United Nations Environment Programme

Distr.
RESTRICTED
UNEP/IG.18/INF.3
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 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

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 observations 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.

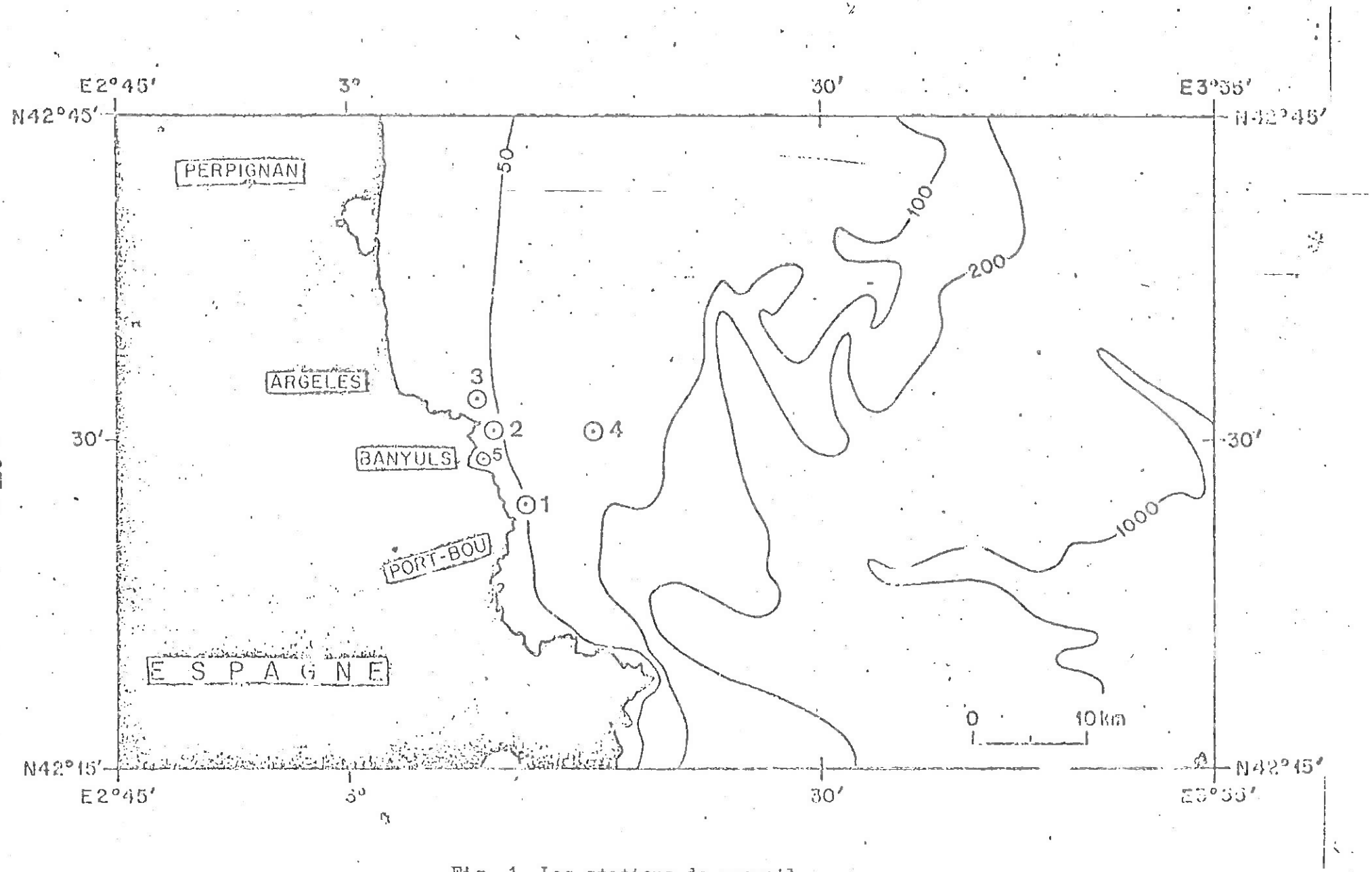


Fig. 1 Les stations de recueil

	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 deja 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.

Composé / Espèce	Σ DDT	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 Σ DDT et des PCBs (en µg/kg de poids frais).

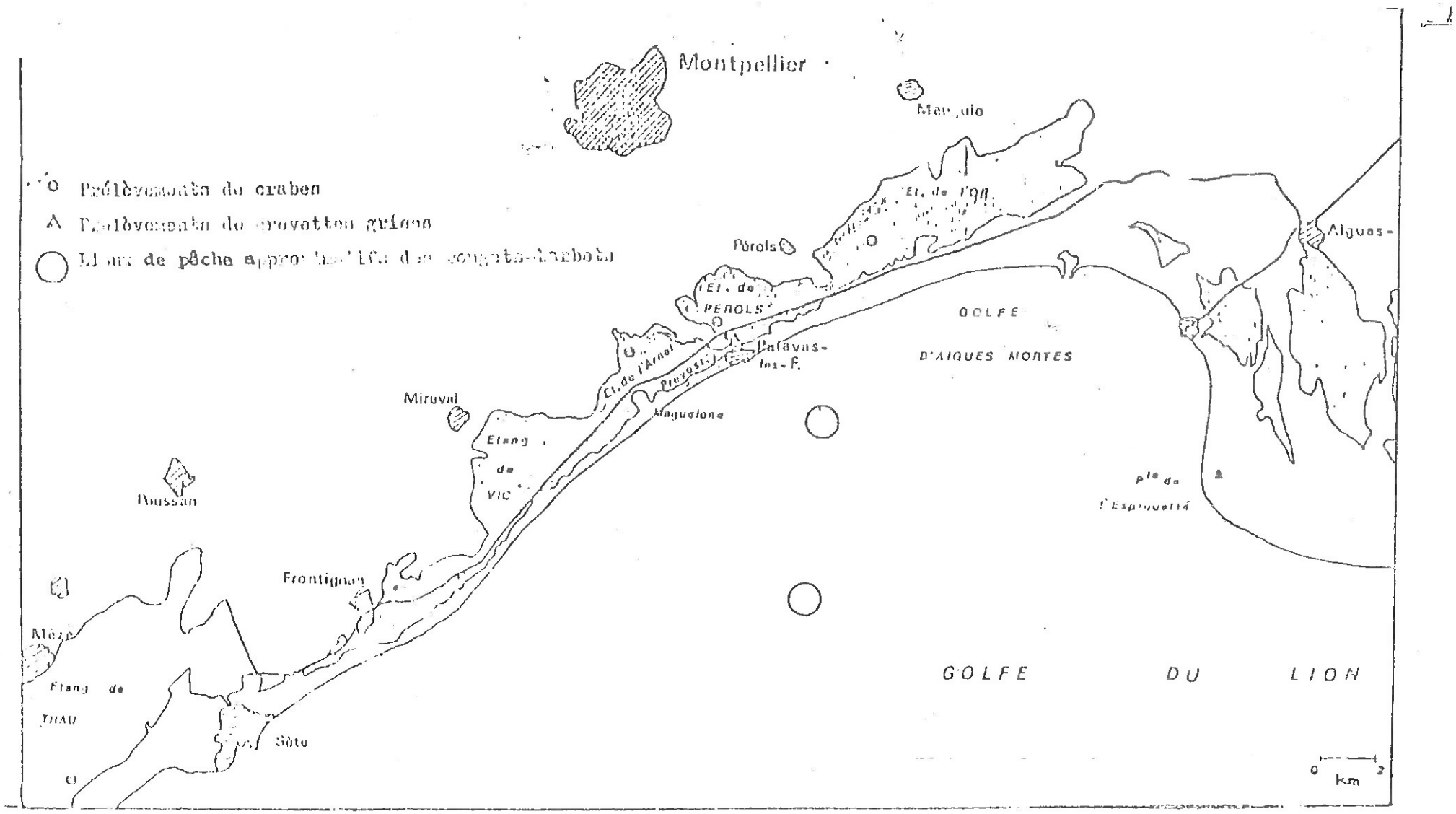


Fig.1 Les stations de prélèvement

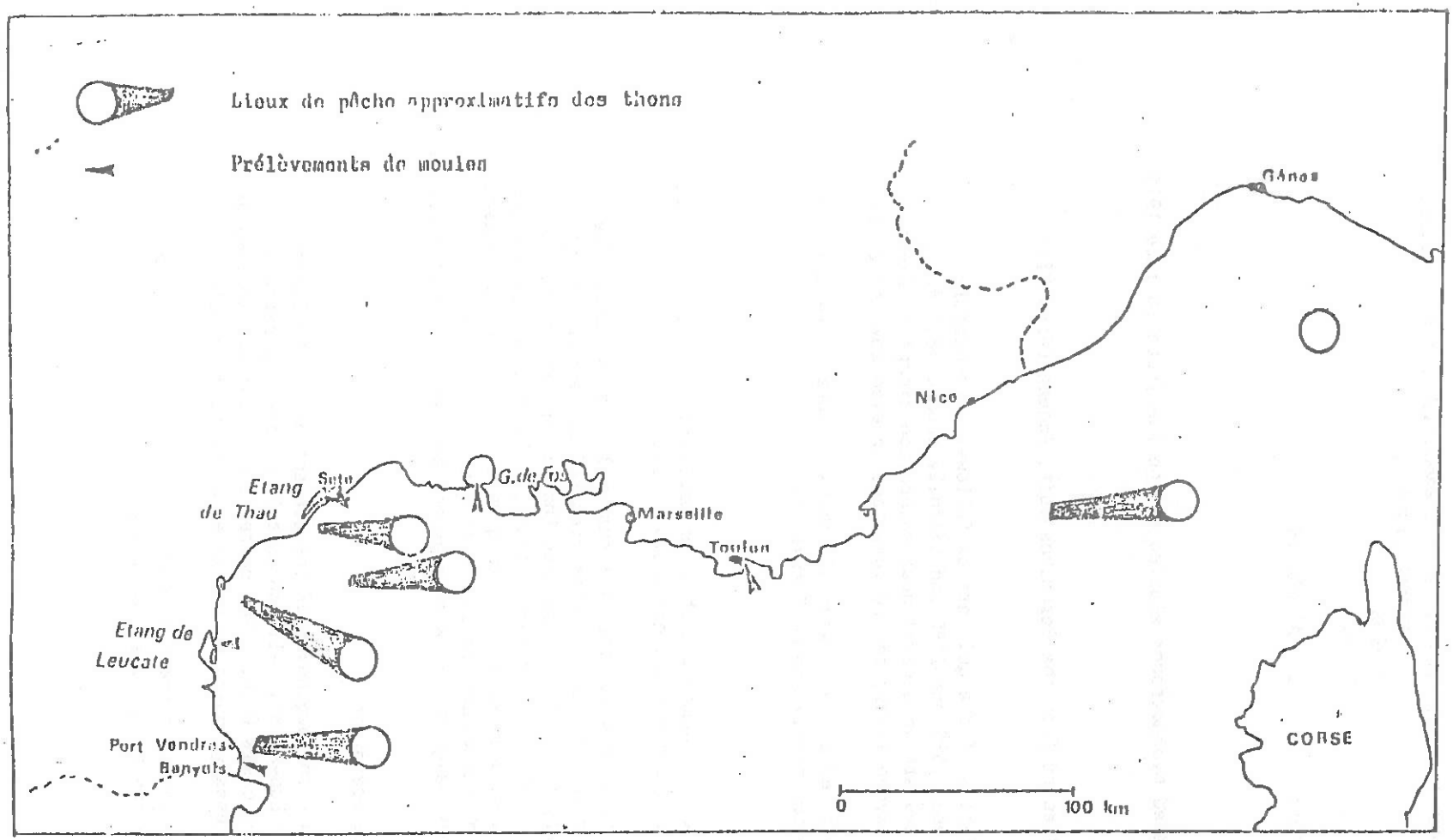


Fig 2: Côte occidentale de la Méditerranée avec les lieux de prélèvement de moules

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 $^{o}/_{oo}$, 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 Σ DDT 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.

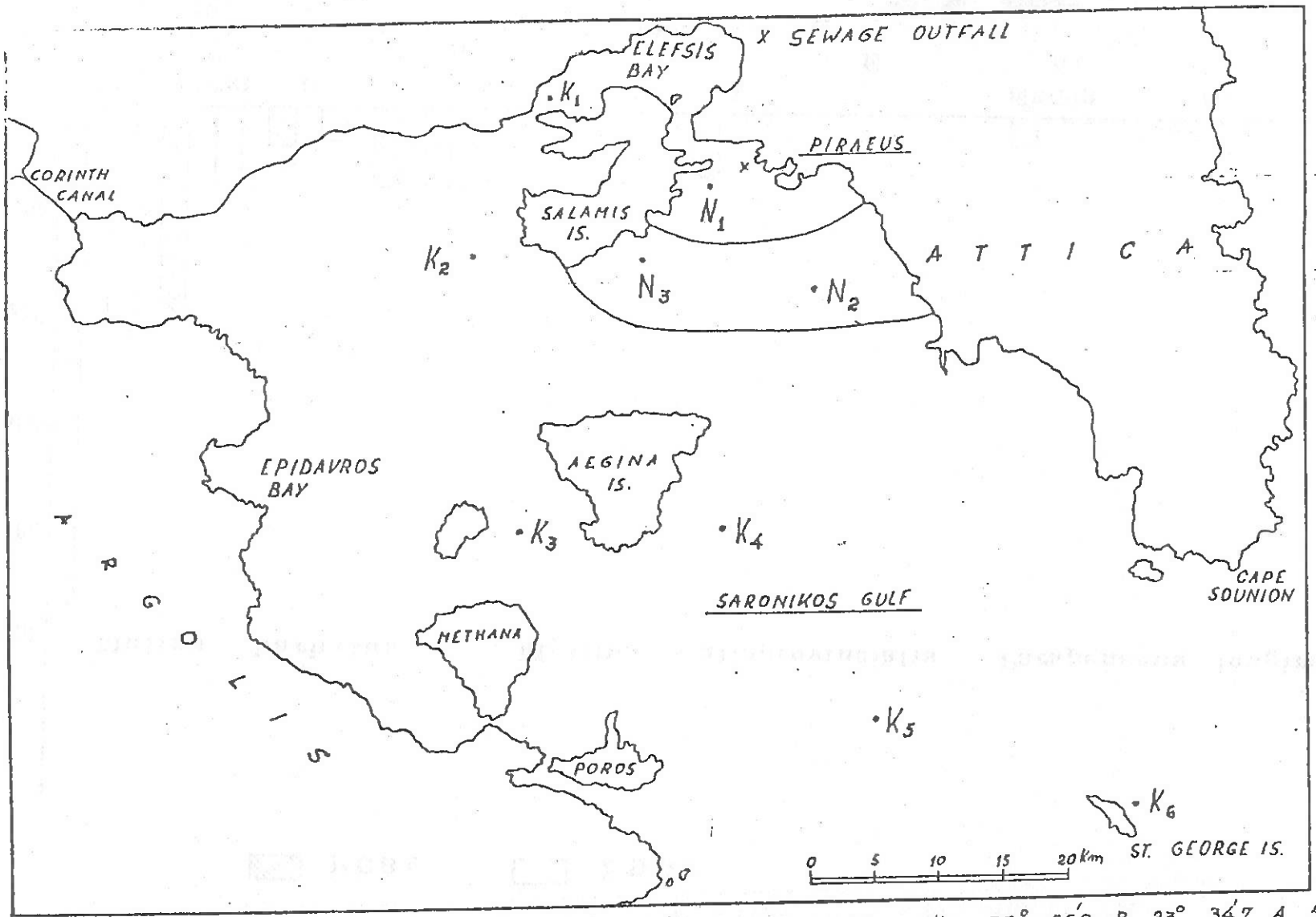
Parapenaeus longirostris and Mytilus galloprovincialis contain amounts 5 to 30 times smaller than Mullus barbatus, taking into account the degree of pollution of the sampling area.

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_4	37°	41,7 B	/ 23°	34,5 A	190 m	N_1	37°	55,8 B	23°	34,7 A	50 m
K_2	37°	53,2 B	/ 23	22,0 A	112 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_3	37°	41,5 B	/ 23	23,8 A	60 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

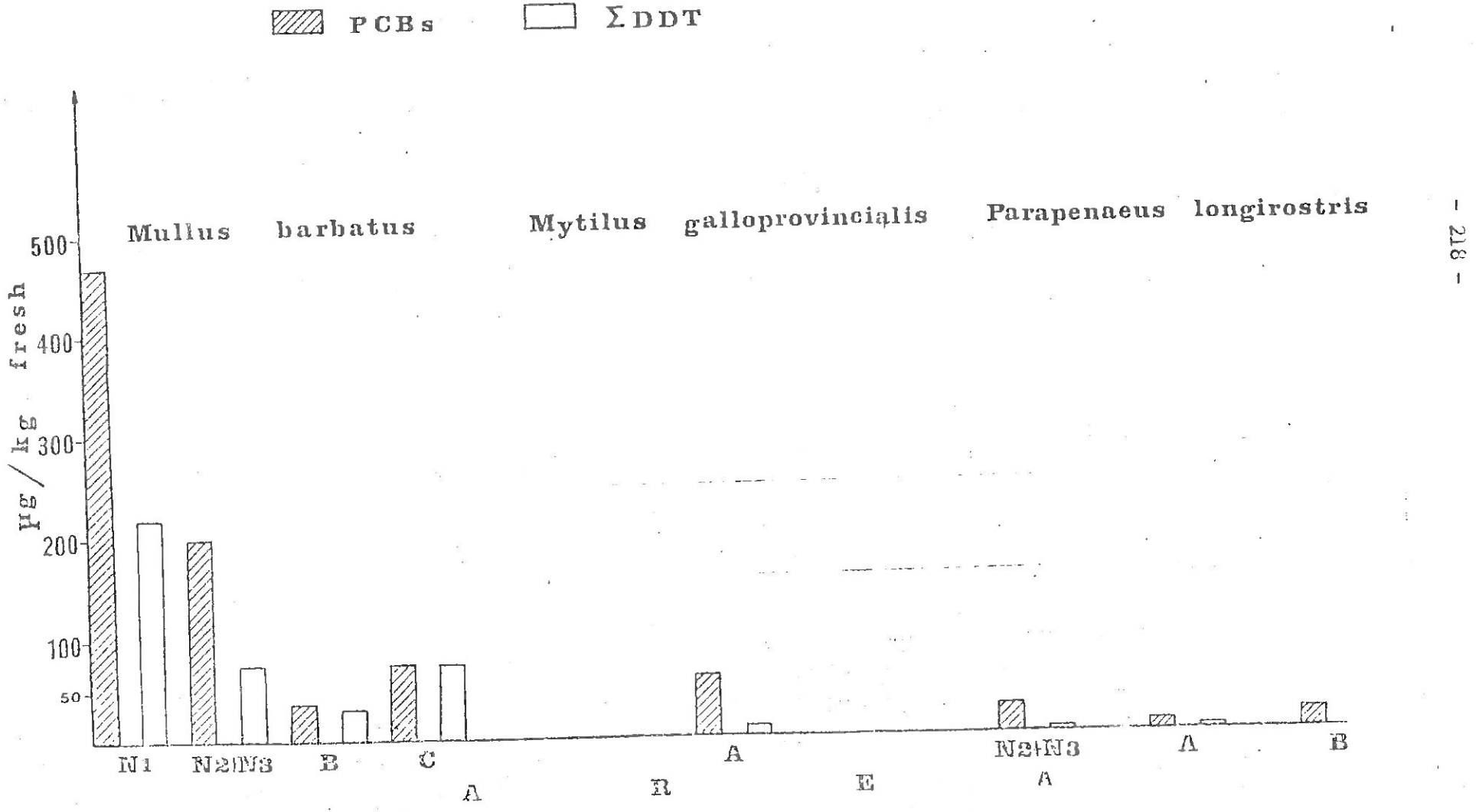
Fig. 1

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 outlet (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

