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Barcelona, 11 - 13 February 1980

SUMMARY REPORTS ON THE SCIENTIFIC RESULTS OF MED POL

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

PART III

RAPPORTS RESUMES DES RESULTATS SCIENTIFIQUES DU MED POL

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

PARTIE III

GE.80-1018

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INTRODUCTION

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

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

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

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

INTRODUCTION

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

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

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

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

MED POL VII : COASTAL WATER QUALITY CONTROL (WHO/UNEP)

MED POL VII : CONTROLE DE LA QUALITE DES EAUX COTIERES (OMS/PNUE)

Centre de Recherche Participant : Centre d'Etudes et de Recherches de Biologie et d'Oceanographie Medicale
C.E.R.B.O.M.
NICE
France

Chercheur Principal; A. FRUCHART

Introduction:

Dans le cadre du projet MED POL VII (PNUE), le Centre d'Etudes et de Recherches de Biologie et d'Océanographie Médicale (C.E.R.B.O.M.) effectue une étude bactériologique des eaux de baignade de la ville de Nice, dans la Baie des Anges.

Cette étude comprend:

1) Des analyses bactériologiques des eaux de baignade :

   - Streptocoques fécaux
   - Coliformes fécaux
   - Coliformes totaux

2) Des analyses physico-chimiques des eaux de baignade :

   - Salinité
   - Température
   - Oxygène dissous

3) Des analyses hydrologiques et météorologiques :

   - Courantologie de la zone
   - Vent (force et direction)
   - Température de l'air
   - Nébulosité du ciel

4) L'observation de la plage afin de recherche d'éventuels polluants liés aux macro-déchets et aux hydrocarbures.

Zone(s) étudiée(s):

Trente prélèvements ont été effectués simultanément dans la zone d'étude. Les stations sont reportées sur le schéma no.1 suivante et sont numérotées de 1 à 30.

Matériel et méthodes:

L'étude de la courantométrie conditionne l'étude de la pollution car elle permet d'étudier le devenir des eaux rejetées par les fleuves côtiers et les collecteurs d'égout.

Etude des courants de la Baie des Anges:

Cette étude ayant été faite partiellement par Romanovsky, nous pouvons résumer les principales données de ce travail publié en 1951.

A ces données nous ajouterons certaines précisions obtenues par nos propres observateurs faites, soit au courantomètre à flotteur soit par l'étude des courbes thermiques, soit par la recherche de la salinité.

En résumé, il existe deux situations générales de circulation des eaux marines dans la Baie de Nice :

- d'une part, par beau temps, un tracé N.E.-S.O. qui s'infléchit pour suivre parallèlement le littoral de la Baie de Nice, les filets du large gardant une direction plus rectiligne.

- d'autre part, une deuxième situation est créée par les vents de secteur Ouest. Si les courants du large conservant à peu près une direction analogue mais plus ralentie, les courants de terre prennent un aspect tourbillonnaire formant près du rivage un contre-courant, c'est-à-dire en direction S.O.-N.E., partant de l'estuaire du Var, longeant la plage de Nice jusqu'à l'entrée de Villefranche o ils se dirigent vers le Sud formant ainsi une zone tourbillonnaire. Ce contre-courant aurait d'après les mesures faites, de 15 à 23 cm/sec.

Une double situation courantométrique se trouve créée : une, liée aux vents d'Est, l'autre aux vents d'Ouest.

1) CAMPAGNE DU 12 JUILLET 1978 ENTRE 9 ET 10 HEURES :

- Météorologie :

  . Etat du ciel : clair à peu nuageux
  . Vent : direction S.W. (force 1)
  . Température de l'air : 22°C

- Etat visuel de la plage :

  . Propre dans l'ensemble
  . Absence de goudrons sur les galets
  . Absence de macro-déchets à la surface de l'eau et sur les galets.

2) CAMPAGNE DU 10 AOUT 1978 ENTRE 9 ET 10 HEURES :

- Météorologie :

  . Etat du ciel : clair à peu nuageux
  . Vent : Direction S.W. (force 1)
  . Température de l'air : 24°C

- Etat visuel de la plage :

  . Propre dans l'ensemble
  . Absence d'hydrocarbures sur les galets
  . Absence de macro-déchets à la surface de l'eau et sur les galets,

3) CAMPAGNE DU 6 SEPTEMBRE 1978 ENTRE 9 ET 10H30 :

- Météorologie :

  . Etat du ciel : clair
  . Vent : Nul
  . Température de l'air : 22.1°C

- Etat visuel de la plage :

  . Traces d'hydrocarbures sur les galets
  . Traces d'hydrocarbures dans l'eau de baignade
  . Présence de macro-déchets dans l'eau de baignade.

4) CAMPAGNE DU 4 DECEMBRE 1978 ENTRE 9 ET 10 HEURES :

- Météorologie :

  . Etat du ciel à clair à peu nuageux
  . Vent : nul
  . Température de l'air : 12°C

- Etat visuel de la plage :

  . Propre dans l'ensemble
  . Absence de macro-déchets dans l'eau de baignade et sur les galets
  . Absence d'hydrocarbures dans l'eau de baignade et sur les galets.

Résultats et leur interprétation :

Les résultats des analyses bactériologiques sont les suivants :

1) Le taux des Streptocoques fécaux est élevé.

Les concentrations les plus importantes sont observées au mois de décembre:

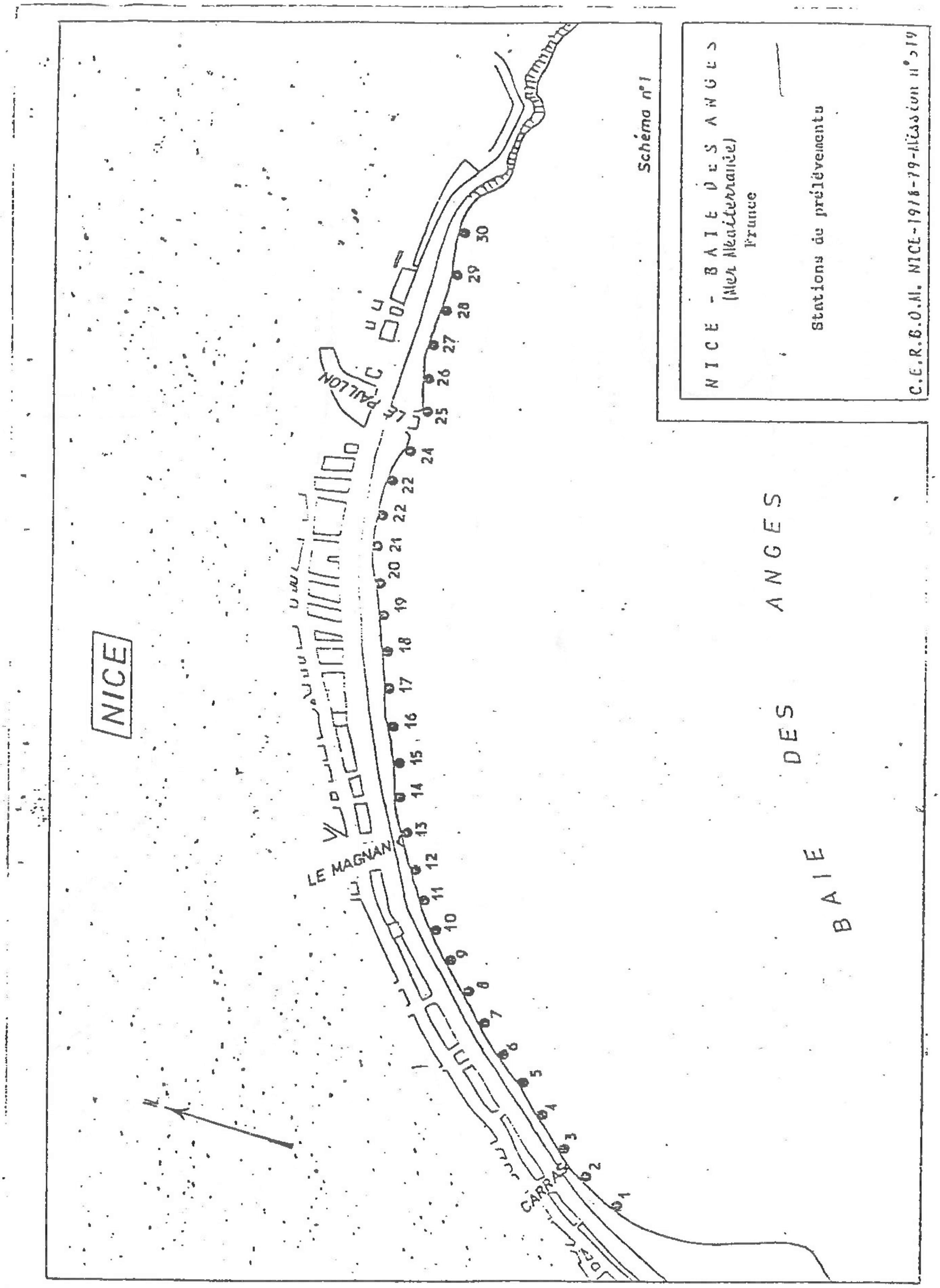
- période d'ensoleillement réduite
- apport de matériaux par les fleuves côtiers durant la saison des pluies, et déversoirs débouchant en mer.

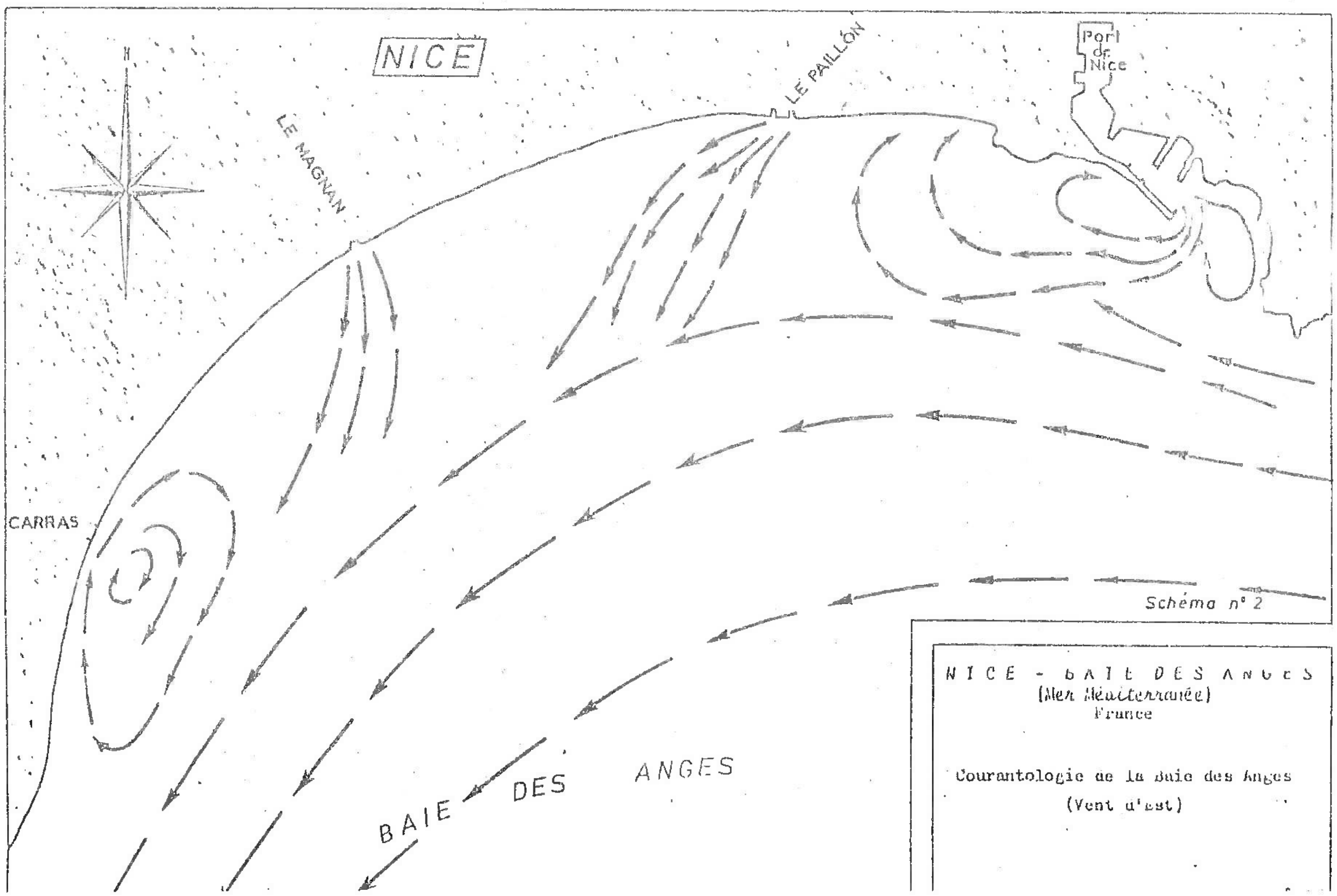
2) Dans l'ensemble les Coliformes fécaux sont les moins répandus.

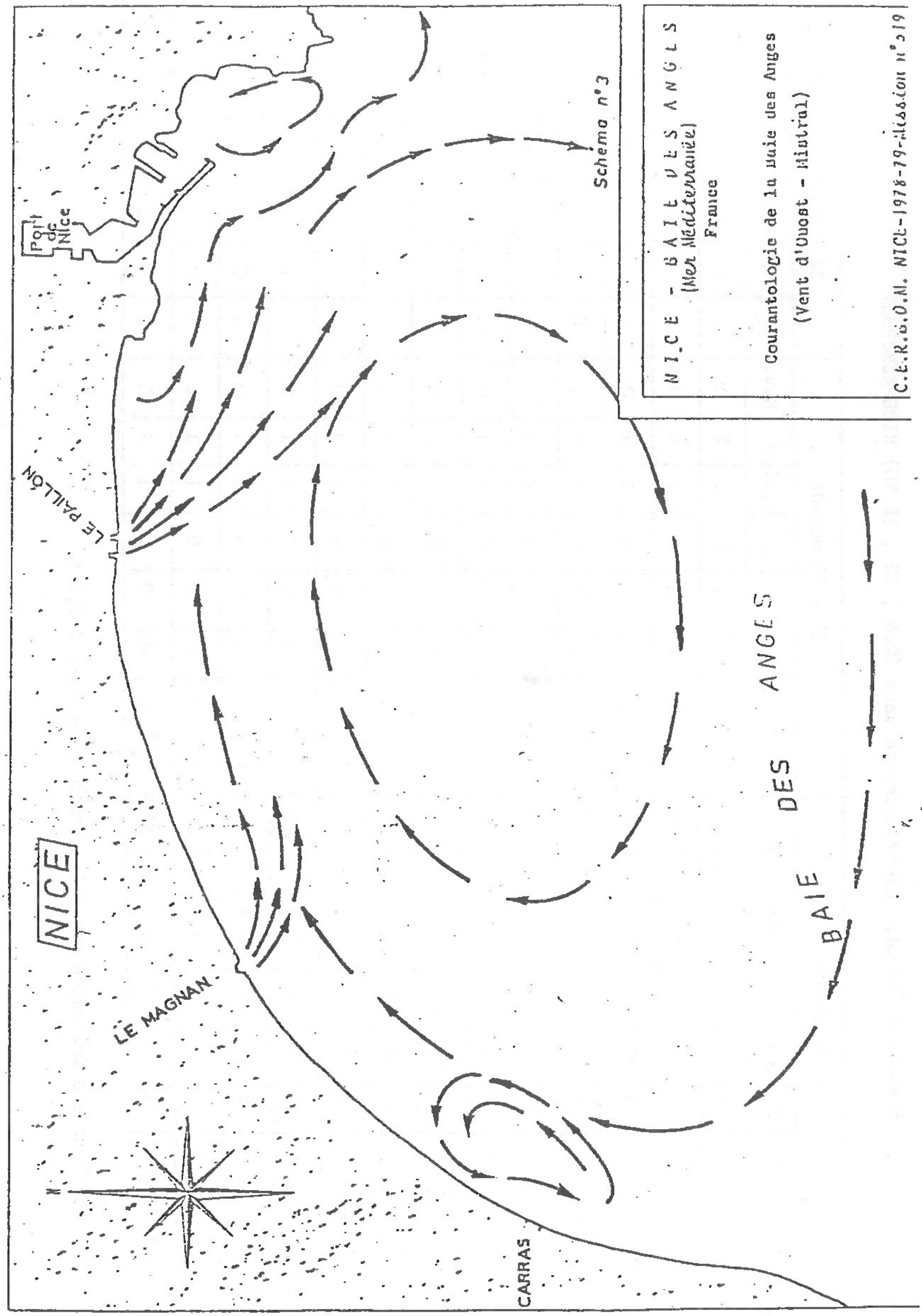
Les taux les plus élevés se rencontrent au mois d'Août :

- période de forte densité de population estivale.

3) Les Coliformes totaux suivent la même évolution dans le temps que les Coliformes fécaux avec une forte concentration au mois d'Août.


NICE - BAIE DES ANGES
(Mer Méditerranée)
France
Stations de prélèvements
C.E.R.B.O.M. NICE-1978-79-Mission n°519
Schéma n°1
NICE
LE PAILLON
LE MAGNAN
BAIE DES ANGES


NICE
LE MAGNAN
LE PAILLON
Port de Nice
CARRAS
BAIE DES ANGES
Schéma n° 2
NICE - BAIE DES ANGES
(Mer Méditerranée)
France
Courantologie de la Baie des Anges
(Vent d'est)


NICE - BAIE DES ANGES
(Mer Méditerranée)
France
Courantologie de la Baie des Anges
(Vent d'Ouest - Mistral)
C.E.R.B.O.M. NICE-1978-79-Mission n°319
Schema n°3
Port de Nice
LE PAILLON
NICE
LE MAGNAN
CARRAS
BAIE DES ANGES

Fréquence (%) des observations de vent (0,6 , 12 , 18 TU) NICE-AEROPORT

MOIS	CALME	1 à 14 noeuds								15 à 31 noeuds								32 noeuds et au-dessus							
		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
Janvier	13	12	4	4	1	2	2	11	43	1	1	3	0	0	0	2	0	.	0	0	0	.	.	.	.
Février	17	12	7	8	4	5	5	6	24	0	2	3	1	0	2	4	0	.	.	0	.	.	0	0	0
Mars	16	10	5	13	6	9	7	6	18	1	1	6	1	0	1	1	0	.	.	0	0	.	.	.	.
Avril	14	6	6	16	6	9	7	5	20	0	1	6	0	0	2	2	.	0	0	0	.	.	.	0	0
Mai	17	6	5	15	7	11	8	4	18	0	2	4	0	1	2	0	.	.	0	0	.	.	.	.	.
Juin	18	6	3	17	12	12	6	3	18	.	0	2	0	0	2	1	0	.	.	.	.	.	0	.	.
Juillet	15	7	3	16	12	12	9	4	18	0	0	2	0	0	1	1	0	.	.	.	.	.	.	0	.
Août	16	5	2	13	12	11	7	5	23	.	0	2	0	0	2	2	0	.	.	.	.	.	0	0	.
Septembre	16	5	4	14	9	10	6	6	23	0	1	3	0	0	1	2	0	.	.	.	.	.	.	.	.
Octobre	17	8	5	11	7	8	5	6	28	.	0	3	0	0	1	1	0	.	.	.	.	.	.	.	.
Novembre	16	11	4	6	1	4	5	7	40	0	1	3	0	0	1	1	0	.	0	0	.	.	0	0	.
Décembre	8	10	3	4	1	0	2	11	56	0	1	2	0	0	1	1	0	.	0	0	.	.	.	.	.
ANNEE	15	8	4	11	7	8	6	6	27	0	1	3	0	0	1	2	0	0	0	0	0	.	0	0	0

Nota : Le chiffre 0 indique une fréquence non nulle, mais inférieure à 0,5 %.

