vitro observations were carried out with concentrations from 1 to 5 ug/ml of mixture and in vivo with concentrations from 0.5 to 1 ug/l of sea water.

DDT (in vitro and in vivo) effects on enzyme activities in young Mugil cephalus (values are given in mu/mg protein) were registered as follows:

		in vitro		in vivo	
	Control	1 ug/ml	5 ug/ml	0.5 ug/l	1.0 ug/l
White muscle					
LDH	27 730	NS	NS	8 360	7 030
SDH	56.6	NS	NS	7.2	6.4
FUM	169	70	115	118	101
Red muscle					
LDH	9 880	NS	NS	6 400	5 670
SDH	6.4	NS	NS	1.4	NS
FUM	796	NS	876	319	257
Liver					
LDH	52.7	208	609	81.7	99.9
SDH	33.3	NS	NS	7.9	3.9
FUM	245	306	339	109	166
B-HBDH	82.8	43	200	18.6	16.9
CYT CX	12.8	NS	NS	*	*

NS = not significant
* = not measurable
No activity change (either in vitro or in vivo) in the malate dehydrogenase

In vivo DDT reduces the activity of the studied enzymes and metabolic processes (respiratory chain and cytric acid cycle). Catabolism of fatty acids and glycolysis are also reduced.

d) Aldrin in vitro effects on enzyme activities in young Mugil cephalus. The same 6 enzymes from liver were studied. Observations were conducted with 1 ug and 5 ug/ml of analysed mixture.

The Aldrin (in vitro) effect on enzyme activities in young Mugil cephalus were as follows:

	LDH		SDH		MDH		FUM		B-HBDH		CYT OX	
Conc. Aldrin (ug/ml) in assay mixture	1	5	1	5	1	5	1	5	1	5	1	5
White muscle	NS	NS	NS	+	NS	NS	-	-				
Red muscle	+	NS	NS	NS	NS	NS	NS	NS				
Liver	+	+	NS	+	NS	NS	+	+	+	+	NS	NS

+ = activation
- = inhibition
NS = not significant
No signifcant effects were recorded in the malate dehydrogenase and cytochrome oxidase, but activating effects in all others.

e) The effects of lead on δ-amino-levulinic acid dehydratase (ALAD) from the blood of adult Scyliorhinus canicula. Lead acetate was added in the in vitro experiment and a 0.1 ml of lead acetate water solution was injected in the in vivo experiments, ALAD activity being recorded at the beginning and after 48 hours.

In in vitro, ALAD activity decreases with concentration. ALAD activity falls to 64 per cent from control to 150 g/ml pb++ in blood.

The in vivo effects of lead on blood ALAD within 48 h in adult Scyliorhinus canicula are shown below:

Conc. $Pb2^+$ (ug/kg)	ALAD activity per cent
500	103
1 000	111
3 000	95.8
5 000	87.7
8 000	81.5

Participating Research Centre: The Biological Institute
DUBROVNIK
Yugoslavia

Principal Investigator: R. KRSINIC

Introduction:

Due to lacking analytical equipment, studies on the impact on marine zooplankton of pollutant introduced by phytoplankton started only recently.

Material and methods:

Present investigations of the Institute include:

1) fate of some chlorinated hydrocarbons in laboratory-grown phytoplankton culture;

2) noxious effects of Diesel oil D-2 and synergistic effect of polychlorinated biphenyls on isopod Eurydice truncata.

Results and their interpretation:

Study of the distribution of chlorinated hydrocarbons, within the experimental system, after separation of particulate water by means of ultrafiltration, was undertaken. The range of percentages shows that the distribution of investigated pollutants is very variable, especially for Milpore filter and Erlenmeyer flask walls.

There are no significant differences in distribution of DDT within the experimental system due to the period of phytoplankton growth (1 day vs. 6 days). There is even no significant difference in the distribution of DDT between systems with and without a phytoplankton culture.

The explanation of such a great variety of results is that DDT used in experiments did not exist as a sea water solution but as some kind of colloid aggregate. It is obvious that the fate of DDT and other investigated low soluble organic pollutants in the systems of laboratory-grown phytoplankton and other similar laboratory systems, is very complex and even unpredictable.

Therefore it is very important to measure concentrations of pollutants in water as frequently as allowed by experiment conditions. It must also be stressed that very often toxicological experiments, with so-called constant concentration levels of pollutants, are unrealistic if pollutants belong to the group of organic compounds characterized by very low water solubility.

Noxious effects of diesel oil D-2 and the synergistic effect of polychlorinated biphenyl (Aroclor 1242) has been studied on the isopod Eurydice truncata. Diesel oil was added at following concentrations: 0.01 ppm, 0.1 ppm, 0.5 ppm, 1 ppm, 5 ppm and 10 ppm and the pesticide at 0.2 ppb. The experiments were performed at 3 temperatures: 14°C, 16°C and 23°C during 4 and 21 days respectively.

Some results are given in the table below:

Table 1 - Percentage of dead animals exposed to different pollutant concentrations, during different temperatures and time periods.

Pollutants at different temperatures	Exposure times	Concentrations of diesel oil D-2 (in ppm)						
		0.01	0.1	0.5	1	5	10	Control
Diesel oil D-2	24 h	-	-	-	-	-	70	0
16 C	96 h	-	-	-	60	-	100	0
Diesel oil D-2 0.2 ppb Aroclor 1242								
14 C	96 h	0	0	-	20	10	60	0
23 C	96 h	-	-	-	-	20	60	0

In the course of a four-day experiment the concentrations minor to 1 ppm Diesel oil D-2 as well as Aroclor 1242 did not show any mortality. In a concentration of 10 ppm D-2 more than 50 per cent of organisms died in the course of 48 hours, the mortality not being higher when Aroclor 1242 was added. In spite of high concentration of pollutants certain organisms survived to the end of the experiment. In the three-week experiment with a concentration of 5 ppm and 1 ppm of D-2 mortality was high up to the tenth day while the remaining isopods survived to the end of the experiment. Overall mortality was greater in test animals exposed to higher pollutant concentration. The size of the oil drops in the system was measured after the inoculation and after 24 hours. The size of drops varied from 15-150 microns. Among digested food, oil drops were found in the intestine of the dead isopods. It can be presumed that oil drops, together with algae, are ingested by the organisms and thus block the pylorical part of the stomach in some way. This hinders further digestion which may be one of the causes of mortality. Through parallel experiments with two temperatures it was noted that in the highest temperature (23°C) the organisms were much more active than in the lower one (14°C). Therefore their food requirements were greater and the harmful effects were shown earlier.

List of publications:

PICER, M.N., PICER, N., KRSINIC, F. and SIPOS, V. (1978). Investigation on the distribution of DDT and Aroclor 1254 in laboratory-grown marine photoplankton. Bull.Environ. Contam.Toxicol. (in press).

KRSINIC, F., VILICIC, D., PICER, M. and PICER, N. Noxious effects of Diesel oil D-2 and the synergistic effect of polychlorinated biphenyls (Arochlor 1242) on species Euridice truncata (zooplankton). Presented in the Joint ICSEM/UNEP Workshop on Pollution in the Mediterranean, Antalya, 24-25 November 1978.

PARICIPATING RESEARCH CENTRE: Centre for Marine Research, "Rudjer Boskovic" Institute,
ZAGREB
Yugoslavia

Principal Investigator: B. KURELEC

The requested Summary Report has not been received.

MED POL V : RESEARCH ON THE EFFECT OF POLLUTANTS ON MARINE COMMUNITIES AND ECOSYSTEMS (FAO(GFCM)/UNEP)

MED POL V : RECHERCHE SUR LES EFFETS DES POLLUANTS SUR LES ORGANISMES MARINS ET LEURS PEUPLEMENTS (FAO(CGPM)/PNUE)

Centre de Recherche participant: Centre de recherches oceanographiques et des peches, Jetee Nord,
ALGER
Algerie

Chercheur principal: R. SEMROUD

Introduction:

L'idée générale du projet pilote est l'étude de l'impact des activités humaines sur les communautés et les écosystèmes de la baie d'Alger. Comme zone de réfrence, la baie non-pollue, de Bou Ismail fut selectione. C'est la première approche de ce genre en Algérie, où les résultats obtenus peuvent servir de point de départ pour suivre, à l'avenir, les changements intervenant dans les communautés et les écosystèmes à cause de la pollution. Déterminer les effets des eaux usées non-traitées (industrielles ou domestiques), d'une cité de 2 millions d'habitants, sur la structure et la dynamique des communautés biologiques, tel est le principal but du projet.

Zone(s) étudiée(s):

Jusqu'à ce jour les recherches étaient menées dans la baie d'Alger uniquement (aire d'environ 100 km^2). L'étude faunistique débuta en avril 1976. L'échantillonnage quantitative démarra en janvier 1977. En mai 1977, suite à la visite d'un consultant FAO au CROP, un plusieurs modification furent dans le programme, incluant:

a) l'addition de 4 nouvelles stations pour l'étude de la dynamique des populations benthiques des sables fins du port d'Alger et de la partie est de la baie d'Alger;

b) un accroissement du volume de l'échantillon de sédiment prélevé, à cause de la rareté des populations (seulement pour les stations étudiées quantitativement), et

c) la remise à plus tard de l'échantillonnage de la baie de Bou Ismail.

Matériel et méthodes:

Les échantillons pour l'étude faunistique furent prélevés par de petites dragues. Les échantillons pour les mesures quantitatives furent collectés avec un échantillonneur (benne orange-peel), d'abord dans les 7 stations, et après novembre 1977 dans les 11 stations à un mois d'intervalle.

La benne n'était d'aucune efficacité pour les substrats sableux, aussi, dans ces stations, un aspirateur fut utilisé. Les matériaux obtenus furent tamisés (mailles de 1,5 mm), conservés et séparés plus tard dans le laboratoire. La composition en espèces, l'abondance, la biomasse (indice de Shanon-Weaver) et la densité de la population furent déterminées. Des paramètres d'environnement, tels que la structure granulométrique des sédiments, la salinité, la température, l'oxygène dissout et la matière organique contenue dans les sédiments furent aussi mesurés.

Résultats et leur interprétation:

La carte zoocoenologique de la baie d'Alger furentinitialement donnée tenant compte de la structure qualitative du substrat et des communautés benthiques. Ce travail était basé sur 80 stations entre 5 et 100 m de profondeur. Au milieu de la baie, entre 0 et 25 m de profondeur, le substrat est de sable fin et les espèces dominantes étaient Owenia fusiformis, Cardium tuberculatum, Spisula subtruncata et Mactra mactra. A la même profondeur, plus près de la ville, le substrat est limoneux et contient Owenia fusiformis, Audouinia tentaculata, Diopatra neapolitana et Aonides oxycephala. Dans la portion SE de la baie (de l'autre côté de la ville), dans la vase sableuse entre les roches du fond à 10 - 15 m de profondeur, Owenia fusiformis, Amphiura chiajei, Nephtys hystricis et Sternaspis scutata prédominent. Plus de vase est trouvé quand on approche du Cap de Motifou, sur la partie la plus éloignée de la baie. Les déchets sont communs dans les profondeurs environnant la baie. Au nord-ouest du port, à 0 - 20 m de profondeur, le substrat est du sable grossier. De 20 à 50 m il est, progressivement, plus vaseux. Dans quelques stations à 50 m, quand la vase est réduite, Andouinia tentaculata devient plus abondante. La plupart des zones profondes sont constituées de vase non-polluées et caractérisées par des communautés homogènes de Sternaspis acutata, Alpheus glaber, Gonoplax rhomboides et Nephtys hystricis.

Récemment, les résultats du programme d'analyse quantitative des échantillons furent interprts et compils (voir la liste des publications). Les groupes dominants étaient des mollusques (en particulier, Cardium tuberculatum, Venus gallina, Spisula subtruncata, Pandora inequivalvis, Donax trunculus, Dosinia lupina, Mactra corallina, Nassa mutabilis, Nassa reticulata, Natica sp.), des polychètes (Nephtys hombergii, Owenia fusiformis, Diopatra neapolitana, Glycera convoluta), et l'échinoderme Ophiura texturata, qui était très abondant. De grands changements étaient observés dans l'abondance des espèces les plus importantes (principalement mollusques) en rapport avec la station et la saison. Dans le littoral sableux la population était dominée par des polychètes tels que Owenia fusiformis, Sudorume tentaculata, Nephtys hombergii, Lubrineris impatiens et Diopatra neapolitana. Les sediments des zones entre 20 et 40 m de profondeur (devenant plus vaseux avec la profondeur), constituent des aires de transition de populations. Audouinia tentaculata atteint de hautes densités en quelques points. Sur le fond vaseux, à plus de 40 m, des populations de polychètes (Nephtys hystricis, Sternaspis scutata, Chaetozone setosa) et de crustacées (Gonoplax rhomboides, Alpheus glaber) tiaent dominantes, alors que les mollusques taient rares.

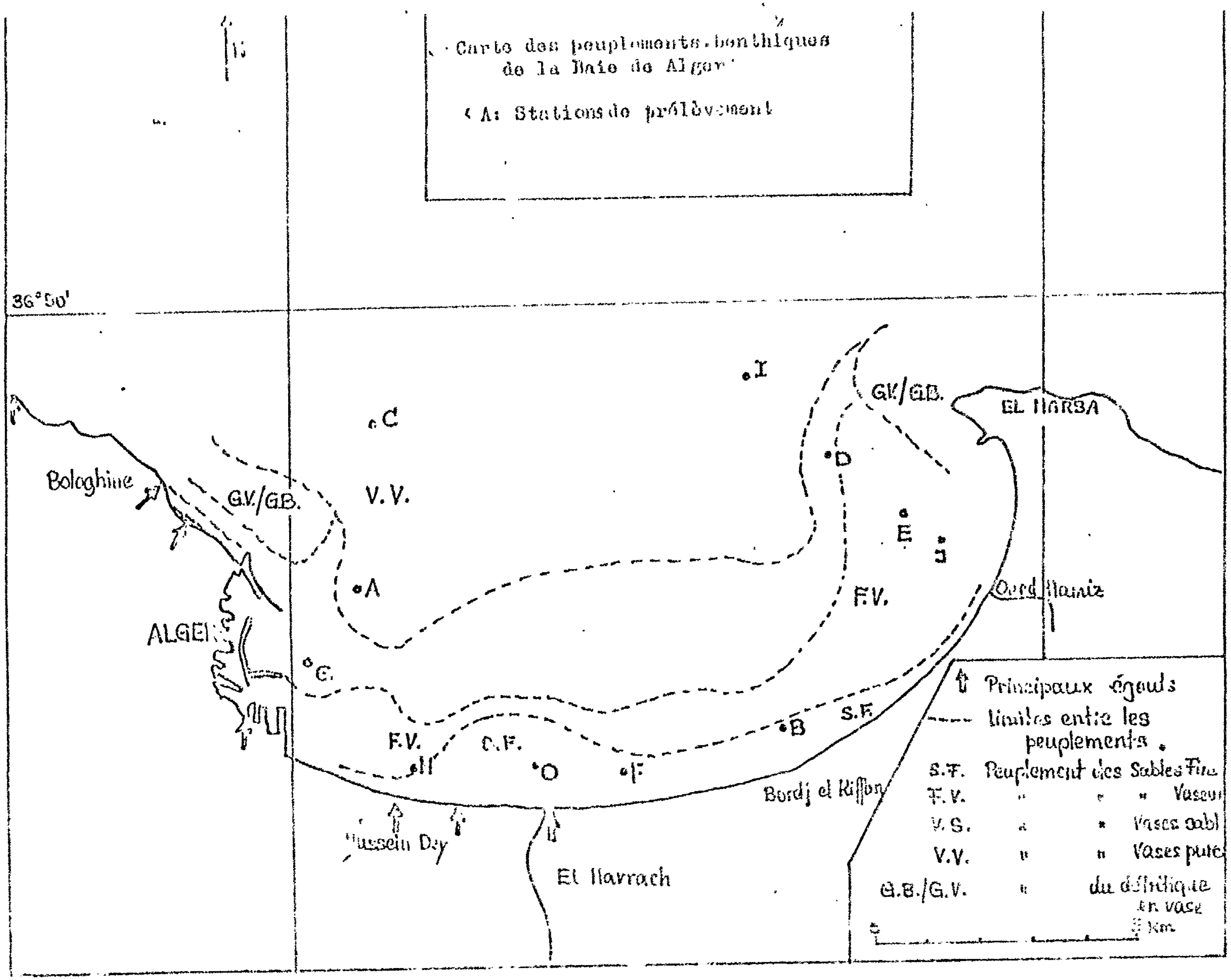
Conclusions:

Les résultats montrent que les polluants déversés dans la baie d'Alger n'ont pas jusqu'ici entrané, d'une manire gnrale, une dgradation dans la structure de la communauté benthique. Les quelques changements observés sont jusque-là limités au voisinage direct des sources de pollution même si la communauté dans son ensemble semble être sensible à une pollution future. A cause des variations hydrographiques les communauts des zones peu profondes sont moins affectées.

Liste des publications:

Bakalem, A. et Romano, J.-C., Etude de la dynamique des peuplements benthiques de la Baie d'Alger. 1. Résultats préliminaires (soumis au groupe de travail, ICSEM/UNEP, sur la pollution de la Méditerranée, Antalya, Turquie, 24 - 27 novembre 1978).

Bakalem, A., (1978). Contributions à l'étude des peuplements benthiques de la Baie d'Alger. Thèse du doctorat de 3ème cycle, 228 pp., 1979.



Carte des peuplements benthiques de la Baie de Alger

• A: Stations de prélèvement

Participating Research Centre: Fisheries Department,
Ministry of Agriculture and Natural Resources,
NICOSIA
Cyprus

Principal Investigator: A. DEMETROPOULOS

Introduction:

In 1975 and early 1976 the Fisheries Department started some preliminary research on benthic organisms and communities in Limassol Bay. The present research is the first phase of the project, the aim of which is to evaluate the effects of pollutants entering the bay. It is also the first time that physical and chemical parameters of the marine environment have been systematically monitored.

Area(s) studied:

The structure of benthic communities in the bay, which receives a sewage discharge, was compared to the "clean" Episkopi Bay which lies west of the Akrotiri peninsula and is a relatively unpolluted area, separated from direct effluent discharges. There are no major settlements close to the sea either. Fish populations of these bays were also observed (see figure 1).

Limassol Bay has two commercial ports, a town of 65,000 inhabitants and light industry (a slaughterhouse and 7 beverage factories, for soft drinks, wine, spirits, and a brewery). All wastes are discharged untreated into the bay. Unpolluted Episkopi Bay was studied for reference values.

Two series of stations have been set up, one for each bay. Each series consists of 7 stations (at 5, 10, 20, 30, 40, 60 and 100 m depths) for benthos investigations, and 9 stations for environmental studies (which includes the 7 stations mentioned and one at 150 m and another at 180 m depth).

Material and methods:

Physical and chemical parameters (light, temperature, pH, salinity, oxygen, nutrient levels, suspended solids, granulometry of the sediments, etc.) were taken in both environments considered, as well as level of pollution in the sea-water and in different benthic organisms. Other measurements undertaken on effluents were:

(a) As, Cr and Ni; (b) phenols, methylene blue active substances, mineral oils (hexane soluble), organophosphorous compounds, chlorinated organic compounds; (c) total phophorus, total Kjeldahl nitrogen, ammonia and (d) COD.

Samples for benthic fauna were taken with orange-peel bucket sampler, beam-trawl and sledge dredge. Fish were collected with triangular dredge and trawl net in the deeper areas. Shore seine was used for shallow waters. Underwater photography and direct observations were effected with diving equipment (SCUBA). Samples were processed by standard methods.

Results and their interpretation:

The composition of the substrate and benthic vegetation along the transect of both stations observed is as follows:

	Limmasol Bay (Station 2)	Episcopi Bay (Station 1)
Beach	sand with some gravel	sandy beach with low rocks
5 m	Posidonia meadows/sand	sand with scattered Posidonia outcrops
10m	Posidonia meadows/muddy sand	sand with scattered Posidonia outcrops
20 m	muddy sand with Caulerpa	sandy mud with Caulerpa
30 m	mud with Caulerpa	
40 m	mud with Caulerpa	
60 m	mud with Caulerpa	
100 m	mud aphytal	

A summary of comparative results is given in table 1. The values obtained show that Limassol Bay appears to be much richer in most parameters measured. Possible biases resulting from sample size and environmental differences have been tested and additional sampling has been done to ensure the correct interpretation of the results. These additional samples are currently being analysed.

Conclusions:

It can be concluded that the impact of organic pollution on benthic communities in Limassol Bay originate from general enrichment of the marine environment. Increased amounts of nutrients and organic matter minimize food availability as a limiting factor. However, some species were not found in the samples, although the evidence shows that they lived in the area. On the other hand, some species (e.g. Holothuria sp.) appear in unusual abundance. Both facts indicate a degradation of benthic community complexity. This conclusion should be considered only as tentative. More detailed evaluation is expected when the latest samples are analysed.

Table 1 Comparison of results on biomass, abundance, infauna, epifauna from Episkopi Bay (Station 1) and Limassol Bay (Station 2)

Depth (meter)	5		10		20		30		40		60		80	
Stations	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2
Biomass (Fauna) Mean wet weight gr/100.1 of sample	8.74	27.25	1.54	23.4	1.98	30,88	7.94	28.17	21.68	30.99	14.27	25.19	4.65	4.65
Biomass (Total) Mean wet weight gr/100 1 of sample	14.79	202.91	3.04	490.65	6.04	245.93	120.64	175.81	401.62	109.58	250.32	146.15	4.65	4.67
Biomass (Total) Dry weight gr/100 1 of samples	6.20	42.08	1.06	81.52	1.38	47.98	20.54	36.48	72.61	24.77	28.23	33.87	1.21	1.89
Abundance Mean No. of individuals/ 100 1 of samples	7	21	20.5	48	16.5	69	51	108	72	62	16	41	115	5.5
Infauna Mean No. of species/ 100 1 of sediment (Orange Peel)	5	18	6.5	23.5	11	24	19	235	19.5	19.5	11	17	7	5
Epifauna Mean No. of 2 samplings 3 hauls each (Sledge dredge)	21.5	44	25	67	66	72.5	71	88.5	52	61.5	52.5	52	36.5	45

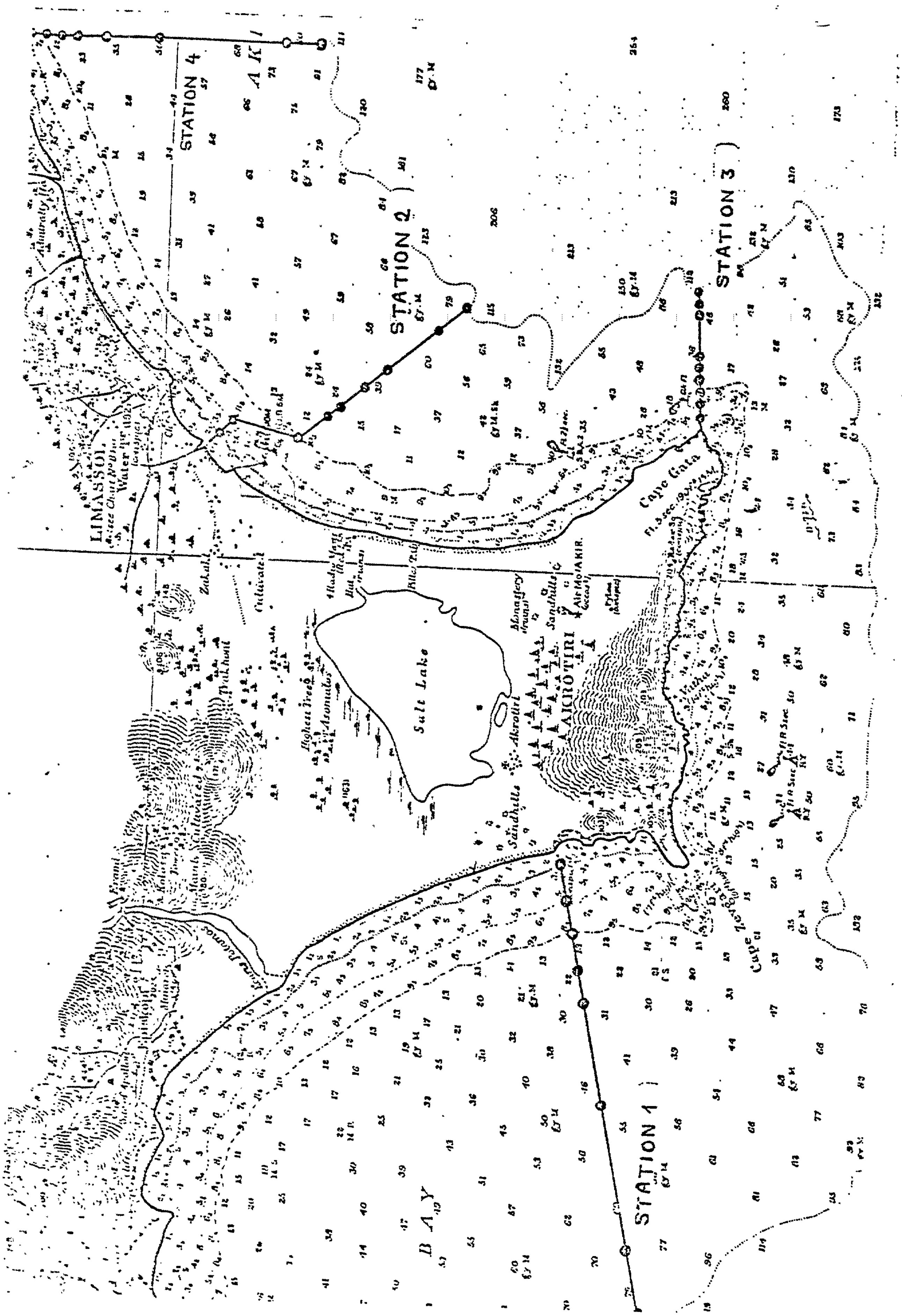


Fig. 1 Sampling area with transects

Participating Research Centre: Institute of Oceanography and Fisheries, Mediterranean Branch, ALEXANDRIA Egypt

Principal Investigator: M.L. EL-HEHYAWI

The requested Summary Report has not been received.

Centre de Recherche participant: Station marine d'Endoume et centre d'oceanographie,
MARSEILLE
France

Chercheur principal: D. BELLAN-SANTINI

Introduction :

La Station marine d'Endoume travaillait depuis plus de vingt ans sur le benthos de la Méditerranée nord occidentale. Depuis plus de 15 ans de nombreux et importants travaux sur les zones polluées et sur l'influence des diverses sources de pollution sur les écosystèmes benthiques ont été réalisés. C'est l'importance de ces études et la connaissance des méthodes utilisées qui ont conduit la SME à accepter la participation dans le cadre du projet pilote.

Zone(s) étudiée(s):

La zone étudiée s'étend du Golfe de Fos au Golfe de Cannes ayant comme sources principales de perturbations étudiées les nombreux rejets urbains et industriels du Golfe de Fos, les rejets d'eau douce de l'Etang de Berre, l'égout de Marseille-Cortiou, l'égout de la ville de Cannes.

Matériel et méthodes :

L'chantillonnage du benthos a t de type classique: prélévements directs en plongée libre ou scaphandre autonome pour les substrats durs, prélèvements par bennes, dragues, chaluts pour les substrats meubles. L'étude qualitative et quantitative numérale et parfois pondérale a été poursuivie.

Résultats et leur interprétation:

Etang de Berre:

A l'exception d'une zone située dans le sud-ouest de l'étang de Berre, soumise à l'influence des eaux marines en provenance du golfe de Fos (Stora, 1976), aucune espèce macrobenthique ne vit dans les substrats meubles de l'étang au-dessous de 5 m de profondeur. Au-dessus de cette limite, la biocénose lagunaire euryhaline et eurytherme (L.E.E.) occupe un mince liséré côtier.

La composition et la répartition du peuplement sont directement liées à un certain nombre d'altéragènes présents dans l'étang. Certains de ces altragnes sont concommitants aux dversements massifs et erratiques d'eaux douces dans un étang marin, et cela depuis la mise en service de l'usine hydroélectrique de St. Chamas, d'autres sont inhérents au rejets domestiques et industriels des villes et usines qui bordent l'étang ou des trois rivières qui se jettent dans celui-ci.

1) A quelques exceptions près, la nature et l'abondance des polluants signalés par Arnoux et al., (1976) dans les sédiments superficiels

n'influencent pas directement la répartition du peuplement dans l'étang de Berre.

Si l'on considère les taux moyens calculés à partir des analyses réalisées sur 100 stations, on s'aperçoit que pour l'ensemble des métaux lourds et l'arsénic, les détergents anioniques et les PCB, la zone sud-ouest présente des taux maxima par rapport aux autres zones. Or, c'est précisément dans cette zone que la biocénose L.E.E. est la plus riche qualitativement et quantitativement.

2) Ces données confirment l'influence prépondérante qu'exercent les rejets des eaux douces de l'usine hydroélectrique sur la composition et la répartition de la biocénose L.E.E. (Sotra, 1976); Bellan & Stora, 1976), ces rejets étant responsables de l'anoxie des fonds, de variations brutales de la salinit du milieu ainsi que de décharges importantes de limon dans l'étang.

3) Il n'en demeure pas moins que si les polluants n'ont pas une action directement décisive sur la répartition du peuplement, les effets synergiques, créés par l'association de tous les altéragènes présents dans le milieu, peuvent exercer une influence importante sur la composition de la biocénose L.E.E.; la dégradation de cette biocénose étant marquée par un appauvrissement qualitatif mais surtout quantitatif du peuplement.

Golfe de Fos :

On note un appauvrissement important des fonds lorsqu'on s'enfonce dans le golfe. De très importantes zones d'herbier de Posidonies sont détruites ou en cours de destruction. On assiste à une inversion de la dominance animaux/ végétaux du concrétionnement, au profit de la partie végétale. On observe une importante sélection des espèces avec élimination de certains groupes zoologiques probablement liée à des résistances différentielles aux agents chimiques.

Golfe de Marseille :

Depuis sa mise en service en 1896 et jusqu'en 1970, l'influence de l'égout de Marseille-Cortiou ne dépassait pas une zone, centrée sur le débouché de l'missaire, d'environ 1,5 km de rayon. Depuis 1970, pour assainir la principale plage de Marseille, le petit fleuve Huveaune est détourné chaque été dans le collecteur de Marseille-Cortiou, les polluants chimiques industriels qu'il renferme se trouvant alors mélangés aux eaux usées essentiellement domestiques de l'agglomération marseillaise, le tout venant en contact avec les argiles en suspension dans l'eau de mer : on constate précisément qu'après 1970, il y a eu brusquement une extension accélérée et considérable de la seule zone subnormale (sédiments devenant noirâtres et nauséabonds dans leur épaisseur, peuplements benthiques modifiés). Cette progression de la limite externe de la zone subnormale (état en 1975) a été d'autant plus rapide qu'elle a atteint des fonds de décantation préexistants, ce qui a alors constitué des "saillants", et a été momentanément freinée au niveau de certaines pénétrations d'eaux du large sur le plateau, ce qui a alors constitué des "rentrants". Actuellement, cette extension paraît surtout limitée à la résorbtion des "rentrants" (observations de 1976 et 1977), les eaux polluées étant entrainées et diluées plus au sud au contact du courant général est-ouest, et plus à l'ouest au contact du rebroussement nord-sud d'un contre-courant côtier qui longe d'ouest en est la chaîne de la Nerthe.

La cartographie des substrats durs a montré en 1978 un nouveau recul des zones de peuplements d'eau pure et une extention des zones de peuplements d'eau polluée.

Golfe de Cannes :

Une étude préalable à la mise en service en juillet 1973 d'un émissaire sous-marin avait permis de constater que les éléments polluants rejetés dans le golfe avaient tendance à y être retenus, ce qui entraînait une détérioration généralisée des peuplements notamment au niveau d'un fond de décantation situé dans le nord-ouest du golfe et référable à la zone subnormale. Quatre ans après la mise en service de l'émissaire, on a pu constater une amélioration de la situation dans l'est du golfe et une aggravation dans la partie ouest, notamment dans le fond de décantation occidental dont le peuplement a évolué vers un peuplement typique de la zone polluée (Zone II) à Capitella capitata et Scolelepis fuliginosa. Entre ce fond et le débouché de l'émissaire subsistent des peuplements parfaitement représentatifs d'une zone subnormale (Zone III).

Liste de publications:

Arnoux, A. et Stora G. Distribution de quelques altéragènes présents dans l'étang de Berre : leur influence sur la répartition de la macrofaune benthique. XXVIe Congrès CIESM, Antalya, Comité "Etangs salés et lagunes".

Bellan, G., (1978). Une tentative sérieuse de réduction de la pollution marine en Méditerranée : l'émissaire sous-marin de la ville de Cannes Tech. de l'eau : 380-381 (sous presse).

Bellan, G. et Bellan-Santini, D. L'étang de Berre et le Golfe de Fos : deux exemples de l'importance des études écologiques dans l'aménagement du territoire. Cent. Soc. Zoologique (sous presse).

Bellan, G., Bellan-Santini, D. et Picard, J. Les modalités de répartition en Méditerranée nord-occidentale des peuplements benthiques des sédiments côtiers soumis à la pollution par matières organiques dominants. XXVIe Congrès CIESM, Antalya, Comité Pollution.

Eugène, C. Epifaune des herbiers de Posidonies du littoral provençal dans des secteurs pollués et non-pollués. XXVIe Congrès CIESM, Antalya, Comité Benthos.

Harmelin, J.G. et Hong Sae Sang. Données préliminaires sur le peuplement d'un fond de concrétionnement soumis à un gradient de pollution. I. Généralités. II. Faune bryozoologique. XXVIe Congrès CIESM, Antalya, Comité Benthos.

Picard, J., (1978). Impact sur le benthos marin de quelques grands types de nuisances liées à l'évolution des complexes urbains et industriels de la Provence occidentale. Oceanis. (sous presse).

Centre de Recherche participant: Station marine d'Endoume et centre d'oceanographie,
MARSEILLE
France

Chercheur principal: F. BLAN et M. LEVEAU

Introduction:

Les effets de la pollution sur les écosystèmes benthiques dans la zone marseillaise ont été systématiquement étudiée depuis 1967 mais peu de chose furententrepris en ce qui concerne l'écosystème pélagique.

Zone(s) étudiée(s):

La zone sud-est du golfe de Marseille reçoit quotidiennement de grandes quantités d'eaux usées domestiques et d'effluents industriels. Le mouvement de la couche d'eau polluée, vers l'est ou l'ouest, dépend des courants dominants et de la direction du vent.

Au cours de ce projet la zone néritique a été systématiquement étudiée. Les prélèvements furent effectués à Cortiou, dans la zone Marseillaise (fig. 1) en avril (deux fois et en septembre 1977, et des mesures et analyses conduites selon un plan établi.

Matériel et méthodes:

De la phase initiale de l'investigation il en résulta des données sur les paramètres physiques et chimiques (salinité, température, turbidité, oxygène dissout, éléments nutritifs ($P-PO_4$, $N-NO_3$, $N-NO_2$, $N-NH_4$, et $Si-SiO_2$) sur les paramètres biologiques (l'importance en bactéries, en phytoplanctons, des indices de diversité, les chlorophilles a et la phaeophytine, les adénylases telles que ATP, ADP et AMP, le carbone organique, le zooplancton) et sur les polluants (les aromatiques et les hydrocarbures du pétrole, les phénols, les détergents et métaux lourds tels que cadmium, zinc, cuivre et plomb).

Des méthodes statistiques standards furent utilisées pour définir la structure spécifique (les associations spatio-temporelles et les interactions avec les polluants) de la communauté planctonique.

Un rapport préliminaire détaillé sur les écosystèmes pélagiques de Marseille - Cortiou a été préparé. A partir de ce rapport et tenant compte de données disponibles les résultats préliminaires peuvent être résumés comme suit:

Résultats et leur interprétation:

Des mesures de la biomasse ont montré une population planctonique dans la zone directement influencée par les rejets de déchets. Une importante arrivée de détritus organiques et une reconstitution progressive des populations planctonique est observée quand on passe du point d'arrivée des déchets à la pleine mer. La zone entière a pu être divisée en 3 parties: zone très polluée (approximativement 200 m^3 autour du point d'arrivée des déchets), zone polluée et enfin la zone qui est moins polluée; les deux dernières étant sous la dépendance des vents dominants (E ou NO). Au delà de ces 3 zones les conditions sont caractéristiques d'un environnement néritique oligotrophique.

Des bactries marines en grand nombre furent trouves prs du point d'arrive des déchets (plus de 10^6 de cellules/ml) à cause du taux élevé de matières organiques libérées, alors que le nombre décroit, vers la pleine mer, pour atteindre un niveau inférieur à 10^3 cellules/ml (en dehors de Cortiou). La distribution quantitative des bactéries terrestres est pratiquement parallèle à celle des bactéries marines. Des colibacilles (Enterococcus et Escherichia coli), en grand nombre près du point d'arrivée des déchets, décroissent rapidement pour finalement disparaître quand on atteint la pleine mer, exceptés les colibacilles que l'on trouve dans l'eau non-polluée du golfe de Marseille.

Pour ce qui est du phytoplancton, à ct d'une abondance de Cyanophycées et Cryptophycées il furentobservé un faible nombre d'autres espèces même de celles, telles que Skeletonema costatum, normalement caractéristiques d'eutrophisation excessive. Il semble que l'impact des déchets ne soit réel qu'à l'intérieur de la baie alors que l'écosystème de la pleine mer est inaffecté.

Les organismes zooplanctoniques taient presqu'inexistants dans la zone trs polluée. Dans la zone polluée Acartia clausi était l'espèce dominante, tandis que d'autres espèces euryhalines telles que Oithona nana, Euterpina acutifrons et Clausocalanus sp. étaient présentes. Par ailleurs, dans la même zone et spécialement dans une petite aire avec de l'eau néritique non-polluée ou dans des aires moins polluées à l'extrémité de cette zone, les espèces Paracalanus sp., O. helgolandica, Centropages typicus, de même que les genres Corycaeidae, Fritillariidae et Oikopleuridae furent trouvées. Aucune larve de poisson, de gastropode et de copépode ne furent trouvée, dans l'aire recevant les déchets.

Conclusions:

Les conclusions préliminaires sont:

a) La presence de bactries pathognes qui constitue un danger prs de la zone d'élimination de déchets, particulièrement en été;

b) Toutes les conditions pour l'eutrophisation de la zone sont remplies; de l'eau de mer diluée, de grandes quantités de particules et de matières dissoutes (principalement phosphates et amoniaques) faible oxygénation, zone relativement enfermée.

Par ailleurs, d'autres facteurs, comme l'instabilité thermo-haline, la circulation fréquente de l'eau et la grande quantité de substances ayant un effet nuisible sur des cellules vivantes, même en petites quantités, ralentissent la possibilité d'enrichissment de l'environnement. Aussi, n'existe-t-il que quelques espèces, particulièrement tolérantes, qui puissent survivre et se multiplier. Ces conclusions préliminaires montrent que l'aire étudiée est très complexe et requière d'autres investigations dans le but d'avoir une connaissance plus approfondie du système.

Liste de publications:

Impact d'un effluent urbain sur des populations planctoniques néritiques: présentation du site de Cortiou, E.P.O.P.E.M. Congrès C.I.E.S.M., Antalya, novembre 1978.

Impact de l'effluent urbain de Cortiou sur les populations phytoplanctoniques néritiques. E.P.O.P.E.M. Congrès C.I.E.S.M., Antalya, novembre 1978.

Effet global de la pollution d'un émissaire urbain (Marseille Cortiou) sur les populations zooplanctoniques d'une zone néritique. E.P.O.P.E.M. Congrès C.I.E.S.M., Antalya, novembre 1978.

Bilan et impact des détergents anioniques sur un écosystème pélagique. E.P.O.P.E.M. Congrès C.I.E.S.M., Antalya, novembre 1978.

Système planctonique et pollution urbaines. Présentation du site néritique de Cortiou, calanque de Marseilleveyre. E.P.O.P.E.M., Téthys, sous presse.

Thèse de 3ème cycle

Arfi, R., Plancton et pollution: effets d'un rejet urbain (grand émissaire de Marseille), Traitement des données.

Maurer, D., Phytoplancton et pollution. Lagune Ebrié (Abidjan) - Secteur de Cortiou (Marseille).

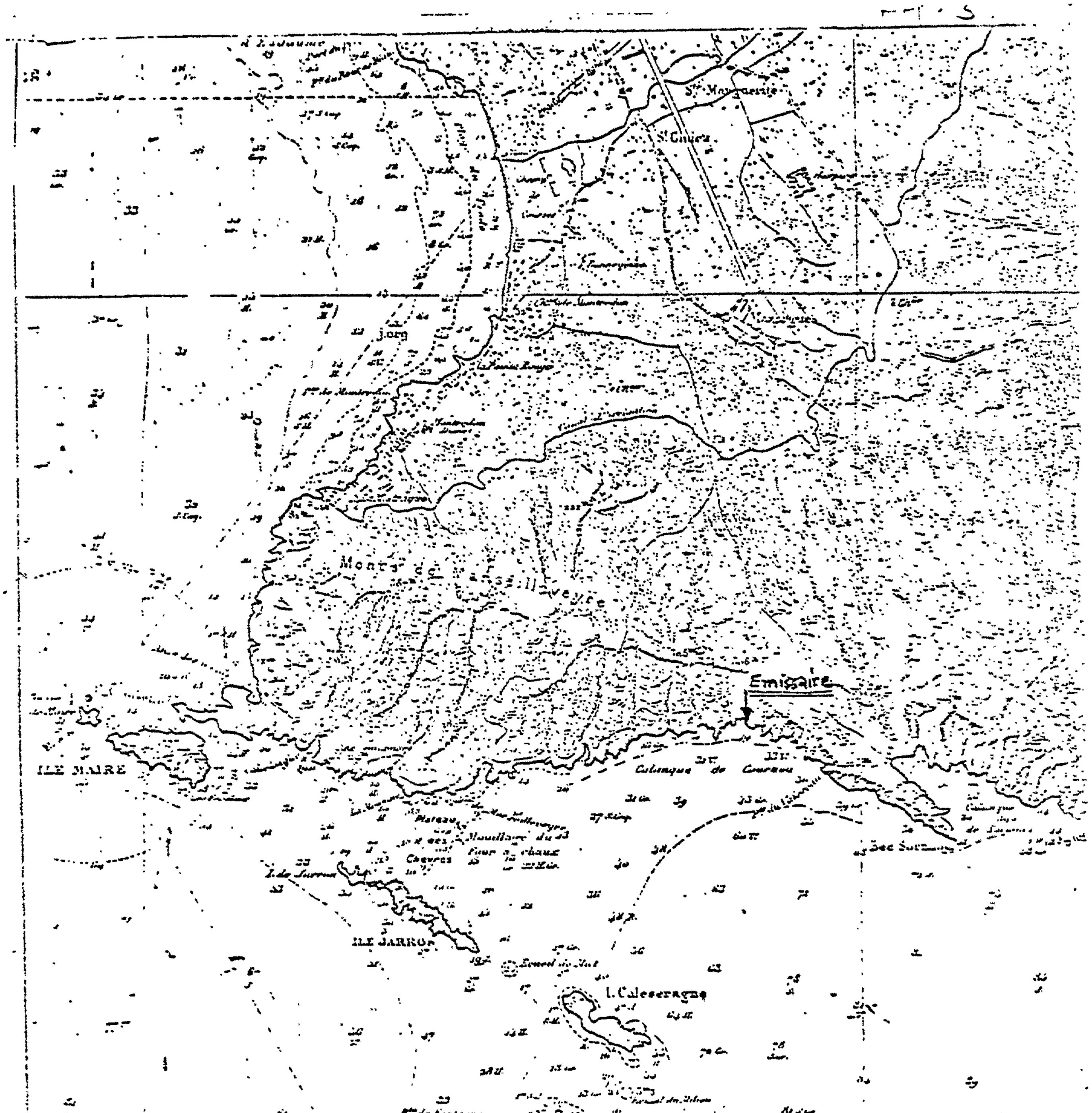


Fig. 1 Echantillonnage de la zone avoisinant Cortiou

Participating Research Centre: Institute of Oceanographic and Fisheries Research (IOKAE), ATHENS Greece

Principal Investigator: C. BOGDANOS

Introduction:

In order to determine the effects of various pollutants (domestic sewage, industrial effluents), the structure of macrobenthic communities at selected sites in Saronikos Gulf was investigated. The Institute has previously done similar research in Saronikos Gulf (1976) as well as in Pagassitikos Gulf and Thermaikos Gulf. Based on obtained results, technical reports have been prepared to assess the effects of the constantly increasing discharges from three main cities, i.e. Athens, Volos and Thessaloniki, located in these gulfs.

Area(s) studied:

The position of the research area and of 16 stations in Saronikos Gulf are shown in figure 1. The investigated area was divided into:

a) heavily polluted section (D1, D2, D3 and D4);

b) polluted section (stations B and A1);

c) clean section (stations, B1 B2, B3, B4, B5, B6, B7, B8, B9 and A2).

Three series of sampling (cruises) have carried out up to now. The first was in March 1977, then in September 1977 and March 1978. For every sample the diversity, biomass, density, abundance, as well as grain size, organic carbon content and hydrogen sulphide concentration of the sediment were determined. Temperature, salinity, nutrients, and dissolved oxygen were also taken into account.

Materials and methods:

The raw material for biological samples was collected with Van Veen grab (0.18 m^2), washed through 2 and 1 mm sieves and preserved in 5 per cent formaline solution. After determinations were finished, dry weight was measured. Diversity indices were calculated using Margalef-Gleason index. Physical and chemical parameters of water and sediment were measured according to standard methods.

Results and their interpretation:

Out of 97 species found in the area, 70 belonged to polychaetes, the dominant group. The most common and abundant species were: Glycera rouxii, Lumbrineris impatiens, Tharyx sp., Paraonis gracilis and Thiasira flexuosa, which were prevalent everywhere except in the three most heavily polluted stations. One of these stations was completely azoic, in the second, only 7 species have been found (lowest species diversity but highest abundance e.g. 874 individuals per sample of Capitella capitata); in the third station, although situated near the outfall, 29 species have been identified. Other dominating species in the second station were: Scolelepis fuliginosa. Notomastus latericeus and Audouinia tentaculata. In the third station (which had a coarser sediment - silty sand rather than sandy silt, in contrast to the other two stations - and better water circulation which sustains a supporting dissolved oxygen level at the bottom), the most abundant species found were: Notomastus latericeus, Polydora caeca, Capitella capitata, Polydora antenata, Ophryotrocha puerilis, Lumbrineris latreilli, Prionospio malmgreni, Ancistrosyllis parva, Spiophanes bombyx, Glycera rouxii, and Corbula gibba.

In the clean southern area the most common and abundant species, except for the dominant ones mentioned above, were Sternaspis scutata, Cossura coasta, Prionospio malmgreni, Turitella communis, Callianassa stebbingi, Aricidea sp., Marphysia belli, Nephthys hystricis, Hyalinoecia bilineata, and Choetozone setosa.

The change of diversity index values throughout the year are prepared in figure 2. They decrease from March 1977 to September 1977 and increase in the following March. This probably occurred because of the reduced dissolved oxygen values as a result of stable hydrographic conditions (no mixing of water masses) which usually happens during summer time. The samples obtained from heavily polluted stations, i.e. D^1, D^2, D^3 and D^4 during the second cruise did not contain living organisms, but in the samples of the next cruise (March 1978) organisms appeared at stations D^2 and D^4 (not near the outfall). Stations D^1 and D^3, close to the outfall, were completely lifeless.

Station A^1 belongs to the polluted zone. It is influenced by industrial effluents (fertilizer factory). The dominant benthic organism of this station is the polychaete Scolelepis fuliginosa, a typical indicator of oxygen deficiency. In the sample from March 1978, among a total of 3 200 macro-zoobenthic individuals, 2 200 belong to Scolelepis fuliginosa. A similar situation was found at station B, which is located south of the small island Psitalia at a considerable distance from the outfall (about 1.5 miles). A very rich bottom fauna (high species number, abundance and biomass) was observed in this moderately polluted zone. The island of Psitalia is a natural barrier which probably prevents the expansion of the sludge field behind it. This fact is also evident from the sediment of station B which is sandy silt to silty sand and without considerable signs of pollution.

The clean zone was identified as a typical Eastern Mediterranean oligotrophic habitat. The survey of this clean site provides background data for subsequent studies after the dumping of outfall begins.

Conclusions:

Benthic communities, situated in the immediate vicinity of the outfalls (stations D^1 adn D^3) were degraded completely. The communities, considerably distant from these outfalls but still influenced by the effects of pollutants (station A^1), are characterized by reduction of normally highly abundant species. The situation observed at station B is characteristic for the marginal zones, i.e. between polluted and clean. It is characterized by very rich fauna, i.e. high number of species and with high abundance. The area between stations B and D^2 is proposed to be studied in order to evaluate the gradient of structural changes in bottom fauna.

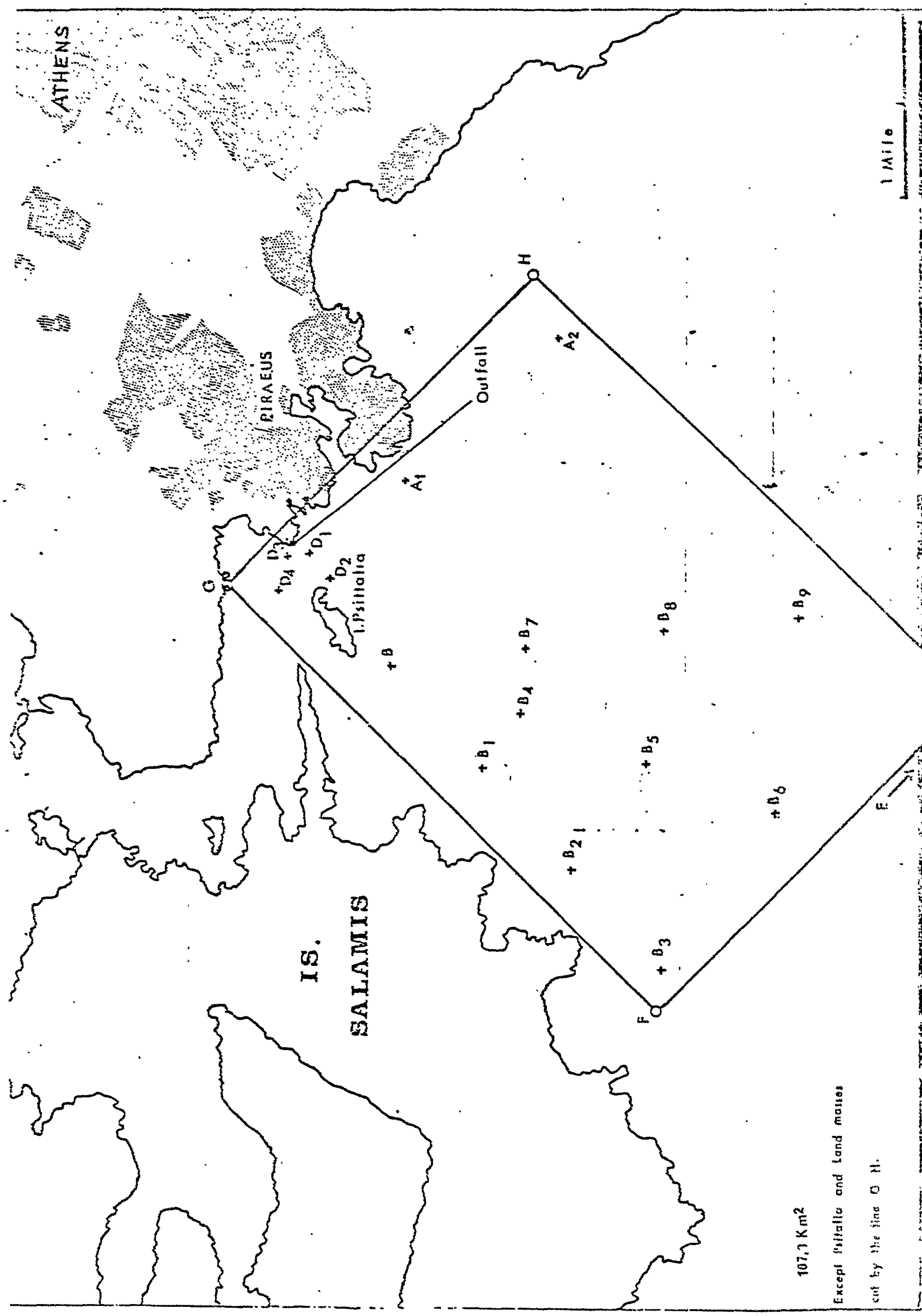


Fig. 1 Sampling area in Saronikos Gulf

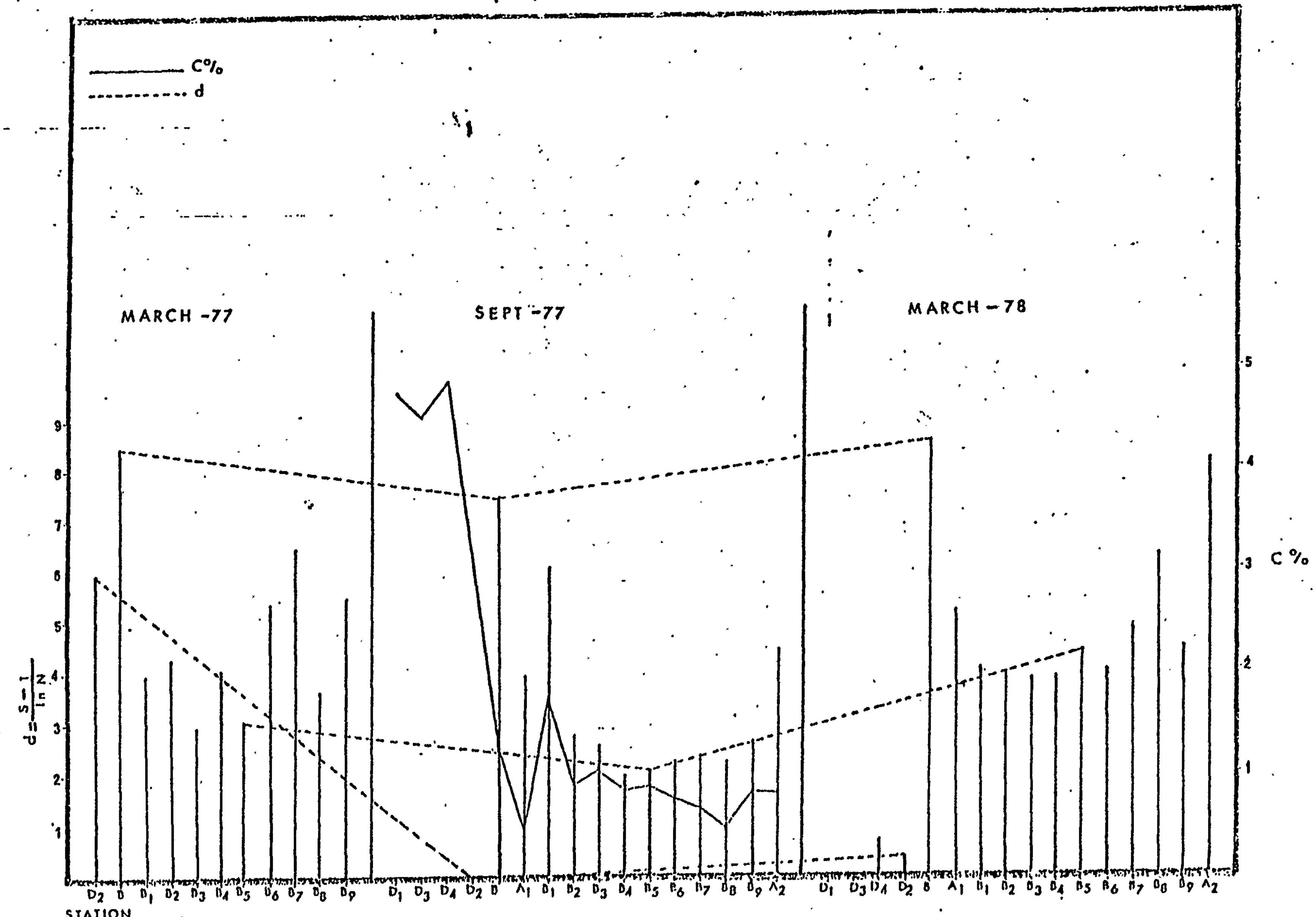


Fig. 2 Changes of diversity index from March 1977 to March 1978 in macrobenthic communities of Saronikos Gulf

Participating Research Centre: Zoological Laboratory and Museum,
University of Athens
ATHENS
Greece

Principal Investigator: C.E. VAMVAKAS

Introduction:

The effects of different kinds of pollutants (domestic sewage, industrial effluents, thermal pollution, etc.) on the structure and development of fouling communities is being studied on submerged panels.

Area(s) studied:

Six experimental sites have been selected for this study. One was in Piraeus harbour and five in the area near Lavrion harbour, southeast of the Attica peninsula, in depths from 1 to 10 m. Besides general pollution, heated effluents from an energy plant, mining dust and phosphorus from a match factory are influencing the sites near Lavrion harbour.

Material and methods:

The biofouling panels were made of polyvinyl chloride, asbestos and wood. They were regularly changed by scuba divers every month, and during summer time every fortnight. Series of panels were also submerged for a longer period (see tables 1 and 2).

The environmental parameters measured each month were: temperature, salinity, dissolved oxygen, transparency, phosphates, nitrites, nitrates, ammonia, silicates, pH and suspended matter.

Standard methods were used to determine physical and chemical parameters of the water. Testing panels were manipulated by divers.

Results and their interpretation:

The study of the following community examined on approximately 157 panels has shown some differences between different sites, especially compared to Piraeus harbour. Systematic identification of the organisms has been undertaken in the samples taken from the panels in Piraeus while constituents of the community on the panels placed in the 5 sites in the Lavrion area were partly identified, the the others being kept for further identification. The whole panel has been preserved for biomass measurements.

Twenty-nine species of fouling and boring organisms have been identified on the panels in Piraeus harbour. The most important and common species found was in the barnacle Balanus amphitrite. Other common species were among the serpulids, e.g. Serpula vermicularis, Hydroides norvegica and Spirorbis sp. and bryozoans, e.g. Bugula stolonifera, B. neritina, Watersipora subovoidea and Cryptosula pallasiana.

The interpretation of the biological data was carried out in conjunction with the study of chemical parameters. So far, the fouling communities in Lavrion harbour have proved to be rather poor in comparison with those in Piraeus. The most common groups in the Lavrion area were bryozoans and polychaetes (Serpulids). A complete list of the species found in Piraeus harbour is given in tables 1 and 2. The maximum settlement and growth of organisms was observed during the summer months, and particularly in July.

Conclusions:

A preliminary comparison between Piraeus harbour and the sites in the Lavrion area has shown that, in spite of evident pollution, the fouling community in Piraeus (mainly domestic wastes) is richer in species abundance and diversity than the one in Lavrion (higher percentage of industrial discharge). Temperature and related parameters seem to play the dominant role in the settlement and growth of fouling organisms while other factors like turbidity are less important.

TABLE 4

List of species found in >1 month submersion PVC panels.

	Π-2	Π-3	Π-4	Π-5	Π-6	Π-8	Π-10	Π-12
Balanus amphitrite	+	+	+	+	+	+	+	+
Balanus eburneus		+	+	+	+	+	+	+
Balanus tintinnabulum		+	+	+	+	+	+	+
Balanus perforatus				+	+	+	+	+
Tubularia sp.	+							
Obelia geniculata	+							
Bugula stolonifera	+	+	+	+	+	+	+	+
Bugula neritina	+	+	+	+	+	+	+	+
Zoobotryon verticillatum			+	+	+			
Bowerbankia imbricata			+	+				
Bowerbankia gracilis		+	+	+	+			
Watersipora subovoidea	+		+	+	+	+		
Cryptosula pallasiana	+	+	+	+	+	+		+
Schizoporella unicornis					+			
Serpula vermicularis	+	+	+	+	+	+	+	+
Hydroides norvegica	+	+	+	+	+	+	+	+
Spirorbis sp.	+	+	+	+	+	+	+	+
Botryllus schlosseri	+	+	+	+	+	+	+	+
Botrylloides leacki			+	+	+	+	+	+
Ascidia virginea					+	+	+	+
Styela partita				+	+	+	+	+
Phallusia mammillata				+	+	+	+	+
Ostrea edulis					+	+		
Mytilus edulis			+			+	+	+
Sycon raphanus					+	+	+	+
Miscelaneous		+	+	+	+	+	+	+

Π-2, Π-3,... : Panel submerged for 2, 3, ... months.

TABLE 2

List of species founds in ⟩1 month submersion asbestos - wood panels.

	AP-JL	AP-NO	AU-NO	AP-MR	DE-MR
Balanus amphitrite	+*	+*	+*	+*	+*
Balanus eburneus	+*	+*	+*	+*	
Balanus tintinnabulum	+*	+*	+	+*	
Balanus perforatus		*		+*	
Bugula stolonifera	+*	+*	+*	+*	
Bugula neritina	+*	+*	+*	+*	+
Watersipora subovoidea			*	+	
Cryptosula pallasiana	+	+	*	+*	+*
Schizoporella unicornis			*		
Serpula vermicularis	+*	+*	+*	+*	+*
Hydroides norvegica	+*	+*	+*	+*	+*
Spirorbis pagesteceri	+*	+*	+*	+*	+*
Pomatostegus polytrema					*
Pomatoceros triqueter					+
Botryllus schlosseri		*	+*	+*	+*
Botrylloides leacki	+*	+	+*	+*	+*
Ascidia virginea	+	+*	*	+*	*
Styela partita	+*	+*	+	+*	
Phallusia mammillata	+	+*		+*	
Ostrea edulis		*			
Mytilus edulis	+*	+		+	
Sycon raphanus		*	+	+*	
Miscelanous	+*	+*	+	+*	

+ asbestos

* wood

Participating Research Centre: Laboratory of Zoology,
Faculty of Science
University of Thessaloniki
THESSALONIKI
Greece

Principal Investigator: M.E. KATTOULAS

Introduction:

In 1972 the Laboratory initiated a research programme aiming to study the qualitative composition of the benthic populations in the North Aegean Sea. This programme consists of taxonomic and distribution studies of the following taxa: Decapoda (Crustacea), Crinoidea and Holothurioidea (Echinodermata), Cionidae and Ascidiidae (Ascidiacea), Polyplacophora (Mollusca) and Balanomorpha (Cirripedia).

Area(s) studied:

The three gulfs (Thermaikos, Strymonikos and Kavala) and the location of the sampling stations and transect are indicated on the attached maps (figures 1, 2 and 3).

Material and methods:

Qualitative sampling was carried out, once, on a number of stations. Transects were also laid out, and on certain points of them, double quantitative samples were taken in autumn 1976, in winter, spring and summer 1977, i.e. once every season. The qualitative sampling was made by a Sarko dredge and the quantitative by a Van Veen sampler.

The following measurements for physical and chemical parameters were taken in situ: depth, temperature (of sediment and water), salinity (of surface and bottom water), oxygen content (of surface and bottom water), water conductivity, pH of the water and H_2S content of the water.

The following measurements were taken from the water and sediment samples in the laboratory: organic matter (of the water and sediment), oil content of the water, H_2S content of the sediment, HCO_3 content of the water, SO_4 content (of the water and sediment), SO_3 content (of the water and sediment) and chlorinity of the water.

In Thermaikos Gulf, 68 qualitative sampling stations (St.1 - St.68) were made and 5 transects (TA, TB, TC, TD and TE) were laid out (fig. 1).

In Strymonikos Gulf, 71 qualitative sampling stations (St. 69 - St. 138) were made and 2 transects (Sa and SB) were laid out (fig. 2).

In the Gulf of Kavala, 43 qualitative sampling stations (St. 139 - St. 181) were made and 2 transects (KA and KB) were laid out (fig. 3).

For the sorting of the fauna, a sieve with 0.5-mm mesh size, was used.

Results and their interpretation:

The identification of the species is continuing because of the great number of samples and it will not finish before the end of 1980. The analysis of sediments (370 samples) has already been done, but their graphical presentation and their statistical treatment is still incomplete. The chemical analysis for the water and sediment samples has also been finished.

In table 1, the fluctuation of the values of the measured parameters (sediment and water), is given, as well as the type of sediment, the general characteristics of the fauna and a rough estimate of the effect of the pollution on the populations. More detailed information is difficult to give at the present stage of work.

Conclusions:

It is not yet possible to make conclusions apart from the obvious effect of the pollution on the populations in two of the three gulfs (Thermaikos and Kavala) and the fact that in some regions of these gulfs the pollution is so intense that it creates azoic zones.

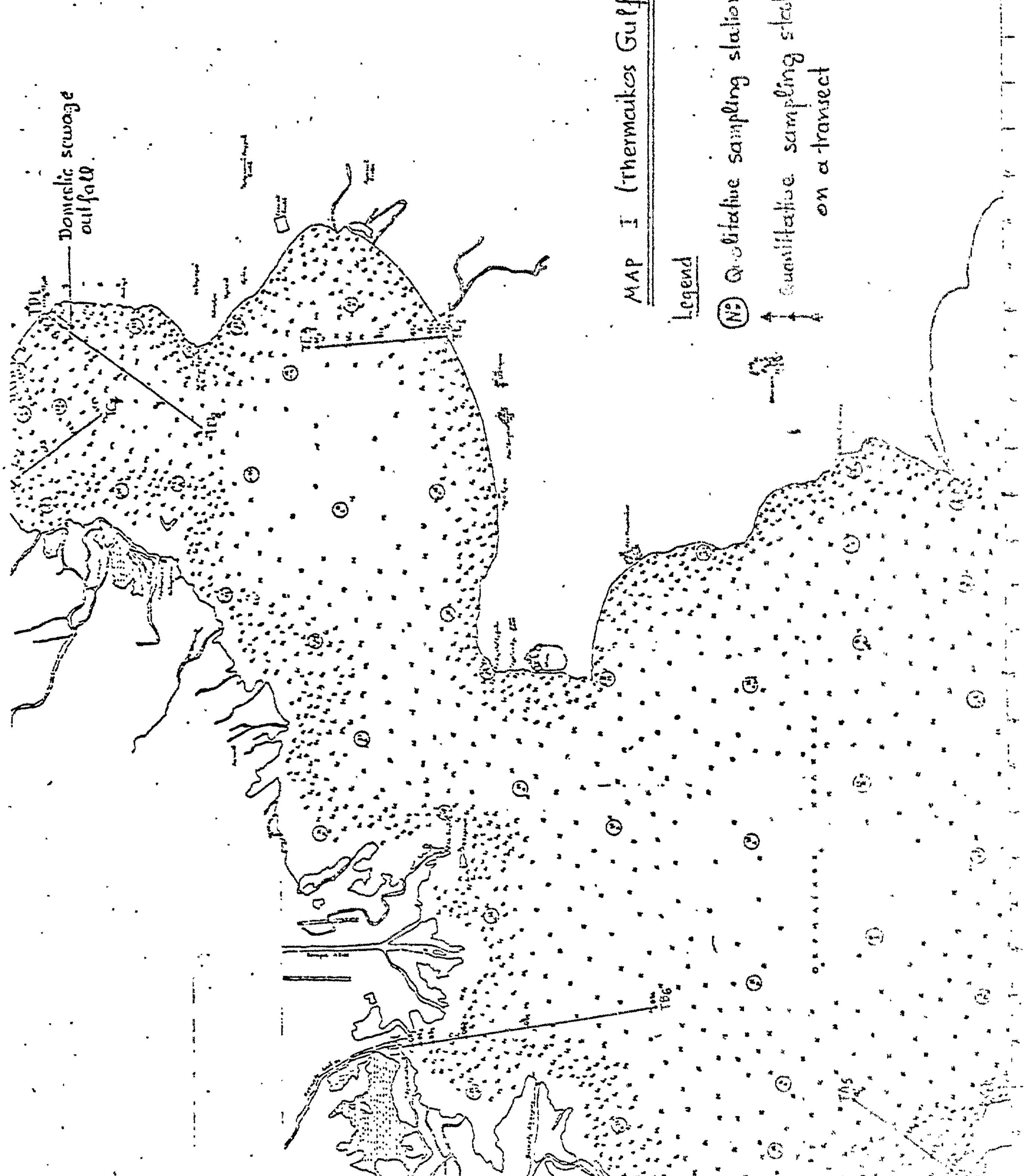
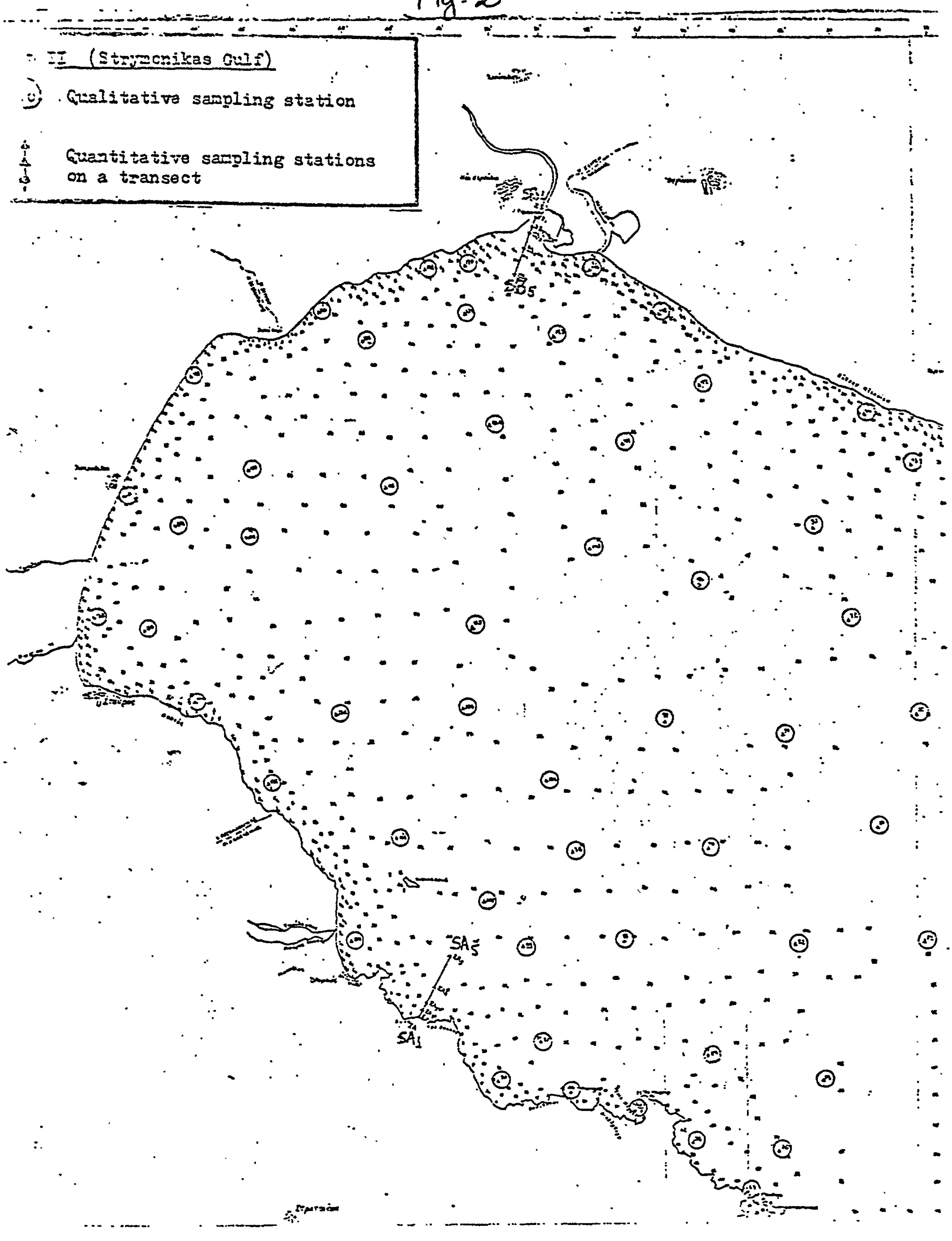

MAP I (Thermaikos Gulf)
Legend
No. Qualitative sampling stations
Quantitative sampling stations, on a transect
Domestic sewage outfall
TD1
TB6
TA5

Fig. 1

Fig. 2


II (Strymonikas Gulf)
Qualitative sampling station
Quantitative sampling stations on a transect
SB1
SB5
SA5
SA1

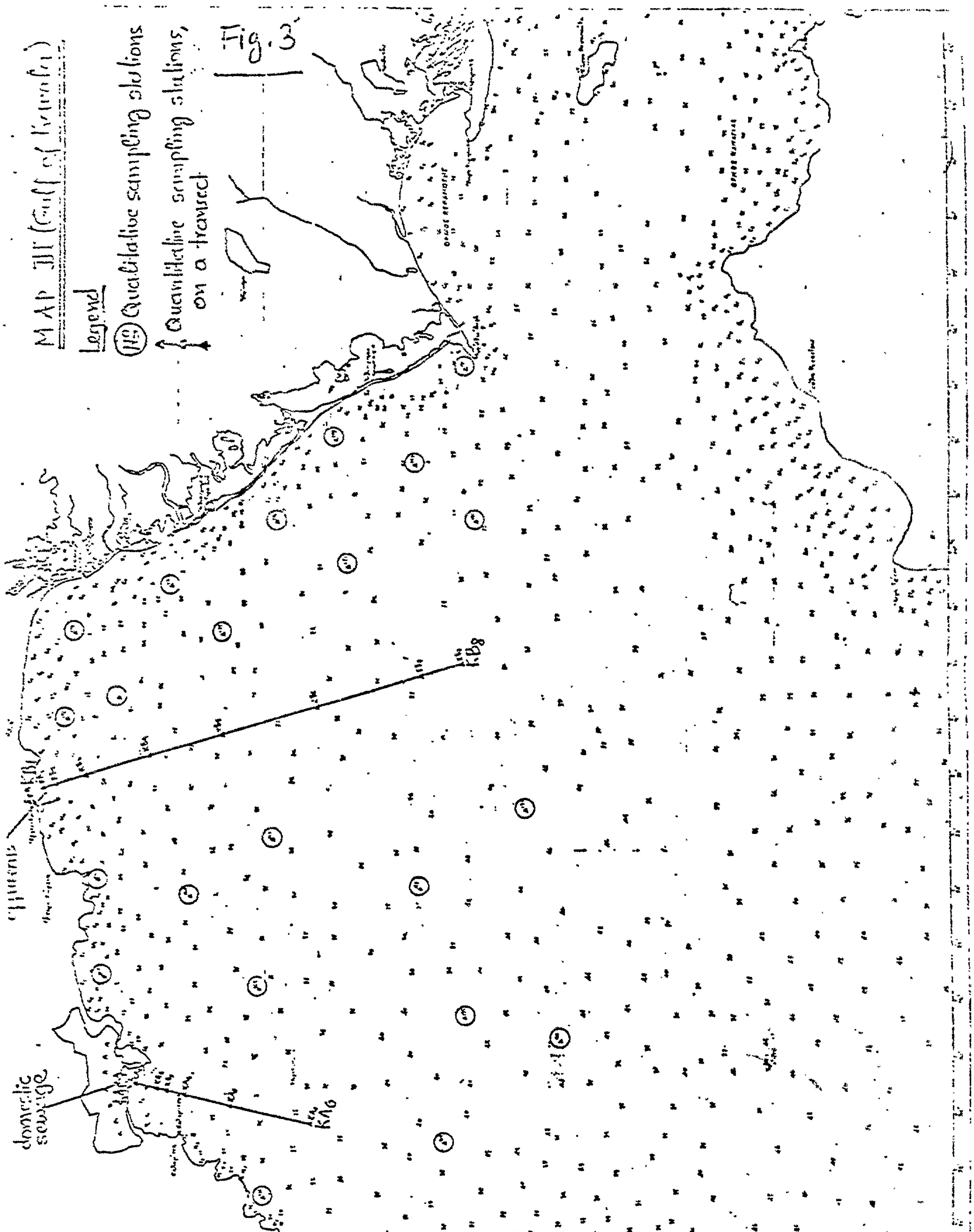

Legend
Qualitative sampling stations
Quantitative sampling stations, on a transect
Fig. 3
domestic sewage
KB8

Table 1 Showing the fluctuation of the values of the measured ...

Physical and Chemical Paramotors	Chlorinity	Type of Sediment	Dominant Taxa	Pollution
Thermaikos Gulf Sediment Water	– 19800–22250	Granules to very find soft	Polychaeta Bivalvia	1. In the region of the central domestic sewage outfall (map I) we can distinguish the zones: a. Polluted (Capitella capitata, Audouinia tentaculata) b. Sub-normal (A. tentaculata) 2. In the region of the industrial effluents outfall (map I) we can distinguish the zones: a. azoic b. polluted (C.capitata, A. tentaculata) c. sub-normal (A. tentaculata)
Strymonikos Gulf Sediment Water	– 17800–22400	Granules to coarse silt	Polychaeta Bivalvia Echinodermata	There is no obvious effect of pollution, on the marine communities from our data, up to now.
Gulf of Kavala Sediment Water	– 19900–20750	Granules to fine silt	Polychaeta Bivalvia Echinodermata	1. In the region of the discharge of the industrial effluents (map II) we can distinguish the zones: a. azoic (st.KB1) b. sub-normal (A. tentaculata) (St. KB_2 and KB_3) 2. In Kavala harbour (domestic sewage discharge) we can distinguish the: polluted zone (C.capitata, A. tentaculata) (St.KA_1)

Table 1. Showing the fluctuation of the values of the measured parameters ad the caracteristics of the fauna

Centre de Recherche participant: Department de Oceanographie biologique
et Institut de Hydrobiologie
Faculte de Science
Universite EGE
BORNOVA/IZMIR
Turquie

Chercheur principal: A. KOCATAS

Introduction:

La recherche entreprise dans le golfe d'Izmir est la confirmation d'une approche systématique au problème de la pollution dans cette aire. Le groupe de recherche entreprit ses travaux de 1972 jusqu'à 1974 et 1975. Depuis, l'industrialisation et la pollution inhérente ont beaucoup augméent. En 1977 l'étude était orientée dans le but de déterminer si un changement pouvait être mis en rapport avec la croissance des décharges d'effluents industriels et des déchets municipaux.

Zone(s) étudiée(s):

Le golfe d'Izmir est une baie modérément encaissée de 60 km de long (fig. 1). La partie intérieure à l'est, de faible profondeur (8 - 12 m), est densément peuplée, alors qu'il y a seulement quelques villages sur les deux côtés de la zone extérieure.

Pendant une période de 15 mois (juin 1977 - août 1978) des paramtres physico-chimiques et des échantillons du benthos furent prélevés dans 10 stations dans la partie intrieure du golfe trs exposee à l'influence de polluants variés. Polychètes, crustacées et mollusques étaient pris en considération. Leur abondance, la dominance et la diversité des échantillons étaient déterminées. La température, la salinité, le pH, l'oxygène dissout, les nitrates, nitrites, phosphates et silicates étaient mesurés de mai à août 1977.

Matériel et méthodes:

Des échantillons du benthos étaient obtenus avec une 5 litre "orange peel" benne. Les paramètres physiques et chimiques de l'eau étaient mesurés par des méthodes classiques.

Résultats et leur interprétation:

La structure qualitative des communautés benthiques donne une liste cumulative des principaux groupes taxonomiques (Tableau 1 et 2). Les valeurs prsentes sont la somme de toutes les données provenant des 150 échantillons des 10 stations.

Les résultats montrent que les populations benthiques, dans la partie intérieure du golfe sont fortement affectées par la pollution. Le nombre des espèces aussi bien que l'abondance des individus augmentent légèrement vers les parties extérieures du golfe.

Durant le premier échantillonnage de 1971/72 seulement quelques zones polluées furent rélevées. En 1974/75 aucun changement majeur ne furent observé, comparé aux premières indications, mis à part l'élargissement considérable de la zone subnormale. Les derniers résultats (1977/78) montrent la rapide dégradation des communauts benthiques atteignant presque le niveau maximal dans quelques points du golfe intérieur.

L'alarmant développement de la zone subnormale atteint maintenant toute la partie intérieure du golfe (fig. 1).

Conclusions:

En comparant les donnes de 1971 et 1974 à celles de 1977/78 une importante dégradation des communautés benthiques était enregistrée et concernait principalement la partie intrieure du golfe. Si cette tendance continue au taux actuel, il faut s'attendre à voir apparaître dans quelques années de larges zones azoiques.

Liste de publications:

Geldiay, R. et Kocatas, A. (1972). Note préliminaire sur les peuplements benthiques du golfe d'Izmir. Sci.Mon.Fac. Science, Ege Univ., 12: 1-34.

Geldiay, R. *et al.*, Some effects of pollution on the benthic communities of the soft substrate in the bay of Izmir (Turkey). In print.

Kocatas, A. Distribution et évolution des peuplements benthiques du golfe d'Izmir (Partie intérieure) soumis à de multiples pollutions. CIESM/PNUE, Journées d'études "Lutte contre les pollutions marines", XXVI Congrès, Assemblée plénière de la CIESM, Antalya, 24-27 novembre 1978.

Groupes systématiques	Nombre d'espèces	Pourcentage du nombre total d'espèce	Nombre d'individus	Pourcentage du nombre total d'individus
Polychètes	36	40.44	1348	28.69
Crustacées	25	28.08	983	20.92
Mollusques	17	19.10	2349	50.01
Algues et angiospermes	3	3.37	-	-
Echinodermes	3	3.37	12	0.25
Ascidiens	2	2.24	-	-
Nemertines	1	1.12	1	0.02
Planaires	1	1.12	1	0.02
Céphalopodes	1	1.12	3	0.06
Total	89	99.96	4697	99.97

Tableau 1. Structure de la communauté observée dans les 10 stations du Golfe d'Izmir en tenant compte des principaux groupes systématiques

Le tableau suivant compare des données quantitatives observées dans les mêmes stations.

Stations	Nombre d'échantillons	Nombre d'espèces	Nombre d'individus	Indices de diversité
1	15	8	94	3,51
2	15	7	69	3,26
3	15	5	16	3,32
4	15	11	414	3,82
5	15	9	56	4,57
6	15	27	612	9,33
7	15	9	78	4,22
8	15	12	115	5,33
9	15	59	2667	16,92
10	15	56	554	20,05

Tableau 2 - Comparaison entre le nombre d'espèces et d'individus dans les 10 stations du Golfe d'Izmir

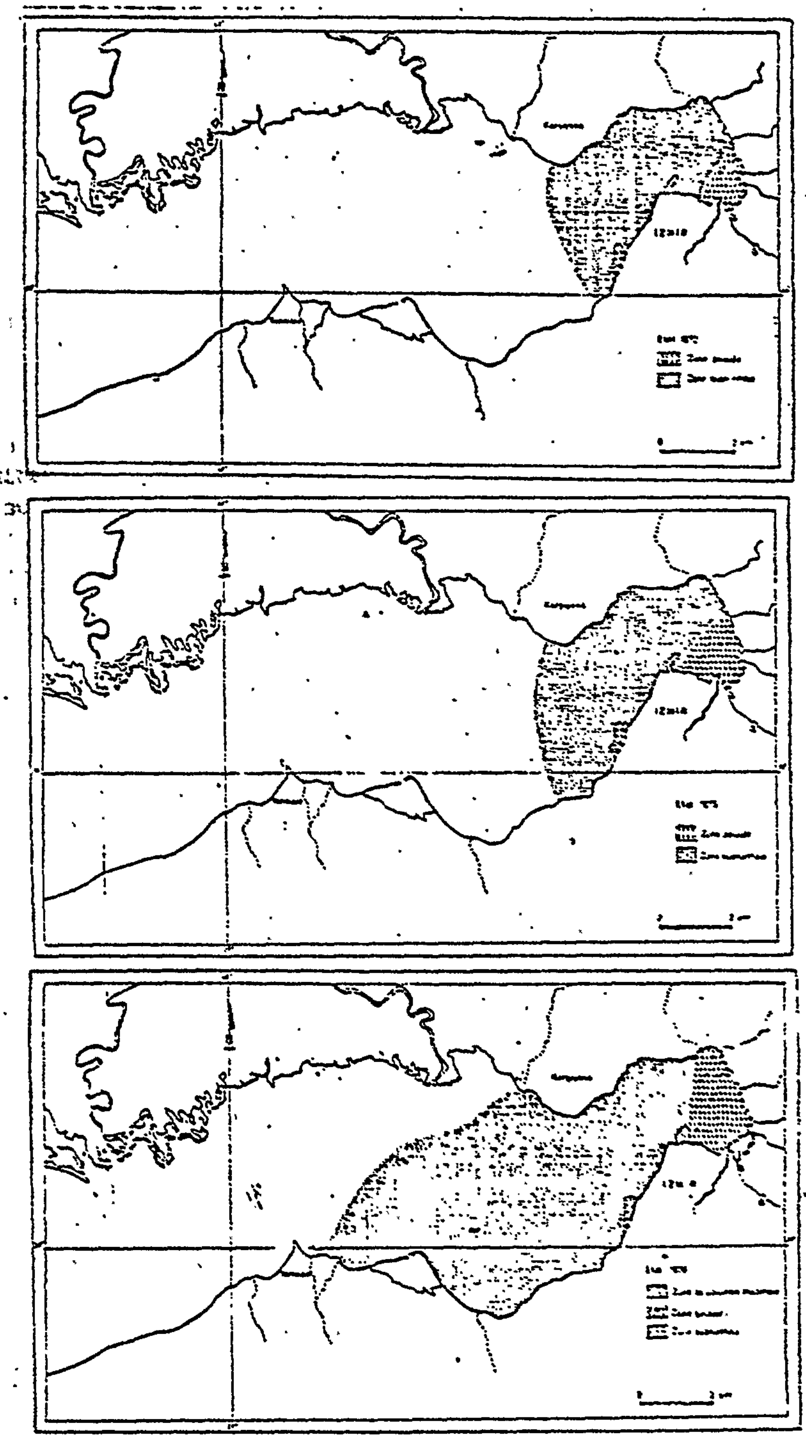


Fig. 1 Evolution des zones polluées du golfe d'Izmir de 1971 à nos jours.

Participating Research Centre: Institute for Oceanography and Fisheries
SPLIT
Yugoslavia

Principal Investigator: T. PUCHER-PETKOVIC

Introduction:

Systematic investigations of the central Adriatic were started in 1956. Seasonal and long-term fluctuations in primary and secondary production correlated with dynamics of abiotic factors, were studied.

More recent investigations were oriented towards the pollution effects of urban wastes and industrial effluents on coastal communities.

Area(s) studied:

Qualitative and quantative plankton structure, as well as physical and chemical parameters were monitored regularly on stations I-III (figure 1). Station I (Split-Kastela bay) represents the heavily polluted area of Split and its surroundings (200 000 inhabitants, with highly industrialized area). Station II is located in the archipelago area (Island of Hvar), and station III (Stoncica) was selected as a clean, open waters reference area. Six cruises were undertaken in order to obtain plankton samples and environmental parameters.

Benthic communities were monitored twice a year in four different areas as shown in figure 2 (Rijeka bay, Island of Vir, Sibenik channel and Split-Kastela bay with the islands).

Material and methods:

During the project duration, the following observations were carried out:

(a) environmental parameters: temperature, salinity, density, transparency, alkalinity, dissolved oxygen, oxygen saturation, CO_2, phosphates, nitrates, nitrites, ammonia, silicates; Zn, Cd, Pb and Cu;

(b) plankton: (i) phytoplankton: Primary production (C^{14}), numerical abundance, biomass (pigements), structure; (ii) zooplankton: biomass, qualitative and quantitative structure (main groups), especially copepods; (iii) bacteria: biomass of heterotrophic bacteria;

(c) benthos: (i) phytobenthos: structure, abundance, biomass; (ii) zoobenthos: structure, abundance, biomass; (iii) ichthyobenthos: structure, abundance, biomass;

(d) nekton: (i) plankton stages of small pelagic fish: abundance, distribution; (ii) adult pelagic fish: abundance, population dynamics, distribution.

Standard methods were used to determine physical and chemical parameters of the water. Zooplankton samples were obtained with Henser net, No.3 (hauls from bottom to the surface). Benthic samples were obtained with Petersen grab and trawl net, as well as with diving equipment (SCUBA). Underwater photography and television were used to survey the area. Membrane filtration and plate count technique were used for bacterial samples. Fish larvae were collected with Helgoland net. Adult fish were observed with echointegrator.

Results and their interpretation:

Phytoplankton

Rather high values of abundance, biomass and photosynthetic activity were reported from Kastela bay. The higher values of the parameters observed at the surface layers (0-10 m) were due to nutrient enrichment caused by fresh- water inflow. The increasing rate of phytoplankton productivity, compared to the previous available data, was also reported. The most abundant species observed in the area were: Skeletonema costatum, Nitzschia seriata, Leptocylindrus danicus and Eucampia cornuta which are also characteristic of a moderately eutrophicated environment. Station II is under alternating effect of coastal waters, especially influenced by the river Neretva estuary and open sea-waters.

On Station II coccolithophorids were the dominant group, which is characteristic for low productive open waters.

Zooplankton

The highest values of zooplankton biomass were observed in June samples. Higher values are reported from Kastela bay (Station I) than from Stoncica (Station III).

Copepods were the dominant group in almost all stations and in all seasons; their number was much higher in Stoncica than in Kastela bay and more prevalent in March than in June. Ostracods and appendicularians were well represented in both seasons at all stations, while cladocerans were found mainly in June and were more numerous in Kastea bay than in Stoncica. Dominant copepod species were Acartia clausi, Centropages typicus (found at almost all stations and in all seasons, though less numerous in Kastela bay than in Stoncica) and Ctenocalanus vanus.

Bacteria

Considerably high numbers of heterotrophs were obsrved in Kastela bay (557 colonies) compared to the open water station Stoncica (99 colonies). Maximum values were observed in July 1978. In Kastela bay the minimum values were observed in September and in Stoncica in January. The vertical distribution has changed, compared to the earlier records.

Fish Larvae

There was considerable decrease in fish larvae abundance from the open waters to the shore transect (ratio for stations III, II and I was 1.9 : 1.8:1). Minimum numbers of species was recorded in December, maximum in

June-July. Sardina pilchardus was dominant in winter and Engraulis encrasicolus in summer.

Pelagic Fish

Echo-integrator survey showed a rather significant adult pelagic fish stock in the central and northern Adriatic. The population was not evenly distributed. Sardine population was dominant in the central Adriatic, while anchovy (and to a less extent sprat) was predominant in the northern Adriatic.

Benthic Communities

Sampling on several previously investigated profiles was repeated recently and some new areas were also included in the research (fig. 2). The cummulative results are given in table 1.

The general observation was that the number of species (algae and animals) increases along the transect from the shore to the open waters. Biocoenological changes caused by pollution, especially in the intertidal zone, were reported from the areas under the impact of industrial and urban effluents (Rijeka, Sibenik and Split).

Some tolerant species, especially nitrophilous algae, were observed growing abundantly on the substrate where less tolerant species disappeared. Some degraded communities were reported also from deeper and enclosed areas not far from the shore.

Conclusions:

A complex study and a comparison of the present situtation with reference data from the last two decades in different parts of the northern and middle Adriatic ecosystems were carried out. The research was done on pollution-induced changes in plankton, pelagic fish and benthic communities Considerable changes (qualitative and quantitative) were reported in the areas exposed to domestic sewage and industrial effluent discharges.

Table 1. Number of species and communities identified in four investigated areas

Area	Rijeka Gulf	Vir Isl.	Šibenik channel	Šibenik bay	Kaštela bay E[1]	Kaštela bay	Kaštela bay C
Total number of macrobenthic species	280	233	190	95	110	220	207
Plant species	125	104	117	34		121	
Animal species	155	129	73	61		99	
Number of transects	3	2	1	1	1		1
Number of communities identified	9	20	10	7		10	
Remarks	Relatively clear water. No significant changes in the composition or distribution of communities have been noted from the species composition	2/	Pollution influence is rather insignificant in the channel	Harmful impact of pollution is indicated by the considerable reduction of the macrobenthic species	High pollution impact. Degradation of communities		

1/E = East C = Centre - 2/ The same remarks as for Rijeka Gulf apply

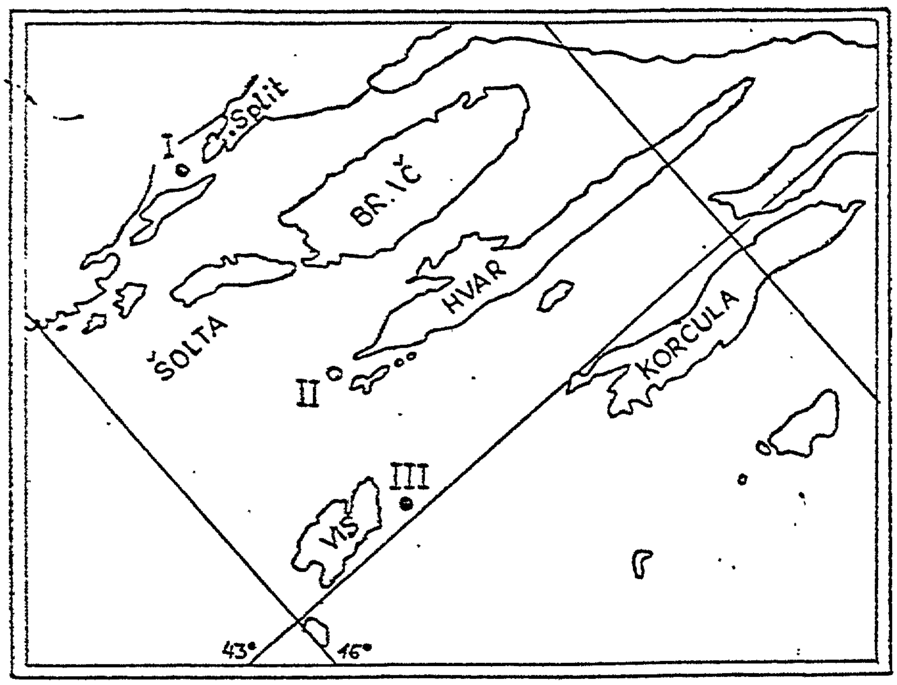


Fig. 1. Investigated central Adriatic region

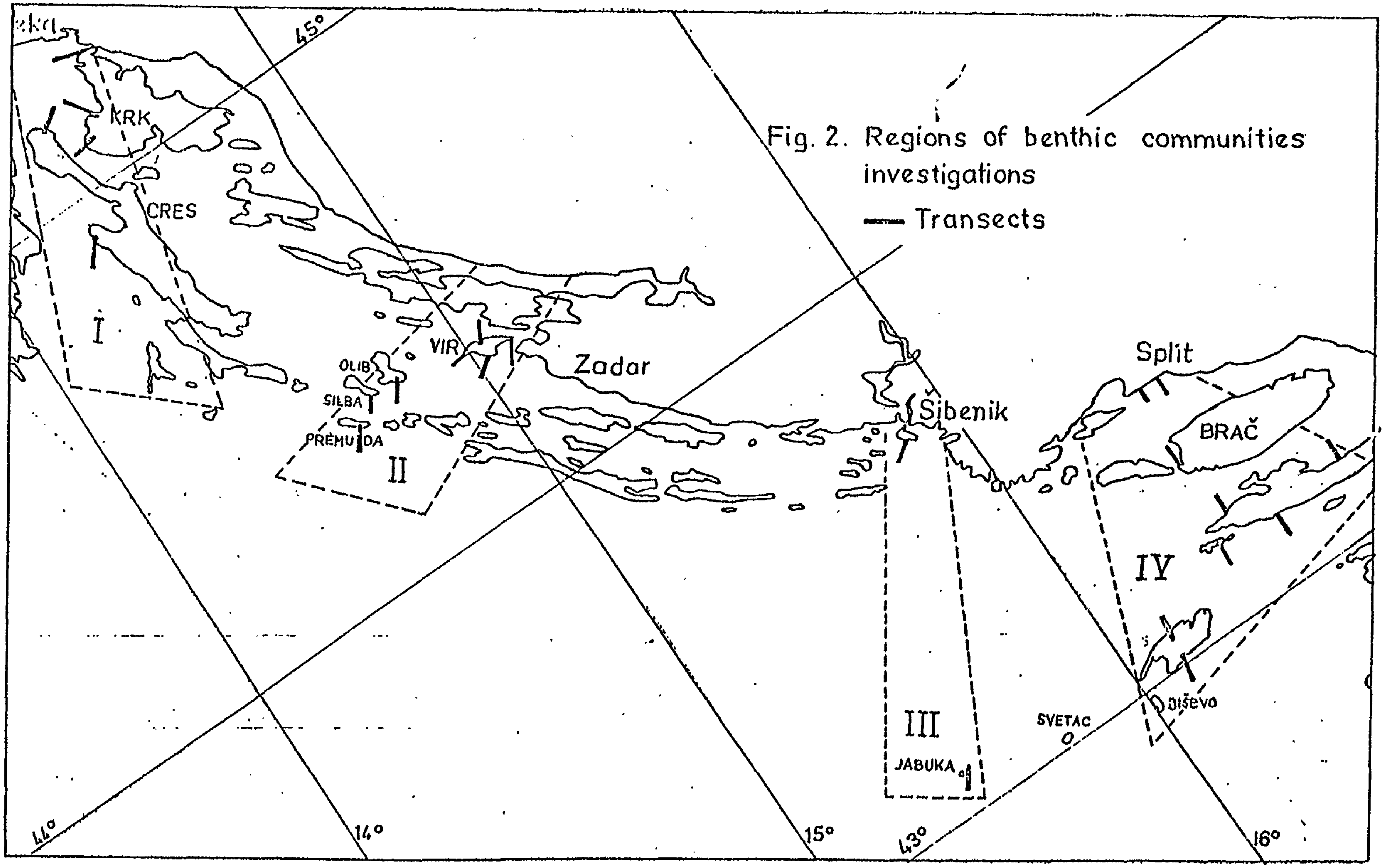


Fig. 2. Regions of benthic communities investigations
— Transects

Participating Research Centre: The Biological Institute
DUBROVNIK
Yugoslavia

Principal Investigator: A. BENOVIC

Introduction:

The structure and population dynamics of middle Adriatic zooplankton communities have been studied for more than 20 years. Recently, an effort was made also to evaluate the communities of zooplankton and their biomass changes as a result of pollution impact on the coastal ecosystem.

Samples from the polluted areas were compared to those taken from the clean ones. Qualitative and quantitative evaluations of tintinnid populations (important indicators of organic pollution) as well as of the most important net plankton, sampled through horizontal and vertical hauls, was also made.

Area(s) studied:

Samples of microzooplankton and 78 samples of net plankton were collected at 8 stations in the NW inshore waters close to Dubrovnik (figure 1). The stations were located near the polluted harbour of Gruz, the estuary of the river Rijeka, Dubrovacka and the nearby island area, influenced by deep southern Adriatic waters.

Regular monitoring was also performed at Petka station, where municipal waste discharges are planned to start soon.

Material and methods:

Five series of samples were collected from June 1977 up to June 1978. Microzooplankton was collected with Van Dorn bottle (5 litres) on three horizons (0m, 10m and 20m) and net zooplankton samples were obtained by plankton net (113 cm diameter, 250u mesh size) in vertical tows, from the bottom to the surface.

After Precipitation, microzooplankton was counted and values expressed as number of individuals per m^3. Dry weight, ash weight, organic content, carbon content, and caloric values were obtained by standard methods. Tintinnids, copepods, siphonophorans and appendicularians were determined by species.