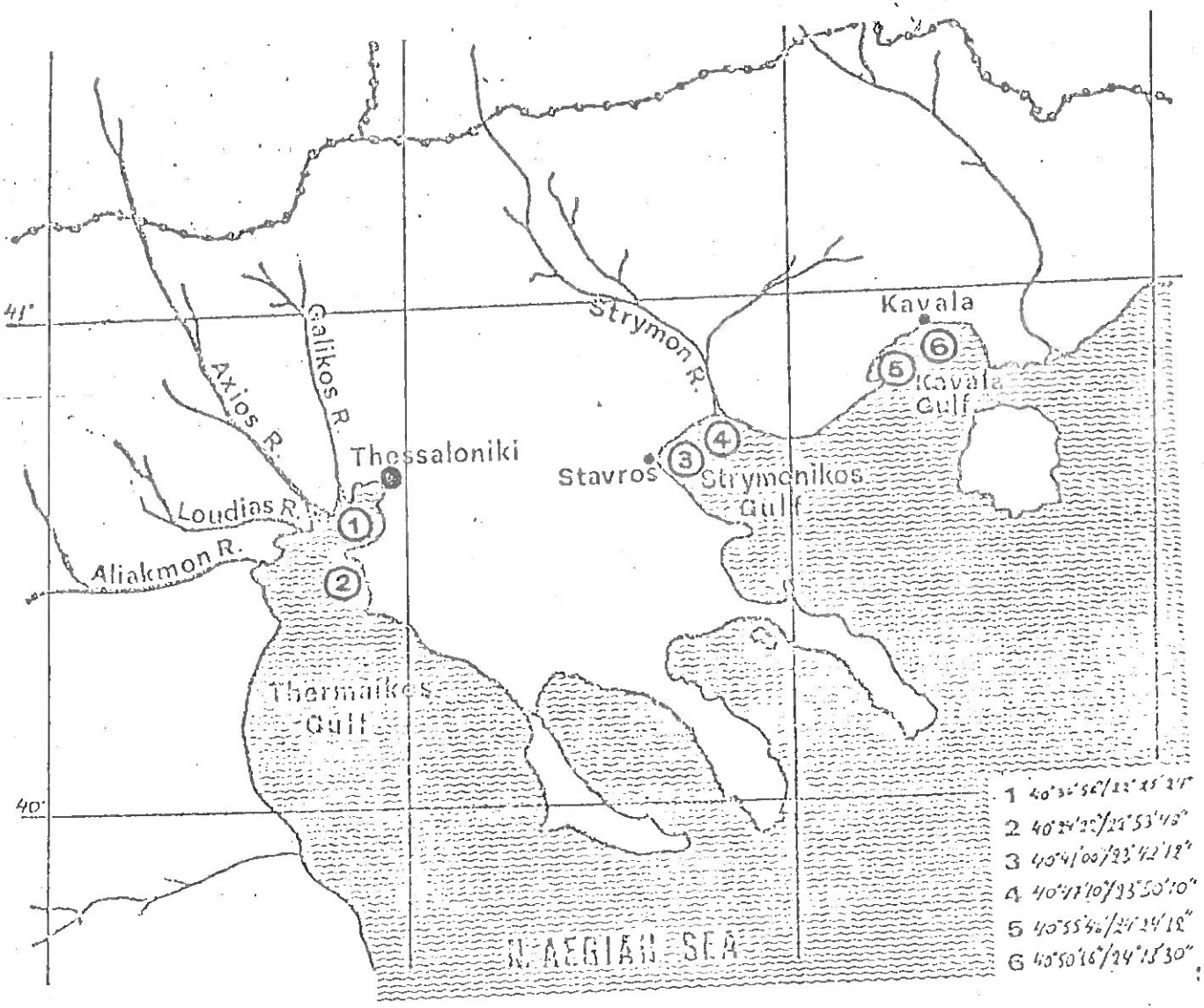


FIG. 1

Sampling areas in Thermaikos Gulf, Strymonikos Gulf, and Kavala Gulf

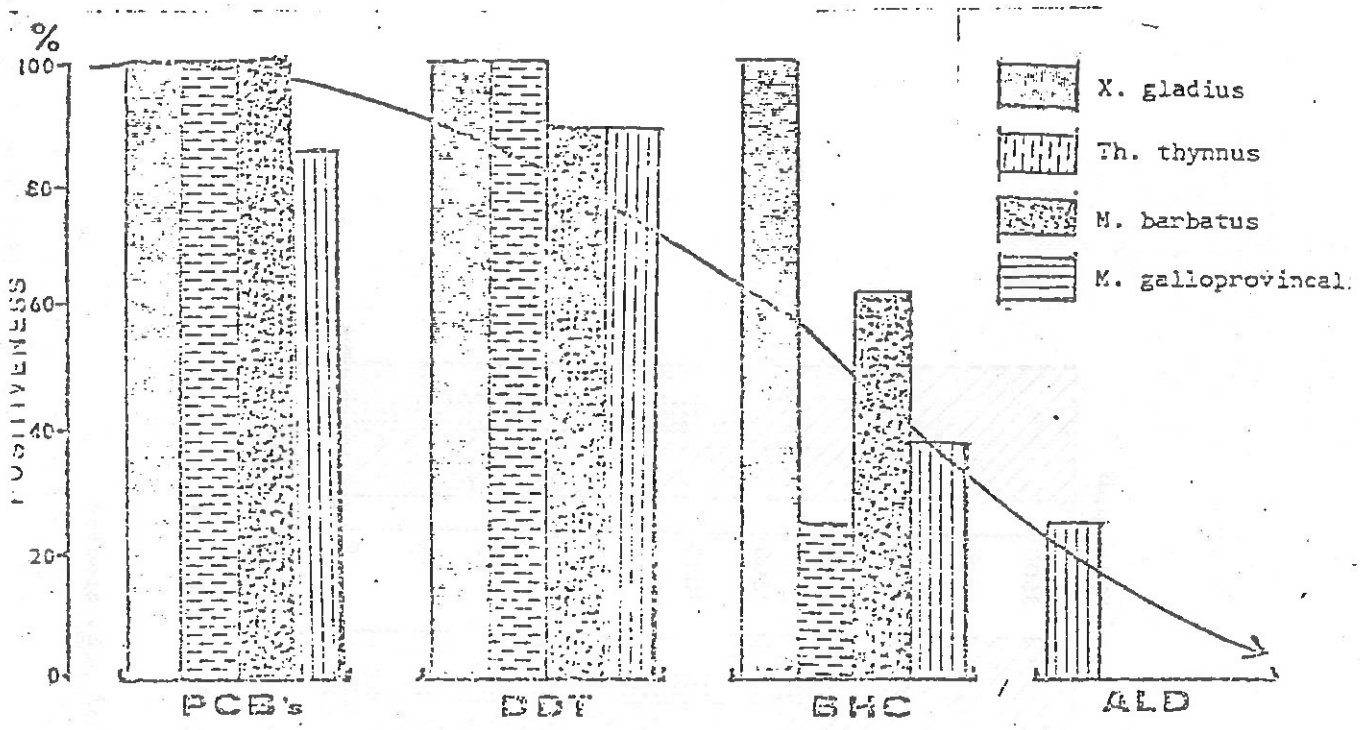

%
100
80
60
40
20
0
X. gladius
Th. thynnus
M. barbatus
M. galloprovincal.
PCB's
DDT
BHC
ALD

FIG. 2

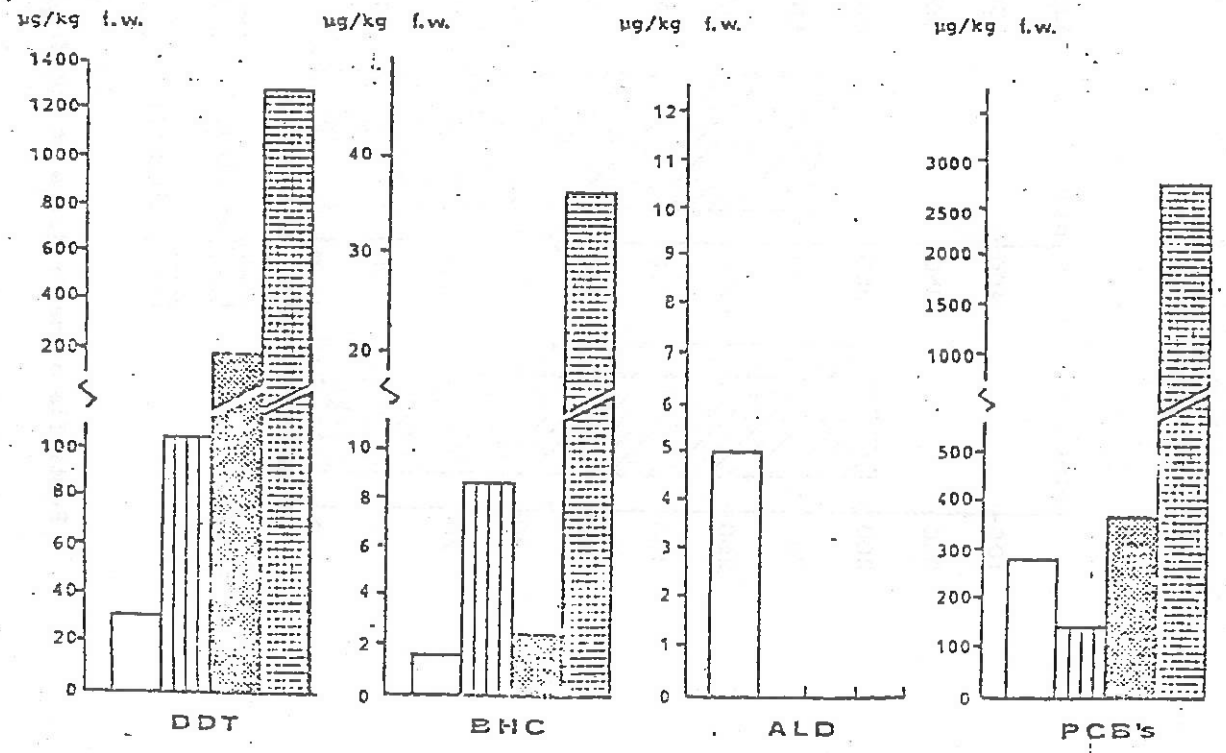

µg/kg f.w.
µg/kg f.w.
µg/kg f.w.
µg/kg f.w.
DDT
BHC
ALD
PCB's
Mytilus galloprovincalis
Mullus barbatus
Xiphias gladius
Thunnus thynnus

FIG. 3

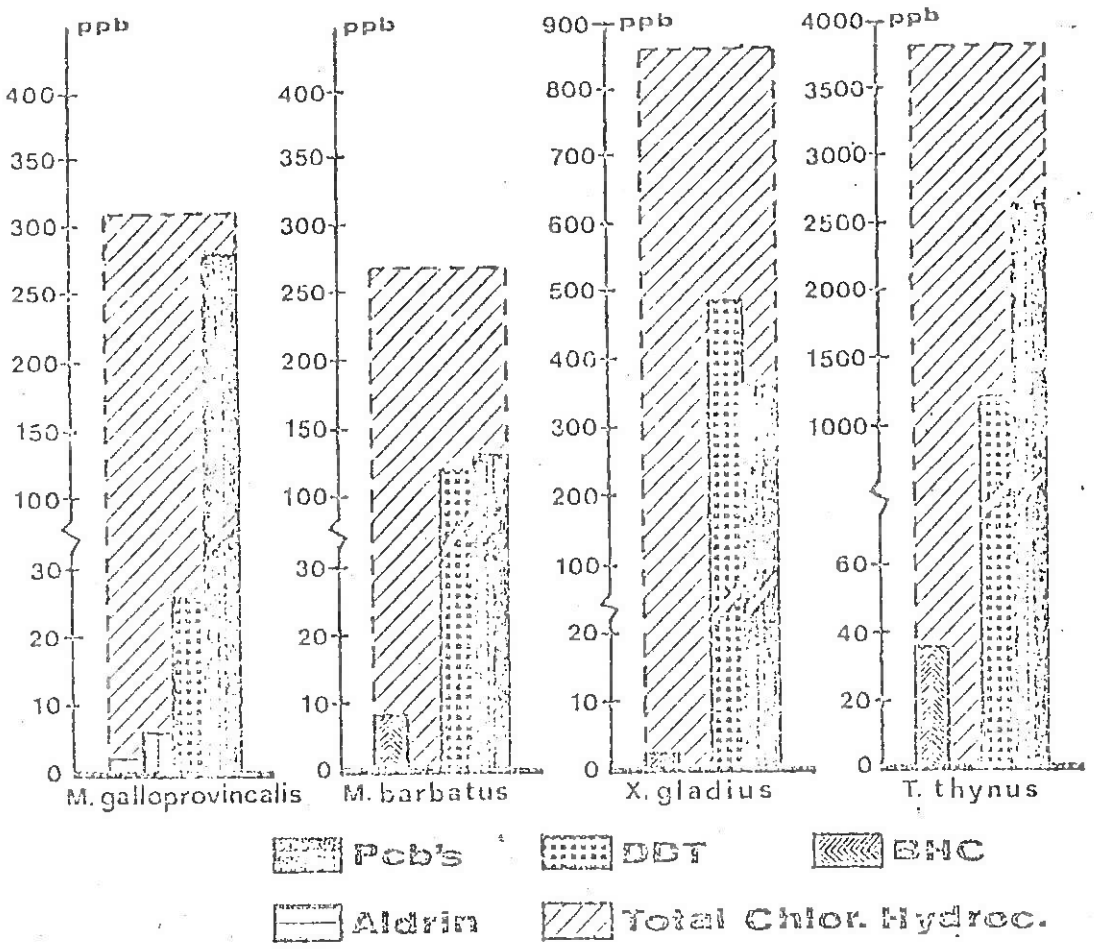


FIG 4

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 $\sum$ DDT 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

$\sum$ DDT 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 $\sum$ DDT 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 $\sum$ DDT et PCBs ont été trouvées dans la zone AA;

b) les concentrations des PCBs sont plus élevées que celles de Σ 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.;

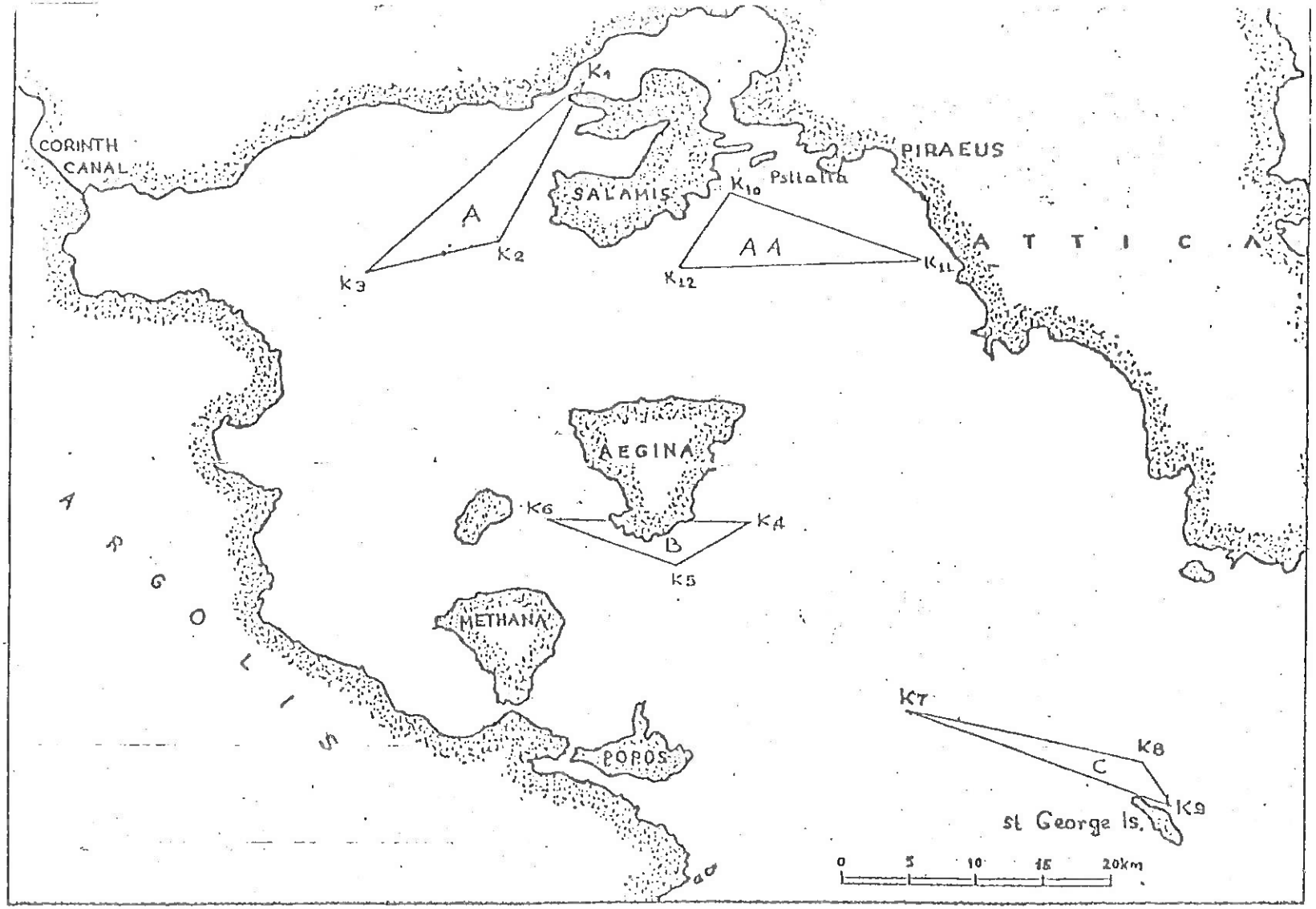
e) pour Parapenaeus longirostris on n'a pas observé de différences significatives entre les zones et les valeurs de 1976 ont été plus élevées que celles de 1977.

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

Espèce \ Zone		AA	A	B	C
Mullus barbatus	n	4	4	6	9
	PCBs	288±443	32±13	31±30	44±28
	ΣDDT	119±146	15±6	24±13	46±21
Mytilus galloprovincialis	n	–	6	–	–
	PCBs	–	64±10	–	–
	ΣDDT	–	9±5	–	–
Paraponaeus longirostris	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				
	≤DDT	PCBs	≤BHC	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. Pagellus 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).
≤DDT = DDE + DDT + DDD ≤BHC = 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 Monsanto 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

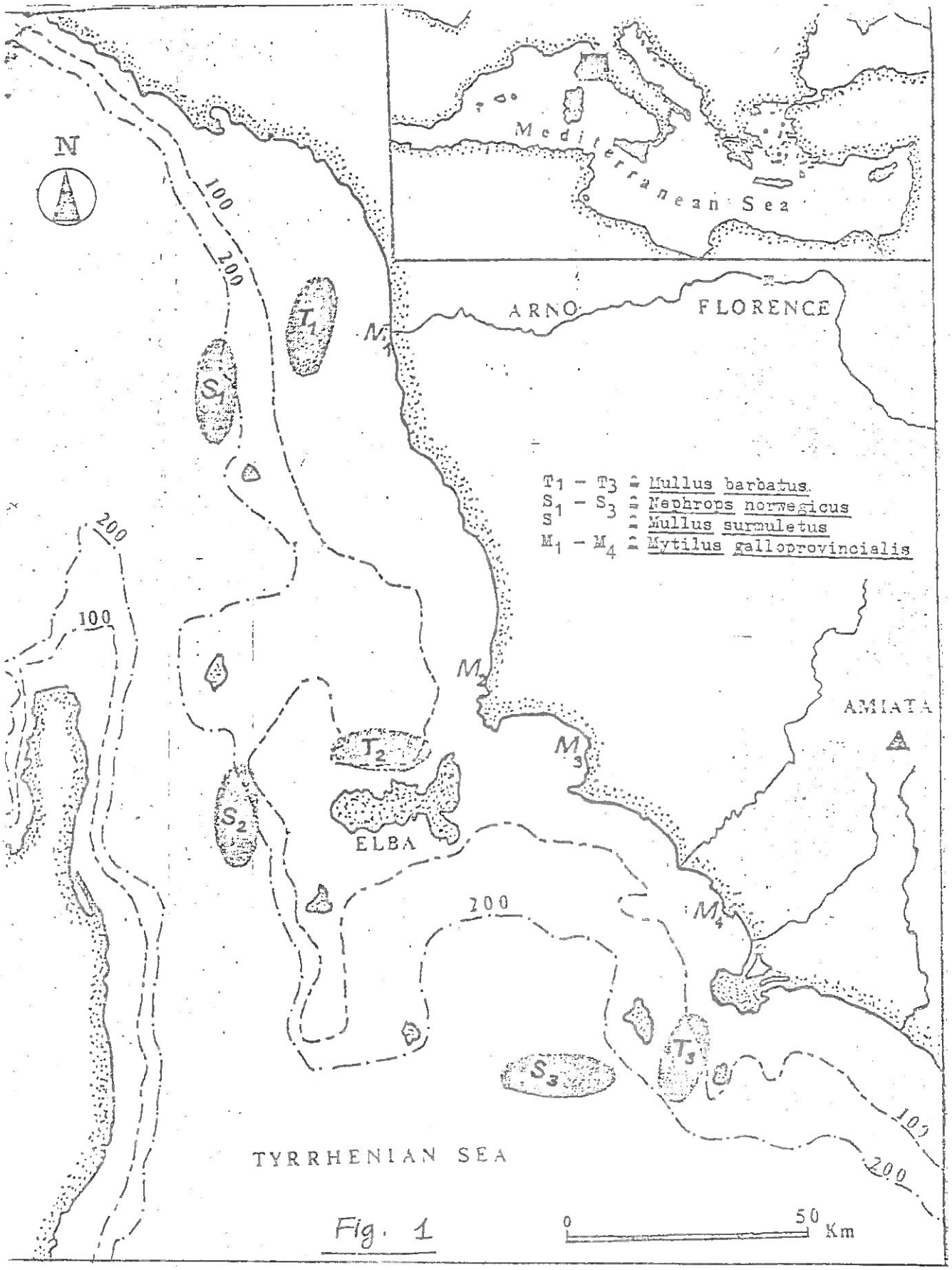

N
Mediterranean Sea
ARNO
FLORENCE
AMIATA
ELBA
TYRRHENIAN SEA
100
200
T_1
T_2
T_3
S_1
S_2
S_3
M_1
M_2
M_3
M_4
T_1 - T_3 = Mullus barbatus
S_1 - S_3 = Nephrops norwegicus
S = Mullus surmuletus
M_1 - M_4 = Mytilus galloprovincialis
0
50 Km

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 $^{o}/_{oo}$ and 38.2 $^{o}/_{oo}$, 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	70 ± 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.