Juillet 1978

Stations	T°C Eau de mer	Salinité S ‰	Oxygène dissous %	Streptocoques fécaux/100 ml	Coliformes fécaux/100 ml	Coliformes totaux/100 ml
1	21,1	37,5	120	30	10	30
2	21,0	37,4	130	0	0	0
3	21,2	37,3	130	10	70	80
4	21,0	37,2	120	0	0	0
5	21,3	37,4	125	20	10	10
6	21,1	37,3	120	0	0	0
7	21,0	37,4	130	40	0	0
8	21,2	37,3	120	0	10	10
9	21,3	37,3	125	10	0	40
10	21,2	37,4	130	30	0	0
11	21,2	37,4	115	30	0	0
12	21,0	37,3	110	370	10	10
13	21,1	37,4	120	300	0	10
14	21,2	37,3	130	780	0	0
15	21,0	37,2	130	270	10	10
16	21,1	37,5	125	150	0	0
17	21,2	37,5	120	280	50	70
18	21,2	37,3	135	480	30	50
19	21,4	37,2	120	410	0	40
20	21,0	37,4	125	40	0	70
21	21,0	37,5	120	40	0	0
22	21,1	37,3	110	10	0	20
23	21,1	37,4	120	80	10	150
24	21,2	37,5	110	10	0	10
25	21,0	37,4	120	0	0	0
26	21,1	37,2	110	0	0	0
27	21,0	37,5	120	80	0	20
28	21,0	37,3	110	0	0	0
29	21,0	37,4	110	0	0	10
30	21,0	37,4	120	10	0	100

Août 1978

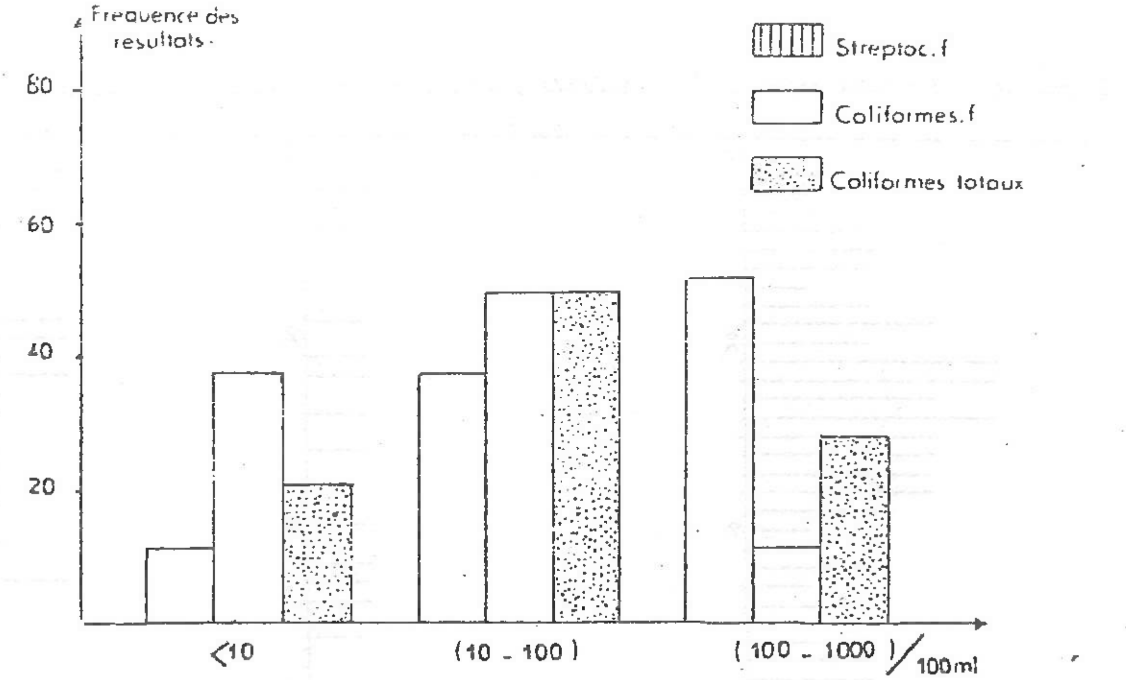
Stations	T°C Eau de mer	Salinité S ‰	Oxygène dissous %	Streptocoques fécaux/100 ml	Coliformes fécaux/100 ml	Coliformes totaux/100
1	24,0	37,0	100	0	0	0
2	24,1	37,2	95	0	10	20
3	23,9	37,3	100	10	20	30
4	23,8	37,1	90	30	10	50
5	23,7	37,0	100	40	40	50
6	24,0	37,4	105	40	90	140
7	24,0	37,6	100	30	100	140
8	24,1	37,8	90	40	20	60
9	23,8	37,3	85	0	20	50
10	23,8	37,1	90	90	100	130
11	23,9	37,1	90	0	30	110
12	24,0	37,0	100	20	20	40
13	24,0	37,0	105	10	40	70
14	24,1	37,2	10[illegible]	30	30	50
15	24,0	37,0	90	50	0	70
16	23,9	36,5	95	500	140	600
17	24,0	37,0	90	20	30	70
18	24,0	37,2	90	360	440	510
19	24,0	37,2	100	140	160	180
20	24,0	37,2	100	80	90	100
21	24,0	37,3	100	130	0	200
22	24,1	37,2	90	0	0	10
23	24,0	37,3	100	20	10	50
24	23,8	37,1	95	20	30	80
25	23,8	37,3	105	10	0	10
26	24,0	37,1	100	200	10	300
27	24,0	37,0	90	50	120	160
28	24,1	37,0	90	30	90	140
29	24,0	37,2	100	120	90	150
30	24,0	37,0	100	40	30	60

Septembre 1978

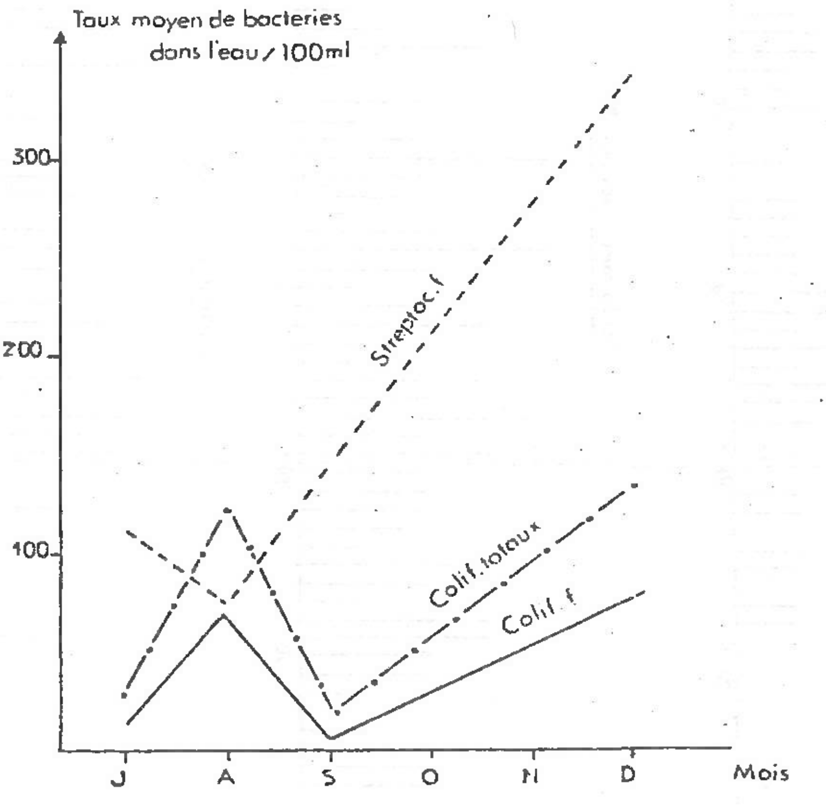
Stations	T°C Eau de mer	Salinité S ‰	Oxygène dissous %	Streptocoques fécaux/100 ml	Coliformes fécaux/100 ml	Coliformes totaux/100 ml
1	22,0	37,0	100	210	10	30
2	22,1	37,2	110	180	0	10
3	22,0	37,3	120	270	20	50
4	22,2	37,4	105	60	10	20
5	22,0	37,5	100	80	0	10
6	22,0	37,3	95	250	0	0
7	22,1	37,2	100	60	0	0
8	22,0	37,2	110	110	20	40
9	22,0	37,3	100	20	0	5
10	22,0	36,8	100	30	0	0
11	22,1	37,1	100	100	5	30
12	22,0	37,2	110	130	10	20
13	22,0	37,2	90	300	0	0
14	22,0	37,3	100	510	0	0
15	22,0	37,2	110	200	0	0
16	22,0	37,3	120	430	20	30
17	22,1	37,3	130	210	10	20
18	22,1	37,4	100	200	0	0
19	22,0	37,2	100	130	0	10
20	22,1	37,3	110	140	0	0
21	22,1	37,4	105	150	0	0
22	22,1	37,1	100	220	5	15
23	22,0	37,2	110	0	0	0
24	22,2	36,4	100	150	0	50
25	22,2	37,2	100	100	0	30
26	22,0	37,3	100	80	20	20
27	22,1	37,2	100	30	0	0
28	22,1	37,4	100	40	0	0
29	22,0	37,2	110	20	0	10
30	22,0	37,2	110	10	0	50

Décembre 1978

Stations	T°C Eau de mer	Salinité S‰	Oxygène dissous %	Streptocoques fécaux/100 ml	Coliformes fecaux/100 ml	Coliformes totaux/100
1	13,9	37,6	120	150	10	40
2	13,7	37,7	130	290	20	30
3	13,6	37,8	140	220	50	80
4	13,7	37,7	120	420	110	160
5	13,8	37,6	130	610	20	30
6	13,9	37,3	140	340	100	160
7	13,7	37,2	120	270	90	100
8	13,8	37,3	130	530	210	360
9	13,5	37,7	120	150	40	110
10	13,6	37,6	120	480	10	50
11	13,7	37,3	100	450	10	50
12	13,8	37,3	110	360	70	170
13	13,8	37,2	130	270	20	130
14	13,8	37,6	130	190	240	340
15	13,9	37,5	130	310	60	80
16	13,9	37,4	120	430	30	60
17	13,8	37,3	100	470	10	110
18	13,7	37,7	120	590	200	320
19	13,8	37,6	110	280	20	50
20	13,8	37,8	120	160	50	110
21	13,7	37,7	120	350	100	210
22	13,9	37,6	130	640	70	80
23	13,8	37,3	120	520	70	190
24	13,8	37,3	130	410	60	160
25	13,7	37,6	130	100	80	120
26	13,7	37,7	130	210	100	150
27	13,8	37,3	130	220	40	50
28	13,8	37,6	120	150	130	240
29	13,9	37,5	120	370	70	130
30	13,8	37,7	120	290	90	110

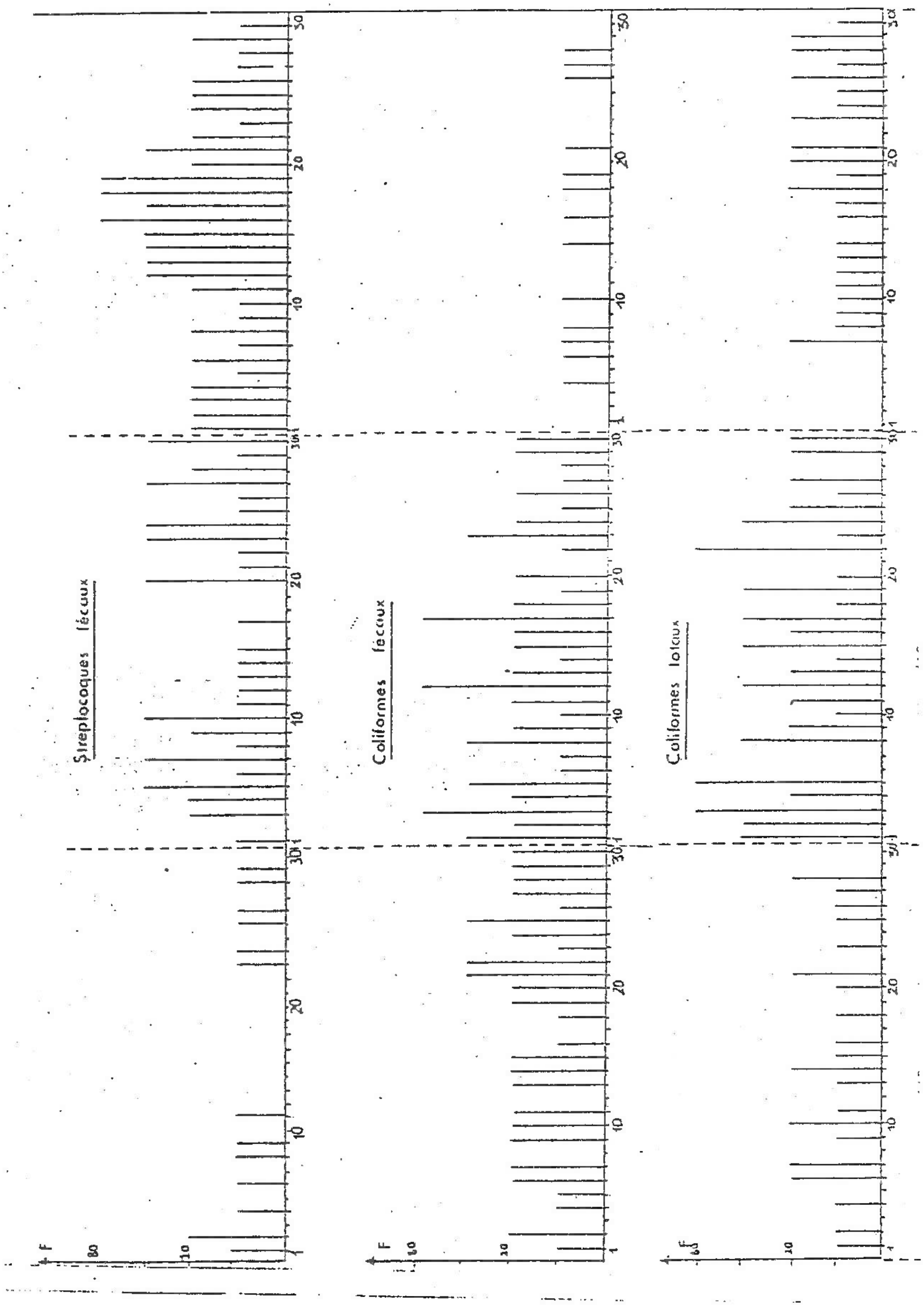


Graphique n° 1 : Histogrammes des résultats pour la zone de la baie des Anges.



Graphique n° 2 : Taux moyens de bactéries en fonction du temps pour la baie des Anges.

Graphique n° 3 : Histogrammes des résultats pour les différentes stations de prélèvements.



Centre de Recherche Participant : Institut scientifique et techniques des pêches maritimes
SETE
France

Chercheur Principal : Y. FAUVEL

Introduction :

L'Institut des pêches maritimes de Sète a été chargé dès Novembre 1978 dans le cadre du projet MED POL VII, de la surveillance des zones conchylicoles (eaux et mollusques) de la côte méditerranéenne. Dans la pratique, cette tâche est la nôtre depuis fort longtemps, aussi, notre connaissance de la salubrité des coquillages et des zones d'élevage, nous permet dans le cadre du programme MED POL VII d'apporter des informations et des données sur les deux zones conchylicoles les plus importantes du littoral méditerranéen français (étangs de Thau et de Leucate).

Zone(s) étudiée(s) :

Les zones étudiées faisant l'objet du présent rapport sont :

1) Etang de Thau (Fig. 4)

Lat. 43 24' 5" N
Long. 3 38' E

Caractéristiques géographiques:

L'étang de Thau, d'une superficie de 7500 ha environ, a une longueur maximale de 19,5 km et sa plus grande largeur atteint 4,5 km. La profondeur moyenne est de 5 mètres environ et la profondeur maximale de 9 à 10 m. L'étang de Thau communique avec la mer à ses deux extrémités, par les canaux de Sète et par le grau de Pisse-Saumes à Marseillan.

Les échanges avec la mer dépendent partiellement de la marée très faible, mais surtout des dépressions atmosphériques et des vents.

Caractéristiques hydrologiques:

Le régime thermique est très étroitement lié aux températures de l'air. Les températures moyennes habituellement de 4 , (janvier - février) à 28 (juillet - août).

La salinité moyenne s'établit aux environs de 34°/oo.

L'étang de Thau reçoit les eaux du Canal du Midi, du Canal de Sète au Rhône, et de nombreux ruisseaux comme la Vène, le Pallas, le Nègue-Vaques, le Soupié, pour ne citer que les plus importants.

Caractéristiques météorologiques:

Vents dominants : N.W. (320)
Pluviométrie moyenne : 650 mm

En ce qui concerne la zone conchylicole celle-ci occupe 1 200 ha dont 352 ha réels de parc d'élevage.

L'échantillonnage d'eau et coquillage est effectué sur 12 stations (de T 6 à T 17), plusieurs fois par mois.

2) Etang de Leucate (Fig. 5)

Caractéristiques géographiques:

Lat. 42 51' 0
Long. 3 03'

L'étang de Leucate occupe une superficie de 5 000 ha et a une profondeur moyenne de 3 mètres, avec des profondeurs maximales de 4,5 m. L'étang de Leucate communique avec la mer par les graus de Leucate et de Port-Barcarès.

Caractéristiques hydrologiques:

Comme pour Thau les variations thermiques ont une amplitude considérable, de 4 à 28 environ. La salinité suivant les années et périodes peut varier de 22°/oo à plus de 40°/oo. Cet étang reçoit essentiellement les eaux douces des ruisseaux de Fontdame et Font-Extramer, dans sa partie méridionale. Les salinités de la partie septentrionale sont généralement plus élevées.