Results and their interpretation:

In microzooplankton samples, the tintinnids were studied with special care, while testing the hypothesis that some tintinnid species become more abundant in eutrophicated waters. The following species were reported as dominant at stations 1, 2 and 4 where organic compounds were present, either from river influx or harbour pollution: Favella ehrenbergii (in June and August 1977), Stenosemella nivalis (in March 1978) and

Tintinnopsis levigata (in June 1978). In December 1977 the most abundant tintinnid species was Rhabdonella spiralis because of the strong inflow of open southern Adriatic waters to the area. Nauplii were the most abundant microzooplankton group while other metazoan groups were not significant enough to draw any conclusion.

High values of net-zooplankton were reported in Rijeka Dubrovacka estuary (stations 1-4) as well as from station 8 where the nearshore waters mix with offshore waters. Higher values obtained for dry weight material in the samples do not correspond to the total number of individuals or their organic content and caloric values. The differences originated from increased amounts of seston (suspended organic and inorganic material) coming from the estuary and harbour area.

Qualitative composition of net-zooplankton in general coincided with the zooplankton diversity structure of other non-polluted coastal areas of the southern Adriatic.

In spite of the presence of locally polluted areas, the whole area under investigation could be characterized as presumably clean and its ecosystem not yet disturbed.

The permanent presence of some species in the inner part of the area as well as the greater quantity of microzooplankters in deeper layers (December 1977) emphasize the significance of deep non-polluted water inflow. During warm seasons this inflow decreases due to low fresh water inflow. Consequently the increased load of pollutants in Rijeka Dubrovacka estuary would result in a considerable enlargement of the present, so far localized, polluted areas.

Conclusions:

Microzooplankton (with special regard to tintinnids) and net-zooplankton were studied over a period of one year. The sampling areas located north of Dubrovnik and affected by pollution were found to have a local character while the rest of the investigated area was reported as presumably clean and its ecosystem not disturbed. The area where the sewage outlet of Dubrovnik is planned to be constructed was also investigated in order to get reference data for future monitoring. Net zooplankton values observed there were very low, but the percentage of organic content and caloric value was high, notably during winter. The data obtained were typical of the clean, unpolluted waters of the southern Adriatic and corresponded to previous investigations in this area.

List of publications:

BENOVIC, A., GAMULIN, T., HURE, J., KRSINIC, F. and SKARAMUCA, B. Zooplankton communities of the NW Adriatic inshore waters near Dubrovnik. Submitted to the Joint ICSEM/UNEP Workshop on Pollution of the Mediterranean, XXVIth Congress and Plenary Assembly of ICSEM, Antalya, 24-27 November 1978.

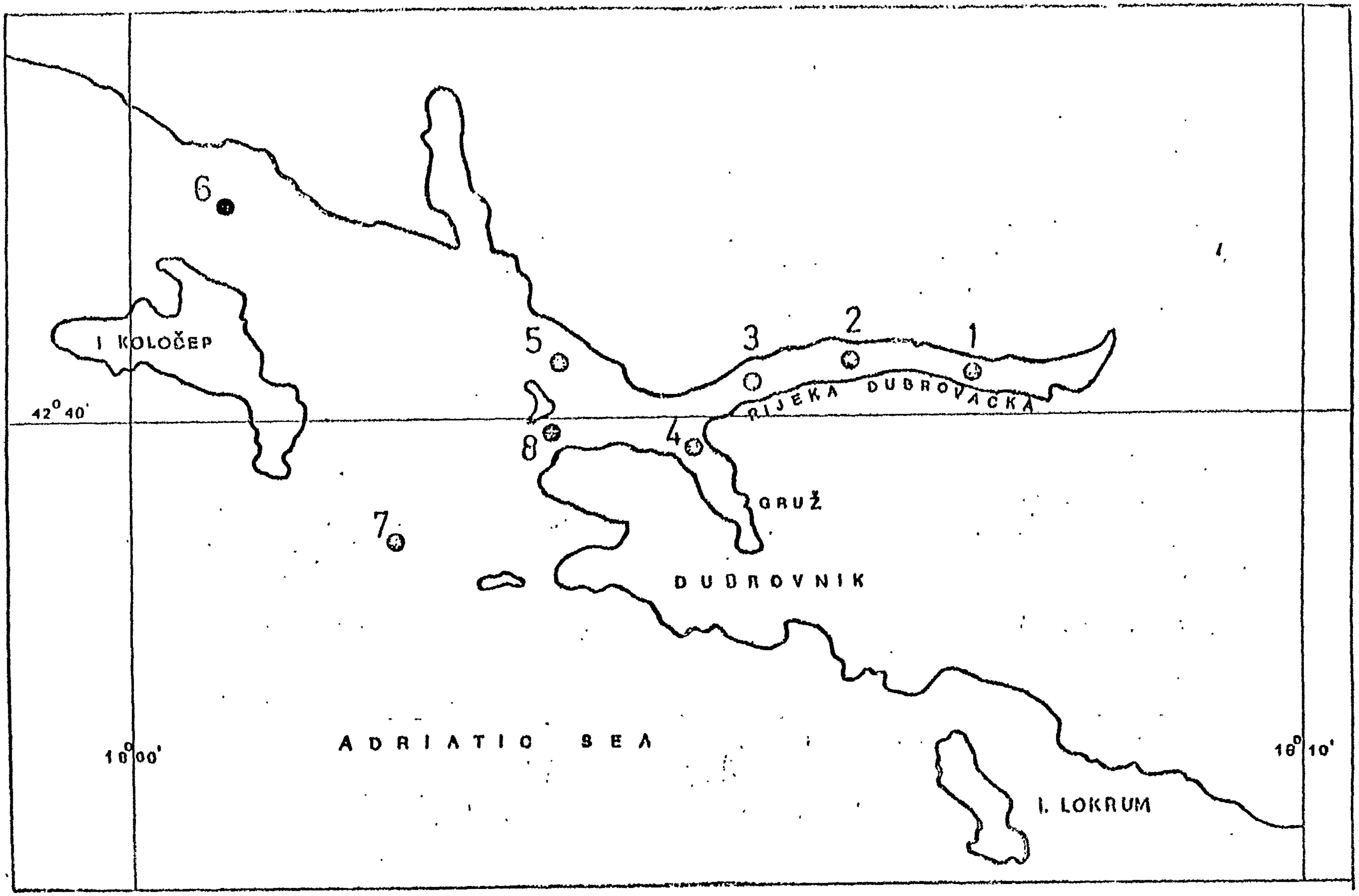


Fig. 1 - Sampling stations in Dubrovnik area

Participating Research Centre: Centre for Marine Research,
"Rudjer Boskovic" Institute
ZAGREB
Yugoslavia

Principal Investigator: D. ZAVODNIK

Introduction:

Baseline studies of benthic marine communities in coastal waters of the northern Adriatic have been carried out since 1960. Primary productivity of phytoplankton and relevant physical and chemical parameters have been monitored there since 1963. The polluted Bay of Rijeka has been especially studied since 1972.

Area(s) studied:

The present study started in 1976 in the following two areas:

- the offshore and coastal waters west of the Istrian peninsula, which are largely influenced by the discharges from the Po river and by sewage from numerous tourist centres and resorts on the mainland. Ten permanent stations are situated in the vicinity of Rovinj and along the transect Rovinj-Punta della Maestra (mouth of the Po river).

- the landlocked Rijeka Bay, where one of the largest industrial and municipal conglomerates in the Adriatic Sea is located. The investigated localities are situated near the city of Rijeka, in the vicinity of the newly constructed oil terminal and the petrochemical complex, and in the open waters of the bay (total 5 stations).

Material and methods:

Complex surveys of phytoplankton communities, at 4 stations (6-9, figure 1) along the Rovinj-river Po estuary transect were carried out. The stations under pollution impact were compared with the "clean" ones. Seasonal variations in structural and functional composition of phytoplankton communities, as well as species diversity, biomass and phtosynthetic pigments, were studied. Physical and chemical parameters of the environment (especially nutrients) were monitored as well as the concentration levels of selected pollutants in phytoplankton samples.

Comparisons of different benthic and intertidal communities in Rijeka bay with the equivalent stations in the Rovinj area were made. In this project, coastal and polluted stations 7 and 9 (figure 1) in Rijeka bay were combined with offshore stations 13, 19 and 31. The results obtained at RI-1S (Rijeka) station were compared with a clean one in Faborsa bay (Rovinj-RO-1) and with polluted Valdibora bay (Rovinj-RO-2).

Standard sampling and preparational methods, used for many years in the Centre for Marine Research of the "Rudjer Boskovic" Institute in Rovinj, were employed also in this study. The samples of sea-water for chemical analyses were taken by Nansen and Van Dorn water bottles, the latter were used also for sampling of phytoplankton. For quantitative sampling of fauna on deep ooze bottoms the Van Veen grab (0.1 m^2) was used. Shallow-water bottom communities were studied visually by skin and SCUBA divers, who also provided the biological material for field and laboratory experiments. The following parameters were measured: temperature, salinity, dissolved oxygen, pH total alkalinity, reactive phosphate, nitrates, nitrites, ammonia, reactive silica, chlorophyll a, photosynthetic activity, number of phytoplankton cells, number of benthic animals and biomass measurings.

Results and their interpretation

Phytoplankton. The northern Adriatic, especially its western part, is one of the most productive regions of the Mediterranean, primarily due to the eutrophication influences of Italian rivers, in particular the Po. During 1977 and until August 1978, 13 cruises at 8 stations were conducted. Basic hydrographical parameters, light penetration scattering, nutrients, cell densities and composition of the phytoplankton community, chlorophyl a concentrations, and ^{14}C primary production were monitored.

Investigations showed that from April to September 1977 in the entire area, the surface layer salinity (about 10 m depth) was unusually low. The fresh water influences were especially noticed in June 1977. At that time the standing crop of phytoplankton was high and in the eastern part reached levels (up to 13 ug chlorophylla/l) never previously observed during 10 years of continuous investigation. The phytoplankton cell densities were relatively high (up to 2×10^5 cells/l) due to the bloom of still unidentified species, which was not recorded previously. High level of organic production was accompanied by unusual decrease in dissolved oxygen in the bottom water layers, which reached the minimum value in September (13 per cent). It is noteworthy that in the low oxygen layers, high nutrient concentrations were observed: nitrate to 10 ug-at/l, phosphate to 0.9 ug-at/l, and silicate to 33 ug-at/l. Concurrently, pH values were unusually high (maximum 8.7) near the surface, and very low (7.8) in the bottom layer. Later in 1977 the increased vertical mixing, a reduction in eastern advection, and the strengthening of southern currents along the Italian coast, created more "normal" conditions. Accompanied by the decrease of organic production, chemical and biological relationships in the eastern part of the northern Adriatic were re-established in December and the observed parameters again fell within normal ranges.

During June 1978 similar conditions did not develop in the eastern part of the area. However, the highest dissolved oxygen concentrations (190 per cent) and pH values (about 8.8) ever reported for the surface waters off the Po delta indicate the extremely high rates of organic production at this time. The data obtained in 1978 are still being processed.

Benthic communities. In offshore waters of the northern Adriatic, at the same stations at which basic hydrographical parameters and phytoplankton productively were monitored, the samples were also taken for estimation of benthic populations. Stations were visited in March and July 1978. The elaboration of the material is still under way, but preliminary analyses revealed some changes in faunal composition of oozy sands when compared with the data obtained by Vatova (1949) 40 years ago. A mass mortality of Turritella communis and an increase in Aspidosiphon populations have started. It is assumed that unfavourable environmental conditions which were found in bottom layers at the time of phytoplankton bloom could also affect benthic organisms. Further research will be focused on this phenomenon.

In Rijeka Bay, research on oozy bottom fauna was continued in 1978. It was found that according to faunal composition the central part of the bay differs somewhat from the northern (close to mainland) and the southern (insular) areas. The communities below 30-40 m seem unaffected by complex pollution even in the immediate vicinity of the Rijeka urban-industrial complex. This phenomenon is in all probability related to specific hydrodynamic conditions in the area, especially to surface and midwinter currents.

Monthly observations of Cymodocea nodosa settlement in Faborsa cove near Rovinj were continued until summer 1978. Thus the seasonal vegetative cycle of this eelgrass, its production and chemical composition were monitored continuously throughout 2 years; these data will serve for subsequent estimations and comparisons of standing crop, vitality and productivity of Cymodocea meadows in polluted areas. It should be added that near Rovinj further retreat of eelgrass communities on sandy and sandy-gravel bottoms is noted. In the Faborsa cove, however, in 1977/78 a mass development of the Mytilus galloprovincialis belt occurred. As well, in the lower mediolittoral zone, the barnacles Balanus perforatus are now settling in large numbers, while in the past 15 years this species has never been found in this locality.

Conclusions:

Extraordinary high plankton blooms, accompanied by extreme deficiency of oxygen in bottom layers, high pH, and nutrients content in the sea-water occurred in the offshores of the northern Adriatic during 1977. At the same stations, the mortality of some benthic species was also noted.

At some localities in the coastal waters of West Istria, the further retreat of eelgrass communities, and large-scale changes in mediolittoral populations were observed.

In Rijeka Bay no modifications in faunal composition of oozy bottom occurred, which could be related to the complex pollution of the area.

List of publications:

DEGOBBIS, D., POJED, I. and SMODLAKA, N. (1978). Non seasonal phytoplankton bloom in the northern Adriatic in 1977. Round Table "The problems of the plankton of the Adriatic Sea", Trieste, 13.-16.4.1978.

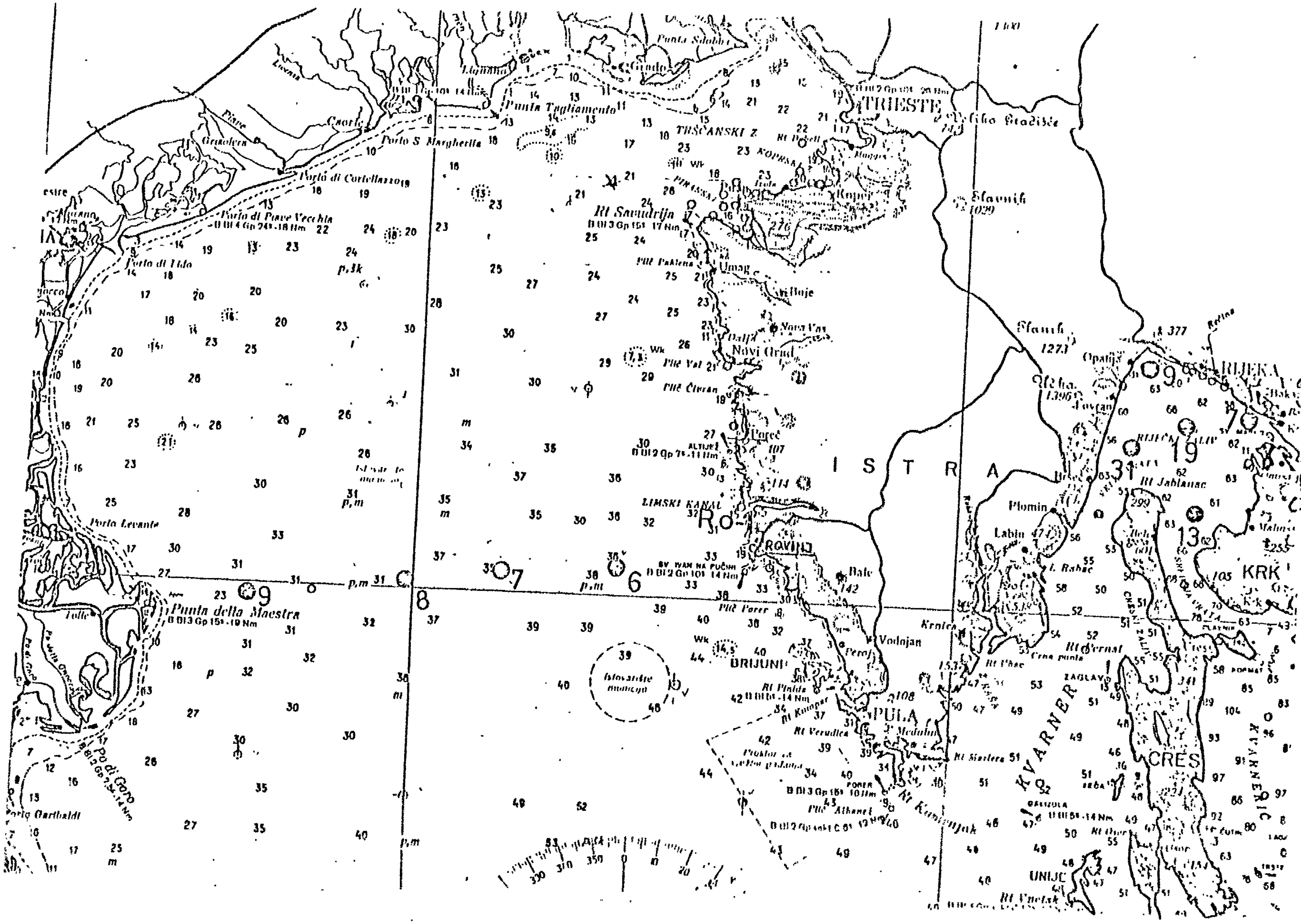


Fig. 1 Map of investigation area with sampling stations

Participating Research Centre: Marine Biological Station
Institute of Biology
University of Ljubljana
PORTOROZ
Yugoslavia

Principal Investigator: J. STIRN

Introduction:

The complex marine pollution monitoring programme (including the structure of benthic communities) has been under way since 1971. Some earlier but scattered data are also available. The present study is an experimental approach in order to determine the disruptive effects of municipal sewage and the succession of modifications in an eelgrass (Cymodocea nodosa and Zosterella noltii) community.

Area(s) studied:

Material and methods:

In the Lagoon of Strunjan (Gulf of Trieste) two experimental ponds were constructed (each 7x9 m surface) containing an undisturbed eelgrass community. Raw domestic sewage was transported from the town of Piran in a 5 m^3 settling tank (I. treatment) situated in the vicinity of the experimental site. A daily amount of 300 litres sewage was introduced into one of the ponds while the other remained unpolluted and served as reference (figure 1). The amount of introduced sewage corresponded to the equivalent of 50.000 inhabitants, which is what the impact of Koper town on the shallow marine waters ecosystem of Koper bay is expected to be in the near future. The experiment was performed from September 1976 until September 1978.

In both experimental and control, as well as on reference stations in the coastal area, a large number of environmental measurements was regularly performed, e.g. water exchanges rate, solar energy input, temperature, salinity, pH, oxygen, carbon dioxide, total phosphorus, phosphate, nitrate, nitrite, ammonia, silica, chlorophyll (a, b, c) and bacterial determinations.

The samples of water, sediments and dominant biota were also taken at regular intervals for further analyses of pesticides, PCBs, heavy metals, detergents and phenols. The following ecological phenomena were under continuous study:

a) Succession, standing crop and productivity at the following community levels (analysis on the species level for dominant or characteristic community members): benthic algae and sea grasses, phtoplankton and tychopelagic diatoms, zooplankton, macrobenthic infauna, meiofauna.

b) Recruitment of benthic macrofauna.

c) Modifications of granulometric, mineralogical and chemical composition of sediments.

d) Basic microbiological processes, particularly nitrogen cycling.

e) Modifications of fouling processes.

f) Modifications of community structure and diversity.

For physical and chemical parameters, standard methods were applied. Benthic samples were taken with a core sampler especially designed for that purpose. Recruitment experiments were done with defaunated sediment. Ceramic tiles were used for fouling observations. The Shanon-Weaver index of diversity was used.

Results and their interpretation:

The series of environmental measurements showed a number of important modifications of the ecosystem within the experimental lagoon. Effects resemble the "classical symptoms" of accelerated eutrophication, especially near the bottom, and include increased CO_2, decreased dissolved oxygen, negative Eh, presence of H_2S increased turbidity and seston. Some parameters normally associated with eutrophication were surprisingly of much less significance than expected: these included nutrient levels, DOC, POC, BOD, total bacterial counts, faecal coliforms and phytoplankton standing crop. The most remarkable observation has been the absence of any significant phytoplankton of tychopelagic bloom in spite of obvious overfertilization by the discharged sewage. Macronutrients have been readily utilized by the massive development of benthic green algae (Ulva rigida, Enteromorpha compressa and others). The explosive growth of these algae took place during the second month of the experiment effectively extirpating all sea grass vegetation, with its related epiflora and fauna, from the experimentally-polluted lagoon. The remaining community, of a quite different type, has been described in similar cases of pollution of natural (non-experimental) communities.

A considerable difference was observed in meiofauna structure between "clean" and polluted ponds. In the latter, the observed species composition biomass and dry weight values were extensively lower than expected.

Table 1 - Differences in meiofauna during the last stage of experiment

Pond	Clean	Polluted
Dry weight ($mg/10\ cm^2$)	21.3	15.7
No of specimens per 10 cm2	2979	1066

In macrofauna, the polychaetes Scolelepis fuliginosa, Neanthes succinea and Capitella capitata, a shrimp Upogebia litoralis and three yet unidentified species of amphipods were the only species which survived the environmental changes in the polluted pond. The abundance of amphipods reached by the end of the experiment was over 3000 specimens/m^2. Also Scolelepis fuliginosa was very abundant. Consequently the diversity indices values dropped to the level found to be characteristic for stress communities (H5 = 1.25) in the most polluted local zones.

For the duration of the experiment a succession of environmental and biocoenological changes was recorded as the result of sewage impact on a lagoon community. It was not expected that such rapid and profound differences would occur with a daily load of 300 litres of sewage in 35m^3 water body in the pond.

Conclusions:

The experiment provided a complex insight into the succession of modifications in the eelgrass (Cymodocea nodosa) community following the primary-treated domestic sewage introduction. During two years' experiment extensive biological and chemical differences were developed between the experimentally polluted and the reference ecosystem. The recovery succession observation is programmed for the near future.

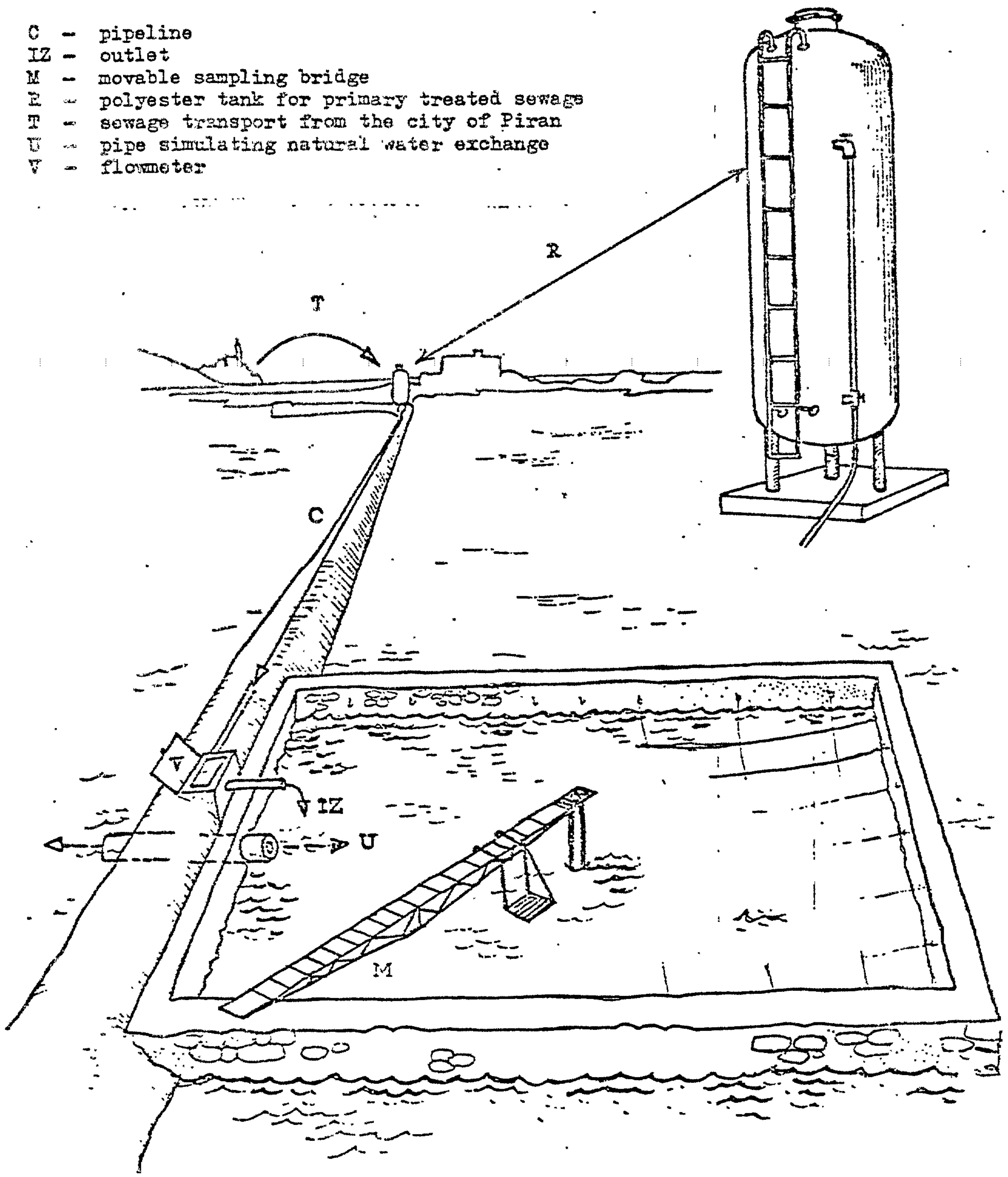


Fig. 1 Schematic presentation of installations ~~for artificially polluting~~ the lagoonary ecosystem in Strunjan, Yugoslavia

MED POL VI : PROBLEMS OF COASTAL TRANSPORT OF POLLUTANTS (IOC/UNEP)

MED POL VI : PROBLEMES DU MOUVEMENT DES POLLUANTS LE LONG DES COTES (COI/PNUE)

Participating research centre: Fisheries Department
Ministry of Agriculture
and Natural Resources
NICOSIA
Cyprus

Principal investigator: A. DEMETROPOULOS

Introduction:

The Department has been active in studies related to the coastal transport of pollutants as part of a survey carried out in Morphou Bay to investigate the extent of pollution and the transportation of material that were being discharged untreated directly into the sea from mining of copper and iron pyrites in the area.

It has not been possible, until recently, to make a sufficient number of direct measurements of coastal currents, though a drogue study was carried out. Measurements of various environmental parameters have been made however. These include: dissolved oxygen, salinity, suspended solids, water temperature, transparency and sediments.

Area(s) studied:

Limassol Bay faces south with Cape Gata in the west sheltering it from the westerly winds. On the Bay is Limassol, a town of about 65,000 inhabitants and light industries which incude mainly wine and spirit and soft drink factories.

The total amount of waste water entering the Bay was 194,000 tons in 1976, and 210,000 in 1977.

Pollution load from industries, measured as BOD_5, was estimated at 238 tons in 1976 and 271 tons in 1977.

Sources of inflow of fresh water are very limited coming mainly from the run-off of rivers.

The continental shelf of the Bay has a gentle slope becoming steeper near Cape Gata.

The sea bed is sand with shingle near the beach, becoming sandy further offshore.

The marine life of the area is characterized by soft-bottom communities with a fair variety of species and relatively low abundance.

Episkopi Bay on the other hand has been studied for purposes of comparison. It lies west of the Akrotiri peninsula and is a relatively unpolluted area free from direct effluent dishcarges. There is no habitation close to the sea.

The bottom morphology and the marine life of the area are similar to those of Limassol Bay.

A map showing the area is given in figure 1.

Material and methods:

Currents were measured with locally made Woodhead sea-bed drifters released at the stations in three groups in Akrotiri (Limassol) Bay (figure 1). Two series of experiments were conducted: one from 26 June 1975 to 11 October 1976; the second during a cruise from 25 to 28 November 1977.

For the latter, 360 Woodhead sea-bed drifters were released between Amathus Beach Hotel and Cape Gata in Limassol Bay. Three sections were chosen: one near Amathus Beach Hotel (stations 1, 2 and 3); one near the new port of Limassol (stations 4, 5, 6 and 7); and the third at Cape Gata (stations 8, 9 and 10).

Releases were made at 5, 15 and 25 fathoms depth, and on the harbour section drifters were also released at a depth of 50 fathoms.

A self-addressed card was attached to the drifter, printed in Greek and English requesting the finder to complete pertinent information and return the card with the drifter to the Department. Cards and drifters were serially numbered for identification.

Meteorological observations were kindly provided by the Meteorological Service of the Ministry of Agriculture and Natural Resources.

Results and their interpretation:

Table 1 shows the currents measured by sea-bed drifters between 26 June 1975 and 11 October 1976. The observer speeds were generally greater farthest from the shore. There was some tendency for the deeper drifters to move at a lower speed than those released at or near the sea surface.

Table II shows the release of 360 sea-bed drifters between 25 and 28 November 1977, and the recoveries.

Of the 360 sea bed drifters released only 29 were recovered, i.e. 8.05 per cent. Station 1 had the most recoveries: 23, or 25.55 per cent of those released at that station.

The drift was approximately 3.4 nautical miles eastward. One drifter travelled eastward approximately 11 nautical miles, reaching the Zygi area.

Fig. 1. Map showing the area studied. Four sections (1, 3, 6 and 7) for hydrographic sampling are shown, as well as the ten sea-bed drifter release stations.

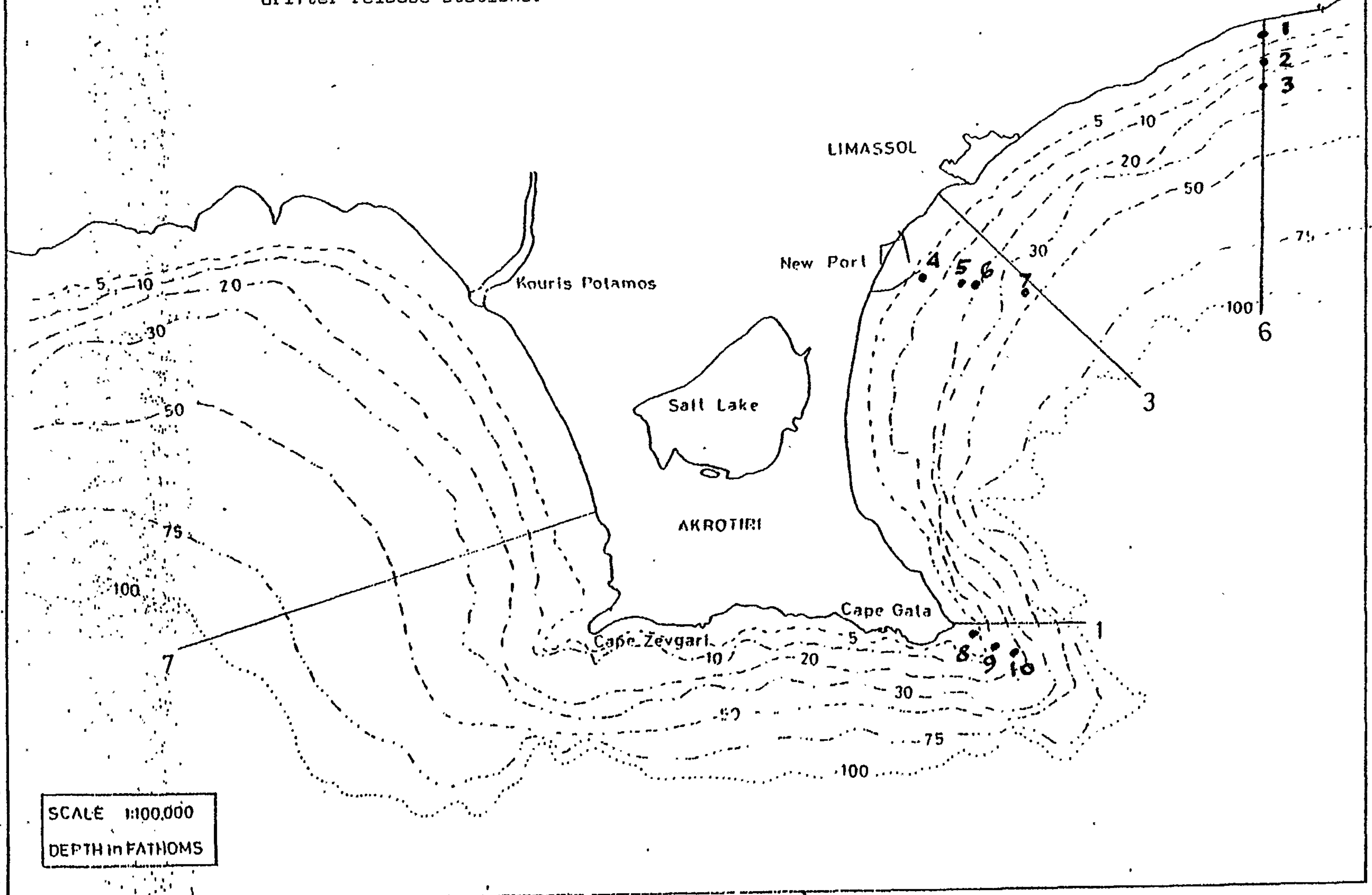


Table: I

Currents estimated by Woodhead sea-bed drifters
released at stations (Figure 1) in 1975 and 1976

Station number	Date	Drogue number	Drogue depth of release-ft.	Current Velocity direction	Current Velocity speed cm/sec.	Wind Direction	Wave height ft
1	26/6/75	1	0	SW	14.7	N	½
		2	10	NW	1.6		
		3	20	SW	14.8		
		4	30	SW	12.0		
2	1/7/75	1	0	NW	7.8	SW	1
		2	10	W	2.8		
		3	20	SW	4.6		
		4	30	SW	5.8		
3	17/10/75	1	0	SW	50.2	SW	Calm
		2	10	NW	10.5		
		3	20	SW	3.8		
		4	30	NW	8.2		
4	18/11/75	1	0	NW	7.4	-	Calm
		2	10	NW	5.9		
		3	20	NW	4.2		
		4	30	NW	2.3		
5	2/12/75	1	0	N	3.0	S	
		2	10	NW	6.7		
		3	20	N	1.9		
		4	30	NE	1.8		

Table: I

Currents estimated by Woodhead sea-bed drifters
released at stations (Figure 1) in 1975 and 1976

Station number	Date	Drogue number	Drogue depth of release-ft.	Current Velocity direction	Current Velocity speed cm/sec.	Wind Direction	Wave height ft
6	4/8/76	1	0	NW	39.4	SW	Calm
		2	10	NW	32.5		
		3	20	NW	28.4		
		4	30	NW	25.8		
7	5/8/76	1	0	SE	31.2	SW	1
		2	10	NE	9.1		
		3	20	SE	35.5		
		4	30	SE	20.0		
8	13/8/76	1	0	W	7.6	-	Calm
		2	10	W	6.8		
		3	20	W	2.7		
		4	30	SW	1.9		
9	27/8/76	1	0	NE	14.2	-	-
		2	10	NE	10.0		
		3	20	N	8.1		
		4	30	NE	5.6		
10	11/10/76	1	0	SW	24.0	S	-
		2	10	SW	22.6		
		3	20	SW	22.6		
		4	30	SW	20.5		

Table: II

Data obtained from the release of Woodhead sea-bed drifters
during Cruise No. 1 25-28 November 1977

Station data	Drifter No.	Recovery Date	Recovery Area	Days Adrift	Remarks
St. 1 drogues 1-90, released at a depth of 5 fms on 25 Nov. 1977	1	1 Dec.77	Moni Station	7	
	3	6 Dec.77	Cement Factory	9	
	6	6 Dec.77	Moni	9	
	10	11 Dec.77	Moni	17	
	12	11 Dec.77	Moni	17	
	17	11 Dec.77	Moni	17	
	31	11 Dec.77	Moni	17	
	35	6 Dec.77	Cement Factory	9	
	38	11 Dec.77	Moni	17	
	49	11 Dec.77	Moni	17	
	54	7 Dec.77	Moni	10	
	57	6 Dec.77	Cement Factory	9	
	58		E Cement Factory		
	62	6 Dec.77	Cement Factory	9	
	66	6 Dec.77	Cement Factory	9	
	70	17 Dec.77	W Cement Factory	23	
	72		E Cement Factory		
	75		E Cement Factory		
	79	11 Dec.77	Ayia Barbara L/ssol	17	
	84	2 Apr.78	500m E of Zygi	128	
	87	6 Dec.77	Cement Factory	9	
	89	22 Jan.78	Zygi	58	
	90	6 Dec.77	Cement Factory	9	

Cont'd.....

Table II

Cont'd

Station data	Drifter No.	Recovery Date	Recovery Area	Days Adrift	Remarks
St.2 #301-330	315	5 Dec. 77	Amathus 36 fms	8	Fished out (Trawler)
St.3 #331-360 25 fms 28 Nov.77	332 350	5 Dec. 77 5 Dec. 77	Amathus 36 fms L/ssol harbour 35 fms	8 8	Fished out (Trawler) Fished out (Trawler)
St.4 #91-120			NO RETURNS		
St. 5 #121-150 15 fms 25 Nov. 77	146	29 Nov. 77	L/ssol harbour	4	Fished out (Fishing boat)
	149	20 Dec. 77	Cement factory	26	Fished out (Trawler)
St. 6 #151-180			NO RETURNS		
St. 7 #181-210 50 fms 25 Nov.77			NO RETURNS		
St. 8 #211-240 5 fms 25 Nov.77	237	8 Dec. 77	Cape Gata 42 fms	14	Fished out (Fishing boat)
St. 9 #241-270 15 fms 25 Nov.77			NO RETURNS		
St.10 #271-300 25 fms 25 Nov.77			NO RETURNS		

Participating research centre: Institute of Oceanography and Fisheries
Mediterranean Branch
ALEXANDRIA
Egypt

Principal investigator: S.D. WAHBY

Introduction:

The Mediterranean Branch of the Institute of Oceanography and Fisheries at Alexandria has been participating in the MED VI pilot project since mid-1976. However, the regular investigations, relevant to the problems of coastal transport, actually started in January 1977. These investigations consisted of two major components: direct current measurements and hydrographic observations. Seasonal measurements of surface currents using drifters and hydrographic surveys have been carried out monthly in the investigated area. Only the direct current measurements are discussed here.

Area(s) studied:

The area selected for MED VI investigations extends for about 70 kilometres along the coast and for a distance of about 35 kilometres seaward (to a water depth of about 100 m). This covers the area from El-Max, west of Alexandria, to Rashid near Rosetta at the mouth of the River Nile. This area receives almost all of the pollutants in this part of the Egyptian Mediterranean coast.

The four main sources of pollutants in the areas are:

	Sources of Pollution
El-Max	Western harbour, fishing boats, oil from harbour and more expected from the oil pipe lines.
Alexandria	Eastern harbour, fishing boats, sewage.
Abu Qir	Industrial wastes, discharges from Lake Idku (agricultural drainage), fishing boats.
Rashid	Nile river discharge.

Figure 1 shows the area studied, including the current mooring sites and the hydrographic stations.

The release stations for the drifters experiments are not indicated on this figure since they are numerous and scattered all over the coast, in and outside the investigated area.

Material and methods:

Monthly releases of Woodhead plastic surface drifters, carrying driftcards, have been made from May 1976 to November 1977, with the exception of the two months September and October 1976. The releases were made at 55 stations along the Egyptian Mediterranean coast, where 2,650 drifters were released.

The procedure is described in the paper: "Drift methods for studying surface currents and some preliminary results of Egyptian experiments in the Mediterranean", by Gerges, M.A., and included in the document IOC-UNEP/DRIFTEX - ad hoc - 1/3 (1976). The data have been analysed using a computer programme development at the Instituto de Investigaciones Pesqueras in Barcelona.

Subsurface currents were measured using Aanderaa current meters moored from a subsurface buoy, from January 1978. Difficulties in maintenance and tape read-out and interpretation have prevented data analysis, however.

Four parallel hydrographic sections were taken in a NW direction normal to the coast. On each of these sections four hydrographic stations were occupied; measurements were made at depths of about 15, 25, 50 and 100 metres.

Salinity and temperature were measured at these standard depths. The depth to the bottom was recorded, and the surface wind speed and direction were obtained using a hand anemometer. Salinity determinations were made using a Beckman induction salinometer.

The following information was also collected at each station during the hydrographic surveys: air temperature, air pressure, cloudiness, sea state and wave height (visual); transparency (Secchi disc reading and water colour), and dissolved oxygen at selected depths and stations.

The four cruises were timed to give seasonal coverage: winter (January); spring (May); summer (July); and autumn (October/November).

Results and their interpretation:

The following table gives the number of drifters released during each monthly experiment from November 1976 to March 1977, the number of cards recived and the percentage recovery for each month and for the whole period.

Month	No. of Drifters released	No. of cards received	Percentage recovery
November 1976	194	42	21.6
December 1976	190	11	5.7
January 1977	85	17	20.0
February 1977	140	31	22.1
March	99	30	30.0
Total	708	131	18.5

Rough computations of both speed and direction of surface currents in the investigated area were made. The estimated velocities were tabluated and the drift routes were plotted on maps.

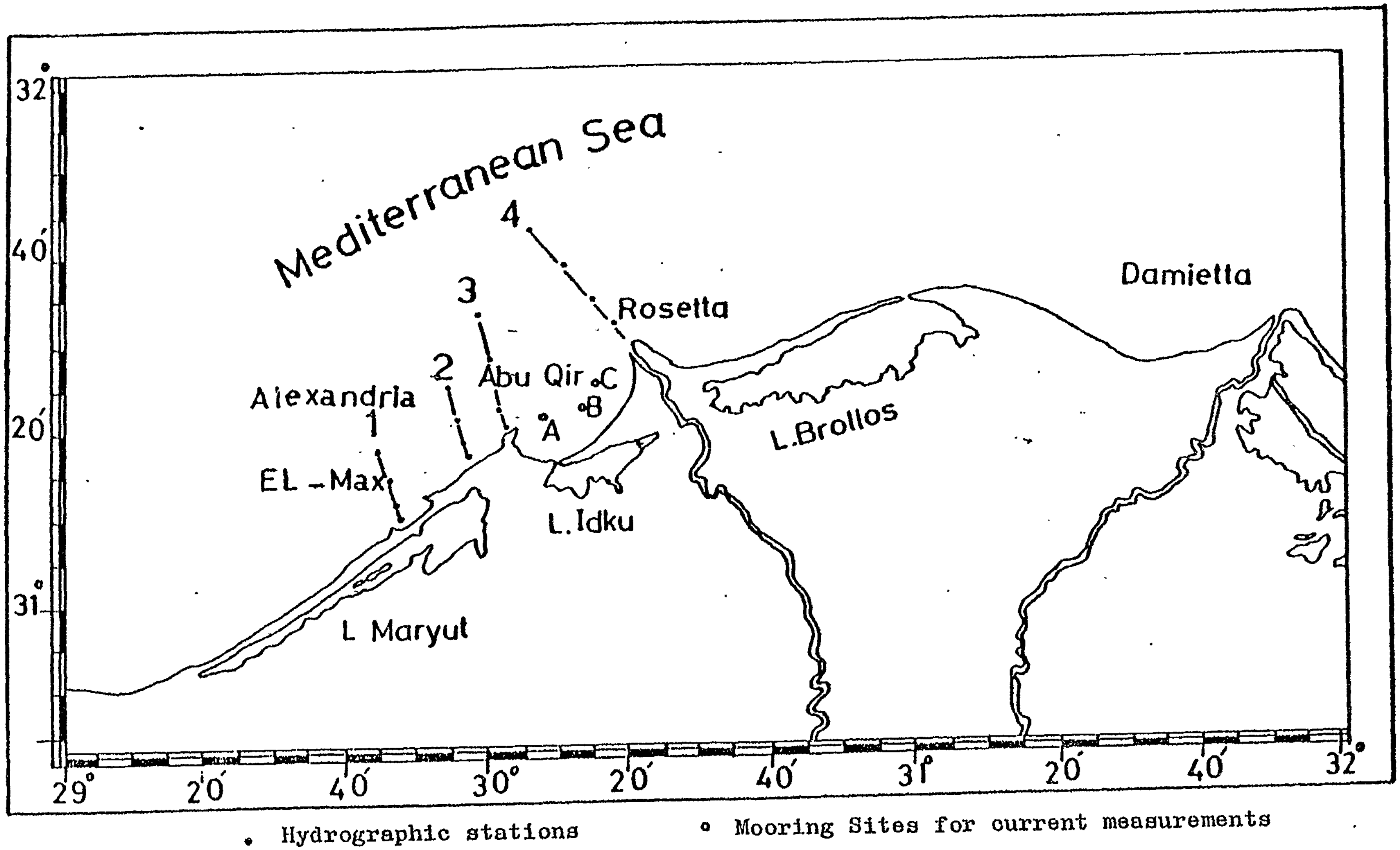
Taking the later data (a further 1842 drifters released) the percentage recovery overall was about 20 per cent.

Some drifters, which were released away from the coast, have travelled long distances to the east, obviously under the influence of the main eastward flow of the general cyclonic circulation in the eastern Mediterranean. Others drifted towards the coast and became stranded on beaches within a short period of time, ranging from a few hours to a few days, indicating a strong onshore component of the surface drift. The results also revealed great monthly variabilities in speed and direction of the surface currents. These variabilities could be correlated with the prevailing meteorological conditions. They were, in most cases, attributed to corresponding changes in the speed and direction of the wind over the investigated area.

The data have been processed using the computer programme mentioned earlier. This programme actually provides "real, theoretical" trajectories according to certain programme criteria, including those based on prevailing meteorological conditions.

Conclusions:

The cards, having been released relatively close to the coast and having been mainly swept rapidly ashore, do not provide highly useful results from the point of view of the project objectives, but the potential value is obvious.



Area of Investigtion and Sampling Stations

Fig. 1 :

Participating research centre: Institute of Oceanography and Fisheries Branch
Ministry of Co-ordination
ATHENS
Greece

Principal investigator: E. VERYKOKAKIS

Introduction:

Oceanographic studies of the Saronikos Gulf were initiated in 1972 as part of a major "Environmental Pollution Control Project". Many cruises were undertaken and a great number of stations were established to investigate the physical, chemical, geological and biological characteristics of the Gulf. Current measurements started in 1975.

The inner Saronikos Gulf has been selected for current measurements. This region is of primary interest because:

a) it is a passage to Pireaus harbour that contributes to the pollutant load, especially with petroleum products;

b) it is the area where the main sewage outfall of metropolitan Athens is located;

c) this area is densely populated, the eastern coast being preferred for recreation.

Area(s) studied:

Saronikos Gulf is a semi-enclosed marine area, bounded on the west by the Argolis peninsula, and on the north and east by Attica. It occupies an area of 2,900 km^2. Islands running north-south tend to divide the Saronikos Gulf into eastern and western sections (figure 1).

Material and methods:

Current measurements were carried out at three stations arranged to form a triangle. The location of these current meters mooring stations is shown in figure 2. Station R^1 can be considered as a long-term mooring station with several breaks. Two Aanderaa recording current meters with extra sensors for temperature, conductivity and depth were used at each station. One of the metres was near the sea bed and the second one approximately 17m below the sea surface to avoid accidents from passing ships. Information on the exact position of Station R^1, the period during which the measurements took place and the depth of the instruments is given in table 1.

A preliminary analysis of the data collected st Station R^1 has been made. The raw data were decoded, tested for their validity and stored on a 7-track magnetic tape. Fortran programs were prepared to plot the continuous cata (speed, direction) and compute the E-W, N-S components, the hourly mean values, histograms and progressive vector diagrams.

A lot of difficulties arose with the safety of the instruments due to the extensive fishing activities and the anchoring of commerical ships near the area of investigation. Up to now four recording current meters and one acoustic release have been lost.

Standard hydrographic observations have also been made throughout the Saronikos Gulf but the results are only briefly mentioned.

On Atalanti, a small uninhabitied island in the northern Saronikos Gulf, a recording anemometer has been installed. Additional meteorological data are obtained from the meteorological stations at Piraeus Port and Hellinikon airport.

Results and their interpretation:

The results of the work done so far can be summarized as follows:

a) the geographical representation of the currents shows irregular oscillations. The amplitude of the E-W components is greater than that of the N-S components;

b) the frequency distribution of the direction of most of the data shows a high concentration in two modal directions 260 and 80 , the former being somewhat more predominant in the bottom currents than in the surface currents;

c) the maximum recorded velocity is 24 cm/sec. Velocities are normally in the range of 3-7 cm/sec.

The flow pattern of the currents at the depth of 35m (period January-February) is variable compared to that at the depth of 17m (period April-October); it demonstrates a reversible flow in the WSW-ENE direction interrupted by flow to the north. On the contrary the flow pattern of the currents near the sea bed is steady towards WSW.

The Saronikos Gulf water appears to be replenished by a western boundary current of North Aegean Sea that flows southward along the continental shelf on the easterly side of Attika peninsula and into the Gulf.

Conclusions:

To investigate the problems of coastal transport of pollutants in the inner Saronikos Gulf, additional computations have to be made with wind records measured at Aralanti station. It is necessary to examine whether southern winds develop an anticyclonic circulation and northern winds a cyclconic circulation.

The evaluation of tidal components is difficult but of minor importance since the area is characterized by a weak tidal velocity field.

TABLE 1

Summary of Aanderaa current-meter data taken at Station R_1.

CURRENT METER SERIAL No	POSITION (1) LONGTITUDE	POSITION (1) LATITUDE	PERIOD	INSTRUMENT DEPTH (2)	VELOCITY MAX cm/sec	VELOCITY MODE cm/sec	DIRECTION MODE	DIRECTION MODE
1209/2	23° 35.53´	37° 54.58´	29/12/75- 4/ 1/76	- 8	5.5	3	27°	110°
1210/2	23° 35.53´	37° 54.58´	29/12/75- 4/ 1/76	35	23	5	260°	80°
1209/3	23° 34.20´	37° 54.45´	6/ 4/76-18/ 4/76	- 7	12.5	6.5	240°	
1210/3	23° 34.20´	37° 54.45´	6/ 4/76- 1/ 6/76	17	24	6.5	260°	80°
1209/4	23° 34. 1´	37° 54. 3´	17/ 6/76- 2/ 8/76	- 7	15	5	260°	90°
1210/4	23° 34. 1´	37° 54. 3´	17/ 6/76-22/ 7/76	17	23	5	260°	70°
1209/5	23° 34. 1´	37° 54. 3´	2/ 8/76-21/ 9/76	- 7	15	4	260°	80°
1210/5	23° 34. 1´	37° 54. 3´	2/ 8/76-20/ 8/76	17	9.5	4	260°	70°
1209/6	23° 34. 1´	37° 54. 3´	4/10/76-28/11/76	- 7	18.5	3	270°	90°
1210/6	23° 34. 1´	37° 54. 3´	4/10/76-25/10/76	16	13.5	5	250°	60°

(1) Station depth is approximately 90 metres.

(2) Minus sign at instrument depth means distance above sea bed, otherwise actual depth is given.

NOTE: The last four columns have been derived from histograms.

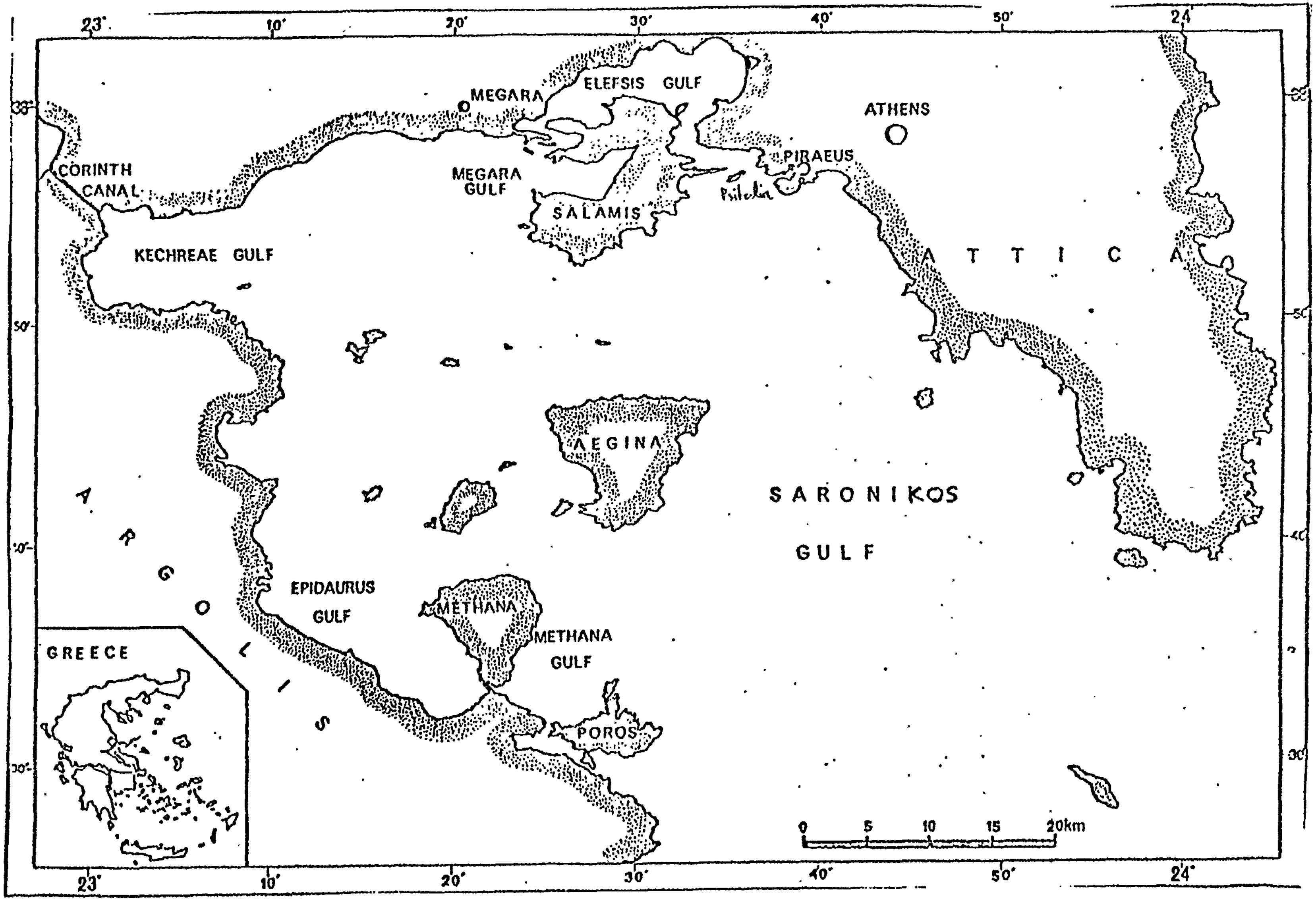


Figure 1. Saronikos Gulf system location and place names.

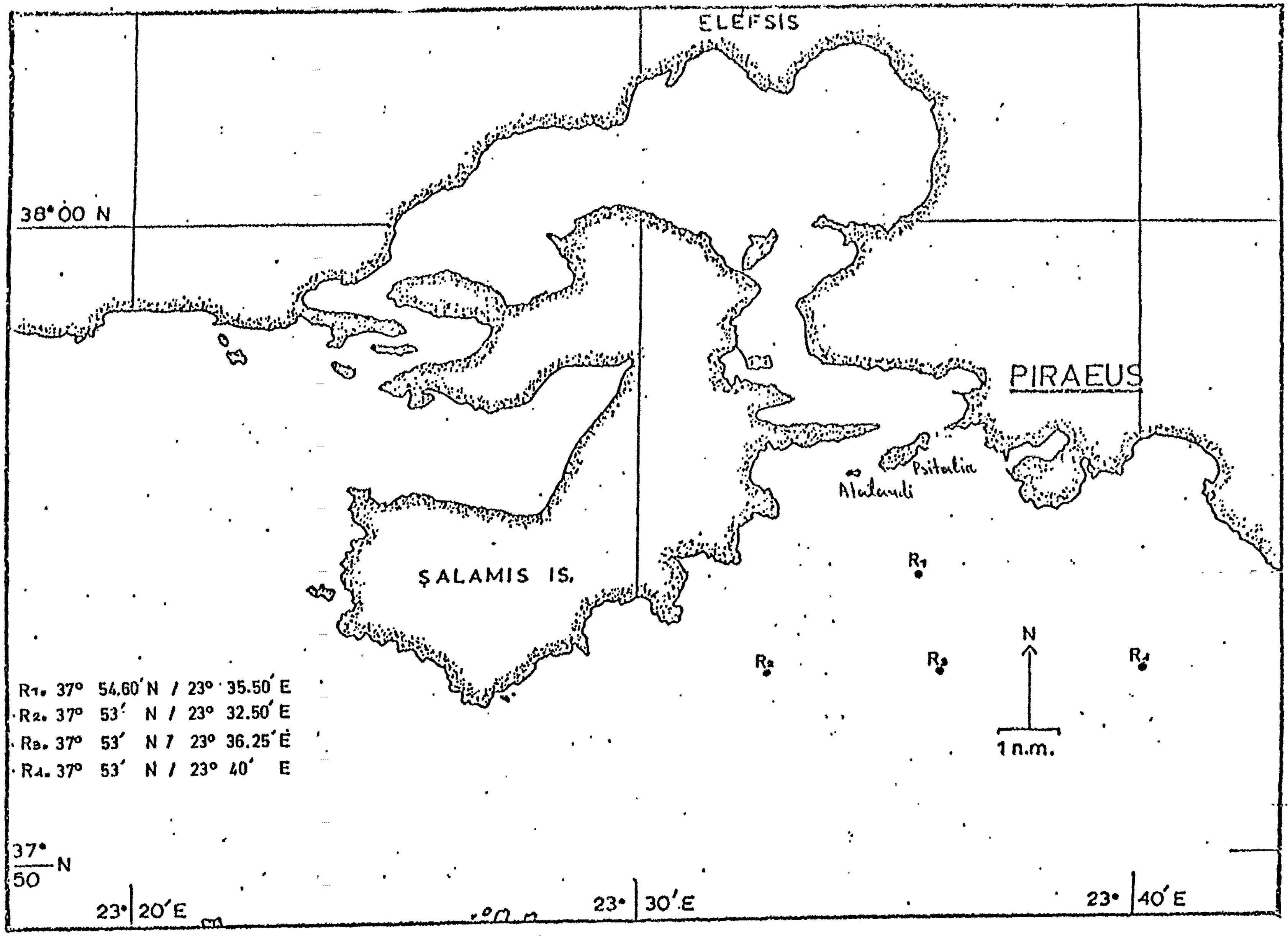


Figure 2. Current-meter mooring stations.

Participating Research Centre: Israel Oceanographic and Limnological Research Ltd.,
HAIFA
Israel

Principal investigator: O.H. OREN

The requested summary report has not been received.

Participating research centre: Group for Oceanographic Research-Genova
Institute of Hydrobiology and Fish Culture
University of Genova
GENOVA
Italy

Principal investigator: I. DAGNINO

The requested summary report has not been received.

Participating research centre: Institute for Water Research - CNR
ROME
Italy

Principal investigator: M. BENEDINI

The requested summary report has not been received.

Participating Research Centre : The Old University
MSIDA
Malta

Principal Investigator : D.A. HAVARD

Introduction:

The coastal water stratification and circulation is being studied for this project. Measurements have been taken of thermal structure and coastal current flow. Previous data of relevance to the project have been collected.

In the study of the problems of the coastal transport of pollutants it is useful to identify the sources and inflow of pollutants. The major effluent outfalls are located at Wied Ghammieq, Malta and Ras il-Hobz, Gozo. Both outfalls have recently been modified and are now submarine outlets. The effluent is mainly domestic waste. Grand Harbour may also be considered as a minor source of pollutants, owing to the concentration of shipping. The other major source of pollutants is from shipping at sea, since Malta lies close to major shipping lanes.

Area(s) studied:

The area of primary interest selected for the study of surface and subsurface currents is the eastern coast of Malta.

The predominant currents in the Malta area are from the N.W. (mean speed about 0.2 m/sec) reflecting the flow of surface water from the Western to Eastern Basins. Levantine intermediate water flows south of Malta over the eastern sill of the Straits of Sicily between Malta and the Medina Bank.

Material and methods:

Currents:

Subsurface currents have been measured during the summer 1978. A recording current meter (Aanderaa RCM 4) is stationed 800 m offshore at the location of the newly constructed submarine outfall (35°54.0'N; 14°32.7'E). The meter was moored 25 m from the surface in a total depth of 35 m using a subsurface taut mooring. The data are summarized in Table 1.

Prior to the arrival of the RCM, spot flow measurements were taken using a Braystoke flowmeter and a direct-reading current meter model CM2 manufactured by Toho Dentan Ltd. These measurements were taken from a moored boat.

A drift-card experiment, using vertically floating cards (25 cm x 12 cm) manufactured by Oceanography Unlimited Inc. was conducted in 1973 and the results analysed for this project. 240 cards were released in three experiments. Further drift-card releases in 1977 produced little significant data.

The changes in coastal currents off the east coast have also been estimated by an indirect method. There are several obsolete submarine telegraph cables running from St. Julians, Malta. Some of these are broken in the coastal region. The potential difference between five cable ends and a reference earth is time-sampled and recorded potentiometrically. The technique is capable of indicating large scale changes in the coastal currents.

Some remotely sensed data from 'Landsat 2' have been inspected.

Bottom topography and the thermal structure of the water column have also been studied in other coastal areas around the Islands. In order to consider the exchange between coastal and offshore regions, previous bathymetric, bathythermographic, station and current data have been collected from an area within about 100 miles of Malta.

Mechanical B.T. measurements have been taken at various stations around the islands. Some samples have been collected using Nansen bottles but the accuracy of the salinity values, for several reasons, is not as high as required for useful intercomparison of results.

Wind speed and direction are continuously recorded at the meteorological station, Luqa. The mean hourly data are tabulated each month and a copy sent to the University for the MED POL projects.

Results and their interpretation:

Currents: data from the RCM for May and June 1978 show diurnal variations of the current. During periods of light surface winds (less than 10 knots) the current sets along the coast to the southeast for the greater part of the day (about 16 hours) and reverses with weak currents for the rest of the day. During periods of stronger northwesterly winds (more than 20 knots) the current sets always to the southeast with a maximum velocity of 0.5 m/sec., the diurnal variation showing as a change in speed but not direction. An increase in temperature of about 5°C, due to the storm mixing of surface and subsurface waters, was also recorded during these periods of stronger southeasterly currents.

The spot flow measurements also show coastal currents setting to the southeast at speeds of 0.1 to 0.2 m/sec. Of the 240 cards released in three drift-card experiments, 21 cards were returned; 10 of these were recovered at sea. The mean currents estimated from these results set in southeasterly and southerly directions along the coast, and lie in the speed range of 0.1 to 0.2 m/sec., despite light surface winds in other directions.

Data from the submarine cables show that the current system often exhibits only small variations over periods of several days, whereas on other occasions, particularly in winter, changes of $\pm$ 0.5 m/sec. may occur in a few hours in the North-South component of the current east of Malta (between Malta and the Hurd Bank). It is sometimes, but not always, possible to associate these with strong winds. The greatest change recorded was during a period of persistent northwesterly gales when this method indicated coastal water transport in excess of 3 m/sec. setting to the southeast.

Remotely sensed data from 'Landsat 2' recorded on 28 March 1975 (ERTS E-2065 - 08555 - 4) showed large surface eddy systems northeast of Malta. The complex character of the surface water in this area, observed by aircraft and shipping, has been previously reported. It is highly probable that similar eddy systems also affect the coastal currents around Malta. It is expected that the presence of the Maltese Islands in the flow of surface water from the western to the eastern basin of the Mediterranean will generate eddies to the southeast of the Islands and in the area of the channels between the Islands.

The hydrographic data for the area around Malta clearly shows the less saline surface water flowing southeast past Malta from the western to eastern basin of the Mediterranean and the more saline Levantine intermediate water flowing in the reverse direction south of Malta.

Conclusions:

Malta lies in the region of water exchange between the western and eastern basins of the Mediterranean. The results of circulation measurements clearly reflect the transport of surface water from the western to eastern basins in a southeasterly direction past Malta. In calm summer conditions a diurnal variation in the coastal current has been observed and strong stratification of the water mass also occurs. In winter the water mass is well mixed to depths in excess of 50 m by the winter storms which strongly influence the surface currents, producing highly variable currents.

The existence of the islands in this west-to-east flow will generate eddy systems. It is expected that these will be mainly to the east and south east of the Islands with complex current flow in the channels between the islands. The coastal current system is also expected to be more strongly influenced by the variable meteorological conditions than other coastal systems in the Mediterranean.

The immediate problem of the coastal transport of pollutants from the major effluent outfalls has been solved by the construction of submarine outlets. The effluent is now rapidly dispersed into a large body of water. However, the potential threat to Malta of an oil slick being transported onto the coast is serious. The coastal current system is so variable, particularly in winter, that no section of the coastline may be considered safe from this potential source of pollution.

List of publications:

A paper "The study of the problems of the coastal transport of pollutants in Maltese coastal waters" D.A. Havard, was presented at the Joint ICSEM/UNEP Workshop on Pollution in the Mediterranean (Antalya, November 1978).

A short communication "Water Stratification and Circulation around the Maltese Islands", D.A. Havard, was submitted to the Physical Oceanography Committee of ICSEM.

Table 1. Summary of current data obtained from moored current meters.

Date	Location	Depth of meter	Current Speed ± 0.03 m/sec	Direction
31/10/75	35°54'N 14°33'E	1 m 15 m	0.17 0.15	S.E.
21/5/76	35°57'N 14°28'E	5 m 2 m	0.16 0.19	S.E.
4/11/76	35°54'N 14°33'E	3 m 15 m	0.25 0.24	S.E.
28/4/77	35°54'N 14°33'E	3 m 10 m 20 m 24 m 15 m 10 m 5 m 1 m	0.13 0.14 0.11 0.10 0.12 0.17 0.20 0.25	S.E.

Participating Research Centre : Instituto de Investigaciones Pesqueras
BARCELONA
Spain

Principal Investigator : A. CRUZADO

Introduction:

Investigations carried out in the neighbourhood of Barcelona are rather scarce. Previous investigations in the Catalan Sea consisted mainly of hydrographic studies, always in connection with other biological and ecological studies. No direct measurements of coastal or off-shore circulation were available, but some estimations have been made by geostrophic computations of the general circulation of the Catalan Sea in summer, excluding shelf waters.

Area(s) studied:

The region studied covers the coastal zone off the city of Barcelona and its metropolitan area (Fig. 1). Two rivers (Rio Llobregat and Rio Besos) border the city of Barcelona. The flow of the two rivers cannot be differentiated, under normal conditions, from the sewage system and amounts to a total of about 45 m^3 sec^{-1}.

A large number of "rambles" (dry water courses) discharge only during heavy rains along the eastern shore. A number of small channels and sewers have their outlets in the harbour and along the eastern shore where the main sewage systems of the city of Barcelona and of other towns discharge directly into the sea.

Material and methods:

Sampling stations were located to the southeast of the Port of Barcelona (Fig. 1) and off the Rio Besos outlet. The investigations have included: basic hydrographic parameters as well as other related chemical, biological and meteorological information in a section off Barcelona (Fig. 1); wind speed and direction have been recorded every six hours during 1975 and 1976 at Barcelona Airport; studies of the fresh water plume formed by the Rio Besos outlet.

Other studies have been carried out under other projects although within a common geographical framework: geostrophic circulation in the Catalan Sea based on the distribution of density in the region; theoretical studies of the diffusion processes applied to the evolution of the seasonal thermocline; and theoretical studies of the air-sea-bottom interaction for modelling the coastal circulation.

The Institute developed a computer programme for the analysis of drift-card data.

Results and their interpretation:

There were no direct current measurements, but the following general points may be made.

The Catalan coast is under the influence of a cyclonic gyre between the mainland and the Balearic Islands maintained by the density gradient established in the centre of the Catalan Sea; this gradient is due to the fresh water from the River Rhône along the northwest coast and to the less saline Atlantic water passing through the channels between the Islands.

The wind fluctuates from the very weak north-northeaster in the morning to the southwesterly breeze in the afternoon (the "garbi"). The latter drives the surface water to the northeast in the near-shore area, probably generating small-scale eddies that tend to transport the pollutants from the Barcelona area to the recreational beaches of the Maresme.

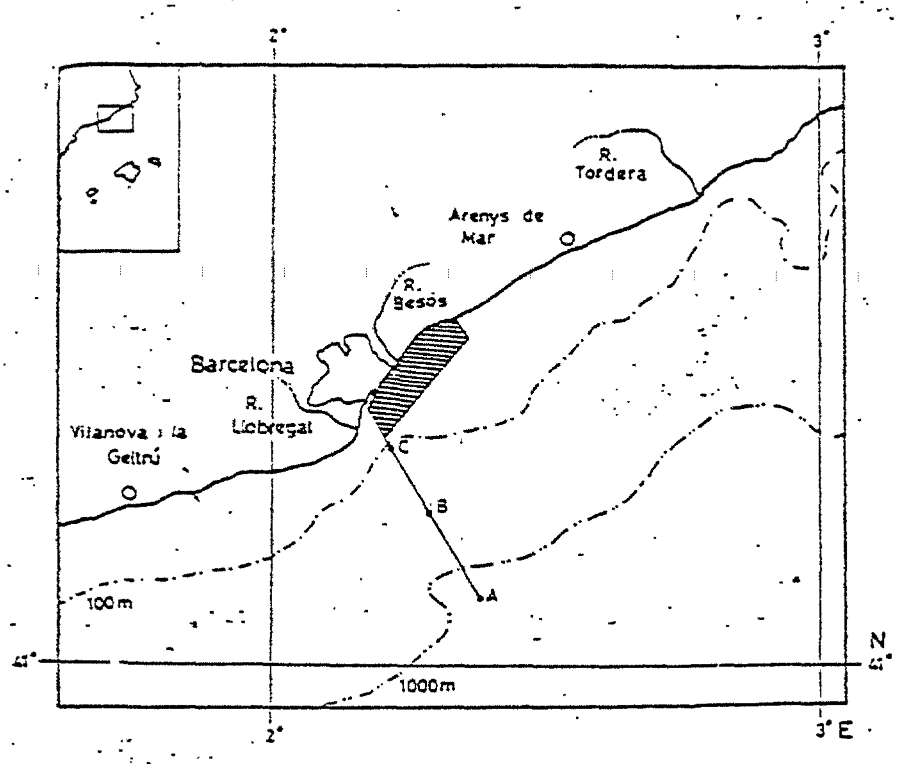
Winter mixing and cooling all strong, the homogeneous water column reaching more than 700 m. deep. Surface water loaded with pollutants is thereafter located between the surface water and the intermediate water (about 200 m), remaining there for the entire year.

The outflow from the Rio Besos, combined with the main sewage outflow in the area, spreads north and south depending on the wind direction. With the southwesterly breeze the fresh water plume tends to widen and move to the north, whereas with the northeasterly wind (Llevant) the water piles up against the southern shores.

Conclusions:

Although some preliminary indications of the general circulation are well established, the flow of water and of sediments, both carrying the pollutants released in this urban and industrial area, are not well known. Direct current measurements both at the surface and on the bottom are required, and current fluctuations compared to the high-frequency fluctuating wind regime (hour scale). The barotropic component of the current velocity should be compared with the sea level and air pressure field. Although fresh water plumes are relatively unstable, plume maps should be compared precisely with meteorological conditions so as to establish a reliable model of the dispersive processes.

The combination of general circulation, wind drift, fresh-water fronts and thermal structure in a model should be attempted to improve understanding and prediction of the fate of the pollutants locally released.


2°
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R.
Tordera
Arenys de
Mar
R.
Besòs
Barcelona
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Llobregat
Vilanova i la
Geltrú
C
B
A
100m
1000m
N
41°
41°
2°
3° E

Fig. 1

Participating Research Centre : Institute for Oceanography and Fisheries
SPLIT
Yugoslavia

Principal Investigator : M. ZORE-ARMANDA

Introduction:

Earlier investigations have been carried out in the whole region covered by this project, partly as part of the Institute's routine work and partly to solve some pollution problems for the local authorities. A considerable amount of data was collected from the Zadar area in 1975-1976 in relation to the proposed location of a nuclear power plant, and another series of data for the same period was collected for a locality close to the city of Zadar. For the Split region the Institute has a long series of data since 1934. Special programmes were carried out in the Sibenik region in 1973-1974 and in the Dubrovnik region in 1970 and in 1977.

Area(s) studied:

The areas of interest are the following Dalmatian urban centres: Zadar, Sibenik, Split and Dubrovnik. (Fig. 1).

The main characteristic of the coast is its prominent indentation, with numerous islands, peninsulas and bays lying mostly in the NW-SE direction. The coast is predominantly made of limestone and dolomite. The rivers are short and do not have much water.

From May to October the weather is warm and dry, under the influence of the etesian winds (maestral). In the winter months the typical winds are bora (northeasterly, cold and dry), and scirocco (jugo) (southeasterly, warm and moist).

Material and methods:

Nine cruises were undertaken : November 1976, April 1977, May 1977, August 1977, November 1977, July 1978, August 1978 and September 1978. Currents were measured by a direct-reading current meter (Kelvin Hughes) in 24-hour series at stations Z1, S1, S1 and D1 (Fig. 1). In September 1978 a special experiment was performed in the Zadar area. At four buoy stations, Aanderaa recording current meters were operated for seven days at two depths.

Temperature and salinity were measured at three stations in each area investigated (Zadar, Sibenik, Split, Dubrovnik) at standard depths and using standard oceanographic methods (reversing thermometres, salinometer, STD probe). Dye (Rhodamine B) experiments were performed in the Zadar, Split and Dubrovnik areas. Meteorological parameters (wind speed and direction, sea state, direction of waves) were also measured.

Results and their interpretation:

Tables I, II, III, IV and V summarize the current data for November 1976, April 1977, May 1977, July 1977, and August 1977, respectively. Later data await analysis.

Current speeds are generally similar in all regions in any given month. Earlier measurements showed different results, but they were not synoptical. Speeds tend to be higher near the bottom than in the surface layer.

Speaking very generally, surface and bottom currents tended to be similar at Sibenik, and tended to be different (to be opposed) at Zadar, Split and Also, at the surface, westerly currents predominated; at the bottom, the data showed no clear pattern, east and southwest being the slightly preferred directions.

We have comparative values for two summers (July and August 1977 and 1978). Speeds and directions are similar in the two years. To see better the vertical distribution, measurements have been taken at one more depth closer to the bottom. After the processing of all the data available, a better discription could be given.

In the coastal basins, two types of vertical and horizontal circulations are found. In vertical circulation essentially two layers are important. Some basins behave like dilution basins where water goes out at the surface and enters at the bottom. In others, which are more common, surface water enters in the basin and bottom water leaves it. In the latter, the influence of the open sea on the oceanographic properties in the basin is more evident.

It seems that the shape of the basin is responsible for the type of vertical circulation. Basins open to the prevalent northwesterly surface current of the open Adriatic usually belong to the second type (e.g. Dubrovacka Rijeka), but rain or the presence of a river (Sibenik and Dubrovnik areas) could also be important. In the Kastelanski Bay near Split water more frequently enters at the surface, although in summer and autumn reversed circulation was found.

Horizontal circulation is mainly cyclonic, as it is for the whole Adriatic, but anticyclonic circulation could also be found, It seems that horizontal circulation depends on meteorological conditions.

Tidal currents are weak with average speeds from 3 to 5 cm/sec, and they do not influence dilution essentially.

Dye experiments were performed in the Zadar area in October 1977, in the Split area in December 1977 and in the Dubrovnik area in September 1977 to study the isotropic horizontal diffusion. Diffusion coefficients for Zadar were 0.19 m^2/sec, for Split, 0.42 m^2/sec. and for Dubrovnik, 0.21 m^2/sec. It seems that the Split area is more turbulent than those of Dubrovnik and Zadar. The relation between currents (U) and diffusion coefficients (K) may be of special interest: Split - K/U = 1.79 km; Zadar - K/U = 1.69 km; Dubrovnik - K/U = 0.73 km.

These relations show that pollutants would be transported faster in the Split area, with lower concentrations and gradients, than in the Zadar aréa and, especially, the Dubrovnik area.

A simple model has been developed to study the water exchange between the bay and the open sea. The density of contaminant per unit surface is applicable at the entrance to the bay, whereas in the bay itself, the density of contaminant per unit length is used. The intensity of the contaminant source and its density at the mouth of the bay are related by dissolution. The model will be applied to the different bays in the region.

Table 1. The main characteristics of the currents in three areas in November 1976.

Station	Depth m	Max. speed cm/sec	Min. speed cm/sec	Average speed cm/sec	Resultant Current Direction Degree	Resultant Current Direction Compass	Resultant Current Speed cm/sec
Zadar	0	22	2	14	166	SE	7
	20	14	2	4	41	NE	5
Split	0	25	5	16	106	E	10
	20	23	1	15	76	E	11
	35	24	8	17	88	E	18
Dubrovnik	0	22	5	13	257	W	9
	20	23	4	15	81	E	9
Average		22	4	13			10

Table II. The main characteristics of the currents in four areas in April 1977.

Station	Depth m	Max. speed cm/sec	Min. speed cm/sec	Average speed cm/sec	Resultant Current Direction Degree	Resultant Current Direction Compass	Resultant Current Speed cm/sec
Zadar	0	16	0	5	346	N	7
	20	24	0	5	348	N	10
Sibenik	0	15	5	11	264	W	5
	30	25	8	16	243	SW	8
Split	0	22	0	5	243	SW	2
	20	36	0	13	253	W	7
	35	35	0	13	97	E	14
Dubrovnik	0	36	0	7	146	SE	2
	20	44	0	9	207	SW	9
Average		28	1	9			7

Table III. The main characteristics of the currents in four areas in May 1977.

Station	Depth m	Max. speed cm/sec	Min. speed cm/sec	Average speed cm/sec	Resultant Current Direction Degree	Resultant Current Direction Compass	Resultant Current Speed cm/sec
Zadar	0	18	0	5	308	NW	6
	20	14	0	6	137	SE	9
Sibenik	0	19	0	4	243	SW	6
	28	26	0	6	254	W	13
Split	0	16	0	6	68	E	3
	20	6	0	1	162	S	3
	35	6	0	1	211	SW	6
Dubrovnik	0	15	0	5	326	NW	2
	20	34	0	13	42	NE	6
Average		17	0	5			6

Table IV. The main characteristics of the currents in four areas in July 1977.

Station	Depth m	Max. speed cm/sec	Min. speed cm/sec	Average speed cm/sec	Resultant Current Direction Degree	Compass	Speed cm/sec
Zadar	0	6	0	1	194	S	4
	20	2	0	0	-	-	-
Sibenik	0	10	1	6	279	W	3
	28	24	5	14	320	NW	9
Split	0	15	0	4	76	E	2
	20	23	0	6	101	E	8
	35	26	0	5	77	E	5
Dubrovnik	0	7	0	1	248	W	3
	20	27	0	4	166	S	11
Average		16	3	5			6

Table V. The main characteristics of the currents in four areas in August 1977.

Station	Depth m	Max. speed cm/sec	Min. speed cm/sec	Average speed cm/sec	Resultant Current Direction Degree	Compass	Speed cm/sec
Zadar	0	25	0	5	305	NW	6
	20	26	0	8	262	W	7
Sibenik	0	9	0	5	254	W	4
	28	19	0	10	225	SW	3
Split	0	23	0	10	259	W	11
	20	33	0	17	219	SW	6
	30	20	0	5	156	SE	5
Dubrovnik	0	14	0	1	45	NE	5
	20	26	0	6	7	N	8
Average		22	0	7			6

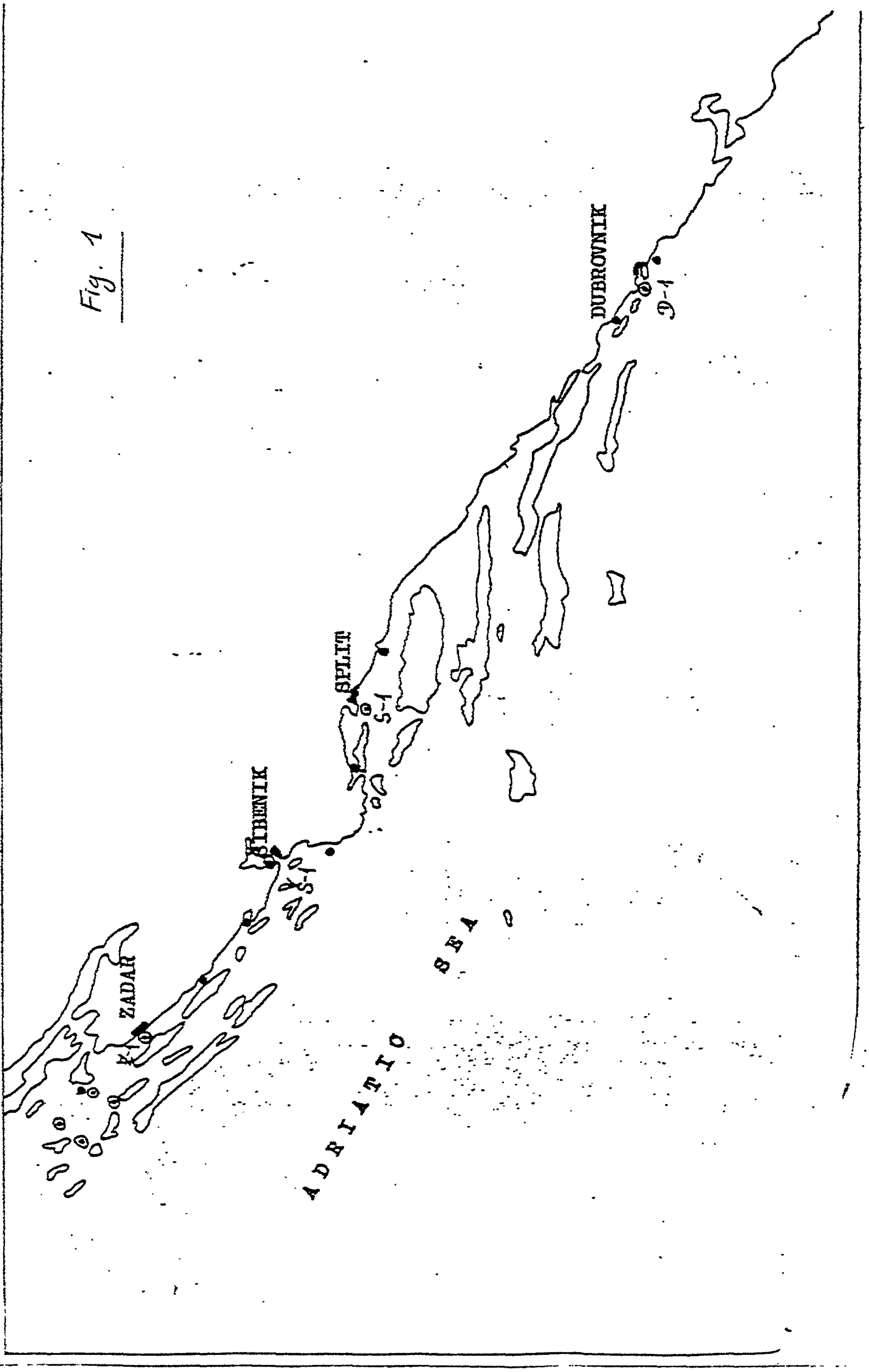


Fig. 1

Participating Research Centre : Centre for Marine Research
"Rudjer Boskovic" Institute
ZAGREB
Yugoslavia

Principal Investigator : L. JEFTIC

Introduction:

The work done under MED POL VI forms part of a complete environmental study of Rijeka Bay.

Area(s) studied:

Rijeka Bay is located between the Istrian peninsula, the mainland, Krk island and Cres island (Fig. 1). It is connected to adjacent waters through three channels: Vela Vrata, Srednja Vrata, and Tihi kanal. Vela Vrata lies between the Istrian peninsula and Cres island. Srednja Vrata lies between Cres and Krk islands. Tihi Kanal lies between the mainland and Krk island. The area of the Rijeka Bay is 449 km^2 and the Bay contains 26.9 km^3 of water. The average depth of the Rijeka Bay is about 60 m.

The only river worth mentioning is the Rijecina (length 17 km, width at the river-mouth 15 m). Rijecina has a very variable flow of water averaging 10-50 m^3 /sec.

In 1971 the whole region had 490,000 inhabitants. It is projected that by the year 2000 the number will increase to 800,000.

Rijeka harbour has a yearly traffic of 13 million tons; it is expected that by the year 2000 the traffic will increase to 80 million tons. There are several industrial enterprises operating or under construction along the Rijeka Bay shoreline, mostly around Rijeka, Bakar Bay and the northwestern part of Krk island. Some of those enterprises are: a refinery, a fossil-fuel power plant, a petrochemical complex, a deep water oil terminal, a cokery, a paper-mill, and a shipyard.

Estimated BOD_5 load (estimated by means of survey) for Rijeka Bay is 3950 tons per year from domestic sources, 3050 tons per year from industry, and 150 tons per year from tourists.

The following basic parameters were measured: temperature, salinity, dissolved oxygen, surface currents (drifters and driftcards), subsurface currents (autonomous current meters) and meteorological observations; pH, total alkalinity, specific alkalinity, total CO_2, nitrate, nitrite, ammonia, total phosphate, phosphate, silicate, zinc, cadmium, lead, copper, mineral oils, hydrocarbons, phenols, detergents, surface active substances, phytoplankton, zooplankton, total coliforms, faecal coliforms, heterotrophs, and benthic communities were also measured or assessed.

Results and their interpretation:

The mean value of the water flow through Rijeka Bay is 0.1 km^3 per hour which corresponds to a flushing time of 11.25 days. This value varies from 0.05 km^3 per hour (τ = 22.5 days) at the beginning of June to 0.27 km^3 per hour (τ = 4.2 days) in the middle of December. It has been found that water circulates through the bay cyclonically from the end of August to the end of May of the following year, and anticyclonically, but much more slowly, from the end of May to the end of August.

The exchange of water masses of the Rijeka Bay is thus achieved by two processes: circulation of water and tides. The first process contributes two thirds to the exchange, whereas the later process contributes the remaining third.

The Vela Vrata and Srednja Vrata channels and the southern part of the Bay have the most intensive exchange of water and the more homogeneous hydrographic characteristics. Between Vela Vrata and Srednja Vrata there is a water circulation system working either clockwise or counterclockwise.

The part of the Bay next to Krk island and the central part of the Bay are fairly often under the influence of inflowing currents from Srednja Vrata, resulting in higher salinity. This zone of higher salinity, depending on the currents, can extend as far as the city of Rijeka.

The northern part of Rijeka Bay is under the complex and variable influence of fresh waters from bottom springs, the river Rijecina and sewage outlets. Most of the time the currents in this zone exhibit a circular behaviour, and it is here that the most pronounced variations in hydrographic characteristics are to be found, especially in the surface layer.

Bakar Bay is an autonomous entity. It is under the strong influence of fresh waters from precipitation and bottom springs. This influence is also evident in the vicinity of Tihi Kanal and in most of the northern part of Rijeka Bay.

It has also been found that exchange of water in Omisalj and Bakar Bays is governed only by tidal processes.

The value of the drift-card experiment was proved by the great similarity of results obtained by driftcards, current meters and drifters.

In winter (December 1976 - February 1977) in Rijeka Bay, the surface currents are cyclonic. In summer (August 1977) a rotatory flow prevailed, especially in the northern and northwesterly parts of Rijeka Bay. In September 1977 the wind was an important factor in the formation of the current pattern in the Bay.

Conclusions:

An investigation of surface currents with drift-cards is practical, informative, and cheap. The drawback of such an experiment is the inability to measure the real speed of currents in the surface layer. The colour of the driftcards does not play a role in the percentage of recovery, but, for practical reasons, it is advisable to carry out each launching with cards of different colours.

The computer programme developed for calculating the exchange of water masses of small bays with adjacent open waters needs several days of continued measurements of currents within a year; it gives a reasonable and fast approximation to exchange rates of water in a bay. This is used, in combination with biochemical parameters, to assess the capacity of the bay to receive each specific pollutant.

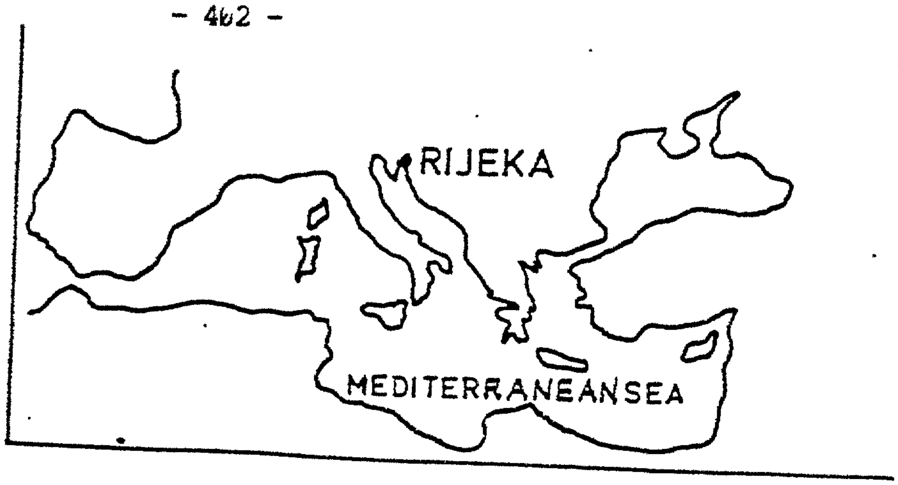
List of publications:

Sekulic, B., (1977), Background Information on Rijeka Bay, in L. Jeftic: Ecological Study of Rijeka Bay, Report, pp. 3-21 (in Croatian).

Degobbis, D., (1977), Chapter 1, Hydrography, in L. Jeftic: Ecological Study of Rijeka Bay, Report, pp. 25-63 (in Croatian).

Ilic, D., and Nozina, I., (1977), Chapter 2, Dynamics of Water Masses, in L. Jeftic: Ecological Study of Rijeka Bay, Report, pp. 65-101 (in Croatian).

Degobbis, D., Ilic, D., Jeftic, L., Nozina, I., Smodlaka, N. and Vucak, Z. : Hydrographic and Hydrodynamic Characteristics of Rijeka Bay. IVes Journées Etud. Pollutions, C.I.E.S.M., Antalya, November 1978, pp. 551-554.


RIJEKA
MEDITERRANEAN SEA

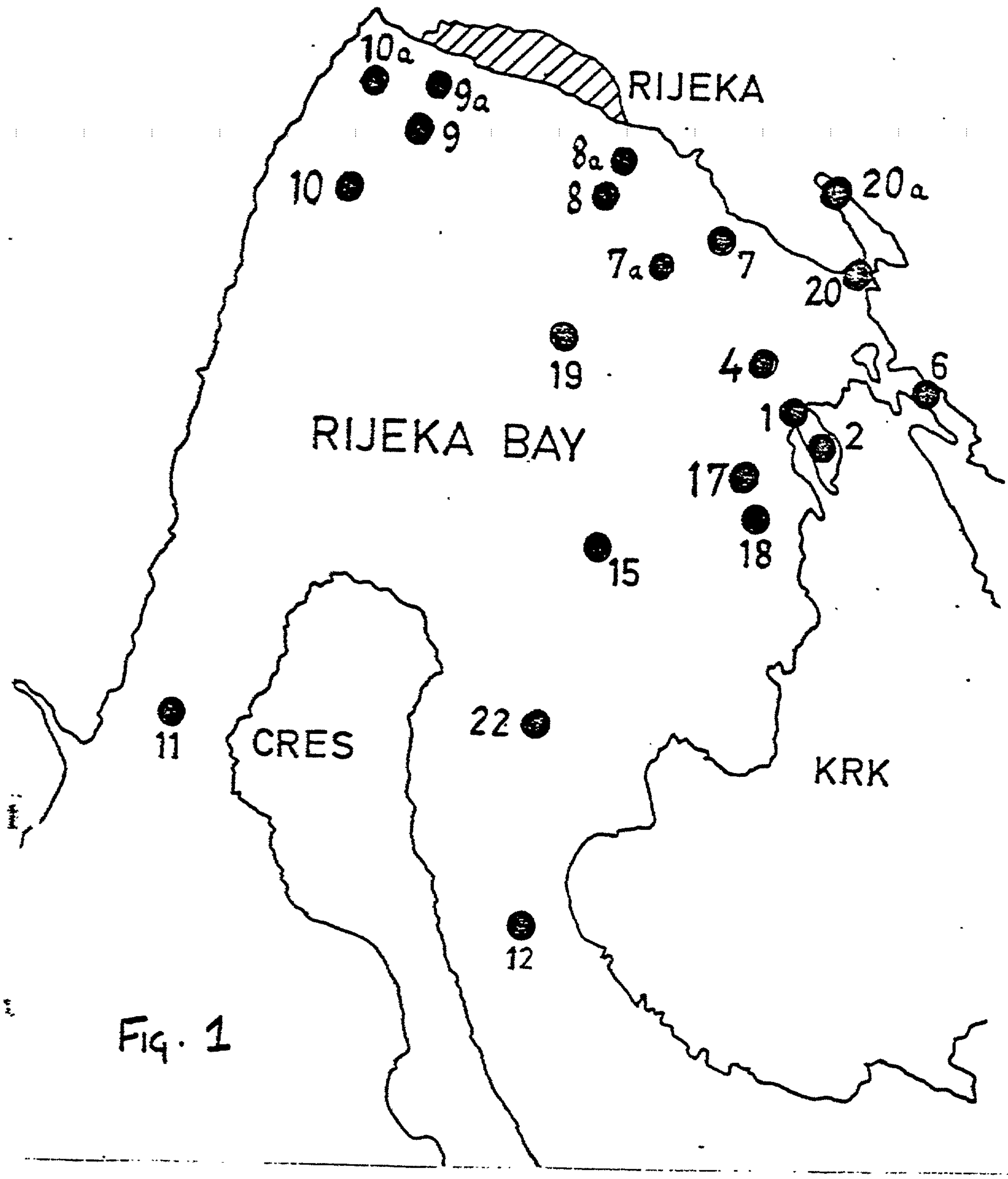
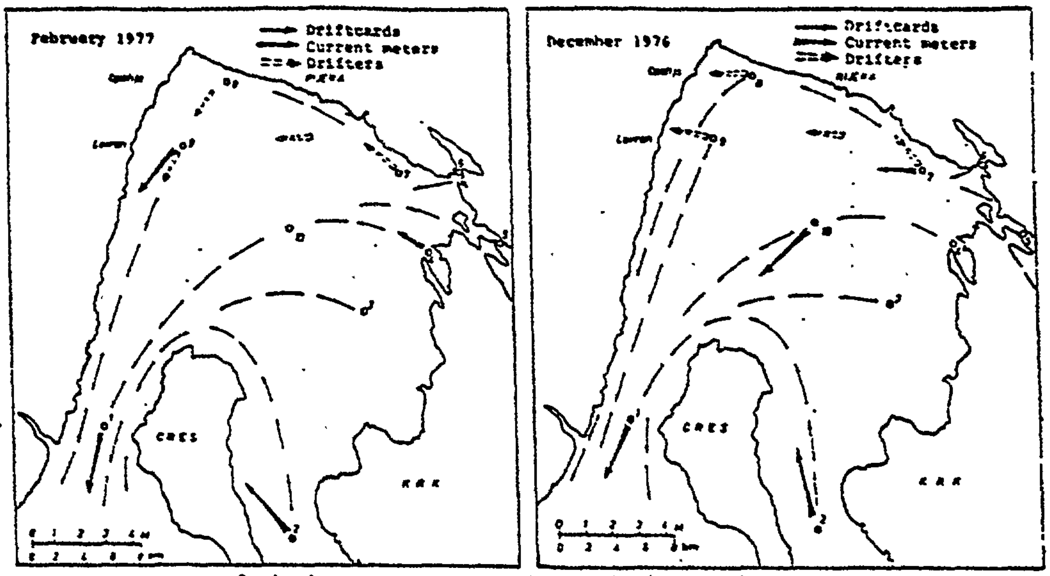
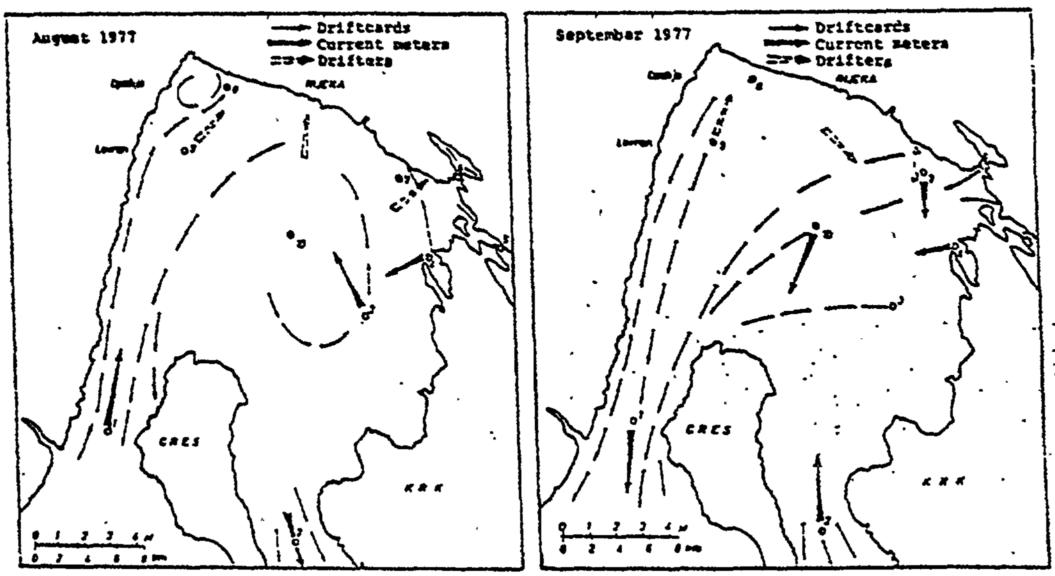

10a
9a
9
10
RIJEKA
8a
8
20a
7a
7
20
19
4
6
1
2
RIJEKA BAY
17
18
15
11
CRES
22
KRK
12

Fig. 1



Results of current measurements by driftcards (—▸), drifters (⇒), and current meters (➡). Current metre measurements were made at 3 m depth for periods of 24 to 72 hours.



Results of current measurements by driftcards (—▸), drifters (⇒), and current meters (➡). Current meter measurements were made at 3 m depth for periods of 24 to 72 hours.

Fig. 2

EP

United Nations Environment Programme

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6 February 1980

Original: ENGLISH
FRENCH
ESPANOL

Intergovernmental Review Meeting of
Mediterranean Coastal States on the
Mediterranean Action Plan

Barcelona, 11 - 13 February 1980

SUMMARY REPORTS ON THE SCIENTIFIC RESULTS OF MED POL

Summary reports of participants in the Co-ordinated Mediterranean
Pollution Monitoring and Research Programme (MED POL)

PART III

RAPPORTS RESUMES DES RESULTATS SCIENTIFIQUES DU MED POL

Rapports résumés des participants au Programme coordonné
de surveillance continue et de recherche en matière de
pollution dans la Méditerranée (MED POL)

PARTIE III

GE.80-1018

Table of Contents/Table des matières

INTRODUCTION

This document contains the summary reports of research centres which have participated in the Co-ordinated Mediterranean Pollution Monitoring and Research Programme (MED POL).

The reports were edited by the specialized United Nations bodies to which they were submitted and are reproduced in the language in which they were originally written.

For convenience, the reports are arranged in order of the MED POL pilot projects and within these projects by countries in alphabetical order.