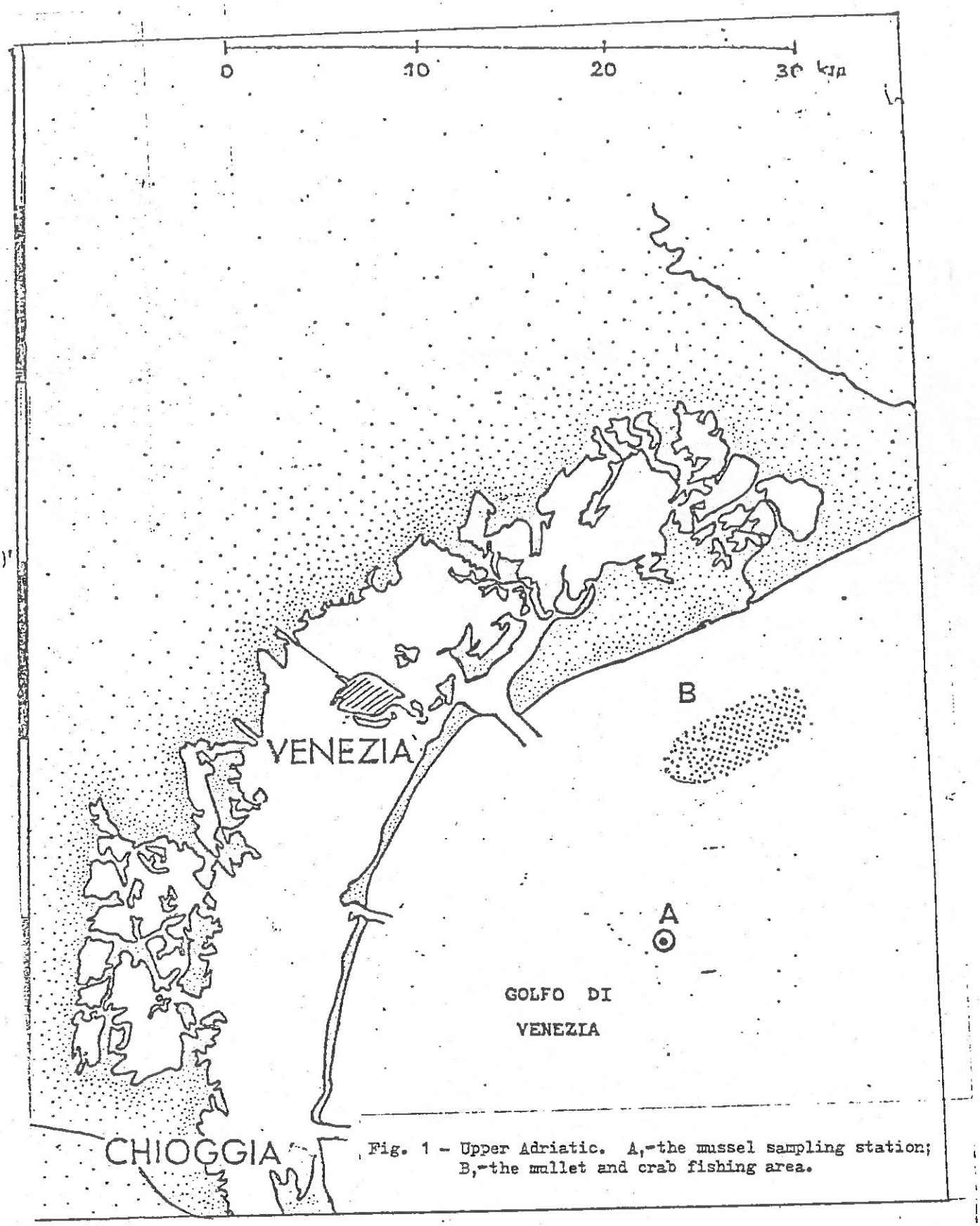


Fig. 1 - Upper Adriatic. A,-the mussel sampling station; B,-the mullet and crab fishing area.

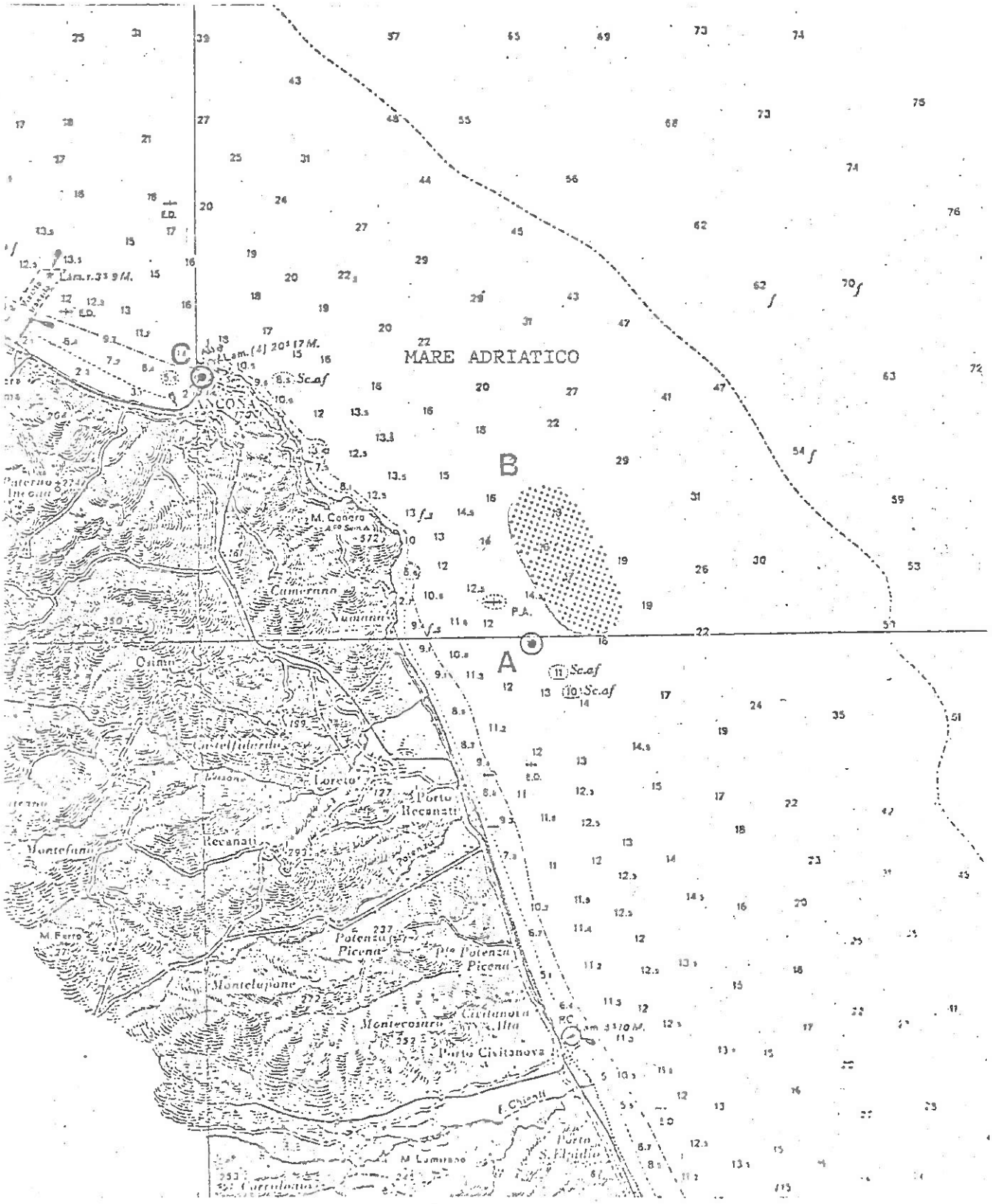


Fig. 2. Mid... Adriatic. A, the mussel sampling station; B, the mullet fishing area; C, the crab sampling station.

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 OC-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:

Accoding 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 mediterrancus	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.

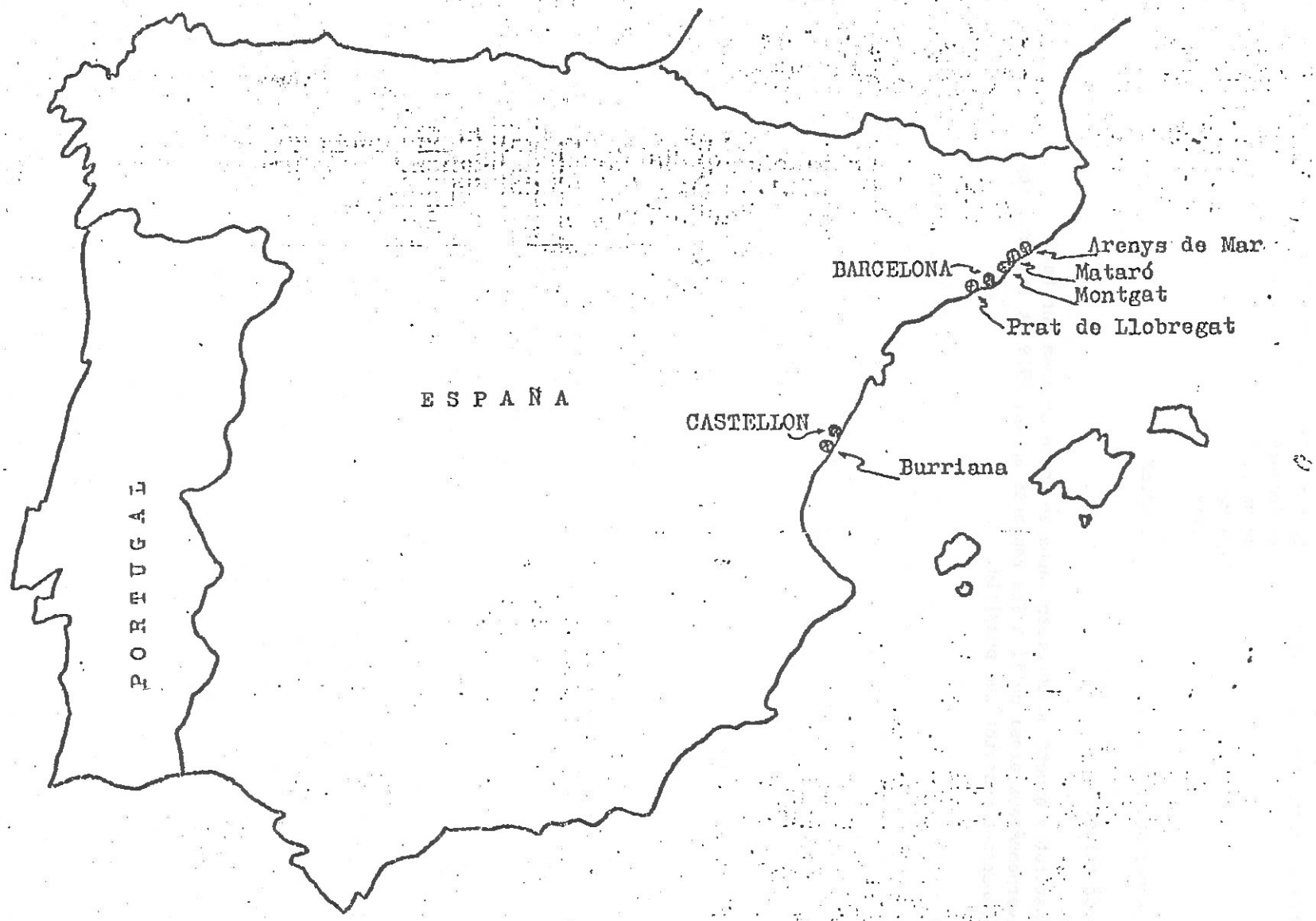


Fig. 1 Sampling areas near Barcelona and Castellon

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 $^{o}/_{oo}$ 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)	≤ DDT			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 ≤DDT 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)

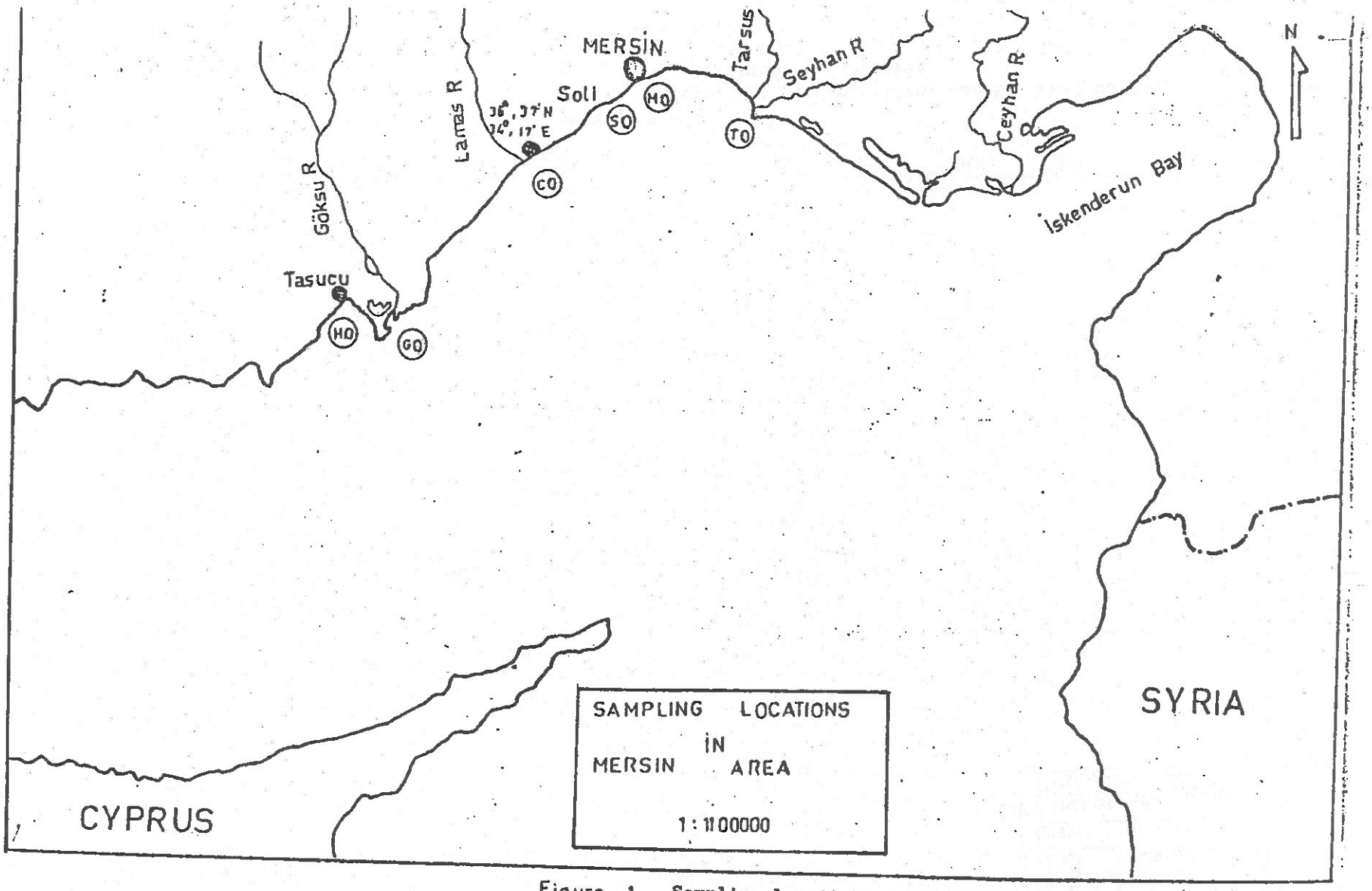


Figure 1 Sampling locations in Mersin area

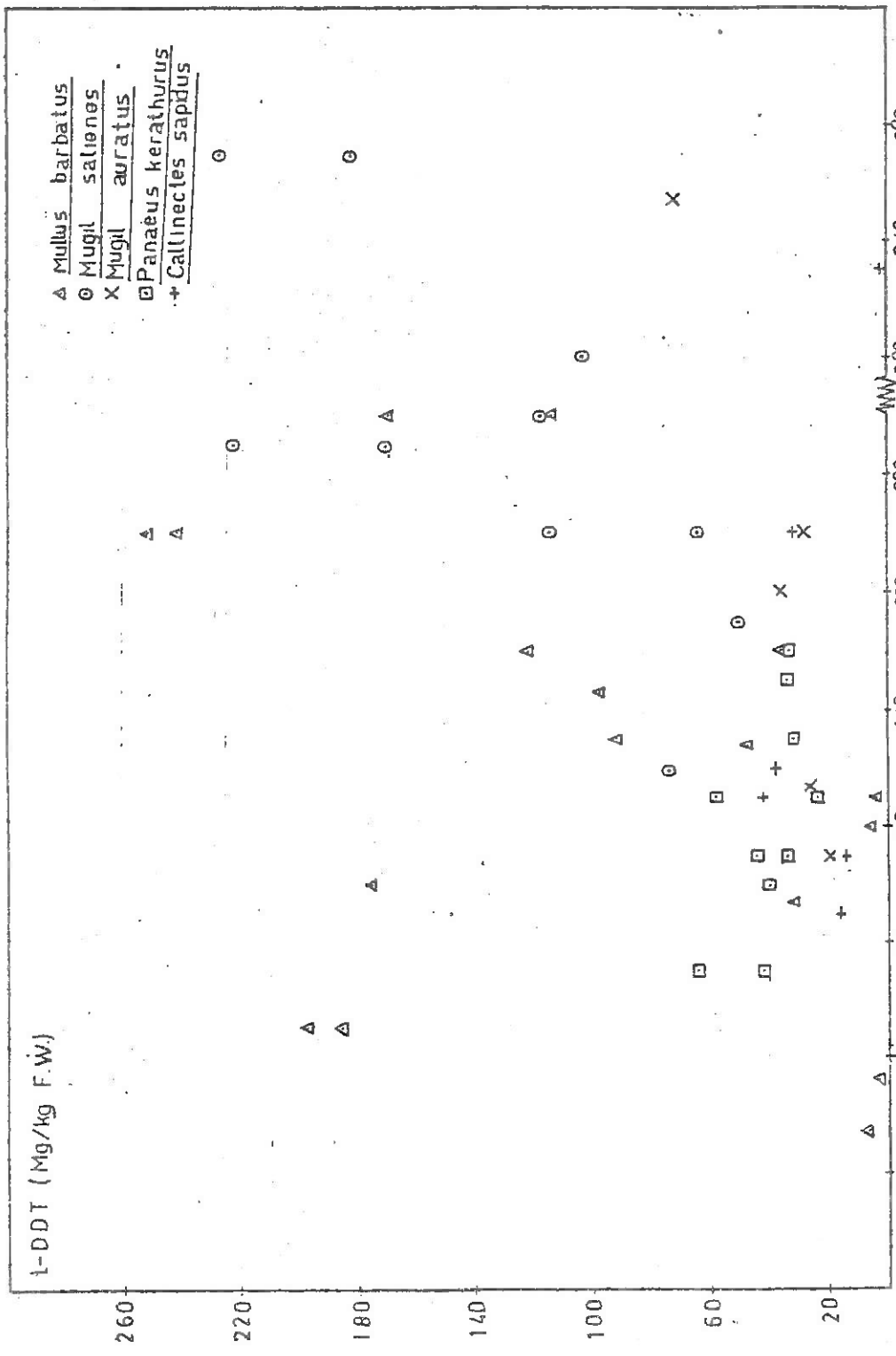


Figure 2 Total DDT-concentrations (mg/kg fresh weight) in various species

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 - 90.0	4.9 - 31.2	0.5 - 18.3	0.5 - 4.4
PCBs	1.0 - 497.0	6.0 - 179.0	1.0 - 540.0	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 ODT 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 Sućuraj	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.)

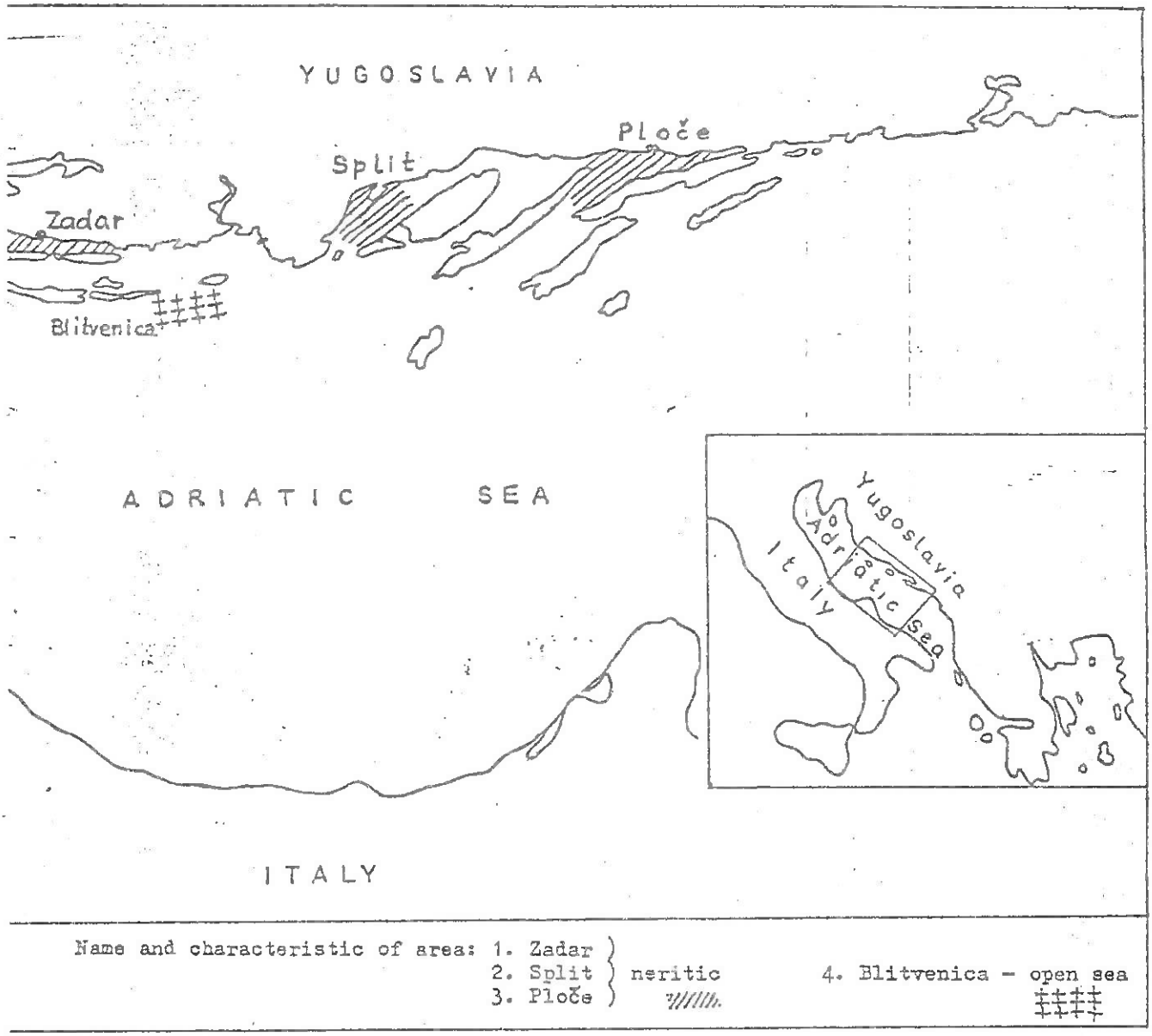


Fig. 1 Sampling sites in the Middle Adriatic (Area V)