Caractéristiques météorologiques:

Vents dominants : W (Tramontane)
Pluviométrie : 600 mm

Les parcs à coquillages occupent 32 ha. L'échantillonnage se fait sur 6 stations (L 8 à L 13) plusieurs fois par mois.

Matériel et méthodes:

La surveillance régulière des deux zones étudiées porte essentiellement sur les polluants bactériens, considérés comme des germes-test de la contamination fécale : Coliformes totaux et surtout Escherichia Coli et sur des facteurs hydrologiques (température et salinité).

Depuis notre participation au programme, la recherche des Streptocoques fécaux est également pratiquée régulièrement.

Les méthodes que nous employons sont basées sur la recherche du MPN aussi bien pour les eaux que pour les coquillages. Le milieu utilisé pour la recherche des Coliformes totaux et fécaux est le bouillon lactosé bilié, au vert brillant avec incubation à 37°C. Pour la recherche d'E. coli on utilise la méthode de MACKENZIE, avec repiquage des tubes positifs sur le même milieu et sur eau peptonée, à 44°C. Il faut remarquer que cette méthode n'est utilisée dans notre laboratoire que depuis juillet 1978, avant la méthode pratiquée par l'I.S.T.P.M. était celle de VINCENT avec ensemencement sur bouillon de même nom, à 41,5°C, méthode donnant directement E. coli.

En ce qui concerne les Streptocoques fécaux, leur recherche est faite également par la méthode MPN, en utilisant successivement les milieux de Rothe et Litsky.

Résultats et leur interprétation:

Les paramètres habituellement mesurés lors de nos tournées de contrôle sanitaire sont : T , S°/₀₀, Coliformes totaux et Escherichia coli. Ces paramètres sont notés sur les formulaires de données, annexés à ce rapport. Nous signalons que les résultats qui y sont portés concernent seulement les échantillons prélevés sur les différentes stations de prélèvement.

Depuis 1978, notre contrôle s'est beaucoup intensifié au niveau des établissements d'expéditions à terre, au détriment de notre contrôle sur les parcs d'élevage.

Les résultats que nous présentons (tableaux 1, 2, 3, 4 et 5) portent sur l'ensemble de nos contrôles.

La classification des résultats bactériologiques est faite en fonction des normes en vigueur en France :

- pour les coquillages : coliformes fécaux/100 ml de chair + liquide intervalvaire.

  satisfaisants : de 0 à 300
  suspects : 300 à 1000
  très suspects : 1001 à 3000
  défavorables : à partir de 3000

- pour l'eau : coliformes fécaux/100 ml d'eau.

  Les limites recommandées par le PNUE ont été appliquées :

  satisfaisant : moins de 10
  suspects : 10 à 100
  défavorables : à partir de 100

Dans le cadre de ce rapport sommaire et par manque de temps, il ne nous a pas été possible de présenter les résultats de façon statistique, comme cela nous a été demandé. Ceux-ci sont présentés sous forme de tableaux (tableaux 1, 2, 3, 4 et 5) et d'histrogrammes (figures 1, 2 et 3). Pour l'étang de Leucate le nombre relativement insuffisant d'observations nous a amené à présenter les résultats globalement sans tenir compte des stations.

En ce qui concerne l'étang de Thau, on constate que dans l'ensemble la pollution bactérienne exprimée en E. coli a fortement baissé en 1978 et ce pour presque toutes les stations. Ceci est étroitement lié à la cadence de réalisation de travaux d'assainissement programmée autour de l'étang de Thau et en particulier pour la ville de Sète (de 45 000 habitants). Une comparaison par station (figure 2) montre que la baisse de la contamination est particulièrement importante pour les stations 11, 16 et 17 les plus polluées en 1976.

L'étang de Leucate présente lui aussi une baisse de la pollution bactérienne, très évidente après un léger regain en 1977. De toutes façons le niveau sanitaire a toujours été ici très convenable.

Il faut préciser pour bien comprendre le processus contaminant de ces étangs, que celui-ci est très rapide lors des périodes très pluvieuses à cause des eaux de ruissellement, et de la remise en suspension des fonds par les fortes tempêtes de secteur sud qui généralement accompagnent les pluies. Dans ces périodes-là, l'expédition de coquillages est rigoureusement interdite jusqu'à ce que le milieu naturel retrouve un état tout à fait normal et que la pollution fécale s'estompe naturellement, ce qui se fait assez rapidement par auto-épuration.

Conclusions:

La qualité sanitaire des zones surveillées apparaît au vu des résultats, comme très bonne en 1978, o il n'y a eu aucune interdiction d'expédition. En 1976 et 1977 la qualité globale est tout de même acceptable, surtout si l'on tient compte que les périodes insalubres et o les expéditions sont interdites, sont comptabilisées dans nos histrogrammes et tableaux.

COQUILLAGES / STATION - 1976

Stations		Normes 0-300 N	0-300 %	301-1000 N	301-1000 %	1001-3000 N	1001-3000 %	3000 N	3000 %	N total
	T 6	31	83.8	4	10.8	2	5.4	0	0	37
	T 7	25	73.5	6	17.7	1	2.9	2	5.8	34
	T 8	22	59.5	5	13.5	4	10.8	6	16.2	37
	T 9	31	83.8	3	8.1	2	5.4	1	2.7	37
	T 10	23	62.2	2	5.4	9	24.3	3	8.1	37
	T 11	16	47.1	6	17.6	7	20.6	5	14.7	34
ETANG	T 12	23	67.7	6	17.6	1	2.9	4	11.8	34
DE THAU	T 13	23	63.9	5	13.9	5	13.9	3	8.3	36
	T 14	23	71.9	3	9.4	3	9.4	3	9.4	32
	T 15	28	75.7	5	13.5	3	8.1	1	2.7	37
	T 16	21	55.3	5	13.2	8	21.0	4	10.5	38
	T 17	22	59.5	5	13.5	5	13.5	5	13.5	37
	Expédition	47	73.5	11	17.2	5	7.8	1	1.5	64
total		335	67.8	66	13,4	55	11,1	38	7.7	494
	L 8	6	85,7	0		0		1	14,3	7
	L 9	3	50	2	33,3	1	16,7	0		6
ETANG	L 10	8	88,9	0		1	11,1	0		9
DE	L 11	6	66,7	3	33,3	0		0		9
LEUCATE	L 12	8	88,9	1	11,1	0		0		9
	L 13	7	87,5	1	12,5	0		0		8
total		38	792	7	14,5	2	4,2	1	2,1	48

Tableau 1 : Répartition par classes de contamination des coquillages en Escherichia coli pour les étangs de THAU et LEUCATE en 1976.

COQUILLAGES / STATION - 1977

Stations		0-300 N	0-300 %	301-1000 N	301-1000 %	1001-3000 N	1001-3000 %	3000 N	3000 %	N total
	T 6	21	77.8	2	7.4	3	11.1	1	3.7	27
	T 7	19	73.1	1	3.8	6	23.1	0	0	26
	T 8	18	56.3	3	9.4	7	21.9	4	12.5	32
	T 9	21	72.4	2	6.9	2	6.9	4	13.8	29
	T 10	23	74.2	3	9.7	2	6.4	3	9.7	31
	T 11	16	50	7	21.9	3	9.4	6	18.7	32
ETANG	T 12	24	72.7	3	9.1	4	12.1	2	6.1	33
DE THAU	T 13	22	68.7	3	9.4	3	9.4	4	12.5	32
	T 14	21	63.6	4	12.2	6	18.3	2	6.1	33
	T 15	24	72.7	4	12.2	3	9.1	2	6.1	33
	T 16	19	63.3	5	16.6	6	20	0	0	30
	T 17	21	63.6	5	15.1	6	18.3	1	3	33
	Expédition	33	61.1	7	13	11	20.4	3	5.7	54
total		282	66	50	11.7	62	14.5	33	7.7	427
	L 8	4	57.1	1	14.3	1	14.3	1	14.3	7
	L 9	3	50	1	16.7	2	33.3	0		6
ETANG	L 10	4	66.7	0		1	16.7	1	16.7	6
DE	L 11	5	71.4	1	14.3	0		1	14.3	7
LEUCATE	L 12	6	85.7	0		0		1	14.3	7
	L 13	6	85,7	0		0		1	14.3	7
total		28	70	3	7.5	4	10	5	12.5	40

Tableau 3 : Répartition par classes de contamination des coquillages en Escherichia coli pour les étangs de Thau et Leucate en 1977.

EAUX / STATION - 1976

Stations		10 N	10 %	10 - 100 N	10 - 100 %	100 N	100 %	Nombre total
ETANG DE THAU	T 6	34	94,4	2	5,6	0	0	36
	T 7	35	97,2	1	2,8	0	0	36
	T 8	29	82,9	6	17,1	0	0	35
	T 9	34	94,4	2	5,6	0	0	36
	T 10	27	77,1	8	22,8	0	0	35
	T 11	24	66,7	9	25	3	8,3	36
	T 12	25	73,5	8	23,6	1	2,9	34
	T 13	30	83,3	5	13,9	1	2,8	36
	T 14	27	79,5	6	17,6	1	2,9	34
	T 15	30	83,3	5	13,9	1	2,8	36
	T 16	25	69,4	8	22,2	3	8,4	36
	T 17	19	52,8	9	25	8	22,2	36
total		339	79,6	69	16,2	18	4,2	426
ETANG DE LEUCATE	L 8	7	87,5	1	12,5	0		8
	L 9	6	75	2	25	0		8
	L 10	8	88,9	1	11,1	0		9
	L 11	9	100	0		0		9
	L 12	9	100	0		0		9
	L 13	9	100	0		0		9
total		48	92,3	4	7,7	0	0	52

Tableau 2 : Répartition par classes de contamination des eaux en Escherichia coli pour les étangs de THAU et LEUCATE en 1976.

COQUILLAGES / STATION - 1978

Stations	Normes	0-300 N	0-300 %	301-1000 N	301-1000 %	1001-3000 N	1001-3000 %	3000 N	3000 %	N total
	T 6	18	90	0	0	1	5	1	5	20
	T 7	17	85	0	0	1	5.5	2	10	20
	T 8	19	86.4	2	9.1	0	0	1	4.5	22
	T 9	19	86.4	1	4.5	1	4.5	1	4.5	22
	T 10	20	87.0	0	0	0	0	3	13	23
	T 11	19	82.6	4	17.4	0	0	0	0	23
ETANG	T 12	18	90	0	0	1	5	1	5	20
DE THAU	T 13	18	81.8	1	4.5	1	4.5	2	9.1	22
	T 14	24	100	0	0	0	0	0	0	24
	T 15	22	95.6	0	0	0	0	1	4.4	23
	T 16	18	78.2	1	4.4	3	13	1	4.4	23
	T 17	19	86.4	0	0	3	13.6	0	0	22
	Expédition	126	94	6	4.5	1	0.7	1	0.7	134
total		357	89.7	15	3.8	12	3	14	3.5	398
	L 8	2								
	L 9	2								
	L 10	4								
ETANG	L 11	3								
DE	L 12	3								
LEUCATE	L 13	2								
	Expédition	76	86.3	6	6.8	4	4.5	2	2.3	88
total		92	88.6	6	5.8	4	3.8	2	1.9	104

Tableau 5 : Répartition par classes de contamination des coquillages en Escherichia coli pour les étangs de Thau et Leucate en 1978.

EAUX / STATION - 1977

Stations	Normes	0 - 10 N	0 - 10 %	10 - 100 N	10 - 100 %	100 N	100 %	Nombre total
	T 6	21	91,3	2	8,7	0	0	23
	T 7	22	95,6	1	4,4	0	0	23
	T 8	16	64	8	32	1	4	25
	T 9	23	92	2	8	0	0	25
	T 10	21	84	2	8	2	8	25
ETANG	T 11	19	76	4	16	2	8	25
DE	T 12	22	88	3	12	0	0	25
THAU	T 13	20	80	4	16	1	4	25
	T 14	20	80	3	12	2	8	25
	T 15	21	84	4	16	0	0	25
	T 16	19	76	2	8	4	16	25
	T 17	16	64	7	28	2	8	25
total		240	81,1	42	14,2	14	4,7	296
	L 8	4	66,7	1	16,7	1	16,7	6
	L 9	5	83,3	0		1	16,7	6
ETANG	L 10	5	83,3	1	16,7	0		6
DE LEU-	L 11	5	83,3	1	16,7	0		6
CATE	L 12	4	80	1	20	0		5
	L 13	5	100	0		0		5
total		28	82,3	4	11,8	2	5,9	34

Tableau 4 : Répartition par classes de contamination des eaux en Escherichia coli pour les étangs de THAU et LEUCATE en 1977.

EAUX / STATION - 1978

Stations		0 - 10 N	0 - 10 %	10 - 100 N	10 - 100 %	100 N	100 %	Nombre total
ETANG DE THAU	T 6	11	100					11
	T 7	10	90,9	1	9,1			11
	T 8	12	92,3	1	7,7			13
	T 9	12	100					12
	T 10	13	100					13
	T 11	12	92,3	1	7,7			13
	T 12	12	92,3	1	7,7			13
	T 13	13	92,9	1	7,1			14
	T 14	14	100					14
	T 15	13	92,9	1	7,1			14
	T 16	14	100					14
	T 17	14	100					14
total		150	96,1	6	3,9	0	0	156
ETANG DE LEUCATE	L 8	3						
	L 9	3						
	L 10	4						
	L 11	4						
	L 12	3						
	L 13	3						
	Expédition	17						
Total		37	100					

Tableau 6 : Répartition par classes de contamination des eaux en Escherichia coli pour les étangs de THAU et LEUCATE 1978.

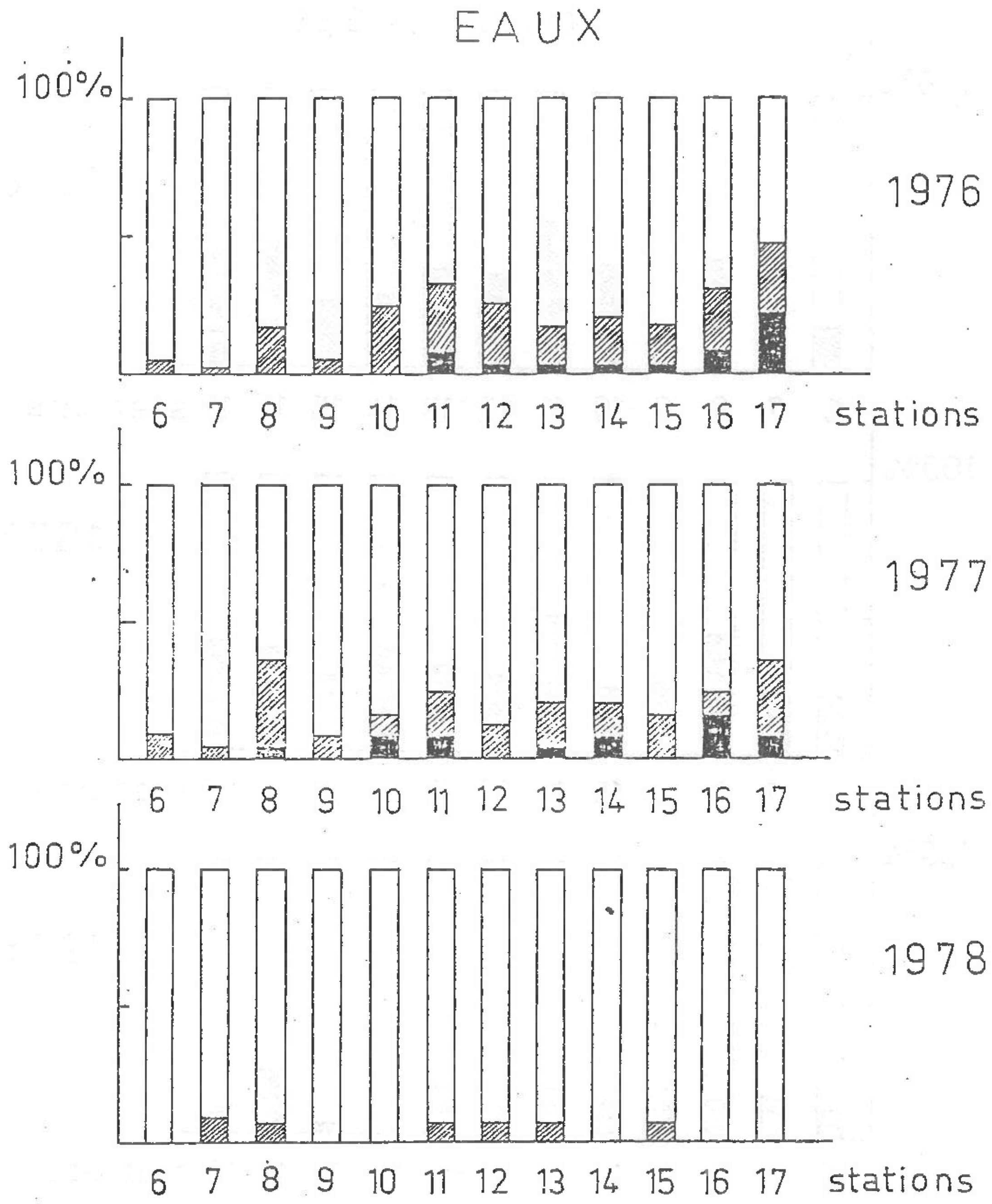
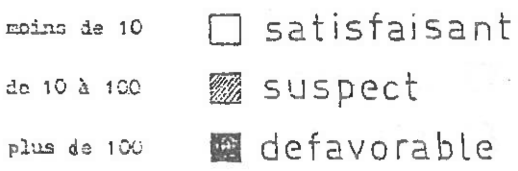


Figure 1 : Fréquences de contamination des EAUX par *E.coli* pour l'étang de THAU selon 3 classes de contamination :