The names of the principal investigators and the research centres are indicated at the beginning of each summary report.

INTRODUCTION

Le présent document contient les rapports résumés des centres de recherche qui ont participé au Programme coordonné de surveillance continue et de recherche en matière de pollution en Méditerranée (MED POL).

Les rapports ont été édités par les organes spécialisés des Nations Unies auxquels les rapports ont été soumis et ils sont reproduits dans leur langue originale.

Pour plus de commodité, les rapports sont présentés dans l'ordre des projets pilotes du Programme MED POL et, dans le cadre de ces projets, ils sont classés par pays, par ordre alphabétique.

Les noms des chercheurs principaux et des centres de recherche sont indiqués en tête de chaque rapport résumé.

MED POL VII : COASTAL WATER QUALITY CONTROL (WHO/UNEP)

MED POL VII : CONTROLE DE LA QUALITE DES EAUX COTIERES (OMS/PNUE)

Centre de Recherche Participant : Centre d'Etudes et de Recherches de Biologie et d'Oceanographie Medicale
C.E.R.B.O.M.
NICE
France

Chercheur Principal; A. FRUCHART

Introduction:

Dans le cadre du projet MED POL VII (PNUE), le Centre d'Etudes et de Recherches de Biologie et d'Océanographie Médicale (C.E.R.B.O.M.) effectue une étude bactériologique des eaux de baignade de la ville de Nice, dans la Baie des Anges.

Cette étude comprend:

1) Des analyses bactériologiques des eaux de baignade :

   - Streptocoques fécaux
   - Coliformes fécaux
   - Coliformes totaux

2) Des analyses physico-chimiques des eaux de baignade :

   - Salinité
   - Température
   - Oxygène dissous

3) Des analyses hydrologiques et météorologiques :

   - Courantologie de la zone
   - Vent (force et direction)
   - Température de l'air
   - Nébulosité du ciel

4) L'observation de la plage afin de recherche d'éventuels polluants liés aux macro-déchets et aux hydrocarbures.

Zone(s) étudiée(s):

Trente prélèvements ont été effectués simultanément dans la zone d'étude. Les stations sont reportées sur le schéma no.1 suivante et sont numérotées de 1 à 30.

Matériel et méthodes:

L'étude de la courantométrie conditionne l'étude de la pollution car elle permet d'étudier le devenir des eaux rejetées par les fleuves côtiers et les collecteurs d'égout.

Etude des courants de la Baie des Anges:

Cette étude ayant été faite partiellement par Romanovsky, nous pouvons résumer les principales données de ce travail publié en 1951.

A ces données nous ajouterons certaines précisions obtenues par nos propres observateurs faites, soit au courantomètre à flotteur soit par l'étude des courbes thermiques, soit par la recherche de la salinité.

En résumé, il existe deux situations générales de circulation des eaux marines dans la Baie de Nice :

- d'une part, par beau temps, un tracé N.E.-S.O. qui s'infléchit pour suivre parallèlement le littoral de la Baie de Nice, les filets du large gardant une direction plus rectiligne.

- d'autre part, une deuxième situation est créée par les vents de secteur Ouest. Si les courants du large conservant à peu près une direction analogue mais plus ralentie, les courants de terre prennent un aspect tourbillonnaire formant près du rivage un contre-courant, c'est-à-dire en direction S.O.-N.E., partant de l'estuaire du Var, longeant la plage de Nice jusqu'à l'entrée de Villefranche o ils se dirigent vers le Sud formant ainsi une zone tourbillonnaire. Ce contre-courant aurait d'après les mesures faites, de 15 à 23 cm/sec.

Une double situation courantométrique se trouve créée : une, liée aux vents d'Est, l'autre aux vents d'Ouest.

1) CAMPAGNE DU 12 JUILLET 1978 ENTRE 9 ET 10 HEURES :

- Météorologie :

  . Etat du ciel : clair à peu nuageux
  . Vent : direction S.W. (force 1)
  . Température de l'air : 22°C

- Etat visuel de la plage :

  . Propre dans l'ensemble
  . Absence de goudrons sur les galets
  . Absence de macro-déchets à la surface de l'eau et sur les galets.

2) CAMPAGNE DU 10 AOUT 1978 ENTRE 9 ET 10 HEURES :

- Météorologie :

  . Etat du ciel : clair à peu nuageux
  . Vent : Direction S.W. (force 1)
  . Température de l'air : 24°C

- Etat visuel de la plage :

  . Propre dans l'ensemble
  . Absence d'hydrocarbures sur les galets
  . Absence de macro-déchets à la surface de l'eau et sur les galets,

3) CAMPAGNE DU 6 SEPTEMBRE 1978 ENTRE 9 ET 10H30 :

- Météorologie :

  . Etat du ciel : clair
  . Vent : Nul
  . Température de l'air : 22.1°C

- Etat visuel de la plage :

  . Traces d'hydrocarbures sur les galets
  . Traces d'hydrocarbures dans l'eau de baignade
  . Présence de macro-déchets dans l'eau de baignade.

4) CAMPAGNE DU 4 DECEMBRE 1978 ENTRE 9 ET 10 HEURES :

- Météorologie :

  . Etat du ciel à clair à peu nuageux
  . Vent : nul
  . Température de l'air : 12°C

- Etat visuel de la plage :

  . Propre dans l'ensemble
  . Absence de macro-déchets dans l'eau de baignade et sur les galets
  . Absence d'hydrocarbures dans l'eau de baignade et sur les galets.

Résultats et leur interprétation :

Les résultats des analyses bactériologiques sont les suivants :

1) Le taux des Streptocoques fécaux est élevé.

Les concentrations les plus importantes sont observées au mois de décembre:

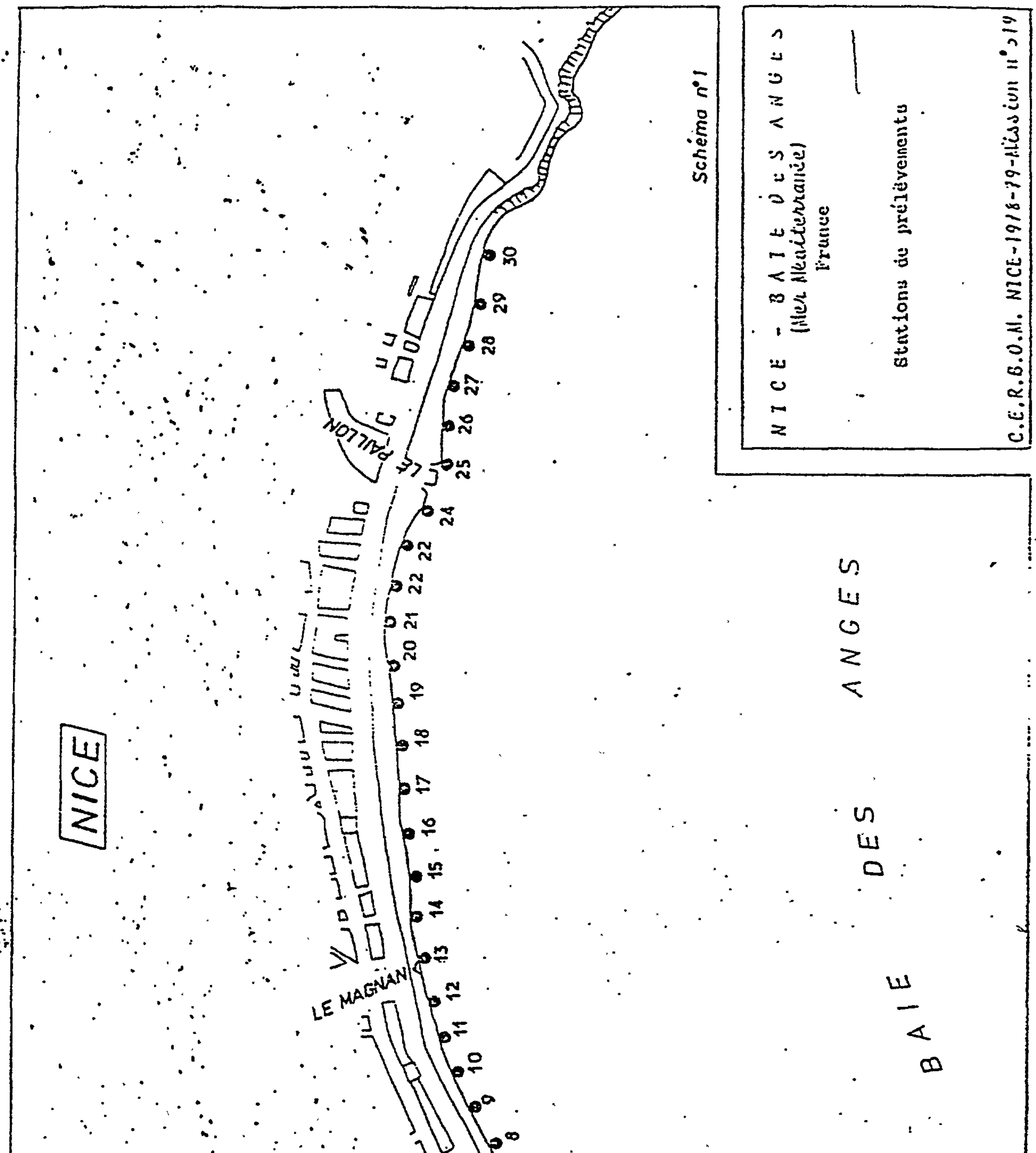
- période d'ensoleillement réduite
- apport de matériaux par les fleuves côtiers durant la saison des pluies, et déversoirs débouchant en mer.

2) Dans l'ensemble les Coliformes fécaux sont les moins répandus.

Les taux les plus élevés se rencontrent au mois d'Août :

- période de forte densité de population estivale.

3) Les Coliformes totaux suivent la même évolution dans le temps que les Coliformes fécaux avec une forte concentration au mois d'Août.


NICE - BAIE DES ANGES
(Mer Méditerranée)
France
Stations de prélèvements
C.E.R.B.O.M. NICE-1978-79-Mission n°5/19
Schéma n°1
NICE
BAIE DES ANGES
LE MAGNAN
PAILLON
CARRAS
1
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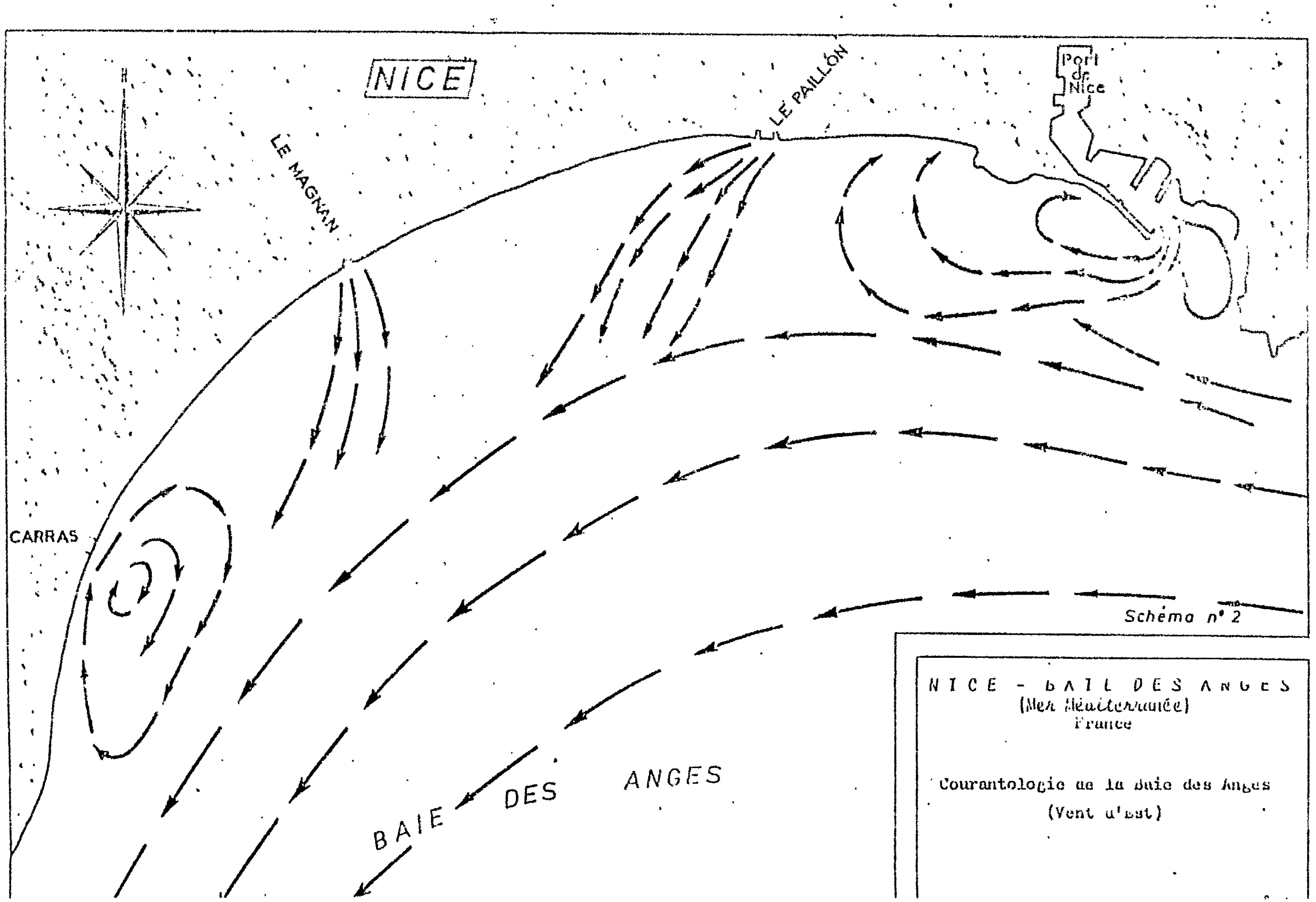
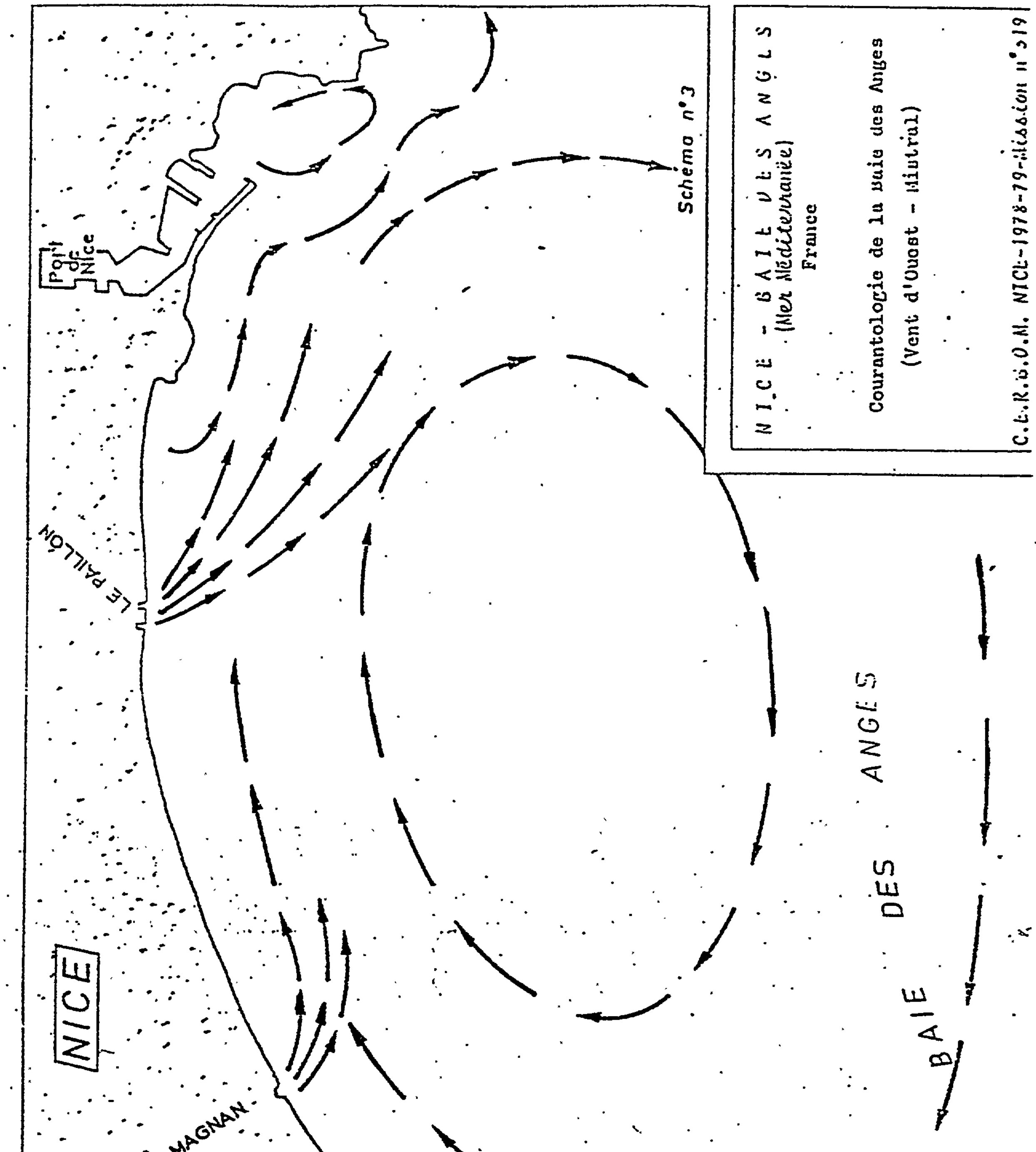

NICE
LE MAGNAN
LE PAILLON
Port de Nice
CARRAS
BAIE DES ANGES
Schéma n° 2
NICE - BAIE DES ANGES
(Mer Méditerranée)
France
Courantologie de la Baie des Anges
(Vent d'Est)



NICE - BAIE DES ANGES (Mer Méditerranée) France

Courantologie de la Baie des Anges (Vent d'Ouest - Mistral)

C.E.R.B.O.M. NICE-1978-79-Mission n°519

Fréquence (%) des observations de vent (0,6 , 12 , 18 TU) NICE-AEROPORT

MOIS	CALME	1 à 14 noeuds								15 à 31 noeuds								32 noeuds et au-dessus							
		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
Janvier	13	12	4	4	1	2	2	11	43	1	1	3	0	0	0	2	0	.	0	0	0	.	.	.	.
Février	17	12	7	8	4	5	5	6	24	0	2	3	1	0	2	4	0	.	.	0	.	.	0	0	0
Mars	16	10	5	13	6	9	7	6	18	1	1	6	1	0	1	1	0	.	.	0	0	.	.	.	.
Avril	14	6	6	16	6	9	7	5	20	0	1	6	0	0	2	2	.	0	0	0	.	.	.	0	0
Mai	17	6	5	15	7	11	8	4	18	0	2	4	0	1	2	0	.	.	0	0	.	.	.	.	.
Juin	18	6	3	17	12	12	6	3	18	.	0	2	0	0	2	1	0	.	.	.	.	.	0	.	.
Juillet	15	7	3	16	12	12	9	4	18	0	0	2	0	0	1	1	0	.	.	.	.	.	.	0	.
Août	16	5	2	13	12	11	7	5	23	.	0	2	0	0	2	2	0	.	.	.	.	.	0	0	.
Septembre	16	5	4	14	9	10	6	6	23	0	1	3	0	0	1	2	0	.	.	.	.	.	.	.	.
Octobre	17	8	5	11	7	8	5	6	28	.	0	3	0	0	1	1	0	.	.	.	.	.	.	.	.
Novembre	16	11	4	6	1	4	5	7	40	0	1	3	0	0	1	1	0	.	0	0	.	.	0	0	.
Décembre	8	10	3	4	1	0	2	11	56	0	1	2	0	0	1	1	0	.	0	0	.	.	.	.	.
ANNEE	15	8	4	11	7	8	6	6	27	0	1	3	0	0	1	2	0	0	0	0	0	.	0	0	0

Nota : Le chiffre 0 indique une fréquence non nulle, mais inférieure à 0,5 %.

Juillet 1978

Stations	T°C . Eau de mer	Salinité S ‰	Oxygène dissous %	Streptocoques fécaux/100 ml	Coliformes fécaux/100 ml	Coliformes totaux/100 ml
1	21,1	37,5	120	30	10	30
2	21,0	37,4	130	0	0	0
3	21,2	37,3	130	10	70	80
4	21,0	37,2	120	0	0	0
5	21,3	37,4	125	20	10	10
6	21,1	37,3	120	0	0	0
7	21,0	37,4	130	40	0	0
8	21,2	37,3	120	0	10	10
9	21,3	37,3	125	10	0	40
10	21,2	37,4	130	30	0	0
11	21,2	37,4	115	30	0	0
12	21,0	37,3	110	370	10	10
13	21,1	37,4	120	300	0	10
14	21,2	37,3	130	780	0	0
15	21,0	37,2	130	270	10	10
16	21,1	37,5	125	150	0	0
17	21,2	37,5	120	280	50	70
18	21,2	37,3	135	480	30	50
19	21,4	37,2	120	410	0	40
20	21,0	37,4	125	40	0	70
21	21,0	37,5	120	40	0	0
22	21,1	37,3	110	10	0	20
23	21,1	37,4	120	80	10	150
24	21,2	37,5	110	10	0	10
25	21,0	37,4	120	0	0	0
26	21,1	37,2	110	0	0	0
27	21,0	37,5	120	80	0	20
28	21,0	37,3	110	0	0	0
29	21,0	37,4	110	0	0	10
30	21,0	37,4	120	10	0	100

Août 1978

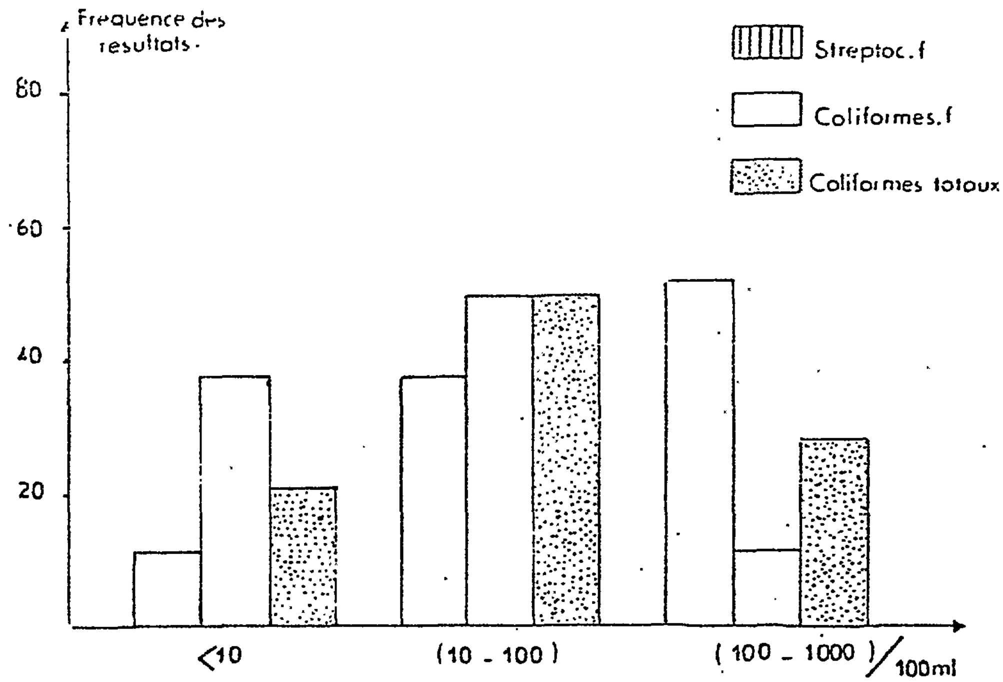
Stations	T°C Eau de mer	Salinité S ‰	Oxygène dissous %	Streptocoques fécaux/100 ml	Coliformes fécaux/100 ml	Coliformes totaux/100
1	24,0	37,0	100	0	0	0
2	24,1	37,2	95	0	10	20
3	23,9	37,3	100	10	20	30
4	23,8	37,1	90	30	10	50
5	23,7	37,0	100	40	40	50
6	24,0	37,4	105	40	90	140
7	24,0	37,6	100	30	100	140
8	24,1	37,8	90	40	20	60
9	23,8	37,3	85	0	20	50
10	23,8	37,1	90	90	100	130
11	23,9	37,1	90	0	30	110
12	24,0	37,0	100	20	20	40
13	24,0	37,0	105	10	40	70
14	24,1	37,2	10[illegible]	30	30	50
15	24,0	37,0	90	50	0	70
16	23,9	36,5	95	500	140	600
17	24,0	37,0	90	20	30	70
18	24,0	37,2	90	360	440	510
19	24,0	37,2	100	140	160	180
20	24,0	37,2	100	80	90	100
21	24,0	37,3	100	130	0	200
22	24,1	37,2	90	0	0	10
23	24,0	37,3	100	20	10	50
24	23,8	37,1	95	20	30	80
25	23,8	37,3	105	10	0	10
26	24,0	37,1	100	200	10	300
27	24,0	37,0	90	50	120	160
28	24,1	37,0	90	30	90	140
29	24,0	37,2	100	120	90	150
30	24,0	37,0	100	40	30	60

Septembre 1978

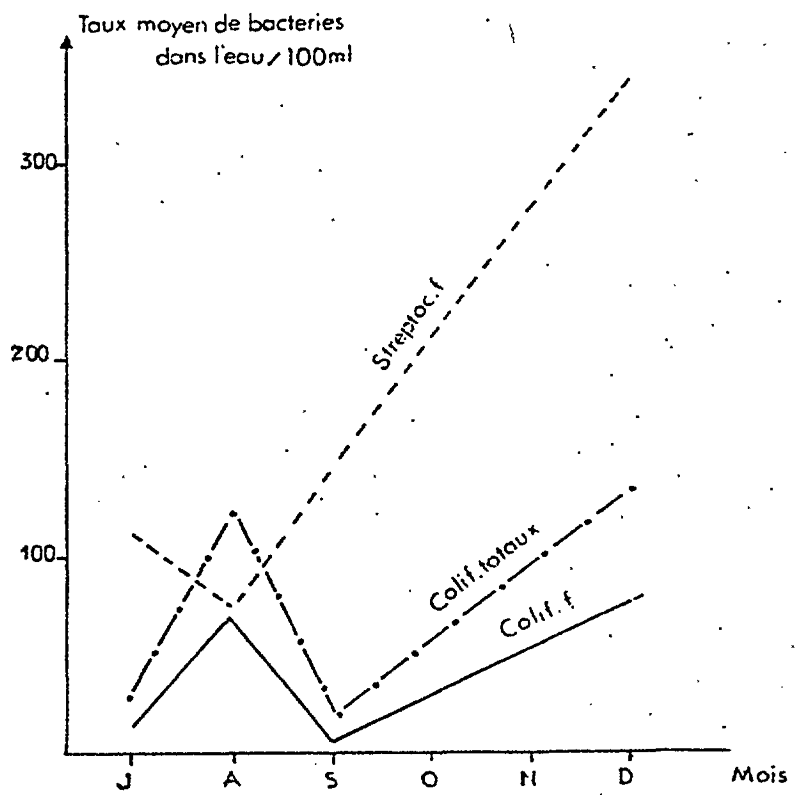
Stations	T°C Eau de mer	Salinité S ‰	Oxygène dissous %	Streptocoques fécaux/100 ml	Coliformes fécaux/100 ml	Coliformes totaux/100 ml
1	22,0	37,0	100	210	10	30
2	22,1	37,2	110	180	0	10
3	22,0	37,3	120	270	20	50
4	22,2	37,4	105	60	10	20
5	22,0	37,5	100	80	0	10
6	22,0	37,3	95	250	0	0
7	22,1	37,2	100	60	0	0
8	22,0	37,2	110	110	20	40
9	22,0	37,3	100	20	0	5
10	22,0	36,8	100	30	0	0
11	22,1	37,1	100	100	5	30
12	22,0	37,2	110	130	10	20
13	22,0	37,2	90	300	0	0
14	22,0	37,3	100	510	0	0
15	22,0	37,2	110	200	0	0
16	22,0	37,3	120	430	20	30
17	22,1	37,3	130	210	10	20
18	22,1	37,4	100	200	0	0
19	22,0	37,2	100	130	0	10
20	22,1	37,3	110	140	0	0
21	22,1	37,4	105	150	0	0
22	22,1	37,1	100	220	5	15
23	22,0	37,2	110	0	0	0
24	22,2	36,4	100	150	0	50
25	22,2	37,2	100	100	0	30
26	22,0	37,3	100	80	20	20
27	22,1	37,2	100	30	0	0
28	22,1	37,4	100	40	0	0
29	22,0	37,2	110	20	0	10
30	22,0	37,2	110	10	0	50

Décembre 1978

Stations	T°C Eau de mer	Salinité S‰	Oxygène dissous %	Streptocoques fecaux/100 ml	Coliformes fecaux/100 ml	Coliformes totaux/100
1	13,9	37,6	120	150	10	40
2	13,7	37,7	130	290	20	30
3	13,6	37,8	140	220	50	80
4	13,7	37,7	120	420	110	160
5	13,8	37,6	130	610	20	30
6	13,9	37,3	140	340	100	160
7	13,7	37,2	120	270	90	100
8	13,8	37,3	130	530	210	360
9	13,5	37,7	120	150	40	110
10	13,6	37,6	120	430	10	50
11	13,7	37,3	100	450	10	50
12	13,8	37,3	110	360	70	170
13	13,8	37,2	130	270	20	130
14	13,8	37,6	130	190	240	340
15	13,9	37,5	130	310	60	80
16	13,9	37,4	120	430	30	60
17	13,8	37,3	100	470	10	110
18	13,7	37,7	120	590	200	320
19	13,8	37,6	110	280	20	50
20	13,8	37,8	120	160	50	110
21	13,7	37,7	120	350	100	210
22	13,9	37,6	130	640	70	80
23	13,8	37,3	120	520	70	190
24	13,8	37,3	130	410	60	160
25	13,7	37,6	130	100	80	120
26	13,7	37,7	130	210	100	150
27	13,8	37,3	130	220	40	50
28	13,8	37,6	120	150	130	240
29	13,9	37,5	120	370	70	130
30	13,8	37,7	120	290	90	110

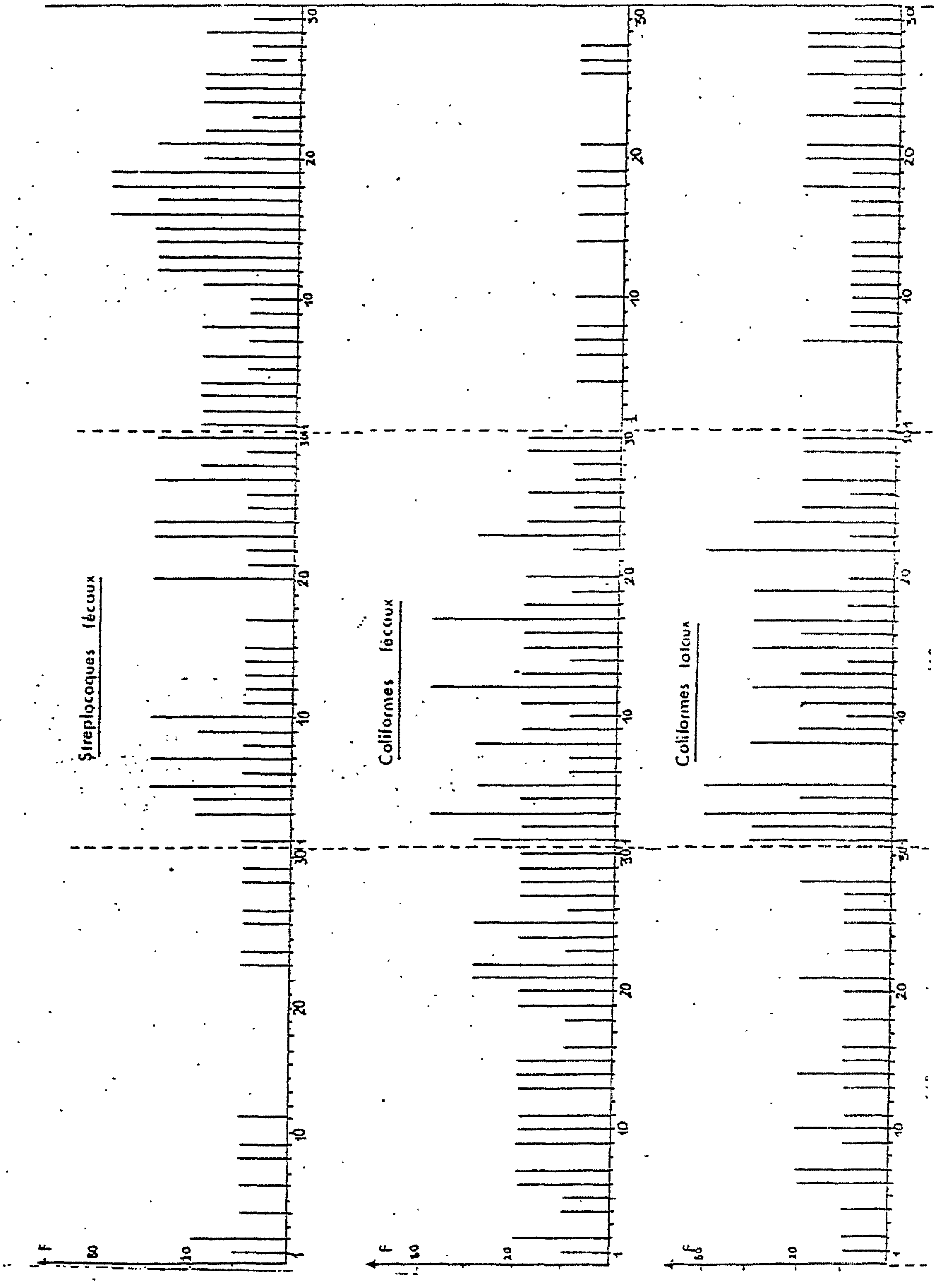


Graphique n° 1 : Histogrammes des résultats pour la zone de la baie des Anges.



Graphique n° 2 : Taux moyens de bactéries en fonction du temps pour la baie des Anges.

Graphique n° 3 : Histogrammes des résultats pour les différentes stations de prélèvements.



Centre de Recherche Participant : Institut scientifique et techniques des pêches maritimes
SETE
France

Chercheur Principal : Y. FAUVEL

Introduction :

L'Institut des pêches maritimes de Sète a été chargé dès Novembre 1978 dans le cadre du projet MED POL VII, de la surveillance des zones conchylicoles (eaux et mollusques) de la côte méditerranéenne. Dans la pratique, cette tâche est la nôtre depuis fort longtemps, aussi, notre connaissance de la salubrité des coquillages et des zones d'élevage, nous permet dans le cadre du programme MED POL VII d'apporter des informations et des données sur les deux zones conchylicoles les plus importantes du littoral méditerranéen français (étangs de Thau et de Leucate).

Zone(s) étudiée(s) :

Les zones étudiées faisant l'objet du présent rapport sont :

1) Etang de Thau (Fig. 4)

Lat. 43 24' 5" N
Long. 3 38' E

Caractéristiques géographiques:

L'étang de Thau, d'une superficie de 7500 ha environ, a une longueur maximale de 19,5 km et sa plus grande largeur atteint 4,5 km. La profondeur moyenne est de 5 mètres environ et la profondeur maximale de 9 à 10 m. L'étang de Thau communique avec la mer à ses deux extrémités, par les canaux de Sète et par le grau de Pisse-Saumes à Marseillan.

Les échanges avec la mer dépendent partiellement de la marée très faible, mais surtout des dépressions atmosphériques et des vents.

Caractéristiques hydrologiques:

Le régime thermique est très étroitement lié aux températures de l'air. Les températures moyennes habituellement de 4 , (janvier - février) à 28 (juillet - août).

La salinité moyenne s'établit aux environs de $34^{\circ}/_{oo}$.

L'étang de Thau reçoit les eaux du Canal du Midi, du Canal de Sète au Rhône, et de nombreux ruisseaux comme la Vène, le Pallas, le Nègue-Vaques, le Soupié, pour ne citer que les plus importants.

<u>Caractéristiques météorologiques</u>:

Vents dominants : N.W. (320)
Pluviométrie moyenne : 650 mm

En ce qui concerne la zone conchylicole celle-ci occupe 1 200 ha dont 352 ha réels de parc d'élevage.

L'échantillonnage d'eau et coquillage est effectué sur 12 stations (de T 6 à T 17), plusieurs fois par mois.

2) <u>Etang de Leucate</u> (Fig. 5)

<u>Caractéristiques géographiques</u>:

Lat. 42 51' 0
Long. 3 03'

L'étang de Leucate occupe une superficie de 5 000 ha et a une profondeur moyenne de 3 mètres, avec des profondeurs maximales de 4,5 m. L'étang de Leucate communique avec la mer par les graus de Leucate et de Port-Barcarès.

<u>Caractéristiques hydrologiques</u>:

Comme pour Thau les variations thermiques ont une amplitude considérable, de 4 à 28 environ. La salinité suivant les années et périodes peut varier de $22^{\circ}/_{oo}$ à plus de $40^{\circ}/_{oo}$. Cet étang reçoit essentiellement les eaux douces des ruisseaux de Fontdame et Font-Extramer, dans sa partie méridionale. Les salinités de la partie septentrionale sont généralement plus élevées.

<u>Caractéristiques météorologiques</u>:

Vents dominants : W (Tramontane)
Pluviométrie : 600 mm

Les parcs à coquillages occupent 32 ha. L'échantillonnage se fait sur 6 stations (L 8 à L 13) plusieurs fois par mois.

Matériel et méthodes:

La surveillance régulière des deux zones étudiées porte essentiellement sur les polluants bactériens, considérés comme des germes-test de la contamination fécale : Coliformes totaux et surtout Escherichia Coli et sur des facteurs hydrologiques (température et salinité).

Depuis notre participation au programme, la recherche des Streptocoques fécaux est également pratiquée régulièrement.

Les méthodes que nous employons sont basées sur la recherche du MPN aussi bien pour les eaux que pour les coquillages. Le milieu utilisé pour la recherche des Coliformes totaux et fécaux est le bouillon lactosé bilié, au vert brillant avec incubation à 37°C. Pour la recherche d'E. coli on utilise la méthode de MACKENZIE, avec repiquage des tubes positifs sur le même milieu et sur eau peptonée, à 44°C. Il faut remarquer que cette méthode n'est utilisée dans notre laboratoire que depuis juillet 1978, avant la méthode pratiquée par l'I.S.T.P.M. était celle de VINCENT avec ensemencement sur bouillon de même nom, à 41,5°C, méthode donnant directement E. coli.

En ce qui concerne les Streptocoques fécaux, leur recherche est faite également par la méthode MPN, en utilisant successivement les milieux de Rothe et Litsky.

Résultats et leur interprétation:

Les paramètres habituellement mesurés lors de nos tournées de contrôle sanitaire sont : T , $S^{o}/_{oo}$, Coliformes totaux et Escherichia coli. Ces paramètres sont notés sur les formulaires de données, annexés à ce rapport. Nous signalons que les résultats qui y sont portés concernent seulement les échantillons prélevés sur les différentes stations de prélèvement.

Depuis 1978, notre contrôle s'est beaucoup intensifié au niveau des établissements d'expéditions à terre, au détriment de notre contrôle sur les parcs d'élevage.

Les résultats que nous présentons (tableaux 1, 2, 3, 4 et 5) portent sur l'ensemble de nos contrôles.

La classification des résultats bactériologiques est faite en fonction des normes en vigueur en France :

- pour les coquillages : coliformes fécaux/100 ml de chair + liquide intervalvaire.

  satisfaisants : de 0 à 300
  suspects : 300 à 1000
  très suspects : 1001 à 3000
  défavorables : à partir de 3000

- pour l'eau : coliformes fécaux/100 ml d'eau.

  Les limites recommandées par le PNUE ont été appliquées :

  satisfaisant : moins de 10
  suspects : 10 à 100
  défavorables : à partir de 100

Dans le cadre de ce rapport sommaire et par manque de temps, il ne nous a pas été possible de présenter les résultats de façon statistique, comme cela nous a été demandé. Ceux-ci sont présentés sous forme de tableaux (tableaux 1, 2, 3, 4 et 5) et d'histrogrammes (figures 1, 2 et 3). Pour l'étang de Leucate le nombre relativement insuffisant d'observations nous a amené à présenter les résultats globalement sans tenir compte des stations.

En ce qui concerne l'étang de Thau, on constate que dans l'ensemble la pollution bactérienne exprimée en E. coli a fortement baissé en 1978 et ce pour presque toutes les stations. Ceci est étroitement lié à la cadence de réalisation de travaux d'assainissement programmée autour de l'étang de Thau et en particulier pour la ville de Sète (de 45 000 habitants). Une comparaison par station (figure 2) montre que la baisse de la contamination est particulièrement importante pour les stations 11, 16 et 17 les plus polluées en 1976.

L'étang de Leucate présente lui aussi une baisse de la pollution bactérienne, très évidente après un léger regain en 1977. De toutes façons le niveau sanitaire a toujours été ici très convenable.

Il faut préciser pour bien comprendre le processus contaminant de ces étangs, que celui-ci est très rapide lors des périodes très pluvieuses à cause des eaux de ruissellement, et de la remise en suspension des fonds par les fortes tempêtes de secteur sud qui généralement accompagnent les pluies. Dans ces périodes-là, l'expédition de coquillages est rigoureusement interdite jusqu'à ce que le milieu naturel retrouve un état tout à fait normal et que la pollution fécale s'estompe naturellement, ce qui se fait assez rapidement par auto-épuration.

Conclusions:

La qualité sanitaire des zones surveillées apparaît au vu des résultats, comme très bonne en 1978, o il n'y a eu aucune interdiction d'expédition. En 1976 et 1977 la qualité globale est tout de même acceptable, surtout si l'on tient compte que les périodes insalubres et o les expéditions sont interdites, sont comptabilisées dans nos histrogrammes et tableaux.

COQUILLAGES / STATION - 1976

Stations	Normes	0-300 N	0-300 %	301-1000 N	301-1000 %	1001-3000 N	1001-3000 %	3000 N	3000 %	N total
	T 6	31	83.8	4	10.8	2	5.4	0	0	37
	T 7	25	73.5	6	17.7	1	2.9	2	5.8	34
	T 8	22	59.5	5	13.5	4	10.8	6	16.2	37
	T 9	31	83.8	3	8.1	2	5.4	1	2.7	37
	T 10	23	62.2	2	5.4	9	24.3	3	8.1	37
	T 11	16	47.1	6	17.6	7	20.6	5	14.7	34
ETANG	T 12	23	67.7	6	17.6	1	2.9	4	11.8	34
DE THAU	T 13	23	63.9	5	13.9	5	13.9	3	8.3	36
	T 14	23	71.9	3	9.4	3	9.4	3	9.4	32
	T 15	28	75.7	5	13.5	3	8.1	1	2.7	37
	T 16	21	55.3	5	13.2	8	21.0	4	10.5	38
	T 17	22	59.5	5	13.5	5	13.5	5	13.5	37
	Expédition	47	73.5	11	17.2	5	7.8	1	1.5	64
total		335	67.8	66	13,4	55	11,1	38	7.7	494
	L 8	6	85,7	0		0		1	14,3	7
	L 9	3	50	2	33,3	1	16,7	0		6
ETANG	L 10	8	88,9	0		1	11,1	0		9
DE	L 11	6	66,7	3	33,3	0		0		9
LEUCATE	L 12	8	88,9	1	11,1	0		0		9
	L 13	7	87,5	1	12,5	0		0		8
total		38	792	7	14,5	2	4,2	1	2,1	48

Tableau 1 : Répartition par classes de contamination des coquillages en Escherichia coli pour les étangs de THAU et LEUCATE en 1976.

COQUILLAGES / STATION - 1977

Stations	Normes	0-300 N	0-300 %	301-1000 N	301-1000 %	1001-3000 N	1001-3000 %	3000 N	3000 %	N total
	T 6	21	77.8	2	7.4	3	11.1	1	3.7	27
	T 7	19	73.1	1	3.8	6	23.1	0	0	26
	T 8	18	56.3	3	9.4	7	21.9	4	12.5	32
	T 9	21	72.4	2	6.9	2	6.9	4	13.8	29
	T 10	23	74.2	3	9.7	2	6.4	3	9.7	31
	T 11	16	50	7	21.9	3	9.4	6	18.7	32
ETANG	T 12	24	72.7	3	9.1	4	12.1	2	6.1	33
DE THAU	T 13	22	68.7	3	9.4	3	9.4	4	12.5	32
	T 14	21	63.6	4	12.2	6	18.3	2	6.1	33
	T 15	24	72.7	4	12.2	3	9.1	2	6.1	33
	T 16	19	63.3	5	16.6	6	20	0	0	30
	T 17	21	63.6	5	15.1	6	18.3	1	3	33
	Expédi-tion	33	61.1	7	13	11	20.4	3	5.7	54
total		282	66	50	11.7	62	14.5	33	7.7	427
	L 8	4	57.1	1	14.3	1	14.3	1	14.3	7
	L 9	3	50	1	16.7	2	33.3	0		6
ETANG	L 10	4	66.7	0		1	16.7	1	16.7	6
DE	L 11	5	71.4	1	14.3	0		1	14.3	7
LEUCATE	L 12	6	85.7	0		0		1	14.3	7
	L 13	6	85,7	0		0		1	14.3	7
total		28	70	3	7.5	4	10	5	12.5	40

Tableau 3 : Répartition par classes de contamination des coquillages en Escherichia coli pour les étangs de Thau et Leucate en 1977.

EAUX / STATION - 1976

Stations \ Normes		10		10 - 100		100		Nombre total
		N	%	N	%	N	%	
ETANG DE THAU	T 6	34	94,4	2	5,6	0	0	36
	T 7	35	97,2	1	2,8	0	0	36
	T 8	29	82,9	6	17,1	0	0	35
	T 9	34	94,4	2	5,6	0	0	36
	T 10	27	77,1	8	22,8	0	0	35
	T 11	24	66,7	9	25	3	8,3	36
	T 12	25	73,5	8	23,6	1	2,9	34
	T 13	30	83,3	5	13,9	1	2,8	36
	T 14	27	79,5	6	17,6	1	2,9	34
	T 15	30	83,3	5	13,9	1	2,8	36
	T 16	25	69,4	8	22,2	3	8,4	36
	T 17	19	52,8	9	25	8	22,2	36
total		339	79,6	69	16,2	18	4,2	426
ETANG DE LEUCATE	L 8	7	87,5	1	12,5	0		8
	L 9	6	75	2	25	0		8
	L 10	8	88,9	1	11,1	0		9
	L 11	9	100	0		0		9
	L 12	9	100	0		0		9
	L 13	9	100	0		0		9
total		48	92,3	4	7,7	0	0	52

Tableau 2 : Répartition par classes de contamination des eaux en Escherichia coli pour les étangs de THAU et LEUCATE en 1976.

COQUILLAGES / STATION - 1978

Stations	Normes	0-300 N	0-300 %	301-1000 N	301-1000 %	1001-3000 N	1001-3000 %	3000 N	3000 %	N total
	T 6	18	90	0	0	1	5	1	5	20
	T 7	17	85	0	0	1	5.5	2	10	20
	T 8	19	86.4	2	9.1	0	0	1	4.5	22
	T 9	19	86.4	1	4.5	1	4.5	1	4.5	22
	T 10	20	87.0	0	0	0	0	3	13	23
	T 11	19	82.6	4	17.4	0	0	0	0	23
ETANG	T 12	18	90	0	0	1	5	1	5	20
DE THAU	T 13	18	81.8	1	4.5	1	4.5	2	9.1	22
	T 14	24	100	0	0	0	0	0	0	24
	T 15	22	95.6	0	0	0	0	1	4.4	23
	T 16	18	78.2	1	4.4	3	13	1	4.4	23
	T 17	19	86.4	0	0	3	13.6	0	0	22
	Expédition	126	94	6	4.5	1	0.7	1	0.7	134
total		357	89.7	15	3.8	12	3	14	3.5	398
	L 8	2								
	L 9	2								
	L 10	4								
ETANG	L 11	3								
DE	L 12	3								
LEUCATE	L 13	2								
	Expédition	76	86.3	6	6.8	4	4.5	2	2.3	88
total		92	88.6	6	5.8	4	3.8	2	1.9	104

Tableau 5 : Répartition par classes de contamination des coquillages en Escherichia coli pour les étangs de Thau et Leucate en 1978.

EAUX / STATION - 1977

Stations \ Normes		0 - 10 N	0 - 10 %	10 - 100 N	10 - 100 %	100 N	100 %	Nombre total
	T 6	21	91,3	2	8,7	0	0	23
	T 7	22	95,6	1	4,4	0	0	23
	T 8	16	64	8	32	1	4	25
	T 9	23	92	2	8	0	0	25
	T 10	21	84	2	8	2	8	25
ETANG	T 11	19	76	4	16	2	8	25
DE	T 12	22	88	3	12	0	0	25
THAU	T 13	20	80	4	16	1	4	25
	T 14	20	80	3	12	2	8	25
	T 15	21	84	4	16	0	0	25
	T 16	19	76	2	8	4	16	25
	T 17	16	64	7	28	2	8	25
total		240	81,1	42	14,2	14	4,7	296
	L 8	4	66,7	1	16,7	1	16,7	6
	L 9	5	83,3	0		1	16,7	6
ETANG	L 10	5	83,3	1	16,7	0		6
DE LEU-	L 11	5	83,3	1	16,7	0		6
CATE	L 12	4	80	1	20	0		5
	L 13	5	100	0		0		5
total		28	82,3	4	11,8	2	5,9	34

Tableau 4 : Répartition par classes de contamination des eaux en Escherichia coli pour les étangs de THAU et LEUCATE en 1977.

EAUX / STATION - 1978

Stations		0 - 10 N	0 - 10 %	10 - 100 N	10 - 100 %	100 N	100 %	Nombre total
	T 6	11	100					11
	T 7	10	90,9	1	9,1			11
	T 8	12	92,3	1	7,7			13
	T 9	12	100					12
	T 10	13	100					13
ETANG	T 11	12	92,3	1	7,7			13
DE	T 12	12	92,3	1	7,7			13
THAU	T 13	13	92,9	1	7,1			14
	T 14	14	100					14
	T 15	13	92,9	1	7,1			14
	T 16	14	100					14
	T 17	14	100					14
total		150	96,1	6	3,9	0	0	156
	L 8	3						
	L 9	3						
ETANG	L 10	4						
DE LEU-	L 11	4						
CATE	L 12	3						
	L 13	3						
	Expédition	17						
Total		37	100					

Tableau 6 : Répartition par classes de contamination des eaux en Escherichia coli pour les étangs de THAU et LEUCATE 1978.

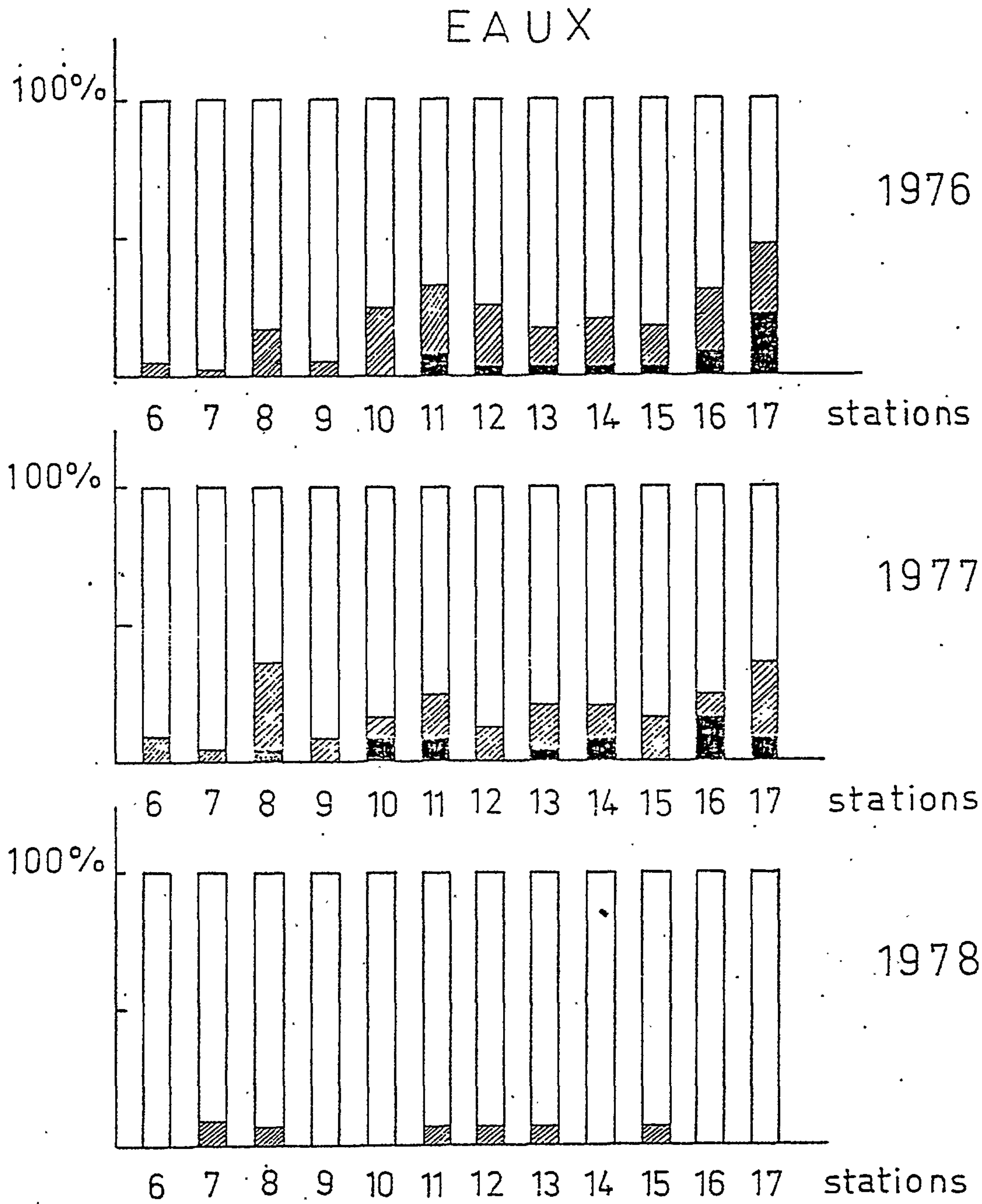


Figure 1 : Fréquences de contamination des EAUX par E.coli pour l'étang de THAU selon 3 classes de contamination :

moins de 10 ☐ satisfaisant

de 10 à 100 ▨ suspect

plus de 100 ■ defavorable

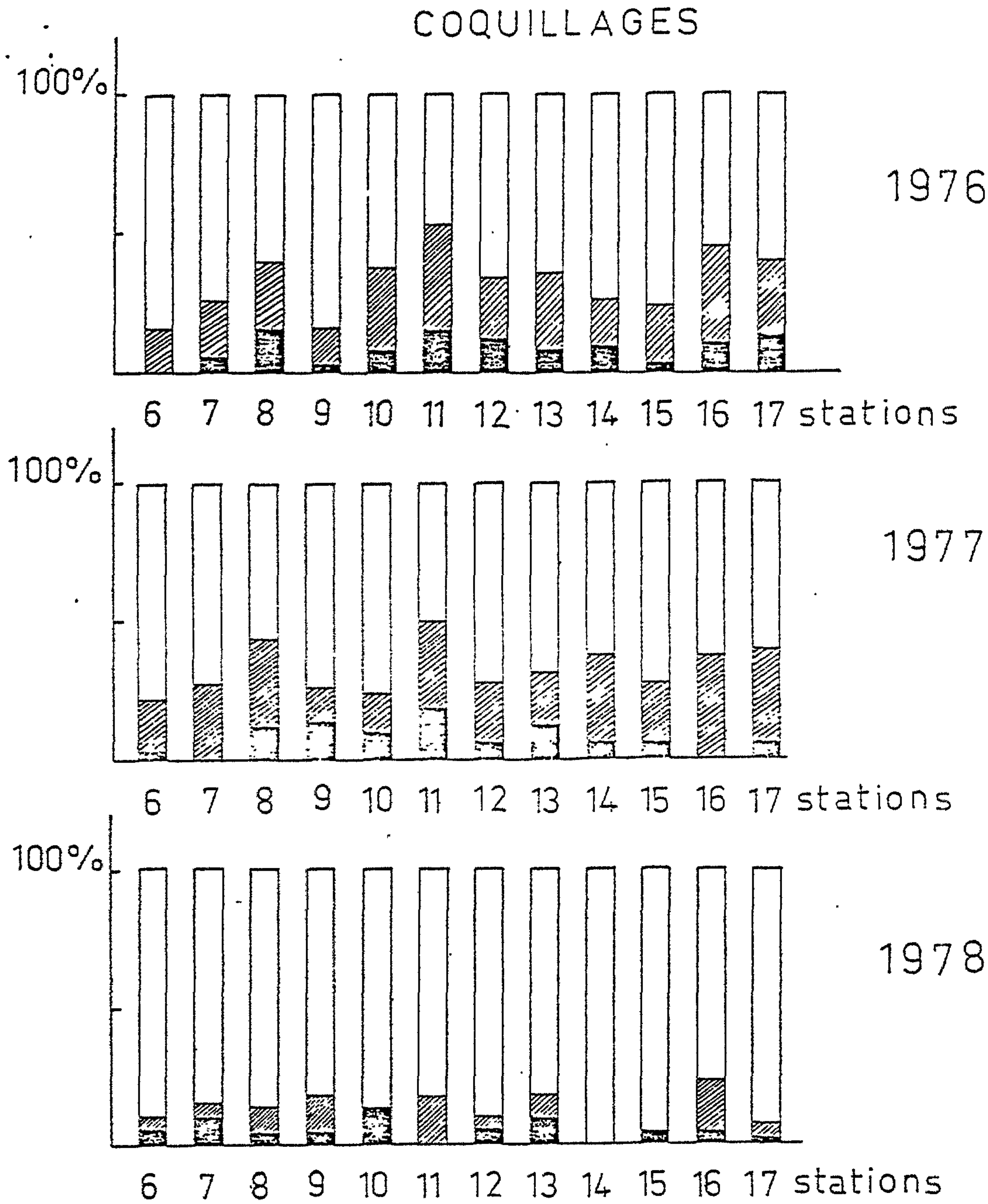


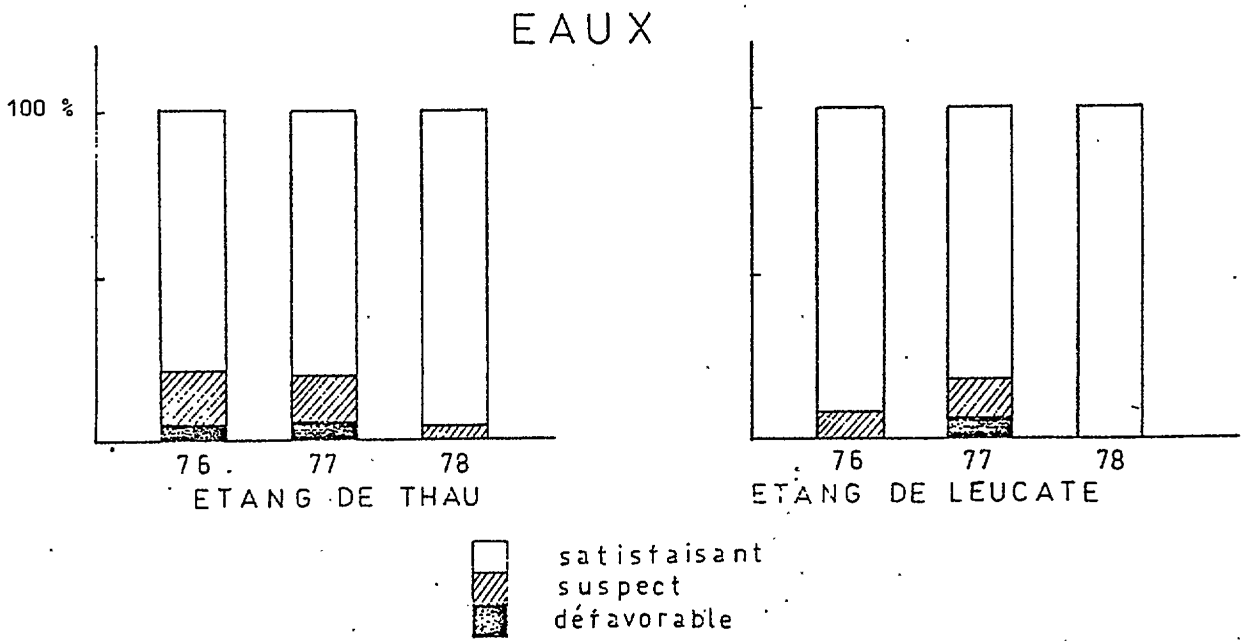
Figure 2 : Fréquences de contamination des COQUILLAGES par *E.coli* pour l'étang de THAU selon 3 classes de contamination :

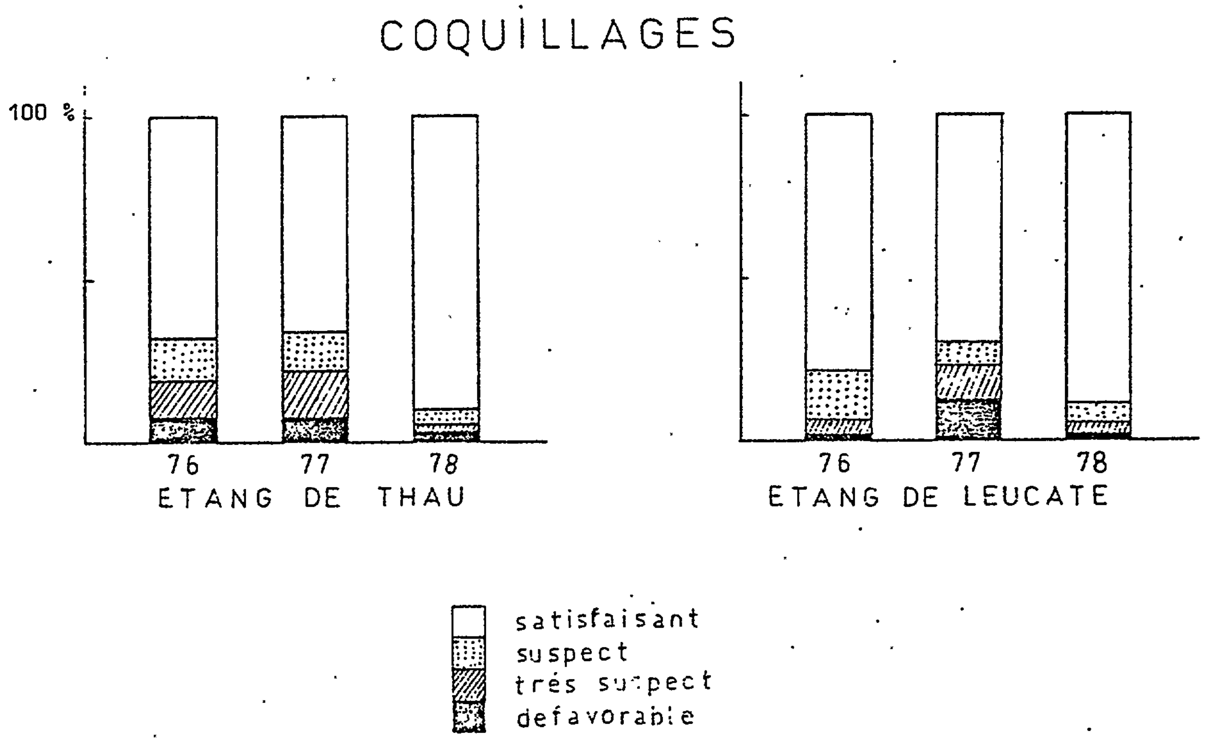
de 0 à 300 ☐ satisfaisant

de 300 à 3000 ▨ suspect

plus de 3000 ▩ defavorable

<u>Figure 3</u> : Fréquences globales de contamination par <u>E.coli</u> en 1976, 1977 et 1978.





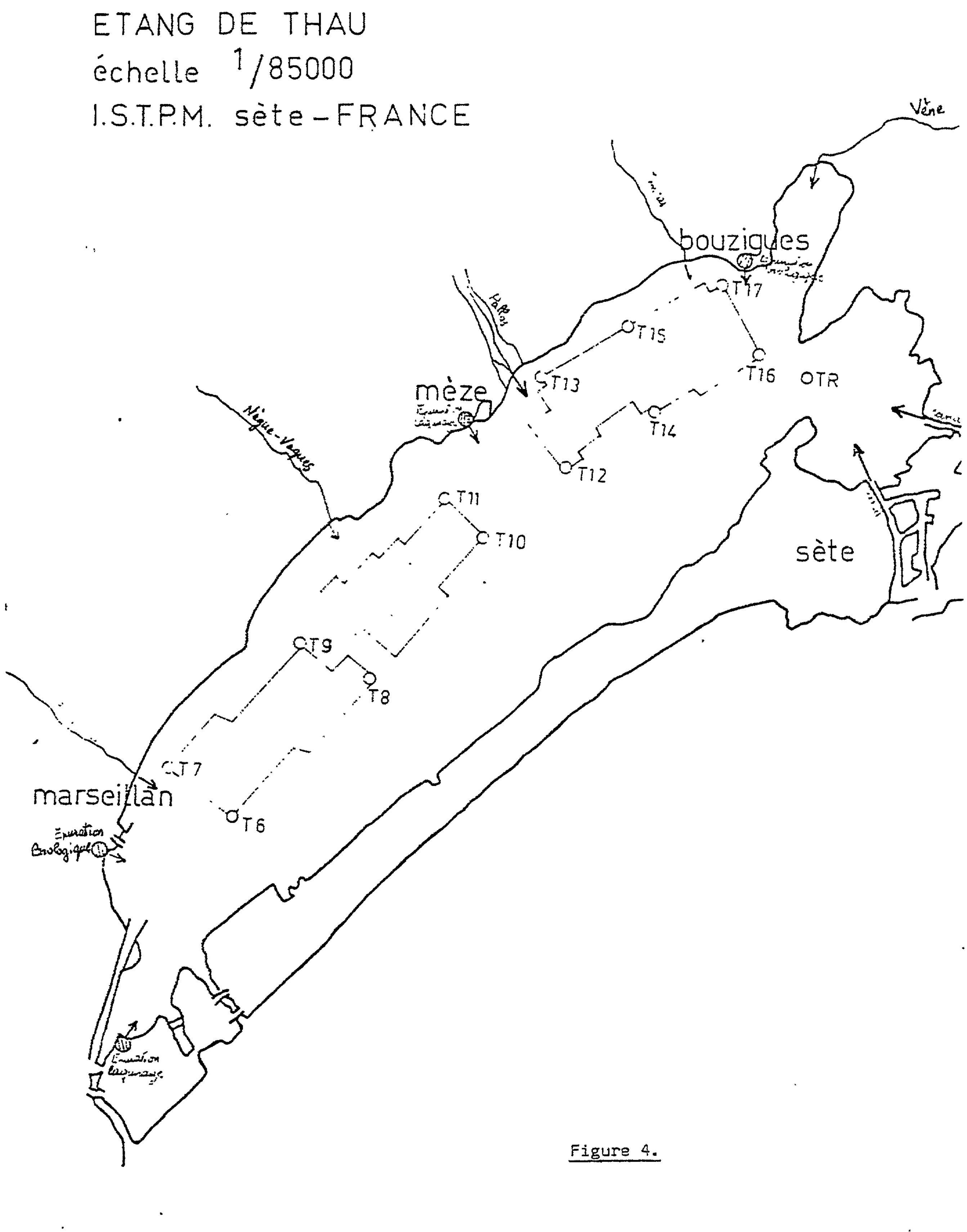

ETANG DE THAU
échelle 1/85000
I.S.T.P.M. sète-FRANCE
bouziques
mèze
marseillan
sète
Nègue-Vaques
Vène
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
T16
T17
OTR
Epuration Biologique
Epuration lagunage

Figure 4.

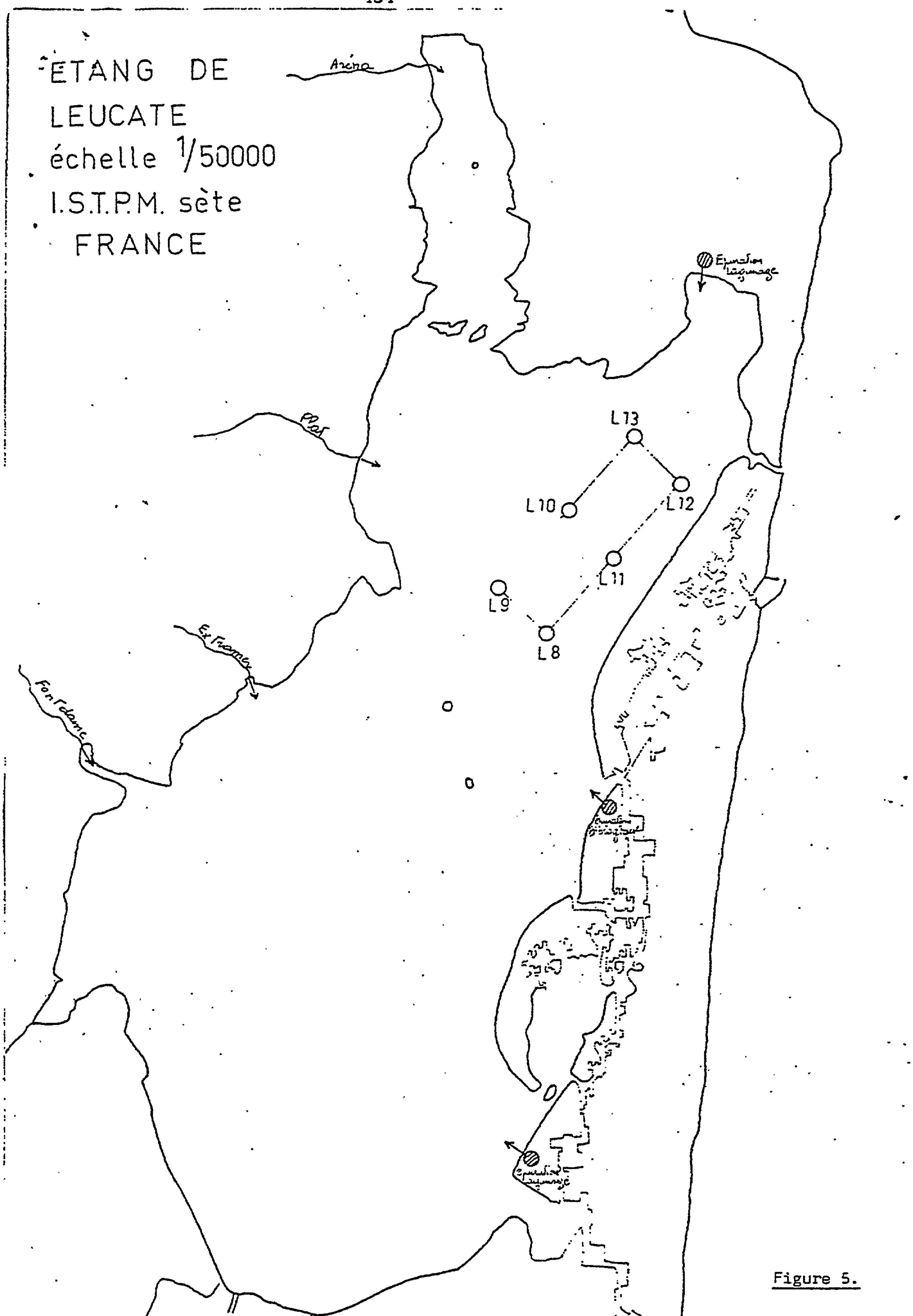

ETANG DE
LEUCATE
échelle 1/50000
I.S.T.P.M. sète
FRANCE
L13
L10
L12
L11
L9
L8

Figure 5.

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Principal Investigator: A.J. MANTIS

Introduction:

The laboratory has had no previous activities directly relevant to MED VII except for V. parahaemolyticus. This microorganism has been investigated since 1970, and 3 papers have already been published concerning the existence and enumeration of the above Vibrio in seafood and seawater in the North Aegean sea.

Area(s) studied:

The laboratory performs microbiological monitoring of shellfish (Mytilus galloprovincialis and Ostrea edulis) on the Northwest shore of Thessaloniki gulf (40° 30' N - 21 50' E). The area covered (see attached map, appendix 1) corresponds to an anomalous coast line, formed by the soil brought in by three main rivers. It is characterized by shallow waters which have been proved an excellent environment for cultivation of shellfish. This coast is not suitable for swimming and is mainly accessible by boat. As indicated in the map, the main polluting sources of the gulf are the city's main sewage outlet and an industrial outlet. Since 1960 the pollution of the gulf has been progressive and today it is in a stage which threatens the suitability of large areas of the above coast for shellfish cultivation.

For the purpose of monitoring the area, four sampling points have been selected, covering the main shellfish cultivation beds. Sampling point No. 1 is the nearest to the polluting sources and it falls within the area in which culturing or harvesting of shellfish is prohibited by the public health authorities. It will be regarded as a control.

Materials, methods and parameters measured:

i) Parametres measured:

a) Water of the cultivation beds:

Total coliforms, faecal coliforms, faecal streptococci, Salmonellae, salinity, temperature, DO and BOD_5.

b) Shellfish:

Total coliforms, faecal coliforms, faecal streptococci, total heteroptrophic bacteria, Virio parahaemolyticus and Salmonellae.

Material and methods:

Enumeration of total coliforms and faecal coliforms in water was performed by both MPN and MF methods using MacConkey broth and mFC or mFC-agar respectively, according to "Guidelines for Health related monitoring of coastal Water Quality". For enumeration of the above indicator organisms in shellfish, only MPN method was used. MacConkey broth and peptone waters were used as culture media, according to the reference method proposed by this project. However, a minor modification was introduced in the preparation of dilutions from a shellfish sample. Thus 30 g of shellfish flesh were homogenized in a waring blender with 270 ml of 0.1 per cent peptone water and thus a 1/10 dilution was prepared while the first five tubes containing 10 ml of double strength MacConkey broth were inoculated with 10 ml each of the 1/10 dilution. This procedure, widely accepted in food microbiology, permits quantitation of coliforms in values greater than 20/100 g or the negative results can be expressed as less than 20/100 g.

For faecal streptococci M-enterococcus agar with the MF method was used for the water and the same medium with the PP method for shellfish.

Vibrio parahaemolyticus was quantified in shellfish only, with the MPN method using Glucose-Salt-Teepol broth as enrichment broth and TCBS agar as plating medium.

Salmonellae recovery was attempted from both water and shellfish. The methods applied and the media used were those proposed for this project.

Results and their interpretation:

Total heteroptrophic bacteria: The results concerning the number of total heterotrophic bacteria are summarized in table 1 (appendix II). Samples of shellfish from sampling point No. 1 had a total count ranging from between 10^4 and 10^5/g while samples from sampling point to 4 (unpolluted water) had always a total count of less than 10^4g. Total count of shellfish derived from sampling point 2 and 3 had a total counts ranging between 10^3 and 10^4 in 75 per cent and 82 per cent of the samples respectively.

Total coliforms and faecal coliforms:

Summarized results concerning total coliforms and faecal coliforms (E. coli) are given in annexes 3 and 4.

From the frequencies distribution of the values of total coliform and E. coli in shellfish and water it can be seen that, except from sampling point No.1 for which high values were expected, sampling point No.2 gives values above the suggested limits in a considerable percentage of samples, while sampling points No.3 and 4 give values which fall within the suggested limits of acceptance.

Faecal streptococci: Results concerning faecal streptococci are summarized in table 2, appendix II. From the above table it can be seen that values for shellfish cultivated in unpolluted water (sampling point 3 and 4) were less than 10/g in the majority of the cases (80 per cent of the samples) while the water from the above sampling point gave values less than 100/100 ml in more than 87 per cent of the samples.

Vibrio parahaemolyticus:

Quantification of Vibrio parahaemolyticus in shellfish with the MPN method revealed that a percentage of the samples ranging between 34 per cent and 60 per cent were positive (appendix V). The MPN value of the positive samples was always smaller than 10^3/100 g. Positivity of the samples increased during the warmer months of the year and decreased markedly during the cold months. This confirms the well established view that V. parahaemolyticus is a natural inhabitant of sea-water and does not correlate with pollution.

During this project more than 600 strains of V. parahaemolyticus were tested for Kanagawa phenomenon and proved to be Kanagawa negative. Randomly selected strains were serologically tested and the majority of them fell into the serotypes O_4K_{12}, O_4K_3, O_5K_{17} and $O_{10}K_{24}$. About 25 per cent of the strains were not typeable with available antisera.

As far as food poisioning concerns, there are no data suggesting possible cases of gastroenteritis among humans in Greece.

No salmonella serotypes were so far isolated from the water or shellfish tested. Although our laboratory has a long experience in salmonella isolation from different sources, we consider the negative results from sampling point No.1 as contradictory and if in the future sampling the situation continues to be so, consideration will be given to the effect that is produced on salmonella and probably on other microorganisms by the industrial (chemical) wastes which are discharged near the above sampling point.

Evaluation of the results according to interim microbiological criteria for shellfish.

On the basis of E. coli, the percentage of samples of shellfish or water which fall within or outside the proposed microbiological limits are presented below in the form of a table.

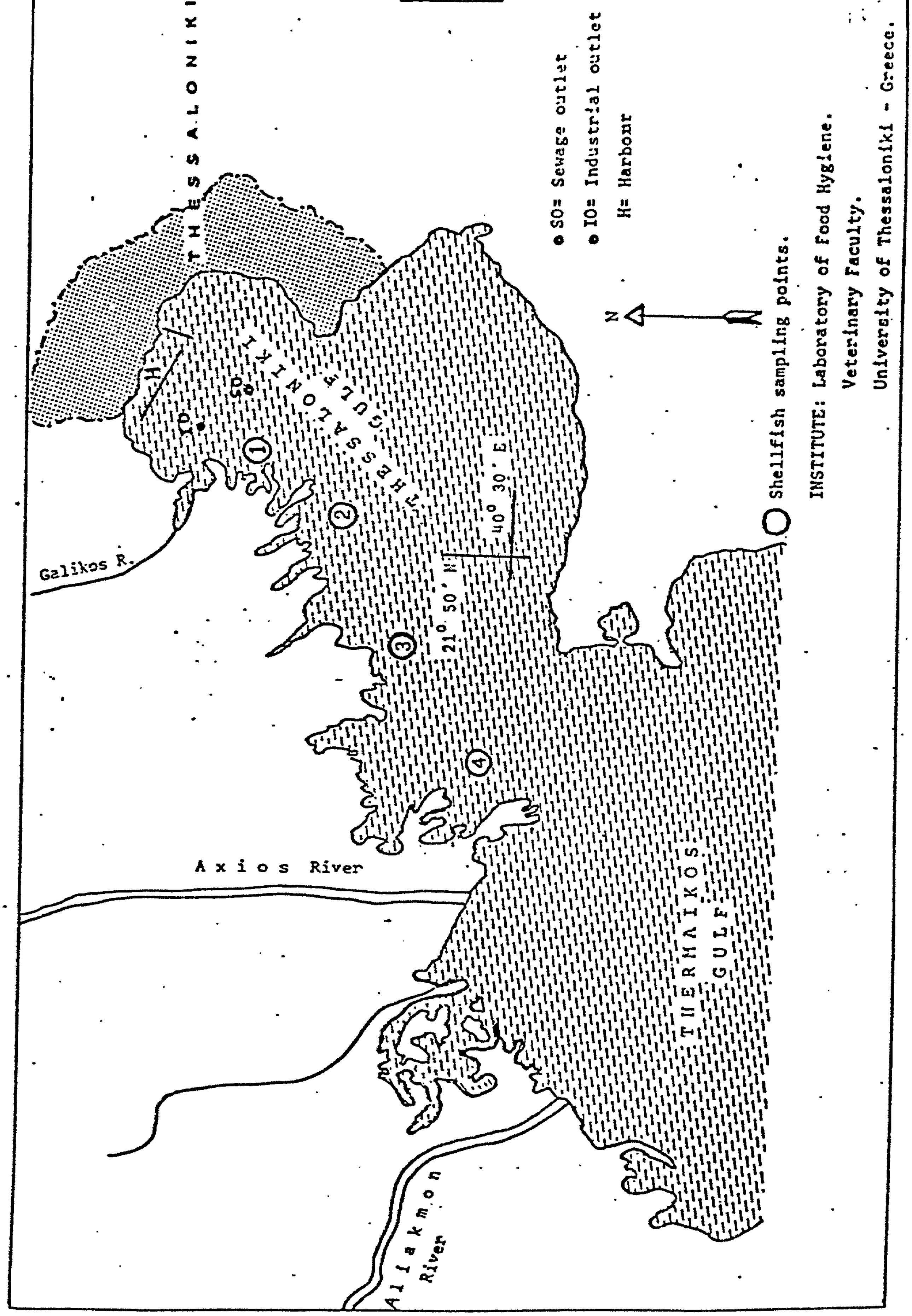
Percentage of samples within the proposed limits
on the basis of E. coli values.

SAMPLING POINT	SHELLFISH			WATER		
Point	0.2/g *	3-10/g **	10/g	10/100 ml	10/100/100ml ***	100/100ml
1	30.4%	52.2%	-	18.7%	75	6.3%
2	79.2%	20.8%	-	62.5%	37.5%	-
3	92.9%	7.1%	-	87.7%	13.3%	-
4	100%	-	-	94.4%	5.6%	-

* Accepted. ** Temporary prohibition of sale.
*** Accepted if not more than 20%.

From the above table it is evident that sampling point No.2 does not fulfil completely the proposed criteria either for shellfish or for the water, while sampling points No.3 and 4 satisfy the criteria. In evaluating the results obtained so far, it is evident that the pollution of the Northwest coast of Thermaikos gulf is expanding year by year, and this in addition to other problems, also creates a problem of shellfish hygiene. This problem is already anticipated by a shellfish cleaning station (ozone treatment) and very soon all shellfish from the above area will be subjected to treatment before they are released to the market.

Appendix I


THESSALONIKI
H
IO
SO
Galikos R.
21° 50' N
40° 30' E
N
Axios River
THERMAIKOS GULF
Aliakmon River
● SO= Sewage outlet
● IO= Industrial outlet
H= Harbour
○ Shellfish sampling points.
INSTITUTE: Laboratory of Food Hygiene.
Veterinary Faculty.
University of Thessaloniki - Greece.

Appendix II

Table 1: TOTAL HETEROTROPHIC BACTERIA (Frequencies %)

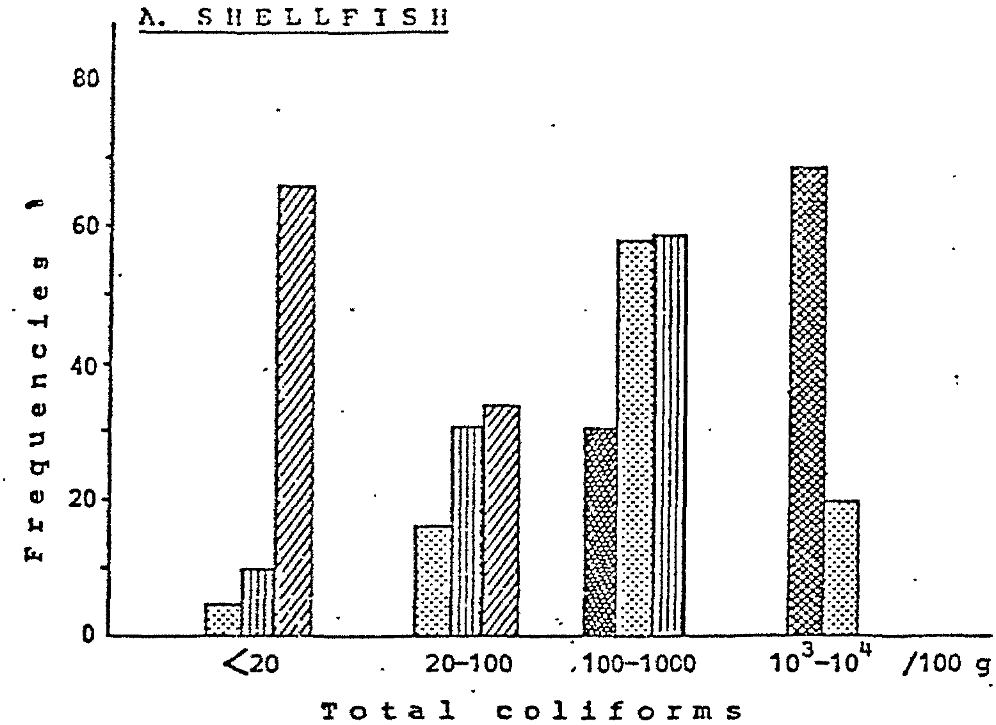
SHELLFISH

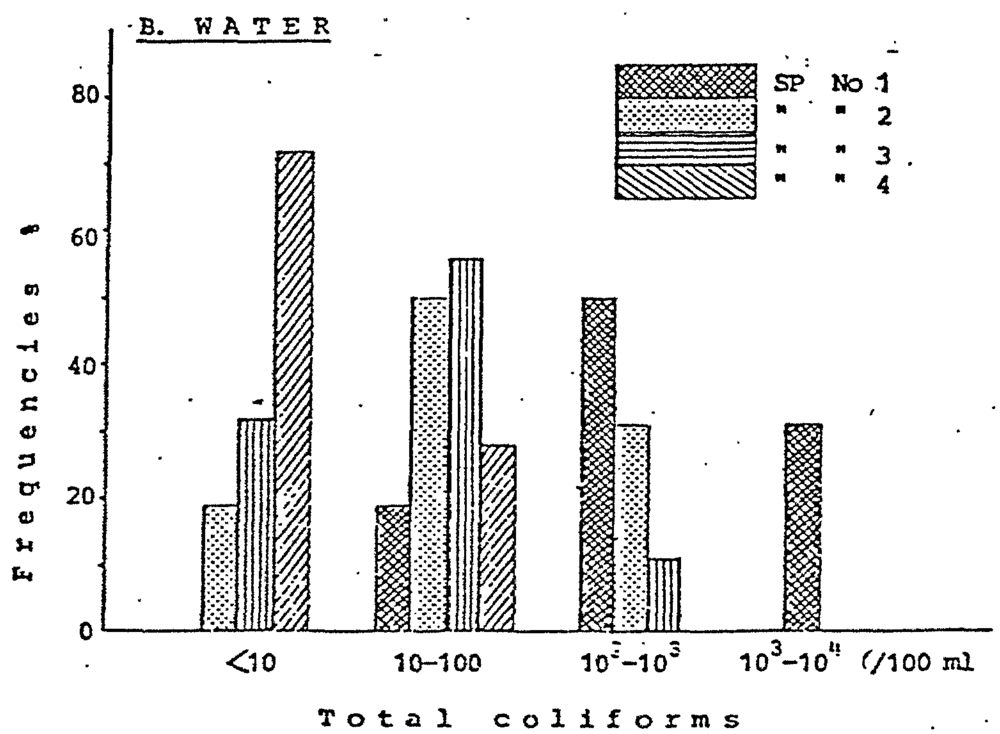
Per gram	Sampling point			
	1	2	3	4
10^2- 10^3	—	4.2 %	—	14.3 %
10^3- 10^4	—	75.0 %	82.1 %	85.7 %
10^4-$5x10^4$	52.2 %	20.8 %	17.9 %	—
$5x10^4$- 10^5	47.8 %	—	—	—

Table 2: ENTEROCOCCI (Frequencies %)

A. SHELLFISH (MPN)				
per gram	Sampling point			
	1	2	3	4
<10	21.7 %	66.7 %	82.8 %	100.0 %
10-100	78.3 %	33.3 %	17.2 %	—
B. WATER (MF)				
per 100 ml				
0	6.25 %	25.0 %	27.8 %	50.0 %
1-10	—	31.3 %	33.3 %	33.3 %
10-100	18.75 %	31.2 %	33.3 %	16.7 %
100-1000	75.00 %	12.5 %	5.6 %	—

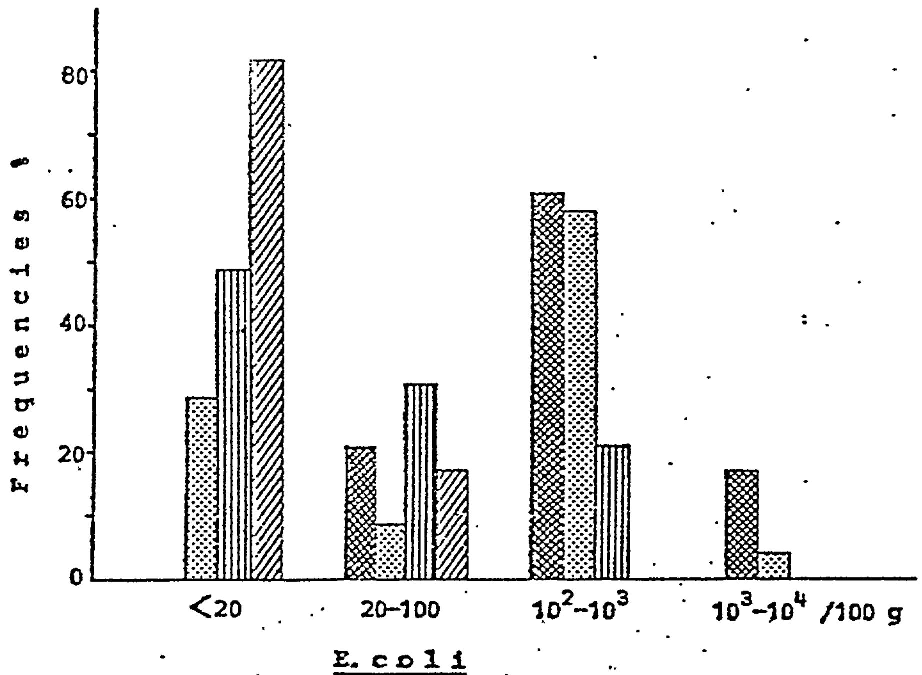
Appendix III



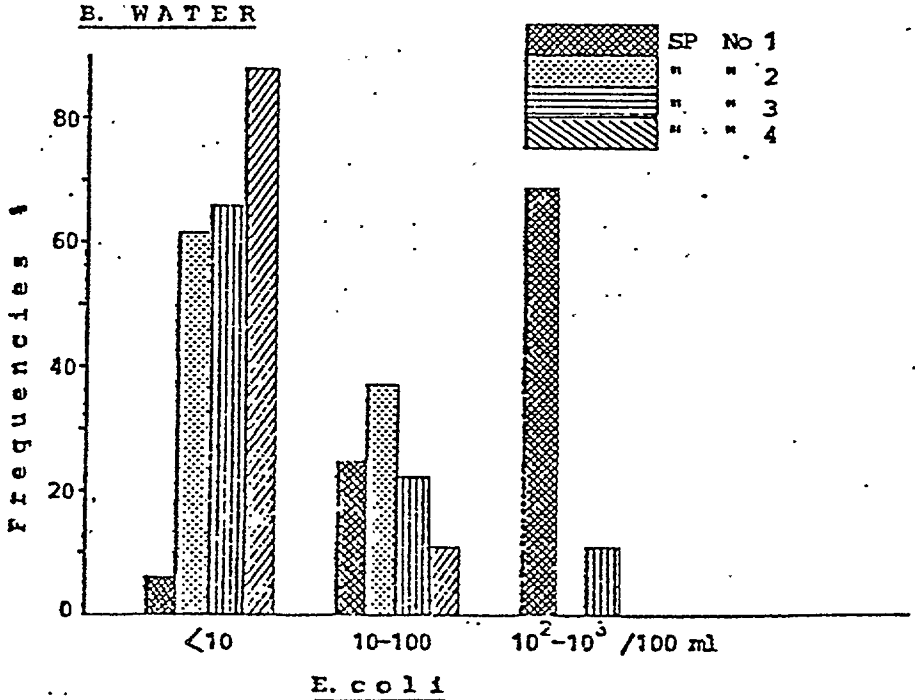


Appendix IV

A. SHELLFISH

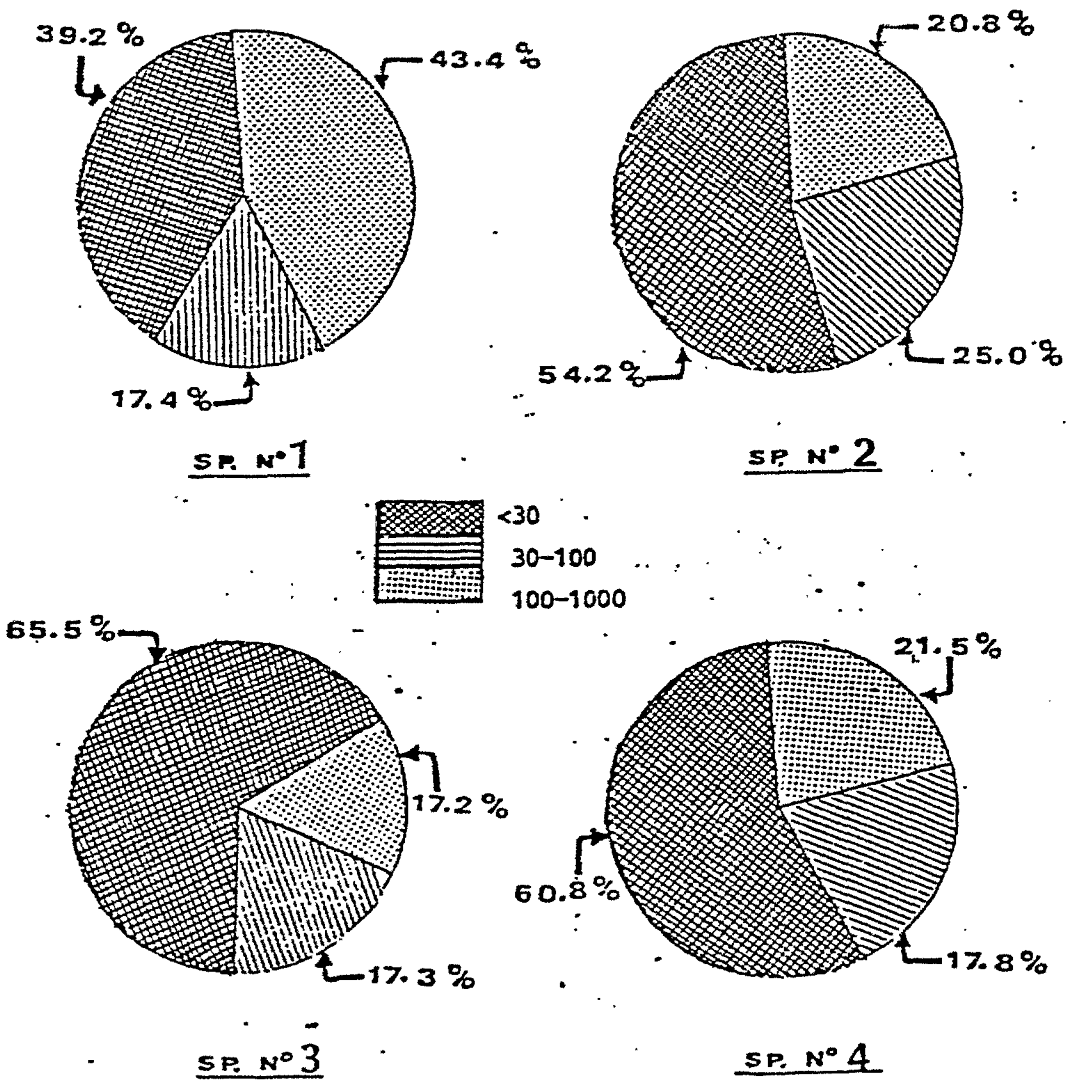


B. WATER



Appendix V

VIBRIO PARAHAEMOLYTICUS IN SHELLFISH (per 100 g)



Participating Research Centre: Institute of Hygiene
Medical School
University of Thessaloniki
THESSALONIKI
Greece

Principal Investigator: T. EDIPIDES

Introduction:

The study on the identification and evaluation of the degree of pollution in the Gulf of Thessaloniki and in Thermaikos Gulf started in 1968. Until 1975, 526 sea-water samples as well as 172 samples of sea sediment, together with an equal number of coastal sand samples, were examined.

All the samples were examined for the following parameters:

1. Number of Coliforms and E. coli (MPN).

2. Isolation and counting of Enterococci and sulfite reducing Clostridia.

3. Searching for Salmonellae, Shigella, V. parahaemoliticum.

4. Physical and chemical parameters, that is, air temperature, wind velocity, relative humidity, sea temperature, turbidity, pH, determination of chlorides, salinity, BOD_5, DO, and tracing and determination of Pb.

During that same period, 529 samples (1 sample X 5 = 2645) of shellfish were examined microbiologically and chemically. At the same time, the two rivers Axios and Aliakmon, flowing into the gulf of Thessaloniki, were examined to determine their pollution.

Area(s) studied:

The map shows the points of sea-water sampling (1, 2, 3, 4, 5, 6) and sediment and coastal sand sampling (3, 4). The sign (■) shows the locations of shellfish culture and fishing. The results of physical, chemical and microbiological parameters are given in tables 1, 2, 3, 4 and 5).

Material and methods:

Seven hundred and fourteen seawater samples taken from the Gulf of Thessaloniki, as indicated on the maps (1-6), were examined during the period of 1975-1978.

The samples were tested for the MPN of Coliforms, E. Coli, Enterococci, sulfite reducing Clostridia, as well as for the isolation of Salmonellae and Shigella.

One hundred and ninety-nine sediment samples, 199 coastal sand samples and 108 shellfish samples (one sample consisted of 5 shellfish) were also examined. All these samples were taken from the Gulf of Thessaloniki at the same time as the sea-water sampling. They were tested for the above microorganisms to which Vibrio parahaemolyticum was added. For shellfish itself, coagulase positive staphylococci were also included in the investigated pathogens.

For the MPN of Coliforms the Multiple tube method was used with the "Minerals modified Glutamate" as a medium as well as the filtration method (millipore) with M-endo agar as a medium. For the MPN of E. Coli the Multiple tube method was used with the same medium used for the Coliforms, and the filtration method with M-FC agar as a medium. It was found that the results obtained by the two methods used, i.e. the multiple tube method and the filtration method, did not differ significantly.

For the MPN of Enterococcus the filtration method was used with M.-enterococci agar as a medium. For the MPN of sulfite reducing Clostridia the medium D.R.C.M. was used. For the isolation of Salmonellae the selenite broth was used and for the isolation of Shigella the G.N. broth was used. For the number of coagulase positive Staphylococcus the medium "Staphylococcus agar" was used and for the isolation of Vibrio Parahaemolyticum the "Alcaline peptone Water".

Results obtained:

The results of the examination of the 714 sea-water samples for Coliforms and E. Coli during the period 1975 - Sep. 1978 are given in table 2, figure 1.

From the table, it is quite clear that Coliforms are more numerous in all but area 3 where Coliforms and E. Coli are present in roughly equal numbers.

Table 3 and figure 2 show the number of Enterococci and sulfite reducing Clostridia found.

Enterococci and sulfite reducing Clostridia are to be found in all areas although Enterococci are present in greater number in areas 2, 4 and 6, while in area 3 Enterococci and sulfite reducing Clostridia are present in roughly equal numbers.

Tables 4 and 5 and figures 3 and 4 show the results obtained by examination of 199 samples of sea sediment and coastal sand. All samples were taken from areas 4, 5, and 6.