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 Σ DDT, PCBs and dieldrin for the species analysed. The results for 8 samples of zooplankton were as follows:

Compound	Range Concentrations (ug/kg F.W.)	Mean
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
Σ DDT Range	0.7–13.1	0.7–25.0	2.1–13.7	1.8–19.4	3.0–17.3
Σ DDT 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
PCBs 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
Dieldrin Mean	0.5	0.4	0.5	0.4	2.6

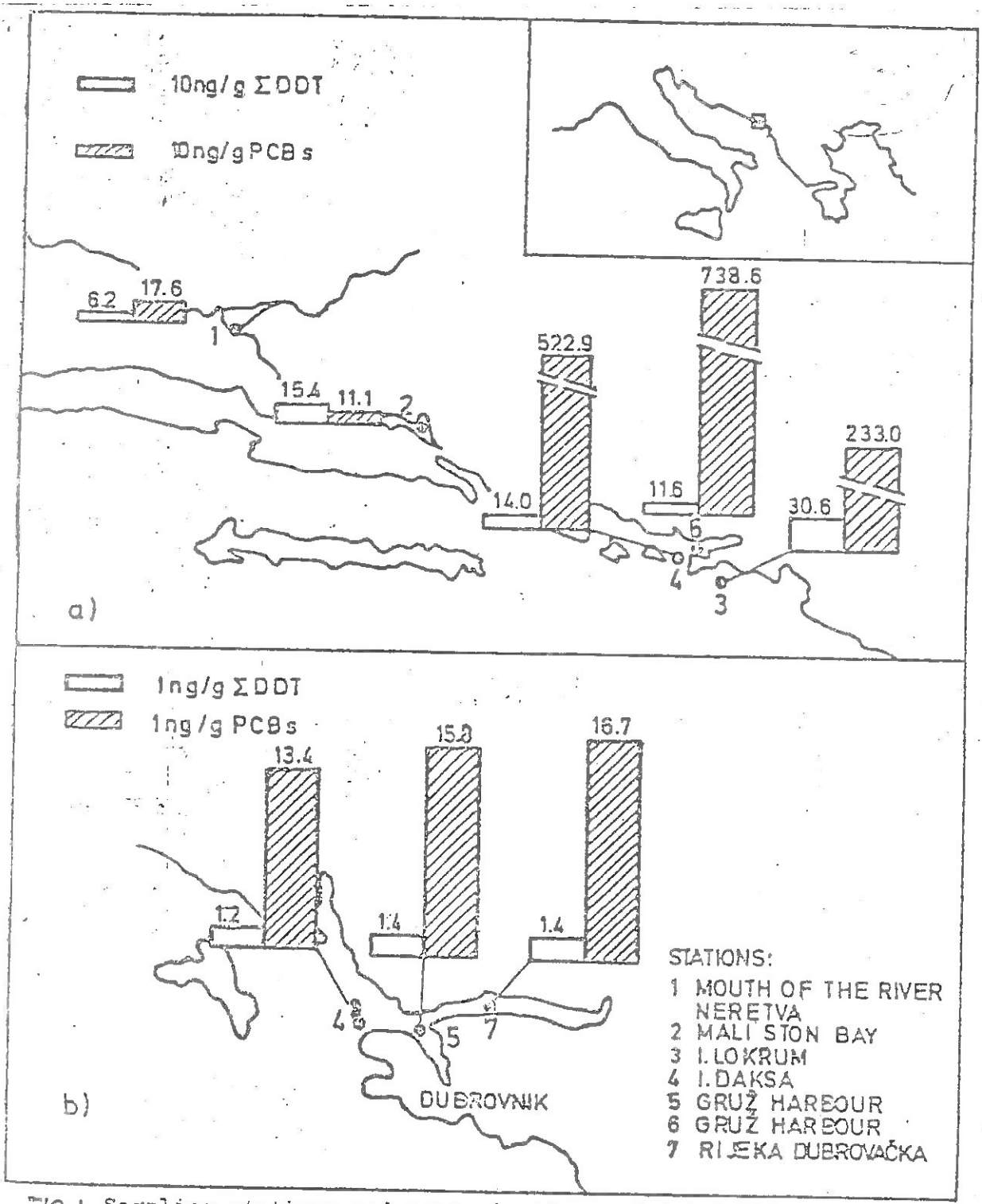


FIG.4 Sampling stations and concentrations of total DDT and PCBs in Mytilus galloprovincialis (a), and in sediment samples (b), expressed graphically as geometrical means on dry weight basis.

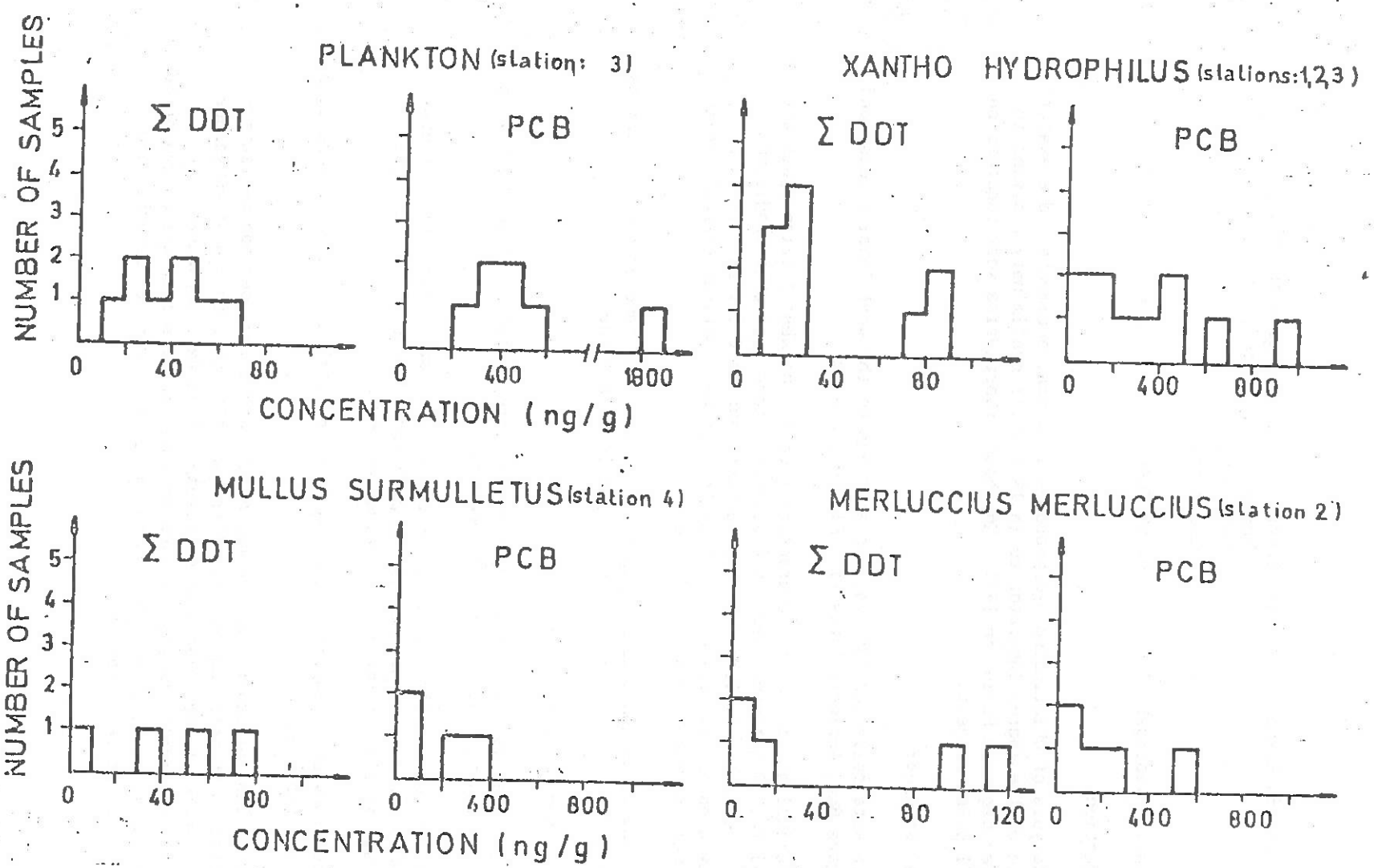


Fig. 2 Distribution of total DDT and PCBs concentrations in tested organisms expressed on dry weight basis.

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 $\sum$ 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 $\sum$ 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.

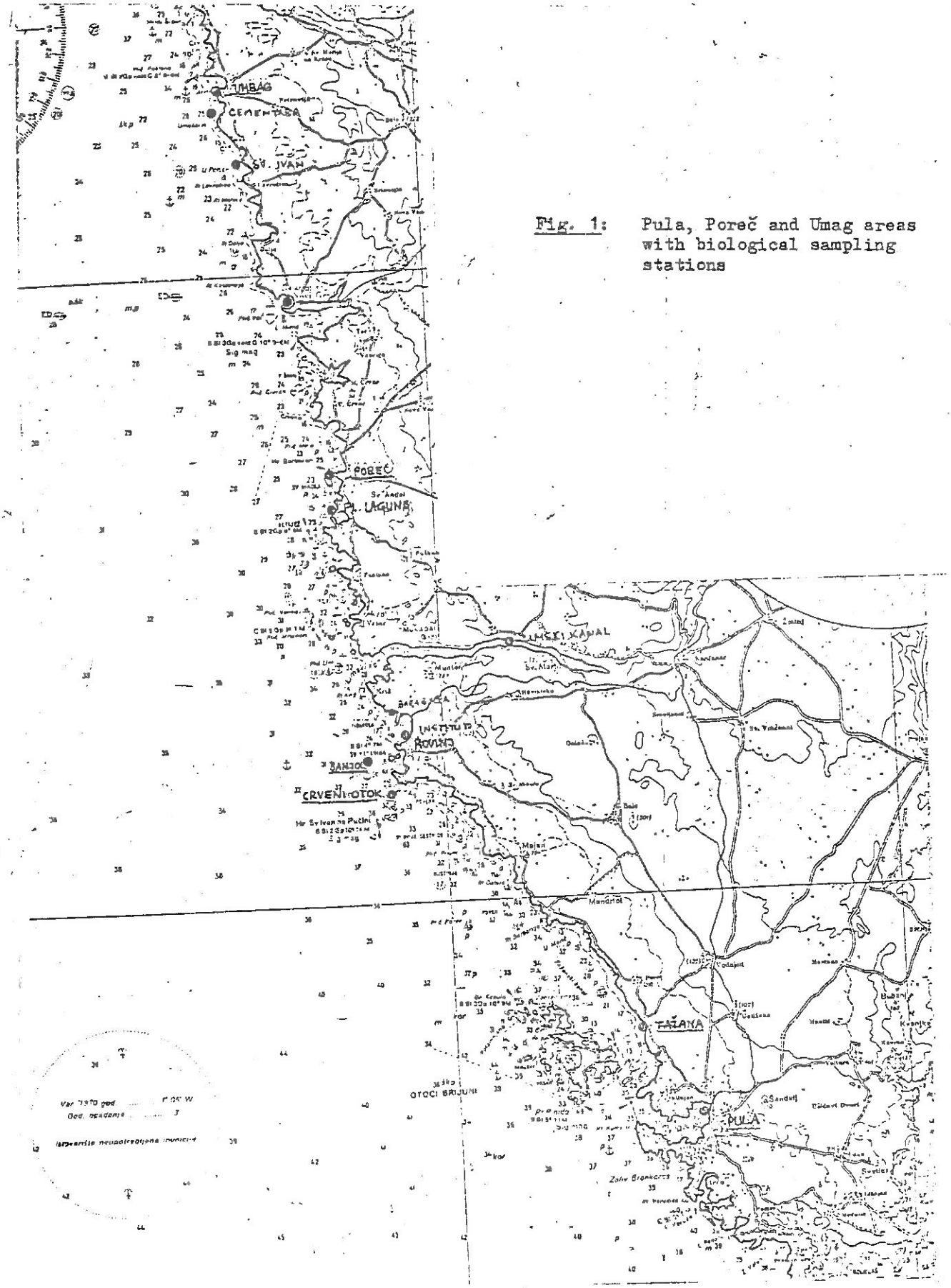


Fig. 1: Pula, Poreč and Umag areas with biological sampling stations

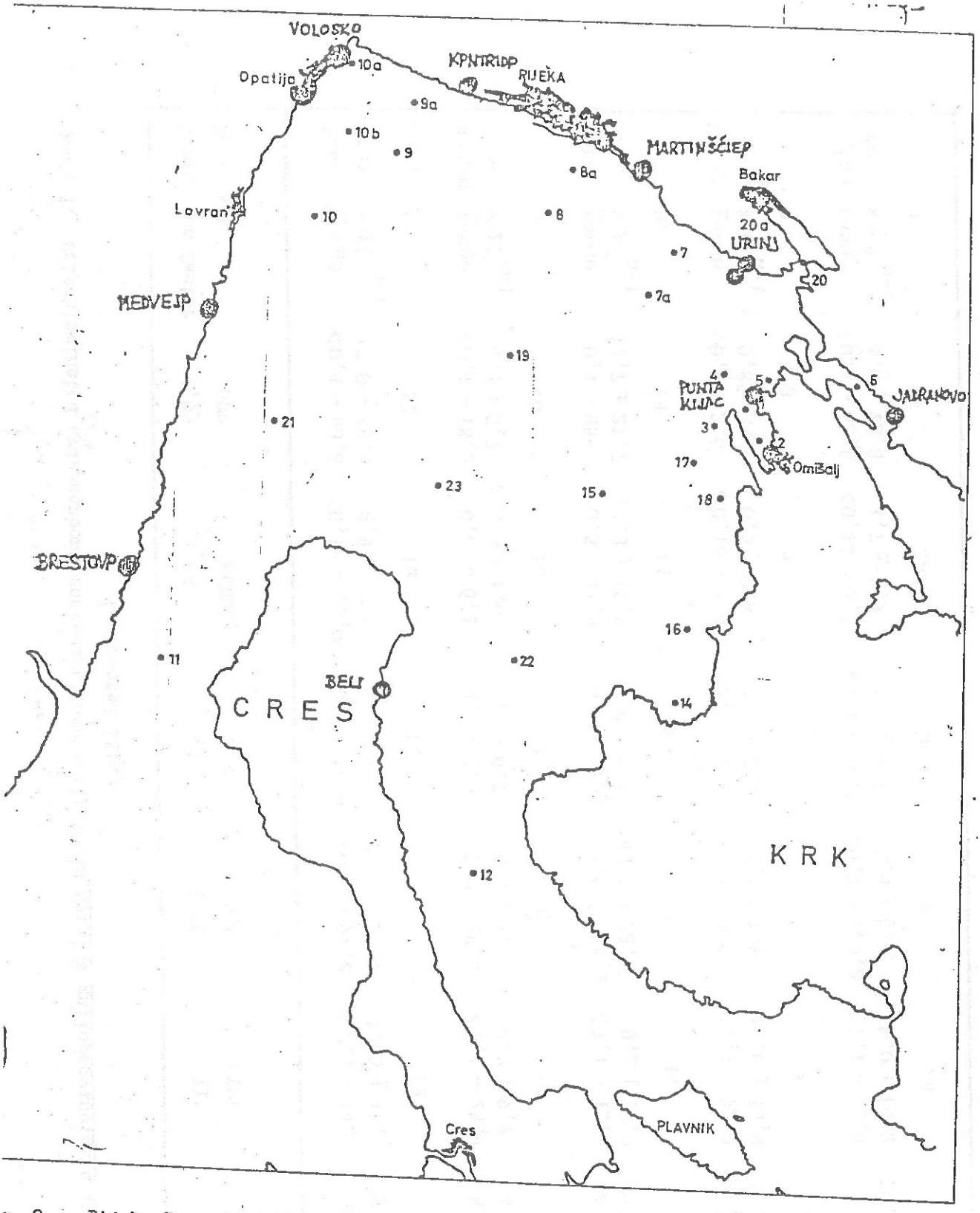


Fig. 2 Rijeka Bay with bilogical sample stations

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	Pattela 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.

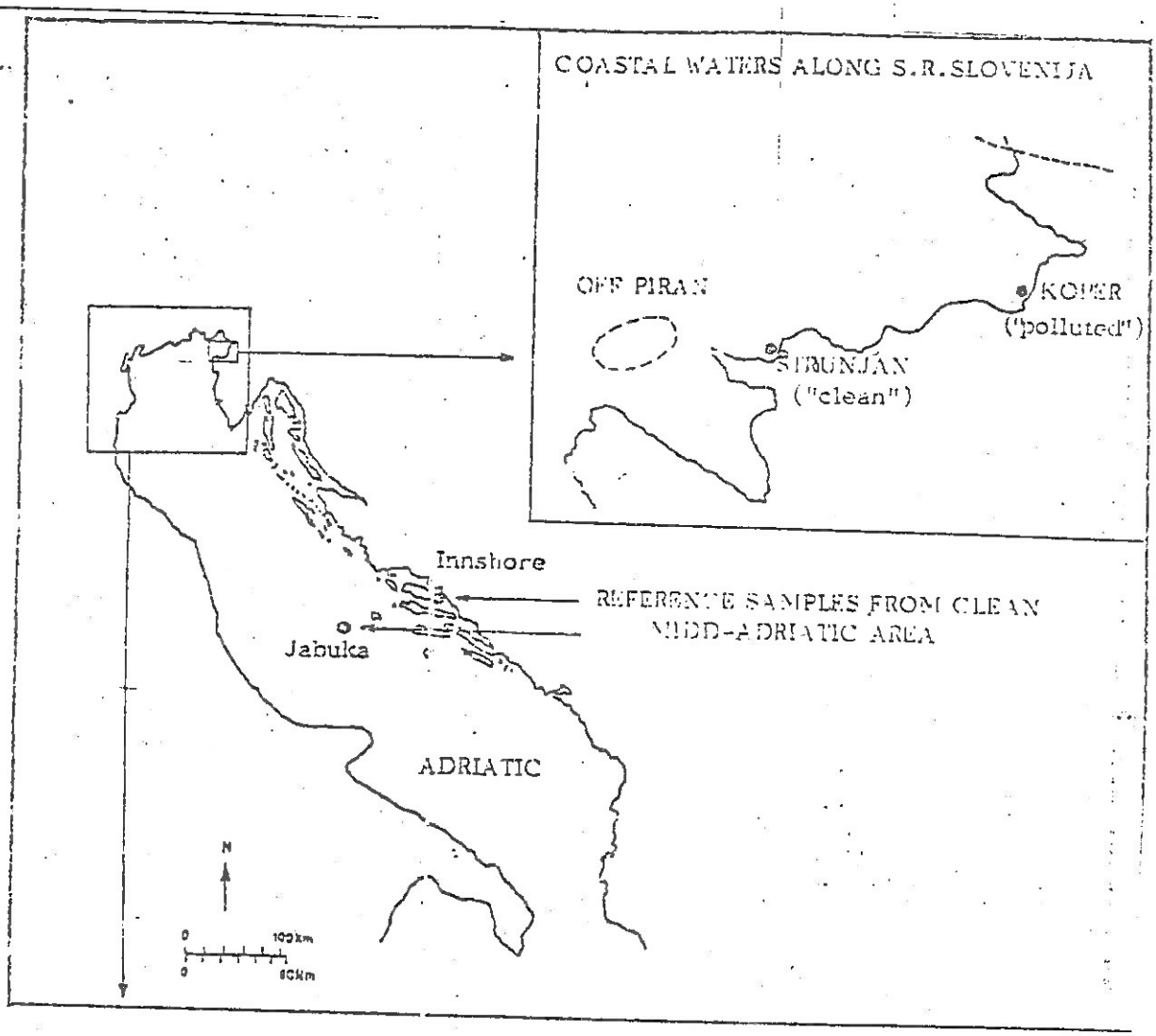


Fig. 1 - Sampling localities in the Northern Adriatic (Area V)

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°/$_{oo}$, 30°/$_{oo}$, et 42°/$_{oo}$ 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°/$_{oo}$, 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 $30°/_{oo}$ à $25°/_{oo}$ 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 I

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
CE 50 % non ioniques	Nonyl phénol 936	41,8	2,2	2	1,4
	Alcool Oxo 431	64,2	0,9	0,7	0,3
	Cesnulsol 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 ± 0,0044	0.082 ± 0,0026
Cd (14°C)	1.20 ± 0,028	1.50 ± 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 répétées. Pour les doses répétées, 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 marins 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.

./.

Effluent dilué	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
Témoins	0	0	0,278	2,336	-	-
Diméthoate	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	0,175	0,301	0,63	0,13
"	20,0	0,5	0,245	1,337	0,88	0,57
Malathion	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	2,323	0,44	0,99
"	10,0	0,2	0,189	2,332	0,68	0,99

[1] 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 $^{o}/_{oo}$; 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 $^{o}/_{oo}$; 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.

Table 1 Results of [illegible]

Locality	Sampling date	Dry %	Cu	Mn	Zn	Fe	Pb	Co	Cr	Cd	Hg
R. Pasa 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	22.7	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.)