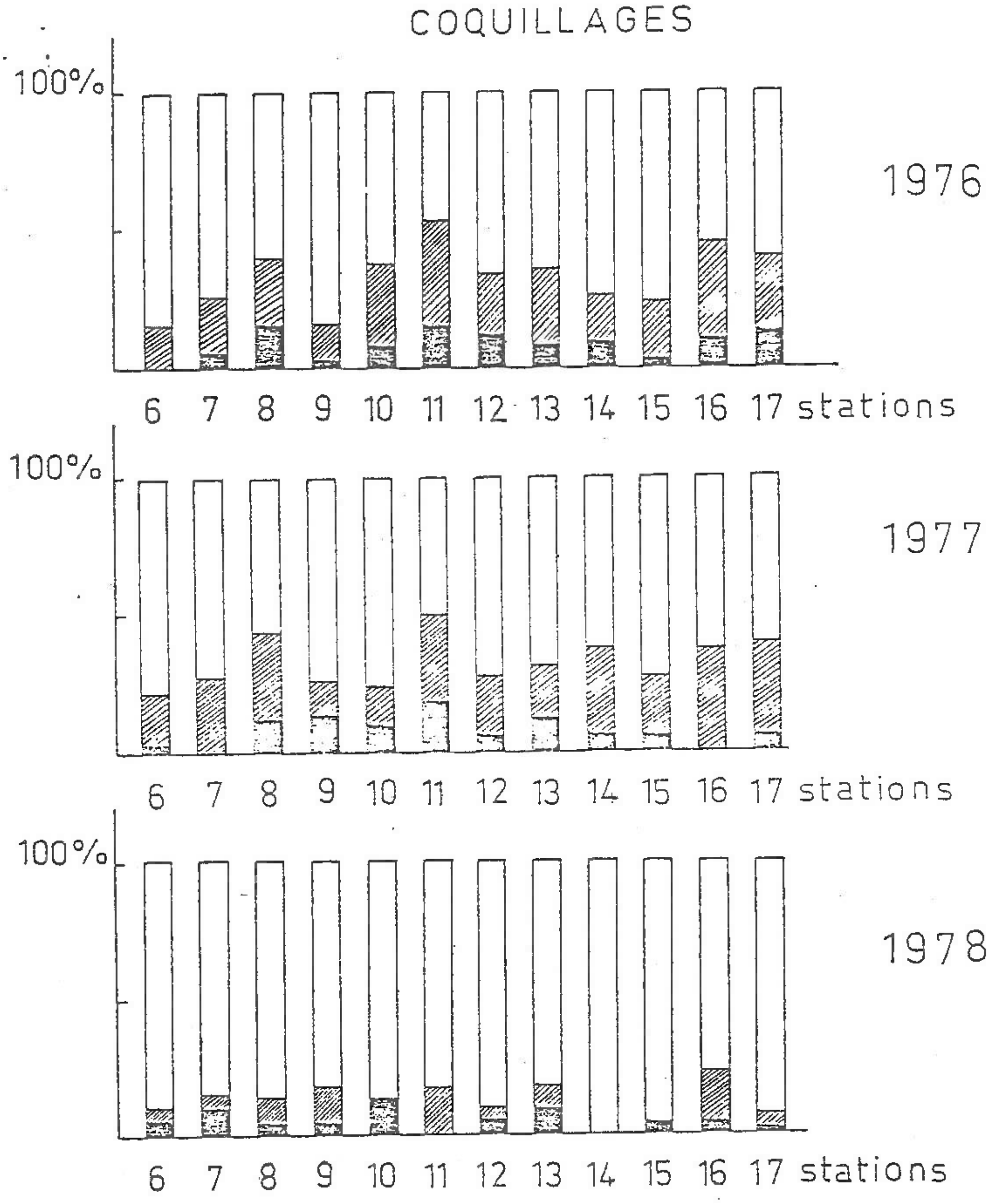


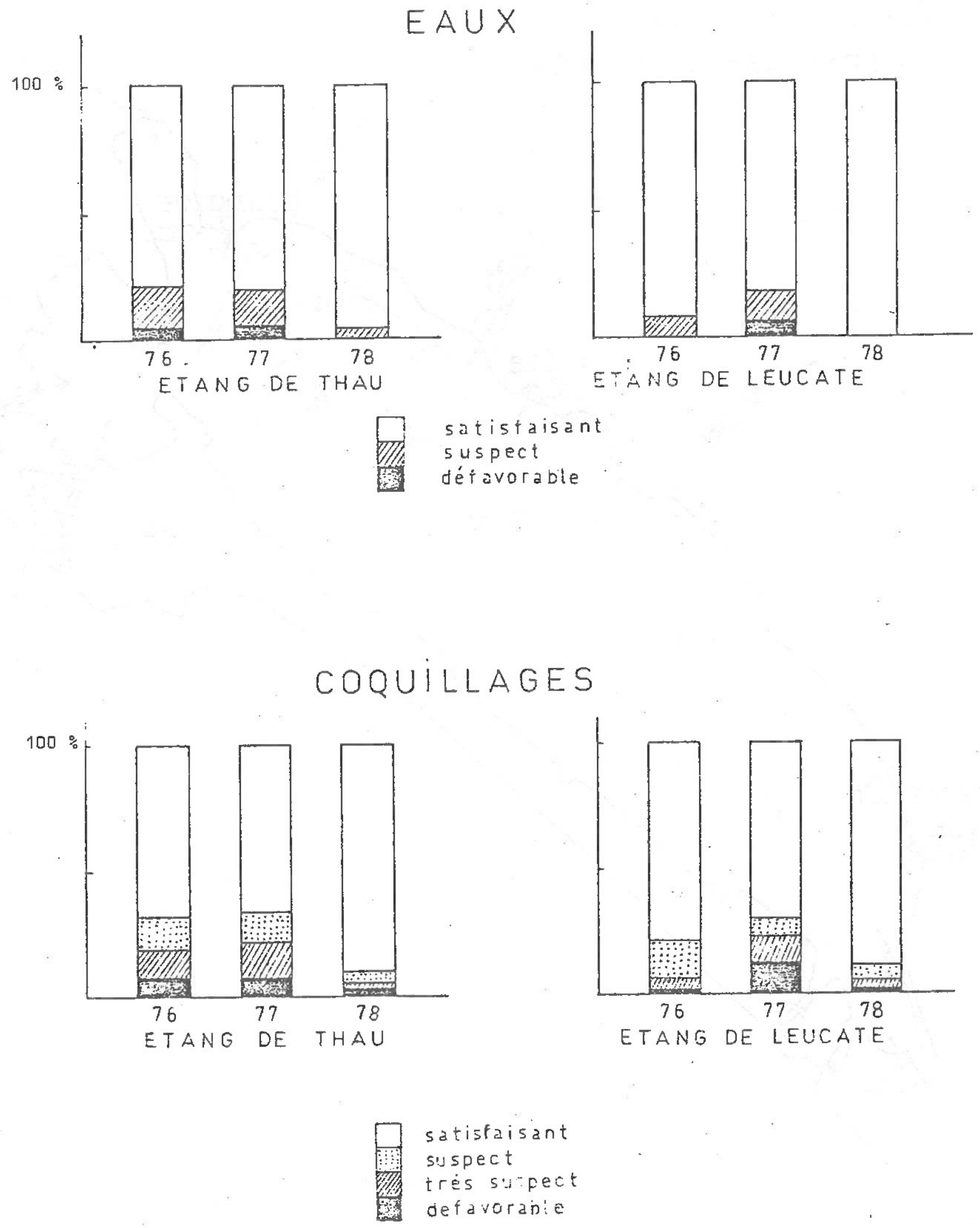
Figure 2 : Fréquences de contamination des COQUILLAGES par *E.coli* pour l'étang de THAU selon 3 classes de contamination :

de 0 à 300 □ satisfaisant

de 300 à 3000 ▨ suspect

plus de 3000 ▩ defavorable

Figure 3 : Fréquences globales de contamination par E.coli en 1976, 1977 et 1978.



ETANG DE THAU
échelle 1/85000
I.S.T.P.M. sète - FRANCE

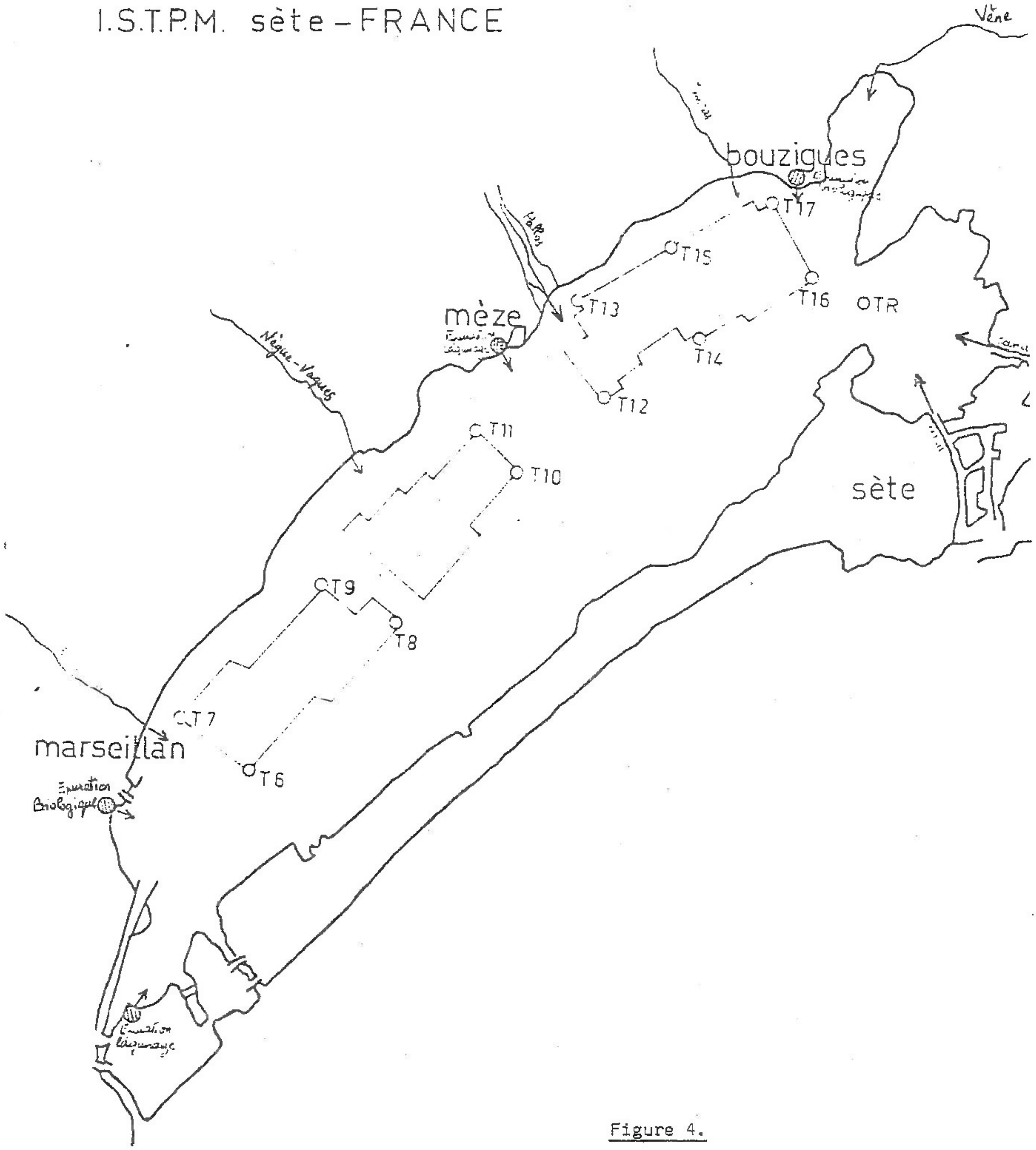


Figure 4.

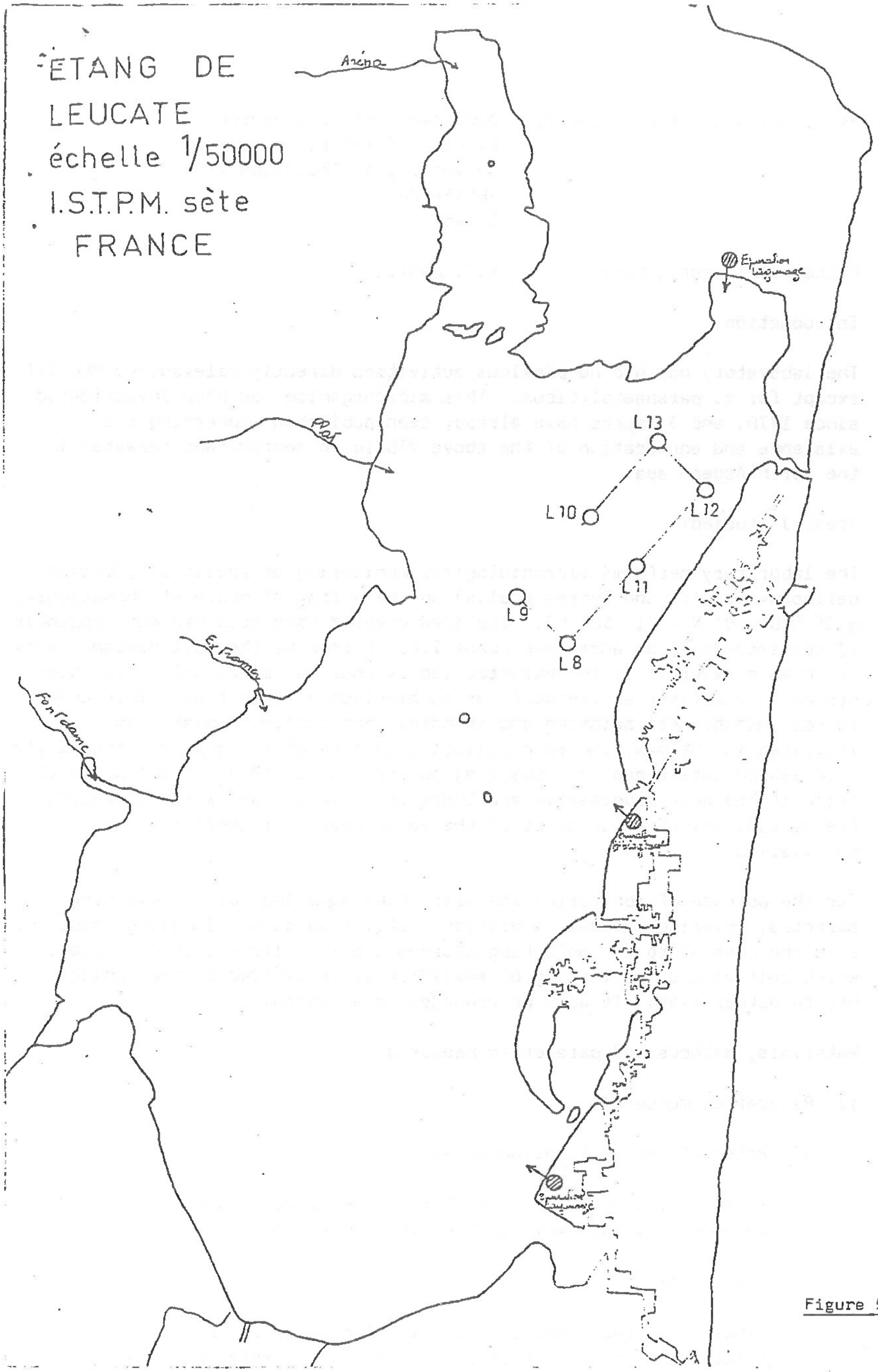

ETANG DE
LEUCATE
échelle 1/50000
I.S.T.P.M. sète
FRANCE
L13
L12
L10
L11
L9
L8

Figure 5.

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

Principal Investigator: A.J. MANTIS

Introduction:

The laboratory has had no previous activities directly relevant to MED VII except for V. parahaemolyticus. This microorganism has been investigated since 1970, and 3 papers have already been published concerning the existence and enumeration of the above Vibrio in seafood and seawater in the North Aegean sea.

Area(s) studied:

The laboratory performs microbiological monitoring of shellfish (Mytilus galloprovincialis and Ostrea edulis) on the Northwest shore of Thessaloniki gulf (40° 30' N - 21 50' E). The area covered (see attached map, appendix 1) corresponds to an anomalous coast line, formed by the soil brought in by three main rivers. It is characterized by shallow waters which have been proved an excellent environment for cultivation of shellfish. This coast is not suitable for swimming and is mainly accessible by boat. As indicated in the map, the main polluting sources of the gulf are the city's main sewage outlet and an industrial outlet. Since 1960 the pollution of the gulf has been progressive and today it is in a stage which threatens the suitability of large areas of the above coast for shellfish cultivation.

For the purpose of monitoring the area, four sampling points have been selected, covering the main shellfish cultivation beds. Sampling point No. 1 is the nearest to the polluting sources and it falls within the area in which culturing or harvesting of shellfish is prohibited by the public health authorities. It will be regarded as a control.

Materials, methods and parameters measured:

i) Parametres measured:

a) Water of the cultivation beds:

Total coliforms, faecal coliforms, faecal streptococci, Salmonellae, salinity, temperature, DO and BOD_5.

b) Shellfish:

Total coliforms, faecal coliforms, faecal streptococci, total heteroptrophic bacteria, Virio parahaemolyticus and Salmonellae.

Material and methods:

Enumeration of total coliforms and faecal coliforms in water was performed by both MPN and MF methods using MacConkey broth and mFC or mFC-agar respectively, according to "Guidelines for Health related monitoring of coastal Water Quality". For enumeration of the above indicator organisms in shellfish, only MPN method was used. MacConkey broth and peptone waters were used as culture media, according to the reference method proposed by this project. However, a minor modification was introduced in the preparation of dilutions from a shellfish sample. Thus 30 g of shellfish flesh were homogenized in a waring blender with 270 ml of 0.1 per cent peptone water and thus a 1/10 dilution was prepared while the first five tubes containing 10 ml of double strength MacConkey broth were inoculated with 10 ml each of the 1/10 dilution. This procedure, widely accepted in food microbiology, permits quantitation of coliforms in values greater than 20/100 g or the negative results can be expressed as less than 20/100 g.

For faecal streptococci M-enterococcus agar with the MF method was used for the water and the same medium with the PP method for shellfish.

Vibrio parahaemolyticus was quantified in shellfish only, with the MPN method using Glucose-Salt-Teepol broth as enrichment broth and TCBS agar as plating medium.

Salmonellae recovery was attempted from both water and shellfish. The methods applied and the media used were those proposed for this project.

Results and their interpretation:

Total heteroptrophic bacteria: The results concerning the number of total heterotrophic bacteria are summarized in table 1 (appendix II). Samples of shellfish from sampling point No. 1 had a total count ranging from between 10^4 and 10^5/g while samples from sampling point to 4 (unpolluted water) had always a total count of less than 10^4g. Total count of shellfish derived from sampling point 2 and 3 had a total counts ranging between 10^3 and 10^4 in 75 per cent and 82 per cent of the samples respectively.

Total coliforms and faecal coliforms:

Summarized results concerning total coliforms and faecal coliforms (E. coli) are given in annexes 3 and 4.

From the frequencies distribution of the values of total coliform and E. coli in shellfish and water it can be seen that, except from sampling point No.1 for which high values were expected, sampling point No.2 gives values above the suggested limits in a considerable percentage of samples, while sampling points No.3 and 4 give values which fall within the suggested limits of acceptance.

Faecal streptococci: Results concerning faecal streptococci are summarized in table 2, appendix II. From the above table it can be seen that values for shellfish cultivated in unpolluted water (sampling point 3 and 4) were less than 10/g in the majority of the cases (80 per cent of the samples) while the water from the above sampling point gave values less than 100/100 ml in more than 87 per cent of the samples.