From the tables and figures it is evident that the number of Coliforms is much greater in area 5 found in almost 100 per cent of the samples.

Certainly, E. Coli are to be found in all three areas, especially in areas 4 and 5. In area 6 they are present in smaller number, being found only in 5 per cent of the samples.

As far as Enterococci and sulfite reducing Clostridia are concerned, the results are given in tables 6, 7, and in figures 5 and 6.

To find out the extent to which the gulf is polluted, 20 samples of sea water and sediment were collected in 1978 in four runs: A, B, C, D (see map of Thermaikos Gulf).

The distance of the runs from the coast were as follows:

A-1250 m, B-2500 m, C-5500m, and D-11000 m.

From the water samples obtained during the runs, the following were isolated:

Four Vibrio parahaemolyticum, 10 Serotypes of Salmonellae: S. Senftenberg (4), S. Agona (3), S. Blockley (1), S. Fresno (1) and S. Wien (1).

Finally by the method of swabs the following microorganisms were isolated during the runs:

Seven Serotypes of Salmonellae: S. Agona (4), S. Senftenberg (2), S. Paratyphi B (1).

Table 8 shows the results of microbiological and chemical analysis of the 108 samples of shellfish from the Gulf of Thessaloniki (five shellfish constitute 1 sample).

In detail, the results are as follows: Out of the 108 samples, Coliforms were found in 86 and great numbers of E. Coli were found in 74.

Pathogenic Staphylococci were isolated in 35 samples. Sulfite reducing Clostridia in 52. Enterococci were found in 62 samples.

In 5 samples during the runs, Serotype E. Coli (O_{55}/B_5, O_{26}/B_6, O_{125}/B_5), were found in one sample S. Typhi, in 10 samples Shigella Sonnei and in 8 samples Proteus.

At the same time, the above mentioned samples were tested chemically for the determination of Pb and Hg: The results were for Pb 1.25-4.15 mg/l and for Hg 0.02 mg/l.

Results and their interpretation:

From the results obtained, it is evident that the Gulf of Thessaloniki is polluted continuously and at a great distance from the coast and from the wastes of the city of Thessaloniki. The results also show that in order to draw the right conclusions two samplings should be carried out from the same point and at the same time, one of sea-water and the other of sediment. Sea water often appears less polluted than sediment.

List of publications:

1) Neuere Untersuchungen auf die Schalentiere-bedingten (Austern) Infectionen - 1968.

2) Research on the pollution of the sea-water of the Gulf of Thessaloniki - 1971.

3) Analysis of the sea-water polluting fatty substances by Gas-Chromatography - 1971.

4) Purifications of sewage from microorganisms through the action of Entomostraca of the genus Daphnia of the order Cladocera - 1971.

5) Mediterranean Pilot study on Environmental degradation and pollution from Coastal development. Pollution in the Thermaic Gulf - 1973.

6) Les résultats des examens de l'eau de mer du golfe de Thessalonique du 26.5.77 jusqu' a Mars 1978. (1978).

7) Observations sur la pollution (Chimique et microbienne) du Golfe de Thessalonique pendant les dernieres dix annees (1968-1978) - 1978.

8) La pollution des rivières de la Grèce du Nord. - 1978.

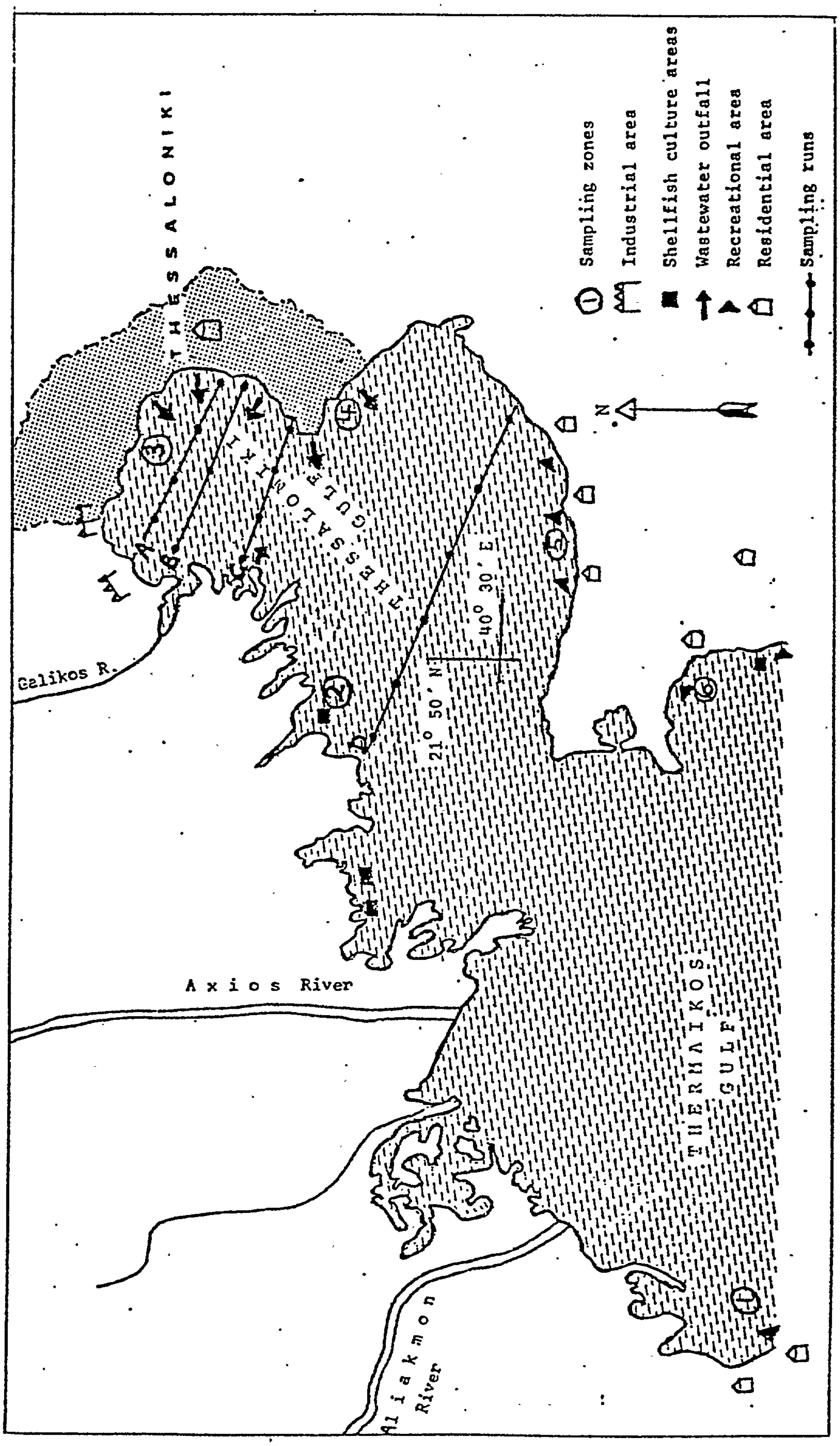

THESSALONIKI
THESSALONIKI GULF
THERMAIKOS GULF
Galikos R.
Axios River
Aliakmon River
21° 50' N
40° 30' E
N
Sampling zones
Industrial area
Shellfish culture areas
Wastewater outfall
Recreational area
Residential area
Sampling runs

Table 1: Results of chemical analysis of 714 samples of sea-water from the Gulf of Thessaloniki from 1 January 1975 to 30 September 1978

	Meteorological conditions					Chemical analysis						
Sec-tions	Air temp. ^{o}C	Wind velocity m/min.	Relative humidity %	Sea temp. ^{o}C	Turbidity (Secchi)	pH	Cl^{o}/oo	Salinity $^{o}/oo$	BOD_5 mg/l	DO mg/l	Pb mg/l
1	13-25	80-180	65-80	16-22	1-2.5	8.01-8.40	19.51-19.85	34.65-36.71	0.7-2.8	7.9-8.6	0.00-0.05
2	12-23	55-90	73-85	18-20	1-3	8.6-8.9	19.16-20.29	35.21-35.88	0.7-7.8	9.0-12.6	0.01-0.04
3	17-24	90-110	75-88	19-23	0.30-0.80	8.03-8.9	19.21-19.71	35.11-36.60	1.9-19.5	6.8-14.9	0.03-0.05
4	11.5-25	40-230	50-88	18-24	0.50-1.25	8.02-8.42	19.18-20.21	34.74-36.60	0.8-11.5	6.5-13.9	0.02-0.11
5	11-24	85-190	75-77	17-20	0.80-1.25	8.11-8.55	19.51-20.29	35.28-36.65	1.9-10.1	7.1-8.6	0.01-0.04
6	17-23	90-103	73-77	20-24	0.50-1.25	7.64-8.95	19.74-19.85	35.53-35.86	1.6-2.7	8.1-8.7	0.008-0.04

Table 2: Sample areas for sea-water and the results of microbiological examination for coliforms and E. coli from 1 January 1975 to 30 September 1978

SEA WATER

		Coliforms per 100 ml		*E. coli* per 100 ml	
Sections	Samples	1-2000	0	1-2000	0
1	12	7 (58.3%)	5 (41.7%)	3 (25.0%)	9 (75.0%)
2	130	51 (39.2%)	79 (60.8%)	30 (23.1%)	100 (76.9%)
3	109	69 (62.3%)	40 (37.7%)	66 (60.5%)	43 (39.5%)
4	224	144 (61.2%)	80 (38.8%)	95 (42.4%)	129 (57.6%)
5	149	96 (64.4%)	53 (35.6%)	59 (39.5%)	90 (60.5%)
6	90	44 (48.8%)	46 (51.2%)	31 (34.4%)	59 (65.6%)
Total	714	411 (57.5%)	303 (42.5%)	284 (39.7%)	430 (60.3%)

Figure 1

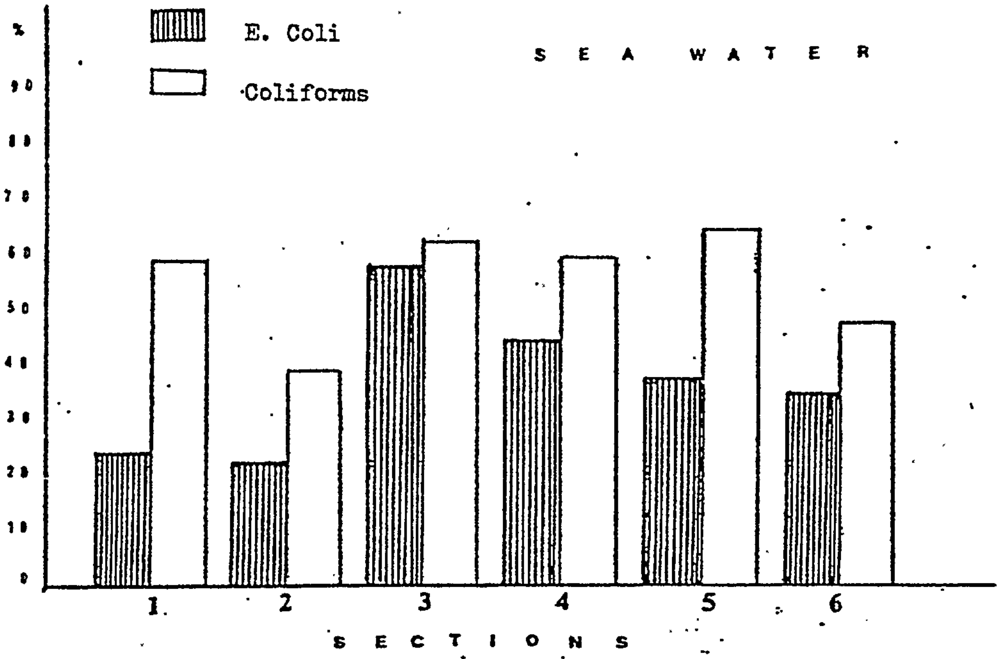


Table 3: Sample areas for sea-water and the results of microbiological examinations for enterococci and sulfite-reducing Clostridia from 1 January 1975 to 30 September 1978

SEA WATER

		Enterococci per 100 ml		Sulfite-reducing Clostridia per 100 ml	
Sections	Samples	1-1000	0	1-1000	0
1	21	6 (28.5%)	15 (71.5%)	5 (23.8%)	16 (76.2%)
2	152	123 (80.9%)	29 (19.1%)	61 (40.1%)	91 (59.9%)
3	68	48 (70.5%)	20 (29.5%)	48 (70.5%)	20 (29.5%)
4	241	141 (58.5%)	100 (41.5%)	48 (19.9%)	193 (80.1%)
5	179	54 (30.1%)	125 (69.9%)	63 (35.1%)	116 (64.9%)
6	53	36 (67.9%)	17 (32.1%)	8 (15.1%)	445 (84.9%)
Total	714	408 (57.1%)	306 (42.9%)	233 (32.6%)	481 (67.4%)

Figure 2

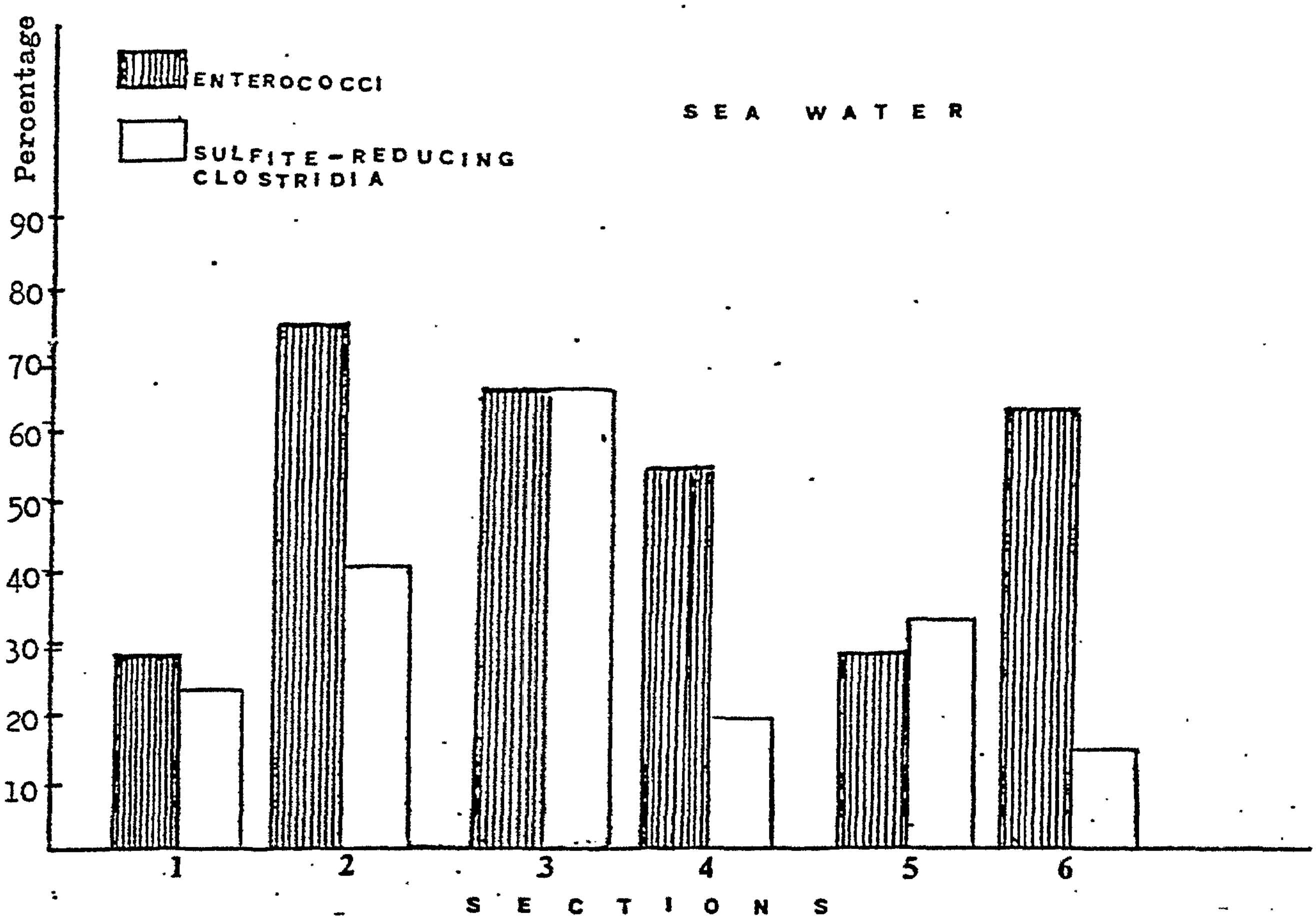


Table 4: Sample areas for sediment and the results of microbiological examination for coliforms and E. coli from 1 January 1975 to 30 September 1978

SEDIMENT

		Coliforms				E. coli			
Sections	Samples	Pos.	%	Neg.	%	Pos.	%	Neg.	%
4	132	70	53.1	62	49.6	24	18.2	108	81.8
5	38	38	100.0	0	0.0	21	55.2	17	44.8
6	29	8	27.5	21	72.5	2	6.8	27	93.2
Total	199	116		83		47		152	

Figure 3

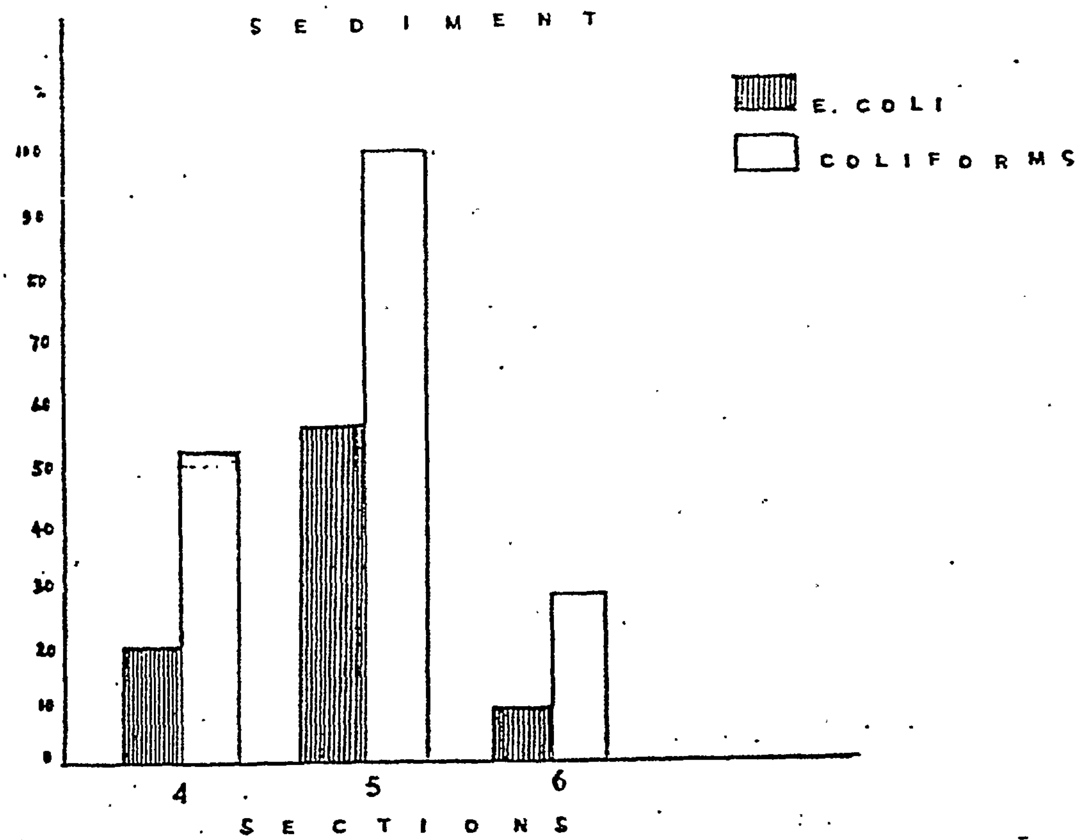


Table 5: Sample areas for coastal sand and the results of microbiological examination for coliforms and E. coli from 1 January 1975 to 30 September 1978

COASTAL SAND

		Coliforms				E. coli			
Sections	Samples	Pos.	%	Neg.	%	Pos.	%	Neg.	%
4	132	78	59.1	54	40.9	18	13.6	114	86.4
5	38	37	97.4	1	2.6	20	52.6	18	47.4
6	29	11	37.9	18	62.1	1	3.4	28	96.6
Total	199	126		73		39		160	

Figure 4

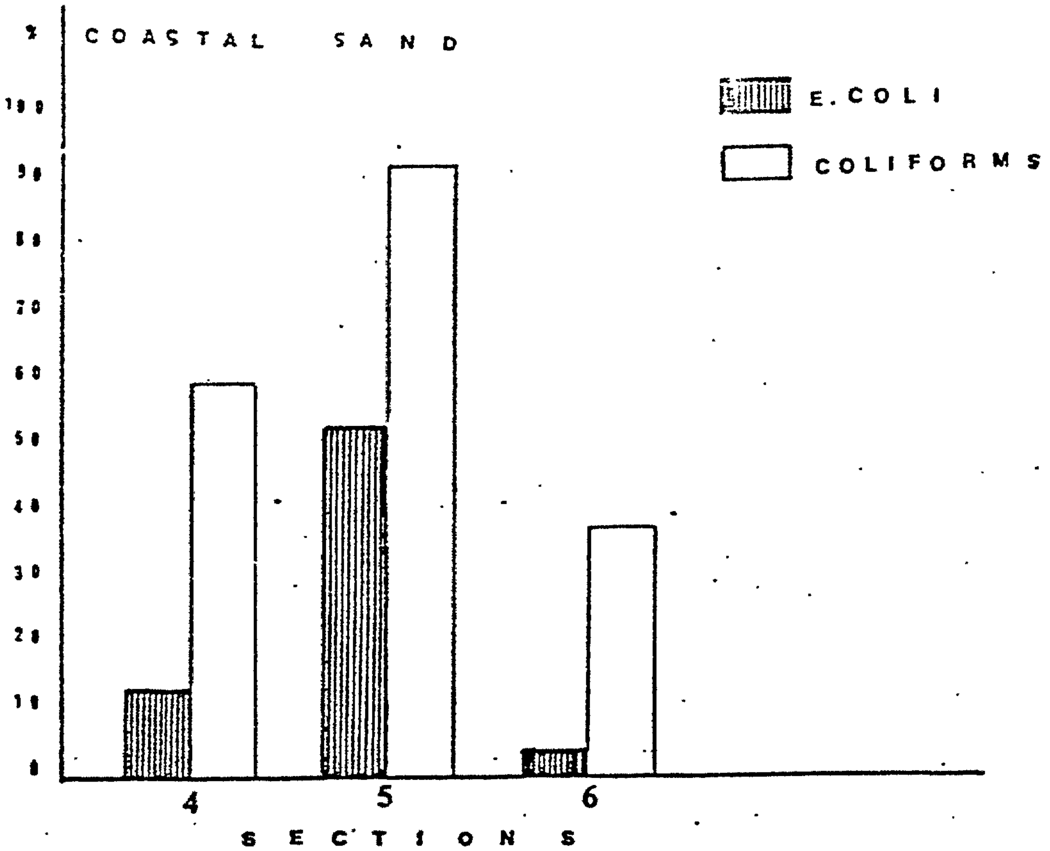


Table 6: Sample areas for sediment and the results of microbiological examination for enterococci and sulfite-reducing Clostridia from 1 January 1975 to 30 September 1978

SEDIMENT

			Enterococci				Clostridia			
Sections	Samples	Pos.	%	Neg.	%	Pos.	%	Neg.	%
4	113	78	69.1	35	30.9	69	61.1	44	38.9
5	59	24	40.6	35	59.4	25	42.4	34	57.6
6	27	25	92.5	2	7.5	15	55.5	12	44.5
Total	199	127		72		109		90	

Figure 5

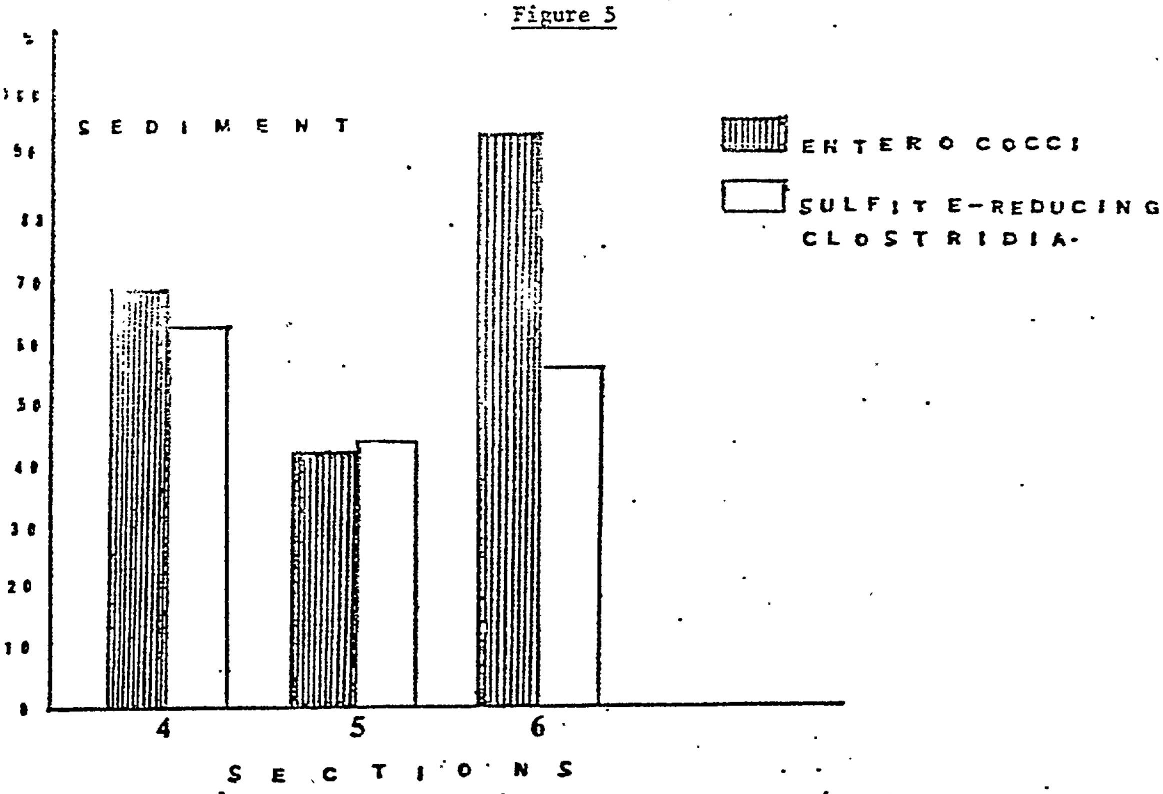


Table 7: Sample areas for coastal sand and the results of microbiological examination for enterococci and sulfite-reducing Clostridia from 1 January 1975 to 30 September 1978

COASTAL SAND

		Enterococci				Clostridia			
Sections	Samples	Pos.	%	Neg.	%	Pos.	%	Neg.	%
4	113	53	46.9	60	53.1	57	50.4	56	49.6
5	59	44	74.5	15	25.5	28	47.4	31	52.6
6	27	21	77.3	6	22.3	I4	51.8	13	48.2
Total	199	118		81		99		100	

Figure 6

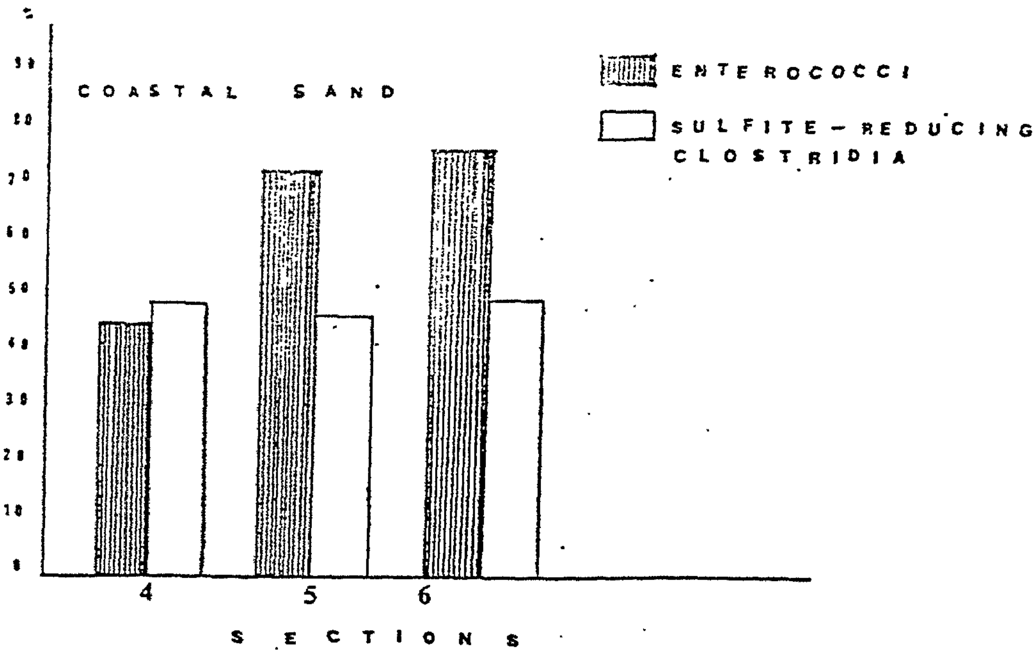


Table 8: Results of microbiological and chemical examination of 540 (108x5) samples of shellfish from the Gulf of Thessaloniki from 1 January 1975 to 30 September 1978

ISOLATED MICROORGANISMS	SAMPLES
Coliforms	86
E. coli	74
Staphylococci coagulase positive	35
Sulfite-reducing *Clostridia*	57
Enterococci	62
Serotype of *E. coli* O_{55}/B_5	1
Serotype of *E. coli* O_{26}/B_6	1
Serotype of *E. coli* O_{125}/B_{15}	3
Salmonella typhi	1
Shigella sonnei	10
Proteus	8
Pb mg/l	1.25-4.25
Hg mg/l	0.02

Participating Research Centre: Environmental pollution control project
Ministry of Social Services
ATHENS
Greece

Principal Investigator: J.A. PAPADAKIS/M. THALASSINOU-TZATZANI/
A. SOTIRACOPOULOS

Introduction:

The Ministry of Social Services participates in project MED VII through its three laboratories:

a) Environmental Pollution Control Project

b) Athens School of Hygiene, and

c) Central Public Health Laboratory

Because the above laboratories are monitoring the coastal water quality in the same geographical area, the monitoring work has been allocated according to their data collection and analysis capabilities and co-ordinated by the above Project.

A survey during the period 1962-77 of a number of bathing beaches near Athens, using the mean value MPN of coliforms for sea-water and carried out for the most part during the bathing season (15 May to 15 October), revealed the influence of land-based sources of pollution on the quality of the sea-water.

As a result of the above study and the yearly routine examination of beaches, the Ministry of Social Services has forbidden bathing at some beaches of the Athens area and taken appropriate measures to improve the quality of others.

Since the establishment of the Environmental Pollution Control Project, a broad sampling network was developed and progressively extended, reaching 72 sampling stations.

The Central Public Health Laboratory has been involved in the microbiological examination of recreational coastal water as well as shellfish culture areas since 1965.

Area(s) studied:

Four bathing beaches along the Attica peninsula were chosen as sites for MED VII recreational multiple sampling monitoring and one as a site for shellfish area monitoring: Alimos, Varkiza, Ag. Marina, Lagonissi (the latter chosen as reference beach), and Loutropyrgos as a shellfish-growing area. The exact location of the above beaches is shown on figure 1 attached.

Materials and methods:

The "Guidelines for Health Related Monitoring of Coastal Water Quality" (WHO, 1977) were used as the basic document for the implementation of the work undertaken. More specifically the following methods and materials were used for each of the parameters monitored:

Sea-water samples:

Total coliforms: (a) Multiple tube method with glutamate modified for sea-water (Papadakis, 1975); (b) Membrane filtration method with M-endo agar according to the Guidelines as well as with Teepol broth. The m-FC agar proposed at the Rome meeting (May 1977) was found unsatisfactory. Dilutions were made with phosphate buffer.

E. Coli: (a) Multiple tube method (as above) with differentiation at 44°C (gas from lactose, indole positive); (b) Membrane filtration method according to the Guidelines.

Faecal Streptococci: Membrane filtration method according to the Guidelines.

Pathogens: (a) Salmonellae - filtration through membranes incubated in buffer phosphate for 20-24 hours at 37°C and subculture in modified Rappaport's medium and Muller-Kauffman's tetrathionate broth at 43°C. Enrichment media were plated on brillant green lactose-sucropse agar; (b) Vibrio-filtration through membranes incubated in alkaline peptone water for 6-8 hours and subculture on TCBS agar.

Sediment samples:

In accordance with the Guidelines, sediments were shaken for 30 minutes in phosphate buffer and dilutions were made, of which 1 ml was examined with the pour plate technique.

(a) Total coliforms: Teepol agar; (b) Faecal coliforms: M-FC agar;
(c) Faecal streptococci: K-F agar.

Beach material samples:

(a) Total coliforms; (b) Faecal coliforms and
(c) Faecal streptococci.

The beach materials were examined according to the Guidelines, using the multiple tube technique. The amount of beach material samples processed was 100 g.

(d) Pathogens: Beach material pathogens were examined using similar methodology to that used in shellfish-growing areas (see below).

(e) Fungi: The spread plate technique was employed using rose bengal agar as it is described in the "Method for Microbiological Analysis of Waters, Wastewaters and Sediments" (Inland Waters Directorate, Canada Centre for Inland Waters, Burlington, Ontario, Canada).

Shellfish area samples:

(a) Total coliforms, (b) Faecal coliforms and (c) Faecal streptococci were all examined on the shellfish flesh, sea-water and sediments of the area, using the multiple tube technique with sodium azide broth as presumptive medium and ethyl azide broth as the confirmatory medium. The amount of shellfish flesh, including the sediment sample processed for the analysis, was 100 g.

(d) Pathogens: the following pathogens were examined on shellfish flesh, sea-water and sediments: Salmonellae, Shigella, Vibrio cholerae and non-agglutinable vibrios, and Vibrio parahaemolyticus. All these tests were performed in accordance with the suggested guidelines. For the Vibrio parahaemolyticus, teepol salt broth was used as enrichment medium instead of the G. Pselichidic salt meat broth. For the Salmonellae test, the pre-enrichment procedure was applied.

Beach sanitary surveillance

The four recreational areas monitored were also surveyed from the sanitary point of view during each sampling. Both the beach and sea-water area were examined and classified according to the Garber code.

Salinity:

Salinity was measured by the hydrometric method, based on the specific weight, and by the argentometric method as described by the US AWWA Standards.

Turbidity:

The Secchi disc method was not applied because of the shallowness and cleanliness of the waters of 10 m from the coastline. Turbidity was therefore measured by the nephelometric method using a turbidimeter as well as by comparison with original SiO_2 suspensions.

Dissolved oxygen:

This was measured by the Winkler method in situ while only the final titration was carried out at the laboratory.

Temperature:

This was measured in situ by simple thermometres.

Meterological data:

Specific meteorological data from two meteorological stations were collected in view of possible correlation between wind and coastal pollution.

Dynamic conditions:

Data on tides were requested from the Army Hydrographic Services. Waves were usually evaluated. Current data presented some difficulties and no information was available for surface currents.

Hydrographic conditions:

The required hydrographic data were collected locally at the sampling points.

Results and their interpretation:

Sea-water

Generally, low densities for coliforms and even lower for faecal coliform organisms were found, except for the two sampling points at which, during October 1977, rather high values of both indicator organisms were noted.

Faecal streptococci were not found consistently lower or higher than faecal coliforms.

The low coliform and especially the very low faecal coliform densities indicated that the monitoring areas are free from sewage pollution and their waters are of excellent quality for bathing and recreational activities.

Pathogens, Salmonellae, Shigella and V. cholerae were not found except at one sampling point from which salmonellae were isolated only once during October 1977 when the area was accidentally polluted by sewage. Non-agglutinable vibrios were occassionally found at all sampling points except for the two points of the reference area.

Sediments

The densities of coliform per gram, found in sediments of all sampling points, are rather low, with the highest values observed during the summer months.

Faecal coliform organisms were generally absent with a few exceptions, but faecal streptococci were observed at levels approaching the coliform densities.

There was a fluctuation for both coliforms and faecal streptococci, the highest densities being found during the summer months of both years.

Beach materials

Sand was the only beach material examined from the microbiological point of view. Our data indicate that occasionally there is some bacterial contamination with coliforms and faecal streptococci. Fungi were consistently present at all the sampling points.

Shellfish-growing area

The water quality of the shellfish-growing area was found to be within the proposed WHO/UNEP standards (Rome 1978) for all samples, while the shellfish flesh quality exceeded them only once.

Beach sanitary surveillance

Suveillance of the sanitary conditions of beaches has shown that at some stations there is a permanent accumulation of rubbish originating from sea-water, beach and domestic refuse, while in others there is only occasional accumulation of some of the above-mentioned litter.

Intensive growth of algae occurs during spring and summer offshore near polluted areas. A considerable population of jelly fish have also occurred recently.

Wind conditions

During MED VII samplings, the winds were quite variable in dirction, particularly at point C (Ellinikon airport), while wind speeds were rather low (0.1-0.4 m/sec) on most of the sampling days. The maximum wind speed during the respective months ranged between 7 and 13 m/sec.

A correlation of winds and pollution of the beaches has been experienced.

Wave conditions

Wave conditions during MED VII sampling days were mostly of rate 1 and 2, i.e. calm and nearly calm with only one exception in January 1978 (rough).

Tidal conditions

The tidal range during MED VII samplings was quite limited. The flood tide ranged from 0.02 to 0.08 while the ebb tide ranged from 0 to 0.21 in relation to respective monthly mean sea-level. No considerable effect, as far as pollution is concerned, is expected from tidal ranges of this order of magnitude.

Currents

The available data for currents do not provide sufficient information on the water movement along the coasts, because they are limited to only one point (D) and also refer to comparatively deep waters (25 m), and they do not give any information on the surface water movements, which are most important for coastal water quality, in relation to pollution transfer.

Publications:

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2. Quality of Coastal Waters-Environment Pollution
Control Project Athens drafted report, May 1977
(unpublished).

3. Hopkins T.S. and Becacos-Kontos T. (1977)
Some parameters indicating the distribution of
Pollution in the Upper Saronikos Gulf XXIII
CIESM Congress Athens.

4. Alivisatos G.P. and J.A. Papadakis (1975a)
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examination of seawater. J. appl. Bact. 39, 287
Papadakis J.A. (1975b). Bacteriological examination
of seawater.

5. Papadakis J.A. (1976). American and English methods
of multiple tubes for the examination of seawater.
Acta Microbiol. Hellen. 21, 255.

6. Biological Indicators of Pollution in Saronikos Gulf.
S. Sotiracipoulos, M. Andriotis and D. Spala.
3rd Panhellenic Medical Congress Athens May 1977.

Figure 1

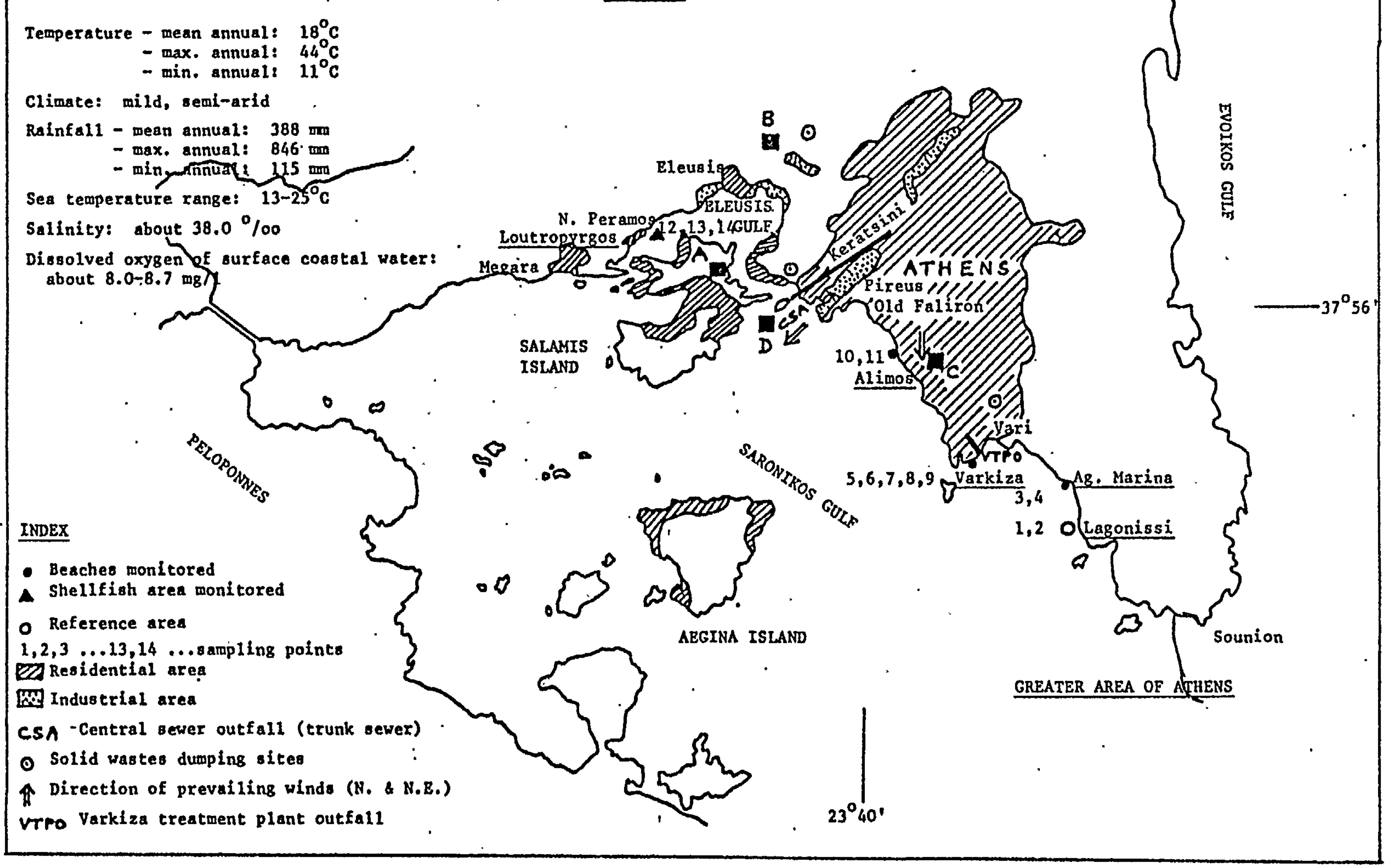
Temperature - mean annual: 18°C
- max. annual: 44°C
- min. annual: 11°C
Climate: mild, semi-arid
Rainfall - mean annual: 388 mm
- max. annual: 846 mm
- min. annual: 115 mm
Sea temperature range: 13-25°C
Salinity: about 38.0 °/oo
Dissolved oxygen of surface coastal water: about 8.0-8.7 mg/l
EVOIKOS GULF
37°56'
B
Eleusis
ELEUSIS GULF
N. Peramos
12,13,14
A
Loutropyrgos
Megara
Keratsini
ATHENS
Pireus
Old Faliron
CSA
D
SALAMIS ISLAND
10,11
Alimos
C
Vari
VTPO
5,6,7,8,9
Varkiza
Ag. Marina
3,4
1,2
Lagonissi
PELOPONNES
SARONIKOS GULF
AEGINA ISLAND
Sounion
GREATER AREA OF ATHENS
23°40'
INDEX
Beaches monitored
Shellfish area monitored
Reference area
1,2,3 ...13,14 ...sampling points
Residential area
Industrial area
CSA -Central sewer outfall (trunk sewer)
Solid wastes dumping sites
Direction of prevailing winds (N. & N.E.)
VTPO Varkiza treatment plant outfall

Table 1

Recreational Water Multiple Sampling

Sea Water- Total Coliforms, Faecal Coliforms and Faecal Streptococci

(All in No./100 ml)

Date / No. of Sampling Point	Parameters	1	2	3	4	5	6	7	8	9	10	11
17 May 1977	T. Coliform	0	0	0	0	1	5	1	18	18	29	35
	F. Coliform	0	0	0	1	0	1	0	9	1	11	14
	E. Strepto.	0	0	0	0	0	8	0	0	5	2	3
14 June 1977	T. Coliform	90	100	40	14	0	6	2	2	22	40	50
	F. Coliform	11	13	0	0	0	4	2	0	0	12	17
	F. Strepto.	0	0	4	0	6	40	58	80	2	0	0
4 July 1977	T. Coliform	3	6	30	16	6	2	-	6	16	160	200
	F. Coliform	1	2	9	5	6	0	-	10	12	89	90
	F. Strepto.	0	0	0	2	0	12	-	24	2	10	13
25 July 1977	T. Coliform	0	11	13	7	0	66	76	4	24	220	260
	F. Coliform	0	0	3	0	2	60	28	0	0	50	83
	F. Strepto.	0	0	2	0	12	6	32	0	38	40	10
3 August 1977	T. Coliform	450	670	350	69	12	0	22	8	12	7	3
	F. Coliform	9	0	7	0	4	0	8	4	8	0	0
	F. Strepto.	0	0	0	0	304	32	84	100	76	1	1
5 September 1977	T. Coliforms	31	6	0	0	12	288	36	4	4	26	7
	F. Coliforms	18	0	0	0	-	-	-	-	0	12	0
	F. Strepto.	1	0	0	0	32	72	44	12	12	1	1
3 October 1977	T. Coliform	6	15	1	3	8	8	14	18	6	8000	8000
	F. Coliform	2	13	0	0	0	0	0	6	0	1200	8000
	F. Strepto.	0	1	0	0	4	6	4	2	0	22	80
21 January 1978	T. Coliform	-	-	0	-	-	6	-	-	32	-	-
	F. Coliform	-	-	-	-	4	8	-	2	2	-	-
	F. Strepto.	-	-	-	-	44	38	10	30	60	-	-
28 February 1978	T. Coliform	2	0	0	2	-	-	-	-	-	-	-
	F. Coliform	0	0	0	0	-	-	-	-	-	25	28
	F. Strepto.	0	0	0	0	-	-	-	-	-	0	0
1 March 1978	T. Coliform	-	-	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-	-	-
17 April 1978	T. Coliform	200	30	4	2	0	14	11	6	2	800	80
	F. Coliform	35	5	0	0	0	3	0	0	0	110	2
	F. Strepto.	16	4	0	0	1	2	0	0	2	23	2
15 May 1978	T. Coliform	0	4	5	0	12	2	8	2	8	18	26
	F. Coliform	0	4	3	0	0	0	0	0	0	7	10
	F. Strepto.	9	0	0	0	0	0	0	6	4	3	1
5 June 1978	T. Coliform	0	0	0	0	2	6	2	0	18	0	0
	F. Coliform	0	0	0	0	0	0	0	0	0	0	0
	F. Strepto.	1	0	1	0	4	50	6	4	14	0	0
3 July 1978	T. Coliform	95	36	180	12	0	0	4	0	4	0	25
	F. Coliform	70	23	50	5	0	0	4	0	0	-	13
	F. Strepto.	0	2	5	0	100	54	7500	500	48	-	0
7 August 1978	T. Coliform	6	1	0	4	4	8	12	22	6	2	1
	F. Coliform	0	0	0	2	2	2	6	0	0	1	0
	F. Strepto.	4	0	0	0	64	56	57	57	36	0	0
4 September 1978	T. Coliform	23	100	75	41	22	108	8	43	30	0	0
	F. Coliform	19	41	58	17	0	0	0	2	0	0	0
	F. Strepto.	14	1	23	11	23	10	126	26	14	0	0

Table 2

Recreational Water Multiple Sampling

Sediments - Total Coliform, Faecal Coliform and Faecal Streptococci

(All in No./100 ml)

Date / No. of Sampling Point	Parameters	1	2	3	4	5	6	7	8	9	10	11
17 May 1977	T. Coliform	-	9	4	9	4	3	16	9	9	6	4
	F. Coliform	-	2	1	2	1	0	2	1	2	1	1
	F. Strepto.	-	2	0	2	0	0	3	2	2	1	1
14 June 1977	T. Coliform	18	4	18	2	6	18	16	16	16	16	6
	F. Coliform	0	0	0	0	0	1	2	2	2	0	0
	F. Strepto.	-	-	-	-	-	-	-	18	16	18	3
4 July 1977	T. Coliform	0	18	0	0	0	1	-	2	35	16	9
	F. Coliform	0	18	0	0	0	0	-	0	13	0	4
	F. Strepto.	0	18	12	0	0	2	-	2	10	18	6
25 July 1977	T. Coliform	4	0	0	0	0	1	1	2	3	18	18
	F. Coliform	0	4	0	0	0	1	0	0	0	4	0
	F. Strepto.	18	16	18	16	18	18	16	16	18	18	18
3 August 1977	T. Coliform	2	0	0	0	0	0	0	0	0	16	0
	F. Coliform	0	0	0	0	15	0	0	0	0	48	48
	F. Strepto.	530	56	600	0	26	193	0	25	33	309	311
5 September 1977	T. Coliform	300	0	22	10	17	12	11	6	4	33	4
	F. Coliform	5	0	10	0	-	-	-	0	-	2	0
	F. Strepto.	250	0	90	0	150	130	1	8	1	27	113
3 October 1977	T. Coliform	180	6	33	10	20	150	21	32	40	1100	900
	F. Coliform	0	0	0	0	0	5	0	0	0	250	150
	F. Strepto.	280	1	50	0	70	80	8	10	13	90	50
21 January 1978	T. Coliform	0	0	0	0	0	0	0	0	0	0	0
	F. Coliform	0	0	0	0	0	0	0	0	0	0	0
	F. Strepto.	0	0	0	0	0	0	0	0	0	2	2
28 February 1978	T. Coliform	-	-	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-	-	-
1 March 1978	T. Coliform	-	-	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-	-	-
17 April 1978	T. Coliform	-	-	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-	-	-
15 May 1978	T. Coliform	280	20	7	33	7	3	4	10	4	130	57
	F. Coliform	0	0	0	0	0	0	0	0	0	2	0
	F. Strepto.	13	1	0	0	1	2	4	1	0	40	11
5 June 1978	T. Coliform	-	-	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-	-	-
	F. Strepto.	20	1	1	0	0	4	0	0	0	40	6
3 July 1978	T. Coliform	100	78	188	50	25	22	50	66	11	77	25
	F. Coliform	0	0	0	0	0	0	0	0	0	0	0
	F. Strepto.	3	2	1	20	1	3	0	33	84	600	52
7 August 1978	T. Coliform	85	83	64	73	81	46	50	101	120	175	251
	F. Coliform	0	0	0	0	0	0	0	0	0	0	0
	F. Strepto.	102	81	89	12	59	45	69	78	78	435	421
4 September 1978	T. Coliform	56	7	73	73	9	0	6	0	6	1	1
	F. Coliform	0	0	0	0	0	0	0	0	0	0	0
	F. Strepto.	120	4	43	43	4	5	10	6	16	9	19

Table 3

Shellfish Multiple Sampling

Total Coliforms, Faecal Coliforms and Faecal Streptococci

Date / Sampling Point	Parameters	Sea Water No./100 ml 12	13	14	Sediments No./100 gr 12	13	14	Shellfish in situ No./100 gr 12	13	14
23 May 1977	T. Coliform	13	6	0	240	23	70	60	130	60
	F. Coliform	0	0	0	0	0	0	0	0	0
	F. Strepto.	0	0	0	0	0	40	0	0	0
20 June 1977	T. Coliform	23	460	23	2400	1500	430	2100	230	230
	F. Coliform	0	0	0	0	0	0	0	0	0
	F. Strepto.	0	0	0	0	0	0	0	0	0
18 July 1977	T. Coliform	43	43	23	1500	430	2400	930	230	230
	F. Coliform	4	23	4	90	0	0	40	230	90
	F. Strepto.	23	43	23	390	640	280	230	230	430
August 1977	T. Coliform	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-
18 September 1977	T. Coliform	2	0	2	2400	340	3500	80	330	1700
	F. Coliform	0	0	0	40	0	0	0	0	0
	F. Strepto.	0	0	0	5400	0	2200	0	0	2200
October 1977	T. Coliform	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-
January 1978	T. Coliform	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-
February 1978	T. Coliform	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-
6 March 1978	T. Coliform	0	0	0	260	1300	790	2400	2400	230
	F. Coliform	0	0	0	20	50	130	210	930	40
	F. Strepto.	0	0	0	0	220	460	4600	1500	0
April 1978	T. Coliform	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-
16 May 1978	T. Coliform	0	0	20	110	0	20	50	170	90
	F. Coliform	0	0	0	0	0	0	0	110	90
	F. Strepto.	0	0	0	0	0	0	0	0	0
6 June 1978	T. Coliform	240	3	4	1200	30	0	40	40	0
	F. Coliform	0	0	0	750	0	0	0	0	0
	F. Strepto.	93	0	0	430	0	0	0	0	0
4 July 1978	T. Coliform	48	0	15	230	0	0	930	0	0
	F. Coliform	7	0	0	40	0	0	0	0	0
	F. Strepto.	43	0	0	90	0	0	0	0	0
8 August 1978	T. Coliform	2400	7	4	0	0	0	0	0	0
	F. Coliform	0	4	0	0	0	0	0	0	0
	F. Strepto.	1200	0	0	0	0	0	0	0	0

Participating Research Centre: Environmental Health Laboratory
The Hebrew University
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Principal Investigator: H.I. SHUVAL

Introduction:

Pathogenic bacteria and viruses are discharged in large numbers into the sea through sewage outfalls, posing a potential health risk to consumers of shellfish bred in adjacent waters or to bathers at contaminated beaches. Although enteric bacterial concentration is rapidly reduced in the sea as a result of dilution and other factors, it has been demonstrated that the pathogens can survive long enough in sufficiently high concentration to lead to disease transmission via bathers swimming at contaminated beaches.

The introduction of uniform standards and test procedures are an essential aspect of marine pollution control. This uniformity has recently been achieved through the UNEP/WHO Mediterranean pollution monitoring and coastal programmes, in which the Environmental Health Laboratory in Israel is an active participant.

In the last five years, the Environmental Health Laboratory initiated the following projects:

a) Analysis of coastal water quality data in the Tel Aviv region during 1963-76. This included bacteriological testing and statistical analysis in co-operation with the Felix Public Health Laboratory of the Ministry of Health, Tel Aviv.

b) Field and laboratory studies on the die-away kinetics of coliforms and enteric viruses in coastal waters.

c) Development of sensitive methods for enteric virus detection in large volumes of sea-water.

Area(s) studied:

In accordance with the MED VII Plan, during the study period routine bacteriological tests were made on samples taken at three (3) main beaches designated as sampling stations. All were in Tel Aviv. About 50 per cent of the samples were also examined for enteroviral content. In addition, occasionally, samples were taken from most of the other Tel Aviv area beaches for purposes of comparison of bacteriological and viral content. (See map number 1).

At a point about 880 metres out to sea, the untreated sewage of Tel Aviv is discharged into the sea through a pipe. The closest beaches are the Tel Baruch beach, No.6, just north of the Reading power plant sewage outfall and Nachshon, No. 8a, and Hilton, No. 8b, beaches which are in the south. (The results from Stations 8a and 8b were unified under one heading. These two stations were combined for data collection purposes because they are very close to each other and provided few samples). Station No. 5, which is further north of the sewage outfall, was selected as a control station. It should be noted that there are other points at which sewage enters the sea. One major source is the Yarkon River, into which cities further inland release their sewage. Another smaller outlet outlet is at Feingold Street, No. 13b, and near Bassa, No. 14a, both of which are to be closed down.

Data on wind velocity and direction, temperature and conductivity were collected for the above-mentioned beaches. The mean wind velocity was 10 and the wind direction generally was from south to north. The temperature of the beaches studied are tabulated in table 1. This table shows the range as 17 - 27°C, with the summer-time mean as 25°C. The mean for the remaining months was 20°C. For the purpose of this study the summer-time was defined as the months of May to October, inclusive. The conductivity for these stations is presented in table 2. The mean for the entire year was 47 millimho. However, it should be noted that the summer-time mean was slightly higher (49 millimho).

Material and methods:

For the measurements of all the parameters, the methods used were those recommended by the project in "Guidelines for Health Related Monitoring of Coastal Water Quality", WHO (Copenhagen, 1977). Because these guidelines do not recommend viral tests, the organic flocculation methods for concentrating and testing viruses in sea-water were developed in our laboratory. These tests yielded a mean virus recovery of 63 per cent with seeded polio virus in 35 litre samples of sea-water.

Results and their interpretation:

The primary data have been recorded in the data forms submitted. In addition to the wind velocity, wind direction, temperature and conductivity, the following parameters were also measured: total coliform (number/100 ml.); faecal coliform (number/100 ml.); faecal streptococci (number/100 ml); and enterovirus (pfu/l.). Due to the limited number of samples tested, it was not possible to gauge each parameter's effect (including seasonal changes). Therefore, only coliform and viral count have been tabluated as requested. (See tables 3-6).

From these tables, the following can be seen.

1. The mean value of the coliform count is lower in the summer than in the reamining months (presented as "Others" in the tables). This was true at all stations but one (table 4, Station No. 8).

2. The percentage of positive enterovirus samples in the summer was 25 per cent in contrast to 70 per cent in the remaining months. This same trend was seen for the coliform.

3. If we compare table 6 to table 3, 4, 5, we observe an interesting finding. About 30 per cent of the positive enterovirus samples were found on beaches for which, in contrast, the bacterial pollution level was within the accepted "safe beach" range.

The correlation analysis between the various bacteria and the enteroviruses are presented in figures 1-3, with the details of the regression line. The presentation in these figures is based on data that are additional to the information in tables 3-6. A significant correlation was found between total coliform v. faecal coli, total coliform v. faecal streptococci and faecal coli v. faecal stretococci.

The mean ratio of positive enteric virus samples v. other positive samples was as follows:

(a) enteric viruses v. total coliform = 1 : 3.0×10^6

(b) enteric viruses v. faecal coliforms = 1 : 8×10^6

(c) enteric viruses v. faecal streptococci = 1 : 4.3×10^4

A total of 15 different enteroviruses were identified, including types of Poliovirus, Echovirus and Coxsackie virus (figure 4). In the sea, total coliforms and faecal coliforms were shown to have more rapid die-away rates than enteroviruses. The die-away rate of the faecal streptococci more closely paralleled that of the enteroviruses (figure 5).

Only two of the beaches surveyed (numbers 5 and 8) met the accepted interim microbiological quality criteria. Their mean values were under 50 faecal coliforms/100 ml. Beach number 6, however, failed to meet the criteria. Its mean value was 174 faecal coliform/100 ml.

Conclusions:

(1) In general, the number of enteric bacteria are reduced in the sea relatively more rapidly than enteroviruses.

(2) Faecal streptococci displayed a die-away rate similar to that of enteroviruses.

(3) A wide range of enteroviruses can be detected in the sea at a distance of up to five kilometres from the sewage discharge point in the sea-water.

(4) The microbiological concentration level in the sea was low in the summer as compared to the remaining months. Apparently, this is due to increased summer-time daylight and solar radiation which affects the micro-organism die-away rate.

Table 1

SEA TEMPERATURE IN SITU - SURFACE (°C)

SAMPLING POINT	Country Club 5	Tel Baruch 6	Hilton & Nachshon 8	All Points
SAMPLE VALUES				
Date				
26.10.77	--	23.0	23.0	23.0
02.11.77	25.0	--	--	25.0
23.11.77	--	--	22.2	22.2
22.01.78	18.0	18.0	--	13.0
02.02.78	--	17.5	16.5	17.0
14.02.78	--	--	17.0	17.0
15.03.78	18.0	18.0	--	18.0
03.04.78	--	21.0	19.5	20.3
11.04.78	--	--	20.0	20.0
02.05.78	20.0	--	--	20.0
29.05.78	--	22.0	24.0	23.0
21.06.78	25.0	25.0	25.0	25.0
28.07.78	27.0	27.0	27.0	27.0
16.08.78	27.0	27.0	27.0	27.0
03.09.78	27.0	27.0	27.0	27.0
Mean values				
Summer	25.2	25.2	25.5	24.6
Others	18.0	18.6	19.0	19.7
Total	23.4	22.6	22.6	21.9
St. Deviations				
Summer	3.0	2.2	1.8	2.7
Others	0	1.6	2.3	2.8
Total	4.0	3.9	3.9	3.7

Table 2

CONDUCTIVITY - SURFACE (Millimho)				
SAMPLING POINT	Country Club 5	Tel Baruch 6	Hilton & Nachshon 8	All Points
SAMPLE VALUES				
Date				
22.01.78	47.0	47.5	--	47.3
02.02.78	--	44.9	44.5	44.7
14.02.78	--	--	44.3	44.3
15.03.78	44.9	45.0	--	45.0
03.04.78	--	42.5	47.5	45.0
11.04.78	--	--	49.0	49.0
02.05.78	48.2	--	--	48.2
29.05.78	--	52.5	52.8	52.7
28.07.78	48.0	47.0	47.0	47.3
16.08.78	47.5	48.0	48.0	47.8
Mean values				
Summer	47.9	49.2	49.3	49.0
Others	45.9	45.0	46.3	45.9
Total	47.1	46.8	47.6	47.1
St. Deviations				
Summer	0.4	2.9	3.1	2.5
Others	1.5	2.0	2.3	1.9
Total	1.3	3.2	2.9	2.6

Table 3

TOTAL COLIFORMS - SURFACE (NO./100 ML)

SAMPLING POINT	Country Club 5	Tel Baruch 6	Hilton & Nachshon 8	All Points
SAMPLE VALUES				
Date				
26.10.77	--	10	0	3.2
02.11.77	60	--	--	60.0
23.11.77	--	—	10	10.0
22.01.78	20	380	—	85.1
02.02.78	--	$6.0x10^4$	40	1513.6
14.02.78	--	--	10	10.0
15.03.78	$8.9x10^3$	980	--	2754.2
03.04.78	--	$7.4x10^3$	250	1318.3
11.04.78	--	--	500	500.0
02.05.78	5	--	--	5.0
29.05.78	--	200	150	147.9
21.06.78	120	$1.7x10^3$	500	457.1
28.07.78	70	$4.3x10^3$	24	190.5
16.08.78	360	$1.1x10^3$	250	457.1
03.09.78	42	420	10	54.9
Log mean values				
Summer	57.5	436.5	40.7	74.1
Others	218.8	3630.8	55.0	186.2
Total	95.5	1000.0	46.8	166.0
St. Deviations				
Summer	4.9	8.5	10.5	7.1
Others	25.8	9.5	6.1	9.5
Total	9.2	10.2	7.6	7.5

Distribution	Country Club 5	PC	Tel Baruch 6	PC	Hilton & Nachshon 8	PC	All Points	PC
0 - 100	5	62	1	10	6	55	12	41
101 - 1000	2	25	4	40	5	45	11	40
+ 1000	1	13	5	50	0	0	6	19

Table 4

FAECAL COLIFORMS - SURFACE (NO./100 ML)				
SAMPLING POINT	Country Club 5	Tel Baruch 6	Hilton & Nachshon 8	All Points
SAMPLE VALUES				
Date				
26.10.77	--	0	0	0
23.11.77	--	--	0	0
22.01.78	20	--	--	20.0
02.02.78	--	$5.2x10^4$	10	537.0
14.02.78	--	--	0	0
15.03.78	$4.6x10^3$	530	--	1513.6
03.04.78	--	$5.1x10^3$	40	446.7
11.04.78	--	--	150	150.0
02.05.78	5	--	--	5.0
29.05.78	--	90	80	83.2
21.06.78	80	700	30	117.5
28.07.78	70	$1.7x10^3$	20	131.8
16.08.78	210	750	130	263.0
03.09.78	33	330	10	46.8
Log mean values				
Summer	45.7	173.8	20.0	36.3
Others	302.0	5248.1	15.7	52.5
Total	77.6	537.0	18.1	43.7
St. Deviations				
Summer	4.1	15.1	5.6	7.6
Others	46.6	10.0	8.5	20.5
Total	8.5	19.5	6.1	12.0
Distribution	PC	PC	PC	PC
0 - 100	5 72	2 22	9 82	16 59
101 - 1000	1 14	4 44	2 18	7 26
+ 1000	1 14	3 34	0 0	4 15

Table 5

FAECAL STREPTOCOCCI - SURFACE (NO./100 ML)								
SAMPLING POINT	Country Club 5		Tel Baruch 6		Hilton & Nachshon 8		All Points	
SAMPLE VALUES								
Date								
02.02.78	--		$2.5x10^4$		0		158.4	
14.02.78	--		--		0		0	
15.03.78	$1.2x10^3$		130		--		389.0	
03.04.78	--		$1.2x10^3$		20		154.8	
11.04.78	--		--		80		80.0	
02.05.78	13		--		--		13.0	
29.05.78	--		330		130		208.9	
21.06.78	40		190		50		72.4	
16.08.78	120		38		20		44.7	
03.09.78	18		180		6		26.9	
Log mean values								
Summer	32.4		144.5		29.5		46.8	
Others	1200.0		1584.9		39.8		60.3	
Total	67.6		398.1		13.8		53.7	
St. Deviations								
Summer	2.7		2.5		3.7		2.8	
Others	--		14.1		2.6		10.5	
Total	6.2		8.1		6.5		5.6	
Distribution		PC		PC		PC		PC
0 - 100	3	60	1	14	7	88	11	55
101 - 1000	1	20	4	57	1	12	6	30
+ 1000	1	20	2	29	0	0	3	15

Table 6

ENTEROVIRUS - SURFACE (PFU/L)								
SAMPLING POINT	Country Club 5		Tel Baruch 6		Hilton & Nachshon 8			
SAMPLE VALUES								
Date								
26.10.77	--		--		2/70			
02.11.77	0/85		--		--			
23.11.77	--		--		0/85			
22.01.78	1/50		4/70		--			
02.02.78	--		--		0/85			
14.02.78	--		--		1/85			
15.03.78	7/85		8/50		--			
03.04.78	--		7/80		7/80			
02.05.78	0/85		--		--			
29.05.78	--		0/85		0/85			
No. of Positive		PC		PC		PC	All Points	PC
	2	50	3	75	3	50	8	57
No. of Negative								
	2	50	1	25	3	50	6	43

Figure 1: Correlation between coliforms and viruses found at beaches

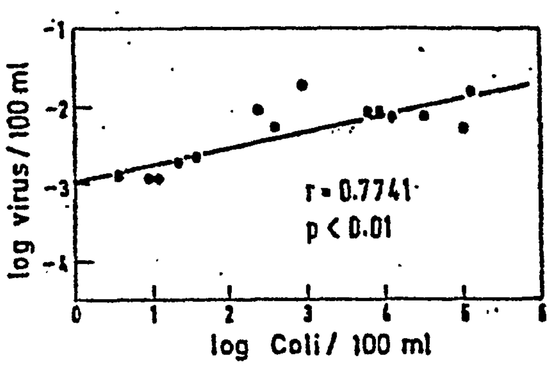


Figure 2: Correlation between faecal coli and viruses found at beaches

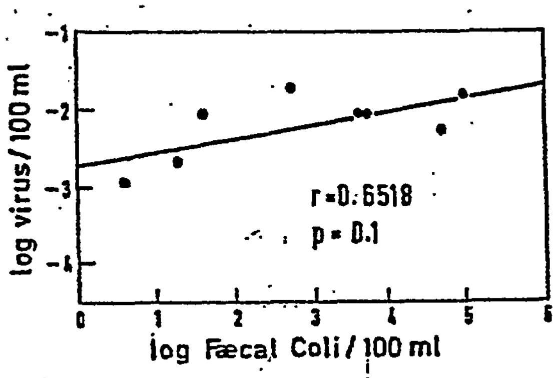


Figure 3: Correlation between faecal streptococci and viruses found at beaches

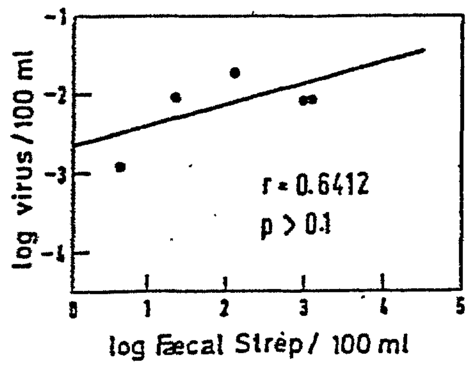


Figure 4: Types of viruses found at beaches

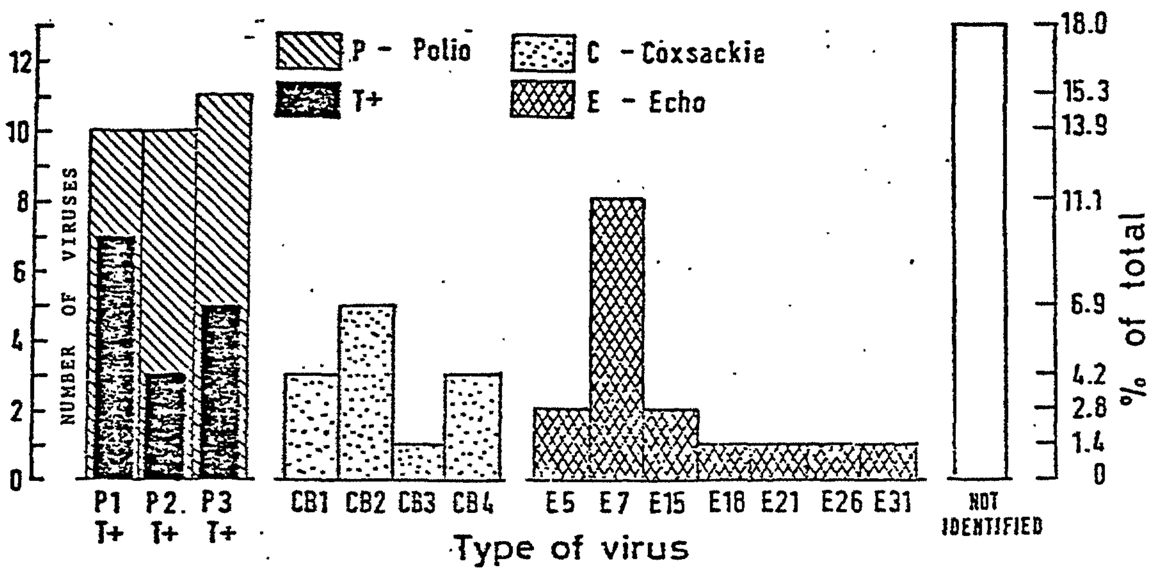
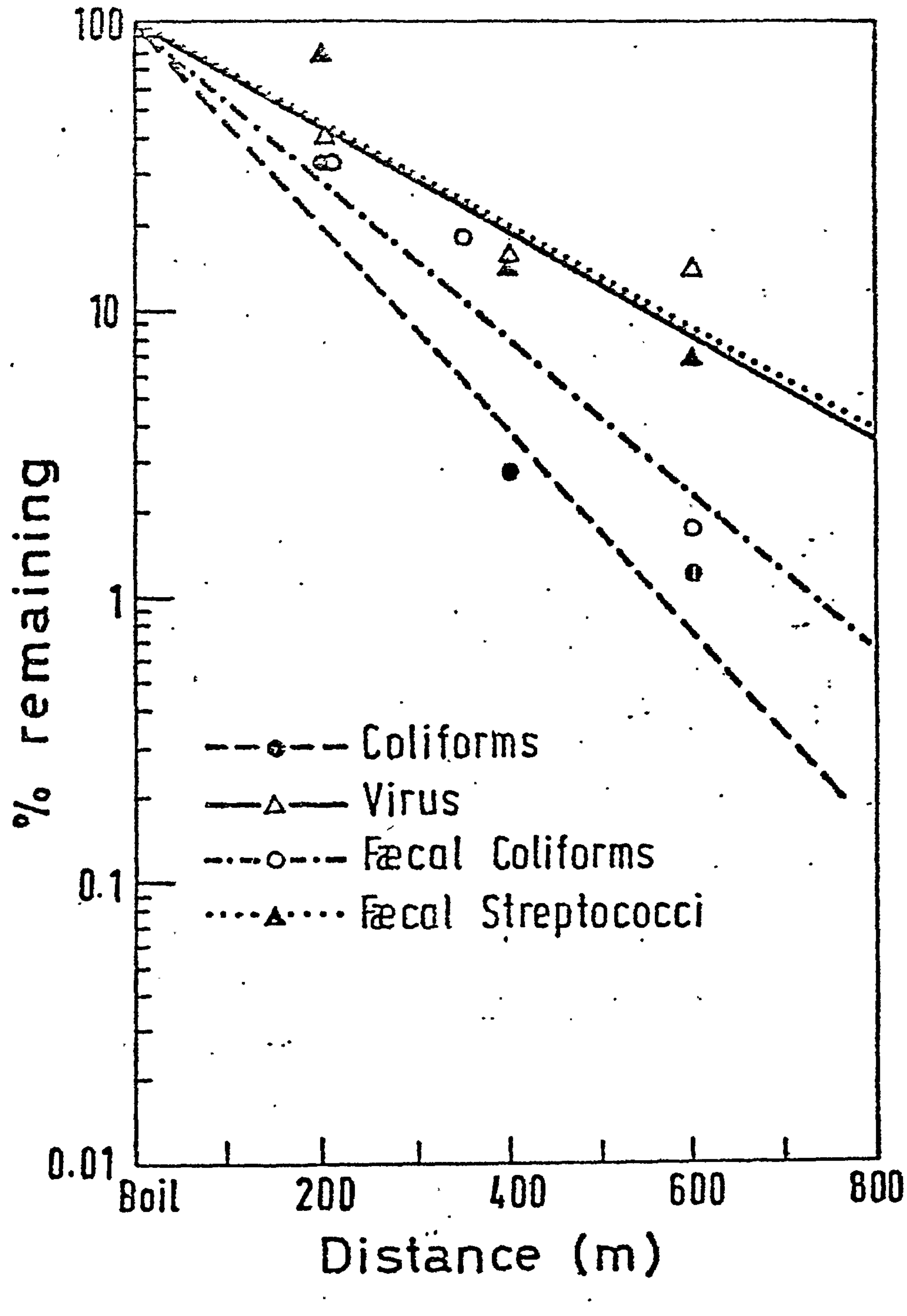
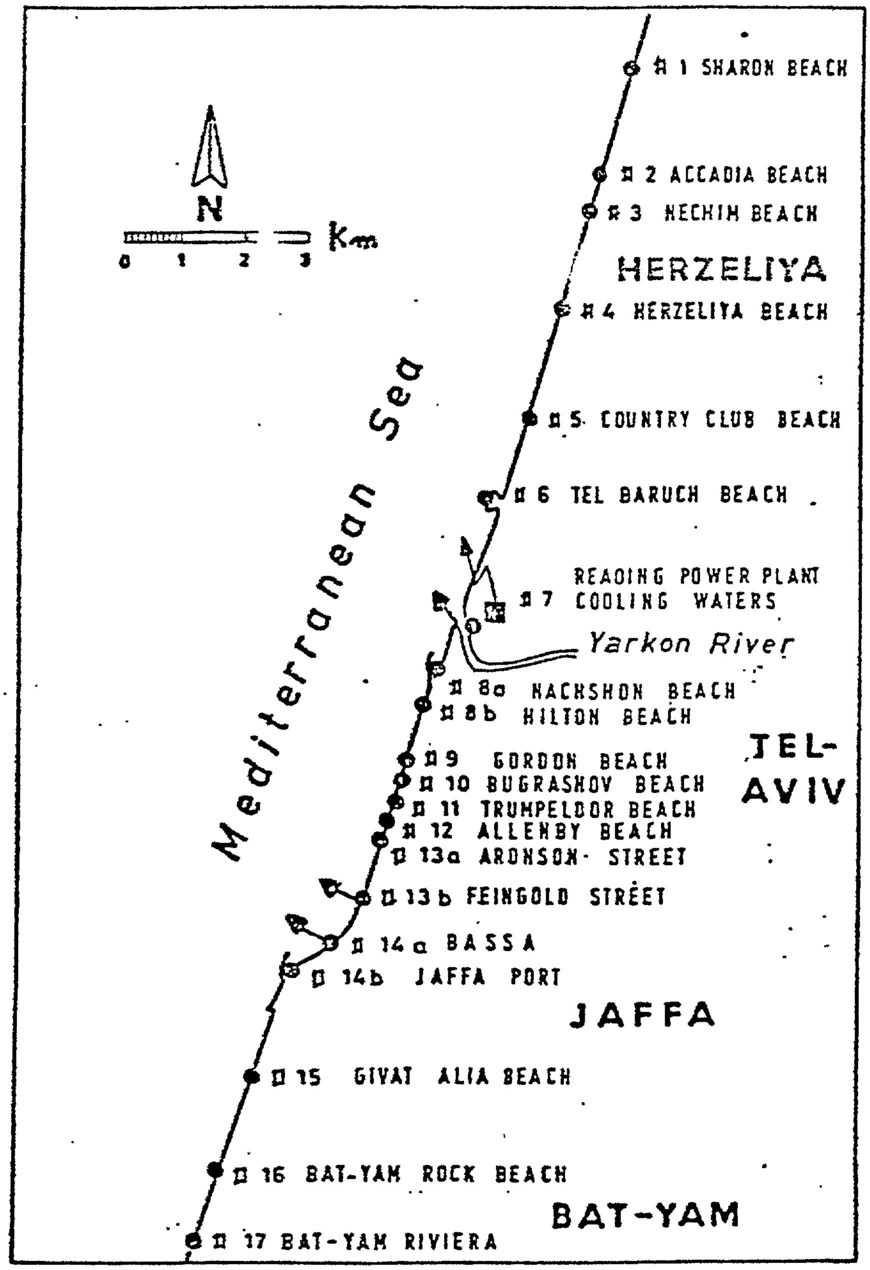


Figure 5: Disappearance of enteric microorganisms at various distances from the point of discharge



Map no. 1: Tel Aviv's Coastal Region in which samples were taken



Participating Research Centre: Environmental and Water Resources Engineering Division
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Principal Investigator: N. BURAS/Y. KOTT

Introduction:

In recent years a number of studies on the recovery and survival of pathogens in sea-waters have indicated the presence of Salmonellae as well as enteric viruses in coastal waters, even when the coliforms densities were low. The pathogens survived for long periods of time in wastewater and their concentration was usually higher in sediment than in sea-water. As the coliform bacteria (the indicators of pollution) are relatively sensitive to the marine environment, the question arose whether it would not be advisable to use a more suitable organism as indicator of pollution in the marine environment.

Previous studies carried out in the laboratory showed that E. coli bacteriophages were more resistant than E. coli bacteria to marine environmental conditions. It was proposed therefore to study and compare the recovery of coliform bacteria, of Salmonellae, E. coli B bacteriophages and human enteric viruses from various coastal waters and sediment samples.

Area(s) studied:

For this study three sampling points were chosen, all located in the Haifa Bay: one at the southern entrance to Haifa, in a residential area (location I) (see attached map), the second in the eastern part of the Bay, in the centre of the industrial area (location II) and the third in an unpolluted area along the sea shore.

Sampling point 1 (location I), at the Tirat Hacarmel outfall (10,000 people community) where mainly treated domestic wastewater is discharged into the sea. The wastewater treatment consists of settling in an Imhoff Settling Tank, and collection into two oxidation ponds. The retention time in each of the ponds is four days. (A total of eight days). The flow rate of the effluent into the sea is 2,000 m^3/day. Frequently, when the quantity of the incoming wastewater is too large, it is made to by-pass the treatment plant and is reintroduced directly into the effluent channel which is discharged into the sea.

The area surrounding the outfall consists of consolidated sand dunes; the beach is sandy and smooth.

The currents at the sampling point flow in a south-east direction. The ground water in the area is in the form of a shallow aquifer.

Sampling point II (location II) is in the eastern part of the Haifa Bay, at the mouth of the Kishon River (see attached map) in the centre of the industrial area.

Feeding the Kishon River are: (1) secondary effluent of the Haifa Treatment Plant. The flow of the effluent is at a rate of 30,000 m^3/day (more than three times the original volume of the river, (2) wastes from a textile factory (mainly dyes), (3) wastes from petrochemical factories, (4) wastes from an oil refinery.

The surrounding land consists of sandy soil. The ground water is a shallow aquifer.

Being heavily polluted the Kishon River does not constitute a water resource. It flows into the sea and as a result the whole area is heavily polluted.

Sampling point III (location III) is an unpolluted sea shore, situated north of the first sampling point. The surrounding area consists of consolidated sand dunes. The beach is sandy.

At location III a number of points have been sampled:

This summer, contrary to usual custom, the effluent has been used for the irrigation of cotton crops. As a result wastewater (or effluent) has not been discharged into the sea during the summer months. The discharge into the sea has been resumed during the month of September. The samples examined at location I have been collected therefore between the end of September and the end of December.

Monthly sampling at all points will continue throughout the year.

Before choosing location I as the sampling point, a number of additional locations have been tested. They are all situated in the vicinity of Tirat Hacarmel (location I) and have very similar characteristics. The results obtained have been summarized in table 2.

Samples were collected as follows:

(a) From the wastewater discharge,

(b) 50 m. north of the outfall, and

(c) 50 m. south of the outfall into the sea.

At each point, water and sediment samples were collected.
The samples were brought immediately to the laboratory and tested.

Material, methods and parameters measured:

Tests for recovery of the following organisms were performed on each sample:-

1. Coliform bacteria

2. Faecal coliform bacteria

3. Salmonellae

4. Bacteria that grow on nutrient agar

5. E. coli bacteriophages

6. Human enteric viruses

On a number of samples the presence of Vibrio parahaemolyticus was also tested. The tests for the recovery of coliforms and faecal bacteria were included.

1. Filtration on membrane filters (growth on MFC medium with incubation at 35°C and 44.5°C).

2. MPN multiple tube fermentation (presumptive and confirmed) and growth of Ec medium with incubation temperature at 44.5°C for faecal coliform bacteria.

3. Enrichment of tetrathionate and selenite medium for the recovery of Salmonellae.

4. Standard plate count on nutrient agar.

5. MPN-phage for the recovery of E. coli B bacteriophages.

6. Concentration of sea-water samples on membrane filters and elution with 3 per cent beef extract for the recovery of human enteric viruses.

7. Direct inoculation of wastewater samples for the recovery of human enteric viruses.

Results and their interpretation:

The results obtained are summarized in tables 1 and 2, they show:

1. In the clean "control" point (location III) bacteria were recovered on the nutrient agar Petri dish. Their number was low (see table 1). Coliform bacteria were recovered in very small numbers. No faecal coliform bacteria, Salmonellae or human enteric viruses were recovered. No E. coli bacteriophages were found.

In addition to the Tirat Hacarmel discharges (location I) two smaller wastewater outfalls at Shikmona and Bat-Galim were examined and the results obtained at all three points are summarized in table 2. Shikmona turned out to be the least polluted of the three sampling points. The number of coliform bacteria recovered from the sediment was higher than in the water above. The standard plate count was also higher in the sediment than in the sea-water (table 2). No Salmonellae were recovered at this sampling point.

At the Bat Galim point the number of coliform bacteria increased with the distance from the discharging point. This may be due to the direction of the current. Salmonellae were recovered from the discharging wastewater and bacteriophages of E. coli B were recovered in all the samples.

At the Tirat Hacarmel sampling point the number of coliform bacteria in the discharging wastewater was high: 3.3 x 107/100 ml. The results obtained by membrane filtration were lower than by the MPN fermentation tube method. The number of E. coli bacteriophages were 3.3 x 106/100 ml a concentration usually found in wastewater.

Salmonellae were isolated, and the strains recovered were: S. typhimurium, S. infantis, S. emek. The number of bacteria (SPC) and coliform bacteria was higher in the sediment than in the sea-water.

The number of E. coli bacteriophages was usually higher in the sediment (figure 4) than in the water above, and the ratio coliform bacteria-E. coli bacteriophages was smaller than in the wastewater. Salmonellae and viruses were recovered from all the wastewater samples tested. No Salmonellae and no human enteric viruses were recovered from the water samples or sediment. Additional data need to be collected during the warm months of the year to allow conclusions to be drawn.

In comparing the efficiency of recovery of coliform bacteria by the MPN method and membrane filtration method, no definite conclusions could be drawn (figure 1). In some instances the recovery was higher by the filtration method especially in the sediment,(samples 1, 9, 10); in others it was higher by the MPN method (sample 14, 15), the recovery of faecal coliform being generally higher by the MPN than by the filtration method.

The concentration of coliform bacteria was higher in the sediment south of the outfall than in the water at the same sampling point. In the water, the concentration of coliform bacteria was higher north of the outfall (figure 3).

It is well know that oysters found in polluted waters concentrate viruses (infectious hepatitis virus). Since fish living and growing in polluted waters might concentrate bacteria as well as viruses in their organs, and might therefore constitute public health hazards, it is important to study the recovery of enteric bacteria (indicator as well as pathogen) E. coli bacteriophages and human enteric viruses from various organs of fish grown in the vicinity of domestic wastewater outfalls into the sea.

Preliminary studies on the recovery of bacteria and viruses from organs of fresh water fish grown in polluted waters have been carried out. The results obtained showed that no bacteria were found in various organs prior to their introduction into the polluted waterpond. At the end of two months growth period in wastewater, polluted water coliform bacteria were recovered from all the organs of the fish. Their concentration ranged between 10^1/gr (in meat and liver) to 10^7/gr in the contents of the digestive tract.

A similar situation might occur in the vicinity of the wastewater outfall into the sea and therefore fish growing in the area might constitute a public health hazard both to fish and man.

It is planned therefore to test fish found in the vicinity of the sampling points and determine the concentration of coliform bacteria, Salmonellae, E. Coli bacteriophages and human enteric viruses in their various organs.

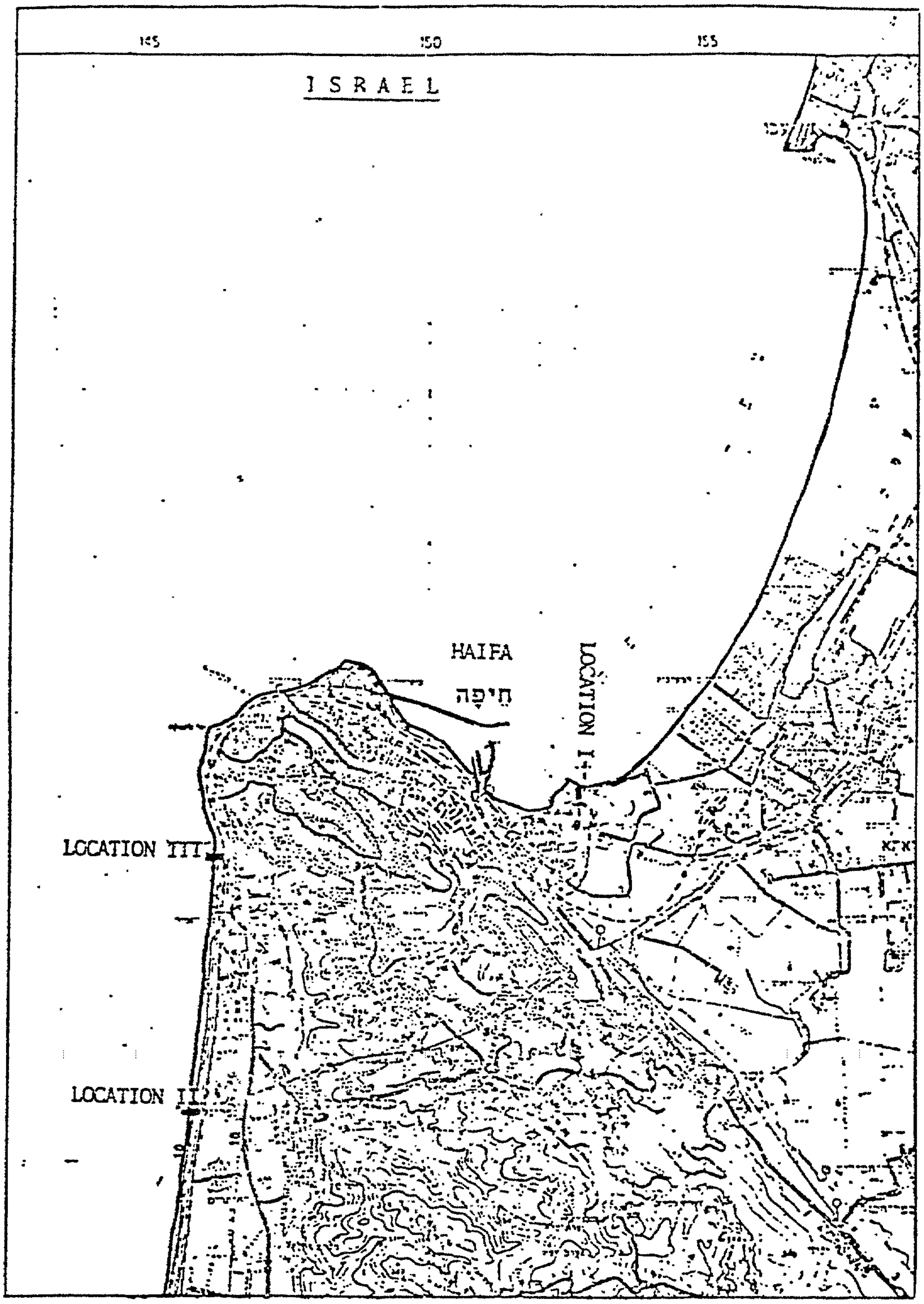

145
150
155
ISRAEL
HAIFA
חיפה
LOCATION I
LOCATION III
LOCATION II

Table 1: Recovery of bacteria, E. coli bacteriophages and human enteric viruses from clean sea-water and sediment samples

Shikmona Location III	MPN/100 ml		Membrane Filtration /100ml			Standard plate count /ml	Salmonella	Human enteric viruses
	Coliform	Faecal coliform	Coliform	Faecal coliform	E. coli B phage			
1. Water	0	0	0	0	0	12	0	0
Sediment	2	0	1	0	0	95	0	0
2. Water	2	0	2	0	0	60	0	0
Sediment	4	0	5	0	0	106	0	0
3. Water	2	0	2	1	0	55	0	0
Sediment	4	0	6	3	0	100	0	0

Table 2: Recovery of bacteria, E. coli bacteriophages and human enteric viruses from sea-water and sediment in the vicinity of a wastewater outfall

Location	MPN/100ml		Membrane filtration/100ml			Standard plate count /ml	Salmonella	Human enteric viruses
	Coliform	Faecal coliform	Coliform	Faecal coliform	E. coli B phage			
1. Shikmona, Water	$4.9x10^2$	6.8x10	$1.3x10^3$	$1.8x10^2$	11	$4.0x10^2$	0	
LocationIII Sediment	$1.3x10^3$	$3.3x10^2$	$3.0x10^4$	$3.7x10^3$	10	$4.5x10^4$	0	
2. Bat Galim Wastewater outlet	$1.6x10^5$	$1.0x10^4$	$9.5x10^4$	$9.0x10^4$	$2.4x10^4$	$1.7x10^6$	++	+
3. Bat Galim South 25m. from sewage outlet	$5.4x10^2$	$1.0x10^2$	$3.0x10^2$	$1.0x10^2$	70	$5.0x10^3$		
4. Bat Galim South 50m. from wastewater discharge	$2.4x10^4$	$1.5x10^3$	$2.5x10^4$	$2.0x10^4$	110	$7.0x10^3$		

Table [illegible] (contin.)

Location	MPN/100ml		Membrane filtration/100ml			Standard plate count /ml	*Salmonella*	Human enteric viruses
	Coliform	Faecal coliform	Coliform	Faecal coliform	*E. coli* B phage			
5. Bat Galim 100m. south of wastewater discharge	3.3×10^{4}	2.9×10^{3}	3.0×10^{4}	2.5×10^{3}	27	5.8×10^{3}		
6. Tirat Hacarmel Location II Wastewater discharge	3.3×10^{7}	1.7×10^{7}	4.0×10^{5}	3.9×10^{3}	3.3×10^{6}	2.2×10^{6}	+++	
7. Tirat Hacarmel Location II 50m. north water	4.9×10^{3}	4.9×10^{3}	3.0×10^{3}	1.1×10^{3}	4.9×10^{2}	5.9×10^{3}		
8. Sediment	2.0×10^{4}	2.0×10^{2}	1.0×10^{4}	1.0×10	1.1×10^{3}	3.0×10^{3}		
9. Tirat Hacarmel Location II 50m. south Water	7.9×10^{3}	3.3×10^{3}	1.0×10^{3}	2.4×10^{2}	4.0×10^{2}	3.5×10^{2}		
10. Sediment	3.3×10^{3}	2.3×10^{3}	2.3×10^{5}	4.8×10^{4}	7.9×10^{3}	1.5×10^{5}		
11. Tirat Hacarmel Location II Wastewater discharge Water	6.8×10^{6}	4.0×10^{6}	2.5×10^{7}	7.6×10^{5}	2.2×10^{5}	2.9×10^{6}	+++	+
12. Tirat Hacarmel Location II 50m. north Water	4.9×10^{2}	2.3×10^{2}	7.1×10^{2}	24	68	1.5×10^{3}		
13. Tirat Hacarmel Location II Sediment	7.9×10^{2}	4.9×10^{2}	8.0×10^{2}	1.0×10^{2}	2.4×10^{2}	3.0×10^{3}		
14. Nahsholim B 50m south Water	4.9×10^{2}	4.0×10^{2}	5.3×10^{2}	2.8×10	1.3×10^{2}	4.0×10^{3}		
15. Nahsholim B Sediment	6.8×10^{3}	4.0×10^{3}	3.0×10^{3}	1.0×10^{3}	7.9×10^{2}	1.5×10^{4}		

Fig. 1 RECOVERY OF COLIFORMS FROM SEA WATER AND SEDIMENT IN THE VICINITY OF WASTEWATER OUTFALL. (MPN).