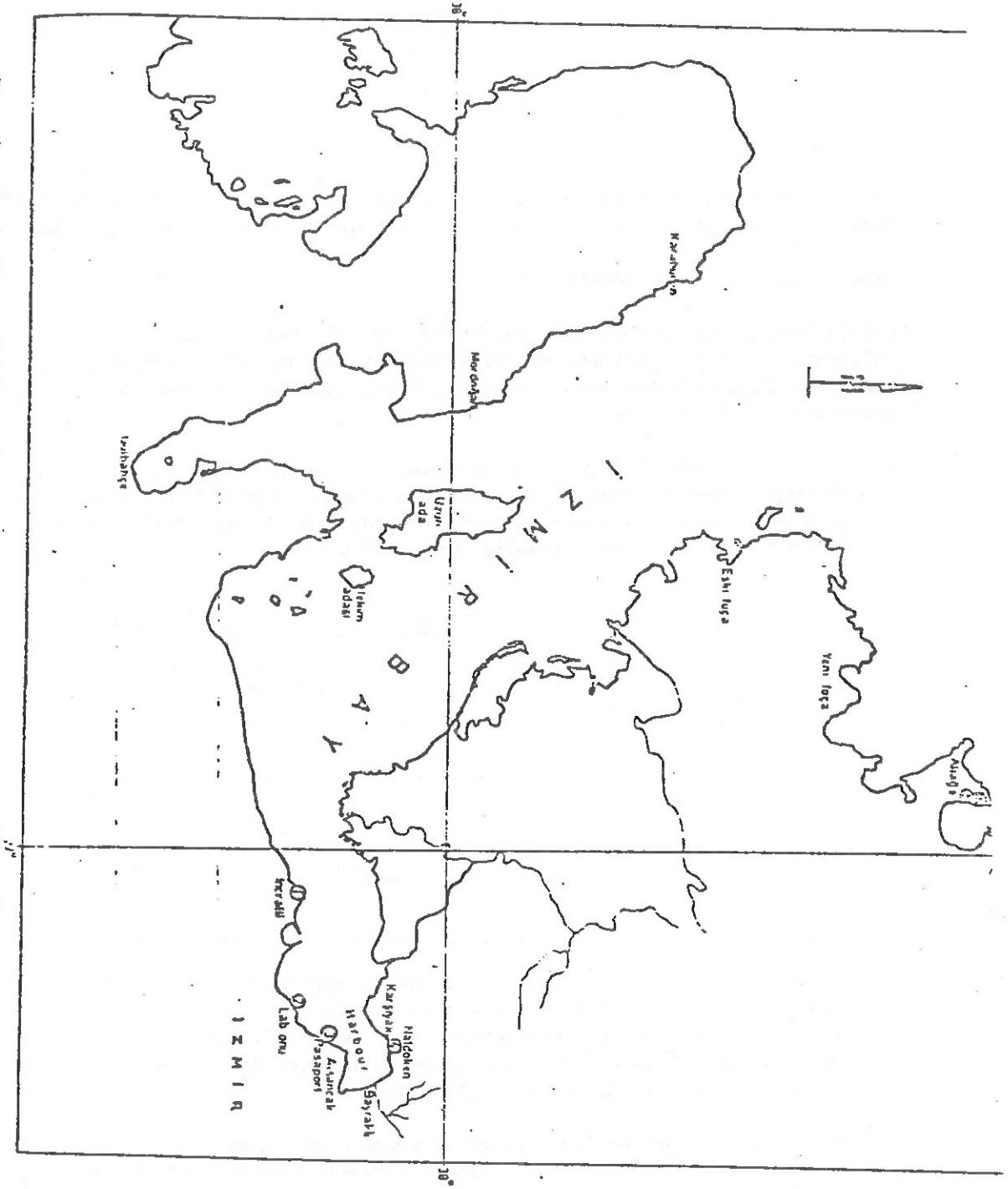


Fig. 1 Izmir Bay and Aliaga Bay with experimental station (1 - 6).

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.

		Cumulative number of dead fish			
Hours	Control	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 cytohaematological 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, -hydro-xybutirate 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 16 C	24 h	-	-	-	-	-	70	0
	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:

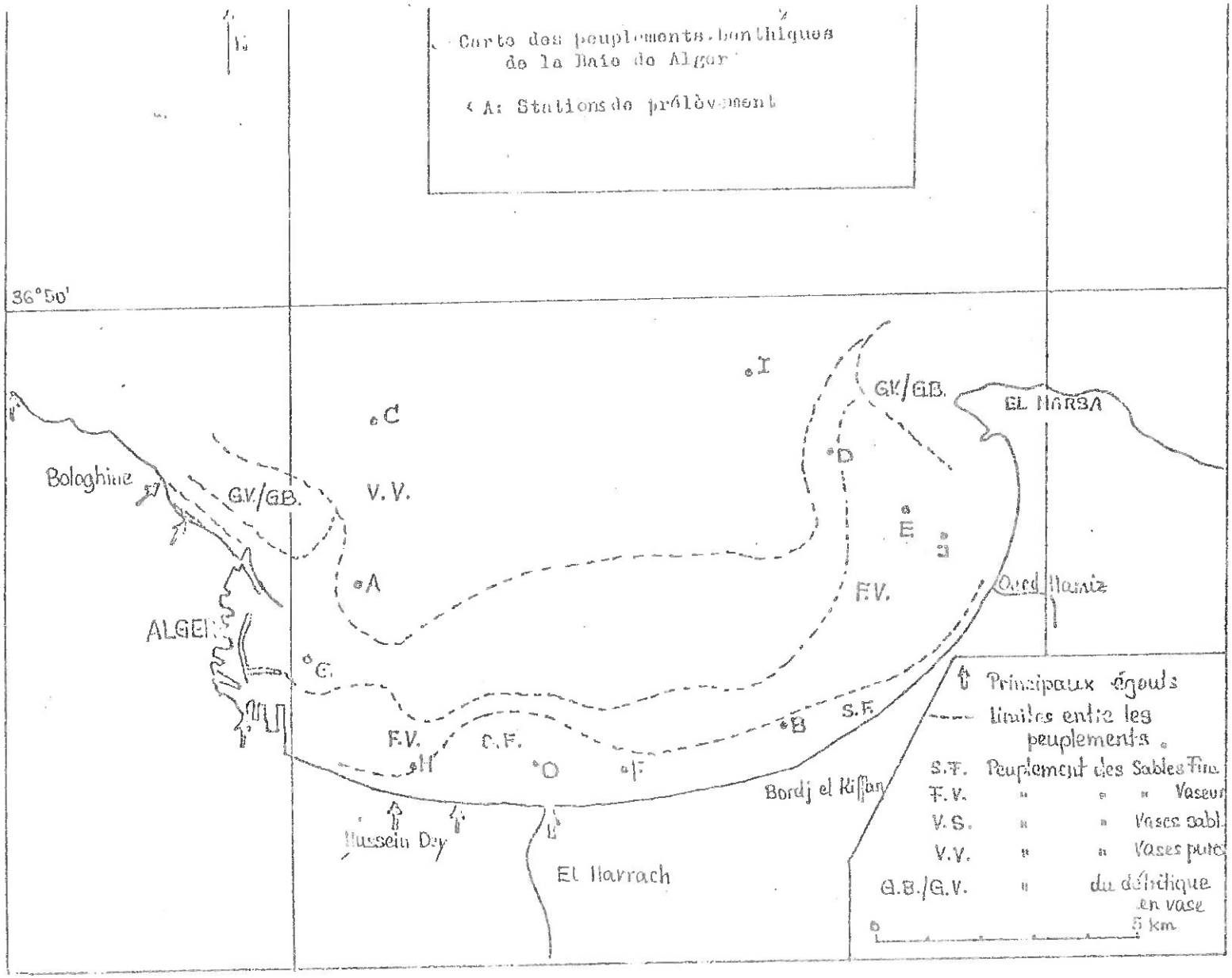
Les résultats montrent que les polluants déversés dans la baie d'Alger n'ont pas jusqu'ici entrané, d'une manire gnrale, une dgradation dans la structure de la communauté benthique. Les quelques changements observés sont jusque-là limités au voisinage direct des sources de pollution même si

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
36°50'
Beloghine
G.V./G.B.
V.V.
A
C
I
G.V./G.B.
EL HARRA
D
E
F.V.
Oued Hamiz
ALGER
G
F.V.
C.F.
H
O
F
B
S.F.
Bordj el Kiffan
Hussein Dey
El Harrach
Principaux égouts
limites entre les peuplements
S.F. Peuplement des Sables Fins
F.V. " " Vaseux
V.S. " " Vases sabl.
V.V. " " Vases pure
G.B./G.V. " du détritique en vase
5 km

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 Epikopi Bay (Station 1) and Limanuol 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 l 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 l 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 l 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 l 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 l 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

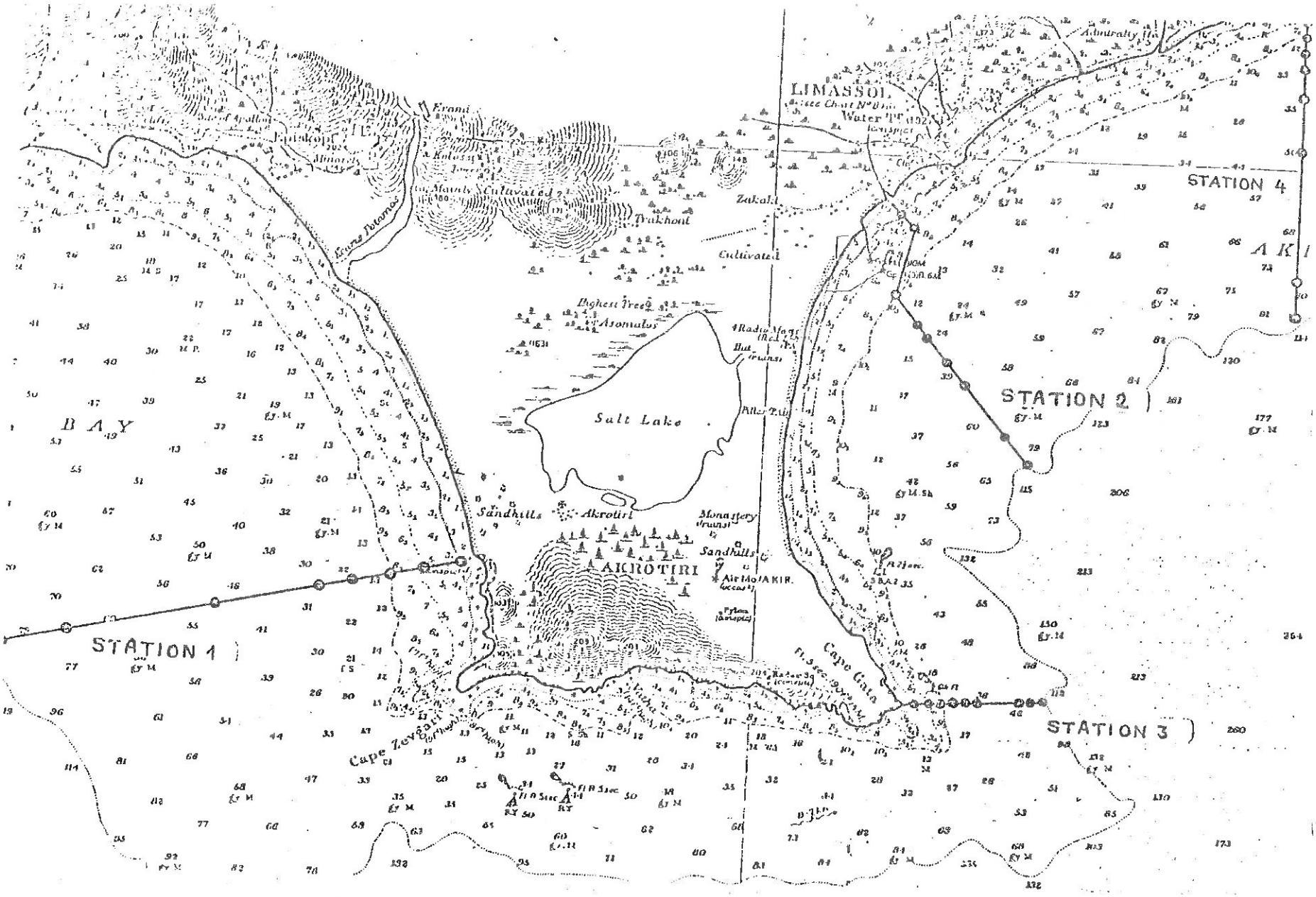


Fig. 1 Sampling area with transects

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 entraînées 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 ($P\text{-}PO_4$, $N\text{-}NO_3$, $N\text{-}NO_2$, $N\text{-}NH_4$, et $Si\text{-}SiO_2$) 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).

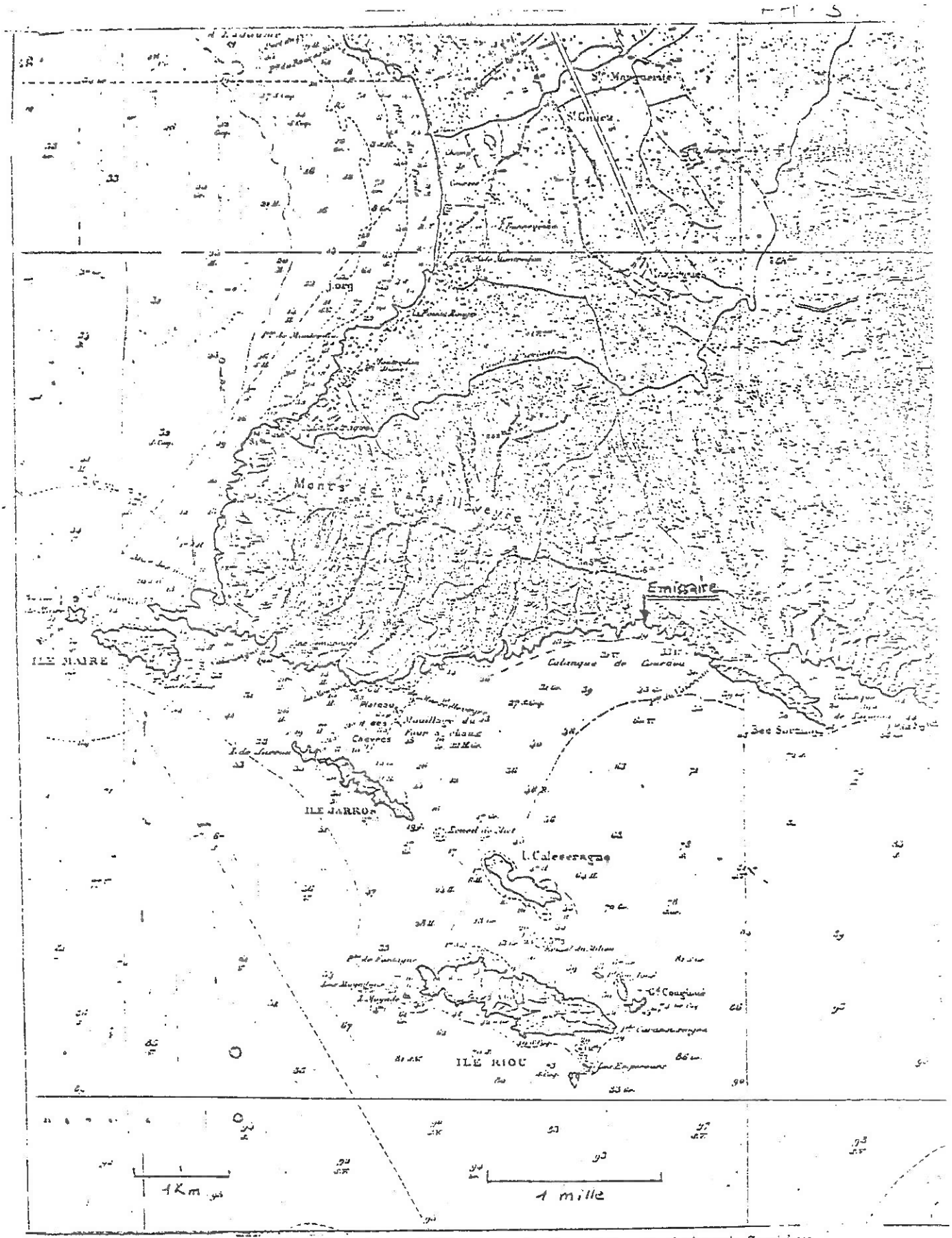


Fig. 1 Echantillonnage de la zone avoisinant Cortiou

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.

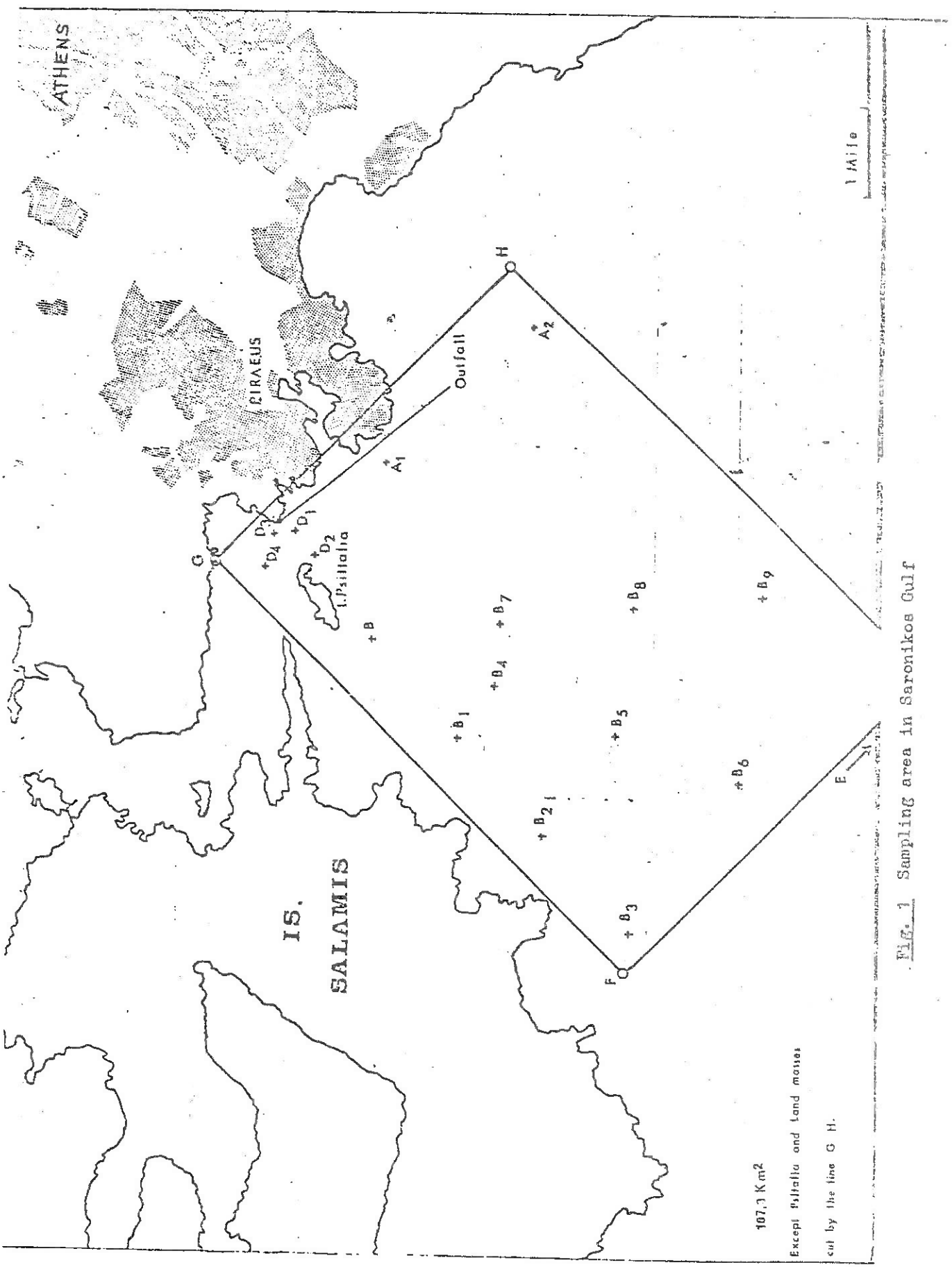


Fig. 1 Sampling area in Saronikos Gulf

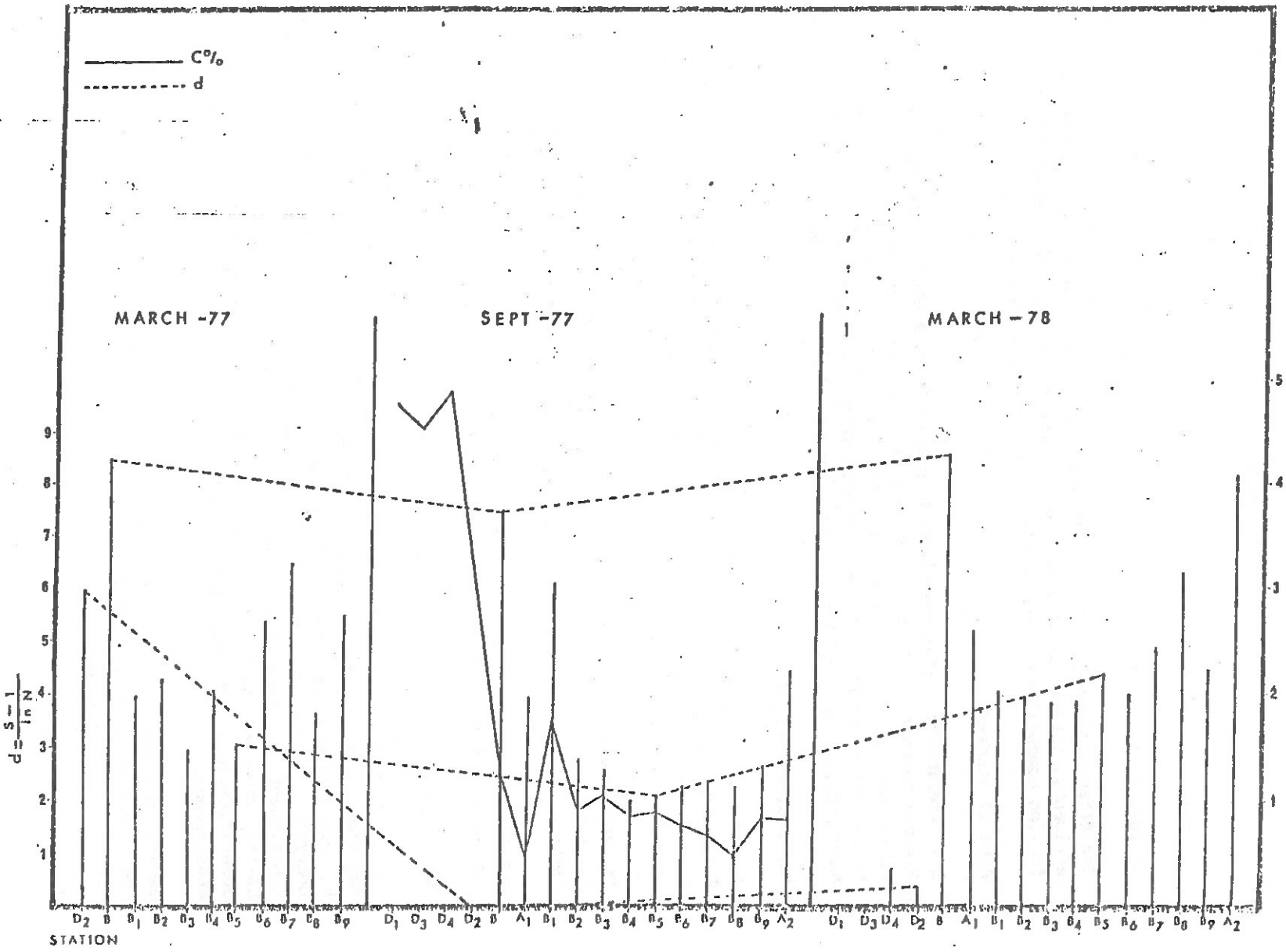


Fig. 2 Changes of diversity index from March 1977 to March 1978 in macrobenthic communities of Saronikos Gulf

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 1

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					+	+	+	+
Miscelaneus		+	+	+	+	+	+	+

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.