Vibrio parahaemolyticus:

Quantification of Vibrio parahaemolyticus in shellfish with the MPN method revealed that a percentage of the samples ranging between 34 per cent and 60 per cent were positive (appendix V). The MPN value of the positive samples was always smaller than 10^3/100 g. Positivity of the samples increased during the warmer months of the year and decreased markedly during the cold months. This confirms the well established view that V. parahaemolyticus is a natural inhabitant of sea-water and does not correlate with pollution.

During this project more than 600 strains of V. parahaemolyticus were tested for Kanagawa phenomenon and proved to be Kanagawa negative. Randomly selected strains were serologically tested and the majority of them fell into the serotypes O_4K_{12}, O_4K_3, O_5K_{17} and $O_{10}K_{24}$. About 25 per cent of the strains were not typeable with available antisera.

As far as food poisioning concerns, there are no data suggesting possible cases of gastroenteritis among humans in Greece.

No salmonella serotypes were so far isolated from the water or shellfish tested. Although our laboratory has a long experience in salmonella isolation from different sources, we consider the negative results from sampling point No.1 as contradictory and if in the future sampling the situation continues to be so, consideration will be given to the effect that is produced on salmonella and probably on other microorganisms by the industrial (chemical) wastes which are discharged near the above sampling point.

Evaluation of the results according to interim microbiological criteria for shellfish.

On the basis of E. coli, the percentage of samples of shellfish or water which fall within or outside the proposed microbiological limits are presented below in the form of a table.

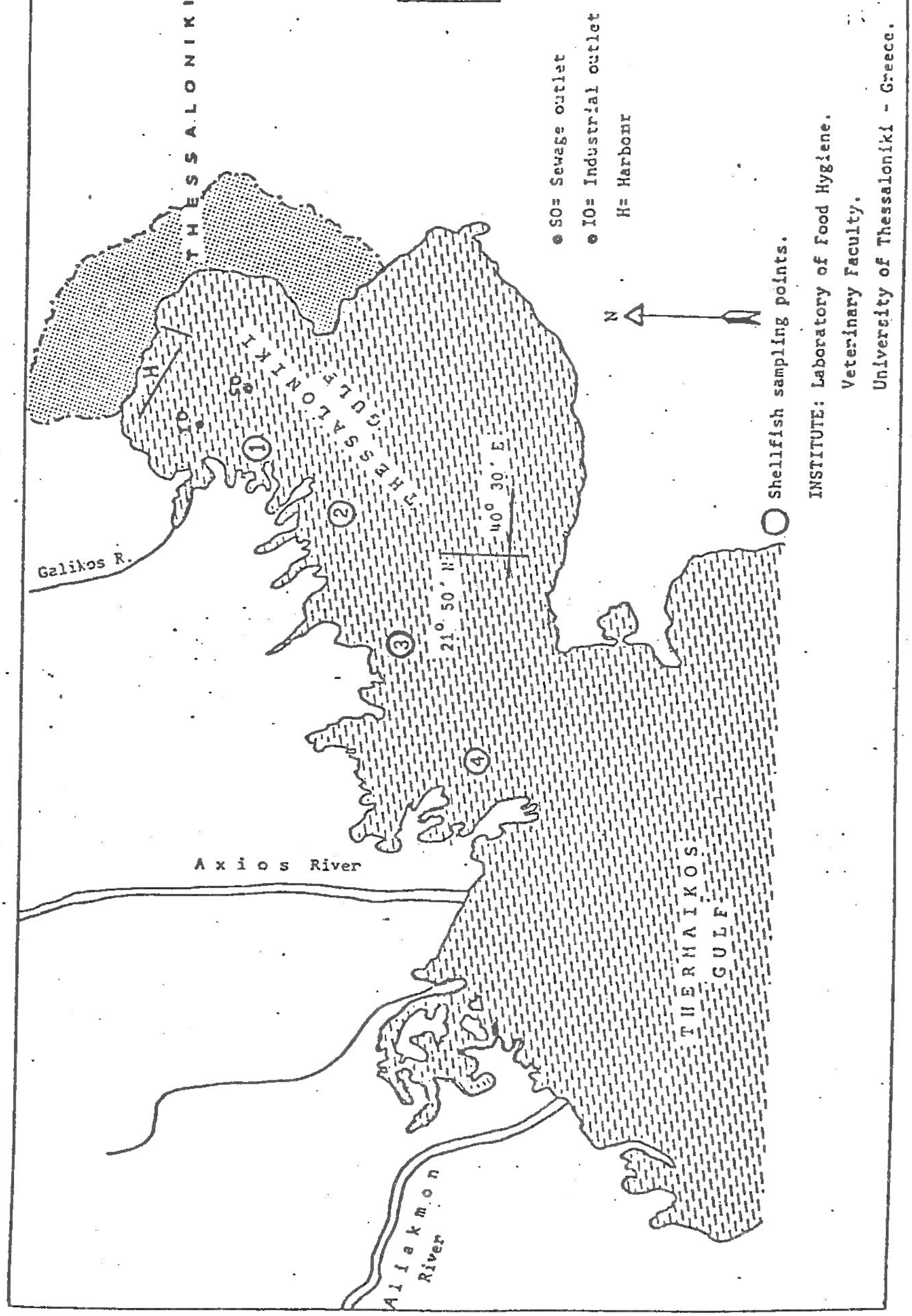
Percentage of samples within the proposed limits on the basis of E. coli values.

SAMPLING POINT	SHELLFISH			WATER		
Point	0.2/g *	3-10/g **	10/g	10/100 ml	10/100/100ml ***	100/100ml
1	30.4%	52.2%	-	18.7%	75	6.3%
2	79.2%	20.8%	-	62.5%	37.5%	-
3	92.9%	7.1%	-	87.7%	13.3%	-
4	100%	-	-	94.4%	5.6%	-

* Accepted. ** Temporary prohibition of sale.
*** Accepted if not more than 20%.

From the above table it is evident that sampling point No.2 does not fulfil completely the proposed criteria either for shellfish or for the water, while sampling points No.3 and 4 satisfy the criteria. In evaluating the results obtained so far, it is evident that the pollution of the Northwest coast of Thermaikos gulf is expanding year by year, and this in addition to other problems, also creates a problem of shellfish hygiene. This problem is already anticipated by a shellfish cleaning station (ozone treatment) and very soon all shellfish from the above area will be subjected to treatment before they are released to the market.

Appendix I


THESSALONIKI
SO= Sewage outlet
IO= Industrial outlet
H= Harbonr
N
Shellfish sampling points.
INSTITUTE: Laboratory of Food Hygiene.
Veterinary Faculty.
University of Thessaloniki - Greece.
21° 50' N
40° 30' E
Galikos R.
Axios River
THERMAIKOS GULF
Aliakmon River

Appendix II

Table 1: TOTAL HETEROTROPHIC BACTERIA (Frequencies %)

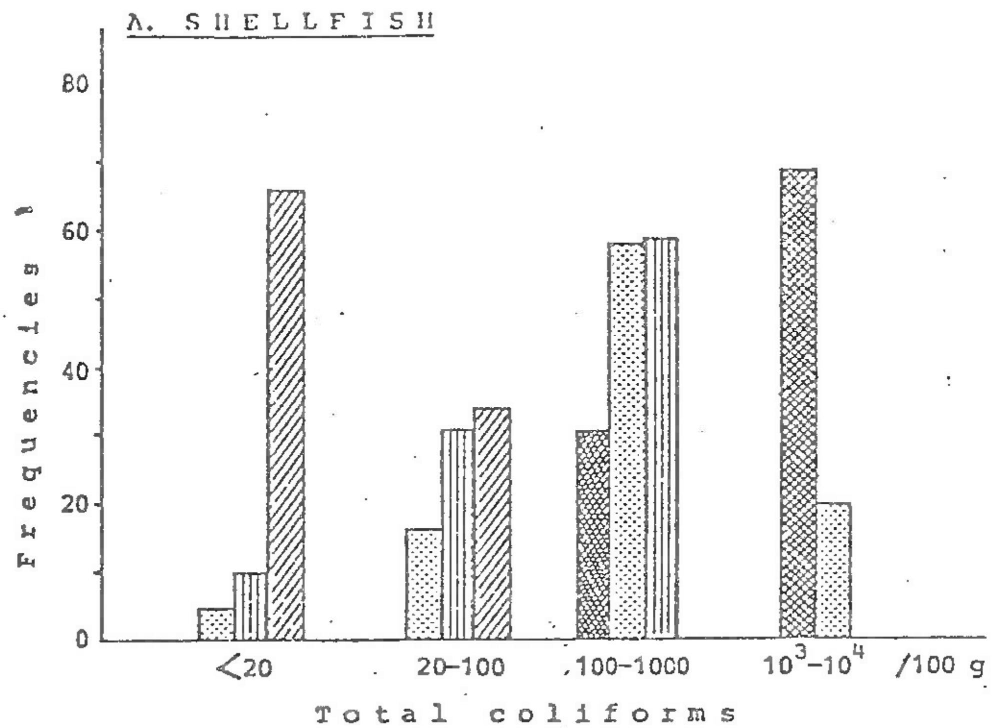
SHELLFISH

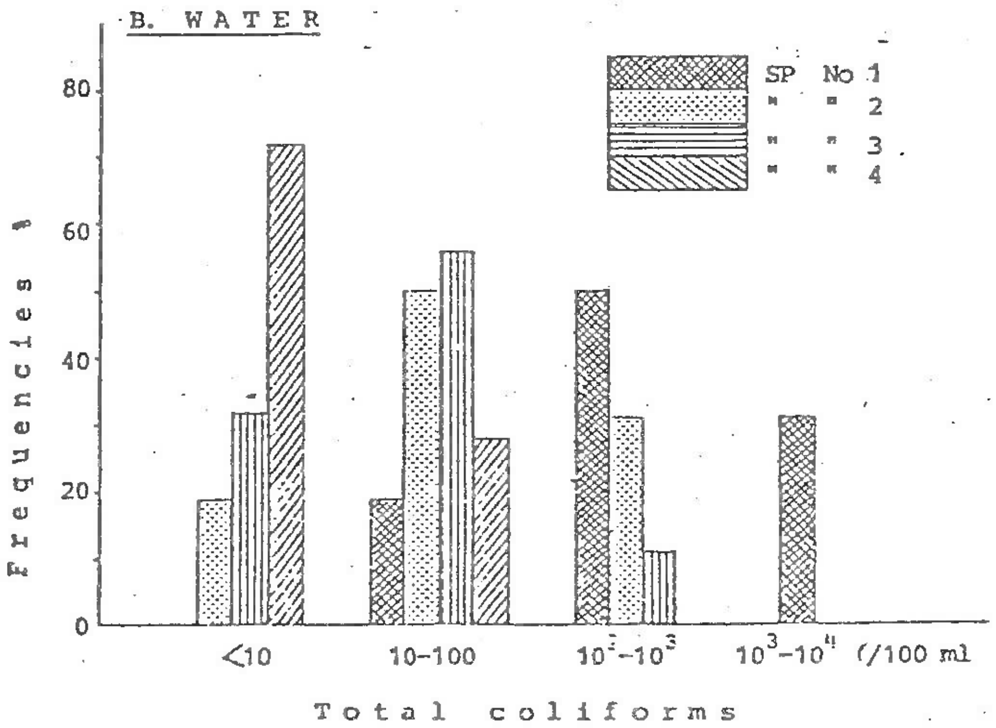
Per gram	Sampling point			
	1	2	3	4
10^2- 10^3	—	4.2 %	—	14.3 %
10^3- 10^4	—	75.0 %	82.1 %	85.7 %
10^4-$5x10^4$	52.2 %	20.8 %	17.9 %	—
$5x10^4$- 10^5	47.8 %	—	—	—

Table 2: ENTEROCOCCI (Frequencies %)

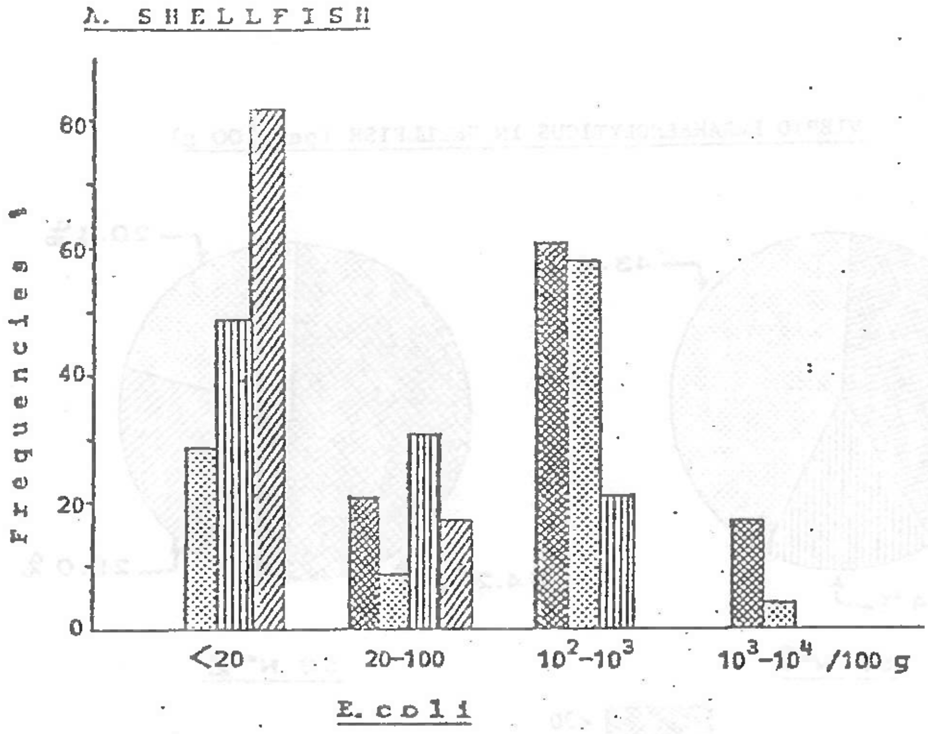
A. SHELLFISH (MPN)				
per gram	Sampling point			
	1	2	3	4
<10	21.7 %	66.7 %	82.8 %	100.0 %
10-100	78.3 %	33.3 %	17.2 %	—
B. WATER (MF)				
per 100 ml				
0	6.25 %	25.0 %	27.8 %	50.0 %
1-10	—	31.3 %	33.3 %	33.3 %
10-100	18.75 %	31.2 %	33.3 %	16.7 %
100-1000	75.00 %	12.5 %	5.6 %	—

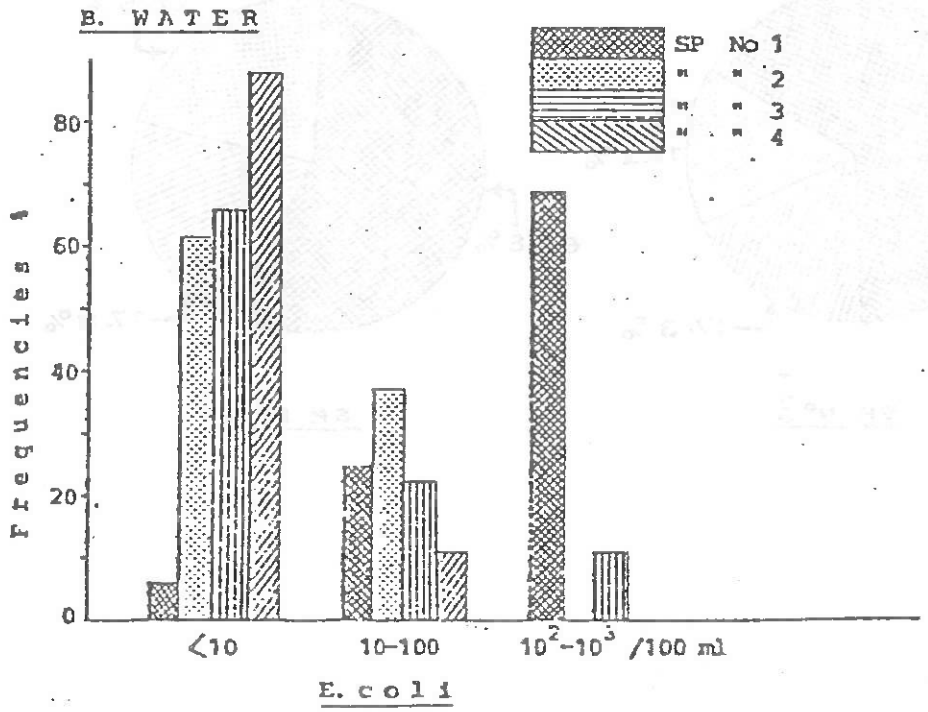
Appendix III





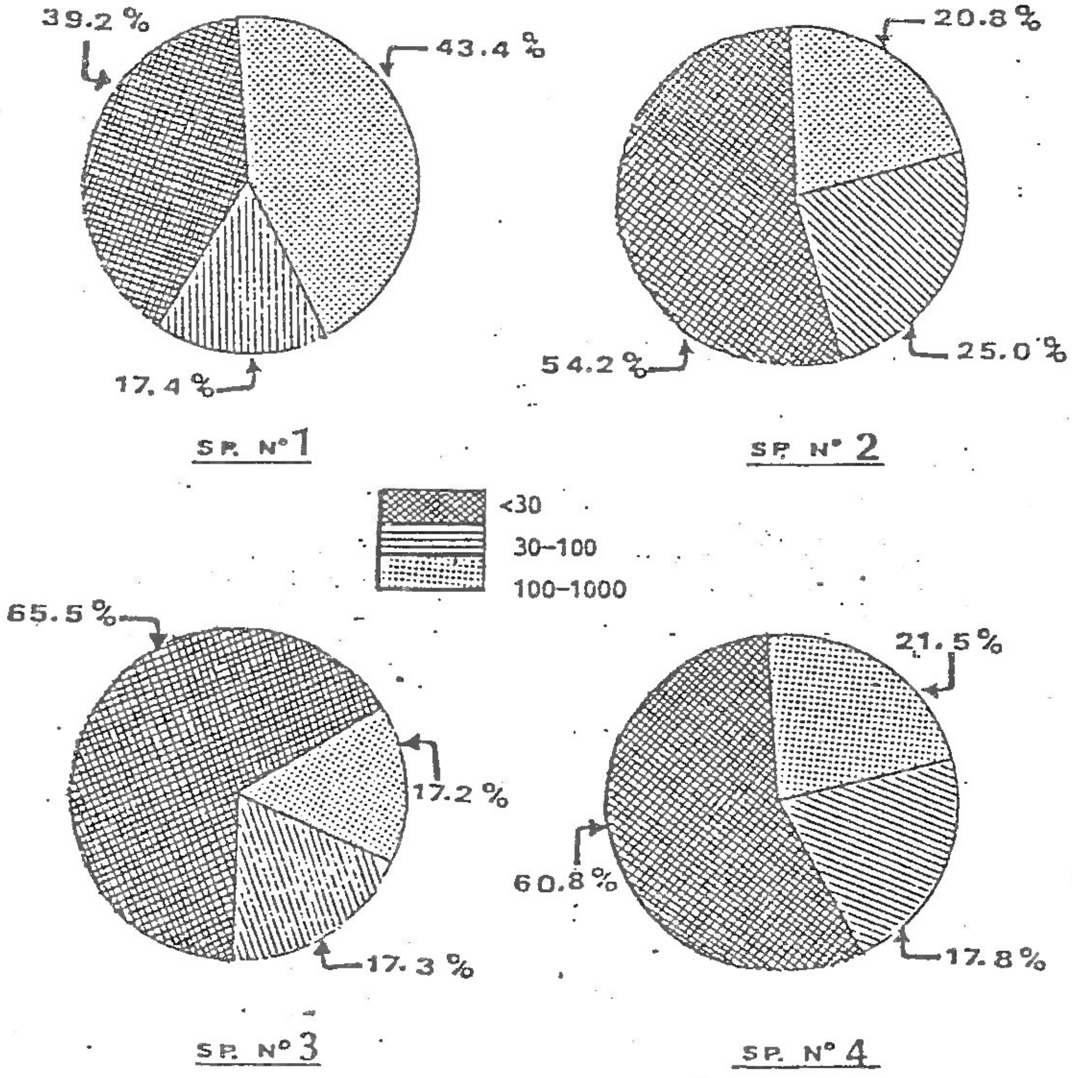
Appendix IV


A. SHELLFISH
Frequencies %
0
20
40
60
80
<20
20-100
10²-10³
10³-10⁴ /100 g
E. coli


B. WATER
SP No 1
" " 2
" " 3
" " 4
Frequencies %
0
20
40
60
80
<10
10-100
10²-10³ /100 ml
E. coli

Appendix V

VIBRIO PARAHAEMOLYTICUS IN SHELLFISH (per 100 g)



Participating Research Centre: Institute of Hygiene
Medical School
University of Thessaloniki
THESSALONIKI
Greece

Principal Investigator: T. EDIPIDES

Introduction:

The study on the identification and evaluation of the degree of pollution in the Gulf of Thessaloniki and in Thermaikos Gulf started in 1968. Until 1975, 526 sea-water samples as well as 172 samples of sea sediment, together with an equal number of coastal sand samples, were examined.