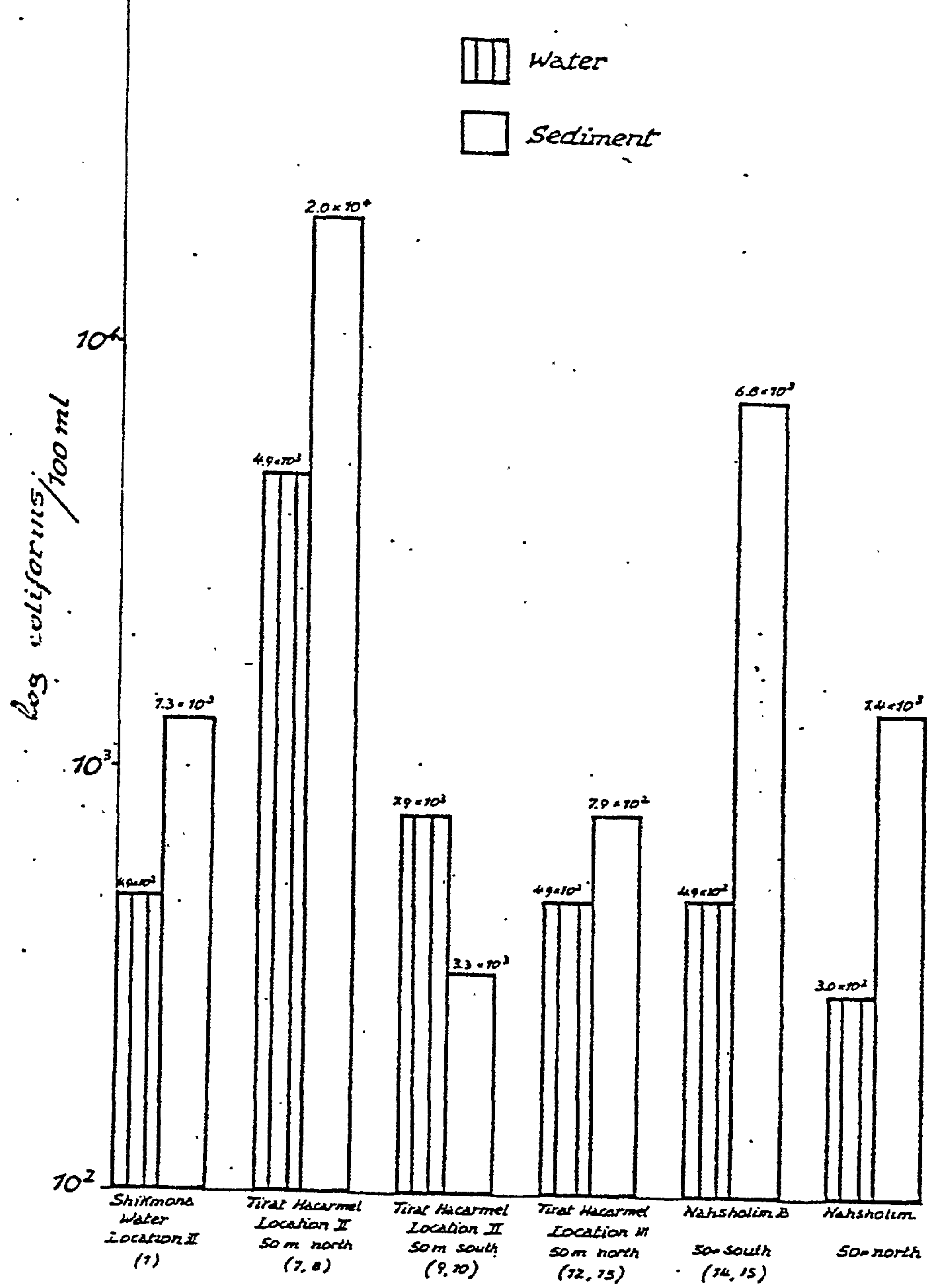


FIG. 2 RECOVERY OF COLIFORMS (MEMBRANE FILTRATION) FROM SEA WATER AND SEDIMENT IN THE VICINITY OF WASTEWATER OUTFALL

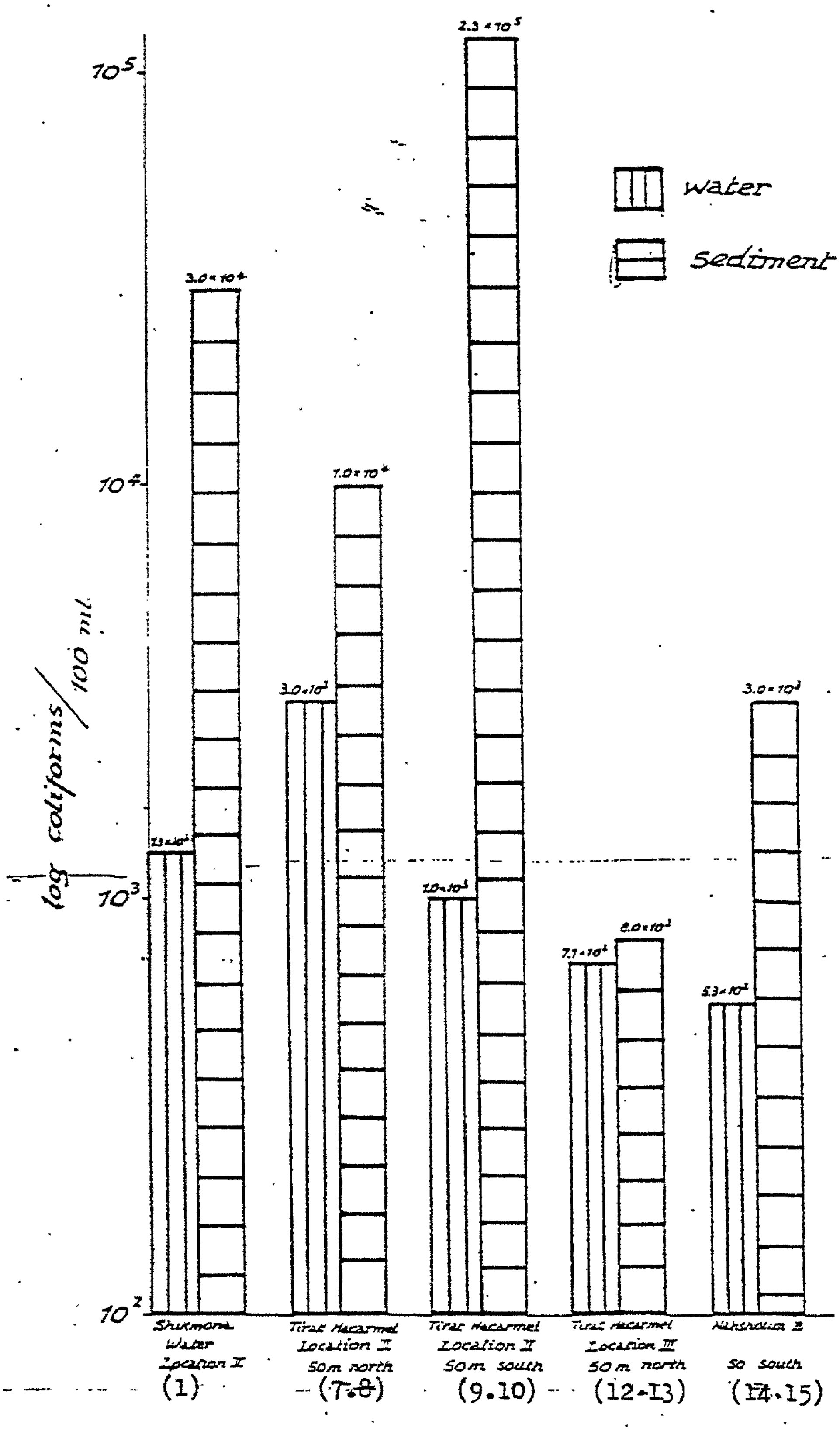


FIG. 3 RECOVERY OF FECAL COLIFORM FROM SEA WATER AND SEDIMENT IN THE VICINITY OF WASTEWATER OUTFALL

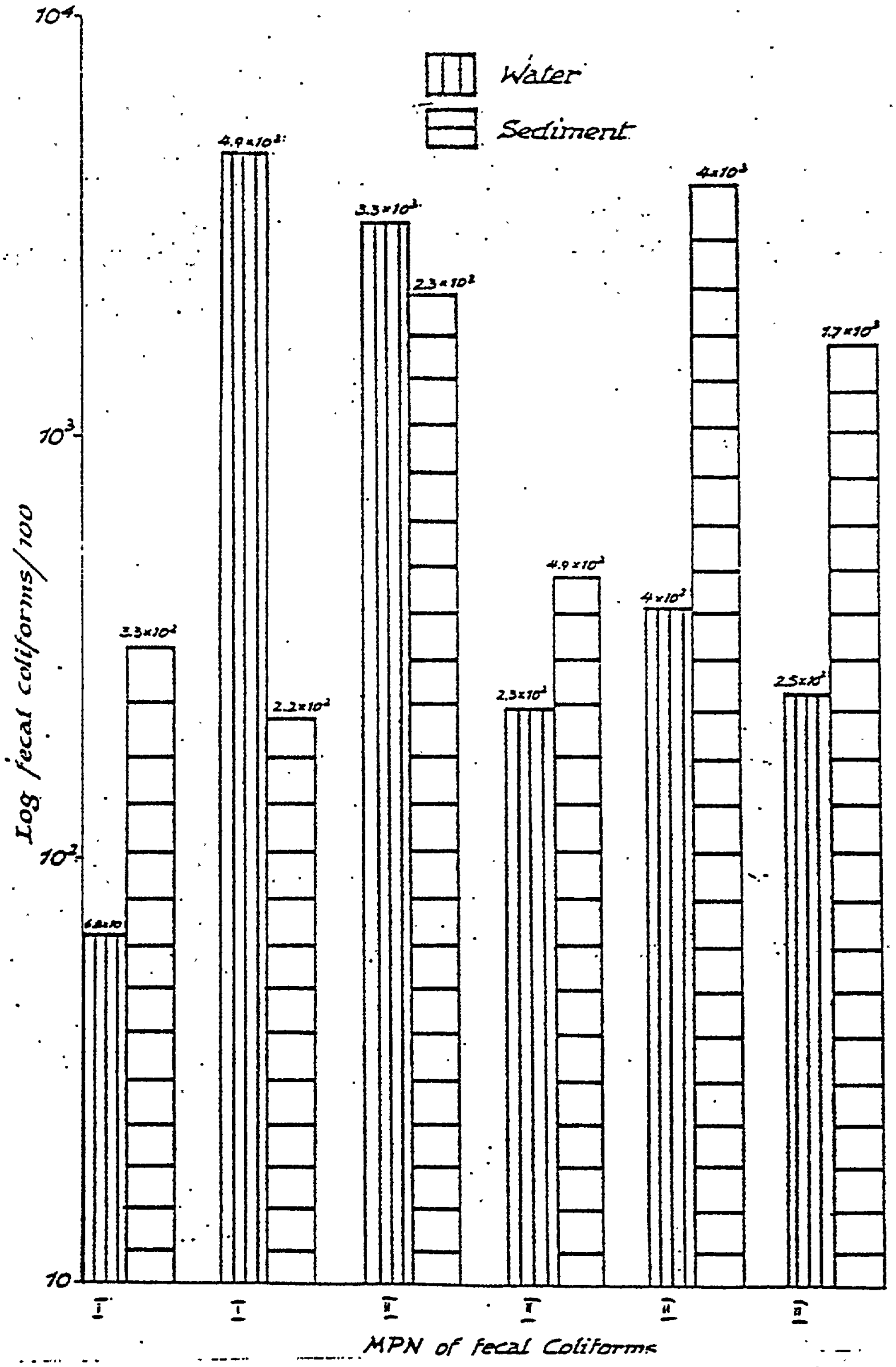
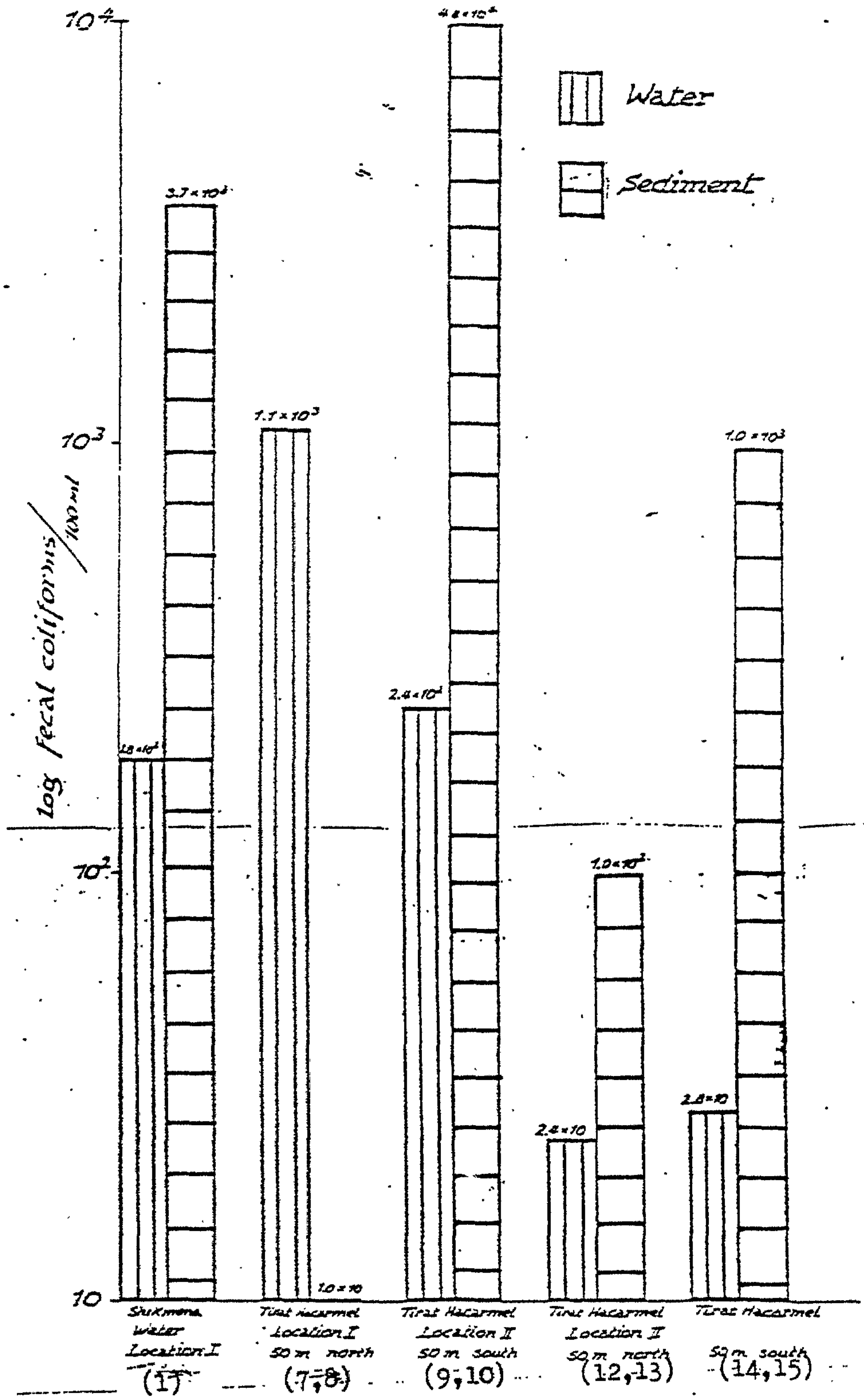


FIG. 4 RECOVERY OF FECAL COLIFORM (MEMBRANE FILTRATION) FROM SEA WATER AND SEDIMENT IN THE VICINITY OF WASTEWATER OUTFALL



Participating Research Centre: Public Health Laboratory
Public Health Department
HAIFA
Israel

Principal Investigator: R. SELIGMANN

Introduction:

Approximately 20 bathing beaches were monitored monthly during the summer using the following parameters:

1967-1977: total and faecal coliforms
1967-1977: total heterotrphic bacteria
1970,1973: Salmonellae
1971,1974,1977: V. parahaemolyticus and V. alginolyticus
3 winter months and 6 summer months 1977: faecal streptococci

Area(s) studied:

The area studied is on the approximately 90 km long shoreline from Rosh Hanikra, the most northern sampling point in the Northern District, to Givat Olga, the most southern point in the Haifa District.

Description of the coast: North District - at Rosh Hanikra Control Station (C 1) and the bathing beaches Shave Zion (Nos. 1, 2) small rock formations reach the coast. Haifa District - the bathing sites at Hof Hacarmel (Nos. 3 & 4), Givat Olga (Nos. 5 & 6), and the Control Station at Caesarea (C2) are on flat sandy beaches.

Material and methods:

Total and faecal coliforms

a) MED VII reference methods

b) Membrane filter procedure, M-endo broth, according to Standard Methods for the Examination of Water and Wastewater, APHA 1975, subculture of up to 5 colonies into EC broth, incubation at 44.5°C/24 hours.

c) Multiple tube technqiue (MPN) according to APHA.

Faecal streptococci

Membrane filter procedure according to APHA; colonies were often confirmed by biochemical tests.

Salmonellae and Shigella

a) Tetrathionate broth incubated at 35°C/24 hours and 48 hours, subculture on BG-agar and SS-agar, incubated at 35°C/24 hours and 48 hours, isolation of suspicious colonies for biochemical and serological examinations.

b) Dulcitol-Selenite broth incubated at 41.5°C/24 hours and 48 hours, subculture on MacConkey and SS-agar, after incubation at 35°C/24 hours and 48 hours isolation of suspicious colonies for further tests.

V. parahaemolyticus and V. cholerae

a) Membrane filter procedure, filter transferred to TCBS medium, incubated at 34°C/24 hours isolation of suspicious colonies for biochemical tests.

b) Sediment after centrifugation spread to TCBS-agar, further examination as (a).

BOD_5

Dissolved oxygen was measured by Azide modifiction of Iodometric method (APHA - 1975).

Settleable matter

Determined in Imhoff cone and reported as ml/l (APHA - 1975).

Total suspended matter

APHA - 1975.

Results and their interpretation:

Total and faecal coliforms

Measured by 3 methods, all samples conformed to the requirements for bathing waters (Council of the European Communities). Total faecal coliforms/100 cc numbered less than 100 in 95 per cent of the samples.

Faecal streptococci

The Council of the European Communities allows 100/faecal streptococci/100 cc. 95 per cent of the samples contained less than 50 enterococci/100 cc. Two samples exceeded the approval limit: 120 enterococci/100 cc. were isolated from one sample in June (Control Station C.1) and 130 enterococci/100 cc from the other in August (Station 4).

Pathogenic organisms

Salmonellae, Shigella and Cholera were negative in all cultures. V. parahaemolyticus were isolated from 5 bathing beaches (nos. 2,3,4,5 and 6) and from one of the Control Stations (C2). The strains were sent to the United Kingdom for serotypisation and the Kanagawa test.

Naaman River

BOD_5: 20 - 25 mg/l O_2
T. S. M. : 140-276 mg/l
Settleable matter: 0 ml/l.

Kishon effluents

BOD_5: 317 - 408 mg/l O_2
T. S. M. : 86 - 228 mg/l
Settleable matter: 0 ml/l

Conclusions:

Quality of coastal waters

As in previous years, the quality of recreational waters at our approved bathing beaches proved highly satisfactory.

Quality of rivers and effluents

In our experience, the two mandatory parameters, BOD_5 and settleable solids, although most informative, are insufficient for the assessment of the pollution in rivers and effluents. We propose the measurement of three more parameters: pH, COD and total suspended matter.

Methodology

Based on the examination of 250 marine and 50 drinking water samples, we recommend not to use the MFC medium at 35°C for the determination of total coliforms. The M.endo broth proved to be far superior.

We refrain from drawing more conclusions. We expect the field and laboratory data compiled from all the institutions participating in MED VII will serve conclusively the objectives of the project.

All samples collected during the summer, including those pertaining to MED VII and 180 samples from 15 other bathing beaches, were examined for the determination of total and faecal coliforms by three methods (see above). For an optimal evaluation of the results obtained by other methods, in addition to the compulsory methods of MED VII, which were applied in our and other institutes we suggest that appropriate recording sheets be prepared. The data on these additional sheets should be studied as part of the information recorded on the relevant MED VII data forms or, if from samples not in the framework of MED VII, they should be analysed independently.

Table 1: Range and median of indicator bacteria isolated from coastal water Haifa and Northern Districts of Israel - summer 1978

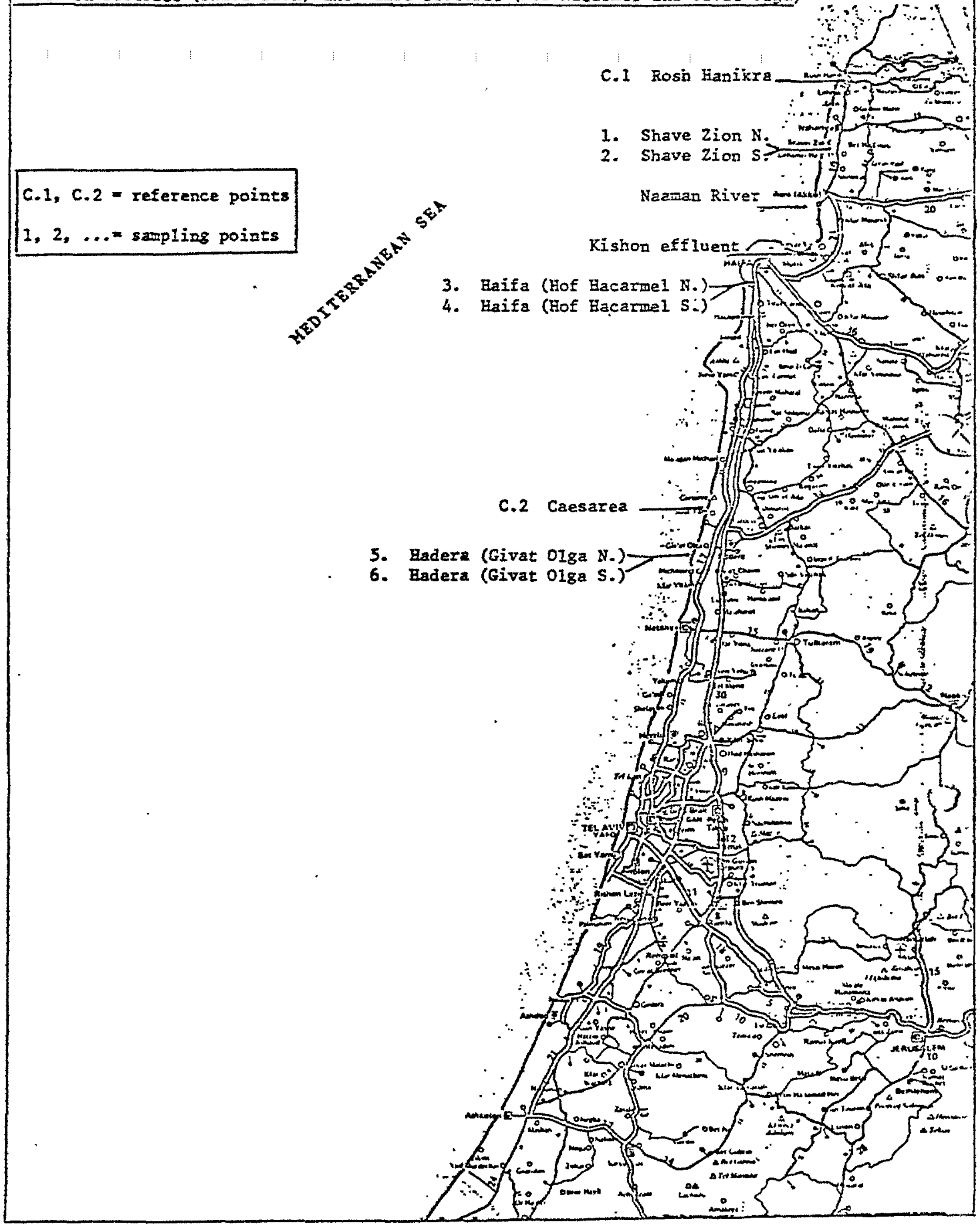
Sampling point	No. of samples	Total coliforms		Faecal coliforms		Faecal streptococci	
		range	median	range	median	range	median
Bathing beaches:							
1. Shave Zion, north	10	0 - 40	0	0 - 20	1	0 - 60	0
2. Shave Zion, south	10	0 - 25	0	0 - 15	2	0 - 50	0
3. Hof Hacarmel, north	10	0 -100	0	0 - 18	0.5	0 - 6	1
4. Hof Hacarmel, south	10	0 -150	1.5	0 -200	1	0 -130	0
5. Givat Olga, north	8	0 - 30	0	0 - 6	0	0 - 2	0
6. Givat Olga, south	8	0 - 3	0	0 - 10	1	0 - 75	2
Control stations:							
C.1 Rosh Hanikra	9	0 - 60	0	0 - 34	4	0 -120	20
C.2 Caesarea	7	0 - 40	0	0 - 50	0	0 - 4	0

Table 2: Mean value and standard deviation of indicator bacteria in coastal water Haifa and Northern Districts in Israel - summer 1978

Sampling point	No. of samples	Total coliforms (MF endo broth)		Faecal coliforms (m-FC 44.5°C)		Faecal streptococci (MF, KF - Agar)	
		mean	S.D.	mean	S.D.	mean	S.D.
Bathing beaches:							
1. Shave Zion, north	10	2.7	4.4	3.0	3.0	3.0	5.0
2. Shave Zion, south	10	1.9	3.7	3.0	3.0	2.0	4.0
3. Hof Hacarmel, north	10	2.9	6.1	2.0	3.0	2.0	2.0
4. Hof Hacarmel, south	10	3.1	5.0	3.0	6.0	3.0	5.0
5. Givat Olga, north	8	1.4	2.0	2.0	2.0	1.0	1.0
6. Givat Olga, south	8	1.1	1.5	2.0	2.0	3.0	5.0
Control stations:							
C.1 Rosh Hanikra	9	3.5	5.1	3.0	3.0	14.0	23.0
C.2 Caesarea	7	2.1	4.2	2.0	4.0	1.0	2.0

Remarks: - Summer = mid-May to mid-October
- "zero" result was considered "one"

Coastal stations for monitoring and reference points
Northern District (Shave Zion) and Haifa District (Hof Hacarmel and Givat Olga)



Participating Research Centre: The Dr. A. Felix Public Health Laboratory
Ministry of Health
TEL AVIV
Israel

Principal Investigator: Y. YOSHPE-PURER

Introduction:

The coastal water of the Central and Southern part of Israel has been monitored since 1963, employing the MPN method for coliforms and since 1975 for faecal coliforms as well. In 1968 membrane filtration with Endo broth was also carried out for the Tel-Aviv area, and compared to the MPN method.

Area(s) studied:

The length of the coastline covered by the MED VII project is about 90 km. The three areas selected for monitoring are the most populated ones along theis coast, namely Nathania in the North, Tel-Aviv in the centre and Ashquelon in the South. Two sampling points were examined at each of these beaches (points 1-6) plus one control point near Nathania and one near Ashquelon. The land surrounding all beaches is mainly sand. Surface or ground water reaches the sea only on rainy days in the winter.

Material and methods used:

Total coliforms - membrane filtration with mFC medium, incubated at 35°C and MPN method with lactose broth, confirmed on MacConkey agar.

Faecal coliforms - a) membrane filtration with mFC medium incubated at 44.5°C. b) MPN method by inoculating the positive tubes of the total coliform test into E.C. broth, incubating at 44.5°C and observing for gas production in 24 hours.

Enterococci - membrane filtration with KF medium.

Salmonellae - Filtration of 500 ml water through membrane filters which were immersed in selenite broth and incubated at 37°C. Plating on brillant green agar and MacConkey agar after 24 and 48 hours incubation. Suspicious colonies were separated and examined biochemically and serologically.

Vibrio parahaemolyticus - a) Enrichment of 10 ml portions in salt colistin broth (Sakazaki) and salt broth (3 per cent NaCl) at 37°C and 42°C respectively and plating on TCBS.

b) Plating of sediment of 10 ml waters after centrifugation and 0.1-0.4 ml of specimen directly on TCBS agar incubated at 37°C.

c) Membrane filtration of 100 ml water and incubation of membrane in salt broth then plating or placing the filter directly on TCBS agar.

d) Biochemical testing of suspect colonies, compared to two reference strains.

Winds and currents - these were not considered since the number of samples was small and all monitoring was done in the forenoon hours of the summer (end of June to end of October).

Results and their interpretation:

Between the last week in June and the last week in October the beaches of Nathania and Ashquelon (points 1, 2, 5 and 6) were examined nine times and the beach of Tel-Aviv (points 3 and 4) eight times, giving a total of 70 samples. According to the present standard in Israel (up to 2 400 coliforms per 100 ml in 80 per cent of the samples) all beaches were very satisfactory. At the Nathania beach the number of total and faecal coliforms ranged from 0 to 150 per 100 ml. In Tel-Aviv the range was 0-210 per 100 ml and in Ashquelon, 0 to 370 per 100 ml. The number of Enterococci was also low (0 to 240 per 100 ml). Salmonellae and Vibrio parahaemolyticus were not isolated. About 500 colonies from 200 samples were examined (including beaches not in the project) and none of them complied with the biochemical criteria for V. parahaemolyticus.

The control points were not free of coliforms, as expected, but their number was low, reaching 80/100 ml in the northern point on 2 occasions only. In the southern point four of the nine tests were positive, reaching 100/100 ml on one occasion and 160/100 ml on another.

Comparison of the MPN with the membrane filtration method showed a fairly good correlation (r=0.8), when the results on the filters could be read distinctly. With m-FC medium at 35°C the results were dubious and on several occasions not even legible when too many pink colonies were present on the filter. Many of these pink colonies were confirmed as non-lactose fermenters. When compared on the basis of percentage of total number of samples examined, the results were as follows:

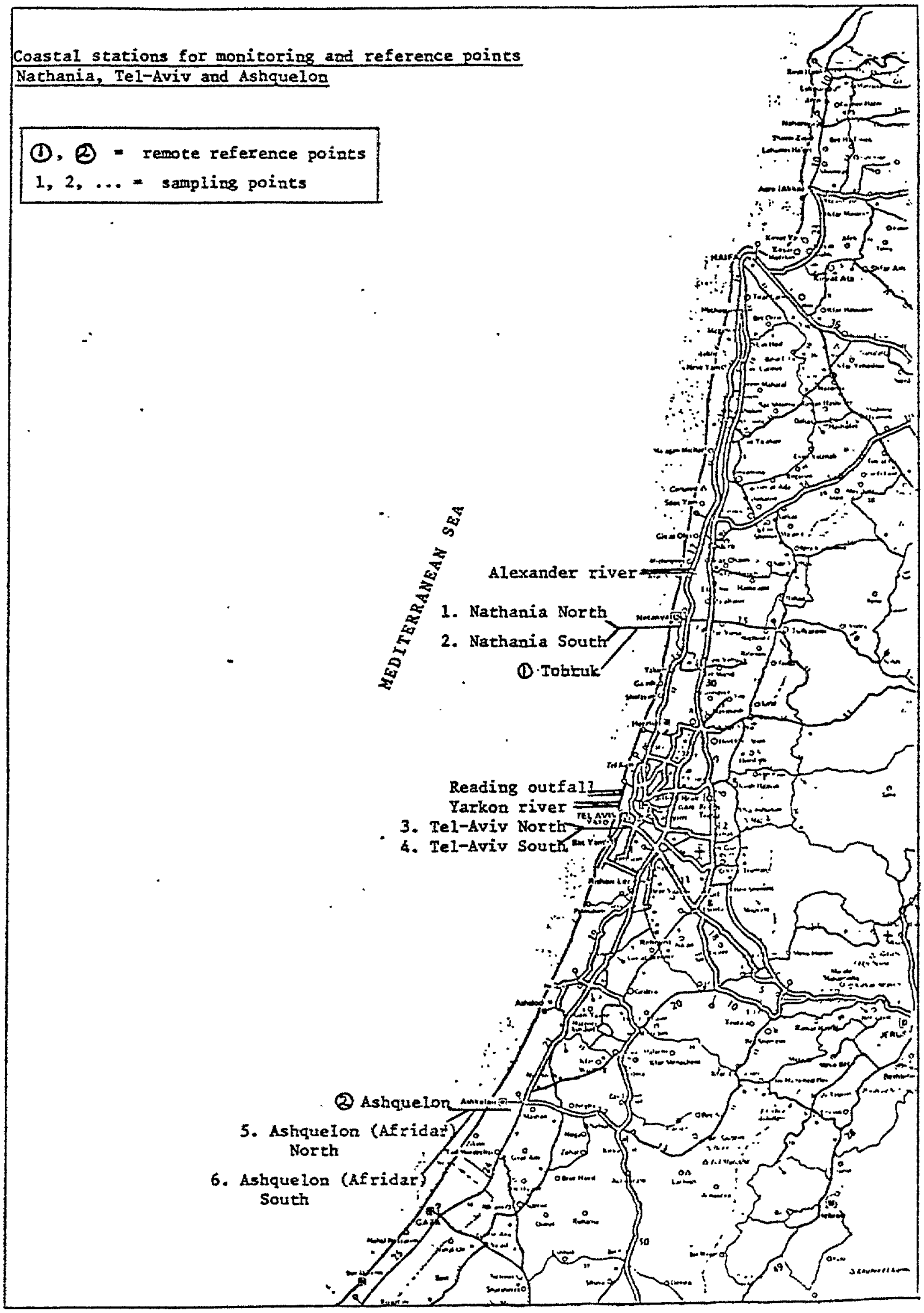
	Comparable results (%)	Higher results by MF (%)	Higher results by MPN (%)
Total coliforms*	49	20	23
Faecal coliforms	54	12	34

* In six samples (eight per cent) the filters were not legible (NR).

Conclusions:

It is difficult to draw conclusions on such a limited number of examinations (70) and more samples should be examined by several mthods for evaluation of the results.

In the experience of the Institute the membrane filtration with m-FC medium is good for faecal coliforms at 44.5°C at least as far as reading the results is concerned. For total coliforms at 35°C it is not recommended since the blue-green colonies of the coliforms are often obscured by dense growth of other bacteria many of them non-lactose fermenters.



Coastal stations for monitoring and reference points
Nathania, Tel-Aviv and Ashquelon

Table 1: Mean values and standard deviation of indicator organisms/100 ml (MF) in coastal water of central and southern Israel during the summer of 1978

Point no.	Total coliforms		Faecal coliforms		Faecal streptococci	
	mean*	S.d.	mean*	S.d.	mean*	S.d.
1. Nathania North	27	7	18	6	17	5
2. Nathania South	13	8	9	6	12	8
3. Tel-Aviv North (Gordon beach)	27	6	16	4	10	7
4. Tel-Aviv South	47	6	18	8	13	9
5. Ashquelon North	17	8	7	9	8	8
6. Ashquelon South	24	8	6	6	7	5
7. Control point N. (near Nathania)	13	5	4	3	11	5
8. Control point S. (near Ashquelon)	5	9	3	7	6	6

*Values of 0 were taken into consideration as 1, with log 0.

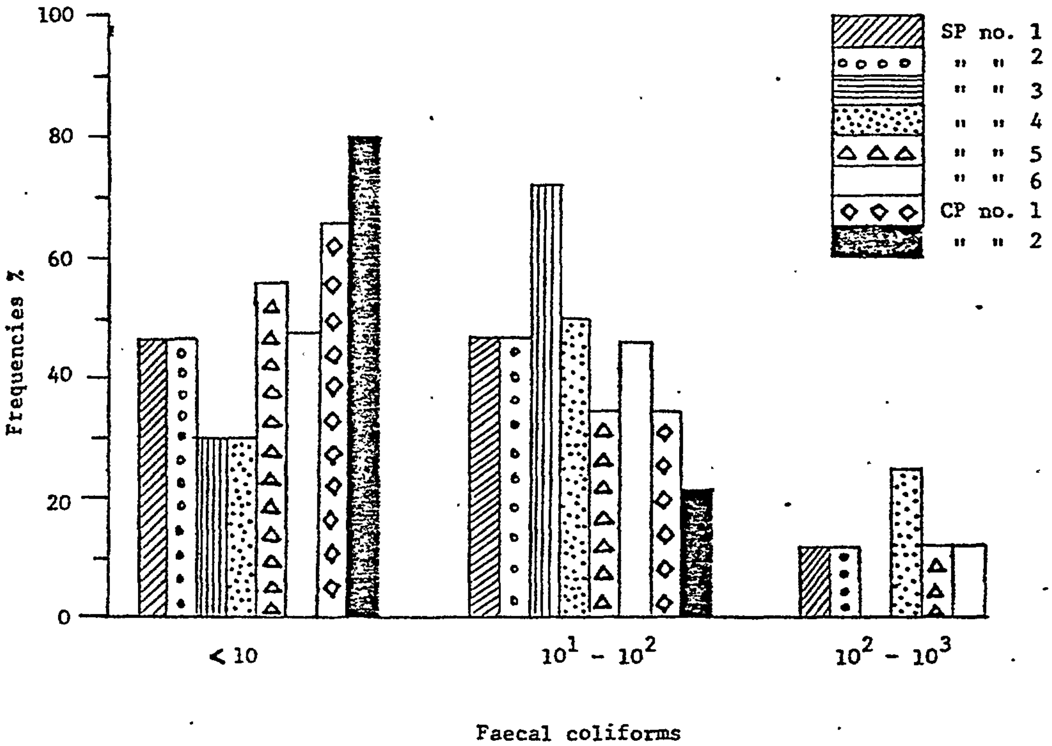
The number of data is too low to draw statistically valid conclusions and it seems to me that the following presentation is more meaningful.

Table 2: Correlation between the mandatory parameters

Point no.	r TC : FC	r TC : FS	r FC : FS
1	0.995	-0.013	-0.003
2	0.889.	0.348	0.401
Nathania (1 & 2)	0.988		
3	0.823	0.061	0.336
4	0.748	0.278	-0.126
Tel-Aviv			
(Gordon beach) (3 & 4)	0.763		
5	0.993	-0.187	-0.178
6	0.540	0.805	0.159
Ashquelon			
(Afridar beach)(5 & 6)	- 0.790		
Control 1 (Nathania)	0.485	-0.293	-0.299
Control 2 (Ashquelon)	0.924	-0.362	-0.408
All points (N = 69)	0.929		

There is a good correlation between the total coliforms and faecal coliforms when the number of samples is adequate, but no correlation between any of them and the number of faecal streptococci. This is quite understandable since we are dealing with different organisms that vary greatly in their susceptibility to environmental conditions and rate of survival.

Figure 1



Salmonella, V. parahaemolyticus and V. cholerae were not found.

Participating Research Centre: Institute of Hydrobiology and Fish Culture
University of Messina
MESSINA
Italy

Principal Investigator: S. GENOVESE

Introduction:

The Institute of Hydrobiology has for a long time been carrying out intense research activity in order to evaluate the pollution rate in coastal and brackish Sicilian and Calabrian waters. Research started in 1964 and has concentrated on the eastern coast of Sicily, in the area between the Gulf of Patti and Siracusa and the western coast of Calabria, from Capo Suvero to Capo delle Armi. The Straits of Messina, Augusta inlet and Gulf of Milazzo have been studied in a more detailed way.

Area(s) studied:

The study zone, shown in detail in figure 1, includes two coastal tracts, one located along the Tyrrhenian coast, the other along the Ionian coast, with 12 and 14 sampling stations, respectively, and two reference points, one for each zone, 1 km from the coast. These particular areas have been selected because during the summer, bathing and recreational activities take place here. We prefer to describe the two zones separately as, even if they are very close to each other, they are part of two compeletely different environments. Only very scarce scientific information is available about the Tyrrhenian zone. There is no evidence of the occurrence of natural or artificial draining of water effluents from very limited urban settlements. However, it must be noted that as there are many (nine) urban bathing establishments and numerous villas located in this zone, the density of the summer population is very high. Winds mainly influencing the zone are from the north-east; they are discontinuous, with brief gusts, but can cause violent sea-storms. Southern winds, frequent and strong in the Messina area, only indirectly influence the coastal tract examined.

There is quite extensive information concerning the Ionian zone as the Straits of Messina have long been the object of study by various oceanographic disciplines because of their strong tidal currents and the consequent hydrological and biological processes. However, much of this research has little to do with the present project and we intend to summarize only what is known about the microbiological features of the Messina Straits, based on research carried out by the Institute of Hydrobiology in the period 1964-1978.

Drains of varied capacity, flood and torrent spillways, waste waters coming from urban settlements, with varying pollution loads, either due to the number of inhabitants, or in proportion to the discontinuous and variable town water supply, are discharged along the coasts of the Messina Straits.

When these waters reach the sea, the main alternating currents and the more complex littoral counter-currents distribute the pollution load irregularly. There is evidence that currents may disperse waters with heavy faecal flora content to zones not directly polluted just as, in the same way, it may occur that as a result of the dispersion, areas receiving sewage wastes are free from faecal pollution. The Straits' central axis itself is practically free from polluting phenomena and it is possible that the currents might act as an important self-depuration factor.

In this area the shore entrance is free and there are no recreational facilities. However, it should be noted that, from 1970, along almost all the Ionian coast between Messina and Capo Peloro, which includes the zone under study, bathing has been forbidden by a municipal injunction, as the faecal coliform rate exceeds the current Italian norm allowed. It should also be added that a new sewage system with a treatment plant is about to be constructed near Capo Peloro. There are two sewage outlets in this zone, one at Pace Village corresponding to station 17, and the other at S. Agata village close to station 25. Immediately to the north of the study zone there are four other sewers and two more to the south. All drains are of small capacity, receiving refuse waters from the houses close to them. The study zone includes the Pace torrent between stations 15 and 16 and the Guardia torrent in close proximity to station 23. Immediately to the north of our stations are the torrents S. Agata and Papardo. As to the wind system, easterly and southerly winds blow in the Straits, where they reach their greatest velocity; the north-east wind is the most prevalent but is of moderate strength and blows mainly during the summer. There are occasional west winds of short duration.

Material and methods used:

As requested for this study, methods in which filter membranes are used on a single culture medium at different temperatures have been adopted. In this respect it might be pointed out that the filter membrane technique with different media for faecal and total coliforms has been used for a long time in our microbiological laboratory with very good results. Comparative tests have been carried out, and the single medium at two temperatures was maintained in order to apply unified methods, even if some uncertainties arose about the results obtained with the recommended method.

Results and their interpretation:

From the results obtained to date it is impossible to draw general conclusions without the winter surveys, from which we expect to have useful indications regarding the relations between faecal flora and hydrological parameters. Table 1 shows the distribution in frequency classes of the microbiological data collected and the different pollution rate of the two zones examined is clearly indicated.

In the Tyrrhenian zone there are no signifcant pollution sources. In fact, only faecal coliforms up to a maximum of 12/100 ml have sometimes been noted. Streptococci distribution in these waters, because of their longer survival time in sea-water, shows that there may be pollution by sewage waters, but it does not seem direct or constant. A maximum value of 5.2 x 10^3 streptococci/100 ml near the shore compares with 2.6 x 10^3 obtained on 17 August at 1 km from the shore. Most of the values were less than 100 streptococci/100 ml.

As regards the Ionian Sea, the present pollution level is clearly shown by faecal coliform numbers that are rarely absent and reach a maximum of 1.8 x 10^3/100 ml. Streptococci seem to follow the same development. Only in three water samples of 100 ml were these micro-organisms not observed; this pollution index, even at 1 km from the shore, has reached values of 10^3, and the maximum obtained (30 June 1978) near the coast, was of 1.3 x 10^4 streptococci/100 ml.

Conclusions:

It is possible to state that the Tyrrhenian coastal tract present a good quality level while in the Straits of Messina area the pollution rate observed gives rise to problems for recreational purposes.

Figure 1

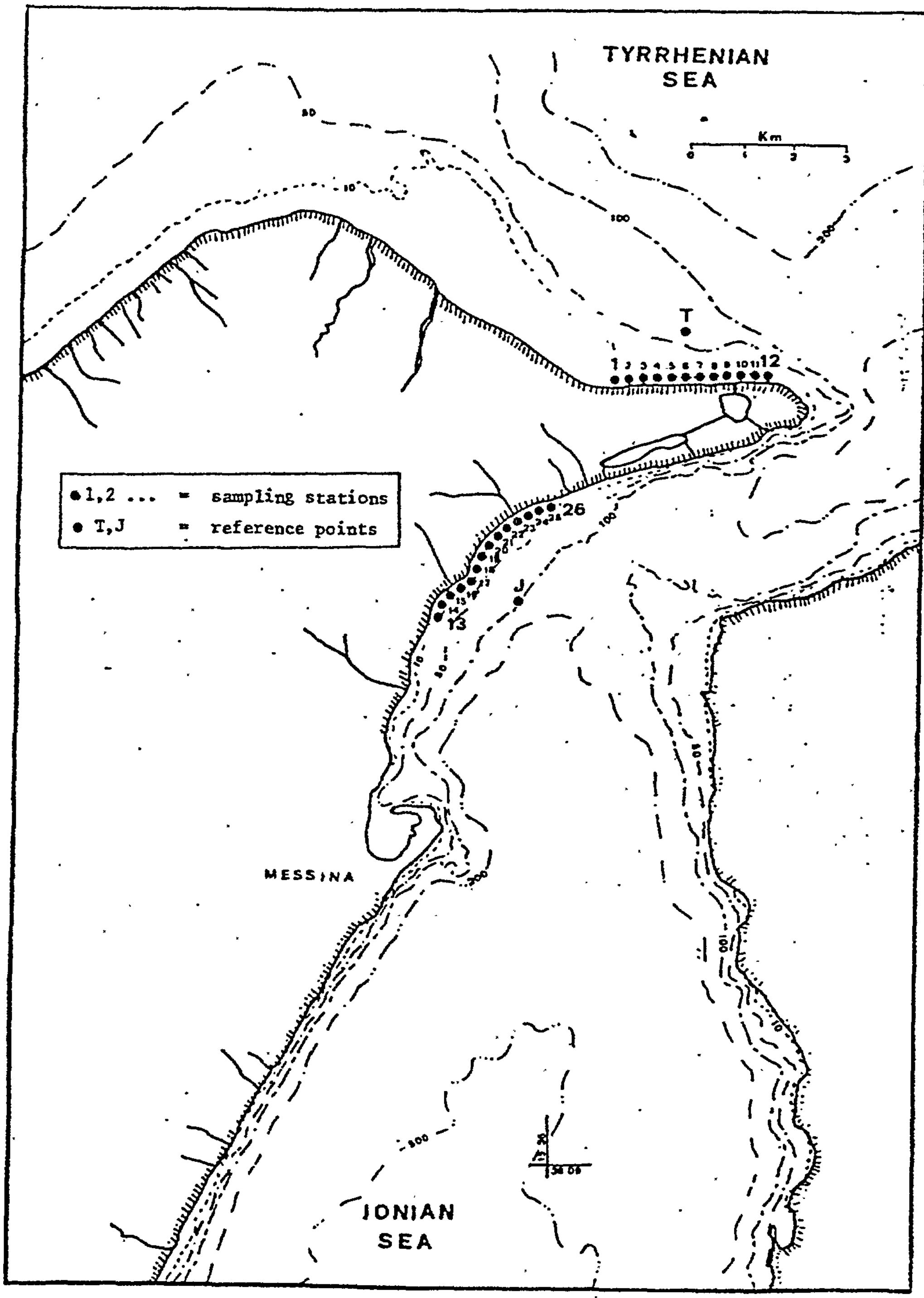

TYRRHENIAN SEA
Km
0 1 2 3
●1,2 ... = sampling stations
● T,J = reference points
T
J
1 2 3 4 5 6 7 8 9 10 11 12
13
26
100
200
300
MESSINA
JONIAN SEA

Table 1: Distribution in frequency classes of the results obtained

			Frequency classes				
			0 – 10	10 – 10^2	10^2 – 10^3	10^3 – 10^4	10^4 – 10^5
% from 60 samples	Tyrrhenian Sea	faecal coliforms	98,3	1,7	0	0	0
		faecal streptococci	70,0	18,3	10	1,7	0
% from 70 samples	Ionian Sea	faecal coliforms	51,4	22,9	21,4	4,3	0
		faecal streptococci	21,4	41,4	31.5	4.3	1,4

Participating Research Centre: Centre for Study and Research in Sanitary Engineering
Institute of Water Supply and Waste Disposal
University of Naples
NAPLES
Italy

and

Zoological Station of Naples
NAPLES

Principal Investigator: L. MENDIA

Introduction:

The constant sampling in the Gulf of Naples begun in 1976 has been regularly continued at the Naples Zoological Station together with the Sanitary Egnineering Centre (Institute of Water Supply and Wastes Disposal) from September 1977 until today.

Work has begun in 1976 in collaboration with Dr. Lilian M. Evison of the Department of Civil Engineering, University of Newcastle upon Tyne.

Samples of sea-water were taken at frequent intervals in the Bay of Naples from Nisida to the harbour of S. Lucia. The sampling points were selected so that both unpolluted and polluted waters could be investigated in order to make a comprehensive analysis of the coastal water quality.

Area(s) studied:

The sea stretch between Nisida and St. Lucia harbour was monitored in the framework of the MED VII pilot for recreational coastal water control. Along this area 40 stations were located. Two reference points were chosen: station no.102 (Rotonda Diaz) for locations 109 to 87; and station No.76 (Villa Beck) for locations 86 to 64.

Two sampling stations (Bacoli and Coroglio) located in the Gulf of Pozzuoli, were chosen for shellfish monitoring activities. Moreover shellfish samples collected in the market were analyzed.

The two maps (figure 1 and figure 2) give details on the selected areas.

Material and methods used:

Sea-water samples were collected by boat at a distance of approximately 10 m from the shore. At each point triplicate samples were taken.

(1) 500 ml in a sterile bottle for bacteriological analysis

(2) 250 ml sample, immediately fixed for D.O. analysis

(3) 125 ml sample for salinity determination.

In addition water temperature and "Secchi disc" readings were measured at the same sites. Air temperature, wind direction and wind speed were also measured at the reference points using an anemometer.

Biological tests

All samples were analysed by membrane filtration using 47 mm diameter membrane filters, 0.45 u pore size. For every sample three different volumes of water (1, 10, 100 ml) were filtered in tripilicate for three different analyses: one set was analysed for coliforms, one set for E. coli and one set for faecal streptococci.

Coliform counts (37°C for 20 hours) - Membrane enriched teepol broth.

E. coli counts (44°C for 20 hours) - Membrane faecal coliforms agar.

Faecal Streptococci counts (44°C for 48 hours) - Slanetz and Bartley agar.

Shellfish monitoring:

MPN method was followed for enumerating total coliforms, faecal coliforms and Escherichia coli, in the shellfish flesh according to the directives fixed by the working group at the meeting held in Rome on the 4th - 7th April 1978.

Shellfish growing was analyzed according to the MF method, utilizing the same media described above.

Enterococci and heterotrophic bacteria were detected with the PP method as described in the Guidelines.

The analyses on shellfish were performed adding to the samples four times the diluent equivalent to the flesh weight.

Results and discussion:

The results of the analysis of superficial water samples are summarized in tables 1 and 2; the following comments may be made:

(1) The coliform count is generally higher than the E. coli count. The enterococci count invariably gives the lowest count values in respect of the others.

(2) The dissolved oxygen concentration for the various samplings is more or less near saturation; for seven samples among the 25, the D. O. is less than 90 per cent but always higher than 63 per cent.

(3) The majority of samples present salinities in the range 36.4-37.8. Seven samples show salinities between 33.9 and 35.9 (table 1).

Table 1 shows the results obtained during various periods of time at three different stations, as follows: (1) (point 64) at the outfall of Coroglio; (2) (point 76) and authorized bathing place; and (3) (point 101) an unauthorized bathing place.

It is possible to note that at point 64 (polluted water), even during meteorological changes, the values of E. coli remain the same. These values are higher than the standard ones; in fact they are in the order of 10^4. It is clear that the sewage coming from the outfall is not influenced by external conditions. It is in fact diluted very slowly as is proved by the samples collected along the coast (see also table 2 from points 64 to 74). At point 76 (an authorized bathing place) it has been noted that the values of E. coli are lower than the standard ones. Higher counts are generally noted when wind strength increases and it exceeds 10 m/sec. At point 101 (an unauthorized bathing place) the values of E. coli are very high only when the current comes from the east. The strength of the current influences the dispersion of the sewage from the S. Giovanni outfall. Without the influence of this current, the values of E. coli are in accordance with the standard.

Table 2 gives the results of sample collection during two days in summer 1978 - 20 sampling points each day (in total 45 points). The values measured during these two days are significative of the water quality of the sampling points. In fact the results obtained are more or less the same as those of sample collections during other periods of the year at the same points.

Analyses carried out on shellfish and shellfish water growing areas showed higher microbial values for stations No.1 than for station No.2 (Coroglio and Bacoli, respectively). However also in this case, when particular metereological and hydrographic conditions happened (such as currents coming from the east) a reverse condition was registered. This was the case, for example, at X4, where higher values, at least for total coliforms, were observed in samples collected at Bacoli.

Conclusions:

The m-FC medium for total coliforms detection was unsuitable. Pink colonies often influenced large areas on the membranes; as a result, the development of lactose fermenter colonies was not always appropriate.

Teepol broth was more suitable for total coliform detection.

More observations on local conditions must be undertaken in future monitoring work.

Table 1

Point 64 - near the collector of Coroglio (polluted water)

Date	Wind	Water temp.(°C)	D.O. (%)	Salinity (%)	Coliforms (/100 ml)	*E. coli* (/100 ml)	Enterococci (/100 ml)
13.6.78	9 km/h	22	87	36.436	1.23×10^5	4.7×10^4	1.3×10^4
26.6.78	3 km/h	23	63.8	-	2.52×10^4	4.08×10^4	1.7×10^3
11.7.78	0.5 m/sec	22	100	33.94	7×10^5	3×10^5	2.6×10^4
17.7.78	calm	24	85	35.16	1.06×10^4	3×10^5	2.4×10^4
21.7.78	5 m/sec	24	95	37.45	2.4×10^5	1.3×10^3	4.7×10^3
26.7.78	calm	23	90	36.87	7.5×10^5	3.1×10^5	3.1×10^3
9.11.78	calm	17.5	83	35.63	TNTC	TNTC	5.7×10^3
21.11.78	calm	17.7	94	35.47	TNTC/1 ml	TNTC/1 ml	3900

Point 76 - authorized bathing place (unpolluted water)

Date	Wind	Water temp.(°C)	D.O. (%)	Salinity (%)	Coliforms (/100 ml)	*E. coli* (/100 ml)	Enterococci (/100 ml)
13.6.78	9 km/h	22	100	37.24	1.08×10^3	7.2×10^2	4
26.6.78	3 km/h	23	68	36.68	2×10^3	3.28×10^3	6.8×10^2
11.7.78	0.5 m/sec	22	118	37.15	3	0	0
17.7.78	calm	24	108	37.21	0	0	0
21.7.78*	5 m/sec	24	>100	37.45	33	3	0
26.7.78	calm	23	105	37.51	12	12	2
9.11.78	calm	17.5	95	37.80	206	28	1
21.11.78	calm	17.7	95	37.67	TNTC	52	152

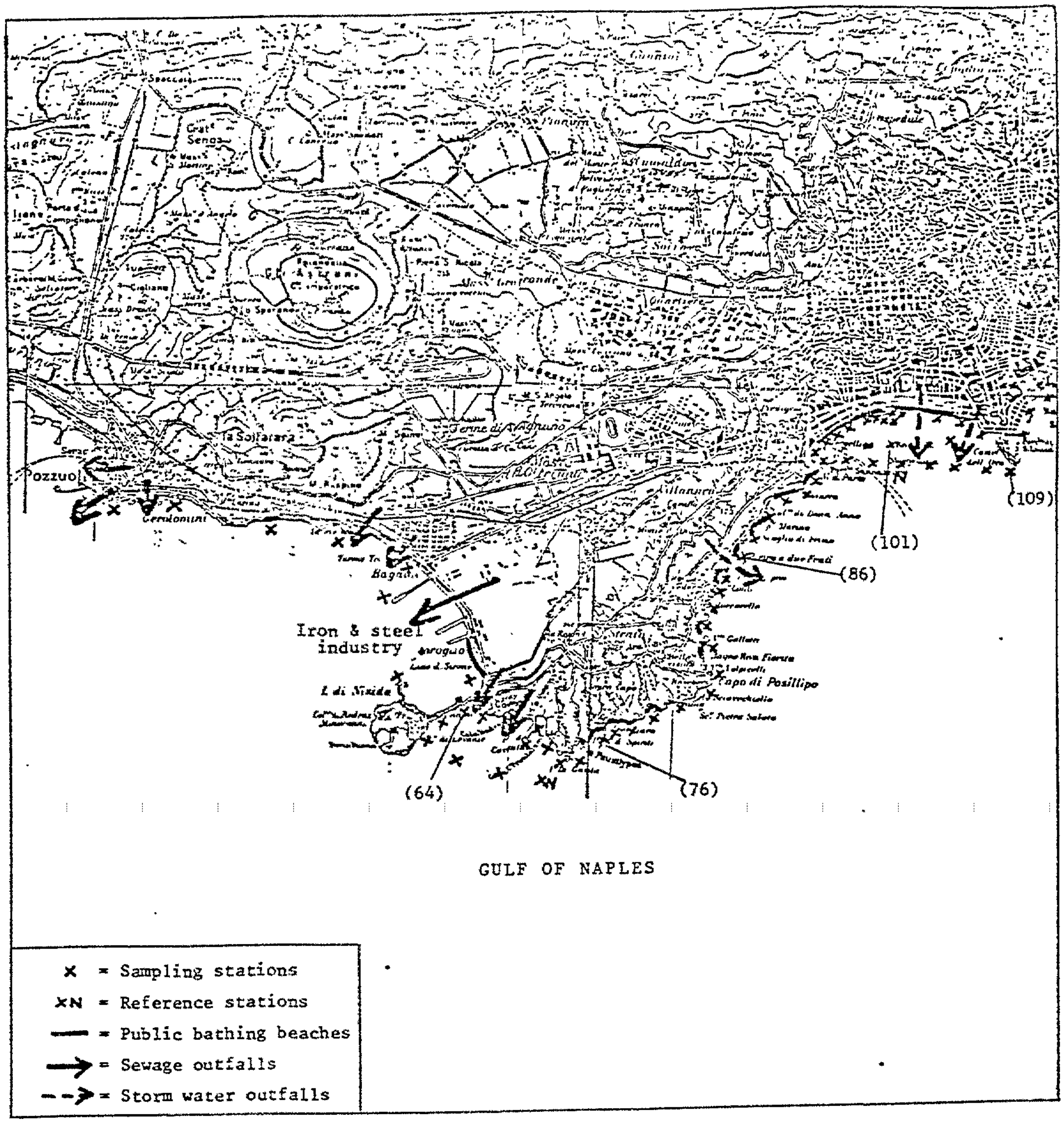
Point 101 - Rotonda Diaz - unauthorized bathing place

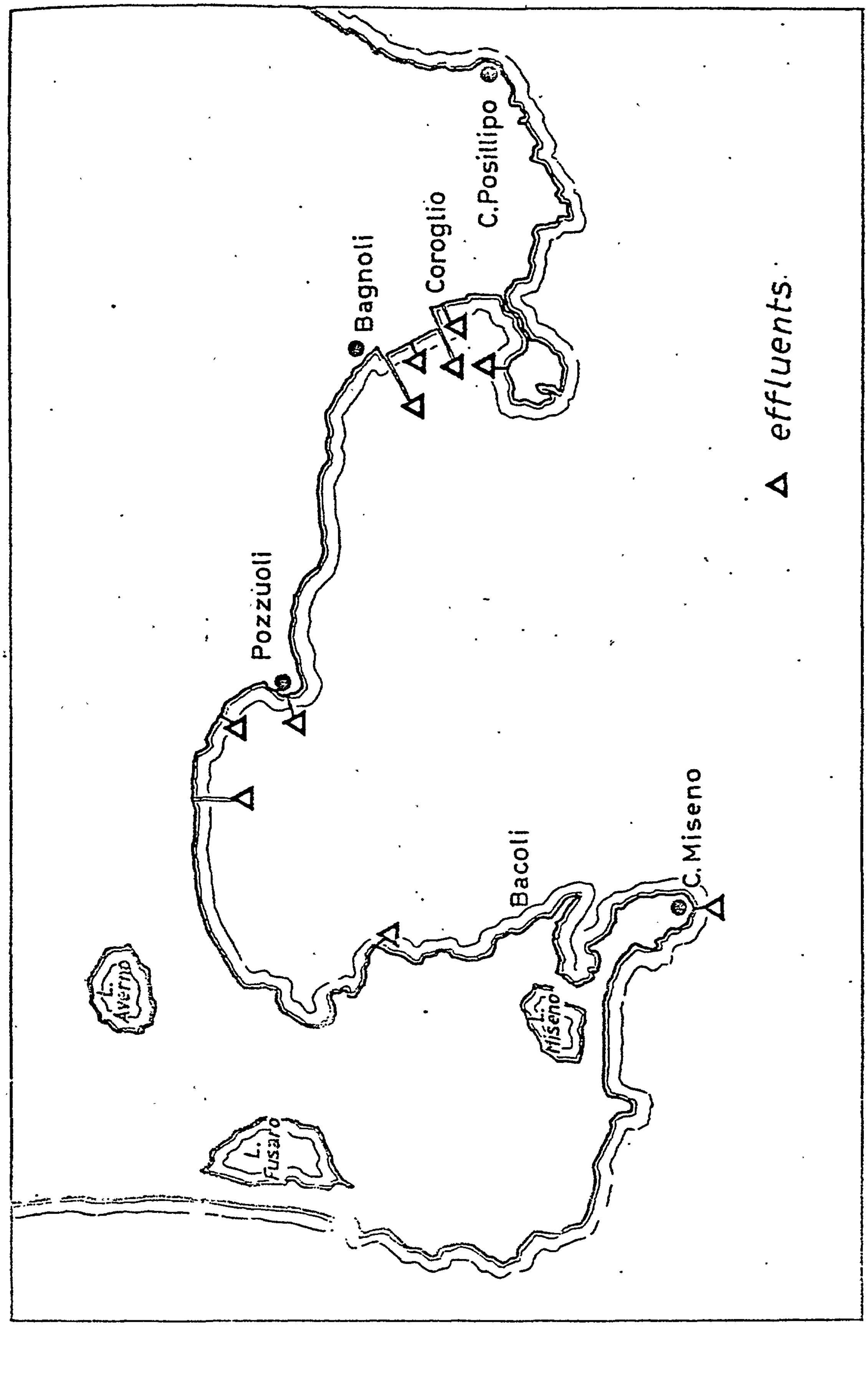
Date	Wind	Water temp.(°C)	D.O. (%)	Salinity (%)	Coliforms (/100 ml)	*E. coli* (/100 ml)	Enterococci (/100 ml)	Current
6.6.78	-	-	121	35.74	3.2×10^4	1.58×10^4	60	east
20.6.78	2 km/h	23	104	36.61	30	0/10 ml	0	west
6.7.78	calm	24	99	36.87	43	32	1	west
13.7.78	calm	23	104	35.96	$>1 \times 10^4$	$>1 \times 10^4$	8×10^3	east
20.7.78	3 m/sec	25	77	35.21	6×10^4	7×10^4	6×10^3	east
24.7.78	2 m/sec	23.5	130	36.99	9×10^2	1×10^2	10	east
28.7.78	calm	23.5	106	37.40	1×10^2	10^2	10	west
15.11.78	calm	17	89	37.84	18	3	1	west
6.12.78	-	15	94	37.68	760	19	1	west

*Salmonella test negative

Table 2: Results of monitoring in forty sampling points during two days of summer 1978

Date	Point	Wind	Water temp. (°C)	D.O. (%)	Salinity (%)	Coliforms (/100 ml)	E. coli (/100 ml)	Enterococci (/100 ml)
13.6.78	64	2 km/h	23	87	36.43	1.23×10^5	4.7×10^4	1.3×10^4
"	65	"	"	83	36.33	6.5×10^4	5.4×10^4	9×10^2
"	66	"	"	66	33.60	2.8×10^4	3.3×10^4	3.3×10^4
"	67	"	"	90	36.33	3.4×10^3	2.3×10^3	19
"	68	"	"	91	36.65	1.95×10^3	1.66×10^3	4
"	69	"	"	91	36.91	2.52×10^3	1.77×10^3	3
"	73	"	"	91	36.96	3.4×10^3	1.28×10^3	1
"	74	"	"	95	37.20	2×10^3	1.2×10^3	2
"	75	"	"	90	37.22	2.5×10^3	1.21×10^3	4
"	76	"	"	100	37.26	1.08×10^3	7.2×10^2	4
"	77	"	"	95	37.19	610	410	2
"	78	"	"	101	37.25	650	560	2
"	79	"	"	95	37.29	710	560	7
"	80	"	"	102	37.31	120	80	0
"	81	"	"	90	37.32	1.29×10^3	82	1
"	82	"	"	105	37.37	280	54	0
"	83	"	"	85	37.77	TNTC	TNTC	3
"	84	"	"	101	37.33	10	2	0
"	85	"	"	98	37.35	6	6	0
"	86	"	"	100	37.32	6	6	0
20.6.78	109	2 km/h	25	106	36.84	10	0	0
"	108	"	"	105	36.63	0	0	0
"	107	"	"	107	36.63	0	0	0
"	106	"	"	107	36.62	0	0	0
"	105	"	"	107	36.62	0	0	0
"	104	"	"	101	36.61	0	0	0
"	103	"	"	114	36.59	10	10	0
"	102	"	"	105	36.62	30	0	0
"	100	"	"	104	36.60	10	10	0
"	99	"	"	101	36.59	10	0	0
"	98	"	"	104	36.61	0	10	0
"	97	"	"	106	36.62	10	0	0
"	93	"	"	104	36.61	6	4	0
"	92	"	"	103	36.84	12	0	0
"	91	"	"	101	36.82	0	10	0
"	90	"	"	106	36.86	20	0	0
"	89	"	"	97	36.87	30	0	0
"	88	"	"	102	36.87	0	0	0
"	87	"	"	107	36.87	10	0	0


Pozzuoli
Iron & steel
industry
(64)
(76)
(86)
(101)
(109)
Capo di Posillipo
GULF OF NAPLES
× = Sampling stations
×N = Reference stations
= Public bathing beaches
= Sewage outfalls
= Storm water outfalls


C.Posillipo
Coroglio
Bagnoli
Pozzuoli
Bacoli
C. Miseno
L. Averno
L. Miseno
L. Fusaro
Δ effluents

Participating Research Centre: Istituto Superiore di Sanita
ROME
Italy

Principal Investigator: L. VILLA

Introduction:

The ISS has previously worked on problems concerning Mediterranean coastal environmental hygiene, through activities aimed at pointing out the qualitive aspects of the input of coastal civil or industrial installation effluent waters in coastal waters. We mention, as more precise examples, the survey of microbiological parameters carried out in the Anzio coastal area by L. Villa et al. and the surveys of hydrological parameters and qualitative input in the coastal waters in the areas of Montalto di Castro (Argentario), Nettuno, Circeo, Ponza Island and Elba Island, carried out by G. Ugolini.

Area(s) studied:

The ISS group has monitored a stretch of coast (Castel Porziano) with characteristics representative of the whole Italian coastline. This area is not greatly affected by concentrated discharge but receives waters from inland areas of inhabited land and parkland areas. Moreover, it is close to a large city (Rome) whose population use the area for bathing. The stretch of coastline examined (Castel Porziano, 41°41' N, 12°31' E; 41°40' N, 12°32' E) is delimited by two water courses, Fosso Focetta and Fosso del Tellinaro. Fosso del Tellinaro originates in the parkland of Castel Porziano and collects only rain water. Moreover, it does not reach the sea because it is frequently obstructed at the mouth. On the contrary Fosso Focetta receives water from domestic discharges. The sea currents affecting the sampling points have an off-shore course towards the coast from a SW direction in the daylight hours and come from SE, parallel to the coast, at sunset and dawn (figure 1). The prevailing winds (40 per cent) in the area blow from SW with an average velocity of 4.5 m/s, and the rate of the water temperature, jointly with solar irradiation, for the latitude of 41°N, were measured. The sea-bed on the 3 m bathometric line is sandy with areas of rock, mud and seaweed.

Material and methods used:

The methods for measuring chemical physical and microbiological parameters (MF) agreed for the project were used. In addition, for the MPN usually applied by the I.S.S. was utilized. The salt residue was measured both with a conductivity instrument and by evaporation and then weighed at 180°C, the ratio of the values obtained being practically constant; therefore, salinity is usually determined by the conductivity instrument using the above ratio and, from time to time, as a control, by evaporation. Pathogenic organisms such as Salmonellae, bacteriophages and sulfite reducers were detected at the beach. Chlorophyll was detected according to the method indicated by UNESCO (UNESCO publication Centre, 1969, "Monograph on oceanographic methodology-I. Determination of photosynthetic pigments in seawater"). Occasionally phytoplankton was examined and counted. Additional chemical parameters related to possible eutrophication were analysed: ammonium; nitrite ion; phosphate ion. Moreover, hydrogen sulphide was investigated in some samples.

Results and their interpretation:

The results of microbial parameters obtained are presented in the form of histograms (figures 2, 3, 4). The number of samples carried out is not yet sufficient to analyse and correlate the microbiological parameters with marine biological factors. In future development of our activities it is proposed to analyse and statistically evaluate possible correlation between various parameters (environmental and analytical). At present we noted a correlation between precipitations and variations in the microbiological parameters. All the other observations are presented in the form of histograms (figures 5 to 10).

Conclusions:

A longer period of observations is still needed to acquire homogeneous data.

As a general rule MF values are about 1/10 of the MPN figures in respect to faecal coliforms. We have followed the directives fixed for MED VII for detection of total coliforms. However, we have not noted differences between results obtained on Endo-broth and those on mFC-broth (37°C). This last medium was used in a preliminary step of this project. No correlation was found between Salmonellae recovery and high coliform counts. This finding has to be duly considered when the discussion will be open on the criteria to be established from the epidemiological point of view.

Bacteriophages were detected in water samples and in sediment samples also in absence of their hosts. The counts in sediment samples were always higher than in correspondent water samples.

The analyses followed for detecting possible eutrophication of the stretch of coast under examination were negative. In fact most of the samples exhibited values under 150 cells/ml (see figure 10).

Variations of bacteriological populations were noted in connection with relevant precipitations; these probably drain all the surrounding land.

For the future a study for detecting currents typical of the zone should be developed and an appropriate survey of the hydrodynamic condition at the time of the sampling has to be executed.

These observations could help in gathering appropriate data.

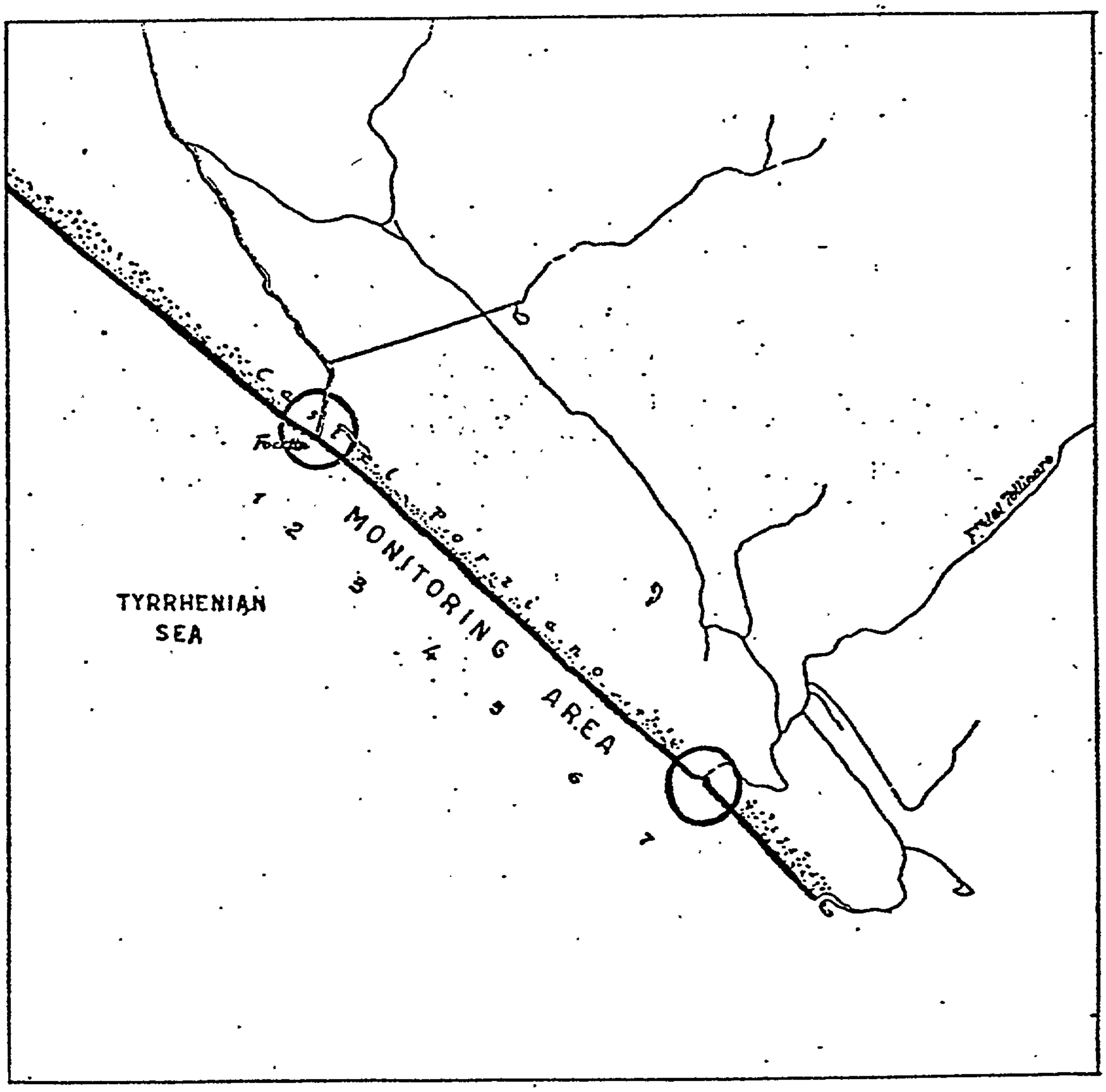
List of publications:

M. BOEDDU., VILLA, L. and VOLTERRA. L. (1977). State of Pollution on Italian coast (Summer 1976). Annali Sclavo 19, 1-4.

FILETICI, E., GIRALDI, V. and VOLTERRA. L. (1977). Enterophages comme organismes indicateurs de pollution. Rev.Int.Océanographie Médical. 47, 151-154.

FILETICI. E. and VOLTERRA. L. Inquinamento di origine terrestre convoliato in mare da corpi idrici: rassegna bibliografica. L'Ing. Mod. in press.

Figure 1



Participating Research Centre: Institute for Water Research - CNR
ROME
Italy

Principal Investigator: T. LA NOCE

Introduction:

An interdisciplinary programme of experimental investigations has been undertaken with the aim of evaluating the impact of the Tiber river on the receiving marine ecosystem. In this area the problems of pollution have reached an alarming level in recent years, mainly because of discharges of untreated waste waters, industrial as well as domestic, from the city of Rome with a population of nearly 3,000,000 inhabitants.

In order to examine the phenomena of conveyance and diffusion of pollutants, and the characteriztion of the ecosystem affected by pollutants, the following actions have been taken:

(a) the study of the particular aspects of the diffusion of fresh water discharged through the two mouths of the Tiber in different hydrological and climatological conditions, by using the most advanced methods;

(b) the determination of basic parameters for a more detailed picture of the distribution of fresh water and of suspended and soluble matter carried by the river into the sea;

(c) the study of the main components of the marine ecosystem (plankton, nekton, benthos) and the assessment of the effects of pollution by "algal bioassays", measurements of biomass and of organic degradation rate;

(d) the construction of mathematical models, useful for the monitoring of operations.

Area(s) studied:

The surveyed areas are the following:

- coastal water affected by the Tiber;
- the final stretch of the Tiber;
- other outlets, close to the Tiber mouths, either natural or artificial.

The main local currents and the main surface distribution of salinity, found during the period of field observation, are reported in figure 1; this led to the conclusion that the area, mostly affected by river discharges, spreads mainly to the north of the river mouths.

Taking the objectives of the MED VII projects into account, the parameters listed in table 1 have been determined. The location of sampling points is reported in figure 1. In ten of them, in collaboration with the Institute of Hygiene, University of Rome, bacteriological examinations, including total coliforms, faecal coliforms and faecal streptococci, were performed.

The surface samples were collected in all stations 1, 3, 23, 24, 25, 26. The frequency of sampling and measurement was fortnightly during 1976 and seasonal during 1977 and 1978.

Material and methods used:

The samples collected during the cruises of the vessel IRSAMARE were stored in polyethylene bottle at 4°C, filtered through 0,45 u millipore filters as soon as possible and analyzed within one day after collection. The analytical methods used for the determination of nitrites, ammonia and orthophosphates were those reported by Strickland and Parsons. Reactive silicates were determined by the method reported in the FAO manual.

Chlorophyll "a" (Ch-a) was measured both by the acetone extraction method and by direct florescence measurements on in vivo cells using continuous ship-board monitoring techniques. The measurement of turbidity was performed by Secchi disc. Salinity, temperature and pH were determined respectively by conductivity meter, bucket thermometer and pH meter. As far as bacteriological parameters were concerned, the MPN method was adopted.

Results and conclusions:

The results concerning the evaluation of eutrophication conditions in the zone farther away from fluvial influence (st. 7, 27, 30, 31, 33) shows a situation which is typical of the oligotrophic feature of Mediterranean waters.

Due to the Tiber influence, the inshore coastal stations show higher values of N and P. In particular, station 1, having the highest nutrients' levels, is characterized by values typical of waters with a tendency to eutrophycation.

As far as the bacteriological data are concerned, the majority of the stations observed, including those 7°N off Ostia and 21°N off Ladispoli, both located 1 mile from the coast, show values which are under the limit established by the accepted interim microbiological quality criteria.

Only the area closest to the river mouths (st. 1, 2, 3, 12, 34 and 35) is characterized by a level of bacteria which is higher than the above mentioned limits.

With a view to a more effective utilization of the data obtained, it was necessary to treat them by using computer facilities. In this respect, a programme has been set up, whereby the collected data can easily be submitted to variability and correlation analysis.

In such a way, it will be possible to study the correlation among the several parameters with a view to reducing the number and frequency of measurements and also to calculate some functions useful for the integration of the results. In tables 2, 3, 4 and 5 are reported the mean values, the standard deviations, the number of data collected from January 1976 to December 1978 and the correlation analysis between the mandatory parameters of the MED VII Project.

List of publications:

PAGNOTTA, R. and PUDDU, A. (1978). "Chlorophyll distribution in the coastal waters surrounding the Tiber River mouth, determined by using a flourometer" (in Italian with summary in English) Inquinamento 7/8 35-39.

BLUNDO, C., LA NOCE, T., PAGNOTTA, R., PETTINE, M. and PUDDU, A. "Distribution of nutrients off the mouth of the Tiber River and its relationships with biomass" in press.

Figure 1: Sampling stations and behaviour of mean surface salinity

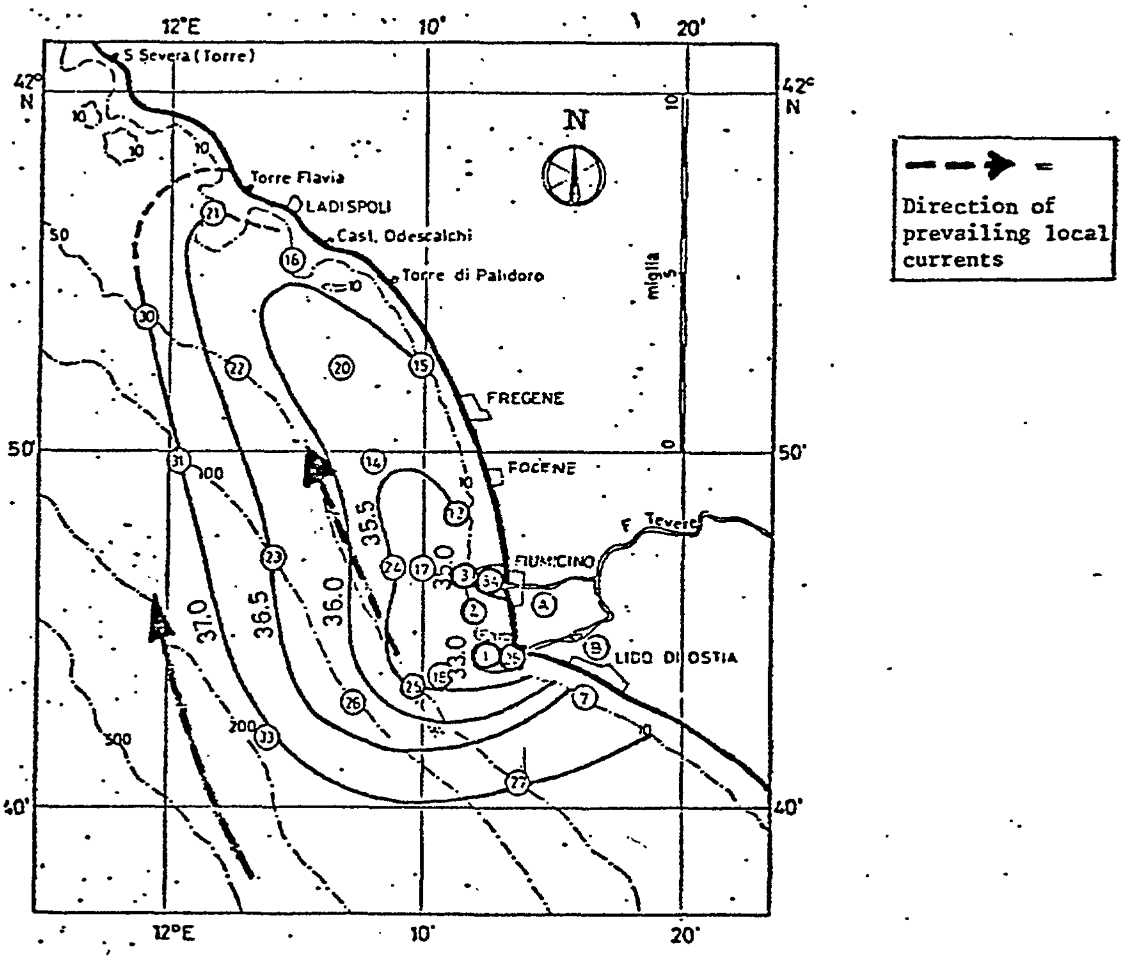


Table 1: Parameters measured for the compulsory and optional parts of the programme

A - Parameters describing general conditions in the monitoring area at the time of sampling

1. Meteorological conditions (data supplied by Italian Air Force Meteorological Service):
   - wind direction and velocity
2. Hydrographic conditions:
   - sea temperature
   - salinity in $^{o}/oo$
   - oxygen in ml/l and % saturation
   - turbidity as Secchi in m
3. Dynamic conditions (in collaboration with the Hydraulic Research Station of Wallingford, UK):
   - state of waves
   - current measurements: direction and speed in m/sec
   - drifts: direction and speed in m/sec

B - Parameters measured on individual samples

1. Accompanying data: (a) air, sea and sample temperature during transportation
   (b) salinity in $^{o}/oo$
2. Bacteriological data (in collaboration with the Institute of Hygiene, University of Rome):
   (a) total coliforms as no. col./100 ml
   (b) faecal coliforms (E. coli) as no. col./100 ml
   (c) faecal streptococci (enterococci) as no. col./100 ml

C - Parameters applied to eutrophication conditions

1. Biomass and density of phytoplankton: (a) chlorophyll in mg/m^3
   (b) density of phytoplankton in no. cells/l
2. Nutrients: (a) PO_4 in mg/m^3
   (b) NH_3, NO_2, NO_3 in mg/m^3

Table 2: Total coliforms: mean values, standard deviations, number of data collected from January 1976 to December 1978 and its correlation analysis with faecal coliforms (FC) and faecal streptococci (FS) - mean and standard deviation are expressed in logs

Point no.	Mean	Stand.dev.	No. data	Correlation with FC	Correlation with FS
1	5.46	1.86	28	r = 0.72 **	r = 0.72 **
3	4.02	1.90	26	r = 0.84 **	r = 0.59 **
7	1.57	1.46	13	r = 0.76 **	r = 0.66 **
12	2.55	1.72	20	r = 0.88 **	r = 0.63 **
21	0.15	0.35	10	r = 0.33	-
23	2.16	2.01	23	r = 0.84 **	r = 0.82 **
24	2.57	2.67	8	r = 0.91 **	r = 0.87 **
25	1.84	1.93	22	r = 0.92 **	r = 0.82 **
26	0.93	1.39	11	r = 0.65 *	-
34	3.97	1.31	14	r = 0.93 **	r = 0.50

*significance level 95%

**significance level 99%

Table 3: Faecal coliforms: mean values, standard deviations, number of data collected from January 1976 to December 1978 and its correlation analysis with total coliforms (TC) and faecal streptococci (FS) - mean and standard deviation are expressed in logs

Point no.	Mean	Stand.dev.	No. data	Correlation with TC	Correlation with FS
1	4.39	1.96	28	r = 0.72 **	r = 0.54 **
3	2.93	2.18	26	r = 0.84 **	r = 0.71 **
7	0.69	0.97	13	r = 0.76 **	r = 0.70 **
12	1.85	1.57	20	r = 0.89 **	r = 0.57 **
21	0.05	0.15	10	r = 0.33	-
23	1.34	1.94	23	r = 0.84 **	r = 0.88 **
24	1.74	2.55	8	r = 0.91 **	r = 0.95 **
25	1.14	1.78	22	r = 0.92 **	r = 0.91 **
26	0.24	0.79	11	r = 0.65 *	-
34	3.24	1.1	14	r = 0.93 **	r = 0.54 *

Table 4: Faecal streptococci: mean values, standard deviations, number of data collected from January 1976 to December 1978 and its correlation analysis with total coliforms (TC) and faecal coliforms (FC) - mean and standard deviation are expressed in logs

Point no.	Mean	Stand.dev.	No. data	Correlation with TC	Correlation with FC
1	2.26	1.18	28	r = 0.72 **	r = 0.54 **
3	1.65	1.49	26	r = 0.59 **	r = 0.71 **
7	0.17	0.45	13	r = 0.66 *	r = 0.70 *
12	0.43	0.63	20	r = 0.63 **	r = 0.57 **
21	-	-	-	-	-
23	0.72	1.31	23	r = 0.82 **	r = 0.88 **
24	0.77	1.18	8	r = 0.95 **	-
25	0.56	1.08	22	r = 0.82 **	r = 0.91 **
34	1.67	1.18	14	r = 0.50	r = 0.54 *

Table 5: Relationship between the mandatory parameters at each station (TC = total coliforms, FC = faecal coliforms, FS = faecal streptococci)

Point no.	TC = x, FC = y	TC = x, FS = y	FC = x, FS = y
1	y = 0.76x + 0.26	y = 0.46x - 0.24	y = 0.33x + 0.82
3	y = 0.96x - 0.94	y = 0.46x - 0.20	y = 0.49x + 0.22
7	y = 0.51x - 0.10	y = 0.20x - 0.15	y = 0.32x - 0.06
12	y = 0.80x - 0.20	y = 0.23x - 0.16	y = 0.23x + 0.001
21	y = 0.14x + 0.03	-	-
23	y = 0.81x - 0.40	y = 0.53x - 0.43	y = 0.60x - 0.08
24	y = 0.87x - 0.47	y = 0.39x - 0.22	y = 0.44x - 0.00
25	y = 0.85x - 0.42	y = 0.46x - 0.29	y = 0.55x - 0.07
26	y = 0.37x - 0.11	-	-
34	y = 0.78x + 0.16	y = 0.44x - 0.05	y = 0.56x - 0.21

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*significance level 95%

**significance level 99%

Participating Research Centre: Institute of Hygiene
University of Genoa
GENOA
Italy

Principal Investigator: S. DE FLORA

Introduction:

A large body of investigations has been devoted to the study of the hygienic conditions of sea-water and of seafood, including the monitoring of specific areas, particularly in the Tyrrhenian Sea. However, some chemical aspects of sea-water pollution and of the marine fauna were also investigated outside the Mediterranean Sea and even in remote areas, e.g. in the Caribbean Sea, in the Indian Ocean, etc. Our activity included the study of physical (e.g. radioactivity), chemistry (including also heavy elements) and microbiological aspects. Particular attention was given to the problem of the virological monitoring of water and marine sediments.

Area(s) studied:

The areas studied were the Tuscany littoral, Elba, Gorgona and Capraia Isles, Calambrone and Cecin rivers (latitude 43°35' N-42° 40'N, longitude 9°45' E - 10°33' E).

The prevailing local currents flow from south to north. However, the direction of the flow is sometimes reversed close to the coastline.

A total of 247 monitoring stations was examined.

Total heterotrophic bacteria were checked by the pour plate method after 48 hours at 35°C in plate count agar. Faecal streptococci were determined by the membrane filter method of m-Enterococcus agar. Total coliforms and E. coli were determined by the multiple tube fermentation method, as follows: presumptive test in lauryl tryptose broth at 35°C (5 tubes/dilution) and confirmatory tests in brillant green lactose bile broth at 35°C and 44°C, respectively.

The MPN method was used instead of the suggested MF method for two reasons.

(a) the MPN method is compulsory in Italy for the monitoring of bathing areas, and therefore is currently used in our laboratory and in those of collaborating institutions;

(b) we have not as yet received (September 1978) the filtration apparatus which was to be kindly supplied by WHO. Comparative assays of the MF and MPN methods will be carried out after receipt of this apparatus.

Results and their interpretation:

The results of the virological investigations, together with similar data collected from other areas of the Northern Tyrrhenian Sea, have provided information on the extent and quality of the viral pollution of surface and bottom seawater and of marine sediments. Moreover, these data have been analyzed to assess the correlation between animal viruses and the bacteriological indicator of pollution in the marine environment (references 1 and 2).

A summary of the results of part of the bacteriological monitoring is given in figures 1 to 4, where an evaluation of the pollution load is expressed in terms of E. coli (mean values) in the coastal areas.

The pollution of sea-water along the Tuscany littoral (figure 1) appears to be highly variable and greatly influenced by the discharge of sewage effluents in coastal areas facing Leghorn port and town and other urban settlements, some of which receive considerable numbers of tourists in the summer season. A very heavy polluted load is provided by the so-call "Fossi" (network of sewage drainage canals of the ancient Leghorn). (See sampling stations in figures 1, 2, 3 and 4 of the Tuscany littoral). However, at some stations the pollution load was lower than expected because the pollution sources, such as small water-courses, were frequently obstructed prior to discharge into the sea. At other stations, the pollution load in multiple samplings was extremely variable, due to the intermittent flow of sewage outlets. In many case, most bathing areas were found to be below the threshold limit fixed by Italian sanitary authorities (100 E. coli in 100 ml sea-water).

The situation appears to be satisfactory in the coastal areas surrounding the Elba Isle (figure 2), with few exceptions in localized water bodies receiving sewage effluents from the major urban settlements and tourist resorts of this island. In Capraia Isle (figure 3) polluted waters could be detected only inside the boat basin, along the wharf, whereas in Gorgona Isle (figure 4) only clean waters could be detected.

Additional technical aspects will be discussed in more detail in the final report when all data gathered have been comprehensively analysed.

However, the bacteriological monitoring showed rather peculiar figures in a coastal area (latitude 43 22' 40 ".N, longitude 10 26'13" E) receiving untreated wastes from an industry producing soda and a number of other chemicals. These alkaline and warm industrial wastes, carrying large amounts of calcareous matter, are combined with domestic sewage prior to discharge into the sea. Concentration of total coliforms and E. coli was far lower than expected, both in wastewater samples and in the recipent sea-water body. Moreover, the numbers of coliforms were unusually and considerably lower than those of faecal streptococci, which represented a large proportion of total heterotrophic bacteria and heavily polluted the whole coastal area under study.

These atypical figures suggested a possible selective inactivation of micro-organisms in the industrial waste water. Such a hypothesis was supported by the results of additional laboratory investigations concerning the survival under various conditions of three bacteria (E. coli, Streptococcus faecalis and S. typhi), of a virus (type 1 poliovirus, strain LSc2ab) and a viral antigen (hepatitis B surface antigen or HB Ag). We completed a multidisciplinary study in this area, including aerial photographic tests, physical parameters of water, particle size analysis of sediments and mutagencity of waste water.

Conclusions:

The results presented above, including the microbiological survey of an extensive area of the Tyrrhenian Sea, show a general picture of the pollution load of domestic sources in the monitored area.

Peculiar interaction phenomena between enteric organisms and pollutants of industrial sources have also been investigated and related to their effects in the marine environment. The definite detailed results of our monitoring programme will become available at the end of the MED VII pilot project.

Figure 1

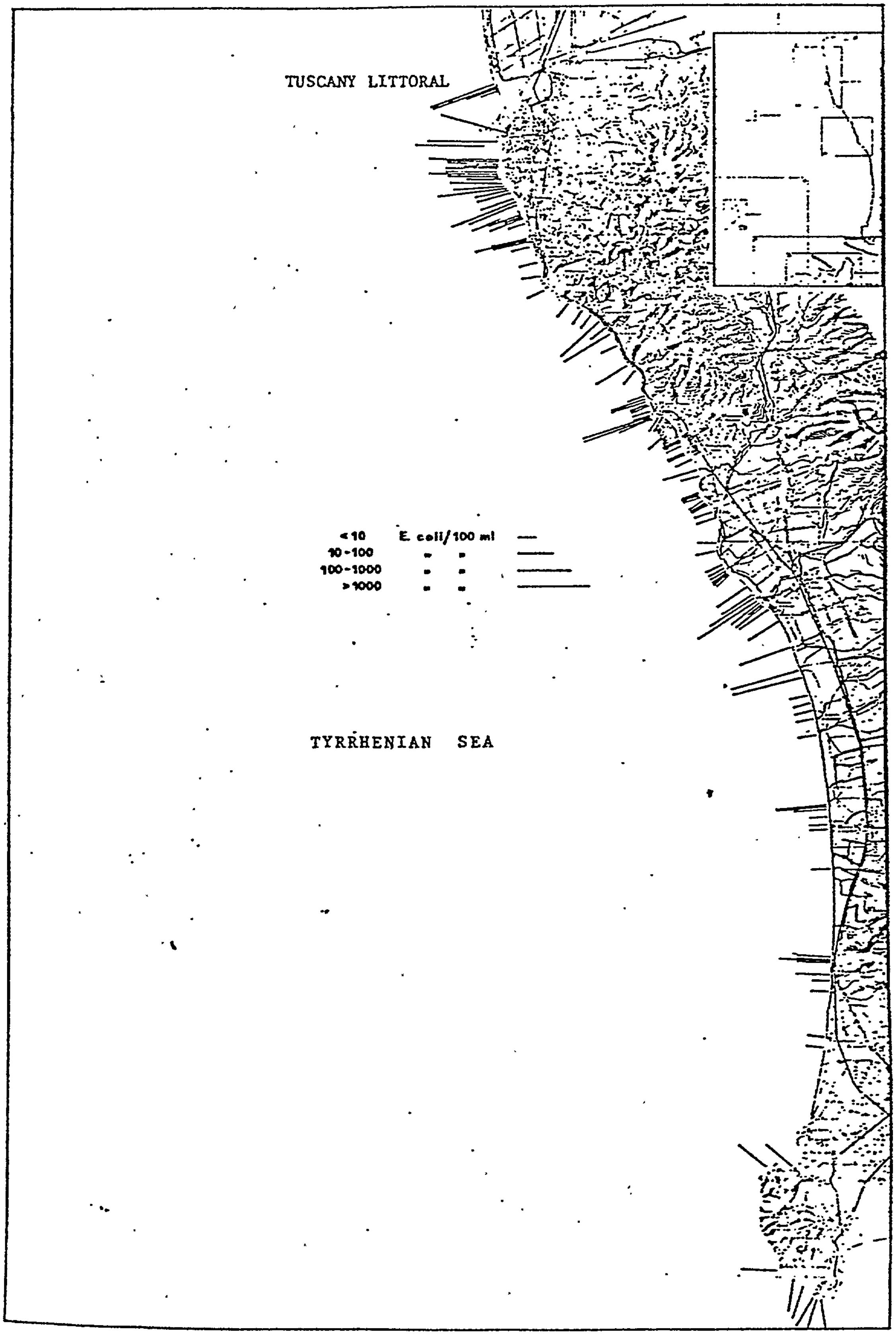

TUSCANY LITTORAL
<10 E. coli/100 ml
10-100 " "
100-1000 " "
>1000 " "
TYRRHENIAN SEA

Figure 2

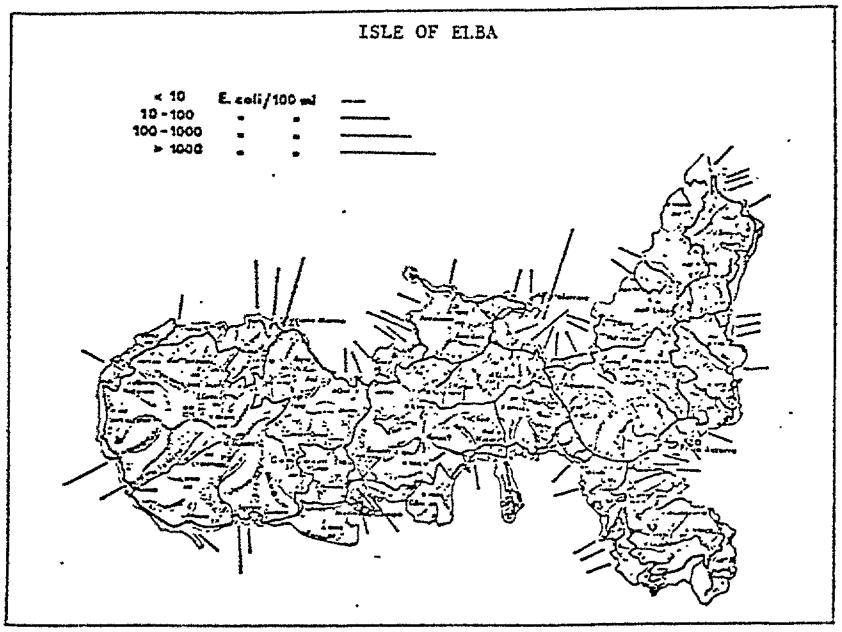


Figure 3

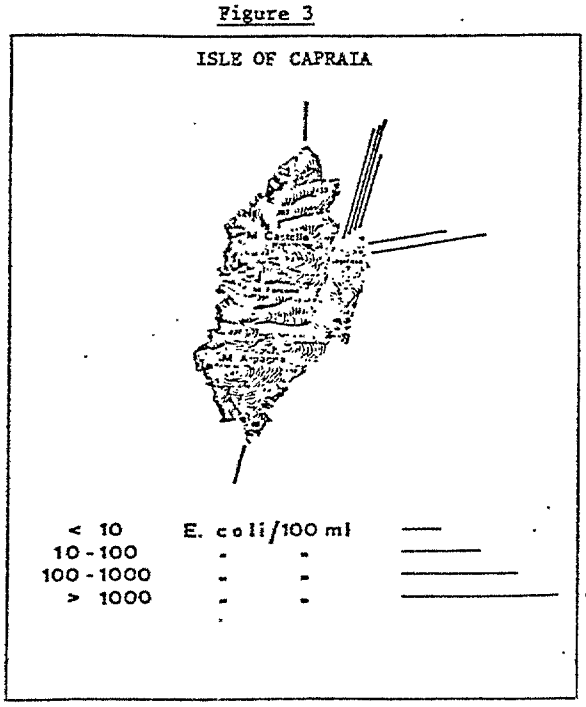
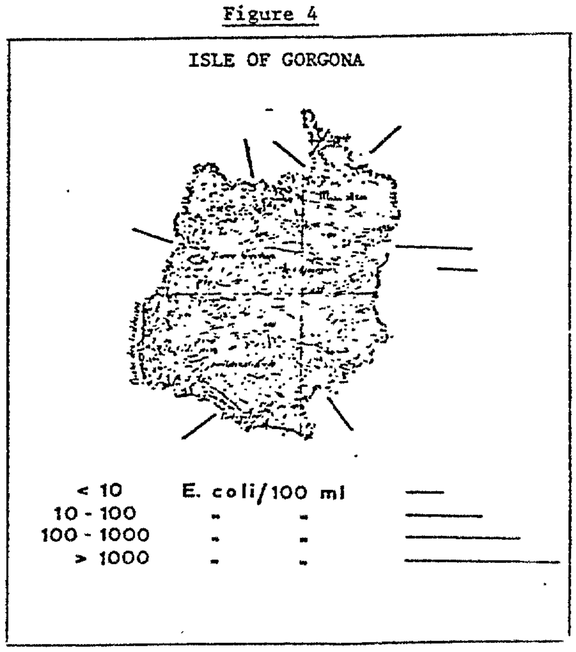


Figure 4



Participating Research Centre: Institute of Hygiene
University of Trieste
TRIESTE
Italy

Principal Investigator: L. MAJORI

Introduction:

The research activity of the Institute of Hygiene of the University of Trieste within the framework of project MED VII, started in 1978. It participates in an integration of numerous other research activities in the field of marine pollution, from the microbiological as well as from the chemical point of view, which was initiated in 1970.

Area(s) studied:

The study area is shown in the attached map (figure 1). The urban and industrial quarters, the outfalls from domestic and industrial wastes, the recreational areas, the rivers and the currents are clearly indicated on the map. The distribution of the sampling points is shown in figure 2. The 55 sampling stations are located along the coast as well as along a line perpendicular to the coast and at a decreasing distance from the beach (10 m, 500 m, 1000m, 1500m).

Material and methods used:

Pretreatment: the determination of ammonia, NO_3, NO_3, dissolved P are executed on the filtered sample by the filter membrane with pores of 0.45 um diameter.

Temperature, conductivity and salinity are measured by an induction salinometer with a sounding probe for recording temperatures at each point.

Dissolved oxygen is determined by the Winkler method modified according to Alsterberger. Total coliforms are determined by the filtration method using m-Endo agar incubated at 37°C (24 hours). Faecal coliforms are determined by the same method with m-FC agar incubated at 44.5°C (24 hours). Enterococcus is determined by the same method with m-enterococcus agar at 37°C (48 hours).

In some sampling points an analysis for qualitive detection of Salmonellae was undertaken.

Monitoring of shellfish has also been performed detecting the following parameters: total coliforms, faecal coliforms, enterococci and qualitative determination of Salmonellae.

Results and their interpretation:

Part of the results concerning the physico-chemical parameters appears in figures 3, 4, 5, 6, 7, 8, 9 and 10. Figures 11 and 12 give respectively a tentative evaluation of the quality of coastal seawaters of the Gulf of Trieste based on E. coli and Enterococci counts and the Italian legislation.

Table 1 gives the summarized results of the microbiological monitoring of the coastal seawater of the Gulf of Trieste for the period May 1978 - April 1979. Tables 2 and 3 gives the similar results for the period May 1978 to September 1978 and for October 1978 to April 1979. Tables 4 and 5 gives the frequency distribution respectively for faecal coliforms and for enterococci.

The areas where pollution is the greatest are limited to the Bay of Muggia (points 10 and 11) and to some of the points along a line orginating in the Bay (points 14, 15 and 16).

Two polluted zones are found south of the Barcola outfall and in the Duino area respectively.

The presence of Salmonellae strains has been confirmed at points 11 and 15 in spite of a low faecal coliform density.

Conclusions:

From the preliminary results described above, we can conclude that there are two areas of high concentrations of pollution, both chemical and bacteriological

The former area is located along the northern dispersion line originating in the Bay of Muggia, into which most of the municipal sewage and the harbour waste from the city of Trieste is discharged.

The latter is located in the northern section of the Gulf section off the town of Duino and is probably due to a defective sewage network and to occasional pollution from other human settlements in the neighbouring touristic areas.