Fig. 1

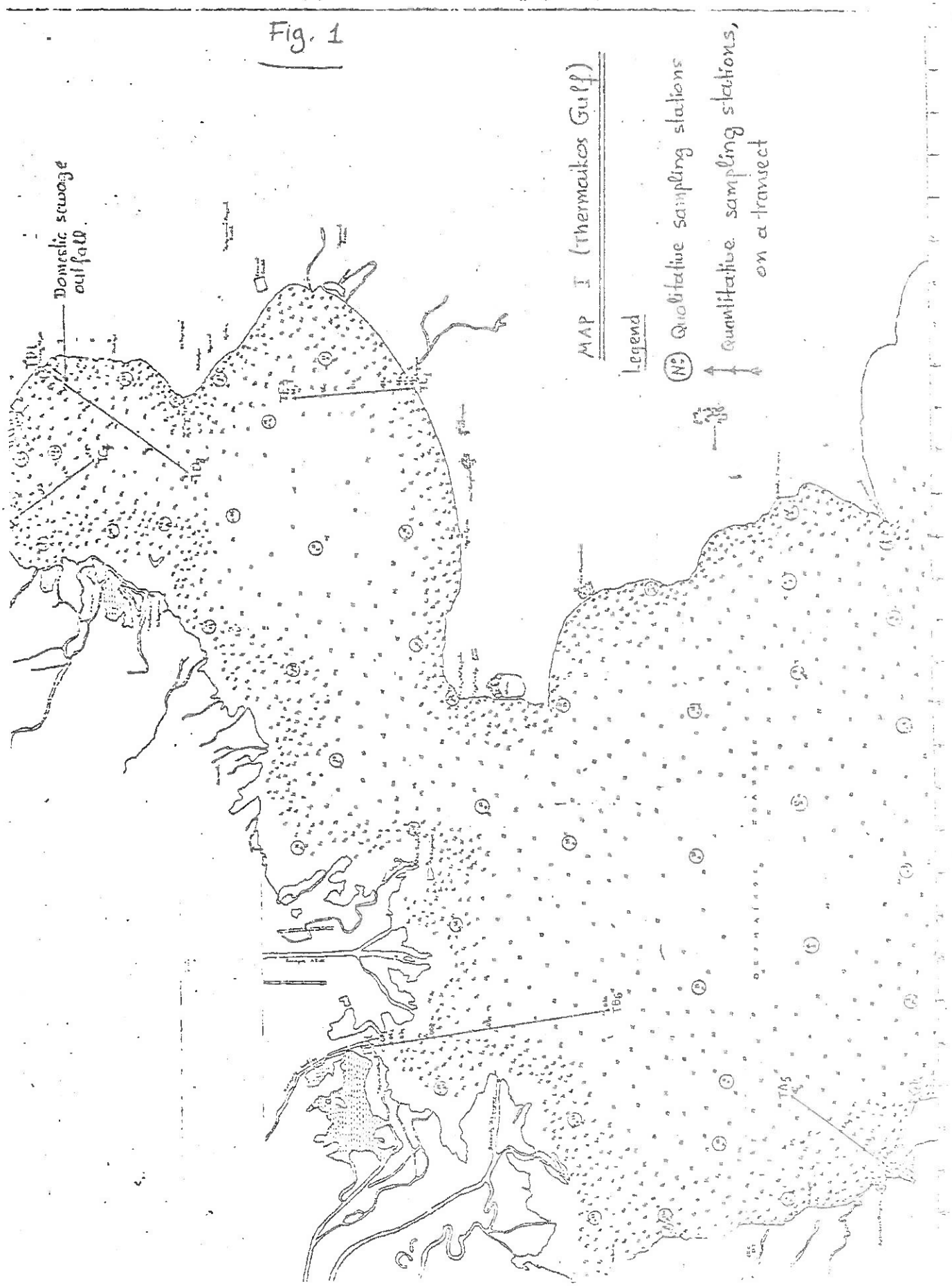
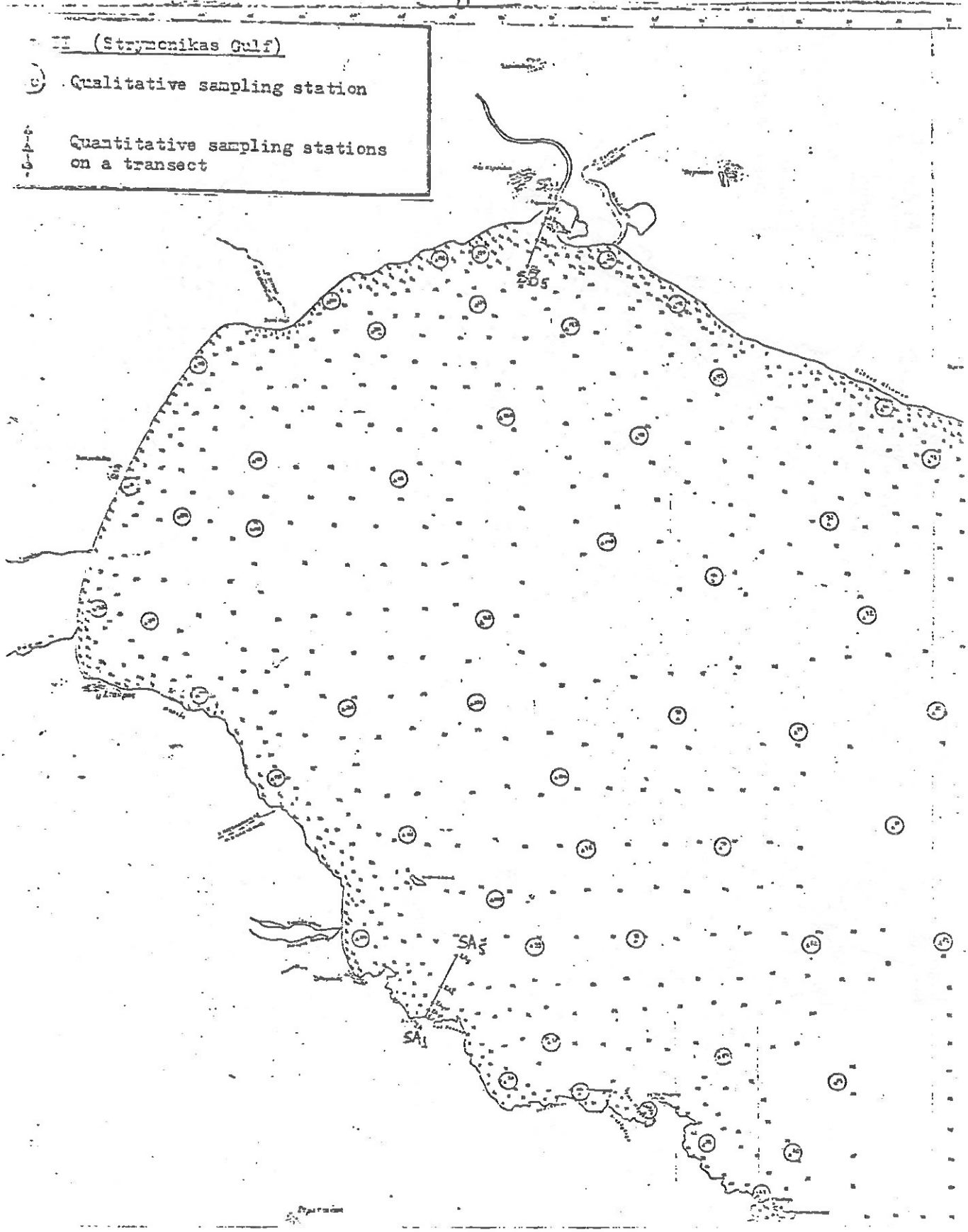

MAP I (Thermaikos Gulf)
Legend
(№) Qualitative sampling stations
Quantitative sampling stations, on a transect
Domestic sewage outfall
TB1
TB2
TB3
TB4
TB5
TB6

Fig. 2


II (Strymonikas Gulf)
Qualitative sampling station
Quantitative sampling stations on a transect
SA5
SA1

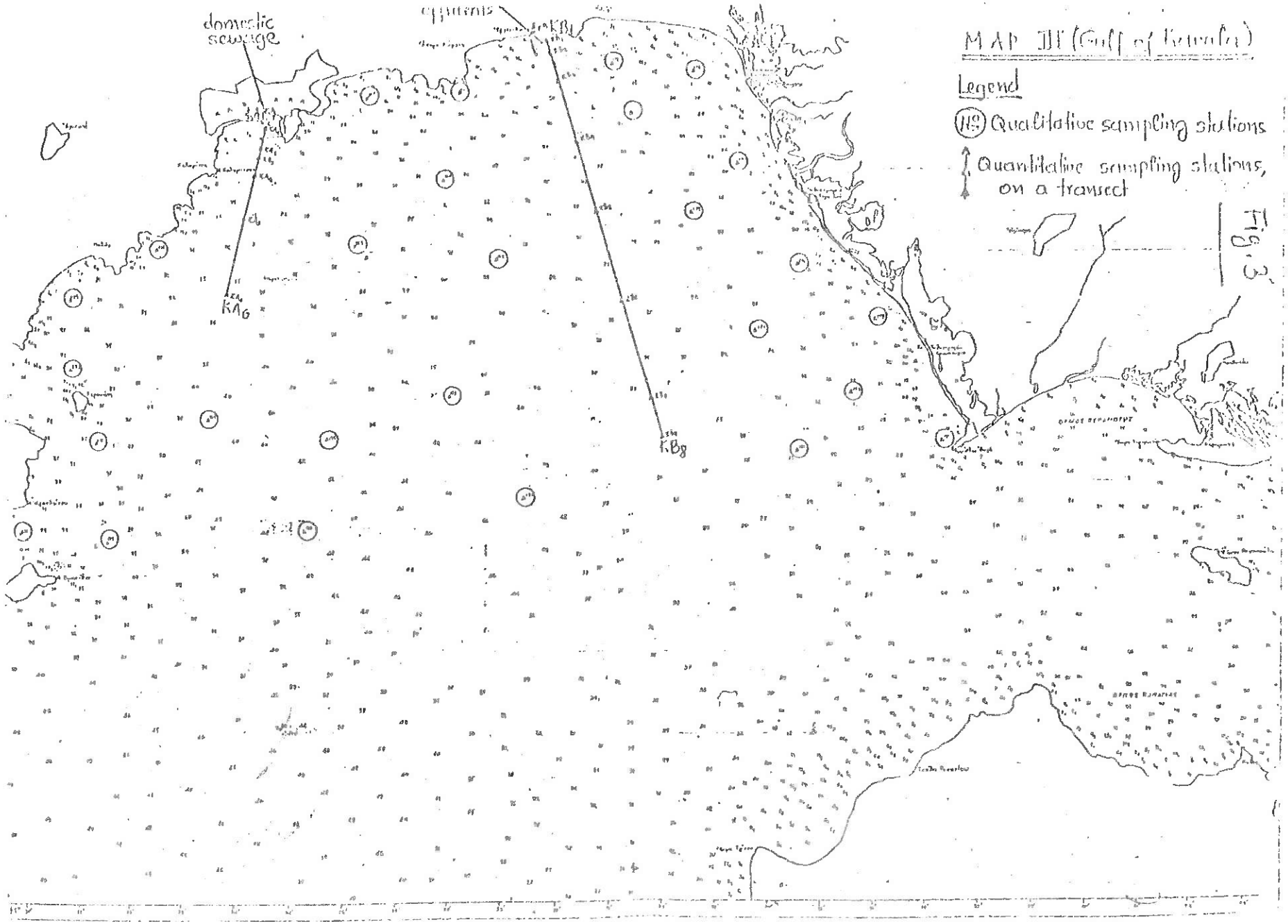

domestic sewage
effluents
KA6
KB8
MAP III (Gulf of Kavaratti)
Legend
Qualitative sampling stations
Quantitative sampling stations, on a transect
Fig. 3

Table 1 Showing the fluctuation of the values of the measured parameters and the characteristics of the fauna

Physical and Chemical Parameters	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.KD1) 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)

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 amphispermes	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

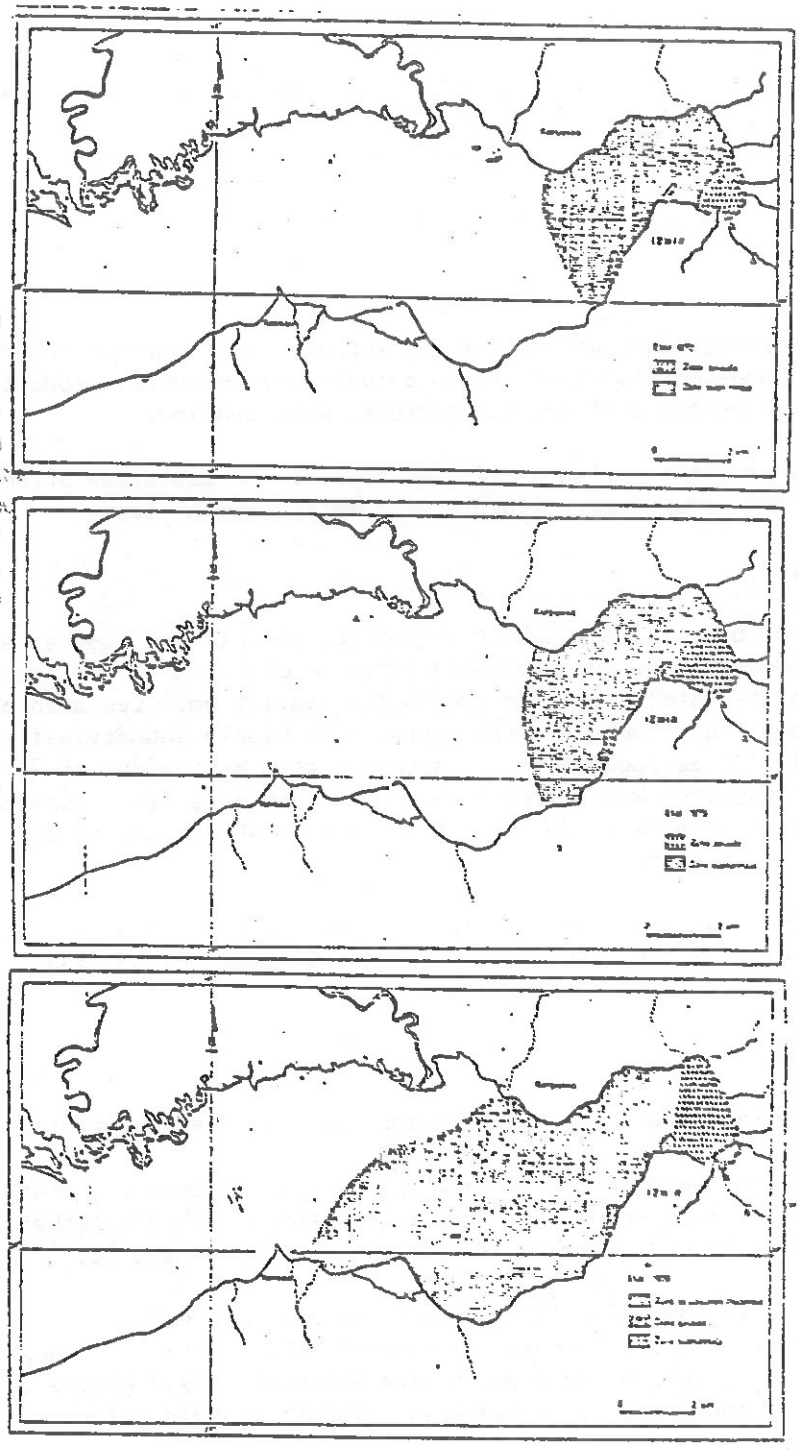


Fig. 1 Evolution des zones polluées du golfe d'Izmir de 1971 à nos jours.

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) ichthyo-benthos: 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 E[1]	Kaštela bay	Kaštela 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

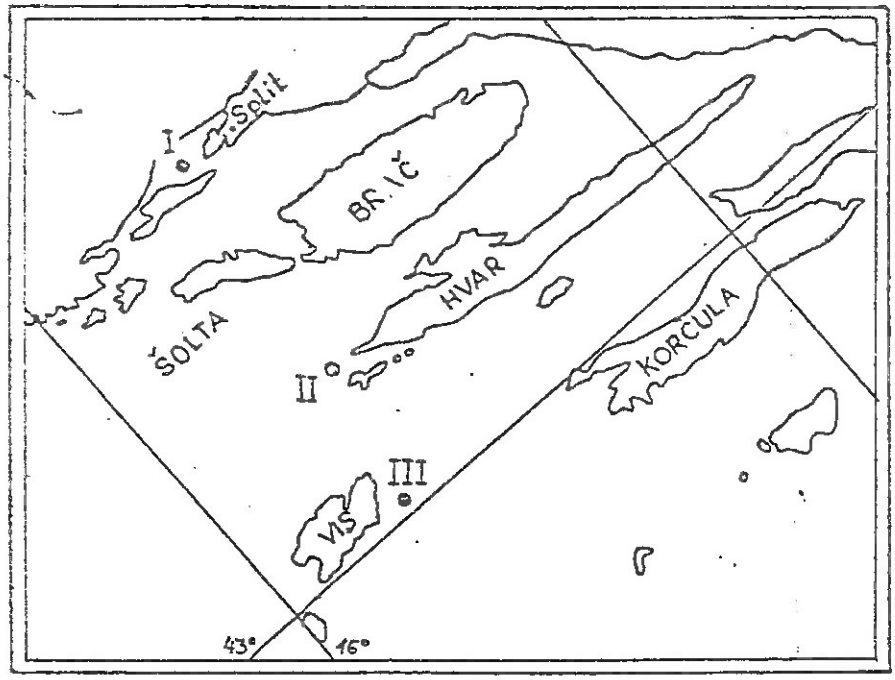


Fig. 1. Investigated central Adriatic region

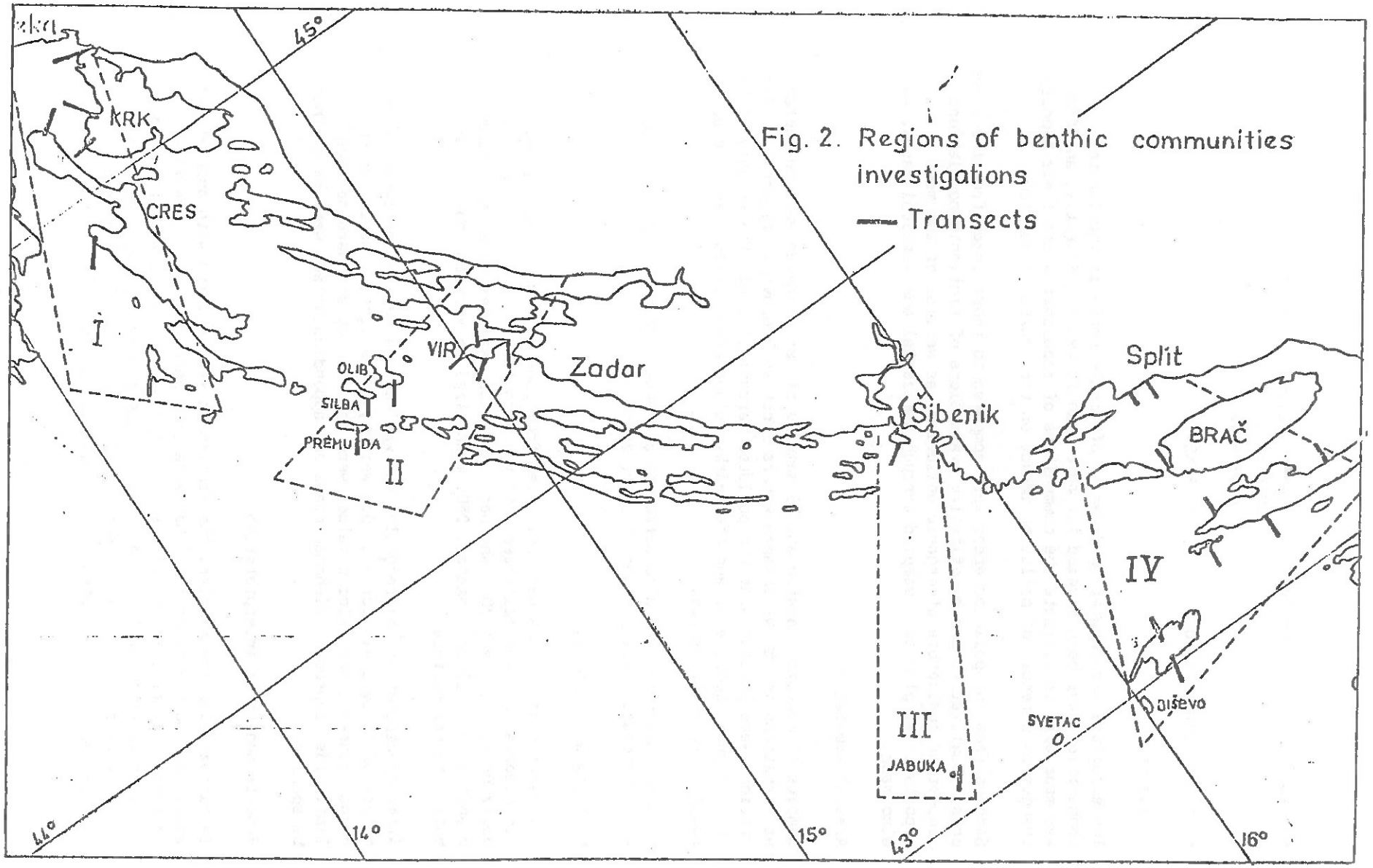


Fig. 2. Regions of benthic communities investigations

— 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.