All the samples were examined for the following parameters:

1. Number of Coliforms and E. coli (MPN).

2. Isolation and counting of Enterococci and sulfite reducing Clostridia.

3. Searching for Salmonellae, Shigella, V. parahaemoliticum.

4. Physical and chemical parameters, that is, air temperature, wind velocity, relative humidity, sea temperature, turbidity, pH, determination of chlorides, salinity, BOD_5, DO, and tracing and determination of Pb.

During that same period, 529 samples (1 sample X 5 = 2645) of shellfish were examined microbiologically and chemically. At the same time, the two rivers Axios and Aliakmon, flowing into the gulf of Thessaloniki, were examined to determine their pollution.

Area(s) studied:

The map shows the points of sea-water sampling (1, 2, 3, 4, 5, 6) and sediment and coastal sand sampling (3, 4). The sign (■) shows the locations of shellfish culture and fishing. The results of physical, chemical and microbiological parameters are given in tables 1, 2, 3, 4 and 5).

Material and methods:

Seven hundred and fourteen seawater samples taken from the Gulf of Thessaloniki, as indicated on the maps (1-6), were examined during the period of 1975-1978.

The samples were tested for the MPN of Coliforms, E. Coli, Enterococci, sulfite reducing Clostridia, as well as for the isolation of Salmonellae and Shigella.

One hundred and ninety-nine sediment samples, 199 coastal sand samples and 108 shellfish samples (one sample consisted of 5 shellfish) were also examined. All these samples were taken from the Gulf of Thessaloniki at the same time as the sea-water sampling. They were tested for the above microorganisms to which Vibrio parahaemolyticum was added. For shellfish itself, coagulase positive staphylococci were also included in the investigated pathogens.

For the MPN of Coliforms the Multiple tube method was used with the "Minerals modified Glutamate" as a medium as well as the filtration method (millipore) with M-endo agar as a medium. For the MPN of E. Coli the Multiple tube method was used with the same medium used for the Coliforms, and the filtration method with M-FC agar as a medium. It was found that the results obtained by the two methods used, i.e. the multiple tube method and the filtration method, did not differ significantly.

For the MPN of Enterococcus the filtration method was used with M.-enterococci agar as a medium. For the MPN of sulfite reducing Clostridia the medium D.R.C.M. was used. For the isolation of Salmonellae the selenite broth was used and for the isolation of Shigella the G.N. broth was used. For the number of coagulase positive Staphylococcus the medium "Staphylococcus agar" was used and for the isolation of Vibrio Parahaemolyticum the "Alcaline peptone Water".

Results obtained:

The results of the examination of the 714 sea-water samples for Coliforms and E. Coli during the period 1975 - Sep. 1978 are given in table 2, figure 1.

From the table, it is quite clear that Coliforms are more numerous in all but area 3 where Coliforms and E. Coli are present in roughly equal numbers.

Table 3 and figure 2 show the number of Enterococci and sulfite reducing Clostridia found.

Enterococci and sulfite reducing Clostridia are to be found in all areas although Enterococci are present in greater number in areas 2, 4 and 6, while in area 3 Enterococci and sulfite reducing Clostridia are present in roughly equal numbers.

Tables 4 and 5 and figures 3 and 4 show the results obtained by examination of 199 samples of sea sediment and coastal sand. All samples were taken from areas 4, 5, and 6.

From the tables and figures it is evident that the number of Coliforms is much greater in area 5 found in almost 100 per cent of the samples.

Certainly, E. Coli are to be found in all three areas, especially in areas 4 and 5. In area 6 they are present in smaller number, being found only in 5 per cent of the samples.

As far as Enterococci and sulfite reducing Clostridia are concerned, the results are given in tables 6, 7, and in figures 5 and 6.

To find out the extent to which the gulf is polluted, 20 samples of sea water and sediment were collected in 1978 in four runs: A, B, C, D (see map of Thermaikos Gulf).

The distance of the runs from the coast were as follows:

A-1250 m, B-2500 m, C-5500m, and D-11000 m.

From the water samples obtained during the runs, the following were isolated:

Four Vibrio parahaemolyticum, 10 Serotypes of Salmonellae: S. Senftenberg (4), S. Agona (3), S. Blockley (1), S. Fresno (1) and S. Wien (1).

Finally by the method of swabs the following microorganisms were isolated during the runs:

Seven Serotypes of Salmonellae: S. Agona (4), S. Senftenberg (2), S. Paratyphi B (1).

Table 8 shows the results of microbiological and chemical analysis of the 108 samples of shellfish from the Gulf of Thessaloniki (five shellfish constitute 1 sample).

In detail, the results are as follows: Out of the 108 samples, Coliforms were found in 86 and great numbers of E. Coli were found in 74.

Pathogenic Staphylococci were isolated in 35 samples. Sulfite reducing Clostridia in 52. Enterococci were found in 62 samples.

In 5 samples during the runs, Serotype E. Coli (O_{55}/B_5, O_{26}/B_6, O_{125}/B_5), were found in one sample S. Typhi, in 10 samples Shigella Sonnei and in 8 samples Proteus.

At the same time, the above mentioned samples were tested chemically for the determination of Pb and Hg: The results were for Pb 1.25-4.15 mg/l and for Hg 0.02 mg/l.

Results and their interpretation:

From the results obtained, it is evident that the Gulf of Thessaloniki is polluted continuously and at a great distance from the coast and from the wastes of the city of Thessaloniki. The results also show that in order to draw the right conclusions two samplings should be carried out from the same point and at the same time, one of sea-water and the other of sediment. Sea water often appears less polluted than sediment.

List of publications:

1) Neuere Untersuchungen auf die Schalentiere-bedingten (Austern) Infectionen - 1968.

2) Research on the pollution of the sea-water of the Gulf of Thessaloniki - 1971.

3) Analysis of the sea-water polluting fatty substances by Gas-Chromatography - 1971.

4) Purifications of sewage from microorganisms through the action of Entomostraca of the genus Daphnia of the order Cladocera - 1971.

5) Mediterranean Pilot study on Environmental degradation and pollution from Coastal development. Pollution in the Thermaic Gulf - 1973.

6) Les résultats des examens de l'eau de mer du golfe de Thessalonique du 26.5.77 jusqu' a Mars 1978. (1978).

7) Observations sur la pollution (Chimique et microbienne) du Golfe de Thessalonique pendant les dernieres dix annees (1968-1978) - 1978.

8) La pollution des rivières de la Grèce du Nord. - 1978.

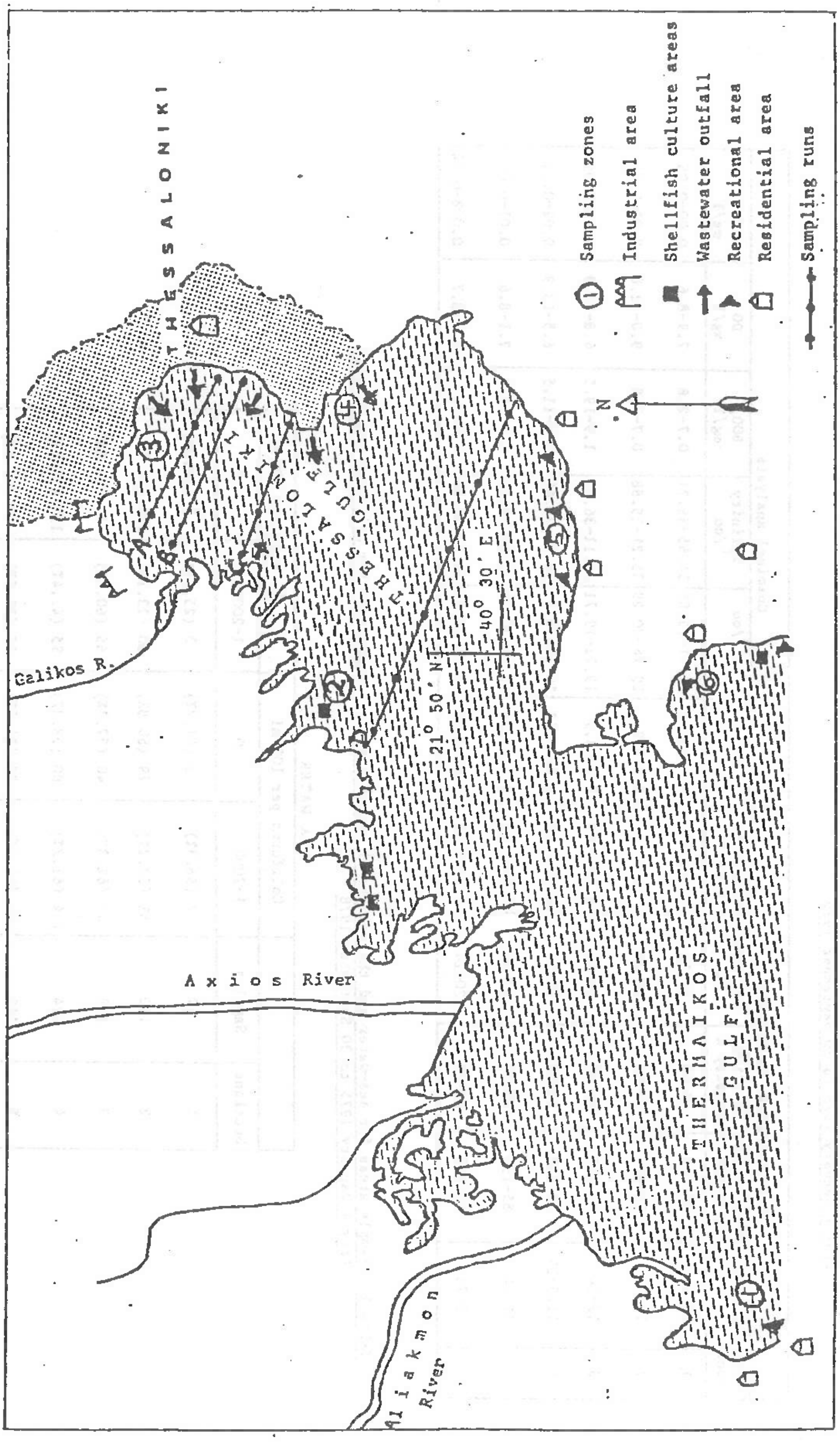

T H E S S A L O N I K I
THESSALONIKI GULF
THERMAIKOS GULF
Galikos R.
A x i o s River
A l i a k m o n River
21° 50' N
40° 30' E
N
Sampling zones
Industrial area
Shellfish culture areas
Wastewater outfall
Recreational area
Residential area
Sampling runs

Table 1: Results of chemical analysis of 714 samples of sea-water from the Gulf of Thessaloniki from 1 January 1975 to 30 September 1978

Meteorological conditions						Chemical analysis						
Sec-tions	Air temp. °C	Wind velocity m/min.	Relative humidity %	Sea temp. °C	Turbidity (Secchi)	pH	Cl °/oo	Salinity °/oo	BOD_5 mg/l	DO mg/l	Pb mg/l
1	13-25	80-180	65-80	16-22	1-2.5	8.01-8.40	19.51-19.85	34.65-36.71	0.7-2.8	7.9-8.6	0.00-0.05
2	12-23	55-90	73-85	18-20	1-3	8.6-8.9	19.16-20.29	35.21-35.88	0.7-7.8	9.0-12.6	0.01-0.04
3	17-24	90-110	75-88	19-23	0.30-0.80	8.03-8.9	19.21-19.71	35.11-36.60	1.9-19.5	6.8-14.9	0.03-0.05
4	11.5-25	40-230	50-88	18-24	0.50-1.25	8.02-8.42	19.18-20.21	34.74-36.60	0.8-11.5	6.5-13.9	0.02-0.11
5	11-24	85-190	75-77	17-20	0.80-1.25	8.11-8.55	19.51-20.29	35.28-36.65	1.9-10.1	7.1-8.6	0.01-0.04
6	17-23	90-103	73-77	20-24	0.50-1.25	7.64-8.95	19.74-19.85	35.53-35.86	1.6-2.7	8.1-8.7	0.008-0.04

Table 2: Sample areas for sea-water and the results of microbiological examination for coliforms and E. coli from 1 January 1975 to 30 September 1978

SEA WATER

		Coliforms per 100 ml		*E. coli* per 100 ml	
Sections	Samples	1-2000	0	1-2000	0
1	12	7 (58.3%)	5 (41.7%)	3 (25.0%)	9 (75.0%)
2	130	51 (39.2%)	79 (60.8%)	30 (23.1%)	100 (76.9%)
3	109	69 (62.3%)	40 (37.7%)	66 (60.5%)	43 (39.5%)
4	224	144 (61.2%)	80 (38.8%)	95 (42.4%)	129 (57.6%)
5	149	96 (64.4%)	53 (35.6%)	59 (39.5%)	90 (60.5%)
6	90	44 (48.8%)	46 (51.2%)	31 (34.4%)	59 (65.6%)
Total	714	411 (57.5%)	303 (42.5%)	284 (39.7%)	430 (60.3%)

Figure 1

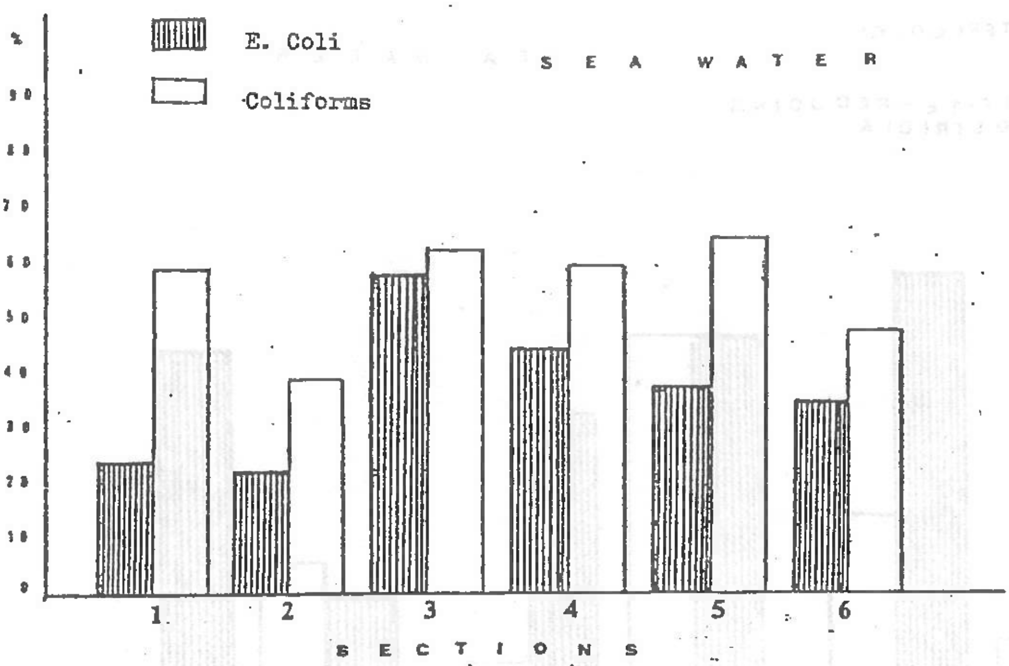


Table 3: Sample areas for sea-water and the results of microbiological examinations for enterococci and sulfite-reducing Clostridia from 1 January 1975 to 30 September 1978

SEA WATER

		Enterococci per 100 ml		Sulfite-reducing Clostridia per 100 ml	
Sections	Samples	1-1000	0	1-1000	0
1	21	6 (28.5%)	15 (71.5%)	5 (23.8%)	16 (76.2%)
2	152	123 (80.9%)	29 (19.1%)	61 (40.1%)	91 (59.9%)
3	68	48 (70.5%)	20 (29.5%)	48 (70.5%)	20 (29.5%)
4	241	141 (58.5%)	100 (41.5%)	48 (19.9%)	193 (80.1%)
5	179	54 (30.1%)	125 (69.9%)	63 (35.1%)	116 (64.9%)
6	53	36 (67.9%)	17 (32.1%)	8 (15.1%)	445 (84.9%)
Total	714	408 (57.1%)	306 (42.9%)	233 (32.6%)	481 (67.4%)