Figure 1

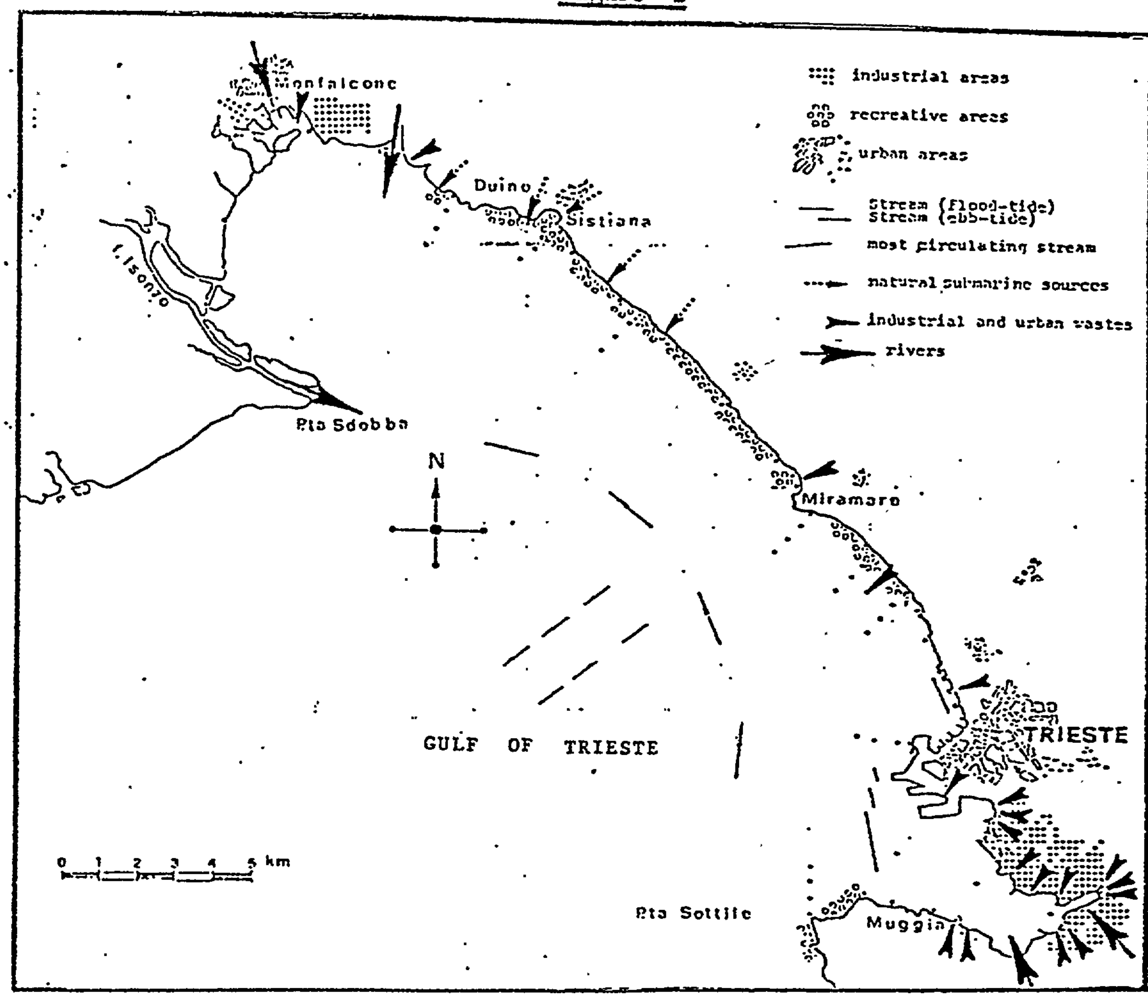

industrial areas
recreative areas
urban areas
Stream (flood-tide)
Stream (ebb-tide)
most circulating stream
natural submarine sources
industrial and urban wastes
rivers
Monfalcone
Duino
Sistiana
Pta Sdobba
N
Miramare
TRIESTE
GULF OF TRIESTE
0 1 2 3 4 5 km
Pta Sottile
Muggia

Figure 2

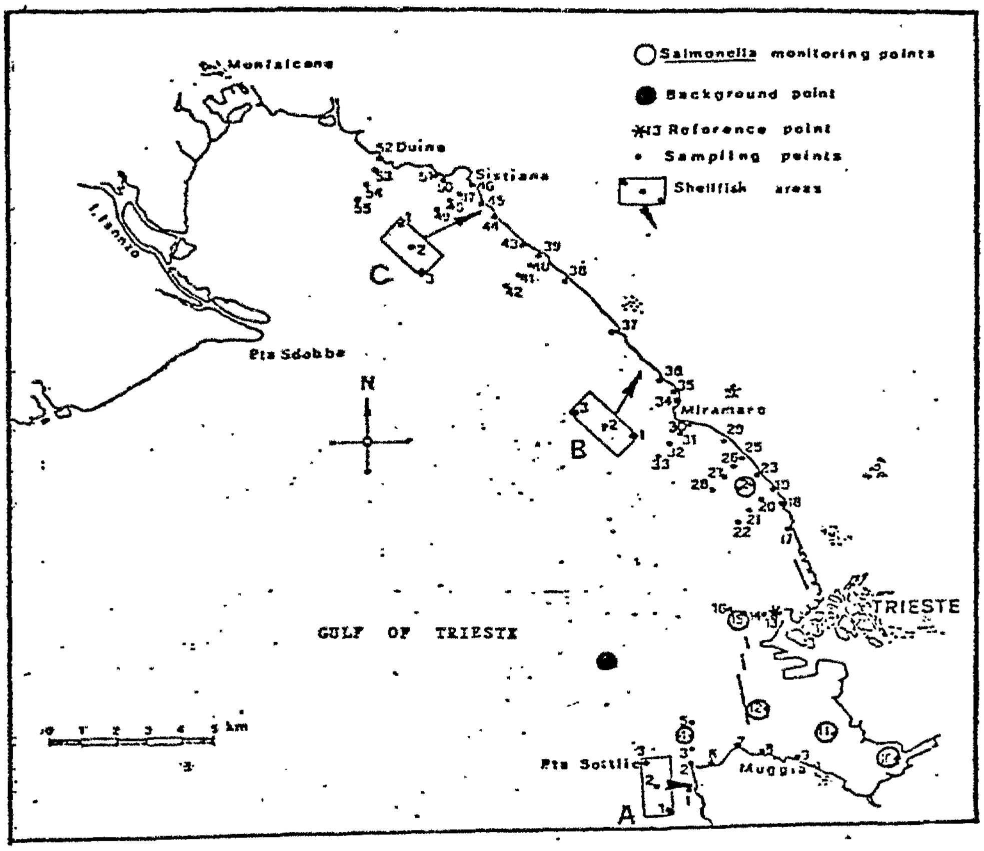


Figure 3

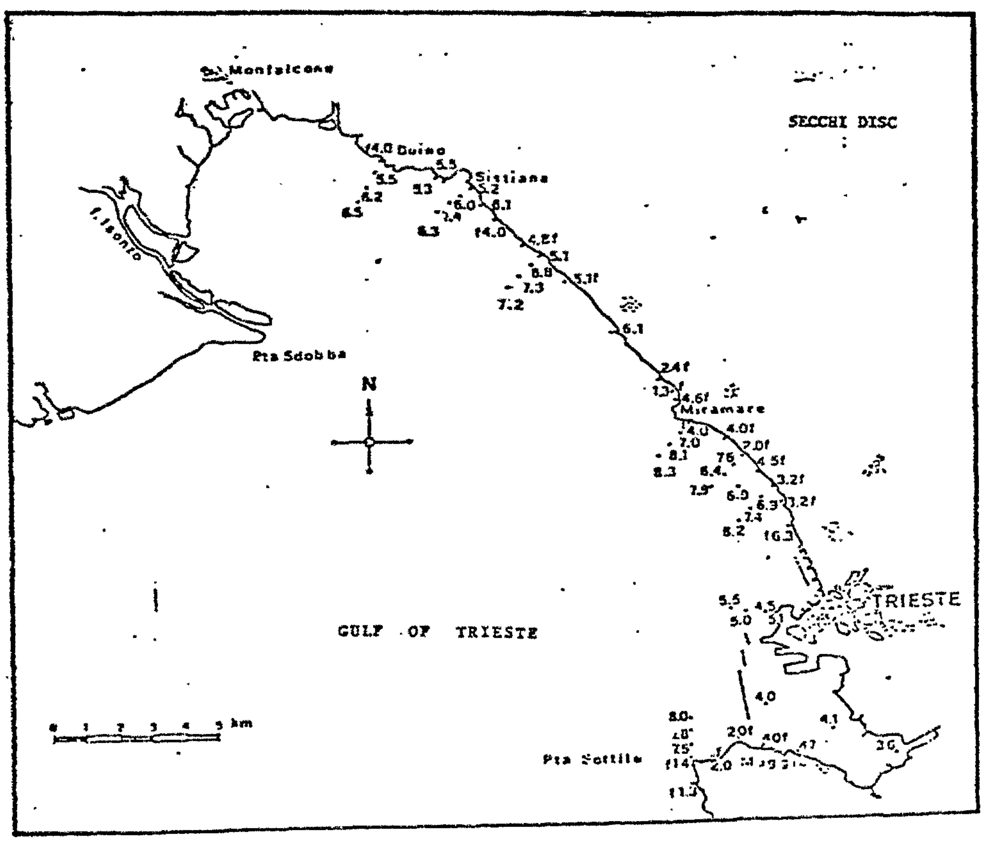


Figure 4

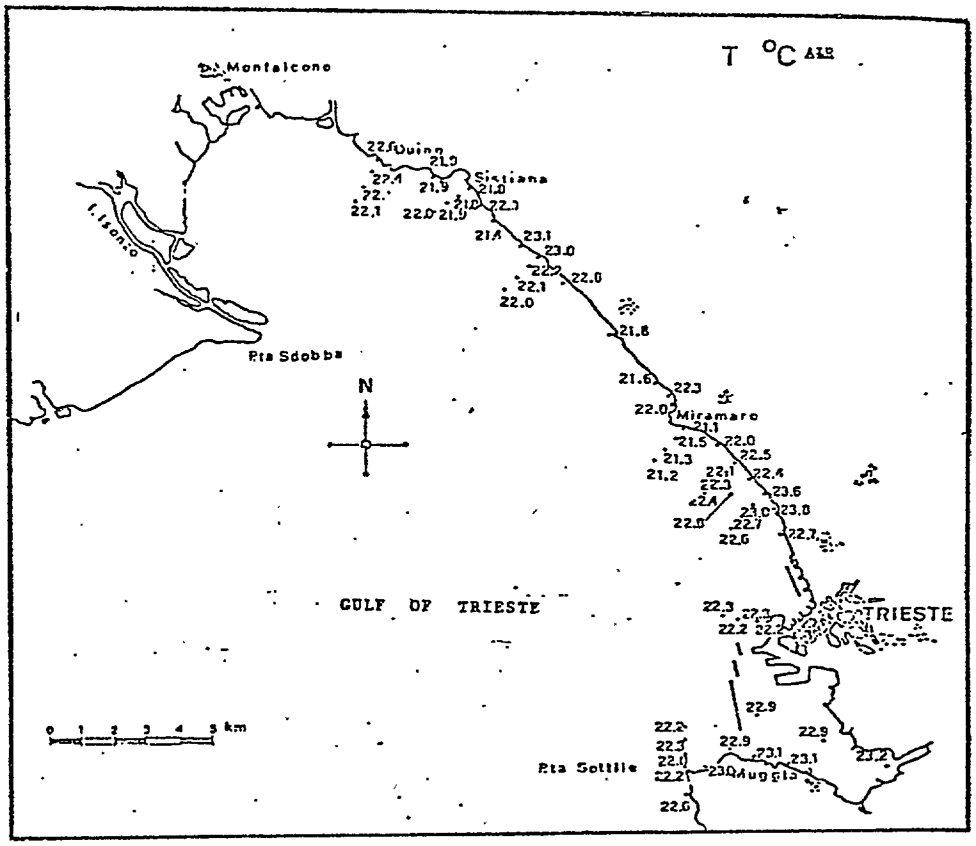


Figure 5

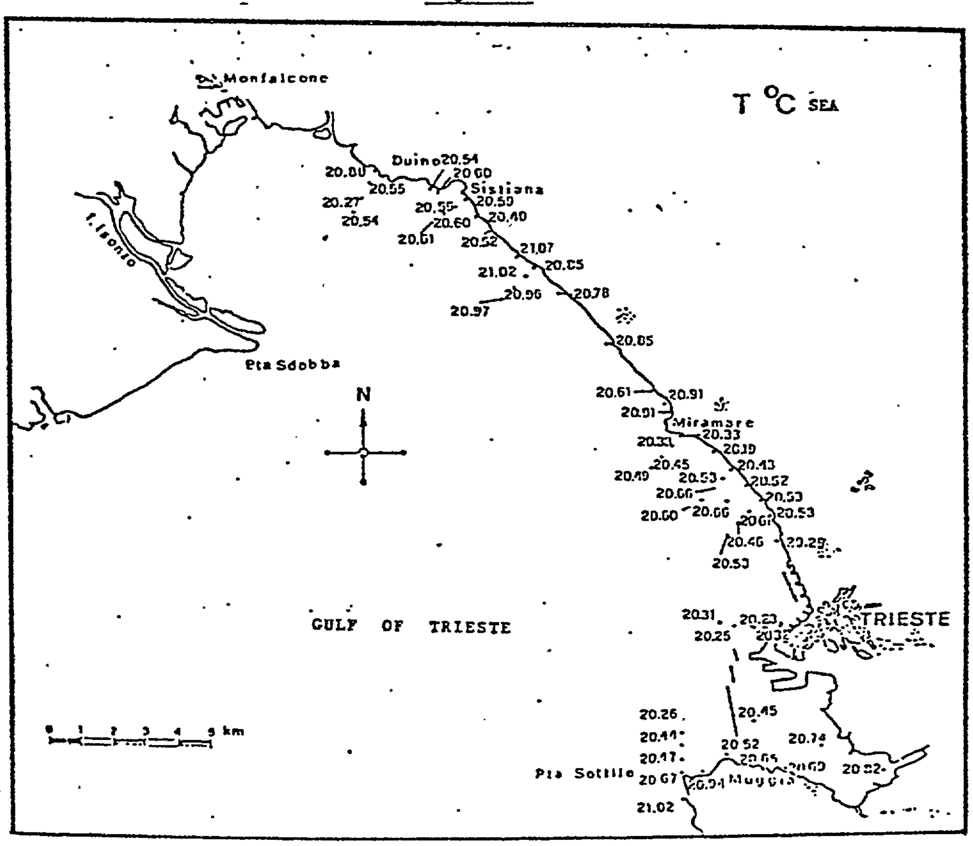


Figure 6

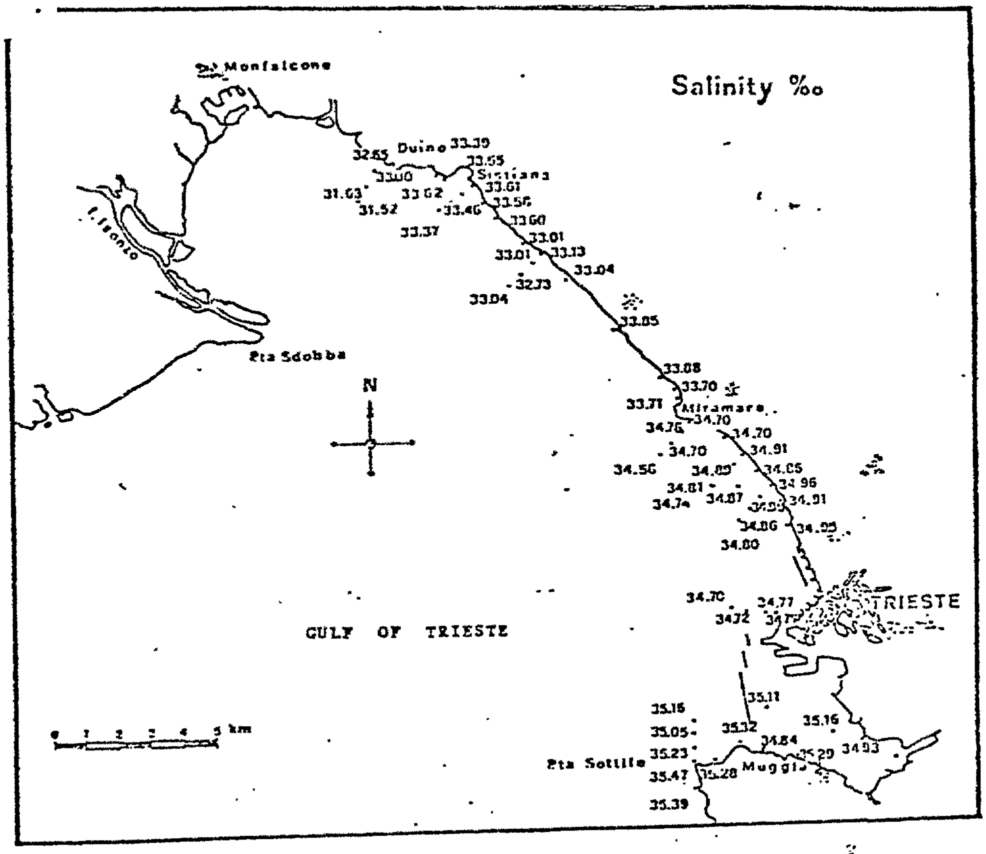


Figure 7

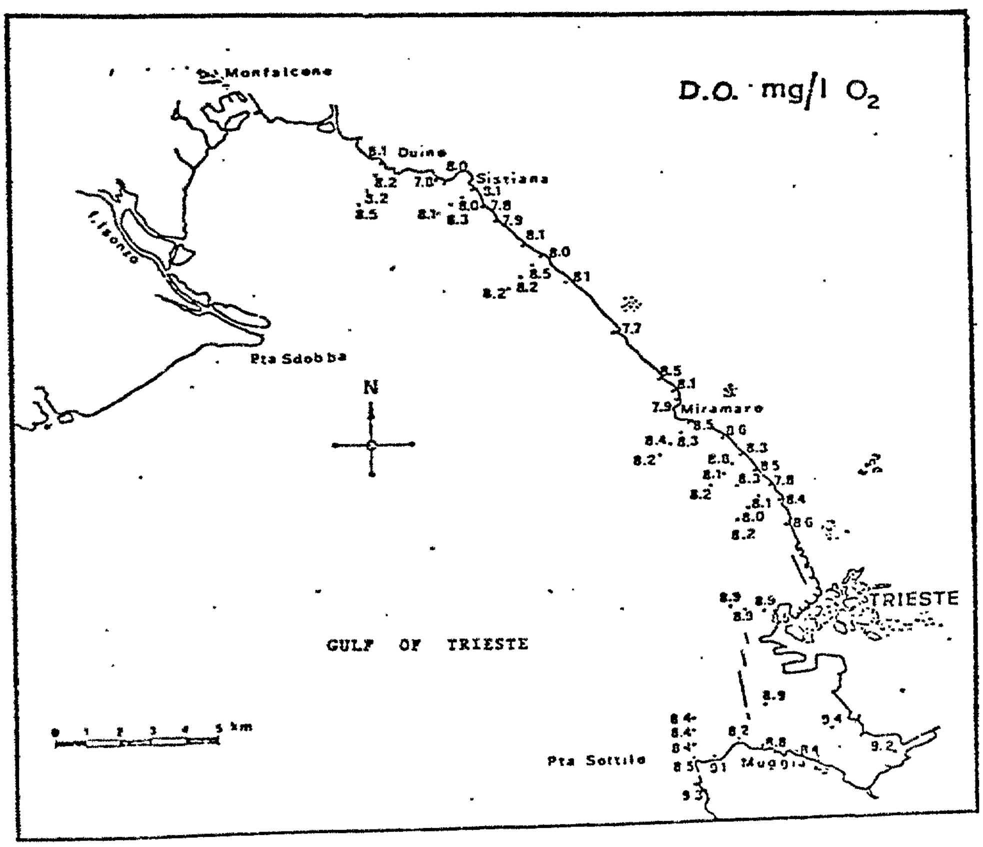


Figure 8

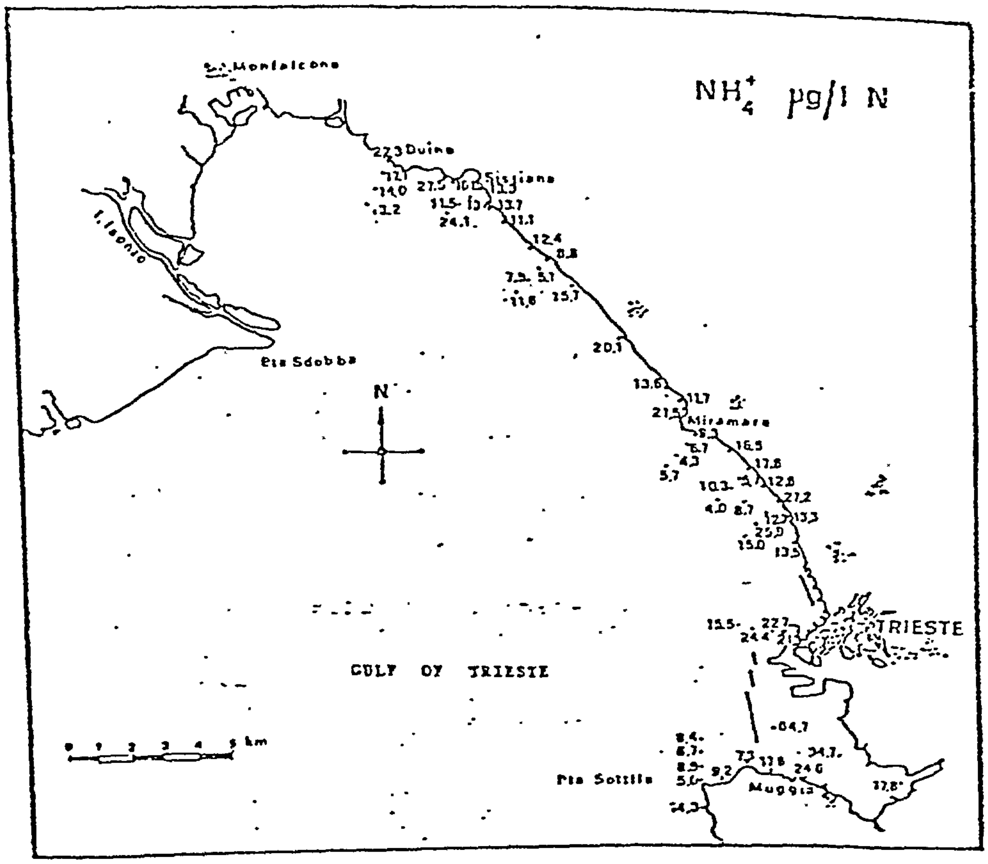


Figure 9

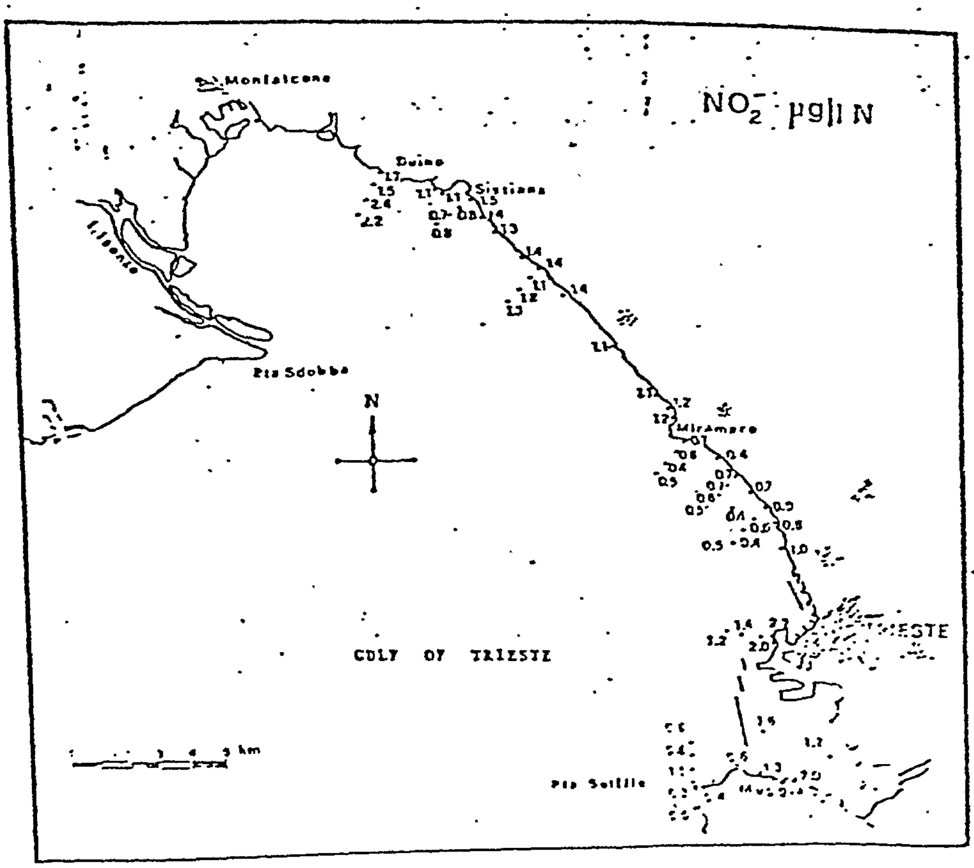
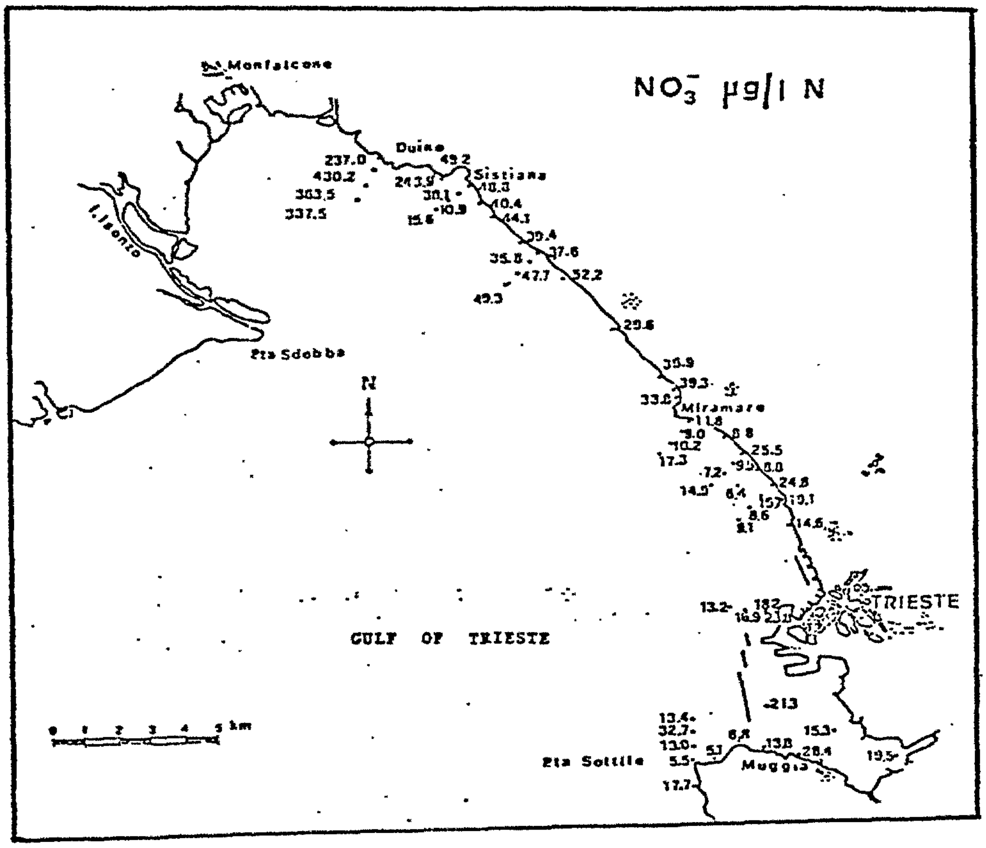


Figure 10



NO$_3^-$ µg/l N
Monfalcone
Duino
Sistiana
I. Isonzo
Pta Sdobba
Miramare
TRIESTE
GULF OF TRIESTE
Pta Sottile
Muggia
N
0 1 2 3 4 5 km

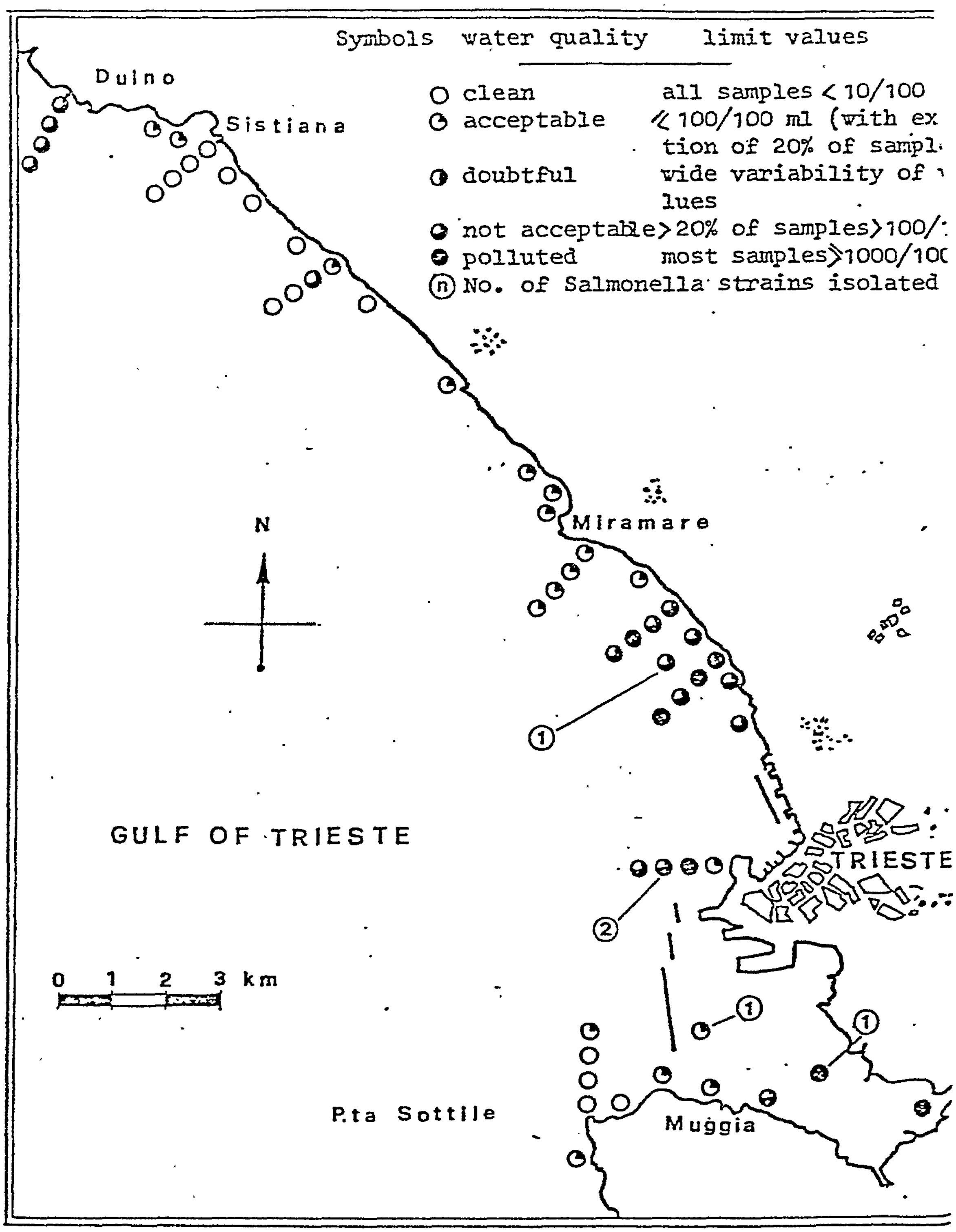


Fig. 11 – Tentative evaluation by means of Escherichia coli counts the quality of coastal seawaters of the Gulf of Trieste. (May 1978 – April 1979).

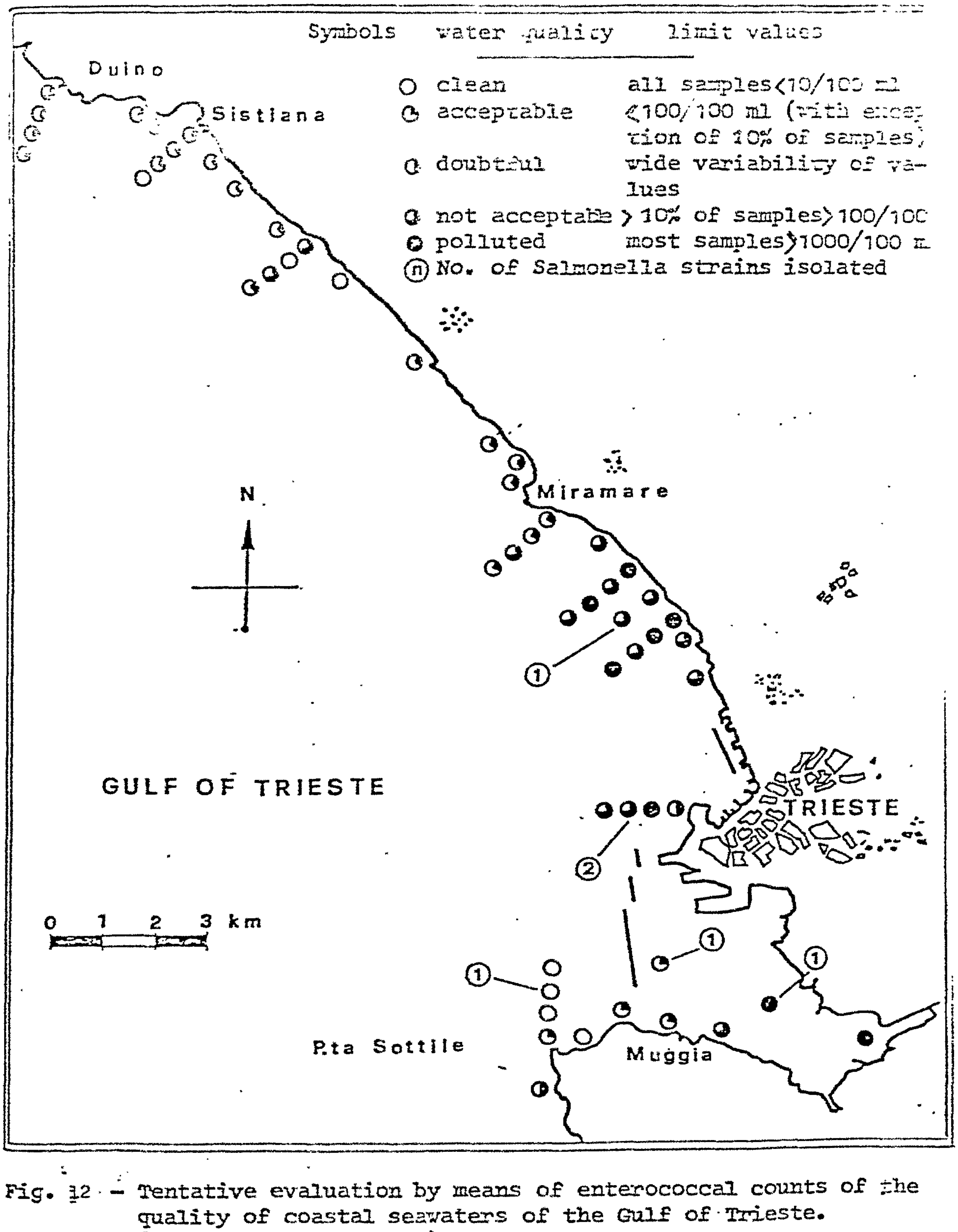


Fig. 12 – Tentative evaluation by means of enterococcal counts of the quality of coastal seawaters of the Gulf of Trieste. (May 1978 – April 1979).

Table N°1 - Summarized data on microbiological monitoring of coastal seawater of the Gulf of Trieste : distribution of microbial counts by the indicated parametric values (May 1978-April 1979).

Station	No. of samplings	TOTAL COLIFORMS/100 ml				FAECAL COLIFORMS/100 ml				ENTEROCOCCI/100 ml				SALMONELLA /5 l	
		<1	1-100	101-10³	>10³	<1	1-100	101-10³	>10³	<1	1-100	101-10³	>10³	pos.	neg.
1	11	2	8	1	0	4	6	1	0	3	7	0	1		
2	11	2	9	0	0	5	6	0	0	2	8	1	0		
3	11	3	6	2	0	7	4	0	0	7	4	0	0		
4	11	4	7	0	0	5	6	0	0	4	7	0	0		
5	11	3	5	1	2	6	4	1	0	4	7	0	0	1	10
6	11	3	6	1	1	6	5	0	0	7	4	0	0		
7	11	0	8	2	1	2	8	1	0	1	10	0	0		
8	11	0	9	1	1	5	6	0	0	4	7	0	0		
9	10	0	3	4	3	2	3	4	1	0	5	5	0		
10	11*	0	2	5	3	2	6	1	2	1	8	1	1	0	11
11	11	0	4	3	4	3	3	3	2	1	8	3	1	1	10
12	11	1	4	5	1	3	6	2	0	4	7	0	0	1	10
13	11	0	7	1	3	1	9	1	0	1	8	0	2		
14	11	0	3	3	5	0	5	4	2	0	6	3	2		
15	11	1	3	4	3	1	4	5	1	1	6	4	0	2	9
16	11	1	3	3	4	5	2	3	1	4	3	3	1		
17	11	1	3	2	5	1	5	4	1	2	4	4	1		
18	10	1	6	2	1	5	2	3	0	2	4	2	2		
19	11	1	5	1	4	3	3	0	5	2	3	2	4		
20	11	2	4	2	3	5	2	1	3	5	2	1	3		
21	11	3	5	2	1	5	4	1	1	3	5	2	1		
22	11	4	2	3	2	5	4	0	2	3	5	1	2		
23	11	1	7	2	1	5	4	1	1	4	3	3	1		
24	11	2	4	3	2	3	4	4	0	4	5	1	1	1	10
25	11	0	7	2	2	3	5	2	1	2	6	1	2		
26	11	2	7	1	1	6	3	1	1	4	5	1	1		
27	11	3	6	0	2	5	4	0	2	7	2	0	2		
28	11	3	6	1	1	7	3	0	1	6	4	0	1		
29	11	0	7	4	0	3	7	1	0	2	7	2	0		
30	11	2	7	2	0	5	6	0	0	5	4	2	0		
31	11	2	7	2	0	6	4	1	0	5	5	0	1		
32	10	0	9	0	1	6	3	0	1	3	5	1	1		
33	11*	7	3	0	0	6	5	0	0	8	3	0	0		
34	10	3	6	1	0	4	6	0	0	2	8	0	0		
35	11	4	3	4	0	5	6	0	0	4	6	1	0		
36	11	1	5	5	0	2	9	0	0	2	9	0	0		
37	11	2	6	3	0	5	6	0	0	8	3	0	0		
38	11	2	7	2	0	4	7	0	0	6	5	0	0		
39	10	2	6	0	2	7	2	1	0	6	2	2	0		
40	11*	5	5	0	0	8	3	0	0	7	4	0	0		
41	11	6	3	0	2	7	2	1	1	6	3	1	1		
42	11*	6	4	0	0	8	3	0	0	6	5	0	0		
43	11	3	7	1	0	6	5	0	0	5	6	0	0		
44	10	2	7	1	0	7	3	0	0	4	5	1	0		
45	11	2	8	1	0	9	2	0	0	6	4	1	0		
46	11	5	6	0	0	6	5	0	0	3	7	1	0		
47	11	3	8	0	0	9	2	0	0	5	5	1	0		
48	11	3	8	0	0	9	2	0	0	5	6	0	0		
49	11	4	7	0	0	9	2	0	0	5	6	0	0		
50	11	1	7	3	0	6	5	0	0	5	6	0	0		
51	11	0	5	5	1	3	7	1	0	2	9	0	0		
52	11	0	2	5	4	1	6	3	1	0	9	2	0		
53	11	3	0	3	5	3	3	2	3	3	8	0	0		
54	11	2	1	4	4	2	7	2	0	3	7	0	1		
55	10	2	3	3	2	4	3	3	0	3	6	1	0		

* One total coliforms count not done.

Table N° 2 - Summarized data on microbiological monitoring of coastal seawater of the Gulf of Trieste: distribution of microbial counts, by the indicated parametric values (May-September 1976).

station	No. of samplings	TOTAL COLIFORMS/100 ml				FAECAL COLIFORMS/100 ml				ENTEROCOCCI/100 ml				SALMONELLA /5 l	
		<1	1-100	101-10³	>10³	<1	1-100	101-10³	>10³	<1	1-100	101-10³	>10³	pos.	neg.
1	5	0	4	1	0	1	3	1	0	1	3	0	1		
2	5	0	5	0	0	1	4	0	0	1	4	0	0		
3	5	1	3	1	0	2	3	0	0	3	2	0	0		
4	5	1	4	0	0	1	4	0	0	1	4	0	0		
5	5	0	2	1	2	2	2	1	0	3	2	0	0	0	5
6	5	2	2	1	0	2	3	0	0	5	0	0	0		
7	5	0	4	1	0	1	4	0	0	1	4	0	0		
8	5	0	4	1	0	2	3	0	0	2	3	0	0		
9	5	0	1	3	1	1	0	4	0	0	1	4	0		
10	5	0	1	3	1	0	3	1	1	0	4	1	0	0	5
11	5	0	2	3	2	1	3	0	1	1	4	0	0	1	4
12	5	0	1	3	1	1	4	0	0	2	3	0	0	0	5
13	5	0	3	1	1	0	5	0	0	1	4	0	0		
14	5	0	1	1	3	0	2	1	2	0	4	1	0		
15	5	1	1	1	2	0	1	3	1	0	4	1	0	2	3
16	5	0	2	1	2	1	2	1	1	2	2	1	0		
17	6	1	3	1	1	1	5	0	0	2	4	0	0		
18	5	1	4	0	0	3	2	0	0	1	4	0	0		
19	6	1	3	0	2	2	2	0	2	2	2	1	1		
20	6	1	3	1	1	3	2	0	1	3	2	0	1		
21	6	2	3	1	0	4	2	0	0	2	3	1	0		
22	6	3	1	2	0	3	3	0	0	2	3	1	0		
23	6	1	5	0	0	4	2	0	0	4	2	0	0		
24	6	1	3	0	2	2	3	1	0	3	3	0	0	0	6
25	6	0	4	2	0	2	3	1	0	2	3	1	0		
26	6	1	5	0	0	5	1	0	0	4	2	0	0		
27	6	3	3	0	0	4	2	0	0	6	0	0	0		
28	6	1	4	1	0	5	1	0	0	4	2	0	0		
29	6	0	4	2	0	2	4	0	0	2	4	0	0		
30	6	1	4	1	0	3	3	0	0	4	2	0	0		
31	6	1	4	1	0	5	1	0	0	4	2	0	0		
32	5	0	5	0	0	4	1	0	0	3	2	0	0		
33	6	4	2	0	0	4	2	0	0	5	1	0	0		
34	6	3	3	0	0	3	3	0	0	2	4	0	0		
35	6	3	2	1	0	3	3	0	0	3	3	0	0		
36	6	0	2	4	0	1	5	0	0	1	5	0	0		
37	6	1	2	3	0	2	4	0	0	5	1	0	0		
38	6	1	3	2	0	2	4	0	0	5	1	0	0		
39	6	1	4	0	1	4	3	1	0	5	1	0	0		
40	6	3	3	0	0	5	1	0	0	5	1	0	0		
41	6	2	3	0	1	4	1	0	1	4	1	0	1		
42	6	3	2	0	1	4	2	0	0	3	3	0	0		
43	6	3	2	1	0	4	2	0	0	3	3	0	0		
44	5	1	3	1	0	3	2	0	0	3	2	0	0		
45	6	1	5	0	0	6	0	0	0	4	2	0	0		
46	6	3	3	0	0	3	3	0	0	3	3	0	0		
47	6	2	4	0	0	5	1	0	0	4	1	1	0		
48	6	2	4	0	0	5	1	0	0	3	3	0	0		
49	6	1	5	0	0	5	1	0	0	3	3	0	0		
50	6	0	5	1	0	4	2	0	0	4	2	0	0		
51	6	0	3	2	1	1	4	1	0	2	4	0	0		
52	6	0	2	2	2	1	4	0	1	0	5	0	0		
53	6	2	0	0	4	2	1	3	0	2	4	0	0		
54	6	1	1	1	3	1	3	2	0	2	4	0	0		
55	5	1	2	1	1	3	0	2	0	2	3	0	0		

Table N° 3 - Summarized data on microbiological monitoring of coastal seawater of the Gulf of Trieste: distribution of microbial counts by the indicated parametric values (October 78–April 79).

Station	No of samplings	TOTAL COLIFORMS/100 ml <1	1–100	$101-10^3$	$>10^3$	FAECAL COLIFORMS/100 ml <1	1–100	$101-10^3$	$>10^3$	ENTEROCOCCI/100 ml <1	1–100	$101-10^3$	$>10^3$	SALMONELLA/5 l pos.	neg.
1	6	2	4	0	0	3	3	0	0	2	4	0	0		
2	6	2	4	0	0	4	2	0	0	1	4	1	0		
3	6	2	3	1	0	5	1	0	0	4	2	0	0		
4	6	3	3	0	0	4	2	0	0	3	3	0	0		
5	6	3	3	0	0	4	2	0	0	4	2	0	0	1	5
6	6	1	4	0	1	4	2	0	0	2	4	0	0		
7	6	0	4	1	1	1	3	2	0	0	6	0	0		
8	6	0	5	0	1	2	4	0	0	2	4	0	0		
9	5	0	2	1	2	1	3	0	1	0	4	1	0		
10*	6	0	1	2	2	2	3	0	1	1	4	0	1	0	6
11	6	0	2	2	2	2	0	3	1	0	2	3	1	0	6
12	6	1	3	2	0	2	0	4	0	2	2	2	0	1	5
13	6	0	4	0	2	1	4	1	0	0	4	0	2		
14	6	0	2	2	2	0	3	3	0	0	2	2	2		
15	6	0	2	3	1	1	3	2	0	1	2	3	0	0	6
16	6	1	1	2	72	4	0	2	0	2	1	2	1		
17	5	0	0	1	4	0	0	4	1	0	0	4	1		
18	5	0	2	2	1	2	0	3	0	1	0	2	2		
19	5	0	2	1	2	1	1	0	3	0	1	1	3		
20	5	1	1	1	2	2	0	1	2	2	0	1	2		
21	5	1	2	1	1	1	2	1	1	1	2	1	1		
22	5	1	1	1	2	2	1	0	2	1	2	0	2		
23	5	0	2	2	1	1	2	1	1	0	1	3	1		
24	5	1	1	3	0	1	1	3	0	1	2	1	1	1	4
25	5	0	3	0	2	1	2	1	1	0	3	0	2		
26	5	1	2	1	1	1	2	1	1	0	3	1	1		
27	5	0	3	0	2	1	2	0	2	1	2	0	2		
28	5	2	2	0	1	2	2	0	1	2	2	0	1		
29	5	0	3	2	0	0	3	1	0	0	3	2	0		
30	5	1	3	1	0	2	3	0	0	1	2	2	0		
31	5	1	3	1	0	1	3	1	0	1	3	0	1		
32	5	0	4	0	1	2	2	0	1	0	3	1	1		
33*	5	3	1	0	0	2	3	0	0	3	2	0	0		
34	4	0	3	1	0	1	3	0	0	0	4	0	0		
35	5	1	1	3	0	2	3	0	0	1	3	1	0		
36	5	1	3	1	0	1	4	0	0	1	4	0	0		
37	5	1	4	0	0	3	2	0	0	3	2	0	0		
38	5	1	4	0	0	2	3	0	0	1	4	0	0		
39	4	1	2	0	1	3	1	0	0	1	1	2	0		
40*	5	2	2	0	0	3	2	0	0	2	3	0	0		
41	5	4	0	0	1	3	1	1	0	2	2	1	0		
42*	5	2	2	0	0	4	1	0	0	3	2	0	0		
43	5	0	5	0	0	2	3	0	0	2	3	0	0		
44	5	1	4	0	0	4	1	0	0	1	3	1	0		
45	5	1	3	1	0	3	2	0	0	2	2	1	0		
46	5	2	3	0	0	3	2	0	0	0	4	1	0		
47	5	1	4	0	0	4	1	0	0	1	4	0	0		
48	5	1	4	0	0	4	1	0	0	2	3	0	0		
49	5	3	2	0	0	4	1	0	0	2	3	0	0		
50	5	1	2	2	0	2	3	0	0	1	4	0	0		
51	5	0	2	3	0	2	3	0	0	0	5	0	0		
52	5	0	0	3	2	0	2	3	0	0	3	2	0		
53	5	1	0	3	1	1	2	1	1	1	4	0	0		
54	5	1	0	3	1	1	4	0	0	1	3	0	1		
55	5	1	1	2	1	1	3	1	0	1	3	1	0		

* One total coliforms count not done.

Table 4. - Frequency distribution for faecal coliform counts as related to major areas and to seasons.

Stations	No. of samples	Season	% samples with counts/100 ml of		
			$\leqslant 100$	$101 - 10^3$	$> 10^3$
1 - 15	75	S	78.9	14.7	6.7
	89	W	79.8	16.8	3.4
16 - 28	76	S	90.7	3.9	5.3
		*			
	66	W	51.5	25.7	22.7
29 - 55	159	S	93.1	5.7	1.2
	133	W	92.5	6.8	0.7
All stations	310	S	89.1	7.4	3.5
		*			
	288	W	79.5	13.5	6.9

Table 5. – Frequency distribution for enterococcal counts as related to major areas and to seasons.

Stations	No. of samples	Season	% samples with counts/100 ml of		
			$\leqslant 100$	$101 - 10^3$	$> 10^3$
1 – 15	75	S	89.3	9.3	1.3
	89	W	85.4	7.9	6.7
16 – 28	76	S *	90.8	6.6	2.6
	66	W	45.4	27.3	27.3
29 – 55	159	S	98.7	0.6	0.6
	133	W	86.5	11.3	2.2
All stations	310	S *	94.5	4.2	1.3
	288	W	76.4	13.5	10.1

Participating Research Centre: Centre de Recherche marine
Conseil national de la Recherche Scientifique
BEYROUTH
Liban

Principal Investigator: F.S. GHORRA/H.H. KOUYOUMJIAN

Introduction:

Work along MED VII lines has been conducted in Lebanon for the past decade, although very few of the findings have been published. Among those published, we generally observe a lack of systematic approach, and a general absence of comparability basically due to different methodologies used.

Area(s) studied:

The area studied falls within the following co-ordinates: 35°38'E, 34°01'N (Maameltein-north of Beirut) and 35°28'E, 33°50'N (Khalde-south of Beirut).

Off the coast of Lebanon the major currents fall within the current pattern of the Eastern Mediterranean. The current in our area has a value which varies between 0.2 and 1.4 knots. Figure 1 gives all the important aspects of this current and is based on unpublished data supplied by T. Goedicke. Figure 2, which is also partially based on Goedicke's work, gives information about rivers and other major outfalls which fall within the general area of study.

A total of about 40 stations are sampled for bacteriological analyses. These are divided as follows: three control stations, seven under influence of discharge points, and 30 regular.

Material and methods used:

Due to the lack of instrumentation and other facilities at the Centre, not all analyses were carried out using the MF method. This was intended to be remedied, but, due to the situation in Lebanon, this transition has been delayed. Eventually the MF method will be used in all bacteriological analyses. The bacteriological parameters studied were: total coliforms, faecal coliforms, faecal streptococci, Vibrio and Clostridium.

The basic methodology is based on the Guidelines prepared by WHO for this purpose.

Of the other relevant parameters, the following are regularly observed: air temperature, water temperature, salinity, pH, waves, wind, visual observation of floating pollutants and garbage on the coast.

Results and their interpretation:

Based on the results obtained for our station throughout the sampling period, these are some of the very general observations:

pH range: 7.13 - 8.28

water temperature: 13°C - 29°C

salinity: 33.72 - 41.12 ‰

At this stage we are unable to present all our data, properly analysed and tabulated.

These are the extreme values and are not indicative of the general mean. They compare favourably with past records. Water temperature was generally colder during 1977. Normally temperatures do not fall below 15°C.

As far as wind and drift are concerned, they tend to concentrate floating material on the coast particularly to the north of Beirut.

As far as bacteriological results are concerned, unfortunately they have not been analysed in detail due to lack of communication between the two principal investigators as a result of the very difficult circumstances we were facing.

Table 1 gives some bacteriological results. For the purpose of this summary report, a few (three) stations representative of the area studied are selected and results reported. They are also compared with three control stations and one station which is known to be influenced by a nearby sewer. It is apparent that all values are below international standards and are under the interim standard set by WHO for the Mediterranean. It must be noted here that almost all sampling operations were conducted after storms and heavy seas. Similarly, we wish to report that so far no vibrios have been isolated from our samples.

Conclusions:

All values fall within internationally accepted limits. Unfortunately, bacteriological parameters were not studied during the summer season due to the temporary cessation of our activities.

Table I

Station no.	Water temp. (°C)	Salinity (%)	pH	*E. coli*	Total coli	*Strep. faecalis*
39	18.0 ± 5.0	38.41 ± 0.17	8.13 ± 1.70	20 ± 31	337 ± 113	I
40	20.7 ± 2.0	38.45 ± 0.27	8.14 ± 0.04	I	158 ± 90	37 ± 23
41	21.1 ± 2.6	39.08 ± 0.60	8.18 ± 1.79	12 ± 5	224 ± 106	57 ± 26
11	21.1 ± 1.5	39.21 ± 0.28	8.18 ± 0.02	21 ± 8	360 ± 78	38 ± 14
29	20.8 ± 2.0	39.45 ± 0.36	8.14 ± 1.50	3 ± 2	163 ± 50	52 ± 29
37	20.8 ± 2.0	38.42 ± 0.16	8.11 ± 0.28	69 ± 58	732 ± 311	40 ± 22
17	21.1 ± 1.48	35.37 ± 4.28	7.78 ± 0.12	50 ± 30	515 ± 235	67 ± 36

N.B.
- stations 39, 40 and 41 are control stations
- stations 11, 29 and 37 are normal stations
- station 17 is under the influence of a domestic sewer
- the standard error of each number is also given in the table
- I = insignificant
- all bacterial counts are per 100 ml of sea-water

Figure 1

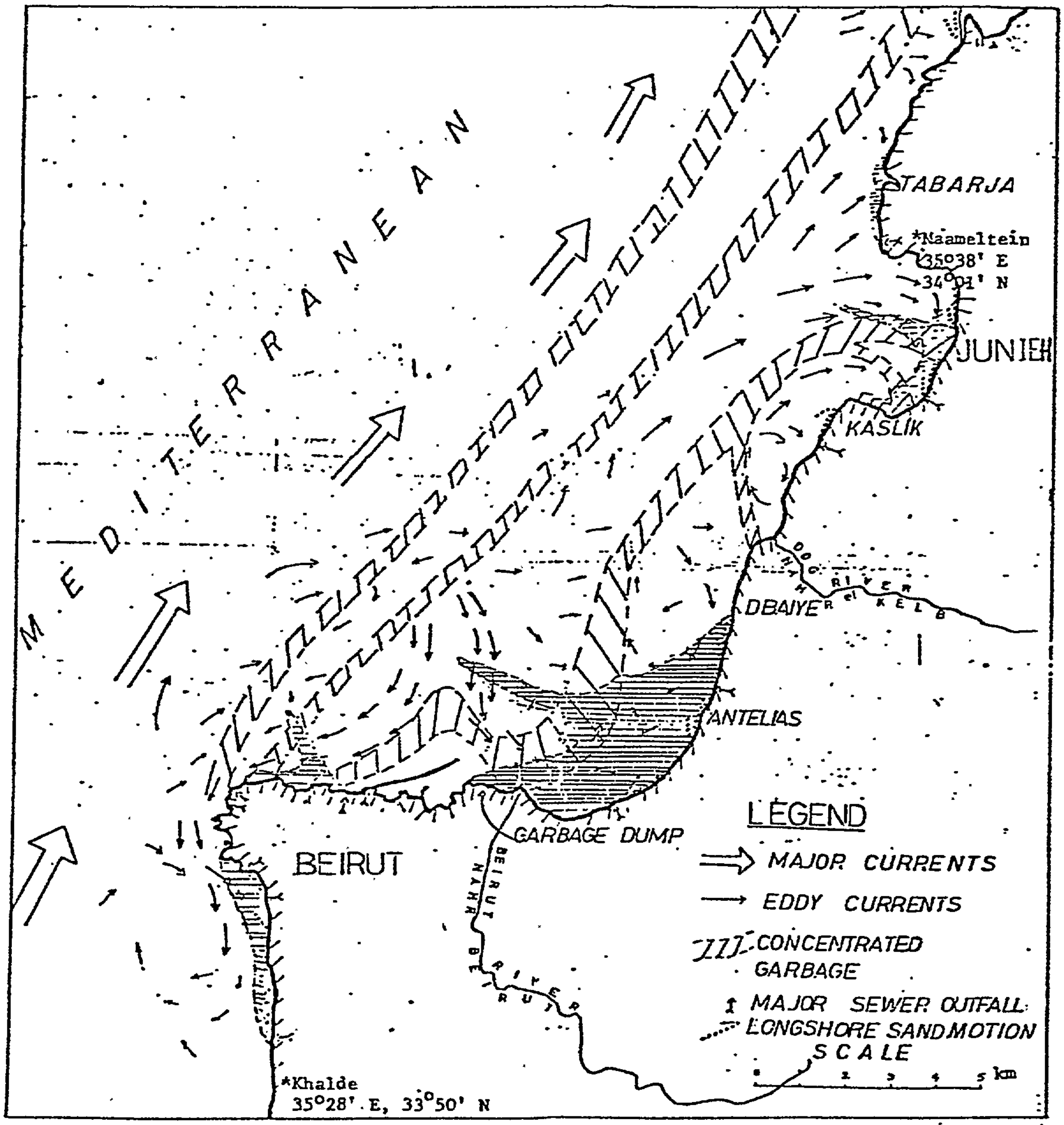
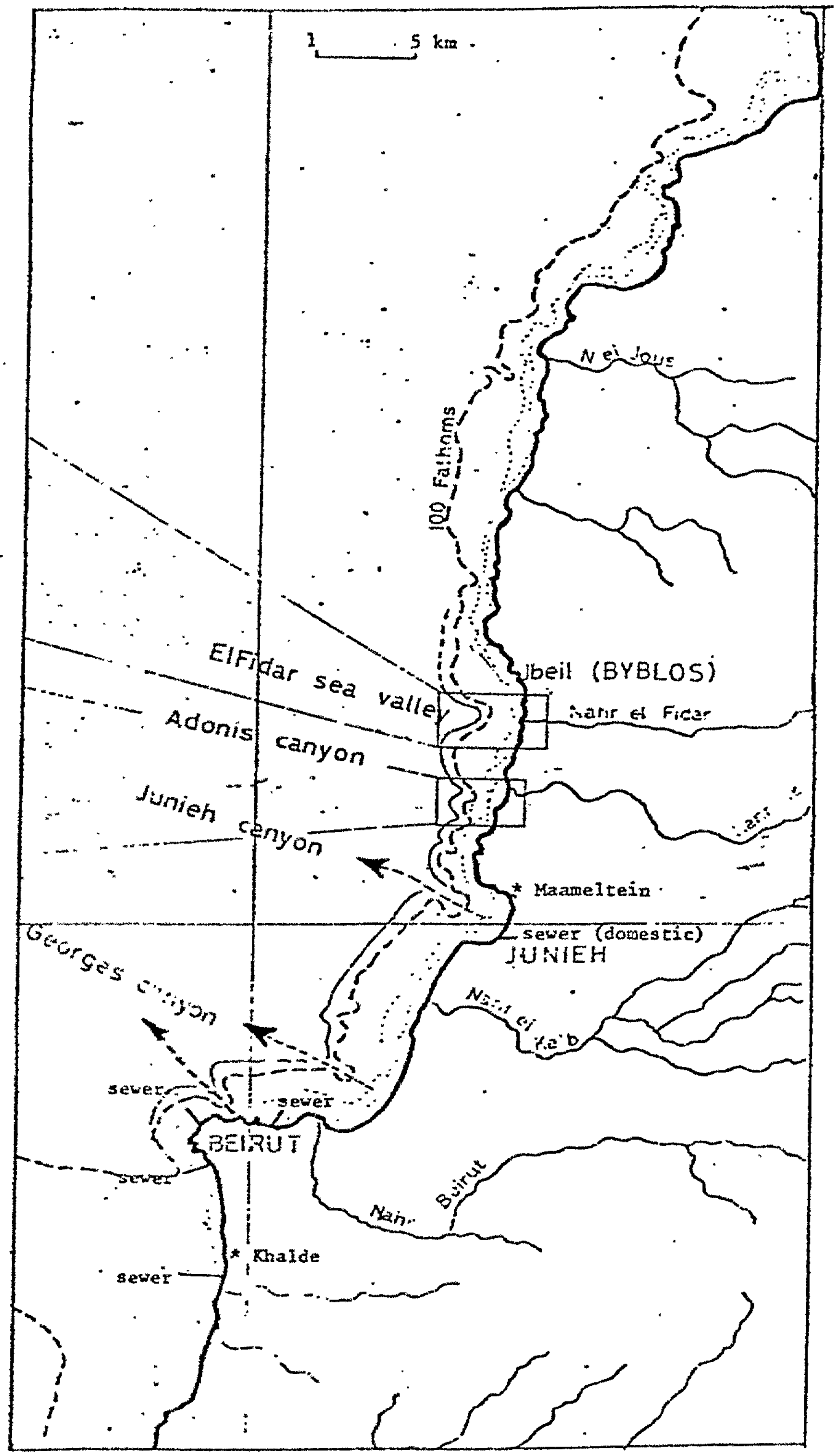

M E D I T E R R A N E A N
TABARJA
*Naameltein
35°38' E
34°01' N
JUNIEH
KASLIK
DBAIYE
NAHR el KELB RIVER
ANTELIAS
GARBAGE DUMP
BEIRUT
NAHR BEIRUT
BEIRUT RIVER
LEGEND
MAJOR CURRENTS
EDDY CURRENTS
CONCENTRATED GARBAGE
MAJOR SEWER OUTFALL
LONGSHORE SANDMOTION
SCALE
5 km
*Khalde
35°28' E, 33°50' N

Figure 2



1 5 km
100 Fathoms
N el Jouz
Jbeil (BYBLOS)
Nahr el Fidar
ElFidar sea valley
Adonis canyon
Junieh canyon
* Maameltein
sewer (domestic)
JUNIEH
Georges canyon
sewer
sewer
BEIRUT
sewer
Nahr Beirut
* Khalde
sewer

Participating Research Centre: Public Health Laboratory
Department of Health
VALLETTA
Malta

Principal Investigator: L.J. SPITERI

Introduction:

Health inspectors submit samples of sea-water routinely to the Health Department Laboratory. Recreational waters are given special importance during the bathing season (May-September). Sites which are liable to contamination due to sewage overflow are examined at least weekly during the bathing season. Bathing is prohibited when counts are constantly greater than 1000 E. coli per 100 ml.

Areas studied

The attached map (figure 1) shows the sampling sites, which are as follows:

San Lucian (reference area- clean)

Rinella (reference area near sewage outfall) - since August 1978 a submarine outfall has been installed at Wield Ghammieq

3, 4, 5 and 6: Ghadira - after heavy rainfall in winter, overflow of an adjacent sewer is possible with contamination with faecal organisms.

Length of coastline: 2 km.

Description of Ghadira Bay: No waste water outlets. Occasional overflow of public sewer after heavy storms may contaminate bay. No solid waste dumping sites on shores or offshore. Prevailing local current - north easterly. Area is sandy. Meteorological data is that applicable to Malta as a whole. Rocky hills on either side. Some cultivated patches. Various types of soil, mainly in isolated pockets. Storm water enters coastal area during N. E. wind periods.

Main recreational season June-September. Two hotels near beach area, two restaurants adjoining beach. Densely utilized during summer. Main urban settlement (Mellieha) does not discharge its wastes into area. No industrial development in area. Whole beach constitutes bathing area. Monitoring to be carried out 10 m from shoreline at points indicated on map.

Materials and methods used:

The bacteriological tests include total coliforms, faecal coliforms and faecal streptococci by MF. MPN is carried out in parallel as well as on other beaches.

The selected parameters which have been measured are:

surface temperature
salinity
visual appearance of beach
state of waves
wind direction
the bacteriological tests include: total coliforms
faecal coliforms
faecal streptococci

Results and their interpretation:

Figures obtained by MF were tabulated and mean values, standard deviation and distribution were obtained according to seasonal variations as shown in Tables 1, 2 and 3.

The number of coliforms in samples is much higher than that of enterococci and the number of faecal coliforms is between the above two.

Sixteen beaches in Malta and three beaches in Gozo cover practically the whole bathing areas used during the summer period in Malta and Gozo (see table 4). Only St. Paul's Bay area fails the accepted interim microbiological criteria (100 E. Coli/100 ml and no more than 10%, of at least ten consecutive samples should exceed 1000 E. Coli/100 ml).

This area now has a new sewage system and better results are expected in the future.

The results obtained clearly show the importance of wave heights, currents and contamination from sewage overflow.

On the whole, higher counts are registered by the MPN method than by the MF.

Conclusions and suggestions for continuation of work

Local legislation against the selling of shellfish as well as the prohibition of bathing in polluted areas have helped against the incidence of intestinal diseases in Malta. The incidence of typhoid has declined by 75% during 1978.

Work will continue and monitoring along the above accepted lines will ensure that bathing areas in Malta will be clean according to the accepted interim microbiological quality criteria.

Table 1: Total coliforms - No./100 ml; sampling point - Mellieha Bay

Sample values	Point 3		Point 4		Point 5		Point 6		All points	
Date (1978):										
7.2	4		42		0		0		11.50	
27.2	0		0		6		4		2.50	
7.3	57		4		0		2		15.75	
23.5	0		75		60		3		34.50	
5.7	0		0		40		2400		610	
25.7	16		96		10		26		37	
8.8	40		57		1320		2400		954.25	
12.9	6		266		48		176		124	
Mean values										
Summer	15.50		104.75		354.5		1250.50		431.31	
Others	15.25		30.25		16.5		2.25		16.06	
Total	15.38		67.50		185.5		626.38		223.69	
Standard deviations										
Summer	17.62		114.50		643.87		1328.74		430.24	
Others	27.90		53.33		29.14		1.71		13.48	
Total	21.60		87.97		459.00		1096.29		358.71	
Distributions - P.C.	No.	%	No.	%	No.	%	No.	%	No.	%
0 - 100	8	100	7	87.5	7	87.5	5	62.5	5	62.5
101 -1000	0	0	1	12.5	1	12.5	1	12.5	3	37.5
> 1000	0	0	0	0	0	0	2	25.0	0	0

Table 2: Faecal coliforms - No./100 ml; sampling point - Mellieha Bay

Sample values	Point 3	Point 4	Point 5	Point 6	All points
Date (1978):					
7.2	2	42	2	0	11.5
27.2	0	0	6	0	1.5
7.3	34	4	0	2	10.0
23.5	0	75	9	3	21.75
5.7	0	0	3	47	12.50
25.7	4	6	5	7	5.50
8.8	5	57	516	720	324.50
12.9	2	146	17	60	56.25
Mean values					
Summer	2.75	52.25	135.25	208.50	99.69
Others	9	30.25	4.25	1.25	11.19
Total	5.88	41.25	69.75	104.88	55.44
Standard deviations					
Summer	2.22	67.53	253.91	341.59	151.55
Others	16.69	35.33	4.03	1.50	8.31
Total	11.52	51.26	180.39	249.65	110.05

Distributions - P.C.	No.	%	No.	%	No.	%	No.	%	No.	%
0 - 100	8	100	7	87.5	7	87.5	7	87.5	7	87.5
101 - 1000	0	0	1	12.5	1	12.5	1	12.5	1	12.5
> 1000	0	0	0	0	0	0	0	0	0	0

Table 3: Faecal streptococci - No./100 ml; sampling point - Mellieha Bay

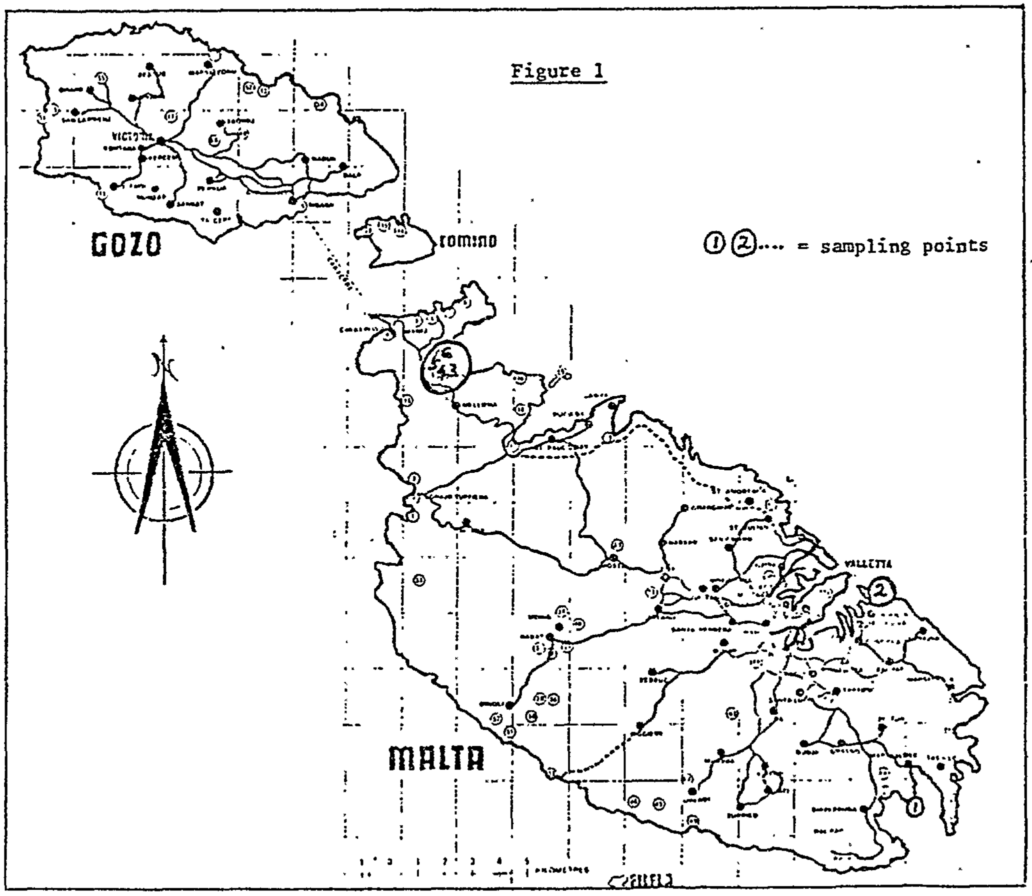
Sample values	Point 3	Point 4	Point 5	Point 6	All point
Data (1978):					
7.2	1	104	1	0	26.50
27.2	1	0	13	2	4
7.3	0	0	1	1	0.5
23.5	0	24	22	1	11.75
5.7	1	0	3	7	2.75
25.7	10	20	12	5	11.75
8.8	5	70	118	48	60.25
12.9	18	13	8	38	19.25
Mean values					
Summer	8.5	25.75	35.25	24.5	23.50
Others	0.5	32.0	9.25	1.0	10.69
Total	4.5	28.88	22.25	12.75	17.10
Standard deviations					
Summer	7.33	30.64	55.29	21.76	25.41
Others	0.58	49.32	10.21	0.82	11.54
Total	6.44	38.16	39.34	19.00	19.51

Distributions - P.C.	No.	%	No.	%	No.	%	No.	%	No.	%
0 - 100	8	100	7	87.5	7	87.5	8	100	8	100
101 - 1000	0	0	1	12.5	1	12.5	0	0	0	0
> 1000	0	0	0	0	0	0	0	0	0	0

Table 4: Sea-water - bacteriological data MPN (1 January - 30 September 1978)

Area	E. coli 0-100 in 100 ml	E. coli 101 - 1000	E. coli in excess of 1000/100 ml
Malta			
Armier	17	6	3
Ghadira	94	11	1
St Paul's Bay Area	402	119	129
Sliema Area	450	11	2
Valletta	123		
Xghira	58	2	
Delimara	36	1	
M'Xlokk Area	66		
Wied iz-Zurrieq	26	1	
Ghar Lapsi	15		
St Thomas Bay	39		
Ghajn Tuffieha	43		
M'Scala	90	1	1
Salina Bay	41		
Bahar ic-Caghaq	22		
B'Bugia Area	221	7	3
Gozo			
M'Forn	37		
Xlendi	36		
Ramla	17		

Figure 1



Centre de Recherche Participant : Institut National d'Hygiène
Ministère de la Santé Publique
RABAT
Maroc

Chercheur Principal : N. Benmansour

Aucun rapport a été soumis.

Centre de Recherche Participant: Centre Scientifique de Monaco
MONTE CARLO
Principauté de Monaco

Chercheur Principal: R. VAISSIERE

Introduction:

Le Laboratoire de Microbiologie et d'Etudes des Pollution Marines a été créé en 1967. Il se compose de scientifiques de formation différente qui se sont spécialisés dans la surveillance des polluants en milieu marin et dans l'étude de leurs effets sur les écosystèmes côtiers.

Les prélèvements d'eau de mer, comme la mesure des composants physiques, chimiques et biologiques de ce milieu, sont devenus des activités de routine du laboratoire qui a, en outre, étudié les conditions hydrologiques de la région et la diffusion des eaux polluées par utilisation des traceurs (Rhodamine, photographies aériennes). Une méthode automatique d'analyses des détergents anioniques a également été mise au point.

Zone(s) étudiée(s):

Depuis 1977, et par conséquent pendant les trois années du projet MED POL VII, la totalité des eaux côtières de la Principauté est soumise à surveillance. Trois kilomètres de côte à vocation balnéaire ou portuaire sont contrôlés à partir de l'analyse d'échantillons d'eau de mer prélevés régulièrement tout au long de l'année en douze stations fixes (fig. 1).

Matériel et méthodes:

Les méthodes d'analyse utilisées pour cette surveillance sont identiques à celles décrites par l'OMS, les analyses bactériologiques étant conduites par filtration sur membrane. La filtration est effectuée à bord du bateau immédiatement après le prélèvement.

Résultats et leur interprétation:

Les eaux usées de Monaco et des agglomérations voisines sont rassemblées depuis juillet 1971 dans un collecteur principal qui débouche en un point situé provisoirement à 450 m. de la côte et 47 m. de profondeur. Quatre petites rivières traversent la Principauté. Deux d'entre-elles débouchent directement en mer, l'une dans le coin nord du port, l'autre à la frontière est. Les deux autres ont été canalisées et se déversent dans le réseau d'assainissement. Afin de décharger ce réseau des crues passagères, un déversoir d'orage a été placé à proximité du raccordement de ces cours d'eau avec le réseau, il débouche à 30 m. de profondeur à 500 m. de la côte.

Les conditions hydrologiques diffèrent suivant que l'on s'intéresse aux masses d'eaux superficielles ou de fond.

En surface règne un régime complexe résultant des effets de trois composants essentiels :

- la topographie côtière : son effet sur la circulation générale des eaux de la mer Ligure conduit à des courants anticycloniques côtiers:

- le vent dont l'action devient prépondérante lorsque celui-ci est bien établi;

- les petits accidents côtiers : pointes digues, terre-plein, entrée de Port qui peuvent protéger certaines zones, ou provoquer des dépressions et conduire ainsi à l'accumulation de polluants et à des mouvements d'eau particuliers d'ampleur limitée.

Au fond, le courant montre une tendance à se déplacer en sens inverse de la couche d'eau superficielle soumise à l'action du vent mais n'atteint jamais l'orientation opposée comme cela est nettement observé dans les circulations océaniques. Un décalage plus ou moins important existe entre ces deux directions, il résulte de la topographie du fond et de la côte.

Enfin, les eaux marines de Monaco sont caractérisées entre la fin avril et le début octobre par une thermocline saisonnière. L'isotherme de valeur la plus elevée qui la délimite se situe au-dessus de 50 mètres de profondeur alors que l'isotherme 15°C peut atteindre le niveau 75 mètres.

Les quatre tableaux saisonniers, (fig. 2, 3, 4 et 5), rassemblent de façon synthétique les résultats obtenus durant le projet MED POL VII.

Afin d'augmenter le nombre d'observations, toutes les analyses effectuées entre 1975 et 1978 (soit environ 7100) ont été prises en compte dans l'élaboration de ce tableau.

Les résultats ont été séparés en sept groupes répondant aux conditions de vent le jour du prélèvement et ordonnés en classes définies suivant une croissance logarithmique :

Classes	Valeurs	Classes	Valeurs
1	< 2	5	55 à 167
2	2 à 6	6	167 à 500
3	6 à 19	7	> 500
4	19 à 55		

Les tableaux regroupent la fréquence des différentes classes en fonction de la station et de la direction du vent.

Conclusions:

On constate que les résultats acquis au cours du projet MED POL VII ne diffèrent pas de ceux obtenus depuis juillet 1972 (date de l'immersion du collecteur principal).

L'analyse de six ans de contrôle de la qualité des eaux marines de Monaco (cf. Boisson M., Vaissière R., Schommers E., Séméria J.) a montré que l'immersion du collecteur principal a créé dans les eaux superficielles un cycle annuel des polluants. Ce cycle se compose d'une phase hivernale (octobre à avril) et d'une phase estivale (mai à septembre).

En hiver, la concentration des polluants en surface s'explique par les conditions hydrologiques du jour du prélèvement. L'éloignement du point de rejet ayant l'effet prépondérant par rapport au gradient thermique.

En été, l'amélioration de la qualité des eaux côtières provient principalement de l'existence de la thermocline saisonnière au-dessus de l'orifice du collecteur principal. Cependant des variations accidentelles des conditions météorologiques et les modifications thermiques des masses d'eau qui en résultent, peuvent conduire à des concentrations de polluants en surface selon un schéma analogue à celui de la phase hivernale.

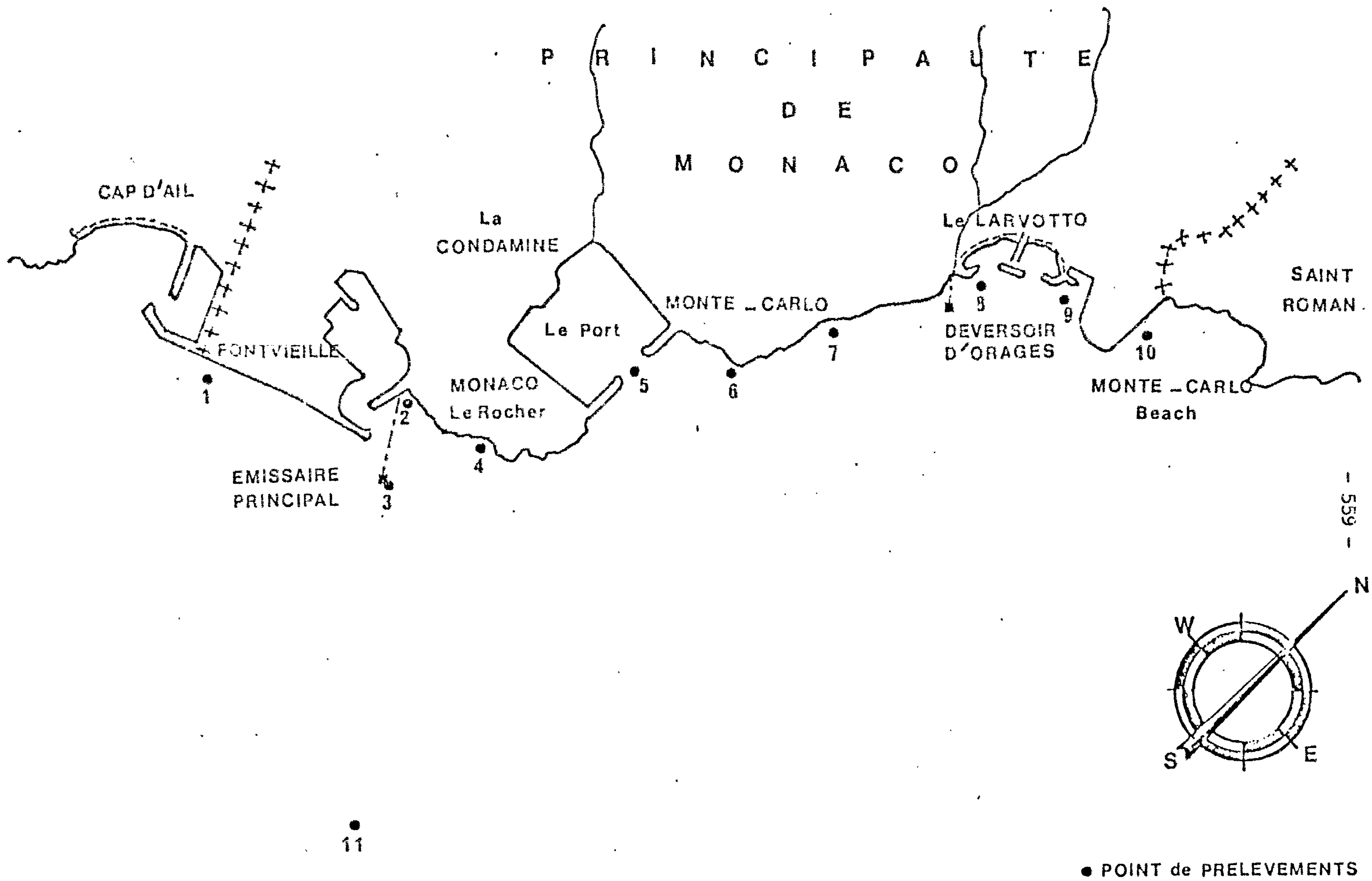

PRINCIPAUTE
DE
MONACO
CAP D'AIL
FONTVIEILLE
EMISSAIRE
PRINCIPAL
La
CONDAMINE
Le Port
MONACO
Le Rocher
MONTE - CARLO
Le LARVOTTO
DEVERSOIR
D'ORAGES
SAINT
ROMAN
MONTE - CARLO
Beach
1
2
3
4
5
6
7
8
9
10
11
N
S
E
W
• POINT de PRELEVEMENTS

Fig. 1

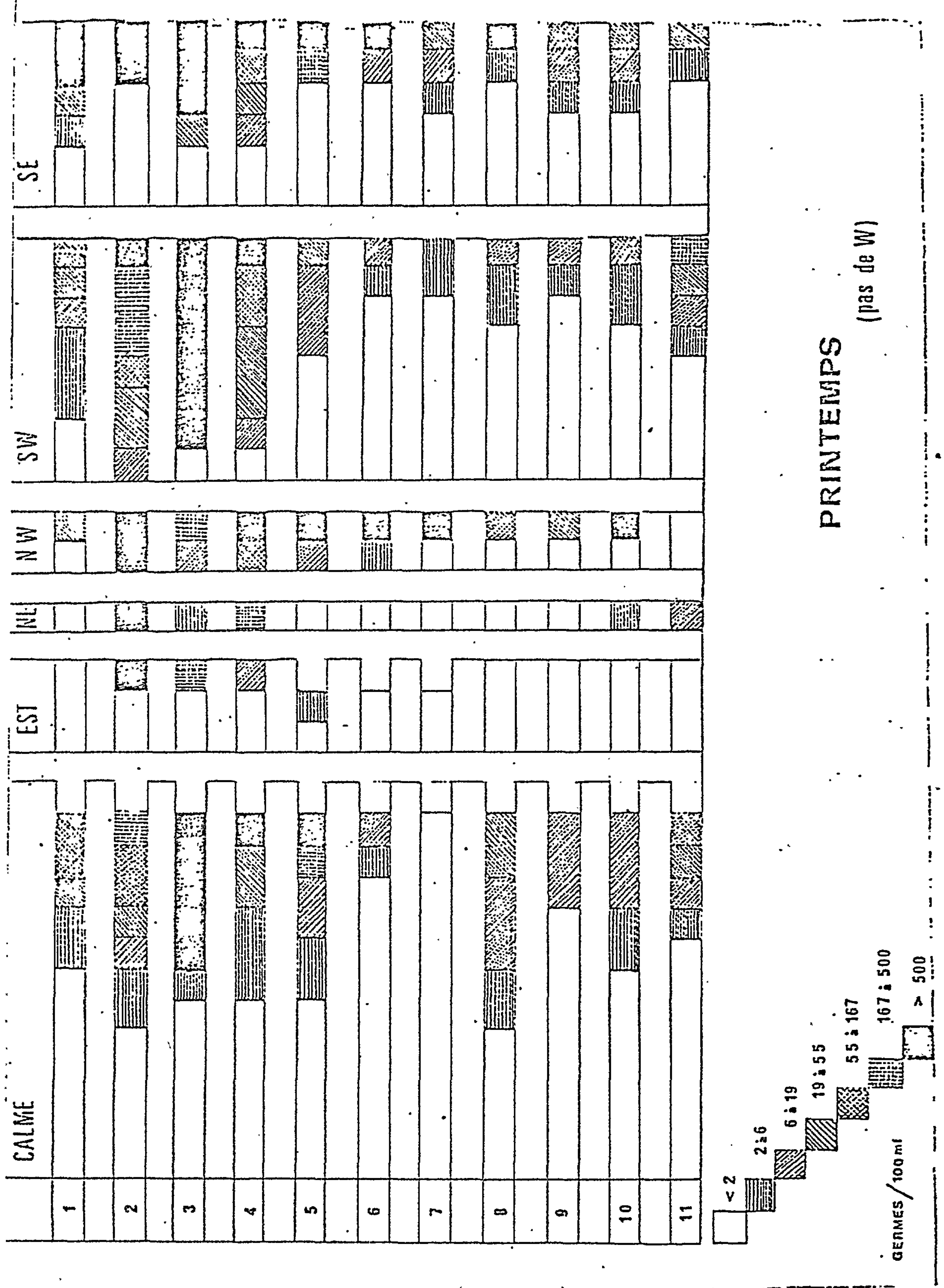
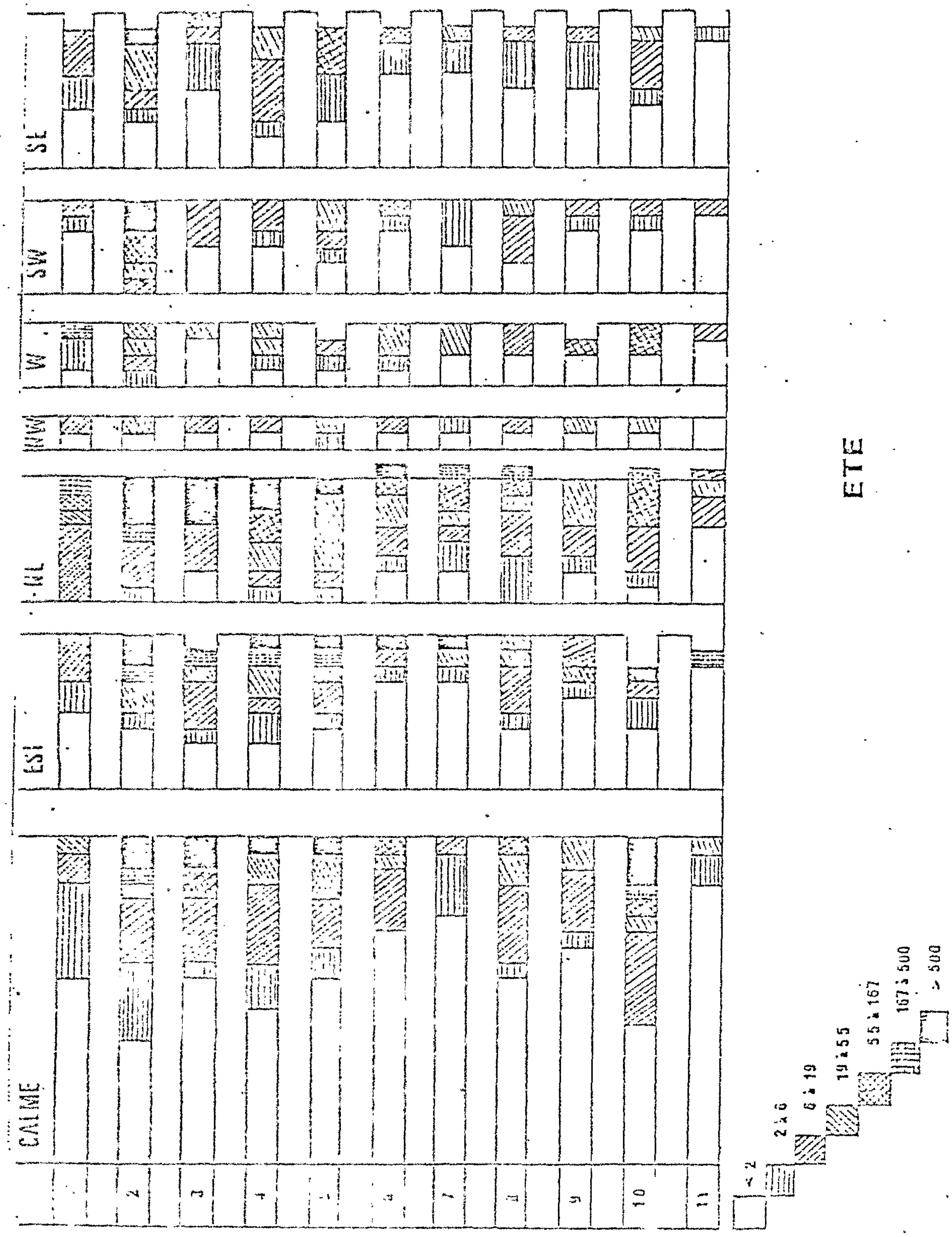

CALME
EST
NL
N W
SW
SE
1
2
3
4
5
6
7
8
9
10
11
< 2
2 à 6
6 à 19
19 à 55
55 à 167
167 à 500
> 500
GERMES/100 ml
PRINTEMPS
(pas de W)

Fig. 2



CALME
EST
NL
NW
W
SW
SE
1
2
3
4
5
6
7
8
9
10
11
< 2
2 à 6
6 à 19
19 à 55
55 à 167
167 à 500
> 500
ETE

Fig. 3

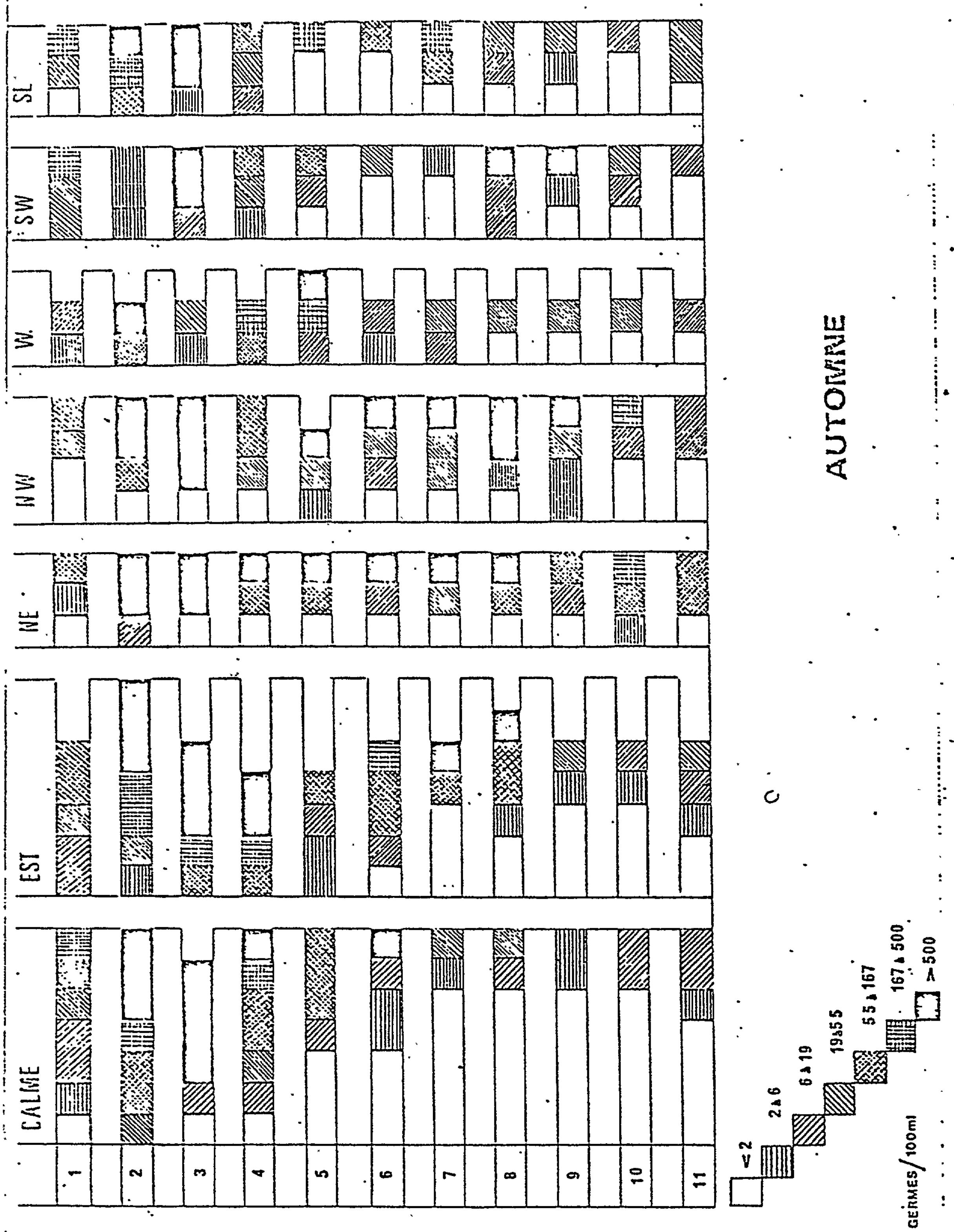

CALME
EST
NE
NW
W.
SW
SL
1
2
3
4
5
6
7
8
9
10
11
< 2
2 à 6
6 à 19
19 à 55
55 à 167
167 à 500
> 500
GERMES/100ml
AUTOMNE

Fig. 4

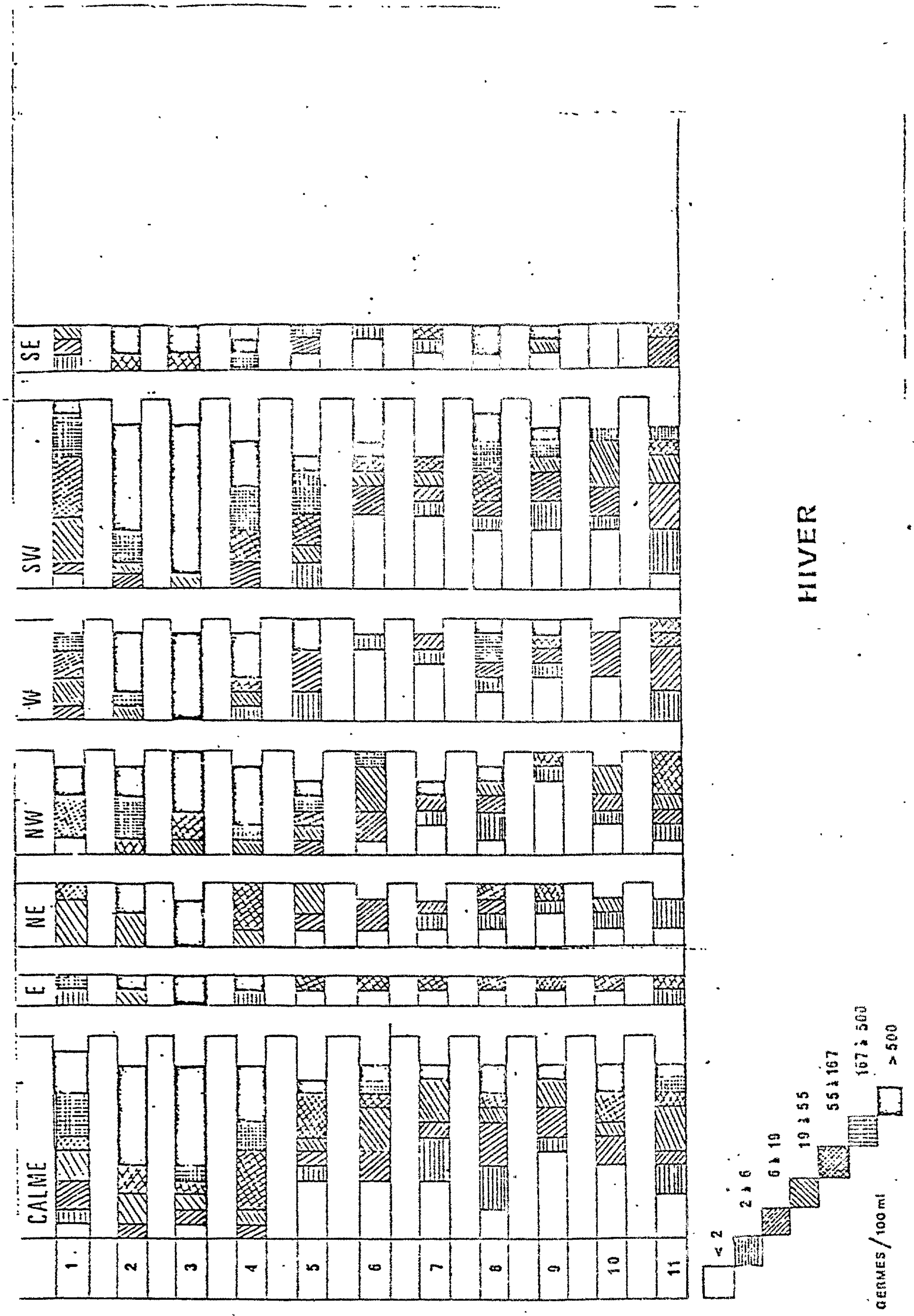

CALME
E
NE
NW
W
SW
SE
1
2
3
4
5
6
7
8
9
10
11
< 2
2 à 6
6 à 19
19 à 55
55 à 167
167 à 500
> 500
GERMES/100 ml
HIVER

Fig 5

Participating Research Centre: Jefatura Provincial de Sanidad
MALAGA
Espana

Principal Investigator: R. MUJERIEGO

Introduction:

Coastal water quality has been a subject of concern to the local authorities of Malaga for several years. Public and private interests to preserve the attractive touristic and recreational coastal resorts, internationally known as the "Costa del Sol", have prompted numerous attempts to evaluate the degree of pollution at the most frequented beaches.

A systematic study was planned and carried out during the 1976 summer season by the provincial public health authorities. However, administrative limitations, coupled with the long distances involved (148 km), resulted in a limited though realistic picture of the recreational water quality.

Area(s) studied:

The 130 sampling stations considered in the 1976 summer session study were initially intended to be used for the monitoring programme called for by the MED VII pilot project agreement. However, in view of (a) the inaccessibility of some areas to holiday makers, (b) the great differences in public attendance at various beaches, and (c) the technical and material limitations of the Institutions, a series of natural beaches were selected at which to carry out the 1977 summer season monitoring programme.

This was considered a more adequate alternative, capable of producing statistically significant and representative results by having each sampling station analysed approximately once every ten calendar days.

The study includes 36 sampling stations located on 18 km of coast east and west of Malaga City, six sampling stations at the main beaches of Marbella and three reference stations at the town of Maro, located on the eastern provincial border.

Attached is a map showing the location of the sampling area (Figure 1).

Materials and methods used:

The microbiolgocal method used throughout this study has been the Most Probable Number technique, instead of the Membrane Filtration method required in document EHE/76.1. The reasons for this change were: (1) the MPN method is the official method routinely applied at the institution, (2) the laboratory technicians are trained to perform the MPN method and (3) the lack of filtration apparatus to perform the MF method at the time.

The "Guidelines for health related monitoring of coastal water quality" were used as reference material throughout the study. The epidemiological survey carried out during the 1977 summer season was essentially in agreement with the criteria contained in "Health criteria and epidemiological studies related to coastal water pollution", though this publication was only made available once the questionnaires had been produced.