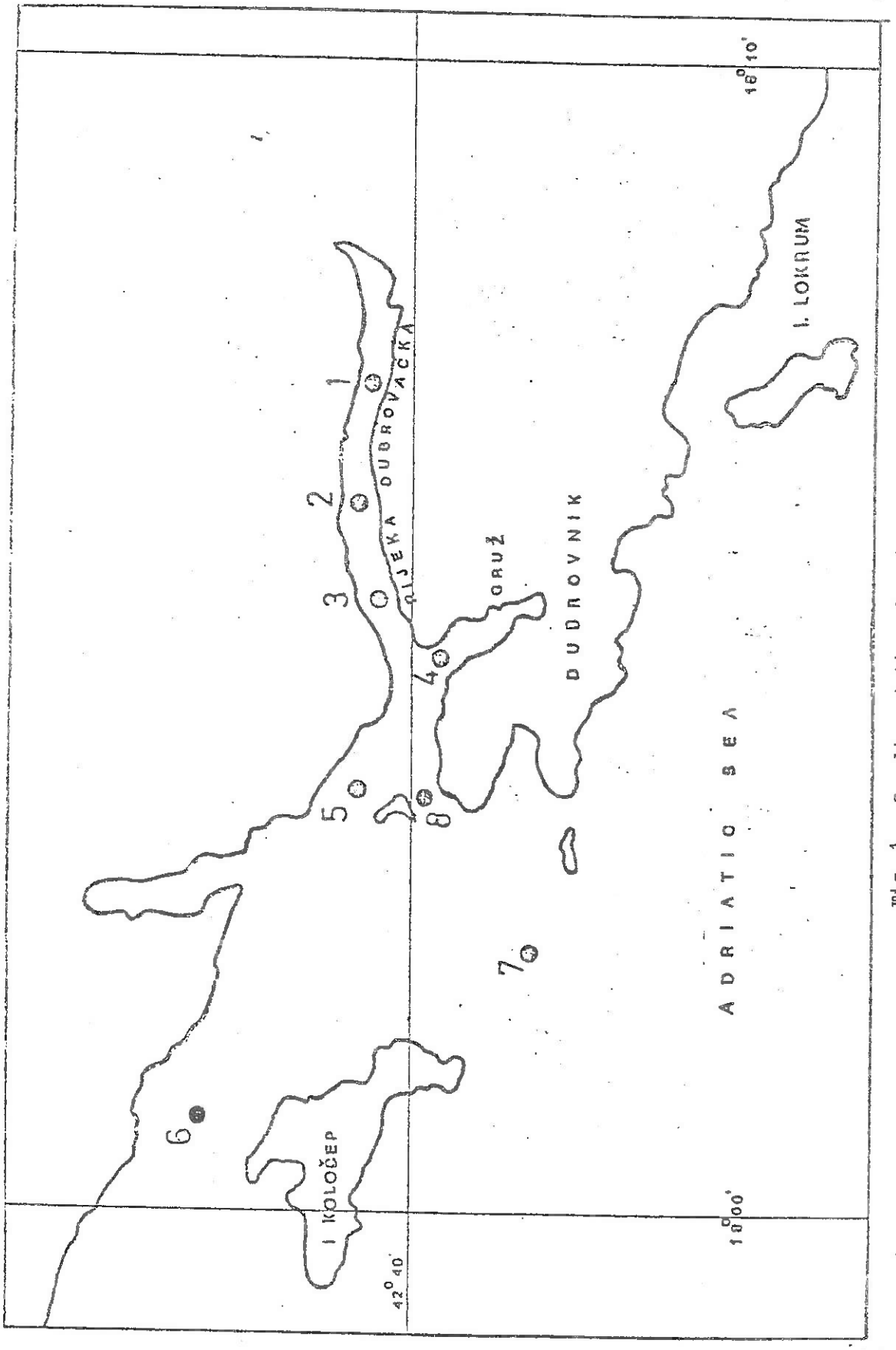


Fig. 1 - Sampling stations in Dubrovnik area

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 oozy 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 x 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.

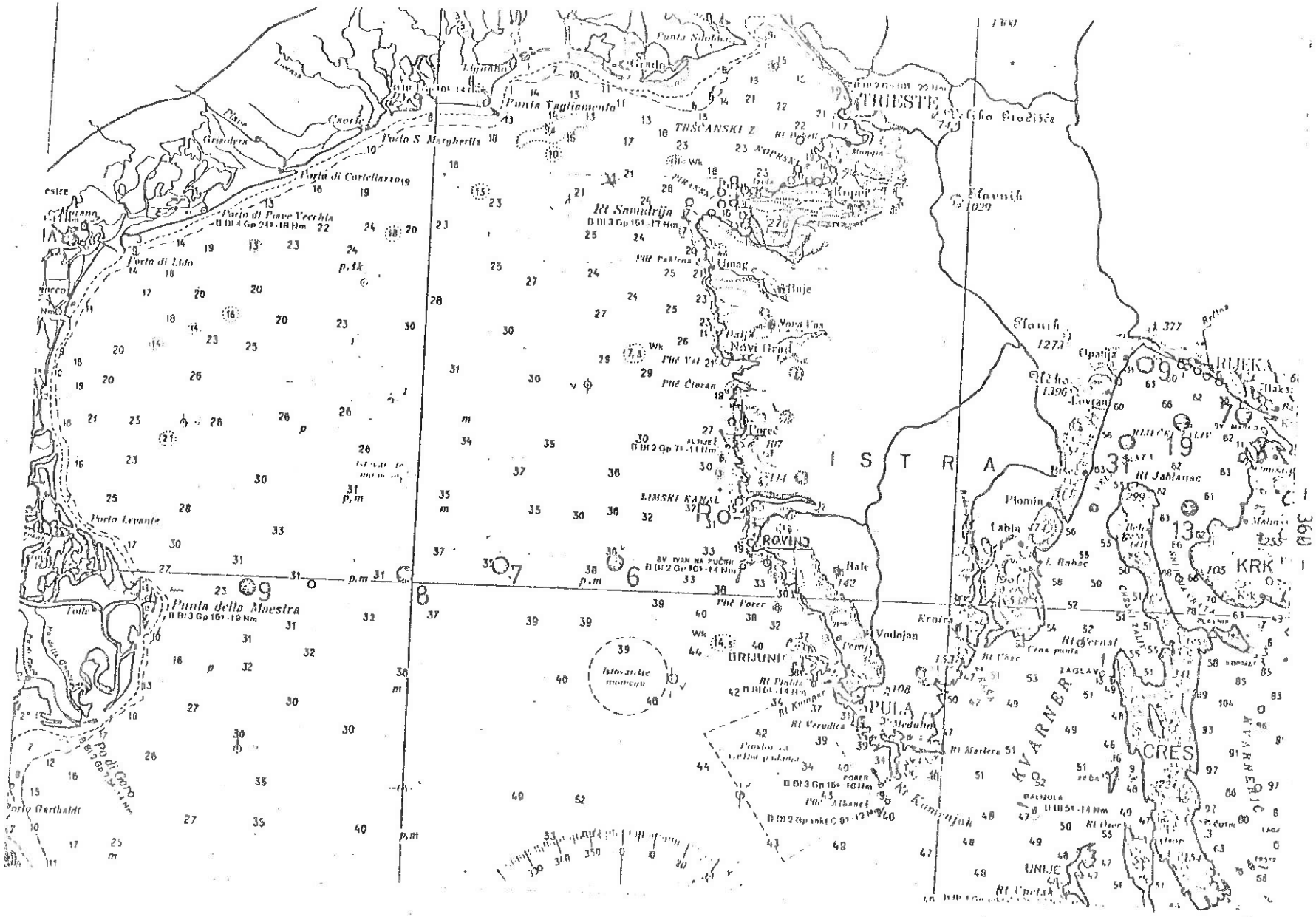


Fig. 1 Map of investigation area with sampling stations

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.

C – pipeline
IZ – outlet
M – movable sampling bridge
R – polyester tank for primary treated sewage
T – sewage transport from the city of Piran
U – pipe simulating natural water exchange
V – flowmeter

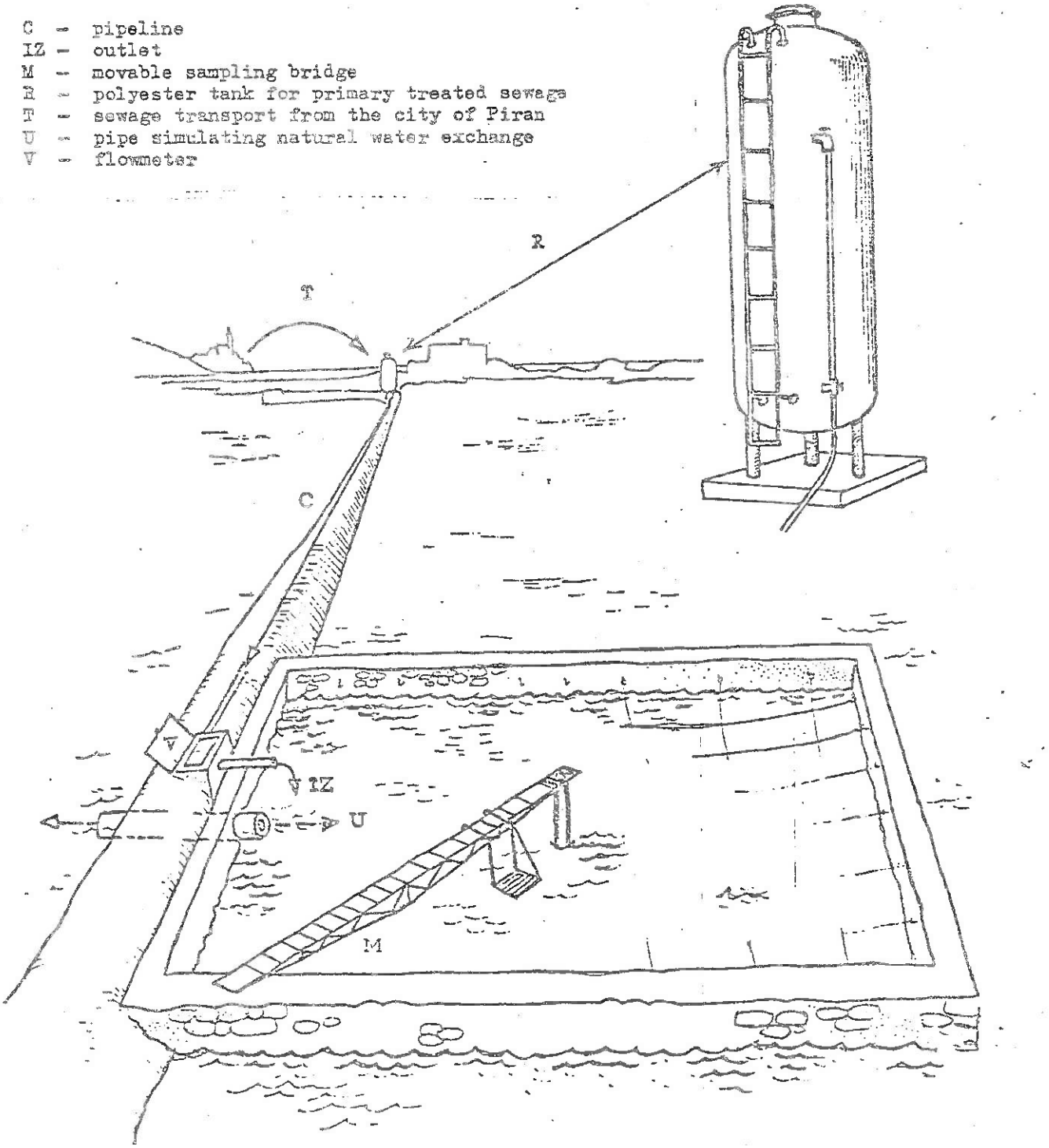


Fig. 1 Schematic presentation of installations for artificially polluting the lagoonary ecosystem in Strunjan, Yugoslavia

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.

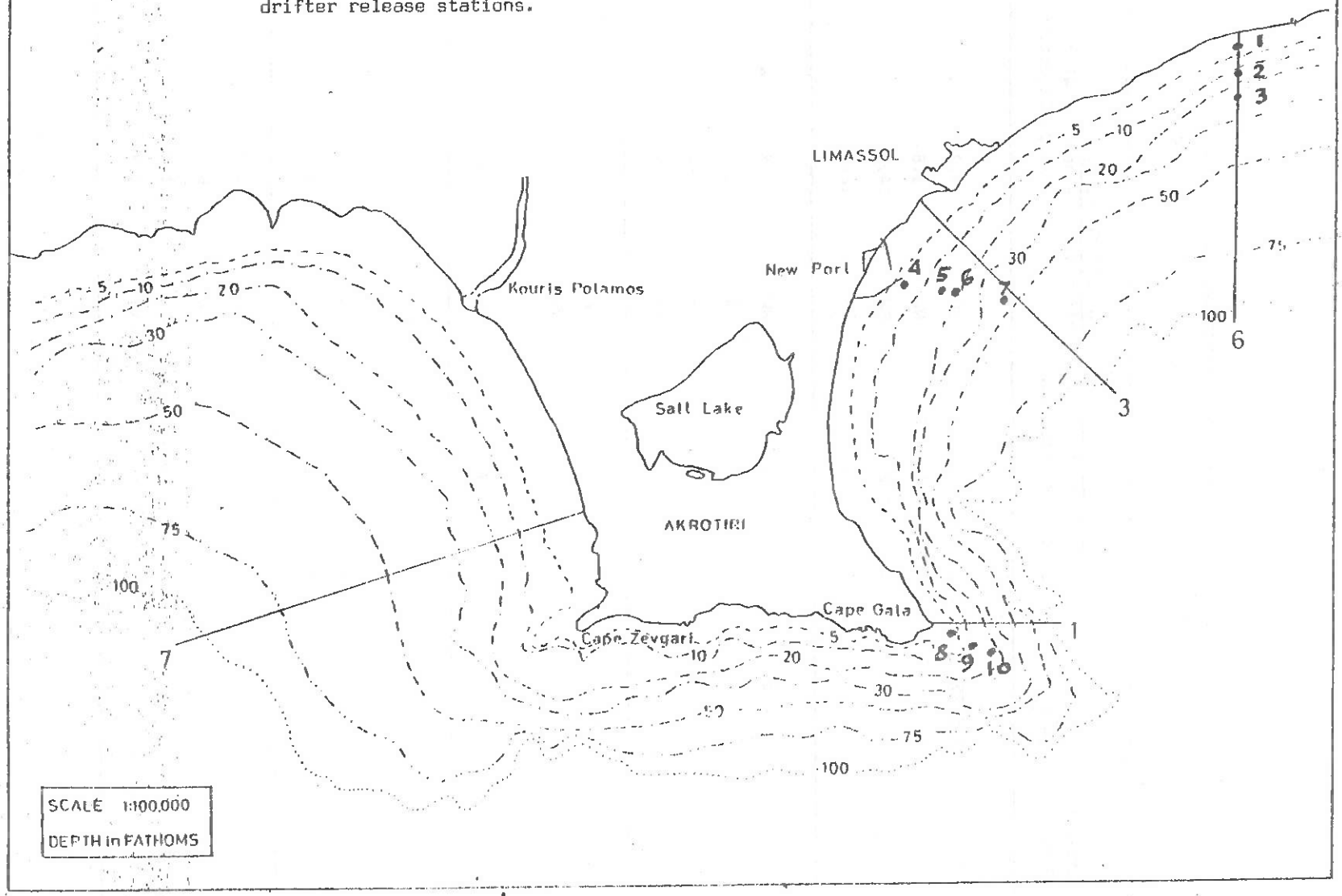


Table: I

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	28/6/75	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	Remerks
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	5 Dec. 77	Amathus 36 fms	8	Fished out (Trawler)
	350	5 Dec. 77	L/ssol harbour 35 fms	8	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.

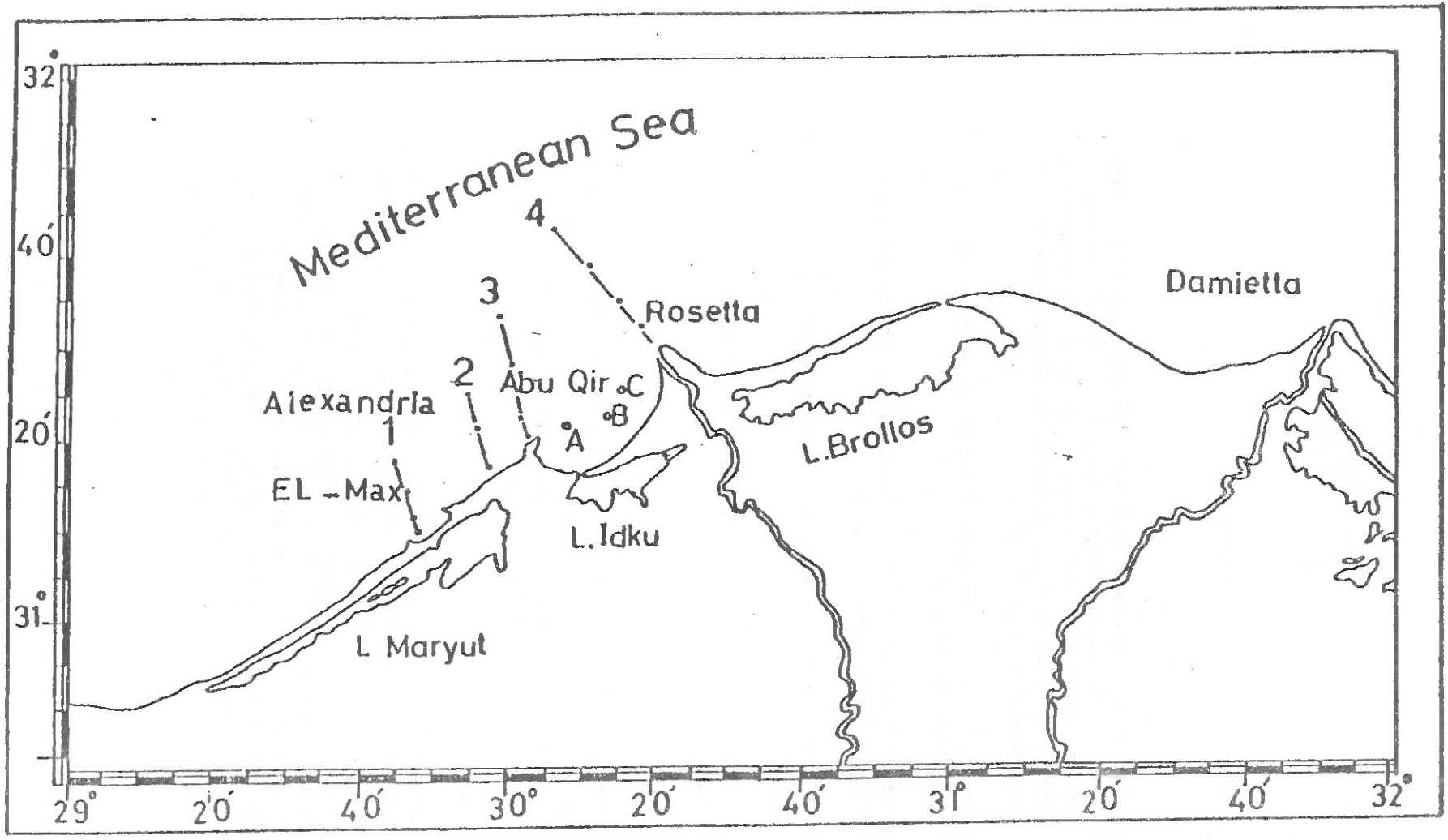
Taking the later data (a further 1842 drifters released) the percentage recovery overall was about 20 per cent.

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.



• Hydrographic stations ° Mooring Sites for current measurements

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 data (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.