Figure 2

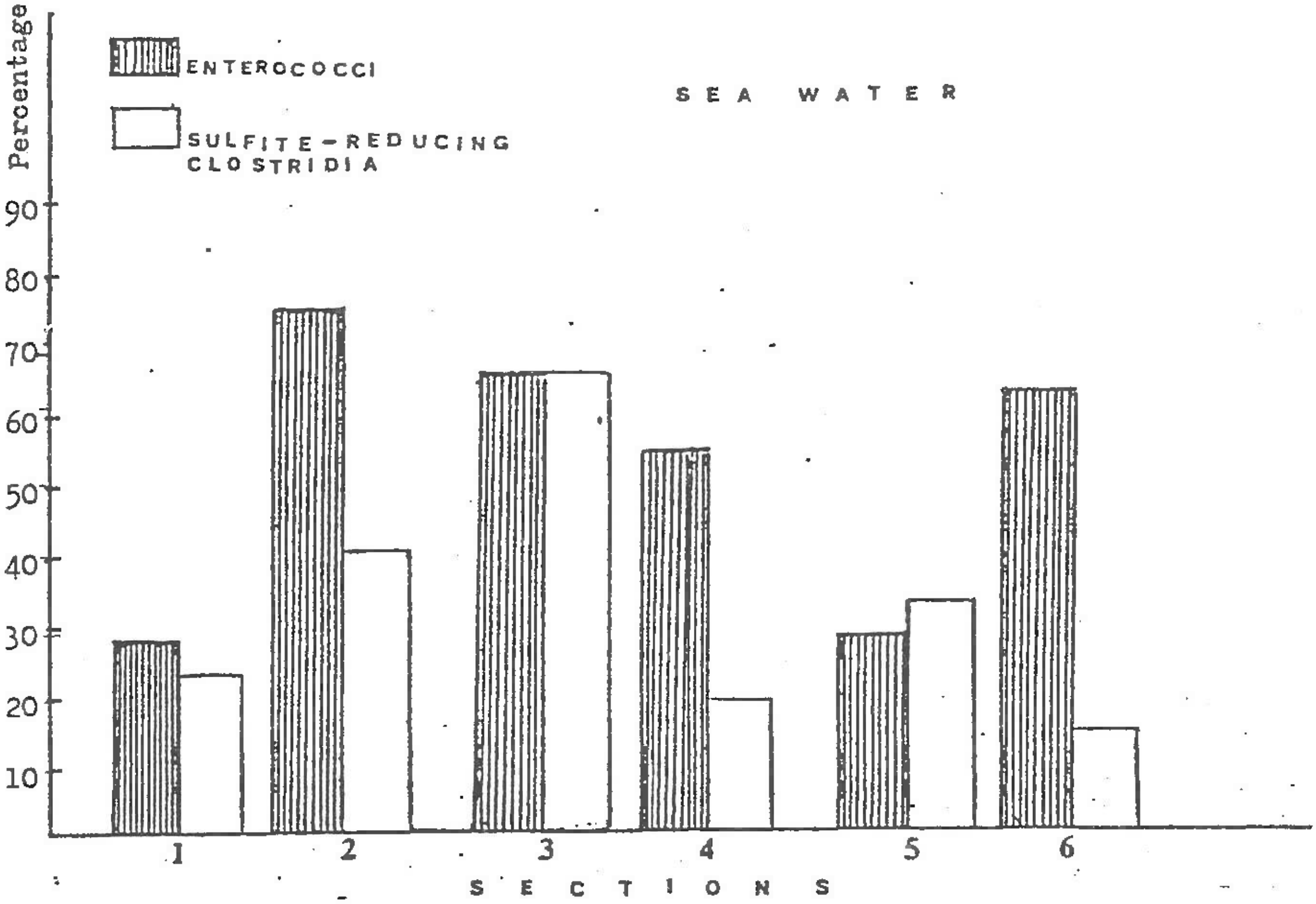


Table 4: Sample areas for sediment and the results of microbiological examination for coliforms and E. coli from 1 January 1975 to 30 September 1978

SEDIMENT

		Coliforms				E. coli			
Sections	Samples	Pos.	%	Neg.	%	Pos.	%	Neg.	%
4	132	70	53.1	62	49.6	24	18.2	108	81.8
5	38	38	100.0	0	0.0	21	55.2	17	44.8
6	29	8	27.5	21	72.5	2	6.8	27	93.2
Total	199	116		83		47		152	

Figure 3

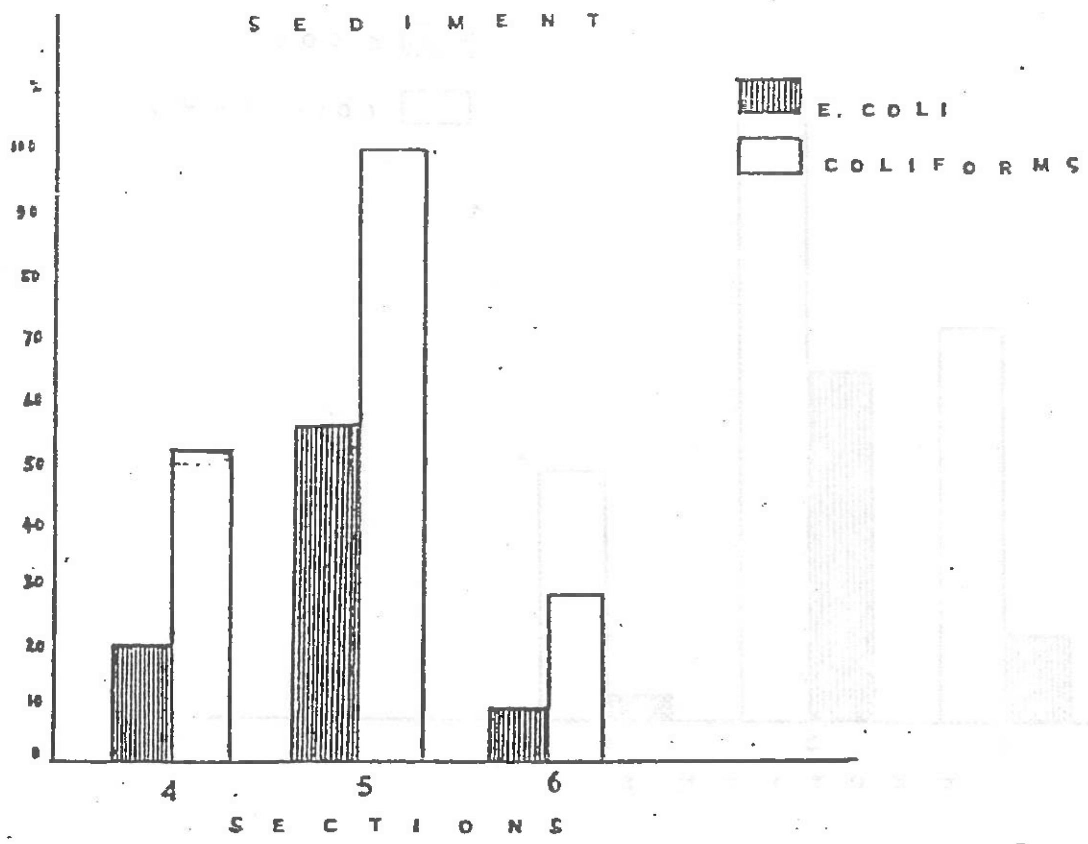


Table 5: Sample areas for coastal sand and the results of microbiological examination for coliforms and E. coli from 1 January 1975 to 30 September 1978

COASTAL SAND

		Coliforms				E. coli			
Sections	Samples	Pos.	%	Neg.	%	Pos.	%	Neg.	%
4	132	78	59.1	54	40.9	18	13.6	114	86.4
5	38	37	97.4	1	2.6	20	52.6	18	47.4
6	29	11	37.9	18	62.1	1	3.4	28	96.6
Total	199	126		73		39		160	

Figure 4

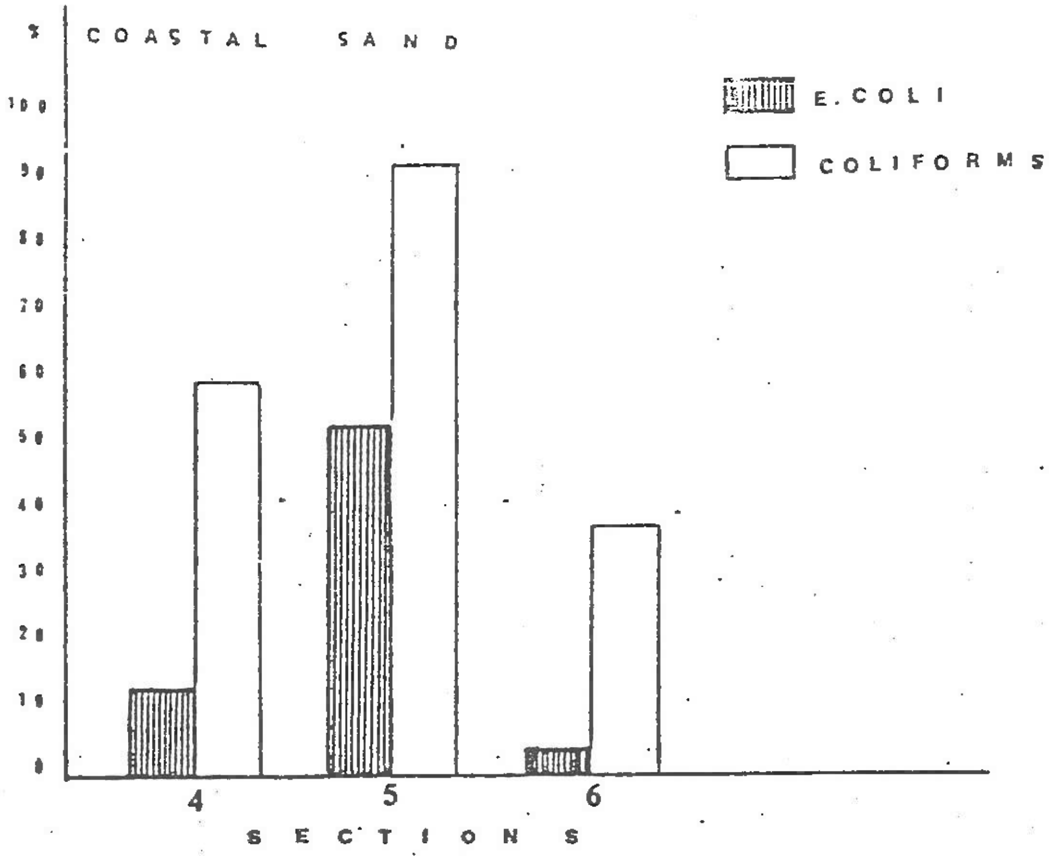


Table 6: Sample areas for sediment and the results of microbiological examination for enterococci and sulfite-reducing Clostridia from 1 January 1975 to 30 September 1978

SEDIMENT

		Enterococci				Clostridia			
Sections	Samples	Pos.	%	Neg.	%	Pos.	%	Neg.	%
4	113	78	69.1	35	30.9	69	61.1	44	38.9
5	59	24	40.6	35	59.4	25	42.4	34	57.6
6	27	25	92.5	2	7.5	15	55.5	12	44.5
Total	199	127		72		109		90	

Figure 5

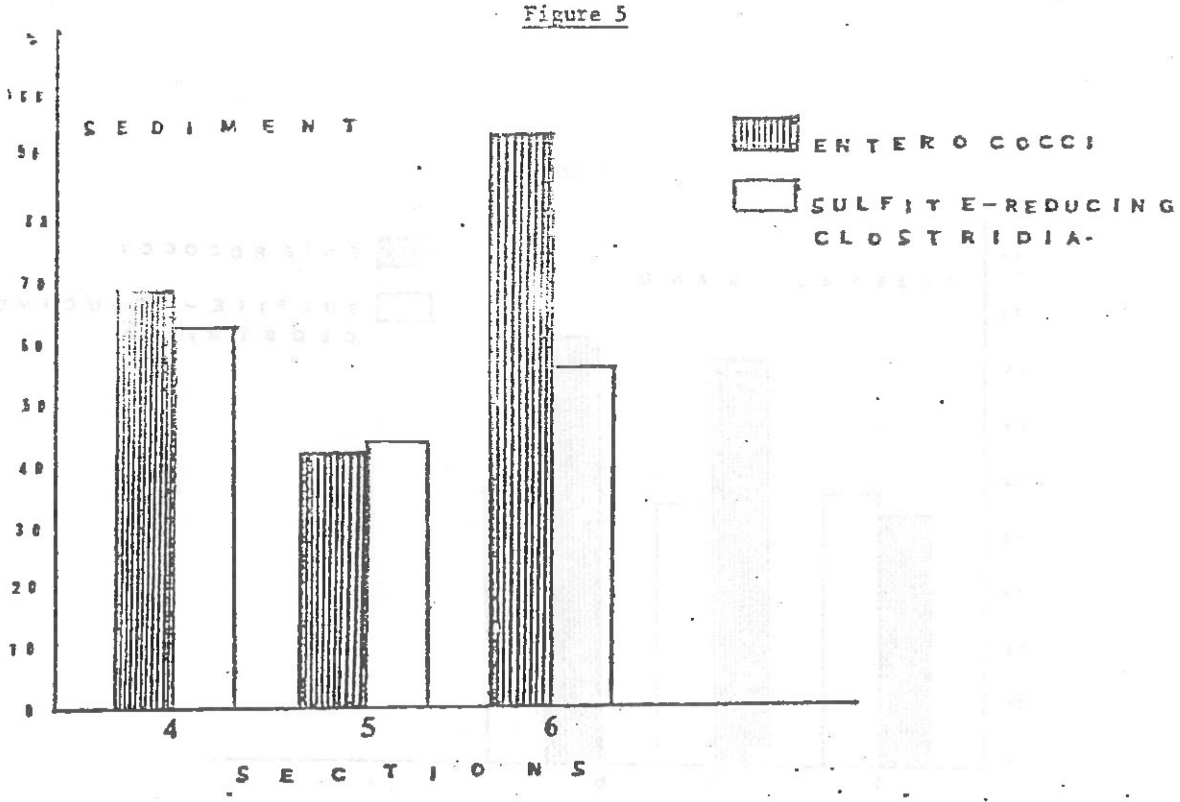


Table 7: Sample areas for coastal sand and the results of microbiological examination for enterococci and sulfite-reducing Clostridia from 1 January 1975 to 30 September 1978

COASTAL SAND

		Enterococci				Clostridia			
Sections	Samples	Pos.	%	Neg.	%	Pos.	%	Neg.	%
4	113	53	46.9	60	53.1	57	50.4	56	49.6
5	59	44	74.5	15	25.5	28	47.4	31	52.6
6	27	21	77.3	6	22.3	I4	51.8	13	48.2
Total	199	118		81		99		100	

Figure 6

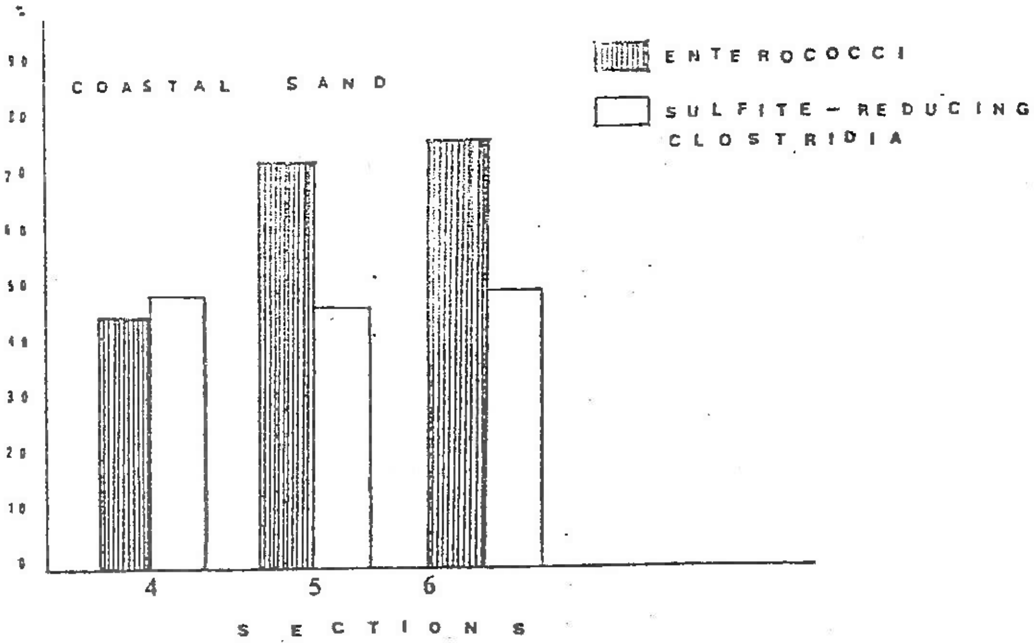


Table 8: Results of microbiological and chemical examination of 540 (108x5) samples of shellfish from the Gulf of Thessaloniki from 1 January 1975 to 30 September 1978

ISOLATED MICROORGANISMS	SAMPLES
Coliforms	86
E. coli	74
Staphylococci coagulase positive	35
Sulfite-reducing *Clostridia*	57
Enterococci	62
Serotype of *E. coli* O_{55}/B_5	1
Serotype of *E. coli* O_{26}/B_6	1
Serotype of *E. coli* O_{125}/B_{15}	3
Salmonella typhi	1
Shigella sonnei	10
Proteus	8
Pb mg/l	1.25-4.25
Hg mg/l	0.02

Participating Research Centre: Environmental pollution control project
Ministry of Social Services
ATHENS
Greece

Principal Investigator: J.A. PAPADAKIS/M. THALASSINOU-TZATZANI/
A. SOTIRACOPOULOS

Introduction:

The Ministry of Social Services participates in project MED VII through its three laboratories:

a) Environmental Pollution Control Project

b) Athens School of Hygiene, and

c) Central Public Health Laboratory

Because the above laboratories are monitoring the coastal water quality in the same geographical area, the monitoring work has been allocated according to their data collection and analysis capabilities and co-ordinated by the above Project.

A survey during the period 1962-77 of a number of bathing beaches near Athens, using the mean value MPN of coliforms for sea-water and carried out for the most part during the bathing season (15 May to 15 October), revealed the influence of land-based sources of pollution on the quality of the sea-water.

As a result of the above study and the yearly routine examination of beaches, the Ministry of Social Services has forbidden bathing at some beaches of the Athens area and taken appropriate measures to improve the quality of others.

Since the establishment of the Environmental Pollution Control Project, a broad sampling network was developed and progressively extended, reaching 72 sampling stations.

The Central Public Health Laboratory has been involved in the microbiological examination of recreational coastal water as well as shellfish culture areas since 1965.

Area(s) studied:

Four bathing beaches along the Attica peninsula were chosen as sites for MED VII recreational multiple sampling monitoring and one as a site for shellfish area monitoring: Alimos, Varkiza, Ag. Marina, Lagonissi (the latter chosen as reference beach), and Loutropyrgos as a shellfish-growing area. The exact location of the above beaches is shown on figure 1 attached.