A comparative study between MPN and MF methods for analysing total coliforms and faecal coliforms was planned for the 1978 summer season utilizing the filtration equipment and culture media sent by UNEP/WHO. However, because of administrative constraints it has not been possible to carry out that study, and only a few sampling stations have been monitored during the 1978 summer season.

There has been practically no monitoring of shellfish, because of the real scarcity of such species in the area. However, it soon became apparent that some fish species, sardines in particular, should be given attention as a really significant indicator for microbiological pollution of marine life.

Results and their interpretation:

From the work carried out until now the following results can be pointed out:

Climatic conditions were particularly abnormal during the 1977 summer season. Results for the same period in 1978 reveal a behaviour much closer to normal summer conditions.

Wind regime was similarly abnormal during the 1977 summer season, giving rise to frequent periods of rough sea conditions and bringing sea-water surface temperature down to as low as 17°C. Information available for the 1978 summer season reveals a behaviour closer to normal conditions, with more frequent periods of calm waters.

It is possible to assert the presence of a coastal current regime parallel to the coast that behaves somehow independently from the wind regime.

It was not possible to detect a defined thermocline formation in the vicinity of the submarine outfalls discharge area during the 1977 summer season.

The most frequently used method of waste water disposal within the pilot zone is through submarine outfalls. Raw waste water is generally discharged through one km long submarine outfalls ending in a single port diffuser, located at approximately 20 m depth.

Waste water effluents are mostly of domestic origin with minor industrial contributions discharging at sea through the Guadalhorce river. Waste water flows are largest during the summer season due to the very important national and international tourist influx.

A significant portion of the wastewater flow coming from the city of Malaga is still discharged directly into the west side of the new harbour area. Plans are underway to construct a new submarine outfall provided with a waste water pretreatment station and a multiport diffuser discharging at 30 m depth.

The bacteriological quality of coastal recreational waters relates quite well to the proximity and characteristics of waste water disposal sites. Experimental results show the presence of a few grossly polluted areas as well as others with a minor degree of pollution.

A comparative analysis of total coliforms and E. coli counts reveals an inconsistent recovery of E. coli. A known reason for that result is the repeatedly observed appearance of Klebsiella microorganisms on the confirmatory agar plates that makes the isolation of E. Coli impossible, in spite of the apparent metallic sheen.

The more spectacular effect of waste water disposal at sea is the formation of visible patches of a yellowish scum 2-3m in width, located within a larger 5-10 m wide oily slick and ranging from a few hundred metres to a few kilometres in length.

Calculated values for waste water initial dilution achieved by submarine outfalls was close to 100: 1.

There is evidence that passenger and cargo ships docking at Malaga harbour dispose of their solid and liquid wastes by dumping at sea, particularly while at the waiting areas outside the harbour, with water quality impairment at the nearby beaches.

Results available from the epidemiological survey reveal that: (a) skin, eyes, ear and nose infections are the most frequent public health ailment among bathers and (b) an increasing number of people are becoming concerned with the impairment of coastal water quality.

Microbiological results from different beaches were statistically analysed by graphical methods. Both total coliform and faecal coliform follow quite well a log-normal probability distribution. Their statistical parameters are summarized in Table 1.

Four statistical parameters hae been considered for total coliforms, namely: TC50, concentration not exceeded by 50% of the samples, TC80, concentration not exceeded by 80% of the samples, TC90, concentration not exceeded by 90% of the samples, and σg, geometric standard deviation. (σg = ln TC84 - ln TC50).

Three statistical parameters have been considered for faecal coliform concentrations, namely, FC50 and FC90, concentrations not exceeded by 50 and 90% of the samples respectively, and σg, geometric standard deviation (σg = ln FC84 - ln FC50). This expression of the standard deviation is considered more illustrative of the phenomenon under study than its corresponding value in terms of coliform concentration.

A preliminary analysis of the data (not included here) reveals a wide variation of the TC/FC ratio, mainly due to low faecal coliform countings. Some of the factors responsible for this fact are indicated in Item 9 hereabove.

It is believed that faecal coliform countings were notably reduced by several analytical interferences. Strictly speaking, all of the beaches surveyed did comply with both the present interim microbiological quality criteria (FC50 = 100 FC/100 ml, FC90 = 1000 FC/100 ml) and the Spanish coastal water quality standards (FC50 =200 Fc/100 ml, FC90 = 1000 FC/100 ml).

However, inspection of total coliform statistical parameters together with visual inspection of the beaches seems to indicate that some of the beaches were in fact not satisfactory from the microbiological point of view. If the widely used aesthetic criteria developed in 1943 at Los Angeles, California, beaches of TC80 = 1000 TC/100 ml is considered as reference, 11 out of 17 beaches could not be considered as aesthetically satisfactory. This is more in agreement with repeated visual appearance of the water mass at the sampling stations.

Conclusions:

From the above results the following conclusions can be drawn:

The relative contribution of submarine outfalls has to be recognized in improving recreational water quality in the coastal areas studied. Furthermore, they represent a short-term solution capable of integration into a more advanced waste water treatment scheme that could be built once additional funds are available.

There is a need for a more adequate design and operation of submarine outfalls within the study area. Recent developments in sanitary engineering practice may be capable of offering more satisfactory solutions than those adopted in some cases for reasons of apparent economy and time constraints.

Considerable improvement of coastal water quality in the study area could be obtained through a suitable combination of pretreatment stages to remove floatable material coupled with an increased initial dilution of waste water by means of a well designed multiport diffuser located at an adequate distance from the coast.

Unless positive action is taken on the waste water disposal methods currently employed, recreational water quality will continue to deteriorate with the resulting effects on local, national and international opinion, particularly as far as tourism is concerned.

There is a real need in all branches of local government, municipal as well as public health authorities, for an active participation in all aspects of coastal water quality management. Adequate numbers of trained personnel should be assigned to carry out management and monitoring tasks. Among the new aspects to be considered are the consequences of the recent ratification of the Barcelona Convention and the two protocols.

List of Publications

Recreational Coastal Water Quality Effects on Public Health. Rafael Mujeriego et al. Presented at the Workshop on Marine Pollution Control in the Mediterranean held at Antalya, Turkey, organized by ICSEM/UNEP. November-December 1978.

Figure 1: General map of the MED VII pilot zone of Malaga

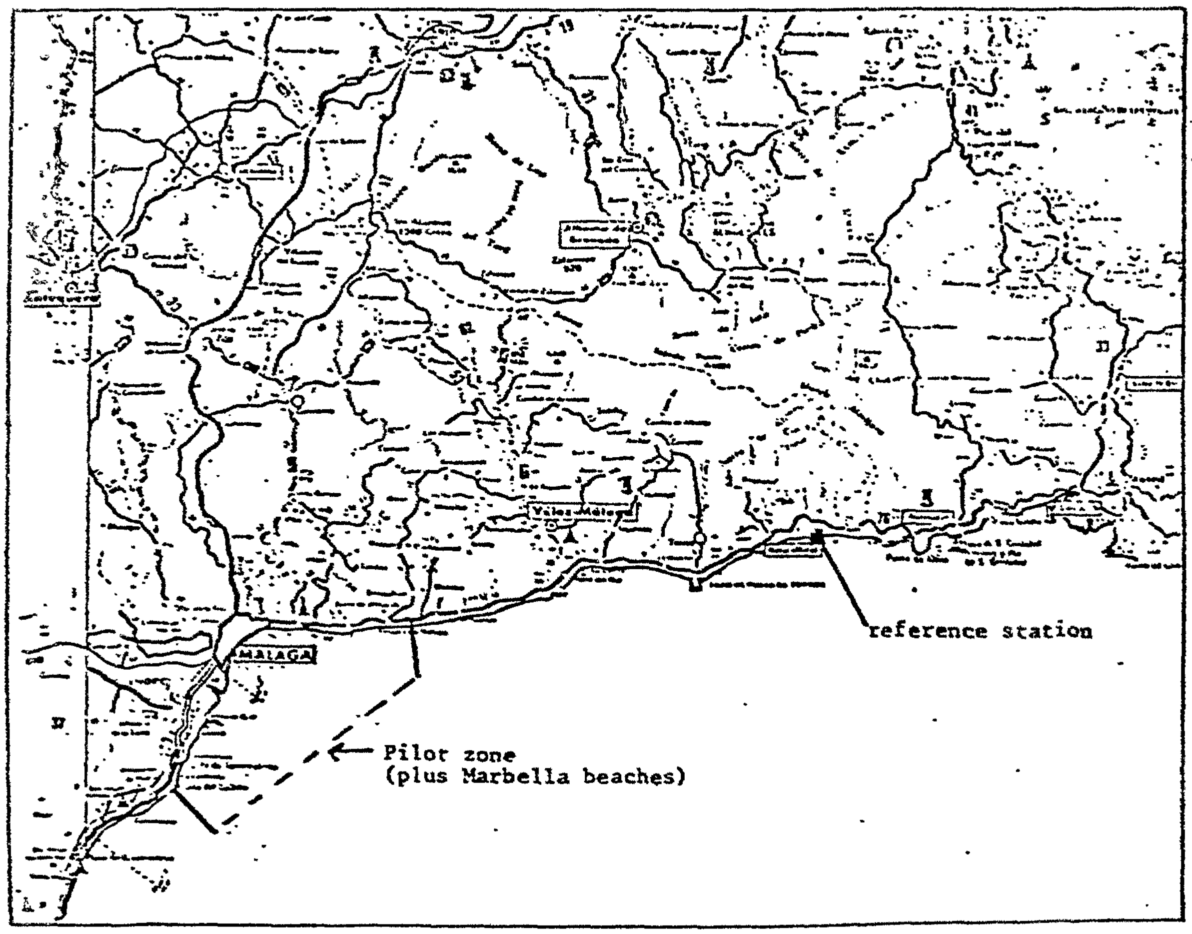


TABLE I. STATISTICAL ANALYSIS OF MICROBIOLOGICAL COASTAL WATER QUALITY (*) MED-VII PILOT ZONE OF MALAGA. JULY AUGUST AND SEPTEMBER 1977

BEACH	NUMBER SAMPLES	TOTAL COLIFORMS Total coliforms/ 100 ml				FECAL COLIFORMS Fecal coliforms/100 ml		
		TC50	TC80	TC90	σ_g	FC50	FC90	σ_g
N 1	12	30	170	380	2.01	1	11	1.65
R 1	16	5	200	1500	4.38	2	14	1.58
R 2	32	450	5800	25000	2.97	8	44	1.37
R 3	24	140	1800	7000	3.00	7	110	2.09
MA 1	18	800	4000	30000	2.53	4	57	2.01
MA 2	11	50	180	340	1.48	7	30	1.08
MA 3	8	24	250	900	2.77	6	200	2.71
MA 5	17	1000	20000	80000	3.44	18	150	1.64
MA 6	16	1500	9400	24000	2.12	45	700	2.10
MA 7	20	500	8500	36000	3.32	8	220	2.71
MA 9	28	2800	12000	26000	1.79	12	360	2.65
MA 10	14	2700	22500	70000	2.43	15	78	1.28
MA 11	51	410	5800	22500	3.17	6	90	2.14
MA 12	27	350	2800	8200	2.46	16	380	2.42
M 3	37	190	750	1500	1.61	16	130	1.61
M 4	11	15	68	150	1.77	3	25	1.80
E 1	9	70	10000	-	-	1	45	3.52

(*) TC50, for example, represents the total coliform concentration per 100 ml that is not surpassed in more than 50% of the samples.

$\sigma_g = \ln TC84 - \ln TC50$ or $\sigma_g = \ln FC84 - \ln FC50$

Participating Research Centre: Jefatura Provincial de Sanidad
TARRAGONA
Espana

Principal Investigator: R. MUJERIEGO

Introduction:

Coastal water quality has been a subject of concern to local authorities in Tarragona for several years. Public and private interests to preserve the attractive touristic and recreational coastal resorts, widely known as the "Costa Dorada", have prompted several attempts to evaluate the degree of pollution at the most frequented beaches.

The development in the early 1970s of a large petrochemical industry complex in the vicinity of Tarragona city made evident the need for renewed involvement of public health authorities in environmental health matters. In spite of increasingly active participation in the waste water disposal permit granting system, Tarragona's public health authorities are fully aware of the need for systematic and continuous monitoring of industrial and municipal discharges into nearby coastal water.

Area(s) studied:

The area studied covers most of the 210 km of provincial coastline from Cunit in the north to Ampolla in the south, near the Ebro river delta.

Considering (a) the inaccessibility of some areas to holiday makers, (b) the great differences in public attendance at various beaches and (c) the institutional constraint of having to monitor simultaneously water supply quality at most of the 72 coastal camping-sites, hosting more than 50 000 people, a series of natural beaches was selected to carry out the monitoring programme for the MED VII pilot project. This was considered a realistic alternative capable of producing statistically significant and representative results by having each station analysed once every calendar week.

The area covers a total of 27 sampling stations of which one is a reference station. It is expected to increase the number of sampling stations during the next year, according to budgetary allocations.

Attached are maps on which the sampling stations have been identified along with other relevant information (figures 1, 2 and 3).

Materials and method used

The microbiological method used throughout this study has been the Membrane Filtration technique, as required by document EHE/76.1. This has been made possible by utilizing the filtration equipment and culture media supplied by UNEP/WHO. The parameters systematically measured during the 1978 season were total coliforms (TC), faecal coliforms (FC) and faecal streptococci (FS). Simultaneously, a comparative study between MPN and MF methods for total coliforms and E. coli has been carried out during the present summer season. "Guidelines for Health Related Monitoring of Coastal Water Quality" has served as reference material throughout the study.

There is a great interest in the proposed training sessions for MED VII participants as an excellent opportunity for discussing the many observations made when performing several of the new analytical techniques at the laboratory, in particular the membrane filtration method for microbiological examination of water.

Information contained in "Health Criteria and Epidemiological Studies Related to Coastal Water Pollution" along with experience gained at the pilot zone of Malaga were used in preparing the new questionnaire employed during the epidemiological survey carried out among recreationists at selected beaches of Tarragona.

Results and their interpretation:

Some preliminary and qualitative results among others are as follows:

Fishing and shellfish collection represent perhaps one of the most popular and significant recreational activities along the coast of Tarragona. Preliminary results from microbiological examination of fish and shellfish specimens reveal the importance of further monitoring of these species, as far as Public Health is concerned. A year-long study programme is under way to evaluate their microbiological and chemical quality.

The most frequently used method of wastewater disposal within the pilot zone is through submarine outfalls. Raw municipal wastewater is generally discharged through a 1-km long outfall ending in either a single port or a multi-port diffuser, located at approximately 20 m depth..

Wastewater effluents at most of the coastal areas are of domestic origin. However, there is an important and rapidly growing petrochemical industry complex near Tarragona City that disposes of its wastewater through a series of submarine outfalls of various lengths and functional characteristics.

There is evidence that cargo ships, especially oil tankers, docking at Tarragona harbour and at the several oil terminals dump their solid and liquid wastes at sea, particularly while at the waiting areas outside the harbour, with the consequent impairment of the nearby beaches.

Further analysis of the collected microbiological data included:

Statistical analysis by graphical methods of microbiological results from different beaches. Both total coliform and faecal coliform follow quite well a log-normal probability distribution. Their statistical parameters are summarized in Table I.

Four statistical parameters have been considered for total coliforms, namely: TC5, concentration not exceeded by 50% of the samples, TC80, concentration not exceeded by 80% of the samples, TC90, concentration not exceeded by 90% of the samples, and σg, geometric standard deviation. ($\sigma g = \ln TC\ 84 - \ln TC50$).

Three statistical parameters have been considered for faecal coliform concentrations, namely FC50 and FC90, concentrations not exceeded by 50 and 90% of the samples respectively, and σg, geometric standard deviation ($\sigma g = \ln FC84 - \ln FC50$).

This expresison of the standard deviation is considered more illustrative of the phenomenon under study than its corresponding value in terms of coliform concentration.

Statistical analysis of faecal streptococci are not completed yet.

A preliminary analysis of the data reveals a wide variation of the TC/FC ratio, mainly due to low faecal coliform countings. Some of the factors responsible for this fact are indicated in this summary final report.

It is believed that faecal coliform countings were notably reduced by several analytical interferences. Strictly speaking, only 5 out of 27 beaches surveyed do not comply with both the present interim microbiologcial quality criteria (FC50 = 100 FC/100 ml), FC90 = 1000 FC/100 ml) and the Spanish coastal water quality standards (FC50= 200 FC/100 ml, FC 90 = 1000 FC/100 ml).

However, inspection of total coliform statistical parameters, together with visual inspection of the beaches, seems to indicate that additional beaches were in fact not satisfactory from the microbiological point of view.

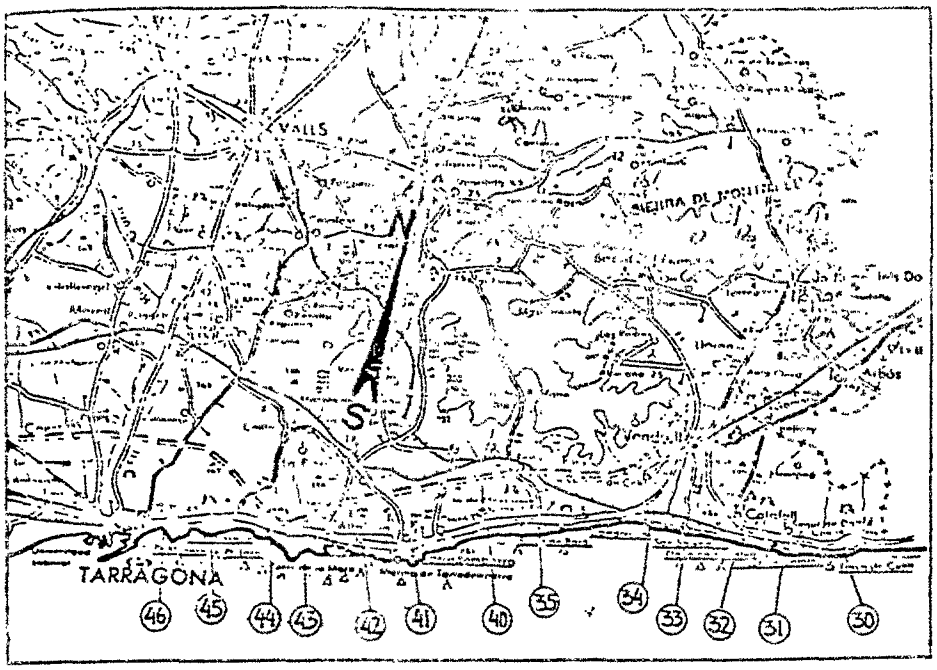
Conclusions:

There is a need for a more adequate design and operation of submarine outfalls within the study area. Specifically, a compulsory and effective monitoring programme to evaluate the mass emission rates of important pollutants should be included in each disposal permit. Otherwise, there is no practical way of knowing the flow and the characteristics of the effluents .

Considerable improvement of coastal water quality in the study area could be obtained through a suitable combination of (a) some pretreatment stage to remove floatable materials, (b) an adequate waste water initial dilution and (c) an adequate distance for protecting natural shellfish growing areas.

There is a real need in all branches of local government, municipal as well as public health, for active participation in all aspects of coastal water quality management. Adequate numbers of trained personnel should be assigned for carrying out management and monitoring tasks. Among the new aspects to be considered are the legal consequences of the recent ratification of the Barcelona Convention and the two protocols.

Figure 1: MED VII pilot zone of Tarragona, subzones 3 and 4



..... = sampling stations

Figure 2: MED VII pilot zone of Tarragona, subzones 5 and 6

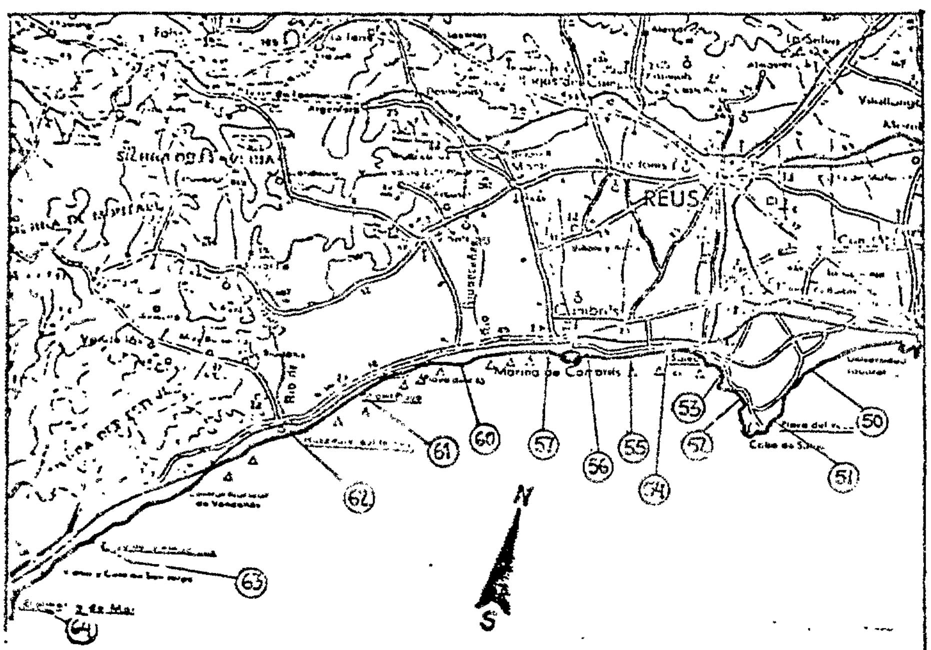
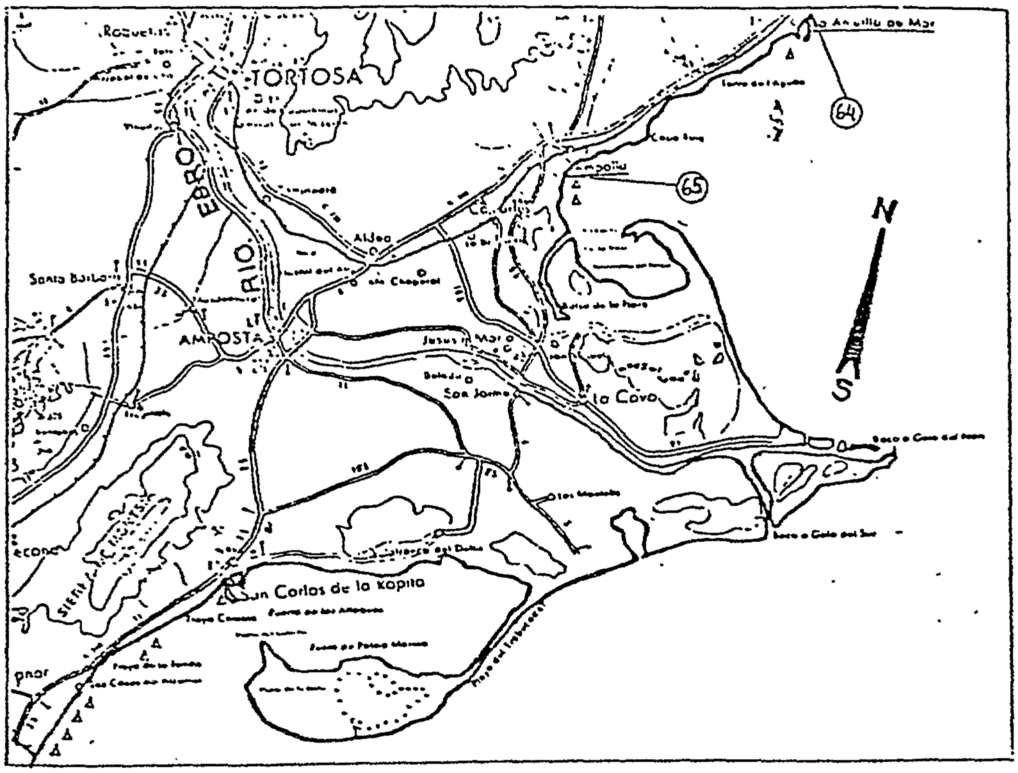


Figure 3: MED VII pilot zone of Tarragona, subzone 6



Participating Research Centre: Marine Biological Station
Institute of Biology
University of Ljubljana
PORTOROZ
Yugoslavia

Principal Investigator: M. LENARCIC

Introduction:

Since 1971 the investigations of bacterial indicators of faecal pollution (such as total coliforms, faecal coliforms, etc.) have been performed as part of the pollution research programme, including complex studies on the quality of coastal water, of Marine Biological Station, Portoroz.

The results obtained by the monitoring programme have been presented at some symposiums, meetings, and in publications and reports.

We started the new monitoring programme in 1977 as a part of UNEP/ WHO Project MED VII.

Area(s) studied:

Our programme on coastal water quality monitoring covered the area of the Yugoslav side of the Gulf of Trieste which is the most northern part of the North Adriatic, i.e. coastal waters along S. R. Slovenia. The length of our coastline is about 35 km, including two shallow and closed bays: Koper Bay and Piran Bay. The average depth is 20 m.

The coastal hinterland, made of flysch sandstone is discharging into the coastal sea important amounts of fine sediments and nutrients. Therefore both turbidity and primary productivity are quite high. Koper Bay is the most polluted part of the area. It is polluted directly by domestic waste discharge (non-treated) via outfalls and by the river Rizana (average flow $1 m^3$/sec) which is polluted by industrial and domestic wastes. The town of Koper is situated on its coast (20.000 inhabitants) with its port (for chemicals and different cargoes, 2-3 million tons/year). On the coast of the same bay is the town of Izola (17.000 inhabitants) with its food industry (figure 1).

Piran Bay is practically unpolluted. It receives the river Dragonja (average flow 0.5 m^3/sec) which is slightly polluted by domestic wastes. The town of Piran is situated there (10.000 inhabitants). The shores of Piran Bay are intensively used as recreational areas and sorrounded by many hotels (15.000 beds). Domestic waste waters treated by primary treatment plant are discharged through the underwater outfall 3 450 m off-shore (0.1 m^3/sec average flow) plus two small outfalls which are located 100-200 m off-shore (Figure 2).

To monitor the sanitary quality of coastal waters used for bathing, twenty-seven representative coastal stations (10 m off-shore in surface waters - 0.5 m) were selected in the recreational waters along our coastline. Seven additional open water stations at different distances offshore were also monitored as reference stations (at different depths - 5 m, 10 m, 15 m, 20 m). The main sources of pollution (rivers Dragonja and Rizana), and main outfalls were included in our programme and twelve stations selected.

The shell-fish culture at Strunjan was chosen for monitoring.

Materials and methods

The membrane filtration technique and media, as described in Guidelines for Health Related Monitoring of Coastal Water Quality, WHO/UNEP, Copenhagen 1977, were used as bacteriological parameters.

The standard methods as described in Strickland and Parsons (1968) and Grasshoff (1976) manuals were used as other parameters.

Results and their interpretation:

The following parameters were monitored at all stations:

- total coliforms
- faecal coliforms
- faecal streptococci
- salinity
- water and air temperatures

At the reference stations (which are also the points of the Marine Biological Station's systematic monitoring programme) complex investigations into the whole pelagic ecosystem and its bioproductivity were performed. The parameters are:

- hydrographic: temperature, salinity, oxygen, pH
- bioproductivity: nutrients, phytoplankton biomasses (chlorophiles)

Surface-sea temperature measured in waters along S. R. Slovenia varied: 7.99°C (January 1978), - 23.75°C (July 1978) and at the bottom temperature 9.03°C (January 1978), 19.80°C (August 1978).

Oxygen values were in the range of 6.90 mg/ml (October 1978) and 9.51 mg/ml (March 1978) at the surface sea-water, and at the bottom 5.85 mg/ml (November 1978) and 9.48 mg/ml (March 1979).

Salinity ranges were 33.52°/₀₀ (July 1978) - 37.29°/₀₀ (January 1979) at the surface and 36.04°/₀₀ (October 1978), 38.17°/₀₀ (January 1979) at the bottom.

pH variations were in the range 8.24 (in the summer) to 8.52 (in the winter) at the surface and 8.18 - 8.52 at the bottom. In the estuaries of the rivers Rizana and Dragonza values were in the range of 8.15 - 8.58 at the bottom and 7.75 - 8.32 at the surface.

In a one-year period (March 1978-March 1979) nutrients concentration values were in the range: 5.06 - 37.72 mg NO_3/m^3, 0.92-30.36 mg NO_2/m^3, 8.50 - 100.64 mg NH_3/m^3, 5.80 - 66.50 mg PO_4/m^3 and 5.27 - 27.59 mg P-tot/m^3 at the surface and 31.00-261.02 mg NO_3/m^3, 2.76 - 57.50 mg NO_2/m^3, 10.03-80.75 mg NH_3/m^3, 2.85 - 37.05 mg PO_4/m^3, 2.17 - 27.28 mg P-tot/m^3 at the bottom.

The minimal concentrations of NO_2 and NO_3 were recorded in the summer and the maximal concentrations recorded in winter, but maximal NH_4 trations were measured in the winter and minimal NH_4 concentrations in spring. Maximal concentration of PO_4 were detected in the winter.

The nutrients concentrations were higher in the Bay of Koper, close to the main outfall area and in the estuaries of Rizana and Dragonza. The measurements were varied in the Bay of Koper: 0.00 3-2194.80 mg NO_3/m^3, 4.60 - 69.00 mg NO_2/m^3, 27.20 - 460.70 mg NH_3/m^3 and up to 228.70 mg PO_4/m^3 and at the surface of the Rizana up to 2322.52 mg NO_3/m^3 and the Dragonja up to 2366.54 mg NO_3/m^3.

The horizontal distribution of dissolved organic nitrogen was uni formly in the range of 11.20-722.40 mg N/m^3. The highest concentra tions were detected in the Bay of Koper, close to the main outfall area (up to 1733.40 mg N/m^3).

Chlorophyll concentrations varied from 0.00 (below detection of the method) up to 6.51 ug/l, registered during the bloom of Sceletonema costatum in March 1978. In general, three sharper peaks were recorded from March to April 1978, from May to June 1978 and from November to December 1978.

The report represents results of investigations into bacterial indicators of faecal pollution from November 1977 to April 1979. Sampling and analysing were done eleven times during November 1977 to April 1979- six months in the winter season (November, February, April 1977/78 and 1978/79) and five times in the summer season (every month from May to September 1978).

Altogether 515 seawater samples were collected as follows:

262 samples were taken at points chosen as coastal stations (recreational water, public beaches), at a distance approximately 10 m off-shore.

144 samples were taken near the main sources of pollution (26 samples at rivers Rizana and Dragonza), and 118 samples at main outfalls.

109 samples were taken at reference stations which were selected at a relatively unpolluted site, 1 - 2 Nm off-shore.

Results obtained by all bacteriological analyses (number of total coliforms, faecal coliforms, faecal stareptococci) were evaluated as mean values for winter and summer months, respectively (Table 1).

These results (see table 1) show that serious faecal pollution in the coastal sea along S. R. Slovenia is confined to only one zone in the Bay of Koper, exactly at the main direct outfall- Stations A, A1, A2 (load 20.000 - 30.000 eqv. units), where high concentrations of bacteria were found (max. 310.000 faecal coliforms/100 ml). But their number decreased rapidly with distance from the source of pollution towards the open sea.

There are some other smaller direct outfalls in the Bay of Koper but they have little effect on public beaches their influence being limited in time and place.

In Piran Bay there is an underwater outfall discharging primarily treated domestic waste waters. The investigations at the outfall (3450 m off-shore), Station C show almost no influence, except at the bottom (depth 20 m) near the diffuser.

There is another small outfall 200 m off-shore in the town of Piran (Station E) which is near a public beach (Station 17) but this also has little influence on the water quality.

Another slight factor contributing to the pollution is the river Rizana flowing into the Bay of Koper and the Dragonza flowing into the Bay of Piran.

The counts at all stations showed lower values than 1000 faecal coliforms/100 ml except at the stations Zusterna (Station 5), Izola (Station), Valdoltra (Station 2) and Ankaran (Station 3). As to station 5, the values obtained could be attributed to the effect of the main outfall from Koper as described above, and most probably to the influence of the smaller outfall near the station. The results from Stations 2, 3 and 8 could be attributed to the effect of the smaller outfall of sewage a few metres off-shore.

The ratios of total coliforms and faecal coliforms and of faecal coliforms and faecal streptococci are shown in Table 3. The computed ratios are varied dependent on the distances of the stations from direct sources of contamination.

Monitoring of shell-fish and culture areas

Our monitoring programme also included investigations on shellfish grown in the experimental shellfish aquaculture farm of mussels Mytilus galloprovincialis in Strunjan Bay (see attached map - Figure 1).

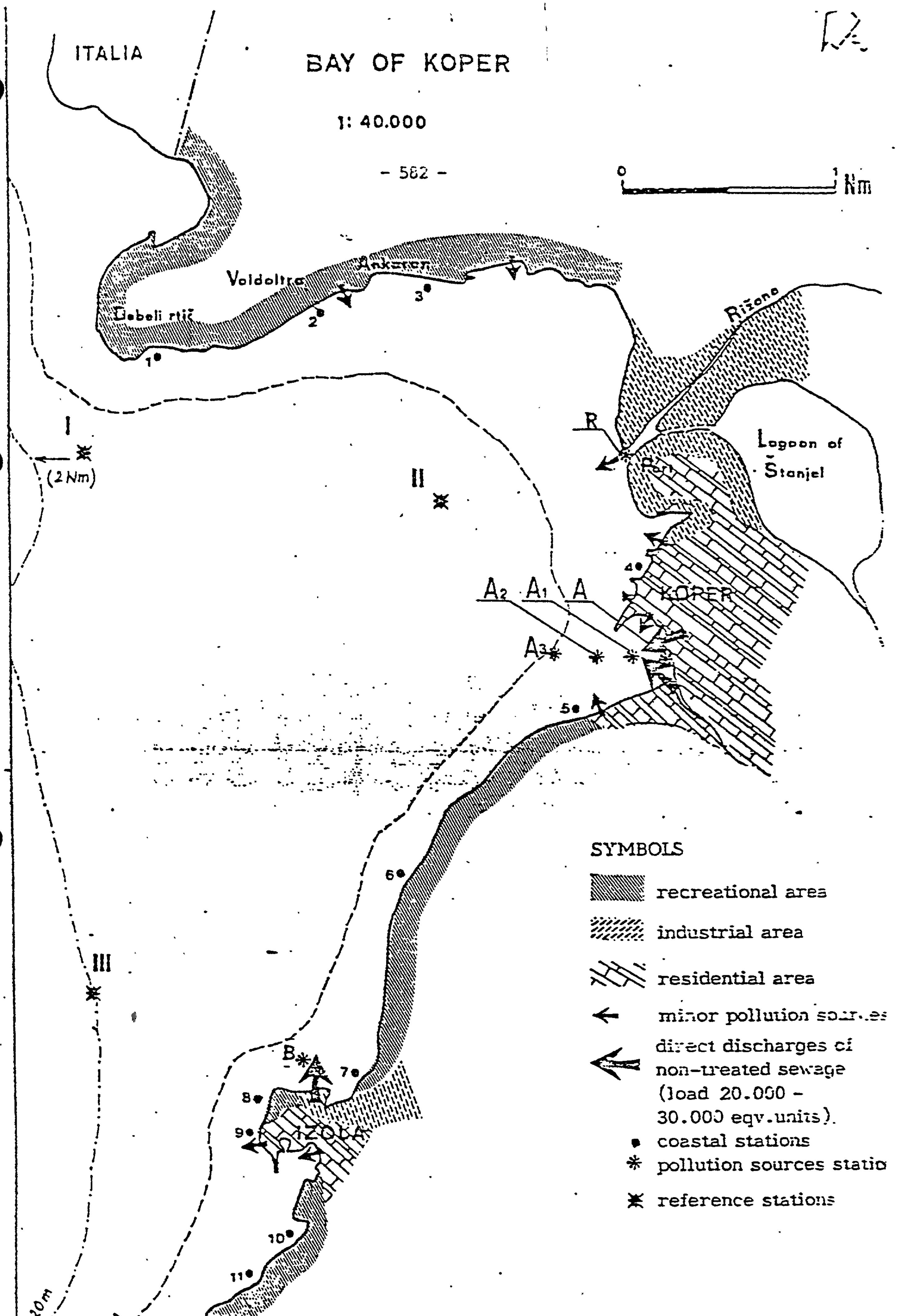
Shellfish and shellfish-growing water sampling was done at the same time. The frequency of sampling and analysing was monthly, from July 1977 to April 1979. The parameters measured were: total coliforms and faecal coliforms. The multiple test tube method was used for shellfish and shellfish-growing water analyses (see Guidelines for Health Related Monitoring of Coastal Water Quality, WHO/UNEP, 1977).

The results of these investigation are shown in table 4.

Considering the recommended interim (WHO, document ICP/RCE 206 (8), Rome, April 1978) 13 samples out of 24 (total number of shellfish flesh samples) fell into the range of 0-2 faecal coliforms/g, 6 samples into the range of 3 - 10 faecal coliforms/g, and 5 samples contained more than 10 faecal coliforms/g of shellfish flesh.

Conclusions:

Taking into the consideration the recommended interim criteria (WHO, document ICP/CEP 209/A (2) 1), Athens, 1977) we can underline in our conclusions that only 9 out of 262 samples taken at public beaches contained more than 1000 faecal coliforms/100 ml while 203 samples were in the range of 0-100 faecal coliforms/100 ml. That means that most of our public beaches could be considered as highly satisfactory bathing areas.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SYMBOLS
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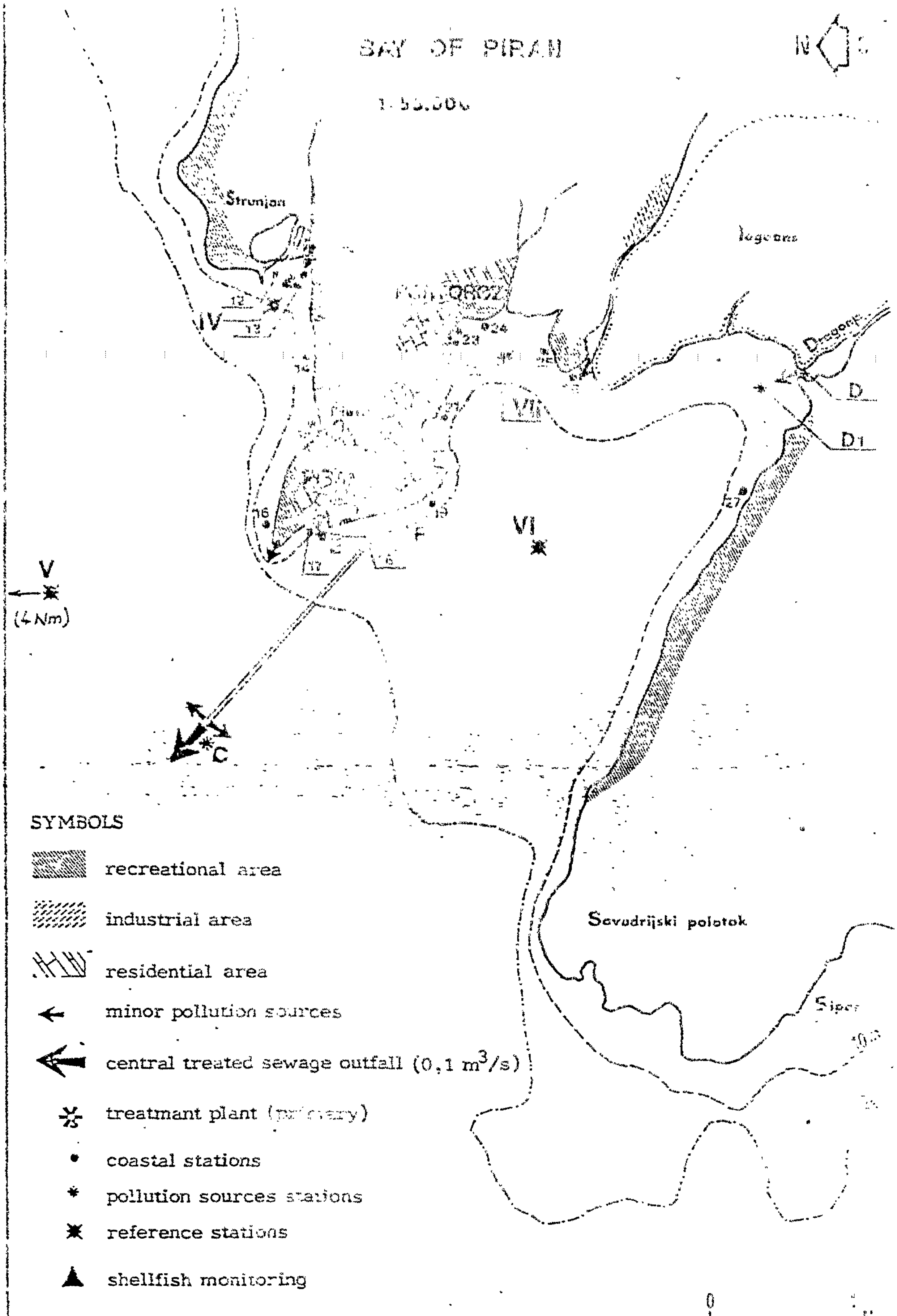
industrial area
residential area
minor pollution sources
direct discharges of non-treated sewage (load 20.000 - 30.000 eqv.units).
coastal stations
pollution sources statio
reference stations

Fig. 3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lagoons
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Savudrijski polotok
SYMBOLS
recreational area
industrial area
residential area
minor pollution sources
central treated sewage outfall (0,1 m3/s)
treatmant plant
coastal stations
pollution sources stations
reference stations
shellfish monitoring
0
Nm

Fig. 2

List of monitoring stations in the coastal sea along S.R.Slovenija (Yugoslav
Gulf of Triest (North Adriatic).

Recrational waters:
(swimming areas, coastal stations, 10 - 20 m from shoreline)

Station symbols	Locality Terms
1	Debeli rtič
2	Valdoltra
3	Ankaran
4	Koper
5	Žusterna
6	Rex
7	Izola – camping
8	Izola – public beach
9	Izola – light house
10	Simonov zaliv
11	Belveder
12	Strunjan – public beach
13	Strunjan – " "
14	Pacug
15	Fiesa
16	Piran – hotel "Punta"
17	Piran – hotel "Piran"
18	Piran – public beach
19	Bernardin – hotel "Emona"
20	Bernardin – public beach
21	Portorož – store-house
22	Portorož – hotel "Riviera"

Station symbols	Locality Terms
23	Portorož - public beach
24	Lucija
25	Seča - camping
26	Seča - "RIBIČ"
27	Kanegra

Pollution point sources

Rivers

R	Rižana - outflow
D	Dragonja - outflow
D1	Dragonja - estuary 500 m from outflow

Outfalls

A	Koper - main direct discharge of non-treated sewage, at the point of discharge	
A1	100 m off the point of discharge	
A2	250 m off " "	(0.5 m, 5 m)
A3	1000 m " "	(0.5 m, 5 m, 10 m)
~~B~~	~~Izola - main direct discharge of non-treated sewage~~	
C	Piran - UW outfall of treated sewage	
E	Piran - outfall at "Punta"	
F	Piran - outfall at "Salvetti" (Meteoric waters only)	

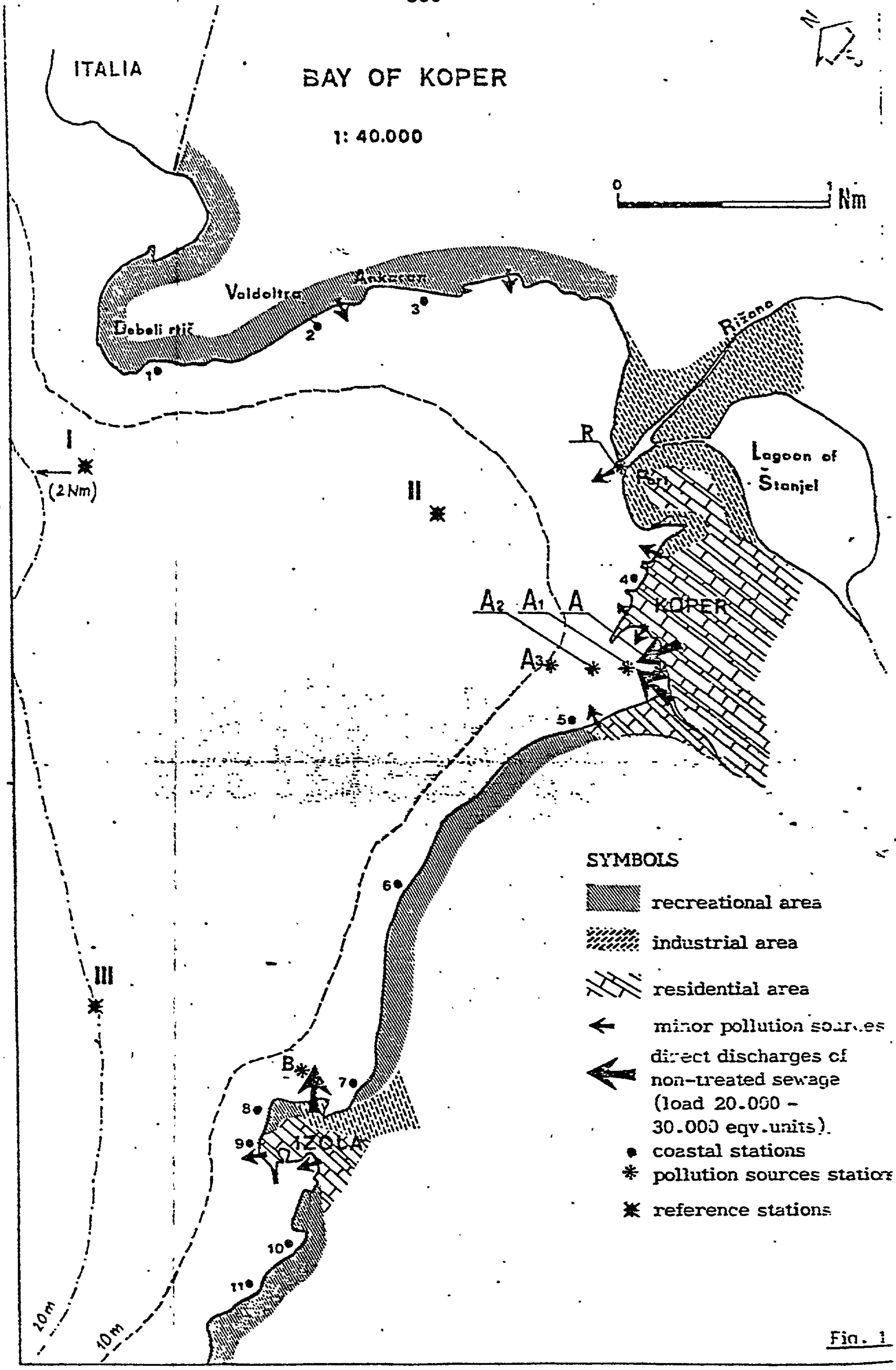
BAY OF KOPER
1: 40.000
ITALIA
0
1 Nm
Valdoltra
Debeli rtič
Ankaran
Rižana
Lagoon of Štanjel
R
Port
KOPER
A2 A1 A
A3
I
(2 Nm)
II
III
B
IZOLA
10m
20m
SYMBOLS
recreational area
industrial area
residential area
minor pollution sources
direct discharges of non-treated sewage (load 20.000 - 30.000 eqv.units).
coastal stations
pollution sources statior
reference stations

Fig. 1

Table: 1 Bacterial indicators of faecal pollution expressed in mean values for winter and summer months

Station depth/m	SUMMER mean values/100 ml[x] Total coliforms	Faecal coliforms	Faecal streptococci	WINTER mean values/100 ml[x] Total coliforms	Faecal coliforms	Faecal streptococci
1	17.8 ± 8.2	8.6 ± 9.4	6.4 ± 6.5	23.3 ± 3.0	19.0 ± 5.3	17.8 ± 3.4
2	62.6 ± 14.6	19.8 ± 15.7	14.3 ± 14.8	13.8 ± 7.2	9.6 ± 8.5	4.9 ± 3.3
3	73.1 ± 2.2	56.2 ± 6.8	13.1 ± 13.1	24.4 ± 6.1	12.7 ± 4.6	3.2 ± 3.6
4	55.5 ± 3.1	33.9 ± 2.5	31.3 ± 2.5	72.8 ± 4.3	30.5 ± 3.2	3.7 ± 1.4
5	902.6 ± 8.1	347.0 ± 6.4	161.6 ± 5.5	439.2 ± 35.3	174.4 ± 51.3	157.1 ± 24.5
6	n. d.	n. d.	n. d.	43.[illegible] ± 2.2	14.5 ± 1.7	8.7 ± 2.2
7	26.4 ± 9.7	11.3 ± 4.4	28.3 ± 4.0	40.6 ± 1.8	35.5 ± 3.3	80.5 ± 2.5
8	1665.5 ± 13.2	932.9 ± 14.6	468.3 ± 4.2	89.1 ± 9.0	42.0 ± 14.8	35.6 ± 2.6
9	41.5 ± 9.2	16.9 ± 17.1	18.0 ± 5.4	107.0 ± 14.[illegible]	64.8 ± 12.1	58.8 ± 4.9
10	5.4 ± 10.1	2.7 ± 6.6	3.8 ± 5.5	12.3 ± 5.6	4.2 ± 5.3	10.2 ± 5.9
11	5.0 ± 5.0	1.8 ± 1.7	1.3 ± 1.5	16.3 ± 3.0	4.8 ± 2.3	5.5 ± 1.7
12	7.5 ± 9.0	4.2 ± 4.7	5.1 ± 3.1	27.0 ± 8.6	[illegible].7 ± 7.6	15.5 ± 2.7
13	8.8 ± 5.6	3.6 ± 4.4	2.4 ± 3.3	31.1 ± 12.1	6.7 ± 5.9	5.8 ± 2.5
14	8.8 ± 1.4	2.8 ± 2.8	1.4 ± 1.6	n. d.	n. d.	n. d.
15	3.9 ± 4.2	3.3 ± 4.4	3.1 ± 3.5	5.9 ± 6.5	1.5 ± 2.1	1.8 ± 2.6
16	3.[illegible] ± 4.8	2.2 ± 3.1	2.5 ± 2.6	6.0 ± 2.4	2.0 ± 3.3	2.3 ± 6.6
17	3.0 ± 2.7	1.8 ± 2.8	1.5 ± 2.4	43.2 ± 4.[illegible]	17.1 ± 5.7	11.4 ± 9.6
18	3.0 ± 9.4	3.1 ± 9.6	5.1 ± 7.3	2.4 ± 3.5	4.9 ± 3.5	3.9 ± 1.4
19	17.4 ± 21.8	15.4 ± 15.7	12.5 ± 11.6	12.5 ± 3.4	3.7 ± 5.3	6.7 ± 4.4

List of monitoring stations in the coastal sea along S.R.Slovenija (Yugoslav. Gulf of Triest (North Adriatic) .

Recrational waters.

(swimming areas, coastal stations, 10 – 20 m from shoreline)

Station symbols	Locality Terms
1	Debeli rtič
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20	Bernardin – public beach
21	Portorož – store-house
22	Portorož – hotel "Riviera"

(Table 1 – page 3)

Station depth/m	SUMMER mean values/100 ml[x] Total coliforms	Faecal coliforms	Faecal streptococci	WINTER mean values/100 ml[x] Total coliforms	Faecal coliforms	Faecal streptococci
VI/15	3.0 ± 3.7	1.7 ± 3.4	1.6 ± 2.9	2.7 ± 1.8	0.0 ± 0.0	2.4 ± 2.3
VII/0.5	2.1 ± 3.5	0.0 ± 0.0	0.0 ± 0.0	105.8 ± 5.4	4.0 ± 2.7	10.6 ± 4.0
R/0.5	5628.6 ± 2.3	841.6 ± 2.4	276.6 ± 2.1	1293.6 ± 1.9	274.0 ± 1.6	171.6 ± 1.6
D/0.5	33.1 ± 2.9	15.7 ± 4.6	8.4 ± 5.3	38.4 ± 3.9	9.8 ± 8.6	5.1 ± 3.0
D1/0.5	6.5 ± 4.3	2.4 ± 3.5	5.0 ± 6.4	[illegible]2.9 ± 5.9	2.8 ± 4.2	6.2 ± 5.1
A/0.5	111837.6 ± 4.1	44410.2 ± 9.4	21213.8 ± 7.7	20004[illegible] ± 4.[illegible]	62783.6 ± 6.3	23201.7 ± 5.3
A1/0.5	4580.1 ± 4.5	2519.9 ± 4.3	1724.2 ± 2.4	23342.5 ± 2.5	8062.1 ± 3.5	4187.0 ± 2.3
A2/0.5	131.1 ± 12.9	15.8 ± 12.4	92.1 ± 4.7	323.1 ± 10.1	213.2 ± 14.0	97.4 ± 13.9
A2/5	25.7 ± 4.4	18.1 ± 5.2	11.6 ± 1.8	80.1 ± 2.[illegible]	50.9 ± 2.0	52.7 ± [illegible].5
A3/0.5	40.4 ± 34.1	17.0 ± 23.0	56.4 ± 10.1	407.9 ± 6.8	140.0 ± 9.[illegible]	217.7 ± 5.3
A3/10	117.3 ± 10.0	11.3 ± 13.6	14.0 ± 2.7	17.1 ± 13.2	7.9 ± 11.3	14.6 ± 4.2
C/0.5	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	3.0 ± [illegible].5	.8 ± 3.8	2.0 ± 2.2
C/10	1.6 ± 2.0	0.0 ± 0.0	1.6 ± 2.0	1.6 ± 1.7	1.2 ± 1.4	1.8 ± 2.8
C/20	151.0 ± 8.3	71.8 ± 5.8	28.0 ± 6.1	52.9 ± 3.9	19.8 ± 12.2	13.0 ± 3.6
E/0.5	3.2 ± 3.4	2.6 ± 3.1	6.4 ± 5.7	49.2 ± [illegible].4	12.2 ± 9.4	13.9 ± 7.1
E/10	262.7 ± 6.6	160.1 ± 4.9	89.2 ± 3.0	102.9 ± [illegible].8	51.8 ± 5.[illegible]	22.1 ± 4.7
[illegible]/0.5	37.4 ± 159.9	20.2 ± 57.8	38.1 ± 39.6	123.[illegible] ± 10[illegible].8	80.5 ± 88.4	43.8 ± 45.[illegible]

[x] mean values and standard deviation expressed as antilog.

n. d. = not determined

Reference stations off-shore

Station symbols	Coordinates	Station Depth (m)
I	45° 36,2' 13° 39,8'	20 m
II	45° 33,6' 13° 43,7'	15 m
III	45° 33,3' 13° 39,3'	18 m
IV	45° 30,3' 13° 32,8'	10 m
V	45° 35,4' 13° 27,0'	20 m
VI	45° 30,3' 13° 34,0'	16 m
VII	45° 30,6' 13° 35,0'	10 m

(Table 2)

Stations depth/m	less than 100		more than 1000	
	All samples	Bathing season samples (1978)	All samples	Bathing season samples (1978)
26	90.9	100.0	0.0	0.0
27	100.0	100.0	0.0	0.0
I/0.5	100.0	100.0	0.0	0.0
I/20	100.0	100.0	0.0	0.0
II/0.5	70.0	100.0	10.0	100.0
II/15	100.0	100.0	0.0	0.0
III/0.5	77.8	100.0	0.0	0.0
III/18	100.0	100.0	0.0	0.0
IV/0.5	100.0	100.0	0.0	0.0
V/0.5	100.0	100.0	0.0	0.0
V/20	100.0	100.0	0.0	0.0
VI/0.5	100.0	100.0	0.0	0.0
VI/15	100.0	100.0	0.0	0.0
VII/0.5	100.0	100.0	0.0	0.0

(Table 1 — page 2)

Station depth/m	SUMMER mean values/100 ml[x] Total coliforms	Faecal coliforms	Faecal streptococci	WINTER mean values/100 ml[x] Total coliforms	Faecal coliforms	Faecal streptococci
20	16.0 ± 3.7	6.5 ± 6.0	3.8 ± 4.1	50.3 ± 2.9	10.5 ± 5.0	9.5 ± 3.7
21	9.5 ± 6.7	7.4 ± 8.1	7.5 ± 7.1	46.1 ± 3.1	7.1 ± 7.8	6.5 ± 5.3
22	263.7 ± 2.4	125.4 ± 1.3	35.9 ± 2.4	22.7 ± 2.7	8.3 ± 2.6	8.2 ± 3.5
23	7.4 ± 5.2	6.3 ± 6.3	6.5 ± 5.8	10.0 ± 8.7	13.5 ± 11.1	14.7 ± 6.5
24	n. d.	n. d.	n. d.	n. d.	n. d.	n. d.
25	15.3 ± 5.5	12.1 ± 5.6	6.1 ± 5.6	12.5 ± 4.8	4.2 ± 6.2	4.2 ± 3.6
26	17.2 ± 3.8	6.4 ± 7.2	3.9 ± 4.9	38.9 ± 11.5	12.1 ± 5.7	3.6 ± 2.2
27	3.3 ± 5.3	2.1 ± 2.9	1.7 ± 1.8	6.7 ± 5.2	1.2 ± 1.6	0.0 ± 0.0
I/0.5	1.1 ± 1.4	0.0 ± 0.0	0.0 ± 0.0	3.9 ± 5.4	1.6 ± 2.2	2.0 ± 2.7
I/20	1.3 ± 1.5	0.0 ± 0.0	0.0 ± 0.0	2.3 ± 2.5	1.1 ± 1.4	1.3 ± 1.5
II/0.5	3.7 ± 2.8	1.6 ± 1.6	5.3 ± 6.0	71.5 ± 23.2	35.2 ± 36.8	7.0 ± 29.4
II/[illegible]	4.0 ± 4.0	0.0 ± 0.0	4.6 ± 4.9	4.3 ± 2.9	1.7 ± 2.8	1.8 ± 2.1
III/0.5	1.4 ± 2.0	1.2 ± 1.6	1.4 ± 2.0	8.3 ± 39.0	14.3 ± 22.1	11.1 ± 19.6
III/18	2.9 ± 4.4	2.0 ± 4.9	2.3 ± 4.4	3.8 ± 2.7	1.5 ± 2.2	2.8 ± 2.3
IV/0.5	1.7 ± 2.5	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
V/0.5	1.1 ± 1.4	0.0 ± 0.0	1.4 ± 1.7	2.4 ± 2.7	1.1 ± 1.4	0.0 ± 0.0
V/20	1.3 ± 1.9	0.0 ± 0.0	1.1 ± 1.4	1.3 ± 1.5	0.0 ± 0.0	0.0 ± 0.0
VI/0.5	0.0 ± 0.0	0.0 ± 0.0	1.5 ± 2.3	3.4 ± 1.7	1.4 ± 1.8	2.0 ± 2.0

Table: 4 Data on faecal contamination of mussel - cultures in Strunjan during 1977 to 1979

		GROWING WATER		MUSSEL	
Date of sampling	Temp. °C	Total coliforms n/100 ml	Faecal coliforms n/100 ml	Total coliforms n/100 g	Faecal coliforms n/100 g
27.7.77	24.5	9	0	430	150
16.8.77	25.2	0	0	230	0
8.9.77	23.5	9	4	430	30
6.10.77	17.5	0	0	430	90
25.11.77	14.3	0	0	930	430
27.12.77	12.0	0	0	30	0
29.1.78	8.0	93	21	4600	430
17.2.78	7.8	460	150	1500	0
11.4.78	11.1	23	0	90	0
9.5.78	17.4	0	0	390	230
9.5.78	17.4	0	0	4600	430
14.6.78	17.5	0	0	2400	430
14.6.78	17.5	0	0	430	430
11.7.78	21.6	29	93	24000	24000
25.7.78	23.7	0	0	46000	9300
2.8.78	23.6	15	15	160	160
18.9.78	21.7	40	0	930	90
6.10.78	18.6	0	0	11000	4500
7.11.78	15.5	0	0	150	150
8.12.78	11.1	4	4	930	930
9.1.79	9.2	0	0	91	91
6.2.79	9.2	43	15	14000	4600
6.3.79	8.8	0	0	230	91
5.4.79	11.0	0	0	1500	1500

Participating Research Centre: Center for Marine Research
"Rudjer Boskovic" Institute
ROVINJ
Yugoslavia

Principal Investigator: D. FUKS

PILOT PROJECT: MED POL VII

Introduction:

The first steps to develop a methodology for the study of microbiological parameters relevant to the quality of coastal waters were taken at the Centre in 1972.

Systematic monitoring of the sanitary quality of recreational beaches and shellfish-growing waters started in 1973 at a limited number of selected stations in the vicinity of Rovinj, using a few basic parameters such as total and faecal coliforms, BOD, basic chemical, physical and meteorological factors. Since then this monitoring programme has evolved considerably and resulted in a number of publications and reports.

Today, regular surveys made by the Centre cover large areas of the Northern Adriatic, in particular along the western and eastern coast of the Istrian peninsula and the Bay of Rijeka. The number and type of parameters studied in these areas have also increased and diversified, and at present the Centre is successfully carrying out complex studies on the quality of coastal waters at the request of the Government (i.g. MED VII), local authorities and industry.

Area(s) studied:

The Bay of Rijeka, as well as the western and eastern coast of the Istrian peninsula, were selected to investigate systematically the quality of the recreational waters as the Centre's contribution to MED VII.

The Bay and the eastern coast of Istria are surrounded by limestone mountains with steep slopes, which continue under the sea, while the western coast of Istria is surrounded by relatively shallow waters. The shoreline is in most cases rocky.

One of the surface waters entering the area is the small river Rjecina (average flow 20 m^3/s), which is heavily polluted by domestic and industrial wastes originating from Rijeka. The other surface water entering the region (river Mirna) is relatiely clean and carries on average 60 m^3/s of water. The waters of the Northern Adriatic, including the coastal waters of western Istria, are influenced by the northern Italian rivers, in particular the river Po (stations 6 and 7).

Owing to the specific characteristics of the region, there are numerous underwater wells in the vicinity of the coastline, their content of water depending on the amount of rain falling over the adjacent mainland. During heavier rainfall the stormwater entering the Bay is considerable. The average annual precipitation in the area is 1 400 mm/m^2.

The shores of the area are used intensively as an almost all-year-round recreational zone, which, in the peak of the season, can accommodate up to 250 000 tourists a day.

The town of Rijeka, situated in the Bay, is one of the largest Yugoslav coastal cities (160 000 inhabitants) and its harbour (8 million tons/ year) is one of the most important in the country. There are a large number of activities in the city itself and in its surroundings: an airport terminal, shipyards, refineries, coking plant, petrochemical, paper, textile, machine and tool industries, etc.

The sanitary quality of the recreational waters of the area has been systematically monitored at 27 coastal stations (not more than 10 m from the shoreline), grouped in four regions (figures 1, 2, 3, 4 and 5) since the summer of 1976.

Materials and methods used:

The operational document for the MED VII project (document EHE/76.1) and the Guidelines for Health Related Monitoring of Coastal Water Quality (WHO, Copenhagen, 1977) were strictly applied in carrying out the work described.

Results and their interpretation:

The following parameters were monitored regularly at all stations: total coliforms, faecal coliforms, faecal streptococci, dissolved oxygen, BOD_5, pH, salinity, temperature and atmospheric conditions. In addition, at the eight open water stations, nutrients, primary productivity and currents were measured.

The comparative analysis of the data obtained in the four selected regions (Figure 1) shows that there exists a significant difference between the stations of these regions. As expected, stations located closer to the land-based sources of pollution, i.e. sewage outfalls, revealed a higher degree of coastal pollution when measured by the indicators used in this study.

The recorded variations of sea and air temperature at the various stations were closely related to the climatological and meteorological conditions of the area. At some stations (i.e. station no. 8) these parameters were also modified by the amount of fresh water entering the sea in the vicinity of these stations, directly from land or through underwater wells. In general, between September and February, when the measurements were made, the temperature of the air was lower than that of the sea. The surface sea temperature varies between 9.0°C (January 1978, station no. 23) and 27.6°C (July 1977, station no. 27).

As a result of uneven inflow of surface waters and fresh waters from underwater wells, the salinity of the sea surface showed great variations at most of the stations.

Salinity ranges recorded at stations in the region of Rijeka showed a particularly wide variation ($19.35^{o}/_{oo}$ - $37.43^{o}/_{oo}$ for all stations of the region with the exception of station no. 8 where salinity occasionally dropped to $4.20^{o}/_{oo}$). Salinity variations at the West Istrian stations were in the range $26.44^{o}/_{oo}$ - $37.89^{o}/_{oo}$.

Owing to the high buffer capacity of the sea-water, pH values were in the range of 8.00 - 8.40. Exceptionally low values were found only at stations (e.g. station No. 8) heavily influenced by coastal waste discharge where a minimum pH of 7.40 was recorded.

Oxygen saturation of sea-water was regularly close to 100%, with occasionally slightly lower saturation at stations in the Rijeka region, due to the amount of oxygen-consuming organic waste.

The mean biochemical oxygen demand was somewhat lower at the stations along the West Istrian coast (0.8 - 1.3 mg O_2/l) than at the stations in the region of Rijeka (1.3 - 1.6 mg O_2/l). The highest recorded value for BOD 5 was at station No 6 (5.1 mg O_2/l).

The mean values for total coliforms, faecal coliforms and faecal streptococci are listed in Table 1.

The majority of stations (except stations no. 4 and 8) in the region of Rijeka showed significantly lower values during the summer season than during the remainder of the year. High mean values during the out-of-season period indicate the certain influence of meteorological and hydrological conditions on the state of pollution in this area.

Higher mean values noted during the summer season, compared with those noted during other seasons at the majority of stations along the West Istrian coast, indicate the increase in coastal pollution due to the growing number of summer tourists accommodated at hotels and other facilities along the coast.

Although the concentration of total coliforms might not be the best indicator for contamination of sea-water with faecal material, results obtained in our survey (table 1) show good correlation with the location of outfalls bringing into the sea either faecal material or material enhancing the survival and reproduction of micro-organisms in the area.

Faecal coliforms (E. coli) were measured at all stations as one of the most sensitive indicators of the degree of sewage pollution and sewage dispersion around points of sewage discharge.

Highly satisfactory bathing areas should show E. coli (faecal coliforms) counts of consistently less than 100 per 100 ml, and to be considered acceptable, bathing waters should not give counts consistently greater than 1 000 E. coli per 100 ml. No more than 10% of at least [illegible] samples collected during the bathing season should exceed [illegible] E. coli per 100 ml.

Taking these criteria into account, stations nos. 1 and 7 are beyond the acceptable limits set for recreational waters (more than 10% of samples having 1 000 FC/100 ml). However, it should be noted that during the bathing season all these stations could be considered as "acceptable". None of the stations can be considered as highly satisfactory from a recreational standpoint (table 2).

The computed ratios of faecal coliforms and faecal streptococci (FC/FS) for stations nos 1-3 are between [illegible] and 5.4 indicating that they are under the direct influence of human faecal material.

Results obtained at stations in the Pula region indicate their high recreational quality, although the computed FC/FS ratios (0.5-2.3) show occasional influence of contamination with human faecal materials from sources that are not in the vicinity of the stations.

Stations in the region of Porec show somewhat higher faecal coliform values, some of them occasionally exceeding (not in the bathing season) the 1 000 FC/100 ml. Two of six examined beaches can be considered as "highly satisfactory bathing areas". The FC/CS ratios indicate that none of the stations is under the direct influence of human faecal contamination.

Stations in the Umag region have never exceeded the 1 000 faecal coliforms/100 ml and had a low FC/FS ration (0.1 - 1.8). Three stations of six examined beaches can be considered as highly satisfactory from a recreational standpoint.

Table 3 gives the period of sampling and the number of analyses per stations in the controlled areas.

The correlation between total coliforms and faecal coliforms on 27 stations examined, are presented in table 4. If "the 0.01 level" is used as a criterion of significance, a good correlation was then found between TC and FC for stations Nos. 1-7, 10, 11, 16-22, 24-27. No correlation between TC and FC was found for stations Nos. 9, 12, 14, 23. One could speculate that the correlation dropped with the degree of pollution.

Seasonal variations of the number of faecal coliforms caused by the influence of NE and S. winds on the spreading of pollution in coastal water are presented in table [illegible]. Due to the lack of significant number of data with the same meteorological conditions only stations Nos. 1-6 were analysed.

The S. wind (in Rijeka Bay) has driven back sewage released from the outlet to the shore and caused higher mean values at all stations (summer and the remaining part of year).

The NE wind has removed pollution from the seashore and caused significantly lower mean values at all stations (except No. 8).

Significantly higher mean values were found for stations Nos. 1-6 influenced by S. wind.

Conclusions:

The survey of recreational waters in four selected regions of the North Adriatic (Figure 1) revealed the correlation between the sanitary (recreational) quality of waters at selected stations and the vicinity of land-based sources of contamination.

The region of Rijeka is influenced by pollutants and some of the stations of this region are close to the limit set for "acceptable" bathing waters. The stations surveyed in the other three regions (Pula,Porec, Umag) are clean (or sporadically slightly polluted) and none of the nineteen controlled beaches can be considered as highly satisfactory from a recreational standpoint, although some of surveyed stations are occasionally influenced by indirect pollution from land-based sources.

List of Publications

D. FUKS: Sanitary Quality of Coastal Waters of Rovinj (in Croatian, with English summary), M. Sc. Thesis, University of Zagreb 1974.

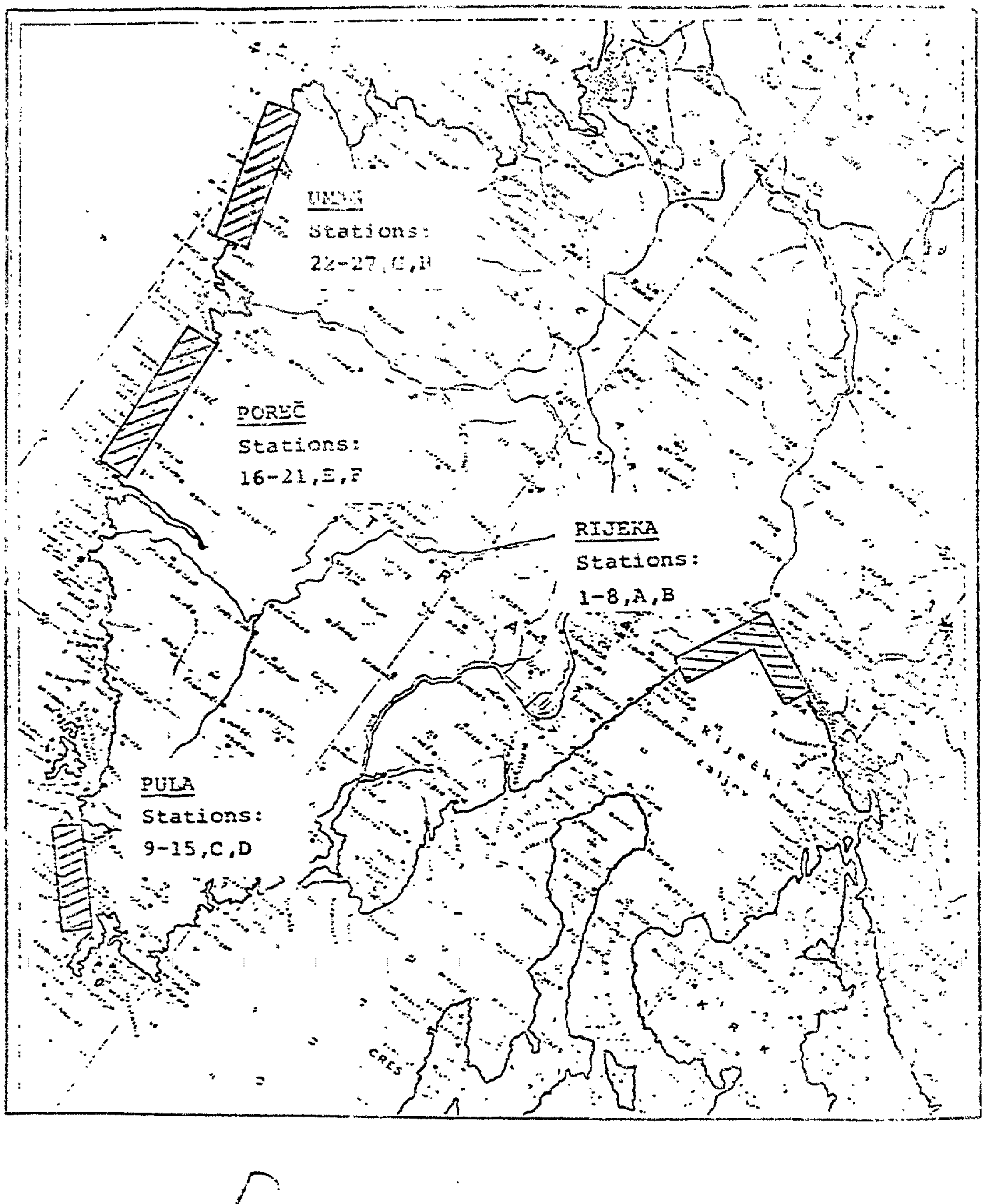
K. HARDT-JURICEV: Sanitary Quality of Coastal Water from Rovinj, to Novigrad (in Croatian, with English summary), M. Sc. Thesis, University of Zagreb, 1975.

D. FUKS and Z. FILIC: Microbiological Quality Control of Shellfish Growing Waters and Elimination of Bacteria by Mussel Mytilus galloprovincialis Lmk. Ichthyologia, 9 (1977) 101-106.

D. FUKS: Cruises of the RV "Vila Velebita" in the Kvarner Region of the Adriatic Sea. III. Concentration of Total Bacteria and Total Coliforms and the Biological Oxygen Demand. Thalassia Yugosl. 8/2, in press.

D. FUKS and S. KEČKES: Variability of certain Microbiological and Environmental Water Quality Indicators in Coastal Recreational Waters off the West Istrian Coast, Yugoslavia. Thalassia Jugosl. 13/1 (1977).

Figure 1: Area studied in the framework of MED VII



Note: Sampling stations are grouped in indicated regions named after the vicinity of the largest town.

Table 1: Mean values and their standard deviations for total coliforms, faecal coliforms and faecal streptococci in samples taken at examined stations (data separated in "summer" and "other" (season) columns)

Stations	Total coliforms n/100 ml		Faecal coliforms n/100 ml		Faecal streptococci n/100 ml	
	Summer	Others	Summer	Others	Summer	Others
1	138.9* ± 7.1*	289.1 ± 6.7	69.3 ± 6.8	147.4 ± 9.8	35.2 ± 7.0	92.5 ± 8.9
2	94.2 ± 10.5	207.6 ± 8.8	44.7 ± 11.2	112.6 ± 9.8	43.6 ± 9.1	53.1 ± 9.9
3	75.3 ± 5.2	239.3 ± 5.4	27.4 ± 7.0	69.6 ± 6.6	19.7 ± 5.0	39.2 ± 9.7
4	56.6 ± 10.0	58.8 ± 10.4	30.8 ± 10.3	25.1 ± 10.3	41.1 ± 7.2	18.5 ± 11.1
5	72.5 ± 7.3	124.9 ± 4.4	34.0 ± 7.2	98.5 ± 4.2	10.4 ± 7.2	15.7 ± 7.5
6	46.7 ± 6.2	136.4 ± 6.1	21.0 ± 5.9	90.9 ± 6.6	13.2 ± 7.6	47.7 ± 8.3
7	192.0 ± 4.7	257.3 ± 6.1	69.8 ± 5.1	131.5 ± 9.3	25.6 ± 7.8	50.2 ± 12.7
8	315.0 ± 3.3	304.2 ± 4.4	178.9 ± 3.6	113.1 ± 4.2	71.1 ± 5.8	62.8 ± 5.9
A	5.8 ± 10.2	75.5 ± 6.8	1.8 ± 3.3	65.9 ± 6.1	4.2 ± 7.9	49.0 ± 20.2
B	7.9 ± 5.2	91.1 ± 4.7	2.6 ± 3.3	46.1 ± 2.5	2.1 ± 3.2	46.1 ± 6.8
9	7.8 ± 7.2	2.3 ± 7.8	3.6 ± 5.6	1.4 ± 2.4	4.4 ± 7.5	2.7 ± 5.8
10	4.0 ± 4.1	1.4 ± 3.1	2.5 ± 2.8	1.2 ± 1.7	3.0 ± 5.6	2.4 ± 3.8
11	13.4 ± 9.2	2.3 ± 4.7	8.1 ± 6.2	1.8 ± 4.1	8.1 ± 3.9	3.3 ± 6.5
12	33.9 ± 5.4	10.7 ± 5.3	9.7 ± 5.6	4.5 ± 3.7	19.9 ± 7.9	3.3 ± 4.7
13	5.7 ± 5.3	1.1 ± 1.3	3.2 ± 4.3	1.3 ± 2.6	4.3 ± 6.2	2.1 ± 3.5
14	4.7 ± 3.9	1.7 ± 2.6	1.9 ± 2.3	1.0 ± 1.0	3.6 ± 4.4	1.6 ± 2.0
15	2.4 ± 4.5	1.4 ± 2.4	1.3 ± 1.7	1.1 ± 1.4	3.5 ± 3.9	1.7 ± 2.7
C	2.6 ± 5.3	1.0 ± 1.0	2.8 ± 4.9	1.0 ± 1.0	3.2 ± 6.2	1.0 ± 1.0
D	1.9 ± 2.8	1.0 ± 1.0	1.3 ± 5.9	1.0 ± 1.0	1.4 ± 2.2	1.0 ± 1.0
16	110.6 ± 8.4	44.3 ± 8.0	80.0 ± 6.5	30.5 ± 6.9	87.3 ± 5.5	27.4 ± 7.4
17	73.1 ± 16.8	2.7 ± 3.9	39.1 ± 12.2	1.3 ± 2.0	50.7 ± 11.8	3.5 ± 6.2
18	28.9 ± 2.3	2.5 ± 2.9	7.4 ± 6.5	1.3 ± 2.3	38.7 ± 3.9	5.1 ± 4.1
19	13.9 ± 5.5	6.9 ± 8.5	5.2 ± 5.0	2.9 ± 6.9	40.6 ± 3.7	5.3 ± 7.1
20	32.1 ± 6.4	22.4 ± 9.4	8.8 ± 8.9	9.4 ± 11.1	16.9 ± 9.6	21.3 ± 8.6
21	20.0 ± 4.1	9.9 ± 5.4	10.5 ± 3.7	2.7 ± 5.7	14.6 ± 6.4	4.6 ± 4.8
E	1.0 ± 1.0	2.0 ± 4.2	1.0 ± 1.0	1.9 ± 2.8	1.8 ± 1.9	1.2 ± 1.4
F	3.1 ± 5.8	1.2 ± 1.4	2.8 ± 5.0	1.0 ± 1.0	6.4 ± 4.5	1.0 ± 1.0
22	30.0 ± 4.7	3.5 ± 5.9	14.7 ± 6.5	2.3 ± 4.9	15.8 ± 5.1	2.3 ± 2.9
23	6.3 ± 5.1	9.1 ± 5.4	2.5 ± 3.7	5.5 ± 4.4	2.8 ± 3.7	3.7 ± 4.9
24	40.9 ± 7.3	26.0 ± 14.3	22.9 ± 8.1	14.3 ± 7.6	16.6 ± 4.5	30.0 ± 8.8
25	6.3 ± 4.4	16.2 ± 5.1	3.4 ± 3.8	11.9 ± 5.8	2.7 ± 3.9	12.7 ± 3.5
26	10.7 ± 7.6	6.7 ± 3.6	5.8 ± 5.9	3.3 ± 4.4	5.3 ± 4.8	4.3 ± 3.4
27	10.3 ± 6.2	26.6 ± 8.1	4.6 ± 5.8	11.8 ± 7.8	7.9 ± 4.9	17.4 ± 9.5
G	3.2 ± 3.9	1.7 ± 2.5	1.9 ± 3.5	1.0 ± 1.0	1.8 ± 4.0	1.4 ± 1.9
H	3.1 ± 4.9	2.0 ± 3.3	1.3 ± 1.4	1.6 ± 1.7	1.6 ± 1.7	1.4 ± 1.9

* Log transformed data

Table 2: Distribution of faecal coliforms and evaluation of stations according to interim criteria, FC/FS ratio

Stations	Samples (%) exceeding limits of -				
	100 faecal coliforms/100 ml		1000 faecal coliforms/100 ml		Ratio
	Total	Summer	Total	Summer	FC/FS
1	41.5	37.5	12.2	8.2	3.2
2	43.9	50.0	7.3	0.0	3.1
3	26.8	25.0	9.8	4.2	3.4
4	29.2	33.3	4.9	4.2	2.3
5	28.9	21.7	5.3	4.3	5.4
6	25.0	13.0	5.0	0.0	3.2
7	35.0	26.1	15.0	8.7	5.4
8	62.5	69.6	7.5	4.3	3.5
A	20.0	0.0	0.0	0.0	0.6
B	20.0	0.0	0.0	0.0	0.9
9	4.2	7.7	0.0	0.0	0.6
10	0.0	0.0	0.0	0.0	0.7
11	8.3	15.4	0.0	0.0	1.5
12	4.2	7.7	0.0	0.0	2.3
13	0.0	0.0	0.0	0.0	0.8
14	0.0	0.0	0.0	0.0	0.5
15	0.0	0.0	0.0	0.0	0.6
C	0.0	0.0	0.0	0.0	0.7
D	0.0	0.0	0.0	0.0	0.6
16	30.4	50.0	4.3	0.0	1.7
17	17.4	33.0	0.0	0.0	0.9
18	4.3	8.3	0.0	0.0	0.8
19	4.3	0.0	0.0	0.0	0.7
20	4.3	8.3	4.3	0.0	2.0
21	0.0	0.0	0.0	0.0	1.1
E	0.0	0.0	0.0	0.0	1.0
F	0.0	0.0	0.0	0.0	0.9
22	10.5	18.2	0.0	0.0	1.3
23	0.0	0.0	0.0	0.0	1.4
24	26.3	36.4	0.0	0.0	1.8
25	5.3	0.0	0.0	0.0	1.6
26	0.0	0.0	0.0	0.0	1.1
27	10.5	9.1	0.0	0.0	0.8
G	0.0	0.0	0.0	0.0	0.7
H	0.0	0.0	0.0	0.0	0.9

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Introduction:

The rather wide range of activities of the Institute for Oceanography and Fisheries in Split covers research into the pollution problem of the coastal water of the central and southern parts of the Adriatic Sea. We would like to report here on the two largest projects carried out recently: "Protection of the Human Environment in the Yugoslav Adriatic Region" and "Monitoring of Coastal Water Quality (Vir-Konavle)".

Area(s) studied:

Under the MED VII programme, the Institute for Oceanography and Fisheries undertook the monitoring studies in four areas (Zadar, Split, Ston and Dubrovnik). As the quality of the coastal water itself was the object of this programme, it was carried out in zones of intensive recreational activities, extensive shipping traffic, discharges of waste waters and shellfish-breeding areas. In most cases these zones are surrounded by limestone mountains. The shoreline is mainly rocky and intensively used for recreation.

The Zadar (approximately 50 000 inhabitants) and the Split areas (approximately 200 000 inhabitants) are under the influence of industrial and domestic waste waters, while the Dubrovnik area (approximately 40 000 inhabitants) is more or less affected by domestic waste waters only. The Stone area is slightly influenced by the M. Ston waste waters (approximately 200 inhabitants). Usually the waste waters of these areas are untreated before their discharge into the sea and they are taken out to sea by submarine pipes to a greater or smaller distance from the coast.

The currents measured were fastest, for the most part, in winter periods and slowest in spring summer periods. As to the layers, the currents were found to be faster in bottom layers than in surface layers.

The Zadar area shows the widest annual range of temperature (12.26°C), while the Dubrovnik area shows the narrowest range (9.17°C). In the course of a year variations of temperature are normal having minimal values in winter periods and maximal ones in summer periods.

As to salinity, its narrowest range was observed in the Zadar area (1.28 $^{o}/_{oo}$)while other areas had a wider range: Dubrovnik (5.12 $^{o}/_{oo}$), Split (6.4 $^{o}/_{oo}$) and Ston (10.71 $^{o}/_{oo}$). For the most part minimal salinity values were found in winter periods and maximal ones in summer periods. The analysis of sediments showed that all bottom zones consist of clayey and loamy sand.

Due to the domestic waste waters in the Split area, the nutrient values are somewhat higher, as well as the quantities of phytoplankton, and therefore eutrophication is observed. The phytoplankton community was mainly characterized by the prevalence of diatoms with relative abundance in the limits from 59 to 83%.

Materials and methods used:

The methods recommended by MED VII were applied (operational document, EHE/76.1, WHO, Geneva, project were applied (the operational document, EHE/76.1, WHO, Geneva, 1976). Nutrients were measured by autoanalyser, both salinity and temperature were determined by the conductivity method and oxygen was determined by the standard Winkler method.

Results and their interpretation:

The following parameters have been monitored:

Total coliforms faecal coliforms faecal streptococci total heterotrophic bacteria meteorological conditions hydrographic conditions dynamic conditions structure of sediment nutrients density of phytoplankton visual observation

The degree of pollution with regard to the bacteria varied a great deal in different areas as well as in different seasons.

In the Zadar area, the town itself is being polluted heavily, especially the town port (stations 2, 3, 4 and 5). Other zones in this area are in a fairly good condition for the time being.

In Split, as well as in Zadar, the town itself is again heavily polluted (town and port). Thus the adjacent recreational zones are being affected by it (stations 1, 3 and 4). Other zones are still suitable for recreation.

The recreational zone in the Ston area (station 1) is under the slight influence of faecal contaminated water (sea-side resort Klek-Neum).

The quality of the sea-water at the shellfish-breeding area is entirely adequate for the purpose. The bacteriological analyses of shellfish have confirmed this.

In the Dubrovnik area the influence of faecal contaminated water was observed in the vicinity of the port of Gruz and the town port (stations 2 and 5). Other zones in this area are suitable for recreation.

The primary data of E. coli are classified according to winds (wind direction in degrees). Their calculated mean and standard deviation are tabulated in tables 1 and 2. For adequate statistical interpretation, however, more observations (primary data) are needed.

Conclusions:

The results obtained so far indicate that all the analysed recreational waters are within the accepted interim microbiological quality criteria, but the sites near the harbour are to a certain degree affected by faecal pollution. Thus some recreational zones near Split and Zadar are affected by the faecal water from the town ports.

Our suggestion for continuation of this work is to eliminate all parameters not so relevant for this purpose. It is sufficient to monitor parameters such as microbiological, meteorological and dynamic conditions.

Figure 1

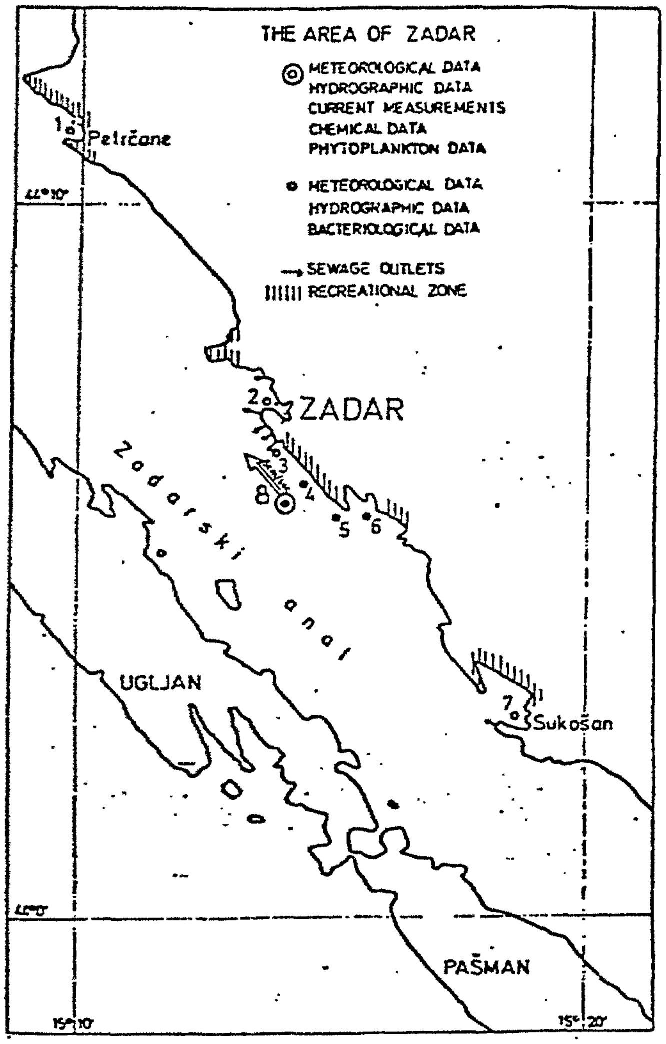


Figure 2

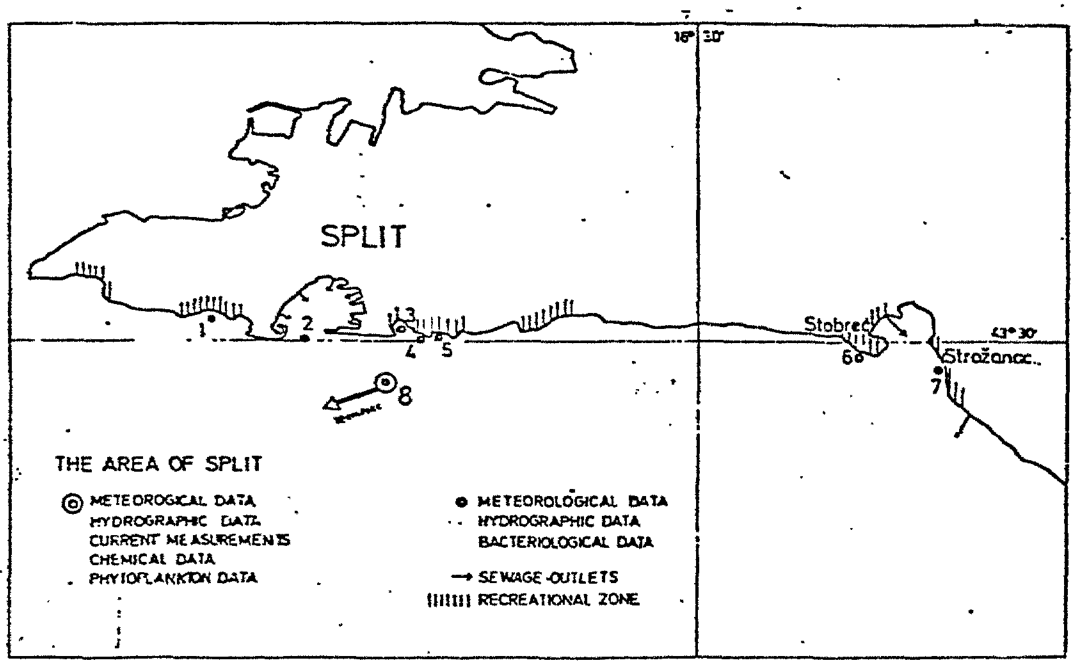


Figure 3

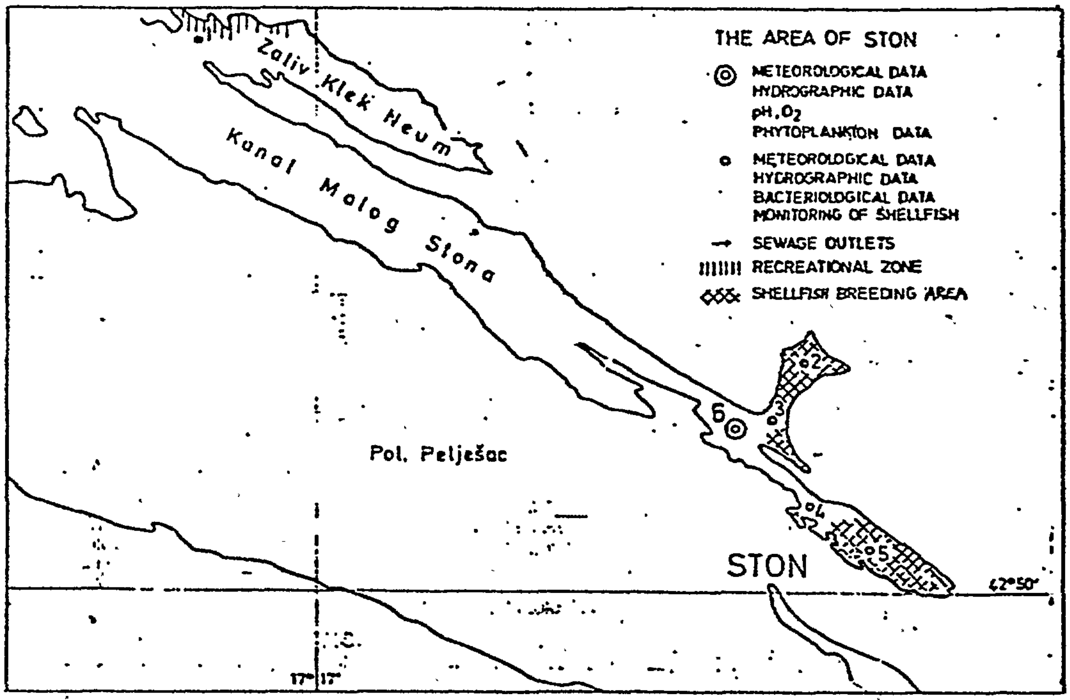


Figure 4

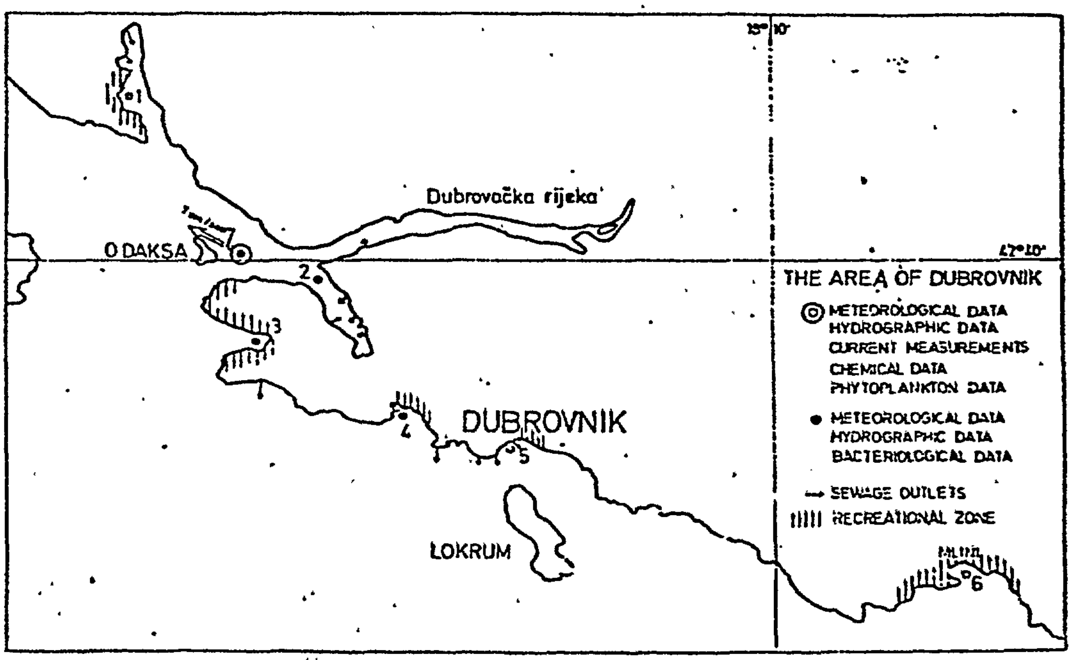


Table 1.a: Individual location tabulation of results (E. coli/100 ml) - ZADAR area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1		2	3	0		11
		1	0	17		1
			1	1		
	log $\bar{x}$	0.151	0.159	0.410		0.521
	log s	0.213	0.276	0.710		0.736
	$\bar{x}$	1.414	1.442	2.571		3.317
	s	1.633	1.886	5.133		5.450
2		124	282	32	140	94
			608			15
			40			550
			100			
	log $\bar{x}$		2.209			1.963
	log s		0.517			0.782
	$\bar{x}$		161.828			91.833
	s		3.289			6.053
3		5	51	6	10	28
			4			30
			910			40
			40			
	log $\bar{x}$		1.718			1.509
	log s		0.966			0.082
	$\bar{x}$		52.201			32.285
	s		9.247			1.208
4		28	100	6	6	50
			2			10
			28			1
			28			
	log $\bar{x}$		1.299			0.900
	log s		0.714			0.854
	$\bar{x}$		19.907			7.943
	s		5.176			7.145
5		3	4	2	7	4
			6			3
			10			10
			6			
	log $\bar{x}$		0.790			0.693
	log s		0.365			0.273
	$\bar{x}$		6.166			4.932
	s		2.317			1.876
6		5	10	47	11	0
			1			1
			1			1
			1			
	log $\bar{x}$		0.250			
	log s		0.500			
	$\bar{x}$		1.778			
	s		3.162			
7		2	1	0	2	2
			0			0
			0			4
			6			
	log $\bar{x}$		0.195			0.301
	log s		0.389			0.301
	$\bar{x}$		1.565			1.999
	s		2.449			1.999

Table: 2 Relative frequencies (%) of the counts of faecal coliforms listed in accordan with interim criteria, i.e. less than 100 faecal coliforms/100 ml and more than 1000 faecal coliforms/100 ml

Stations depth/m	less than 100		more than 1000	
	All samples	Bathing season samples (1978)	All samples	Bathing season samples (1978)
1	81.8	80.0	0.0	0.0
2	77.8	80.0	9.1	20.0
3	81.8	80.0	9.1	20.0
4	80.0	80.0	0.0	0.0
5	45.4	40.0	36.4	20.0
6	100.0	100.0	0.0	0.0
7	90.9	100.0	0.0	0.0
8	33.3	20.0	33.3	60.0
9	63.6	80.0	0.0	0.0
10	100.0	100.0	0.0	0.0
11	100.0	100.0	0.0	0.0
12	90.9	100.0	0.0	0.0
13	100.0	100.0	0.0	0.0
14	100.0	100.0	0.0	0.0
15	100.0	100.0	0.0	0.0
16	100.0	100.0	0.0	0.0
17	72.7	100.0	0.0	0.0
18	100.0	100.0	0.0	0.0
19	90.0	80.0	0.0	0.0
20	100.0	100.0	0.0	0.0
21	100.0	100.0	0.0	0.0
22	50.0	20.0	0.0	0.0
23	90.9	100.0	0.0	0.0
24	n. d.	n. d.	n. d.	n. d.
25	100.0	100.0	0.0	0.0

Table: 3 The correlation between total coliforms and faecal coliforms (TC/FC) and between faecal coliforms and faecal streptococci (FC/FS)

Stations	Ratio TC/FC	Ratio FC/FS	Stations depth/m	Ratio TC/FC	Ratio FC/FS
1	1.58	0.94	I/0.5	4.67	0.82
2	3.58	1.44	I/20	6.00	0.67
3	0.66	14.55	II/0.5	1.14	5.14
4	2.27	1.10	II/15	5.64	0.17
5	1.73	2.79	III/0.5	2.25	0.93
6	n.d.	n.d.	III/18	1.50	0.86
7	5.34	0.26	IV/0.5	5.00	0.00
8	1.44	5.09	V/0.5	6.00	0.43
9	1.58	2.63	V/20	8.00	0.00
10	2.09	0.60	VI/0.5	2.71	0.37
11	4.26	1.15	VI/15	2.88	0.59
12	2.40	1.46	VII/0.5	35.64	0.33
13	7.59	1.98	R/0.5	5.89	2.73
14	4.83	3.00	D/0.5	1.64	2.71
15	1.38	1.25	D1/0.5	3.65	0.33
16	2.76	0.40	A/0.5	2.44	2.36
17	2.55	0.10	A1/0.5	1.91	2.62
18	0.90	1.41	A2/0.5	1.97	1.59
19	1.49	1.80	A2/5	1.66	1.46
20	2.60	1.61	A3/0.5	2.70	1.25
21	1.69	1.42	A3/10	2.61	3.24
22	2.63	2.44	C/0.5	1.38	2.62
23	1.54	0.37	C/10	4.00	0.21
24	n.d.	n.d.	C/20	2.63	3.97
25	1.50	1.85	E/0.5	2.03	0.90
26	5.46	4.16	E/10	2.27	2.88
27	8.39	1.64	F/0.5	7.39	2.90

Table 1.b: Individual location tabulation of results (E. coli/100 ml) - SPLIT area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1			6	38		40
			80	0		0
			0	130		26
				14		
	log $\bar{x}$		0.894	1.210		1.007
	log s		0.957	0.899		0.876
	$\bar{x}$		7.830	16.217		10.132
	s		9.053	7.916		7.515
2			64	780		5
			820	20		10
			33	290		104
				332		
	log $\bar{x}$		2.080	2.294		1.239
	log s		0.938	0.698		0.691
	$\bar{x}$		120.089	196.863		17.325
	s		8.672	4.885		4.905
3			6	74		10
			380	10		18
			10	38		2
				2		
	log $\bar{x}$		1.453	1.188		0.852
	log s		0.982	0.693		0.494
	$\bar{x}$		28.355	15.340		7.114
	s		9.603	4.927		3.119
4			2	5		2
			48	26		11
			13	54		0
				31		
	log $\bar{x}$		1.032	1.334		0.447
	log s		0.679	0.445		0.536
	$\bar{x}$		10.766	21.599		2.802
	s		4.772	2.784		3.435
5			6	4		20
			9	23		7
			10	32		0
				238		
	log $\bar{x}$		0.911	1.461		0.715
	log s		0.117	0.728		0.660
	$\bar{x}$		8.143	28.932		5.192
	s		1.310	5.340		4.572
6		33	4	20	45	22
			4			2
			64			1
						6
	log $\bar{x}$		1.003			0.605
	log s		0.695			0.465
	$\bar{x}$		10.079			4.031
	s		4.957			2.919
7		67	9	52	22	40
			5			21
			6			22
						10
	log $\bar{x}$		0.810			1.317
	log s		0.131			0.247
	$\bar{x}$		6.463			20.734
	s		1.351			1.764

Table 1.c: Individual location tabulation of results (E. coli:100 ml) - STON area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1		20	13	18	0	0
		2		2		
				4		
				0		
				0		
	log $\bar{x}$	0.801		0.432		
	log s	0.707		0.524		
	$\bar{x}$	6.325		2.702		
	s	5.095		3.340		
2		0	0	1	0	0
		0		0		
				0		
				0		
				1		
3		0	0	0	6	1
		0		0		
				0		
				1		
				2		
	log $\bar{x}$			0.060		
	log s			0.135		
	$\bar{x}$			1.149		
	s			1.363		
4		0	0	5	1	0
		0		0		
				0		
				0		
				0		
	log $\bar{x}$			0.140		
	log s			0.313		
	$\bar{x}$			1.380		
	s			2.054		
5		0	0	2	9	0
		0		0		
				0		
				0		
				0		
	log $\bar{x}$			0.060		
	log s			0.135		
	$\bar{x}$			1.149		
	s			1.363		

Table 1.d: Individual location tabulation of results (E. coli/100 ml) - DUBROVNIK area

Station		Wind direction in degrees 0-90	90-180	180-270	270-360	no wind
1		0	0	10	2	2
		0	2			48
			14			
			7			
	log $\bar{x}$		0.573			0.991
	log s		0.518			0.976
	$\bar{x}$		3.742			9.798
	s		3.296			9.461
2		88	5	108	55	6
		36	30			450
			18			
			37			
	log $\bar{x}$	1.750	1.250			1.716
	log s	0.274	0.390			1.356
	$\bar{x}$	36.285	17.778			51.962
	s	1.881	2.455			21.177
3		2	0	13	2	2
		3	0			1
			2			
			1			
	log $\bar{x}$	0.389	0.075			0.151
	log s	0.125	0.151			0.213
	$\bar{x}$	2.449	1.189			1.414
	s	1.332	1.415			1.633
4		1	2	100	2	40
		15	14			1
			0			
			2			
	log $\bar{x}$	0.588	0.437			0.801
	log s	0.832	0.494			1.133
	$\bar{x}$	3.873	2.736			6.325
	s	6.786	3.116			13.578
5		1	6	146	14	250
		39	66			22
			60			
			1			
	log $\bar{x}$	0.796	1.094			1.870
	log s	1.125	0.874			0.746
	$\bar{x}$	6.245	12.415			74.162
	s	13.337	7.480			5.577
6		0	0	116	48	7
		14	30			7
			5			
			1			
	log $\bar{x}$	0.573	0.544			0.845
	log s	0.810	0.704			0.000
	$\bar{x}$	3.742	3.500			7.000
	s	6.463	5.056			0.000

Table 2.a: Mean values and standard deviations (MF/100 ml) for E. coli - ZADAR area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1	$\bar{x}$ s	1.414 1.633	1.442 1.886	2.571 5.133		3.317 5.450
2	$\bar{x}$ s		161.828 3.289			91.833 6.053
3	$\bar{x}$ s		52.201 9.247			32.285 1.208
4	$\bar{x}$ s		19.907 5.176			7.943 7.145
5	$\bar{x}$ s		6.166 2.317			4.932 1.876
6	$\bar{x}$ s		1.778 3.162			
7	$\bar{x}$ s		1.565 2.449			1.999 1.999

Table 2.b: Mean values and standard deviations (MF/100 ml) for E. coli - SPLIT area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1	$\bar{x}$ s		7.830 9.053	16.217 7.916		10.132 7.515
2	$\bar{x}$ s		120.089 8.672	196.863 4.885		17.325 4.905
3	$\bar{x}$ s		28.355 9.603	15.340 4.927		7.114 3.119
4	$\bar{x}$ s		10.766 4.772	21.599 2.784		2.802 3.435
5	$\bar{x}$ s		8.143 1.310	28.932 5.340		5.192 4.572
6	$\bar{x}$ s		10.079 4.957			4.031 2.919
7	$\bar{x}$ s		6.463 1.351			20.734 1.764

Table 2.c: Mean values and standard deviations (MF/100 ml) for E. coli - STON area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1	$\bar{x}$ s	6.325 5.095		2.702 3.340		
2						
3	$\bar{x}$ s			1.149 1.363		
4	$\bar{x}$ s			1.380 2.054		
5	$\bar{x}$ s			1.149 1.363		

Table 2.d: Mean values and standard deviations (MF/100 ml) for E. coli - DUBROVNIK area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1	$\bar{x}$ s		3.742 3.296			9.798 9.461
2	$\bar{x}$ s	36.285 1.881	17.778 2.455			51.962 21.177
3	$\bar{x}$ s	2.449 1.332	1.189 1.415			1.414 1.633
4	$\bar{x}$ s	3.873 6.786	2.736 3.116			6.325 13.578
5	$\bar{x}$ s	6.245 13.337	12.415 7.480			74.162 5.577
6	$\bar{x}$ s	3.742 6.463	3.500 5.056			7.000 0.000

MED POL VIII : BIOGEOCHEMICAL STUDIES OF SELECTED POLLUTANTS IN THE OPEN WATERS OF THE MEDITERRANEAN (IAEA/IOC/UNEP)

MED POL VIII : ETUDES BIOGEOCHIMIQUES DE CERTAINS POLLUANTS AU LARGE DE COTES DE LA MEDITERRANEE (AIEA/COI/PNUE)

Centre de Recherche participant: Centre des Faibles Radioactivités
Laboratoire mixte CNRS-CEA
GIF-SUR-YVETTE
France

Chercheur principal: R. CHESSELET

Introduction

Les études ici présentées sur le contenu en métaux des aérosols et des particules en suspension ont été entreprises pour déterminer le rôle de la matière particulaire dans le transport des métaux vers les océans et à l'intérieur de ces eaux. Ces études sont complémentaires au travail exécuté par le Laboratoire AIEA à Monaco, dont le compte rendu se trouve dans une autre partie de ce rapport.