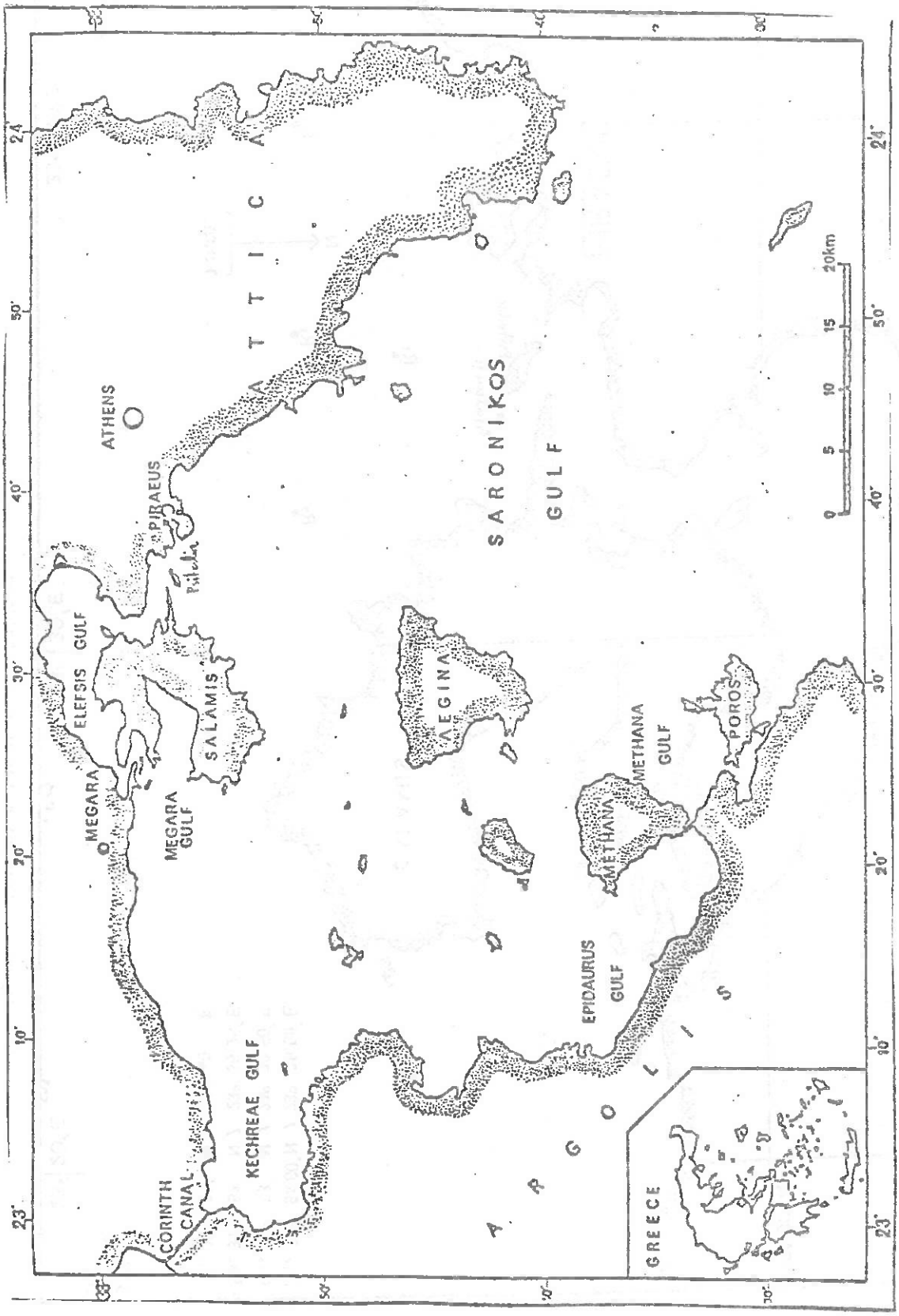


Figure 1. Saronikos Gulf system location and place names.

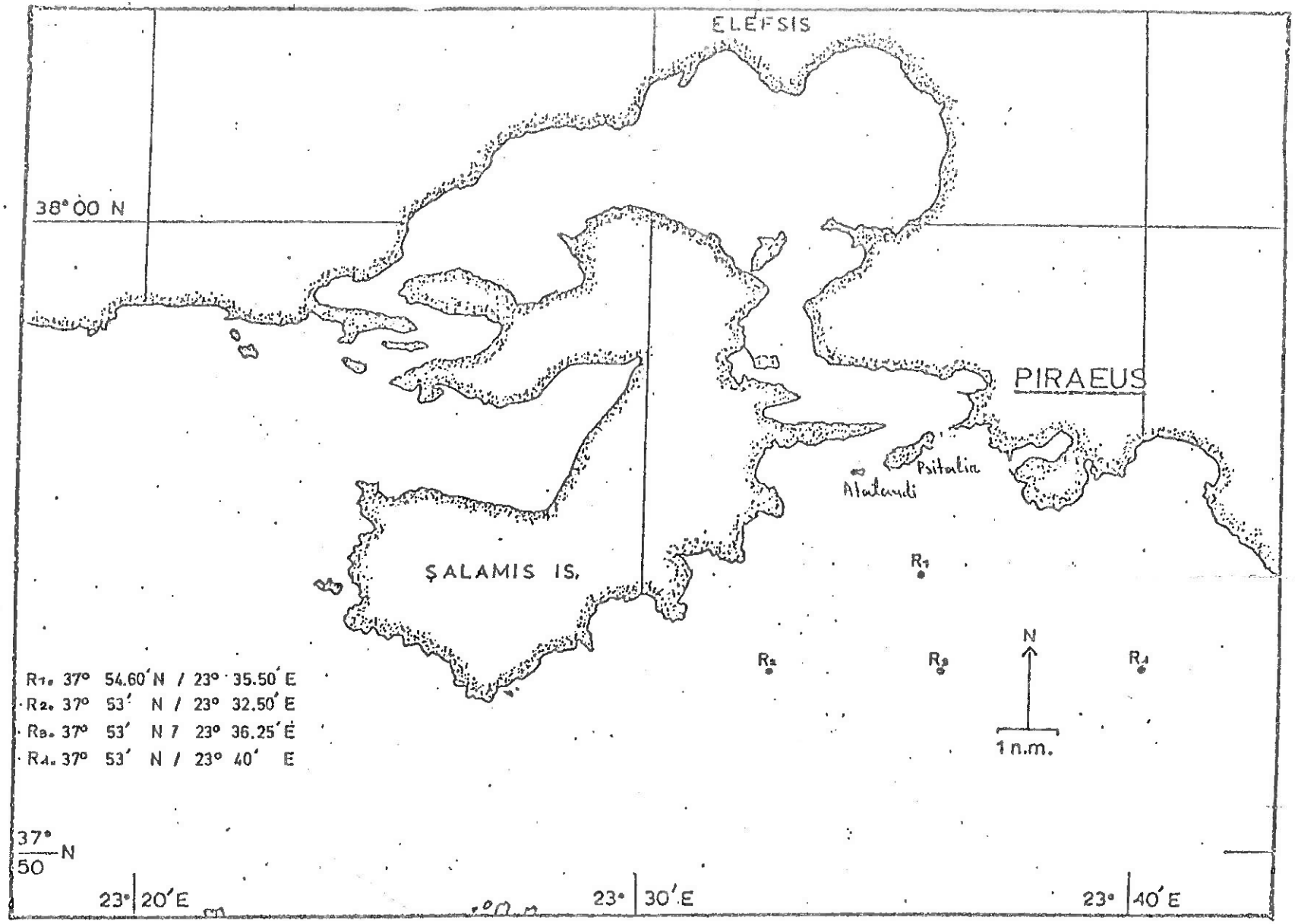


Figure 2. Current-meter mooring stations.

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.

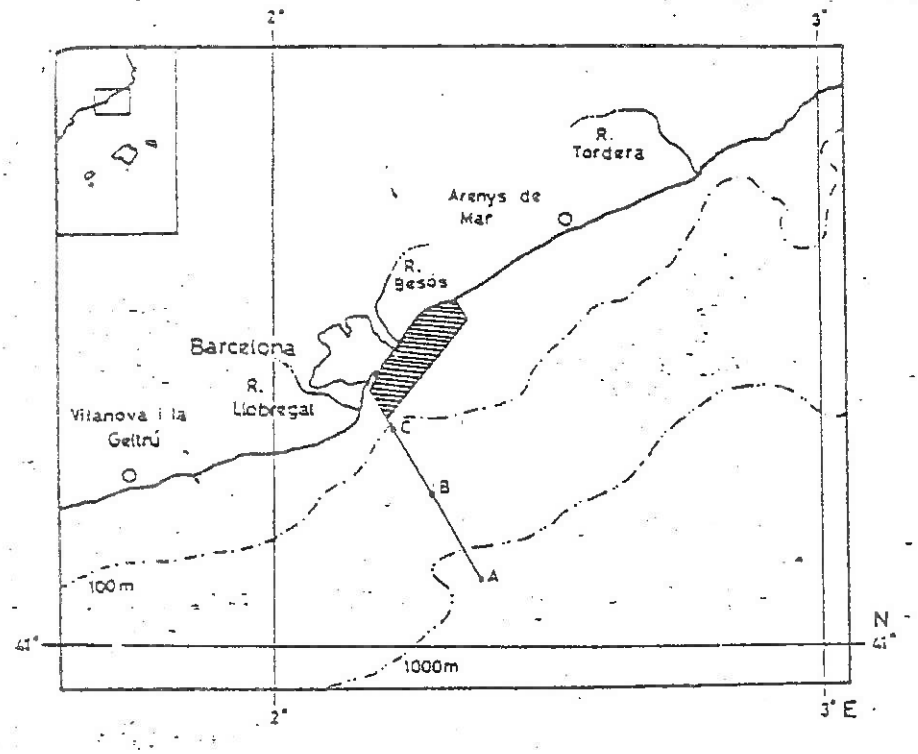

2°
3°
R.
Tordera
Arenys de
Mar
R.
Besós
Barcelona
R.
Llobregat
Vilanova i la
Geltrú
C
B
A
100 m
1000m
41°
N
41°
2°
3° E

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 area 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	Compass	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	Direction Compass	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	Direction Compass	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

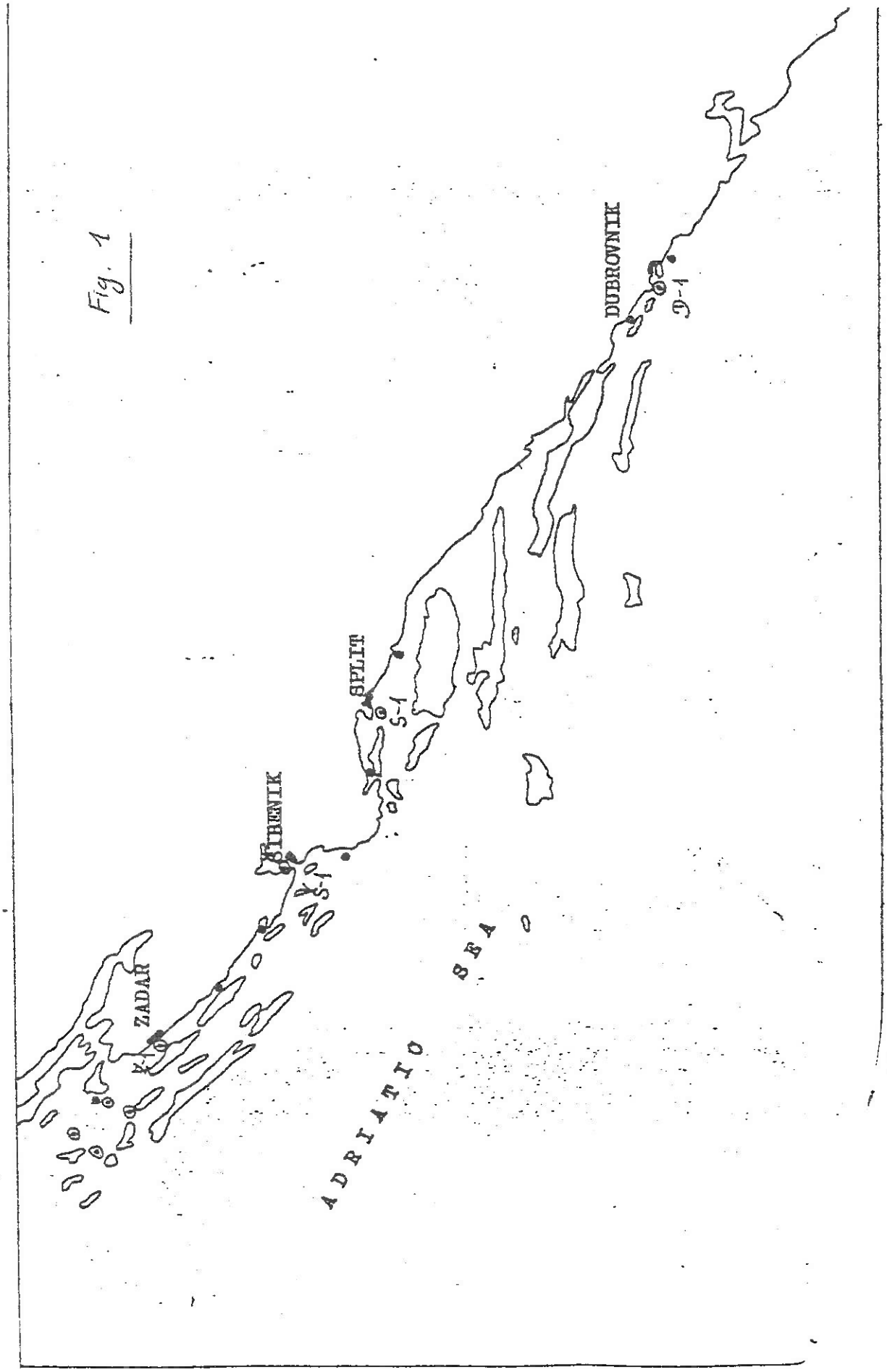
Table IV. The main characteristics of the currents in four areas in July 1977.

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.

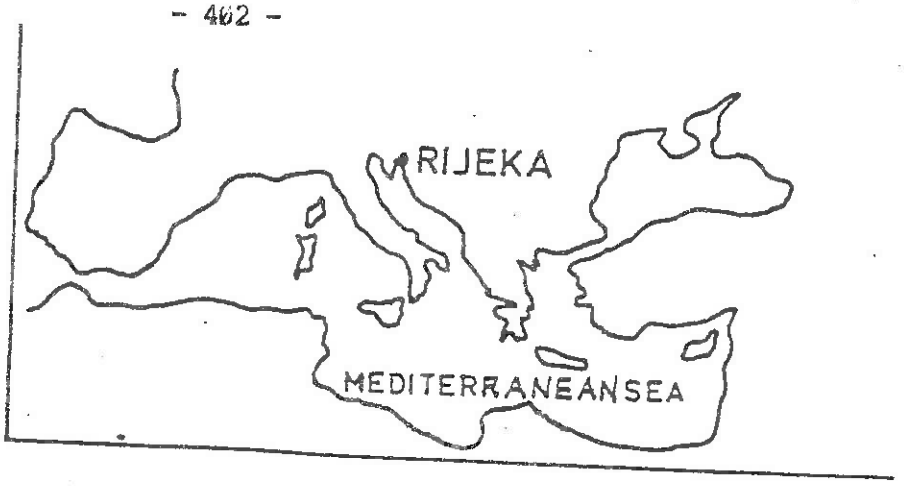
List of publications:

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
MEDITERRANEANSEA

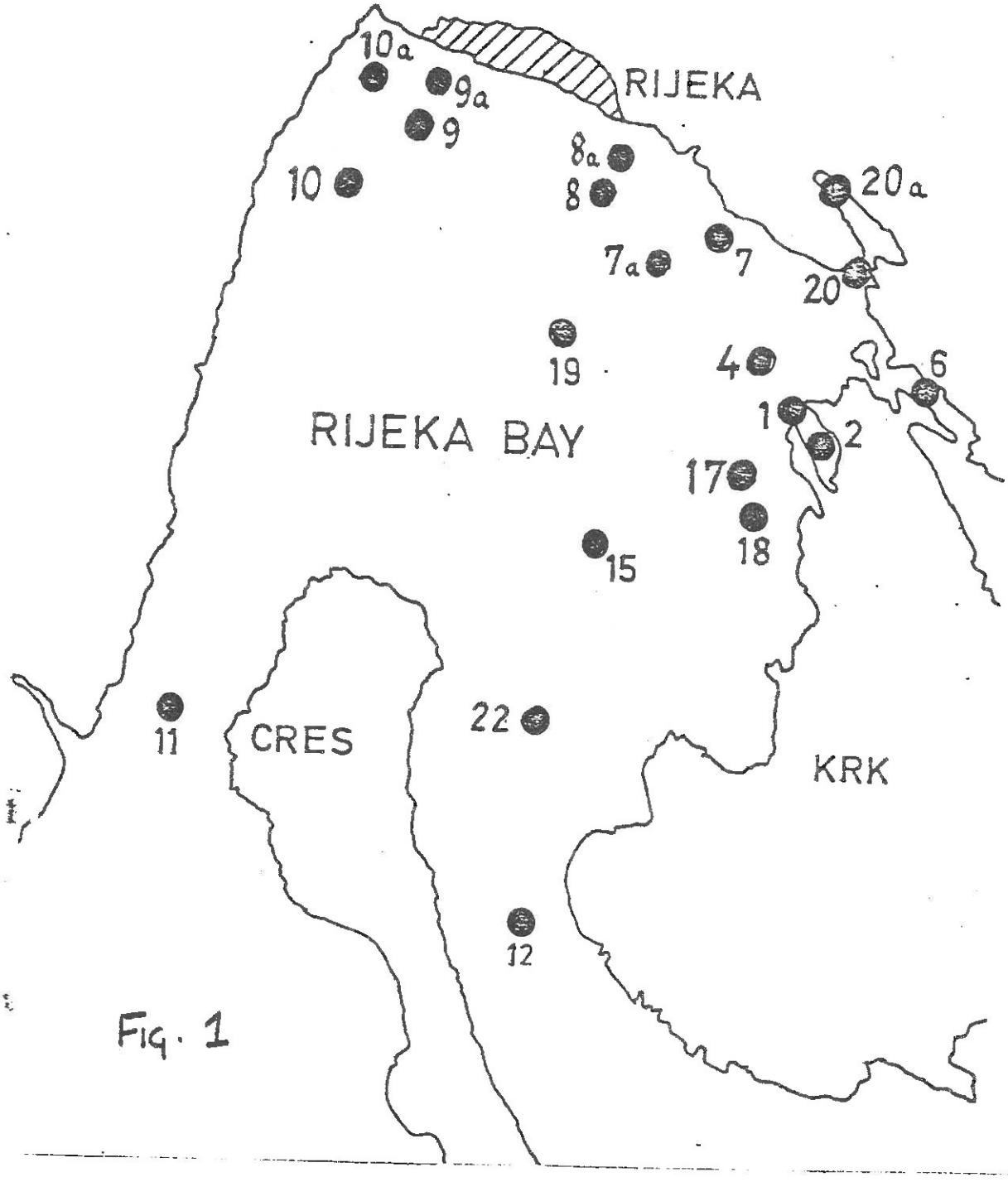
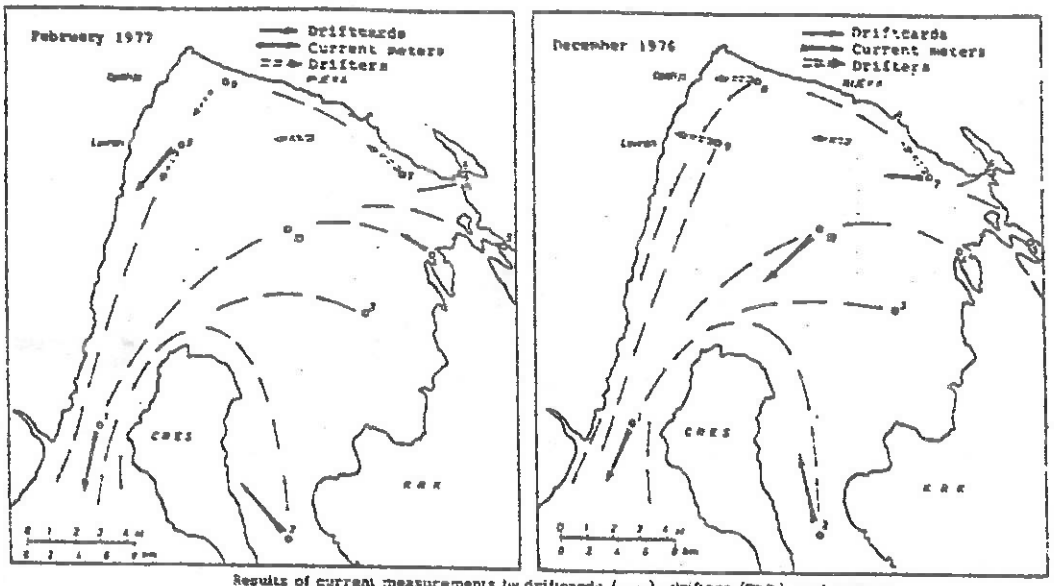
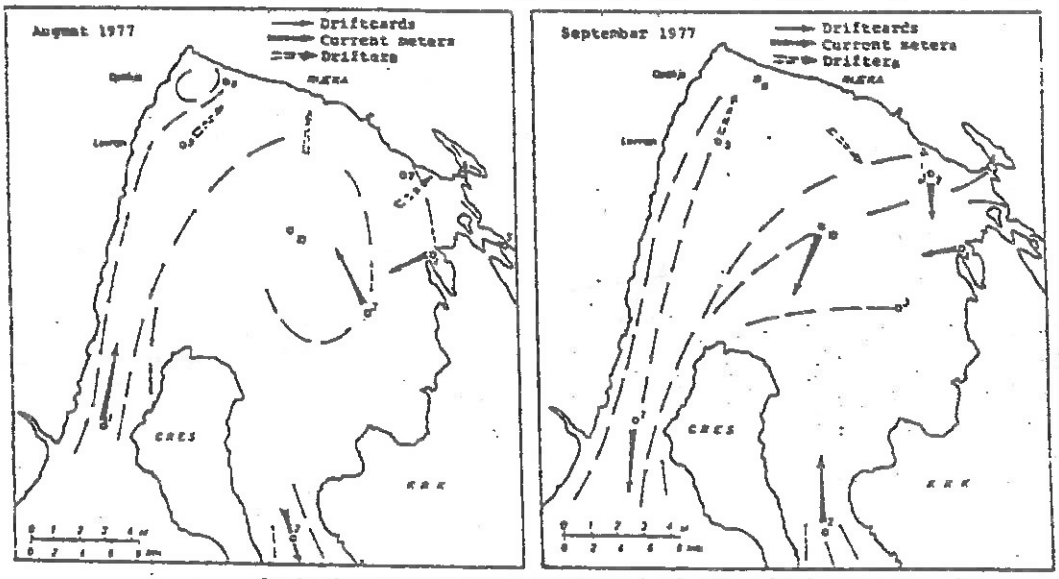

10a
9a
9
10
8a
8
7a
7
20a
20
19
4
6
1
2
RIJEKA
RIJEKA BAY
17
18
15
11
CRES
22
KRK
12

Fig. 1



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.



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