Zones étudiées

A. Zone comprise entre Nice (France) et Calvi - Carte des stations pour l'étude des particules marines - (carte 1).

B. Zone d'étude de la chimie des aérosols marins.
Carte no. 2.

Methodologie*

Etude des particules marines.

L'eau de mer, prélevée à différentes profondeurs à l'aide de bouteilles Niskin PVC (30 l) est filtrée sur des membranes nuclépores de porosité 0,4 um, qui collectent plus de 95% de la matière en suspension. Al, Fe, Cu, Pb, Zn, Cd, As sont dosés par spectrométrie d'absorption atomique sans flammer par voie électro- thermique.

Etude des prélèvements atmosphériques

Les aérosols marins sont collectés par filtration d'air sur papier filtre Whatman de diamètre 7 cm. Ce type de filtre est choisi en raison de sa grande efficacité de filtration (> 99%) et de sa faible teneur en impureté chimique. La méthode d'analyse est la même que celle utilisée pour les particules marines.

Méthodologie analytique

Le dosage des métaux (Cu, Pb, Zn, Fe, Al, Cd, As) nécessite une solubilisation préalable des particules recueillies sur filtre par une attaque dite "à la bombe". Ensuite les métaux, en raison de leur très faible concentration sont dosés par une méthode de très haute sensibilité

* Les méthods de prélèvement et d'analyse sont les mêmes que celles utilisées dans l'Atlantique, en prenant des précautions extremes contre les contaminations accidentelles (Annexe 1).

et qui autorise le micro-échantillonnage : il s'agit de la spectrométrie d'absorption atomique par voie électro-thermique. Au tableau 1 sont présentées des caractéristiques essentielles de cette méthode analytique appliquée au dosage du Cu, Pb, Cd, As, Zn, Fe, Al, dans les particules en suspension dans l'océan.

Afin de s'assurer de la fiabilité de nos dosages, de nombreux contrôles de la justesse ont été effectués à l'aide de standards de référence du N.B.S., de la méthode des ajouts dosés et par une autre méthode lorsque cela était possible (activation neutronique pour Al, Fe, Zn, As, dilution isotopique pour Pb, méthode des hydrures pour As).

Resultats et interpretation

Chimie des particules marines

Les concentrations des éléments Al, Fe, Cn, Pb, Zn, Cd, As sont données aux tableaux

Discussion

Les concentrations de Matière Totale Particulaire collectée sont d'environ 10 ug/l, elles sont très voisines des concentrations de matière totale en suspension que nous observons dans l'Atlantique et le Pacifique.

Les concentrations de Al, élément qui peut être considéré comme indicateur des concentrations des alumino-silicates (1-2-3-4-6) sont du même ordre de grandeur quelle que soit la station (Al = 100 ng/l). Cette concentration est très proche de la concentration d'Al mesurée sur l'ensemble des prélèvements GEOSECS dans l'Atlantique et le Pacifique. Il a été montré que pour ces deux océans les concentrations en Al sont en partie gouvernées par un flux atmosphérique d'origine continentale.

Bien que l'on observe un certain gradient des concentrations moyennes pour les métaux trace étudiés entre la station proche de la côte du Sud de la France (Station 1) et la Station 3, les valeurs moyennes des concentrations de ces éléments sont très voisines des concentrations moyennes de ces éléments à l'échelle de l'Atlantique et du Pacifique.

Un certain nombre d'échantillons ont été pris à des profondeurs quasiment identiques et d'autre part certains filtres proviennent d'échantillons provenant d'une même bouteille. Cette étude a été faite dans le but d'étudier la variabilité des concentrations.

La variabilité que nous constatons ici (tableaux 1-2-3) est d'un facteur 2.4 moyenne : variabilité qui est exactement semblable à celle observée sur 500 échantillons dans le programme C.F.R.-G E O S E C S.

Cette variabilité ne peut pas être prise comme une indication d'une contamination accidentelle ou d'une erreur d'analyse.

Quand on considere les moyennes observées pour chaque station et pour chacun des éléments (Al-Fe-Cu-Pb-Zn-Cd) on observe une diminution de la côte vers le large (de la station 1 vers la station 3).

Ce gradient suggère l'existence d'un effet lié à la proximité du talus continental. Cet effet se superposerait à l'apport atmosphérique et les résultats seront discutés dans la section suivante.

Les figures 1, 2, 3, 4 donnent les concentrations en fonction de la profondeur. On constate que la variabilité dont nous avons fait état au paragraphe 3 se retrouve à toutes les profondeurs et aux trois stations. D'autre part, on n'observe aucun accroissement ou diminution marqué avec la profondeur, ce qui suggère que nous nous trouvons en présence de particules marines appartenant au "bruit de fond" particulaire de l'océan. Cette donnée est en accord avec celle qui a été établie à l'échelle de l'océan au cours du programme GEOSECS. Il semble que pour le Pb, on observe à la station 1, dans les eaux de surface, une très grande concentration qui pourrait avoir pour origine l'influence de la pollution locale.

Discussion des Facteurs d'Enrichissement

Il est d'usage afin de permettre des comparaisons d'exprimer les concentrations en éléments-traces dans la matière particulaire, que ce soit sous forme de particules marines ou d'aérosols, sous forme de Facteurs d'Enrichissement.

Nous avons adopté ici le mode de calcul généralement admis :

Nous comparons les abondances relatives de ces éléments à leur abondance relative moyenne de la croûte terrestre, en prenant l'aluminium comme élément de référence. On obtient ainsi pour chaque élément un Facteur d'Enrichissement :

$$F_{E\,croûte} = \frac{(X/Al)_{particule}}{(X/Al)_{croûte}}$$

Les Facteurs d'Enrichissement en Fe, Cu, Pb, Cd, Zn ainsi calculés sont donnés dans les figures 5-6.

On constate que les F_E ainsi calculés sont trop élevés (> 10) pour que les concentrations des métaux en traces (Cu, Pb, As, Cd, Zn) puissent être expliquées par leurs abondances moyennes dans les particules d'origine détritique continentale.

Dans les figures 5-6 on a fait figurer les valeurs moyennes de l'enrichissement dans les particules de l'Atlantique Nord (4-2).

La comparaison qui est alors possible montre que les F_E sont très proches de ceux observés pour l'Atlantique (7). Pour des raisons de commodité sur les figures 5-6 n'ont pas été figurées les fourchettes des F_E observés dans l'Atlantique. Il n'en demeure pas moins que pour le Fe, le Cu et le Pb ces Enrichissements ont tendance à être supérieurs en Méditerranée dans la région étudiée, à ceux observés dans l'Atlantique.

Discussion de l'origine de l'enrichissement

Etant admis qu'il a été démontré à l'échelle de l'Atlantique que l'apport atmosphérique exerce un certain contrôle sur la chimie des particules marines, on peut tenter de calculer de la même façon que l'on a opéré dans l'Atlantique le flux des particules en suspension dans l'étude présentée ici et comparer les valeurs de ces flux à ceux qui ont été présentés pour l'Atlantique Nord. Cette comparaison figure au tableau 5. Pour calculer ces flux on a utilisé une vitesse de chute des particules de 80 m/an, fondée sur la distribution des tailles des particules observées dans l'Atlantique, à partir de comparaisons de mesures effectuées au Coulter-Counter entre la Méditerranée et l'Atlantique. Il semble qu'il n'y ait pas de différence dans les distributions de taille entre les particules de Méditerranée et d'Atlantique. On peut donc considérer cette vitesse de chute comme valable pour le site de la Méditerranée. Il nous parait significatif à l'examen du tableau 5 que les flux calculés en Méditerranée au cours de cette étude soient 2-3 fois supérieurs à ceux de l'Atlantique Nord alors que le flux d'Al est pratiquement identique.

Cette valeur du flux des éléments-traces comprenant la famille des métaux lourds en Méditerranée peut être considérée comme une première indication de l'influence de la pollution sur la chimie des particules marines. Il faut cependant rappeler ici que nous avons pu montrer que les flux d'origine volcanique pouvaient entrer en compétition avec les flux anthropogéniques (5). La deuxième partie de l'étude portant sur la chimie de l'aérosol marin devrait permettre de répondre à la question soulevée dans la première partie de cette étude.

Une étude limitée de la chimie des particules en Méditerranée démontre l'existence d'anomalies (enrichissements) dans la chimie des métaux Cu, Pb, Cd, Zn et peut-être Fe, associés à la matière particulaire en suspension. Cependant les concentrations et les Enrichissements observées sont du même ordre de grandeur que ceux qui ont été observés à grande échelle dans l'Atlantique et le Pacifique, il semble donce que la chimie des métaux en traces dans la Méditerranée obéisse à des lois identique à celles qui régissent leur chimie à l'échelle de l'océan global.

	Al	Fe	Cu	Pb	Zn	Cd	As
Detection limit	$5\ 10^{-10}$ g	$5\ 10^{-11}$ g	$5\ 10^{-11}$ g	10^{-11} g	$5\ 10^{-12}$ g	10^{-11} g	10^{-10} g
Sensibility $\Delta c / \Delta A$	$3\ 10^{-10}$	$2\ 10^{-11}$	$2\ 10^{-11}$	$0{,}5\ 10^{-11}$	$2\ 10^{-12}$	$0{,}4\ 10^{-11}$	$0{,}5\ 10^{-10}$
Precision	10 %	10%	10 %	5 - 10 %	10 %	10 %	10 - 15 %

Table 1

STATION 1

Sample	DEPTH (m)	T.S.M. µg/1	Al ng/1	Fe ng/1	Cu ng/1	Pb ng/1	Zn ng/1	Cd ng/1
Ko 005	250	13,9	242	1097	<0,1	155,4	26,8	3,2
Ko 105	250	33,2	375	2125	8	106,8	27,4	1,3
Ko 003	300	6,4	103	262	<0,1	14,1	16,3	1,7
Ko 002	350	12,9	128	977	14,8	11,1	4,0	2,7
Ko 104	350	19,6	242	2011	63,4	31,7	23,4	1,6
Ko 008	910	20,9	275	1217	29,1	64,8	15,1	1,4
Ko 009	1660	5,4	70	337	8,2	10,8	13,1	1,3
Ko 010	1670	8,9	98	942	28,2	17,2	17,7	1,1
Ko 001	1680	18	54	2640	34,2	69,0	4,0	4,0
Ko 006	1680	9,5	43	1097	15,4	35,4	15,4	4
Geometric Mean		14,8	128	1029	20	34,5	13,7	2

TABLE 2

STATION 3

Sample	DEPTH (m)	T.S.M. µg/l	Al ng/l	Fe ng/l	Cu ng/l	Pb ng/l
Ko 208	50	49	113	108	17,6	17,4
Ko 209	290	24,5	344	710	44,8	34,5
Ko 210	300	10,5	82	630	24,8	13,7
Ko 306	500	12,7	80	161	1,7	7,3
Ko 307	510	6,8	103	278	55,7	70,3
Ko 305	790	9,8	171	470	13	14,6
Ko 401	1080	5,5	80	170	1,7	4,6
Ko 308	1090	3	51	398	0,3	10,3
Ko 309	1100	9,6	57	478	22,3	8,2
Ko 310	1490	5	59	450	61	11,2
Ko 303	1500	7,1	74	158	3,4	7,5
Ko 302	1880	2,3	40	347	1,4	6,2
Ko 301	1890		26	172	13,4	3,5
Geometric Mean		12,1	79	248	8,4	11,2

TABLE 3

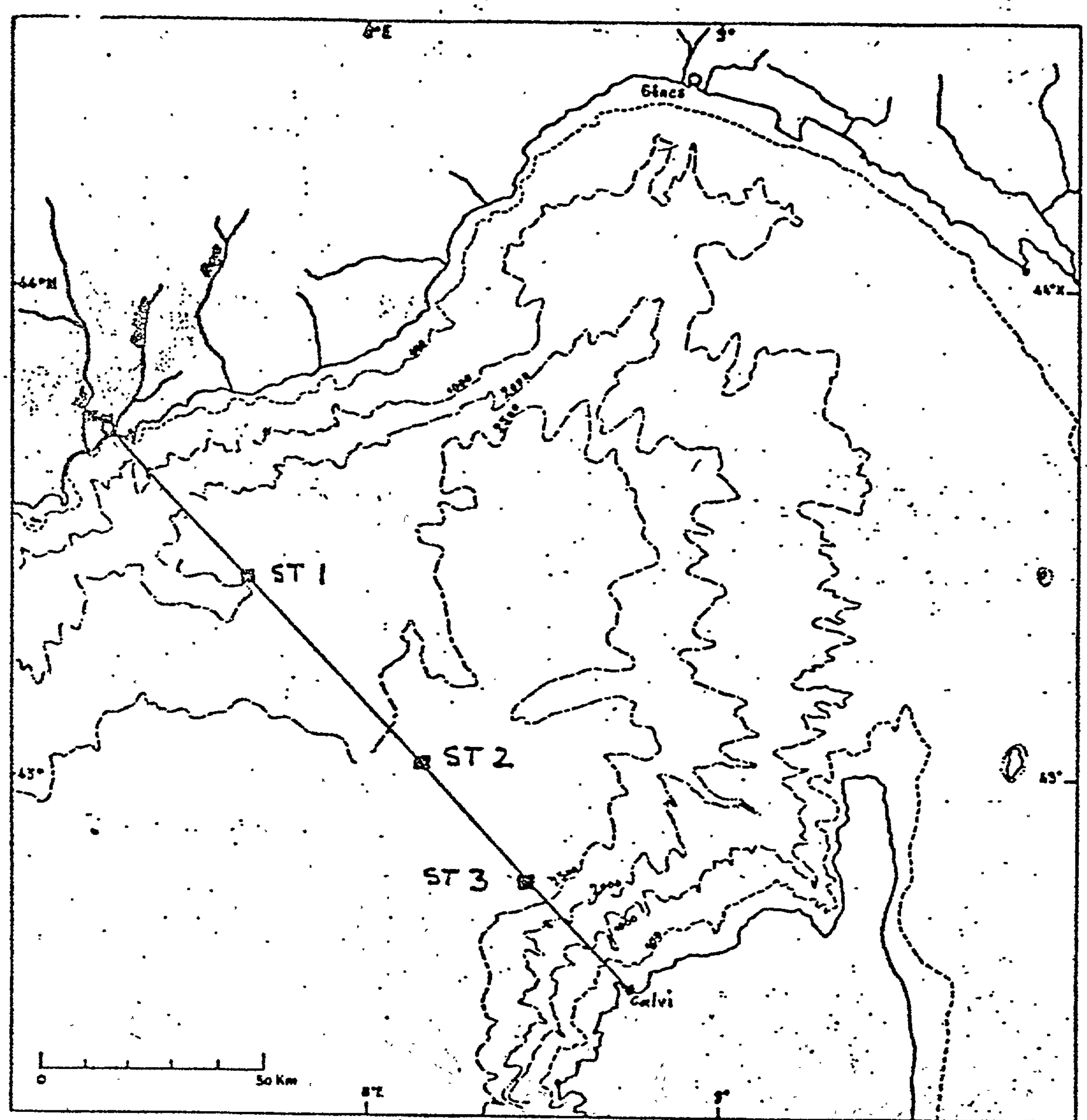
STATION 2

Sample	DEPTH (m)	T.S.M. µg/1	Al ng/1	Fe ng/1	Cu ng/1	Pb ng/1	Zn ng/1	Cd ng/1
Ko 109	50	46,5	86	172	<0,1	17,5		0,9
Ko 103	490	11,6	124	520	12,2	6,5	12,2	0,6
Ko 106	500	7,3	78	662	10,5	12,5	13,1	1,1
Ko 110	700	≤5	97	348	39	24,8		0,9
Ko 202	700	5	161	1020	40	48,5		0,9
Ko 102	880	10,9	150	348	0,9	16,1	15,1	0,3
Ko 101	980	9,3	107	148	12,2	5,1	13,1	0,6
Ko 108	1500	4,1	93	588	22,8	36,2	18,8	
Ko 207	2000	7,9	140	93	7,4	3,9		0,5
Ko 205	2370	≤3	120	498	26	30,5		0,7
Ko 204	2380	6,8	143	421	14	9,8		0,4
Ko 203	2390	3,9	54	441	15	11,9		0,6
Geometric Mean		11,2	107	364	13,1	14,2		0,6

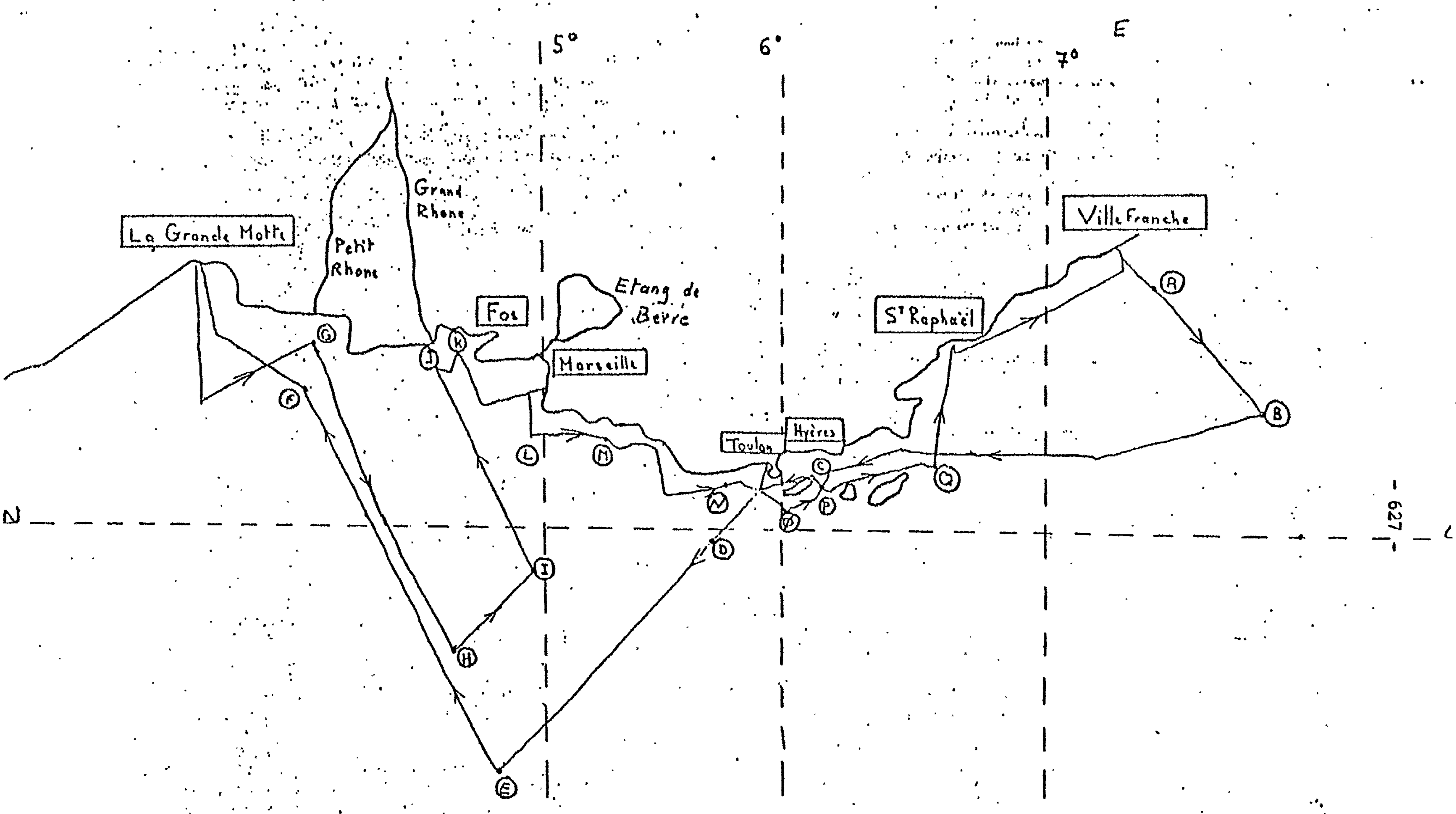
TABLE 4

Φ 10^{-4} g/m²/an	Al	Fe	Cu	Pb	Cd
MEDITERRANEAN this study	86	291	10	11	0,5
NORTH ATLANTIC (c.f.r - cnrs 1977)	90	160	2,4	7	0,1

Table 5



Carte 1


E
5°
6°
7°
La Grande Motte
Petit Rhone
Grand Rhone
Fos
Etang de Berre
Marseille
Toulon
Hyères
St Raphaël
Ville Franche
N
A
B
C
D
E
F
G
H
I
J
K
L
M
N
P
Q
5°
6°
7°

Carte n°2

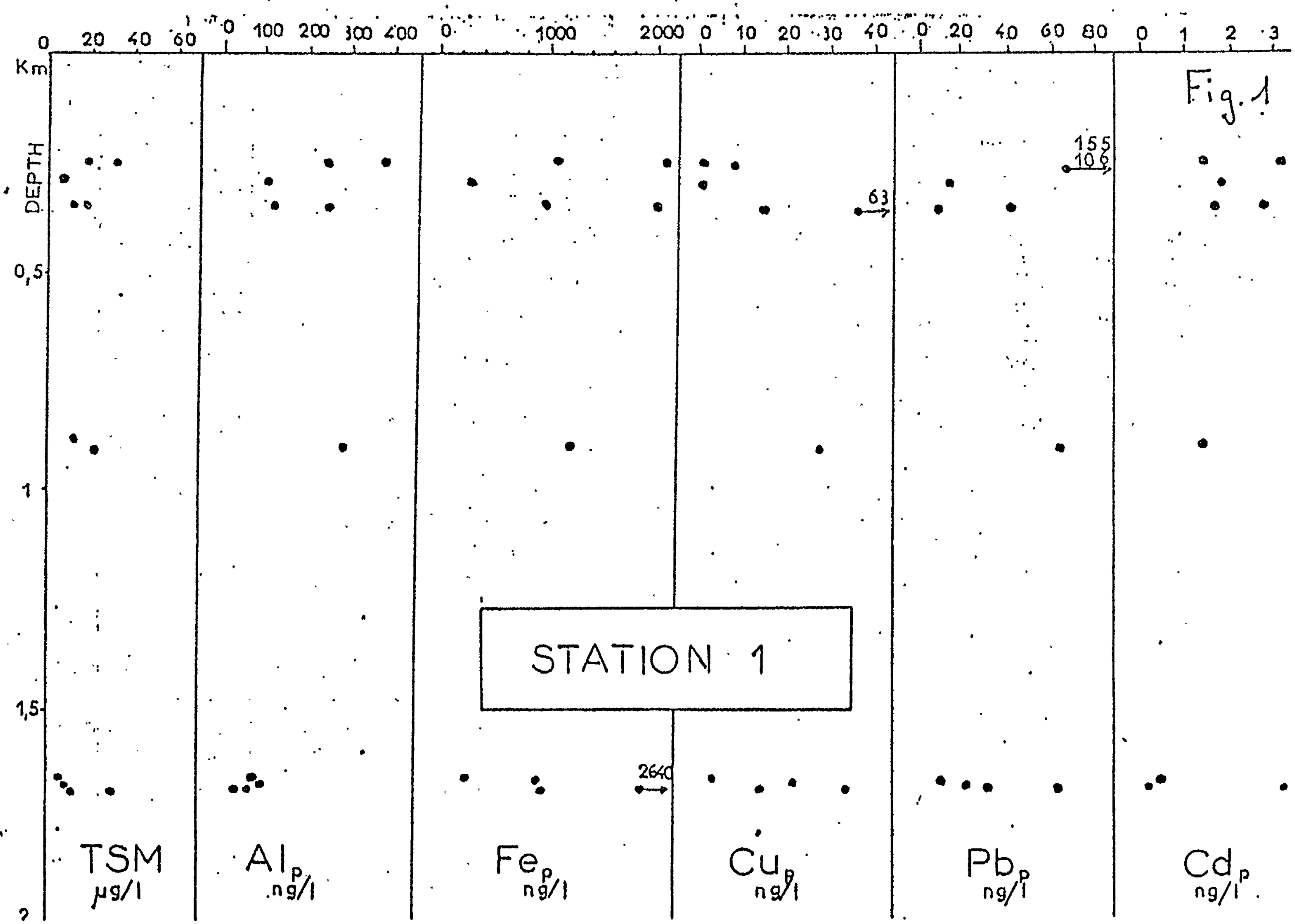
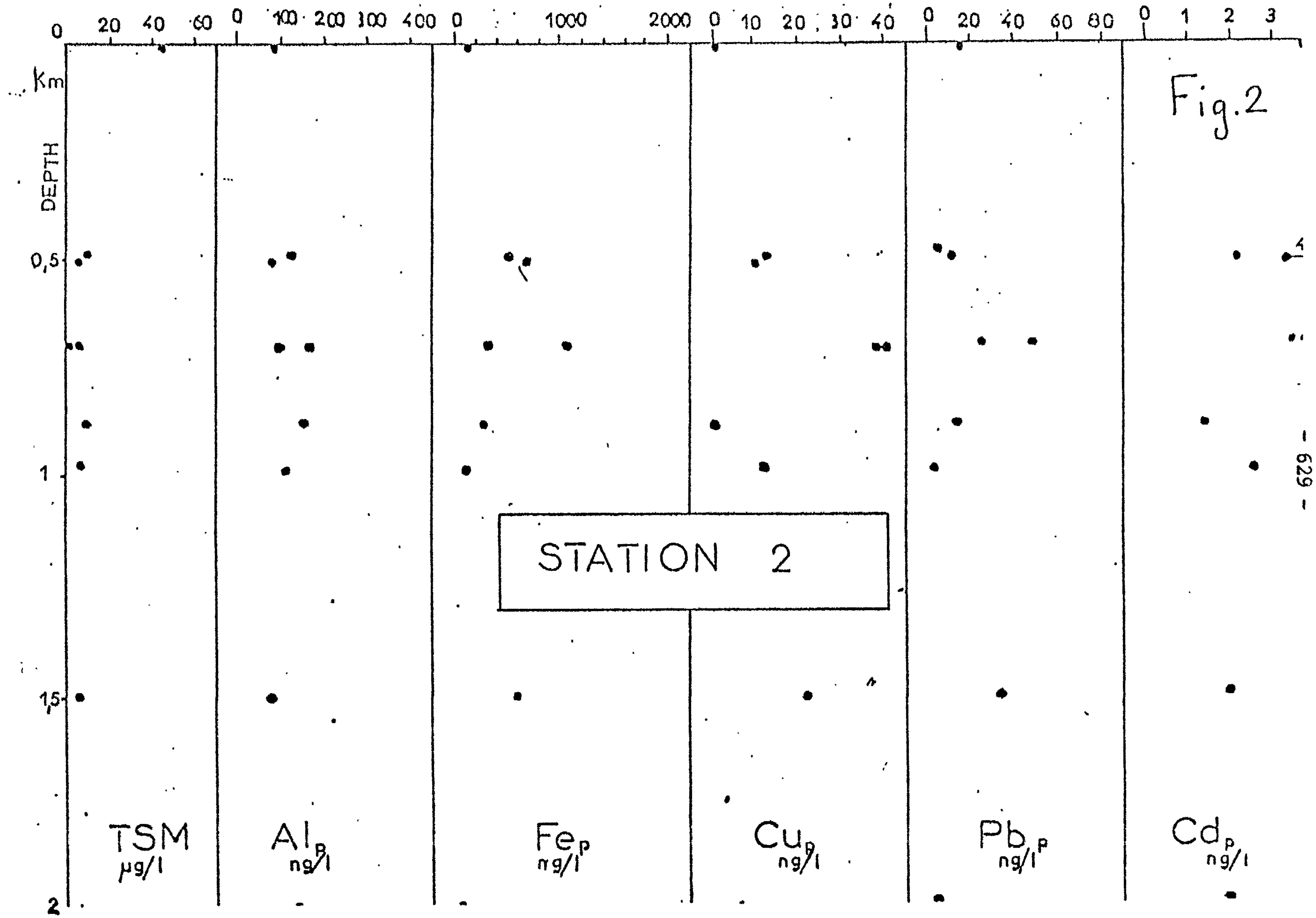


Fig. 1
STATION 1
DEPTH
Km
0,5
1
1,5
2
TSM µg/l
Al p ng/l
Fe p ng/l
Cu p ng/l
Pb p ng/l
Cd p ng/l
0 20 40 60
0 100 200 300 400
0 1000 2000
0 10 20 30 40
0 20 40 60 80
0 1 2 3
2640
63
155
106

Fig.2


STATION 2
DEPTH
Km
0
0,5
1
1,5
2
TSM µg/l
Al p ng/l
Fe p ng/l
Cu p ng/l
Pb p ng/l
Cd p ng/l
0 20 40 60
0 100 200 300 400
0 1000 2000
0 10 20 30 40
0 20 40 60 80
0 1 2 3

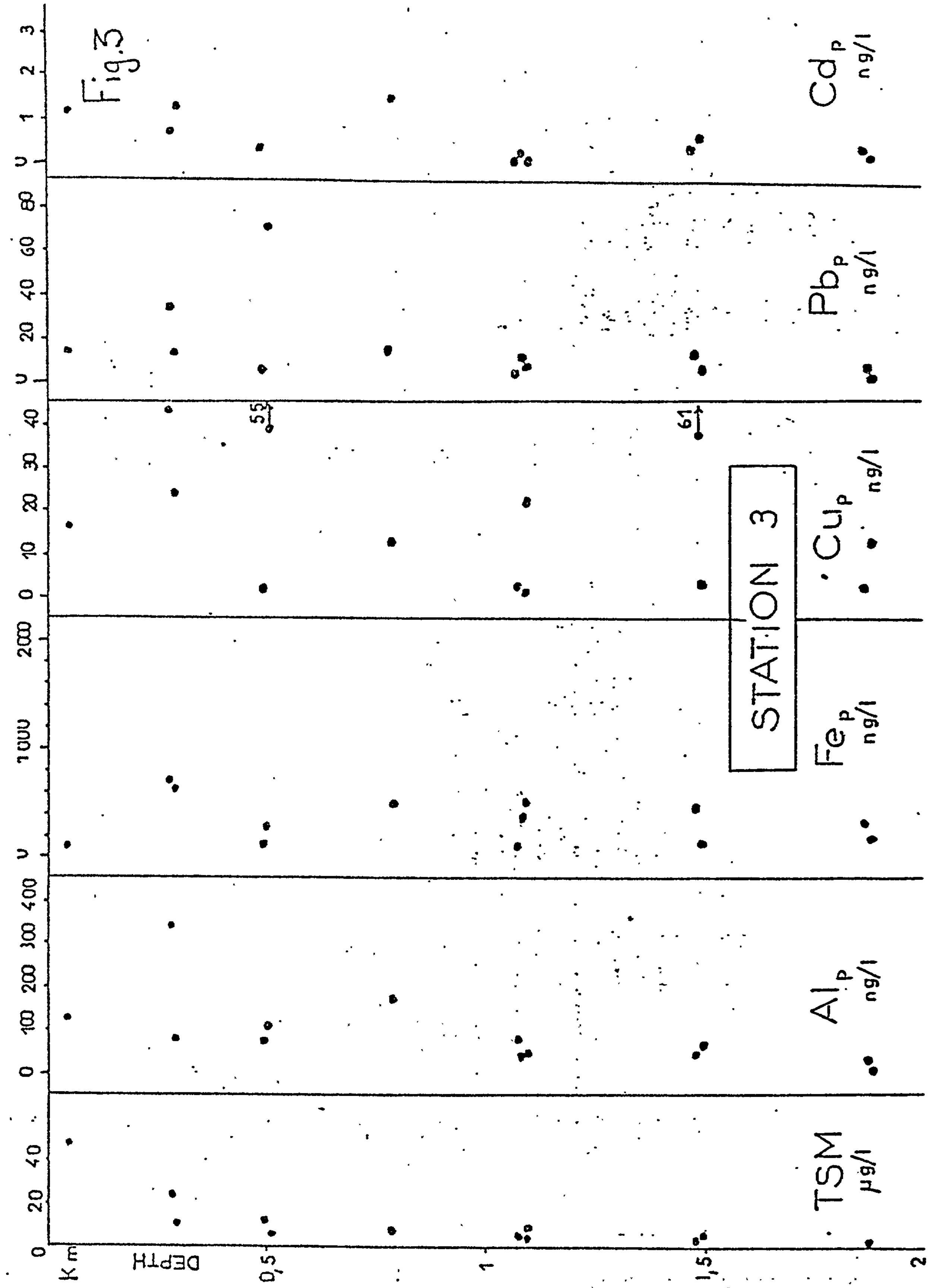


Fig.3
STATION 3
TSM µg/l
Al_p ng/l
Fe_p ng/l
Cu_p ng/l
Pb_p ng/l
Cd_p ng/l
DEPTH
Km
0,5
1
1,5
2
55
61

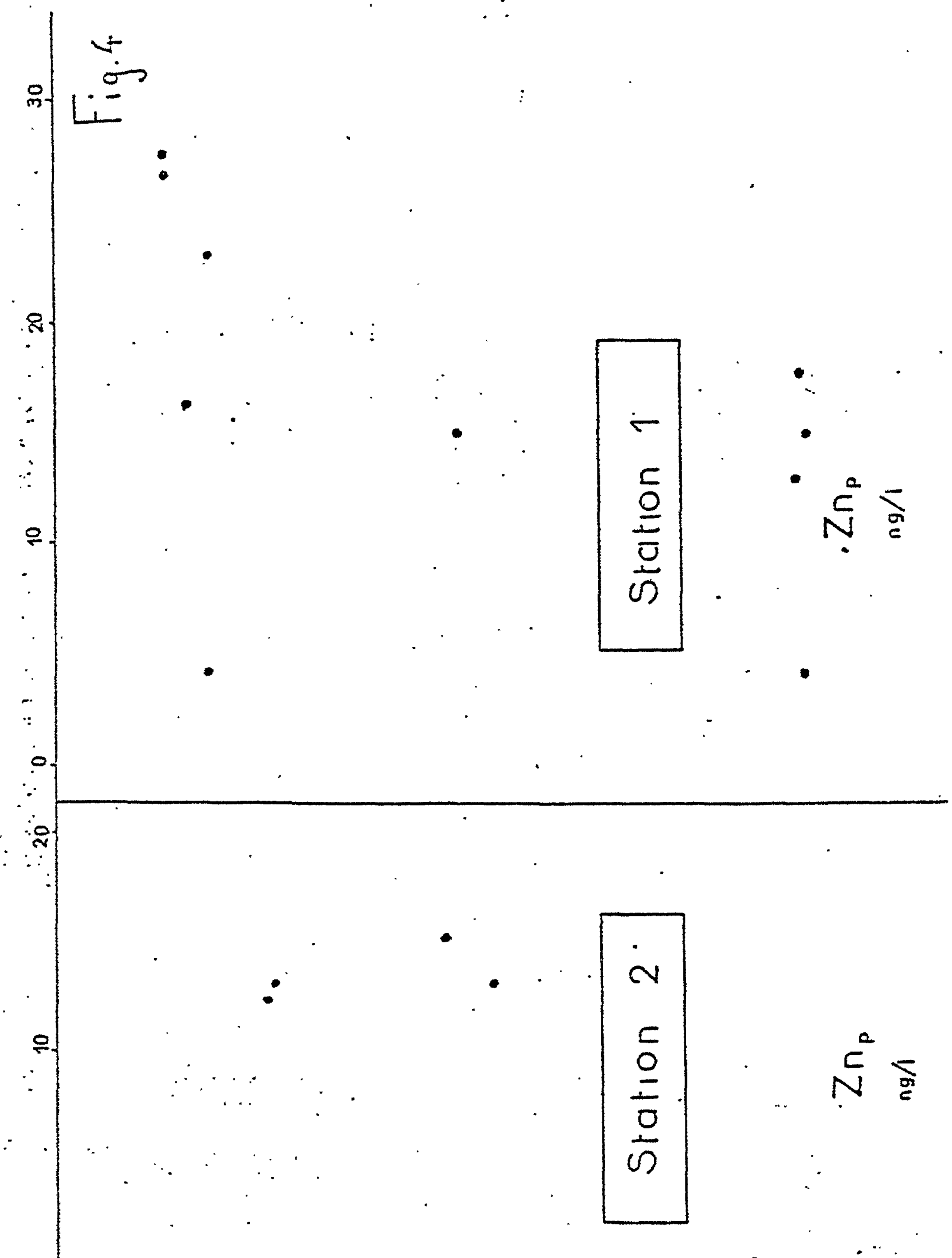


Fig. 4

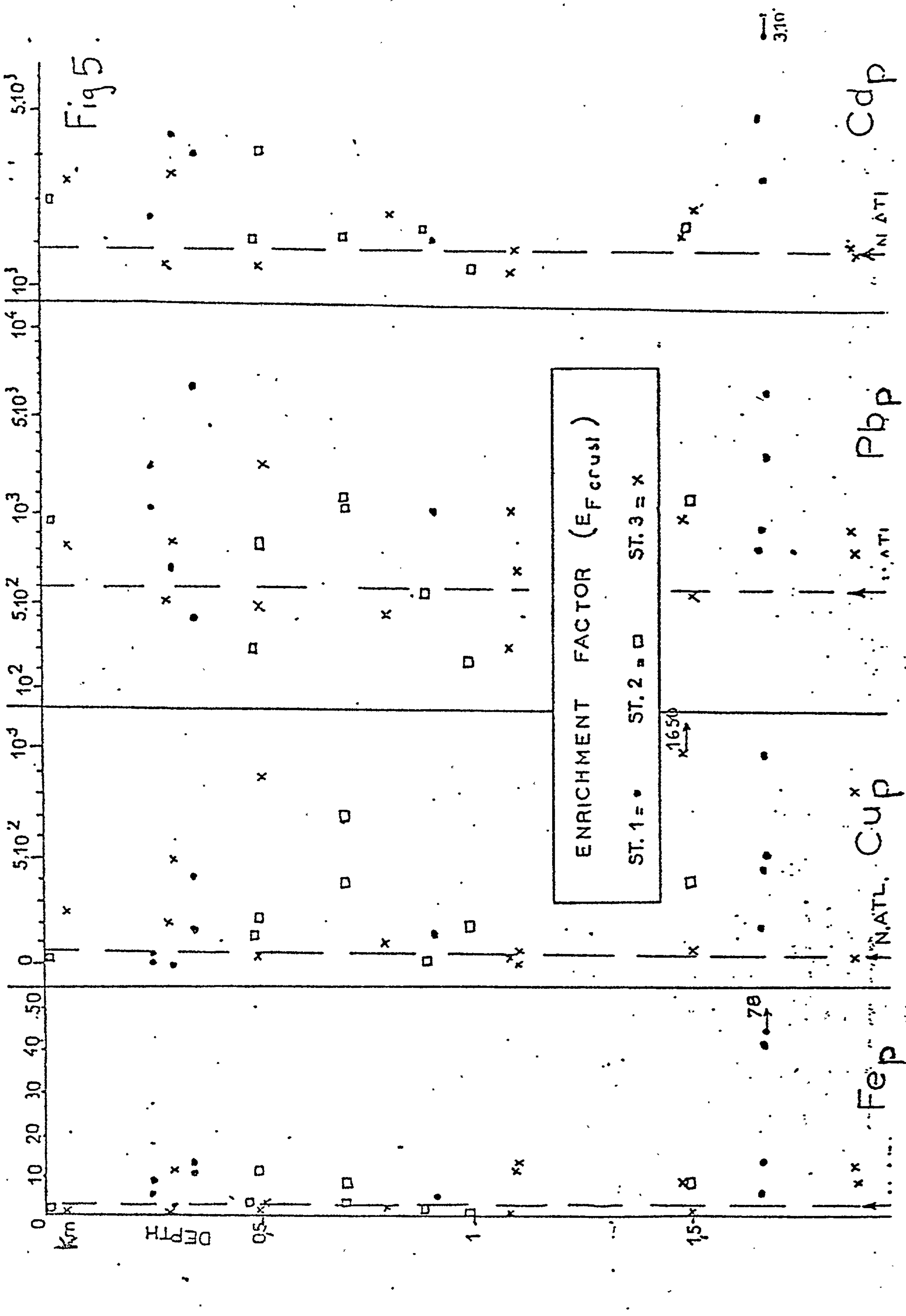


Fig 5
ENRICHMENT FACTOR ($E_{F\,crust}$)
ST. 1 = •
ST. 2 = □
ST. 3 = x
Cd_p
Pb_p
Cu_p
Fe_p
NATL
DEPTH
km
0
0.5
1
1.5
10
20
30
40
50
78
10^3
5.10^2
10^2
10^4
5.10^3
1650
3.10^4

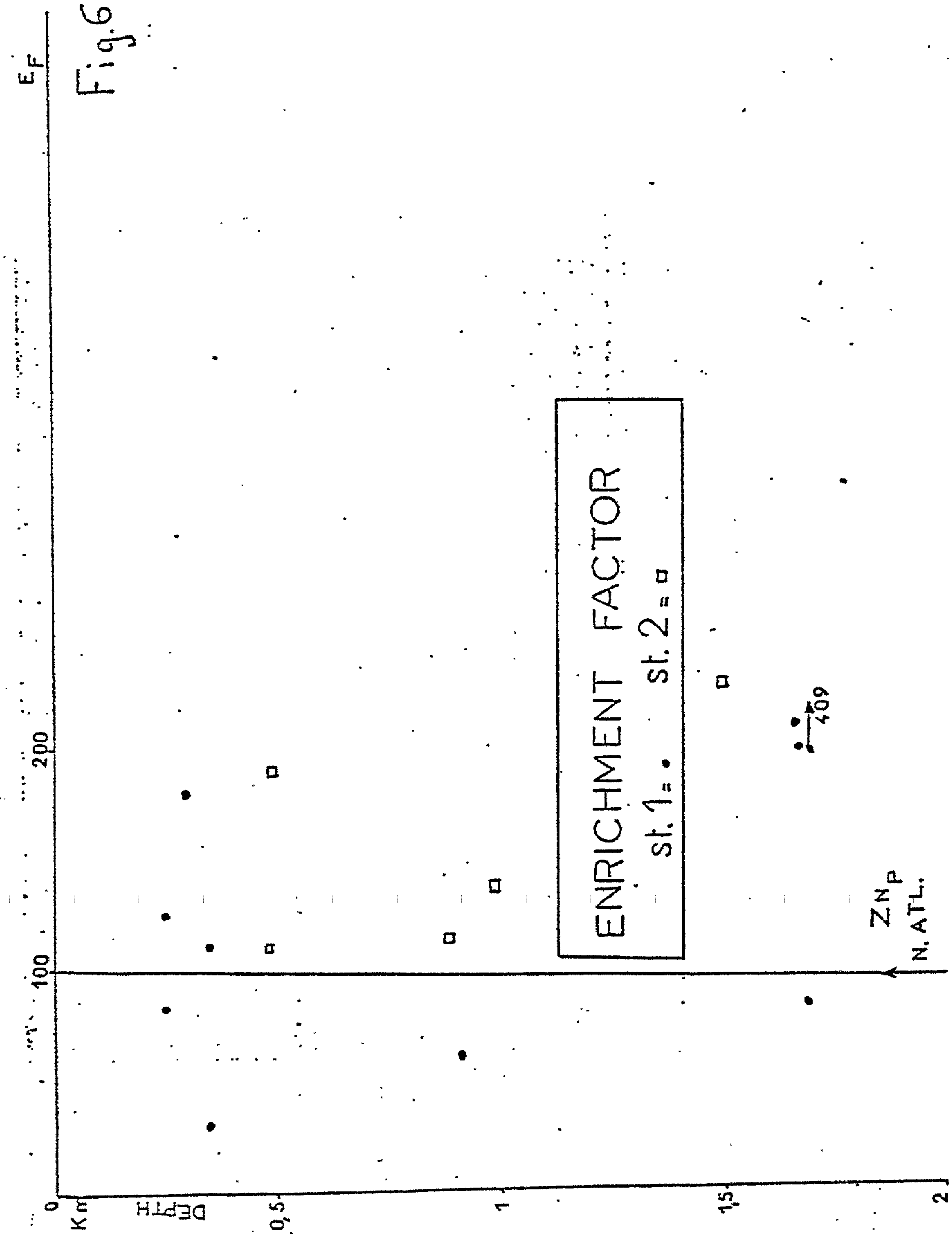

ENRICHMENT FACTOR
st. 1 = •   st. 2 = ▫
E_F
200
100
409
Zn_P
N. ATL.
DEPTH
Km
0
0,5
1
1,5
2

Fig.6

Participating Research Centre: Nuclear Research Center "Demokritos",
Department of Chemistry
Nuclear and Radiochemical Analysis Laboratory
ATHENS
Greece

Principal Investigator: C. PAPADOPOULOU

Introduction:

In our laboratory studies of trace elements in the marine environment have been initiated in 1963. Since then 20 papers have been published on this subject.

The project "Biogeochemical studies of selected pollutants in the open waters of the Mediterranean" had two aims:

(a) The determination of Vanadium, Arsenic and other trace elements which are potential pollutants in organisms of well defined foodchains in order to acquire information on present levels of these elements and their possible biomagnification through foodchains.

(b) The determination of trace elements in particulate products of zooplankton in order to estimate the role of pelagic organisms in vertical transport of these elements.

Area(s) studied:

Scomber japonicus colias specimens were collected from the area South of Andros island on 30 August 1977. Specimens of Trachurus mediterraneus were collected South of Karystos, Evia island, on 22 August 1977 and Skiathos Island on 28 September 1977. Plankton samples were also collected from Skiathos Island simultaneously with the Trachurus m. specimens (see attached map).

All three areas are typically oligotrophic areas of the Aegean Sea with salinities ranging from about 37.4 / to 39.2 / and temperatures from about 14.2°C to 25.6°C.

In order to compare the levels of trace elements in marine organisms, sampling was performed in two areas: the Aegean Sea, a relative unproductive region of the Mediterranean and the more productive western Mediterranean.

Our laboratory has collaborated in this project with the International Laboratory of Marine Radioactivity in:

(a) Analyzing samples from the western Mediterranean. The following determinations have been performed: for Zn, Co, Cs, Se, Rb, 38 samples; for As 28; for V 44; for Ag 20; for Sc and Sb 11; for Cr 4 and for Fe 3. Dr. C. Papadopoulou and D. Zafiropoulos have also participated in the "Hayes" cruise from Piraeus to Corsica (June 1977).

(b) Sampling and analyzing plankton and fish from the Aegean Sea. The pelagic foodchain: plankton collected with nets of different mesh size, and the pelagic fish Trachurus mediterraneus as well as Scomber japonicus colias were sampled and determination of As, V, Se, Co, Cs, Zn and Rb was performed.

Material and methods:

Neutron Activation Analysis was used for the determination of all trace elements studied.

Results and their interpretation:

Arsenic and Vanadium concentrations in the flesh and liver of Trachurus m. are shown in table 1. Arsenic values in the flesh of Trachurus m. ranged from 3.9 to 9.2 ug/g whereas a composite liver sample was found to have 14.1 ug/g. There is a considerable variation (standard deviation 30 per cent) of As concentrations due to individual differences between specimens. Arsenic concentrations are higher in fish collected from Skiathos Island (74 ug/g) than in fish collected from Karystos (3.5 ug/g).

Vanadium concentrations in the flesh of Trachurus m. ranged from 0.071 to 0.15 ug/g. Individual variation is also considerable (28 per cent S.D.). Coccentrations of As and V in the flesh and liver of Scomber j.c. are shown in table 2. Mean As values are 8 and 15 ug/g in the flesh and liver of Scomber j.c. respectively. Individual variation is somewhat lower (25 per cent S.D.).

Vanadium mean values are 0.014 and 0.024 ug/g in the flesh and liver of Scomber j.c. respectively. Individual variation is quite high (47 per cent S.D.). Cocnentrations of Zinc, Co, Se, Cs and Rb in the flesh and liver of Trachurus m. are shown in table 3. Mean values for the flesh of Skiathos specimens are: Zn 19 ug/g, Co 0.030 ug/g, Se 2.9 ug/g, Cs 0.067 ug/g and Rb 0.032 ug/g. For Karystos specimens mean values are: Zn 29 ug/g, Co 0.027 ug/g, Se 2.1 ug/g, Cs 0.027 ug/g and Rb 0.024 ug/g.

Zn and Co concentrations show a quite high individual variation (50 per cent S.D.) whereas Se, Cs and Rb show somewhat lower individual variation (25 per cent, 20 per cent and 16 per cent respectively).

Specimens caught from Karystos have similar concentrations of Co and Se, slightly higher concentrations of Zn and lower concentrations of Cs and Rb.

Table 4 shows concentrations of Zn, Co, Se, Cs and Rb in the flesh of Scomber j.c. Mean values are: ZN 24 ug/g, Co 0.027 ug/g, Se 3.0 ug/g, Cs 0.041 ug/g and Rb 0.23 ug/g. Individual variation for Zn and Co is 25 per cent S.D., for Se 27 per cent, Cs 12 per cent and Rb 35 per cent S.D.

Concentrations of As, Zn, Co, Se, Cs and Rb in the flesh of Scomber j.c. compare very well with those in Trachurus m. whereas V values for Trachurus m. are one order of magnitude higher than those of Scomber j.c.

Se and Cs concentrations in the liver of Scomber j.c. are comparable to those found in the liver of Trachurus m. whereas Zn and Co values are two times higher in Trachurus m. (table 5).

Rb values are higher for the liver of Trachurus m. than for liver of Scomber j.c. (mean of 3 specimens 0.19 ug/g).

As, Zn, Co and Se accumulates preferably in the liver of both fish species. Cs and Rb concentrations are about the same in flesh and liver.

Concentrations of As, Zn, Co, Se, Cs, Rb and V in plankton and Trachurus m. are shown in table 6.

Assuming that the plankton samples of different sizes and Trachurus m. represent different levels of a foodchain, no trend of "foodchain magnification" can be observed.

As, Zn, Cs and V concentrations decrease in higher food level, whereas Se concentrations are constant and Co shows no trend at all.

Conclusions:

Arsenic concentrations found in Scomber j.c. and Trachurus m. are in relatively good agreement with those reported in Pagellus Erythrinus, Gobius niger and Sargus annularis from both polluted and non-polluted waters of the Aegean Sea.

Zn, Co, Se and Cs concentrations in the flesh and liver of the two fish studied are also in good agreement. Comparing values found in this study with values obtained from previous work of our Laboratory for Pagellus erythrinus, Sargus annularis, Gobius niger and Mullus barbatus, and taking into consideration the differences in ecology and feeding habits wer can observe that differences in concentrations are relatively small.

Single specimen analysis is indispensable in trace element analysis of fish for a statistical treatment of results. Variations between specimens of the same species from the same station were found to range from 8 up to 50 per cent (standard deviation of the mean).

The absence of "foodchain magnification" is not surprising. In fact Zn shows a decrease of one order to magnitude and V an increase of two orders of magnitude with increasing food level. The hypothesis of foodchain magnification is based on the theory of foodchain. It is clear that defining a pelagic foodchain is very complex and difficult. Stomach analysis of the Trachurus m. specimens caught from Skiathos Island showed that their food consisted of gastripod, decapod and ostracod larvae and copepods. The presence of fish scales also indicated that Trachurus m. were also feeding on small clupeids.

To the best of our knowledge data concerning V concentrations in fish from the Aegean Sea were non-existent up to now. There is a need of a more extensive study of V levels in various fish species, and from different sea areas.

TABLE 1

Arsenic and Vanadium concentrations in Trachurus mediterraneus (ug/g, dry)

SAMPLE	As(1)	V(2)
Skiathos Island (flesh)		
1	4.0	0.11 ±0.01
2	8.7	0.083±0.008
3	6.0	0.15 ±0.01
4	9.2	0.071±0.009
5	9.2	0.069±0.008
7	5.0	0.074±0.007
10	7.3	0.120±0.009
13	6.7	0.089±0.008
14	8.1	0.086±0.007
Mean	7±2	0.095±0.027
Liver	14.1(3)	-
Karystos		
1	3.9	-
2	3.1	-
3	3.6	-
Mean	3.5±0.4	-

(1) Analytical standard deviations for As are up to 10 per cent
(2) ± Overall standard error of the counting technique
(3) Composite from 14 specimens

TABLE 2

Arsenic and Vanadium concentrations in Scomber japonicus colias from Andros island (ug/g dry)

	As(1)		V(2)	
SAMPLE	Flesh	Liver	Flesh	Liver
5	4.4	15.1	-	-
6	6.4	14.3	<0.01	-
7	11.4	25.5	<0.007	-
8	6.8	14.3	0.014±0.006	-
9	-	-	0.011±0.006	-
24	9.2	15.0	0.018±0.005	0.020±0.002
26	-	-	0.013±0.005	-
27	9.6	13.5	-	-
28	8.8	13.6	<0.007	-
29	7.3	9.7	<0.008	-
30	9.7	13.2	-	0.028±0.008
Mean	8±2	15.±4	0.014±0.003	0.024

(1) Analytical standard deviations for As are up to 10 per cent
(2) ± Overall standard error of the counting technique

TABLE 3

Trace element concentrations in Trachurus mediterraneus (ug/g dry± standard deviation)

SAMPLE	Zn	Co	Se	Cs	Rb
Skiathos (flesh)					
1	20±0.8	0.030±0.003	1.8±0.1	0.066±0.066	0.35±0.07
2	25±0.9	0.026±0.002	4.2±0.2	0.077±0.005	0.28±0.05
3	27±1.0	0.042±0.003	2.2±0.1	0.019±0.005	0.34±0.06
4	42±1.5	0.037±0.003	3.8±0.2	0.073±0.006	0.25±0.06
5	22±0.8	0.019±0.002	2.8±0.1	0.081±0.005	0.29±0.04
6	23±0.9	0.020±0.002	3.5±0.2	0.086±0.006	0.37±0.05
7	20±0.7	0.022±0.002	2.6±0.1	0.066±0.004	0.33±0.04
8	9±1.5	0.024±0.002	2.7±0.1	0.060±0.004	0.26±0.03
9	5±1.4	0.031±0.002	3.1±0.1	0.069±0.004	0.38±0.04
10	10±1.7	0.028±0.002	2.5±0.1	0.071±0.004	0.26±0.03
11	11±2.0	0.024±0.002	2.0±0.1	0.057±0.004	0.32±0.04
12	14±2.1	0.056±0.003	2.5±0.1	0.066±0.004	0.40±0.05
13	20±2.1	0.069±0.003	3.3±0.1	0.061±0.004	0.35±0.04
14	16±2.0	0.040±0.002	2.4±0.1	0.042±0.003	0.35±0.03
Mean	19±9	0.030±0.014	2.9±0.7	0.067±0.012	0.39±0.05
Liver	154±5.0	0.75±0.03	35±1.3	0.048±0.003	0.38±0.08
Karystos (flesh)					
2	22±1.6	0.030±0.009	2.7±0.1	0.035±0.003	-
3	31±1.0	0.020±0.001	1.5±0.1	0.021±0.001	0.19±0.02
4	34±1.2	0.030±0.002	2.1±0.1	0.024±0.002	0.28±0.02
Mean	29±6	0.027±0.006	2.1±0.6	0.027±0.007	0.94±0.06

TABLE 4

Trace elements in the flesh of Scober japonicus colias from Andros (ug/g, dry± standard deviation)

SAMPLE	Zn	Co	Se	Cs	Rb
5	11±0.6	0.014±0.002	2.2±0.1	0.037±0.003	0.25±0.04
6	28±1.2	0.024±0.003	2.8±0.1	0.045±0.004	0.18±0.05
7	23±1.0	0.024±0.002	2.5±0.1	0.051±0.003	0.28±0.04
8	25±1.0	0.034±0.003	2.4±0.1	0.046±0.003	0.26±0.04
9	21±1.0	0.027±0.003	2.3±0.1	0.035±0.003	0.26±0.05
10	20±0.9	0.032±0.003	3.1±0.1	0.041±0.004	0.26±0.05
24	39±1.6	0.022±0.003	2.1±0.1	0.036±0.004	0.25±0.05
26	22±1.1	0.035±0.004	4.2±1.0	0.036±0.003	-
27	20±1.0	0.034±0.004	4.3±1.0	0.039±0.003	0.16±0.06
28	26±1.3	0.018±0.003	3.1±0.7	0.039±0.003	0.10±0.05
29	25±1.2	0.027±0.003	3.7±0.9	0.046±0.003	0.22±0.06
30	26±1.3	0.027±0.003	3.8±0.9	0.041±0.002	0.31±0.06
Mean	24±6	0.027±0.007	3.0±0.8	0.041±0.005	0.23±0.08

TABLE 5

Trace element concentrations in the liver of Scober japonicus colias from Andros (ug/g, dry± standard deviation)

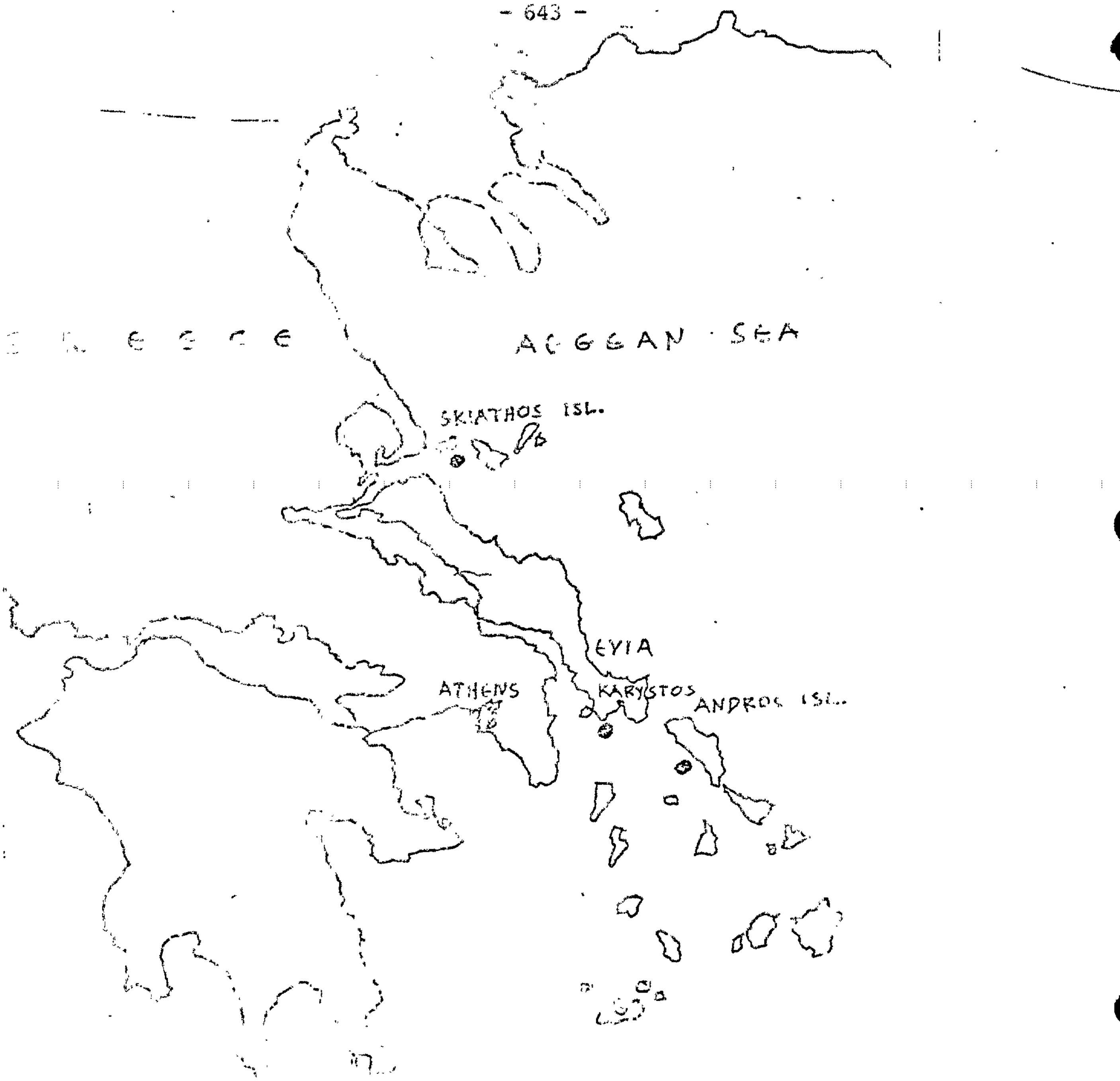
SAMPLE	Zn	Co	Se	Cs
5	66±2	0.17±0.01	30±1.1	0.020±0.004
6	77±3	0.26±0.01	32±1.2	0.026±0.004
7	97±3	0.28±0.01	36±1.3	0.038±0.004
8	86±3	0.40±0.02	33±1.2	0.020±0.008
9	85±3	0.34±0.02	25±1.0	0.032±0.004
10	91±3	0.29±0.02	45±2.0	0.024±0.005
24	98±3	0.36±0.02	33±2.1	0.031±0.004
25	97±6	0.61±0.07	56±2.7	0.070±0.010
26	89±6	0.42±0.05	43±2.0	0.047±0.008
27	87±6	0.46±0.05	45±2.2	0.058±0.009
28	84±6	0.23±0.04	31±1.5	0.055±0.009
29	103±6	0.58±0.06	50±2.5	0.060±0.010
30	91±6	0.49±0.05	46±2.3	0.040±0.005
Mean	89±9.7	0.38±0.12	39±9	0.040±0.017

TABLE 6

Trace element concentrations in plankton and Trachurus mediterraneus
(ug/g, dry± standard deviation)

SAMPLE	As(2)	Zn	Co	Se	Cs	Rb	V(3)
60u net sample	18	-	-	-	-	-	-
250u net sample	18	162±5	0.060±0.002	2.0±0.3	0.99±0.035	0.32±0.08	11.1±0.4
600u net sample	7.7	119±4	0.36±0.014	2.2±0.3	0.37±0.013	-	4.6±0.2
Euphasia kronii	5.4	77±3	0.17±0.07	1.8±0.3	0.55±0.020	0.17±0.05	1.62±0.03
Trachurus m. (flesh)(1)	7±2	19±9	0.030±0.014	2.9±0.7	0.067±0.012	0.32±0.05	0.095±0.02

(1) For Zn, Co, Se, Cs and Rb mean of 14 specimens analyzed, for As and V mean of 9 specimens
(2) Analytical standard deviations for As are up to 10 per cent
(3) Overall standard error of the counting technique


AEGEAN SEA
SKIATHOS ISL.
EYIA
ATHENS
KARYSTOS
ANDROS ISL.

Participating Research Centre: Department of Physiology and Biochemistry
The Old University
MSIDA
Malta

Principal Investigator: J. V. BANNISTER

Area(s) studied:

Mullets of the species (Mugil cephalus) were obtaaned from the coast around Malta.

Material and methods:

Species of about 120 mm length were caught live by means of nets and were acclimated for two months in a large tank filled with continuously running sea water. The fish were fed pelleted food containing 80 per cent protein.

After the acclimation period species were placed in tanks contaminated with 0.5 ppb or 1.0 ppb chlorinated hydrocarbons. The contaminants used were DDt, Aldrin and PCB. The chlorinated hydrocarbons were obtained from Analabs Inc. Species were contaminated with either of these chlorinated hydrocarbons.

At the end of the contamination period, the contaminated mullets were disected and pooled samples of brain, kidney, eyes, heart, liver, gills, skin, stomach, red and white muscle were obtained. The deposition of chlorinated hydrocarbons in these tissues was estimated according to the following procedure.

The combined organs were weighed and homogenised in a 10 per cent mixture of petroleum ether with a Kolbe homogeniser. The petroleum ether solution was concentrated to 20 ml by rotary evaporation. This solution was extracted thrice with 10 ml acetonitrile previously saturated with hexane. The three fractions of acetonitrile extracts were combined and diluted with 250 ml of 10 per cent sodium chloride solution previously depleted of any contaminants with hexane. The aqueous acetonitrile solution was extracted thrice with 50 ml of n-hexane. The three fractions were combined and concentrated by rotary evaporation (temperature 50°C) up to 5-10 ml and Na_2SO_4 solid added. The solution was now ready for Florisil treatment. The purification for elusion was done on a small column, filled with dried Florisil activated at 130°C overnight (Dimensions of the column = internal diameter 8 mm filled up to 5-7 cm, elutant n-hexane 20-25 ml). The solution was concentrated to 2-3 ml.

The separation of PCB from other chlorinated hydrocarbons was carried out on silica gel. The silica gel is heated to 200°C overnight. The internal column diameter is 10 mm, and the column was filled up to 20 cm. After having introduced the concentrated solution, the PCB is first eluted with 40-50 ml of n-hexane. DDT and the other hydrocarbons were afterwards collected with 40-50 ml of benzene. The hexane and benzene solutions were concentrated to a constant volume (2-5 ml) for analysis.

Results and their interpretation:

Pesticide levels are to be measured by an instrument which detects both changed and uncnanged pesticides. Yet since this apparatus was out of order during tne period of analysis, samples are to be analyzed as soon as this instrument is serviced.

Currently under investigation is the clearance rate of chlorinated hydrocarbons by mullets. Preparations are also in hand so that similar experiments to those being carried out on mullets can be started on the mussels (*Mytilus galloprovincialis*).

Participating Research Centre: International Laboratory of Marine Radioactivity - - IAEA
MONACO VILLE
Monaco

Principal Investigator: D. ELDER/S. W. FOWLER/R. FUKAI

Introduction

The overall philosophy of MED VIII has been twofold. First, to gather as much information as possible on inputs, levels and fluxes of pollutants in all major components of the open Mediterranean in order that a general model of the biogeochemical cycles of these substances can be elaborated. Second, these data are intended to supplement and enhance those presently being gathered on levels in selected marine species in the coastal areas.

The marine biogeochemical cycle of a given pollutant can be conceptualized as outlined diagramatically in figure 1.

The approach used in MED VIII has been to measure a suite of heavy metals and organochlorine compounds in the prime components shown in figure 1.

Baseline measurements were made on samples collected during five oceanographic cruises during the period 1977-1979. In addition, determination of trace elements in marine aerosols and particulate matter in sea water were carried out by the Centre des Faibles Radioactivités, CNRS, France.

The biokinetic behaviour of arsenic, vanadium, nickel and PCBs in various marine organisms was examined in order to gain information on the fluxes of these substances once they enter biological cycles.

Vertical flux studies of pollutants were undertaken by utilizing both in situ measurements and analyses of freshly-produced biogenic particulates which account for a large fraction of the particulates trapped at depth using sediment traps.

Heavy metals in sea water and sediments

The results of the measurements of heavy metals on open Mediterranean surface waters are summarized in table 1.

Since far more than half of the samples were below the detection limit for Cu measurements and approximately half of those were below the detection limit for Cd measurements, the average values for these metals represent only the upper limits of the average concentrations. In these cases comparisons between different zones in the Mediterranean are less meaningful. However, the grand averages for the Mediterranean of these metals, <0.33 ug/l for Cu and <0.13 ug/l for Cd, appear to be similar to the values given for oceanic waters by other investigators in this field. There was no correlation between the appearance of high Cu values and high Cd values.

The average concentration of Zn tends to differ from one zone to another; values are higher in the northwestern Mediterranean and Aegean basins and lower in the Tyrrhenian and south Levantine basins, despite the large associated uncertainties. The grand average for the Mediterranean of Zn tends to be lower than the values given in the references cited above.

The zonal differences in the distribution of Hg are not clear from the average concentrations presented in table 1 due to large associated uncertainties. It appears, however, that average concentrations are lower in the southwestern Mediterranean and south Levantine basins. The grand average of Hg is lower than the values given in some references for the Atlantic and Pacific by various investigators, but similar to or slightly higher than those given by others. Our values are definitely higher than those reported for the western Pacific by investigators in Japan.

The vertical distribution of selected trace metals in off-shore sediments was studied in two core samples taken in 1978 from 500 m and 1000 m depth off Villefranche. Selected trace metals such as Mn, Cu, Zn, Pb, etc. were measured in several vertical sections of each core. For the Pb measurements various pretreatment procedures were applied to differentiate between the different chemical forms of Pb so that total organic Pb, alkyl Pb, etc. could be distinguished. The vertical distribution of these different chemical forms of Pb within the cores indicates that Pb in the upper parts of the sediment cores is introduced anthropologically (the Pb concentration decreases from the surface of the sediments to 6-8 cm depths for both sediment cores and the concentration of Pb at the surface in the 500 m core is higher than that in the 9epper 1000 m core Considering the sedimentation rate in the area of study and the vertical distribution of Pb within the sediments there appears to be a downward migration of certain forms of Pb in the sediments.

Trace elements in biota

During the period 1975-1977 pelagic organisms ranging in size from plankton to tuna were sampled throughout the Mediterranean and analyzed for selected heavy metals. Large zooplankton and small nekton from both western and eastern basins were sorted according to individual species thus allowing realistic comparisons to be made between levels in similar species inhabiting different areas. One example is given in table 2 which shows the levels of several metals in euphausiid zooplankton from four regions of the Mediterranean. In general, although occasional high concentrations were noted, the levels encountered in the majority of the organisms were not too unlike those reported for pelagic species from other oceanic regions.

Chlorinated hydrocarbons in biota

Pelagic species from the central and wastern basins of the Mediterranean Sea were surveyed for PCBs and DDT. Residue levels in mixed microplankton from two cruises, which traversed the same general region of the eastern Mediterranean, show some clear differences. PCBs were significantly higher in samples from St. 3a and 6a taken aboard the Atlantis II (table 3). A careful examination of possible sources of contamination suggested that the observed differences may be real.

The ranges of residue concentrations in euphausiids (9.8 to 110 ppb dry for PCB and 2.5 to 115 ppb for DDT) were similar to those measured in mixed plankton. Euphausiids from the eastern basin had higher DDT/PCB ratios than those of the central region. This is due to a greater relative decrease in DDT levels compared to PCB concentrations in going from the central to the eastern region. A pelagic tunicate, P. atlanticum, sampled at one station in the Ionian Sea contained far less PCB and DDT than similar sized individuals from the Levantine basin. Different sized mesopelagic fish, M. glaciale, sampled from a single population, displayed a trend towards increasing DDT/PCB and DDE/PCB ratios with increasing size of fish. Finally, the relatively high levels of chlorinated hydrocarbons (PCB = 660 ppb; DDT = 127 PPB) found in the amphipod Anchylomera blossevillei, may be typical for this group of organisms.

Tuna muscle contained concentrations of PCB and DDT ranging from 8 to 90 ng/g dry and 2.4 to 50 ng/g dry, respectively. Gut contents, which were primarily composed of euphausiids, contained levels (PCB = 67 - 383 ng/g; DDT = 57 - 198 ng/g) which corresponded to those in tuna muscle.

Levels of organochlorine compounds in selected macrozooplankton and nekton as well as mixed microzooplankton have been compared with those in similar species from other oceanic areas. Although the data are sparse, PCBs in macrozooplankton and nekton do not appear to differ significantly from concentrations in similar species measured elsewhere. In the case of microzooplankton there was a trend towards slightly lower values in these organisms.

Vertical flux of trace metals and chlorinated hydrocarbons

Samples of sedimenting particles were collected off the coast by means of sediment traps. Examination of the material showed that zooplankton fecal pellets comprised a relatively large fraction of the total sample. Fluxes of these particulates ranged from 0.40 to 0.77 g $m^{-2}d^{-1}$ over a four-month period. Levels of heavy metals (cd, Cu, Zn, Fe and Mn) in biogenic particulates were high and compared favourably with concentrations of the same elements in freshly-produced biogenic detritus collected immediately over the traps. Clearly, sinking biogenic debris will be instrumental in effecting the downward vertical transport of these metals in certain areas of the Mediterranean.

The same samples discussed above were analyzed for chlorinated hydrocarbons. Table 4 shows that PCB levels were relatively high in the sinking particulates with flux averaging about 100 ug PCB $m^{-2}y^{-1}$ in this area. These measurements compare very well with independent estimates of the same order made by measuring PCBs in sections of sediment cores taken from the same region. These studies underscore the importance of sinking biogenic particulate matter in removing PCBs from the upper layers of the water column and transporting them to depth.

Biokinetic studies

The behaviour and fate of arsenic and vanadium in Mediterranean species was examined in controlled laboratory experiments utilizing radiotracers and stable element techniques. Over a concentration range from approximately 2 to 100 g/l arsenic uptake in the Mediterranean mussel (Mytilus galloprovincialis) and shrimp (Lysmata seticaudata) was dependent upon the arsenic concentration in sea water. Most of the arsenic accumulated was in muscle tissue, and it was taken up by mussels more rapidly at higher temperatures. The increased rate of molting at higher temperature made a temperature effect study difficult. Arsenic uptake was inversely related to salinity in both species and As concentrations on a whole-body weight were higher in smaller than in larger individuals.

Preliminary studies with phytoplankton show that arsenate is rapidly metabolized to a lipid extractable form. Using Dunaliella as the primary producer in a three component food chain it was shown that this lipid.] .Lsoluble arsenic is transferred efficiently to a herbivore (Artemia salina), and subsequently to a carnivorous shrimp. It also appears that Artemia and shrimp cannot mobilize inorganic arsenic into the lipid fraction; arsenate absorbed directly from sea water by these organisms is converted largely to arsenite.

Vanadium-48 and stable vanadium were used to study the uptake from water and elimination of vanadium in four benthic invertebrates - mussels, shrimp and crabs. The highest concentration factor (≈ 30) was noted in mussels after three weeks' exposure. Over a concentration range from approximately 2 to 100 ug V/l, uptake in mussels and shrimp was dependent upon the vanadium concentration in sea water. Uptake in mussels and shrimp appeared to be independent of temperature over a range of 13°C to 24°C but was slightly increased at low salinity (19‰). Vanadium behaves differently from arsenic in that the majority of vanadium (> 90%) becomes fixed to shells of mussels and crustaceans suggesting that surface adsorption plays a strong role in the bioaccumulation of this element. Both radiotracer experiments and stable element data showed that byssus threads of mussels rapidly accumulated vanadium to high levels. Because of the remarkable ability of byssal threads to take up this element, some consideration might be given to using this tissue as a biological monitor for measuring changes in vanadium levels in the natural environment.

Chlorinated hydrocarbon biocycling

Several different experiments were designed to assess the bioaccumulation potential, tissue distribution and depuration of PCB available from water, food and sediments. In order to test the bioavailability of sediment-bound PCB, comparisons were made of the accumulation of a mixture from sediments and from water by benthic worms. Uptake from sediments was dose-dependent, attaining equilibrium concentration factors of approximately 3 to 4 after two months. Subsequent PCB elimination rates were concentration-dependent, with higher initial loss rates evident in the worms containing higher

levels of PCBs. Accumulation of PCBs from water was much more rapid; concentration factors reached approximately 800 after only two weeks. Estimates were made of the relative importance of sediments and water as a source of PCBs to worms exposed to these contaminants in the natural environment. Calculations based on experimentally derived PCB concentration factors and ambient PCB levels in sediments and water suggest that compared to water, sediments contribute the bulk of these compounds to the worms.

The influence of uptake pathway on PCB accumulation and tissue distribution was examined by allowing shrimp to accumulate DP-5 from either food or sea water and analyzing their tissues during a period of one month. Regardless of the uptake pathway the relative tissue distribution was similar. The viscera which includes the hepatopancreas reached the highest levels. Concentrations of PCB in viscera were over an order of magnitude higher than those in exoskeleton and muscle suggesting that surface sorption plays a minor role in the accumulation of PCB from water by shrimp. Despite the fact that PCBs were rapidly absorbed into internal tissues, molted exoskeletons contained significant amounts of these compounds. Concentration factors in molts as high as 10^3 to 10^4 clearly illustrate the importance of crustacean molting as a process for redistributing PCBs in the marine environment. These experiments demonstrate the ease with which PCBs are transferred from the environment to benthic shrimp.

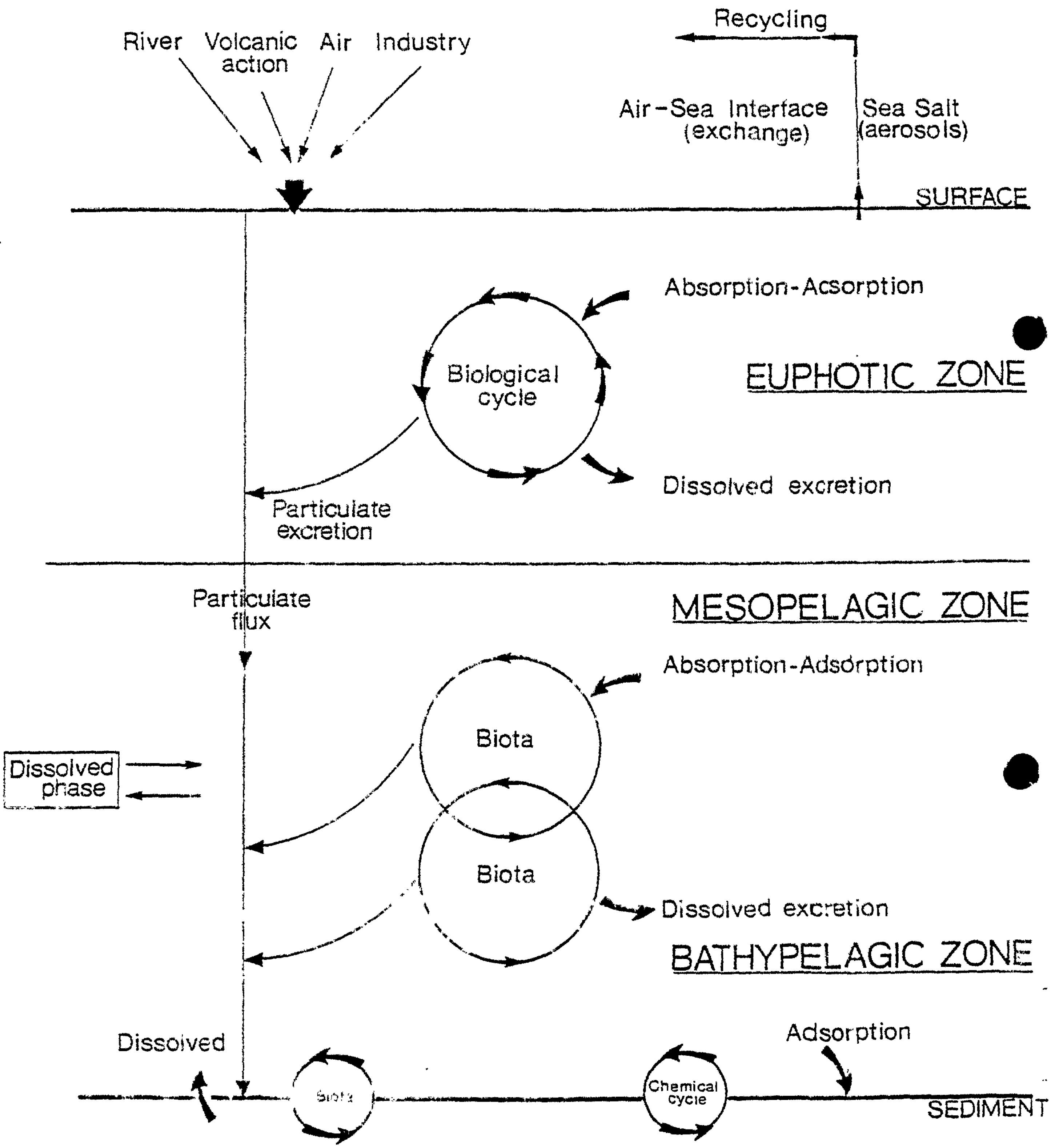

River
Volcanic action
Air
Industry
Recycling
Air-Sea Interface (exchange)
Sea Salt (aerosols)
SURFACE
Absorption-Acsorption
Biological cycle
EUPHOTIC ZONE
Dissolved excretion
Particulate excretion
Particulate flux
MESOPELAGIC ZONE
Absorption-Adsorption
Biota
Dissolved phase
Biota
Dissolved excretion
BATHYPELAGIC ZONE
Dissolved
Adsorption
Chemical cycle
SEDIMENT

Fig. 1

Table 1. Average concentrations of copper, zinc, cadmium and mercury in various zones of the Mediterranean sea

Zone		Cu n*	Cu µg/l**	Zn n*	Zn µg/l**	Cd n*	Cd µg/l**	Hg n*	Hg ng/l**
II	N.W. Med.	34	<0.4±0.2 (<0.04-5.8)	34	2.7±0.4 (0.02-10)	33	<0.15±0.03 (<0.02-0.70)	7	20± 3 (8-32)
III	S.W. Med.	13	<0.10±0.04 (<0.04-0.60)	13	1.2±0.5 (0.02-6.0)	13	<0.11±0.04 (<0.02-0.51)	14	14±2 (5 - 30)
IV	Tyrrhenian	9	<0.18±0.08 (<0.04-0.62)	9	0.9±0.3 (0.02-2.3)	9	<0.11±0.04 (<0.02-0.33)	10	26±4 (10 - 40)
VI-VII	Ionian-Central	6	< 0.7±0.4 (<0.04-2.5)	6	1.8±0.9 (0.02-5.7)	6	<0.15±0.09 (<0.02-0.57)	6	30±10 (5 - 80)
VIII	Aegean	4	<0.3±0.1 (<0.04-0.64)	4	3 ± 1 (0.9-5.8)	4	<0.07±0.02 (<0.02-0.12)	3	40±20 (15-80)
X	S.Levantin	4	<0.04±0.01 (<0.04)	4	0.9±0.2 (0.3-1.3)	4	<0.04±0.03 (<0.02-0.11)	4	16 ± 2 (12-20)
	Grand average	70	<0.33±0.09 (<0.04-5.8)	70	2.0±0.2 (0.02-10)	69	<0.13±0.02 (<0.02-0.70)	44	22±3 (5-80)

*n = No. of samples measured.

** = Uncertainties are expressed in terms of standard errors. Ranges are given in brackets.

Table 2. Trace metals in euphausiids (*Euphausia* sp.) from the open Mediterranean Sea. Values in parentheses represent samples of *Meganyctiphanes norvegica*.

Region	Station	Range of size (cm)	As	V	Zn	Co	Cs	Ag	Se	Sb	Rb	Sc	Fe	Hg*
			μg/g dry											
Eastern	A-3a		49.9	<0.06	58	0.29	0.18	2.7	7.2	0.050	0.11	0.005	150	
	A-6a		33.8	0.24	107	0.24	0.23		4.6		0.31			
	S-2		33.7		100	0.15	0.60		4.0		0.25			
	S-3		38.4		123	0.15	0.43		4.2		0.65			
	S-4		47.2	0.84	140	0.26	0.16	0.92	2.3	0.046	0.08	0.040	80	0.028
Ionian Sea	H-4(≈1)			0.37										
	H-4(1.5-2)													0.148
	H-14(≈ 1)		56.9		84	0.15	0.12		3.6		0.32			0.100
	H-14(1.5-2)													0.192
	H-14			(<0.07)	(39)	(0.06)	(0.06)	(0.16)	(2.9)		(0.27)			(0.092)
Tyrrhenian Sea	H-23(≈1)		20.0	0.48	120	0.23	0.29	2.3	2.9	0.031	0.17	0.038	191	0.076
	H-23(1.5-2)													0.178
	H-37(>2)		34.9	1.24	57	0.19	0.26	1.7	3.5	0.040	0.11	0.013		0.239
	H-37			(1.10)	(144)	(0.25)	(0.08)		(3.3)		(0.38)			
Northwestern	CS-46		29.6	0.23	39	0.23	0.33	1.2	3.4	0.050	0.11	0.070		0.189

* analyzed by AAS

Table 3. Chlorinated hydrocarbon residues in microplankton collected in the eastern Mediterranean during two cruises in 1977.

Cruise	Station†	PCB (DP-5)	pp'DDT	pp'DDD	pp'DDE	ΣDDT / PCB
		µg/Kg dry*				
Atlantis II (4/77)	1	30	7.1	2.4	2.7	0.40
	3a	100	8.7	1.1	3.6	0.13
	6a	230	20	3.1	8.9	0.14
Shikmona (7/77)	1	35	6.9	12	13.6	0.92
	2	19	17	58	9.9	4.57
	3	22	9.4	2.7	2.5	0.66
	4	15	6.2	6.2	6.8	1.25

† Stations refer to those in Fig. 1

* Dry weight averaged 11% of wet weight

Table 4 ESTIMATES OF PCB FLUX IN THE LIGURIAN SEA

Date	Particulate PCB μg/Kg dry	Mass Flux $g\ m^{-2} d^{-1}$	PCB Flux $\mu g\ m^{-2} y^{-1}$
6/78	650	0.77	183
7/78	300	0.64	70
8/78	710	0.40	104
10/78	200	0.77	56
		$\bar{X}$	= 103

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Scientific results

The aim of the present project was the establishment of the biocynetical uptake of V and Ni by marine organisms.

Preliminary considerations resulted in the selection of Pseudomonas sp. as representative for typical marine bacteria, Dunaliella sp. for phytoplankton, Mytilus edulis for invertebrates, Penaeus kerathurus for crustacea and Solea solea for fish.

The primary sources of V and Ni for Pseudomonas and Dunaliella were appropriate culture mediums enriched with solutions of one or both elements.

An outstanding and most interesting part of the experiment was the reproduction of a natural trophic chain:

bacteria mussels fish / crustacea

The transfer of V and Ni from bacteria to mussels was performed by means of previously contaminated bacteria and phytoplankton. The resulting concentration factors for a 15 days-culture-time were the following:

Pseudomonas	Dunaliella
cf V = 0.5	cf V = 2.9
cf Ni = 6.0	cf Ni = 12.5

Pseudomonas were able to develop in cultures containing very high concentrations of V (50 ppm) and Ni (10 ppm) whereas inhibitory effects were detected for Dunaliella at 50 ppm of V and 2.5 ppm of Ni.

The concentration factor in the secondary trophic transfer (Pseudomonas to Mytilus edulis) was very low for a feeding time of 1 day; namely:

cf V = 0.08
cf Ni = 0.21

The concentration factor in the terciary trophic transfer (Mytilus edulis to Penaeus kerathurus and Solea solea) was even lower than the secondary one for a feeding time of 19 days:

Mytilus edulis	to	Solea solea
cf V muscular		tissues = 0.001
cf V liver		= 0.012

Mytilus edulis	to	Penaeus kerathurus
cf V mixed soft tissues		= 0.004

More interesting results were gathered by direct V and Ni contamination of mussels; i.e. using POLIKARPOV'S terminology, "direct absorption" from the water. In fact, the concentration factors resulting from severe experimental conditions were very high (table 1).

TABLE 1

V Enriched sea water (ppm)	Time (days)	Mean V content of mussels (ppm)	Cf
10	1	8	0.8
10	2	20	2.0
50	1	9	0.2
50	2	24	0.5
100	1	269	2.7
100	2	357	3.6

The results shown in table 1 seem to demonstrate the existence of a critical concentration in the enriched sea water culture between 50 and 100 ppm of V.

The sudden increase from 0.20 - 0.47 (at 50 ppm) to 2.69 - 3.57 (at 100 ppm) allows us to introduce the above mentioned hypothesis. In order to gain further knowledge on the "critical concentration" and its determination, a new series of experiments were conducted. Their results are shown in table 2.

TABLE 2

V Enriched sea water (ppm)	Time (days)	Mean V content of mussels (ppm)	Cf
50	1	16	0.3
60	1	23	0.4
70	2	142	1.6
80	1	76	0.9
90	1	250	2.8
100	1	650	6.5

2. Direct absorption of Ni

A series of observations in mussel - cultures (Mytilus edulis) containing 1, 2, 5, 10 and 100 ppm of Ni were conducted in a similar As for the determination of the V direct absorption pathway. After 4 days the level of incorporated Ni was that shown in table 4.

TABLE 4

Ni concentration in enriched s/w culture (ppm)	Time (days)	Ni concentration in soft tissues of mussels (w/w)	Cf
1	4	6	6
2	4	9	9
5	4	14	3
10	4	34	3
100	4	52	1

Somewhat contrary to the observations made in the V experiment, the Cf of a culture containing 150 ppm of Ni (0.5) is of the order of one tenth lower than in cultures containing 0 to 1 ppm Ni (mean value of 4.3).

The meaning of this difference is not clear yet, nevertheless some physiological implications must be assumed; namely that the V cultures are more toxic at a 100 ppm level (excretion mechanisms excluded). In order to know the V concentration in natural systems, two species of sea fish (Mullus barbatus and Pagellus erythrinus) and sediments were collected and analyzed. Analytical values and cf's are shown in table 5.

TABLE 5

V in organism	V in sea water (g/1)	V in dorsal muscle	Cf
Mullus barbatus	0.7×10^{-6}	0.02 ppm	30
Pagellus erythrinus	0.7×10^{-6}	0.05 ppm	70
Sediments	0.7×10^{-6}	28.00 ppm	3.8×10^{4}

We want to point out that the V content of Mullus barbatus conspicoos, a benthic organism feeding in high V contaming sediments is lower than in Pagellus erythrinus.

Though we agree that this experiment is not absolutely complete (effects of the variability under experimental conditions were not considered), the results seem to be consistent since the mean cf/day for 50 ppm V in the first experimental series was 0.33 and 0.32 in the second one; between 60 and 70 ppm V results in a cf increase by a factor of three (0.32 to 1.0); at 80 and 90 ppm V the cf increases abruptly (0.95 to 2.80) and; between 90 and 100 ppm V the cf increases further (2.80 to 6.50).

Up to now we lack evidence about how physiological changes (including deteriorated excretion mechanisms) can affect the equilibrium factors of organism absorption and V culture content - when V concentrations exceed certain levels.

Ni uptake from Ni enriched sea water by bacteria and microalgae

As for Vanadium, we checked the biocynetics of Ni uptake through trophic and direct absorption patnways.

Experiments were performed using Ni enriched sea water and selected organisms. Pseudomonas sp and Dunaliella sp were chosen as representive of bacterial and phytoplanktonic populations respectively.

Preliminary experiments snowed that the minimum inhibitory levels of Ni for both organisms were: 100 ppm for Pseudomonas and 2.5 ppm for Dunaliella. The concentration factors for a feeding time of 20 days were 6 and 12.5 respectibility. Table 3 summarizes experimental conditions and results.

TABLE 3

Organism	Ni concentration s/n enriched culture (ppm)	Time (days)	Ni concentration in organisms	Cf (20 days)
Pseudomonas ps	5	20	30	6
Dunaliella	1	20	12	12

Discussion

Our results are in agreement with Polikarpov's statement that the majority of marine organisms concentrate more radionuclides (and that includes trace metals) by direct absorption from the water rather than by feeding. In consequence our results suggest that food chain transfer may be disregarded - in general - as the main factor in bioaccumulation and transfer of vanadium.

The rapid enrichment of vanadium observed in mussel shells over soft parts may be explained by invoking two different pathways in the incorporation of vanadium: 1) by biochemical mechanisms for soft tissues; 2) by physiochemical processes involving, perhaps, calcium carbonate as the prime matrix for concentration.

The analysis of two species of marine fishes show only moderate levels of vanadium in their tissues even though they live in sediments containing high levels of vanadium. This is to be expected if - as stated before - food chain transfer of vanadium is negligible in marine organisms.

Finally, it is noteworthy that the results from this preliminary study have encouraged us to continue both systematic environmental sampling and laboratory experiments which should help clarify the mechanisms involved in the direct absorption of Vanadium and Nickel from water.