Materials and methods:

The "Guidelines for Health Related Monitoring of Coastal Water Quality" (WHO, 1977) were used as the basic document for the implementation of the work undertaken. More specifically the following methods and materials were used for each of the parameters monitored:

Sea-water samples:

Total coliforms: (a) Multiple tube method with glutamate modified for sea-water (Papadakis, 1975); (b) Membrane filtration method with M-endo agar according to the Guidelines as well as with Teepol broth. The m-FC agar proposed at the Rome meeting (May 1977) was found unsatisfactory. Dilutions were made with phosphate buffer.

E. Coli: (a) Multiple tube method (as above) with differentiation at 44°C (gas from lactose, indole positive); (b) Membrane filtration method according to the Guidelines.

Faecal Streptococci: Membrane filtration method according to the Guidelines.

Pathogens: (a) Salmonellae - filtration through membranes incubated in buffer phosphate for 20-24 hours at 37°C and subculture in modified Rappaport's medium and Muller-Kauffman's tetrathionate broth at 43°C. Enrichment media were plated on brillant green lactose-sucropse agar; (b) Vibrio-filtration through membranes incubated in alkaline peptone water for 6-8 hours and subculture on TCBS agar.

Sediment samples:

In accordance with the Guidelines, sediments were shaken for 30 minutes in phosphate buffer and dilutions were made, of which 1 ml was examined with the pour plate technique.

(a) Total coliforms: Teepol agar; (b) Faecal coliforms: M-FC agar;
(c) Faecal streptococci: K-F agar.

Beach material samples:

(a) Total coliforms; (b) Faecal coliforms and
(c) Faecal streptococci.

The beach materials were examined according to the Guidelines, using the multiple tube technique. The amount of beach material samples processed was 100 g.

(d) Pathogens: Beach material pathogens were examined using similar methodology to that used in shellfish-growing areas (see below).

(e) Fungi: The spread plate technique was employed using rose bengal agar as it is described in the "Method for Microbiological Analysis of Waters, Wastewaters and Sediments" (Inland Waters Directorate, Canada Centre for Inland Waters, Burlington, Ontario, Canada).

Shellfish area samples:

(a) Total coliforms, (b) Faecal coliforms and (c) Faecal streptococci were all examined on the shellfish flesh, sea-water and sediments of the area, using the multiple tube technique with sodium azide broth as presumptive medium and ethyl azide broth as the confirmatory medium. The amount of shellfish flesh, including the sediment sample processed for the analysis, was 100 g.

(d) Pathogens: the following pathogens were examined on shellfish flesh, sea-water and sediments: Salmonellae, Shigella, Vibrio cholerae and non-agglutinable vibrios, and Vibrio parahaemolyticus. All these tests were performed in accordance with the suggested guidelines. For the Vibrio parahaemolyticus, teepol salt broth was used as enrichment medium instead of the G. Pselichidic salt meat broth. For the Salmonellae test, the pre-enrichment procedure was applied.

Beach sanitary surveillance

The four recreational areas monitored were also surveyed from the sanitary point of view during each sampling. Both the beach and sea-water area were examined and classified according to the Garber code.

Salinity:

Salinity was measured by the hydrometric method, based on the specific weight, and by the argentometric method as described by the US AWWA Standards.

Turbidity:

The Secchi disc method was not applied because of the shallowness and cleanliness of the waters of 10 m from the coastline. Turbidity was therefore measured by the nephelometric method using a turbidimeter as well as by comparison with original SiO_2 suspensions.

Dissolved oxygen:

This was measured by the Winkler method in situ while only the final titration was carried out at the laboratory.

Temperature:

This was measured in situ by simple thermometres.

Meterological data:

Specific meteorological data from two meteorological stations were collected in view of possible correlation between wind and coastal pollution.

Dynamic conditions:

Data on tides were requested from the Army Hydrographic Services. Waves were usually evaluated. Current data presented some difficulties and no information was available for surface currents.

Hydrographic conditions:

The required hydrographic data were collected locally at the sampling points.

Results and their interpretation:

Sea-water

Generally, low densities for coliforms and even lower for faecal coliform organisms were found, except for the two sampling points at which, during October 1977, rather high values of both indicator organisms were noted.

Faecal streptococci were not found consistently lower or higher than faecal coliforms.

The low coliform and especially the very low faecal coliform densities indicated that the monitoring areas are free from sewage pollution and their waters are of excellent quality for bathing and recreational activities.

Pathogens, Salmonellae, Shigella and V. cholerae were not found except at one sampling point from which salmonellae were isolated only once during October 1977 when the area was accidentally polluted by sewage. Non-agglutinable vibrios were occassionally found at all sampling points except for the two points of the reference area.

Sediments

The densities of coliform per gram, found in sediments of all sampling points, are rather low, with the highest values observed during the summer months.

Faecal coliform organisms were generally absent with a few exceptions, but faecal streptococci were observed at levels approaching the coliform densities.

There was a fluctuation for both coliforms and faecal streptococci, the highest densities being found during the summer months of both years.

Beach materials

Sand was the only beach material examined from the microbiological point of view. Our data indicate that occasionally there is some bacterial contamination with coliforms and faecal streptococci. Fungi were consistently present at all the sampling points.

Shellfish-growing area

The water quality of the shellfish-growing area was found to be within the proposed WHO/UNEP standards (Rome 1978) for all samples, while the shellfish flesh quality exceeded them only once.

Beach sanitary surveillance

Suveillance of the sanitary conditions of beaches has shown that at some stations there is a permanent accumulation of rubbish originating from sea-water, beach and domestic refuse, while in others there is only occasional accumulation of some of the above-mentioned litter.

Intensive growth of algae occurs during spring and summer offshore near polluted areas. A considerable population of jelly fish have also occurred recently.

Wind conditions

During MED VII samplings, the winds were quite variable in dirction, particularly at point C (Ellinikon airport), while wind speeds were rather low (0.1-0.4 m/sec) on most of the sampling days. The maximum wind speed during the respective months ranged between 7 and 13 m/sec.

A correlation of winds and pollution of the beaches has been experienced.

Wave conditions

Wave conditions during MED VII sampling days were mostly of rate 1 and 2, i.e. calm and nearly calm with only one exception in January 1978 (rough).

Tidal conditions

The tidal range during MED VII samplings was quite limited. The flood tide ranged from 0.02 to 0.08 while the ebb tide ranged from 0 to 0.21 in relation to respective monthly mean sea-level. No considerable effect, as far as pollution is concerned, is expected from tidal ranges of this order of magnitude.

Currents

The available data for currents do not provide sufficient information on the water movement along the coasts, because they are limited to only one point (D) and also refer to comparatively deep waters (25 m), and they do not give any information on the surface water movements, which are most important for coastal water quality, in relation to pollution transfer.

Publications:

1. Environmental Pollution Control Project - Athens Interim Technical Report Vol. III Athens, December 1975.

2. Quality of Coastal Waters-Environment Pollution Control Project Athens drafted report, May 1977 (unpublished).

3. Hopkins T.S. and Becacos-Kontos T. (1977) Some parameters indicating the distribution of Pollution in the Upper Saronikos Gulf XXIII CIESM Congress Athens.

4. Alivisatos G.P. and J.A. Papadakis (1975a) MacConkey and glutamate media in the bacteriological examination of seawater. J. appl. Bact. 39, 287
Papadakis J.A. (1975b). Bacteriological examination of seawater.

5. Papadakis J.A. (1976). American and English methods of multiple tubes for the examination of seawater. Acta Microbiol. Hellen. 21, 255.

6. Biological Indicators of Pollution in Saronikos Gulf. S. Sotiracipoulos, M. Andriotis and D. Spala. 3rd Panhellenic Medical Congress Athens May 1977.

Figure 1

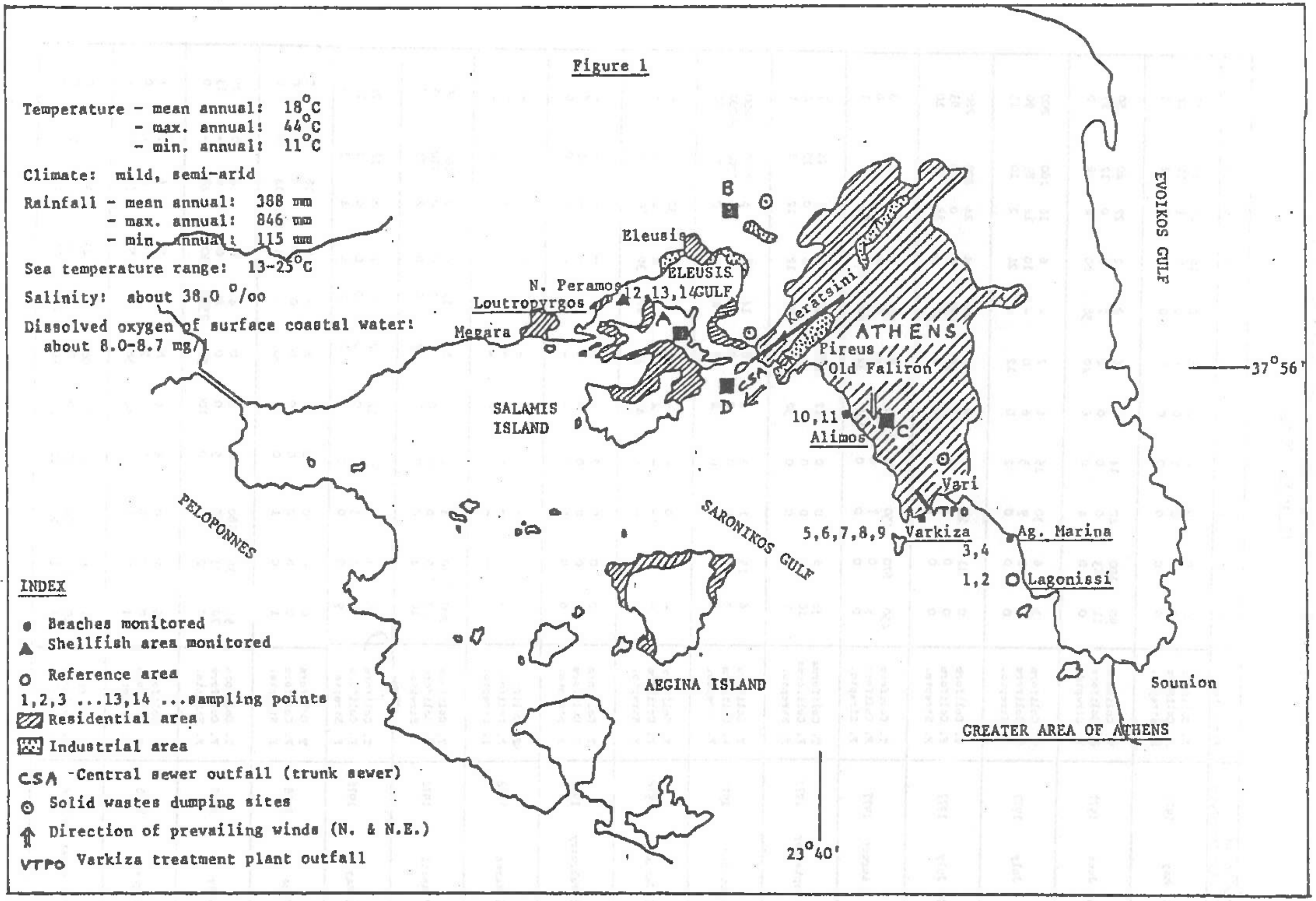

Temperature - mean annual: 18°C
- max. annual: 44°C
- min. annual: 11°C
Climate: mild, semi-arid
Rainfall - mean annual: 388 mm
- max. annual: 846 mm
- min. annual: 115 mm
Sea temperature range: 13-25°C
Salinity: about 38.0 °/oo
Dissolved oxygen of surface coastal water: about 8.0-8.7 mg/l
EVOIKOS GULF
37°56'
B
Eleusis
ELEUSIS GULF
N. Peramos
12,13,14
Loutropyrgos
Megara
A
Keratsini
ATHENS
Pireus
Old Faliron
CSA
D
SALAMIS ISLAND
10,11
Alimos
C
Vari
VTPO
5,6,7,8,9
Varkiza
3,4
Ag. Marina
1,2
Lagonissi
PELOPONNES
SARONIKOS GULF
AEGINA ISLAND
Sounion
GREATER AREA OF ATHENS
23°40'
INDEX
Beaches monitored
Shellfish area monitored
Reference area
1,2,3 ...13,14 ...sampling points
Residential area
Industrial area
CSA -Central sewer outfall (trunk sewer)
Solid wastes dumping sites
Direction of prevailing winds (N. & N.E.)
VTPO Varkiza treatment plant outfall

TABLE I

Recreational Water Multiple Sampling

Sea Water- Total Coliforms, Faecal Coliforms and Faecal Streptococci

(All in No./100 ml)

Date / No. of Sampling Point	Parameters	1	2	3	4	5	6	7	8	9	10	11
17 May 1977	T. Coliform	0	0	0	0	1	5	1	18	18	29	35
	F. Coliform	0	0	0	1	0	1	0	9	1	11	14
	E. Strepto.	0	0	0	0	0	8	0	0	5	2	3
14 June 1977	T. Coliform	90	100	40	14	0	6	2	2	22	40	50
	F. Coliform	11	13	0	0	0	4	2	0	0	12	17
	F. Strepto.	0	0	4	0	6	40	58	80	2	0	0
4 July 1977	T. Coliform	3	6	30	16	6	2	-	6	16	160	200
	F. Coliform	1	2	9	5	6	0	-	10	12	89	90
	F. Strepto.	0	0	0	2	0	12	-	24	2	10	13
25 July 1977	T. Coliform	0	11	13	7	0	66	76	4	24	220	260
	F. Coliform	0	0	3	0	2	60	28	0	0	50	83
	F. Strepto.	0	0	2	0	12	6	32	0	38	40	10
3 August 1977	T. Coliform	450	670	350	69	12	0	22	8	12	7	3
	F. Coliform	9	0	7	0	4	0	8	4	8	0	0
	F. Strepto.	0	0	0	0	304	32	84	100	76	1	1
5 September 1977	T. Coliforms	31	6	0	0	12	288	36	4	4	26	7
	F. Coliforms	18	0	0	0	-	-	-	-	0	12	0
	F. Strepto.	1	0	0	0	32	72	44	12	12	1	1
3 October 1977	T. Coliform	6	15	1	3	8	8	14	18	6	8000	8000
	F. Coliform	2	13	0	0	0	0	0	6	0	1200	8000
	F. Strepto.	0	1	0	0	4	6	4	2	0	22	80
21 January 1978	T. Coliform	-	-	0	-	-	6	-	-	32	-	-
	F. Coliform	-	-	-	-	4	8	-	2	2	-	-
	F. Strepto.	-	-	-	-	44	38	10	30	60	-	-
28 February 1978	T. Coliform	2	0	0	2	-	-	-	-	-	-	-
	F. Coliform	0	0	0	0	-	-	-	-	-	25	28
	F. Strepto.	0	0	0	0	-	-	-	-	-	0	0
1 March 1978	T. Coliform	-	-	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-	-	-
17 April 1978	T. Coliform	200	30	4	2	0	14	11	6	2	800	80
	F. Coliform	35	5	0	0	0	3	0	0	0	110	2
	F. Strepto.	16	4	0	0	1	2	0	0	2	23	2
15 May 1978	T. Coliform	0	4	5	0	12	2	8	2	8	18	26
	F. Coliform	0	4	3	0	0	0	0	0	0	7	10
	F. Strepto.	9	0	0	0	0	0	0	6	4	3	1
5 June 1978	T. Coliform	0	0	0	0	2	6	2	0	18	0	0
	F. Coliform	0	0	0	0	0	0	0	0	0	0	0
	F. Strepto.	1	0	1	0	4	50	6	4	14	0	0
3 July 1978	T. Coliform	95	36	180	12	0	0	4	0	4	0	25
	F. Coliform	70	23	50	5	0	0	4	0	0	-	13
	F. Strepto.	0	2	5	0	100	54	7500	500	48	-	0
7 August 1978	T. Coliform	6	1	0	4	4	8	12	22	6	2	1
	F. Coliform	0	0	0	2	2	2	6	0	0	1	0
	F. Strepto.	4	0	0	0	64	56	57	57	36	0	0
4 September 1978	T. Coliform	23	100	75	41	22	108	8	43	30	0	0
	F. Coliform	19	41	58	17	0	0	0	2	0	0	0
	F. Strepto.	14	1	23	11	23	10	126	26	14	0	0

Table 2

Recreational Water Pollution Sampling

Sediments - Total Coliforms, Faecal Coliforms and Faecal Streptococci

(All in No./100 ml)

Date / No. of Sampling Point	Parameters	1	2	3	4	5	6	7	8	9	10	11
17 May 1977	T. Coliform	–	9	4	9	4	3	16	9	9	6	4
	F. Coliform	–	2	1	2	1	0	2	1	2	1	1
	F. Strepto.	–	2	0	2	0	0	3	2	2	1	1
14 June 1977	T. Coliform	18	4	18	2	6	18	16	16	16	16	6
	F. Coliform	0	0	0	0	0	1	2	2	2	0	0
	F. Strepto.	–	–	–	–	–	–	–	18	18	18	3
4 July 1977	T. Coliform	0	18	0	0	0	1	–	2	35	16	9
	F. Coliform	0	18	0	0	0	0	–	0	13	0	4
	F. Strepto.	0	18	12	0	0	2	–	2	10	18	6
25 July 1977	T. Coliform	4	0	0	0	0	1	1	2	3	18	18
	F. Coliform	0	4	0	0	0	1	0	0	0	4	0
	F. Strepto.	18	16	18	16	18	18	16	16	18	18	18
3 August 1977	T. Coliform	2	0	0	0	0	0	0	0	0	16	0
	F. Coliform	0	0	0	0	15	0	0	0	0	48	48
	F. Strepto.	530	56	600	0	26	193	0	25	33	309	311
5 September 1977	T. Coliform	300	0	22	10	17	12	11	6	4	33	4
	F. Coliform	5	0	10	0	–	–	–	0	–	2	0
	F. Strepto.	250	0	90	0	150	130	1	8	1	27	113
3 October 1977	T. Coliform	180	6	33	10	20	150	21	32	40	1100	900
	F. Coliform	0	0	0	0	0	5	0	0	0	250	150
	F. Strepto.	280	1	50	0	70	80	8	10	13	90	50
21 January 1978	T. Coliform	0	0	0	0	0	0	0	0	0	0	0
	F. Coliform	0	0	0	0	0	0	0	0	0	0	0
	F. Strepto.	0	0	0	0	0	0	0	0	0	2	2
28 February 1978	T. Coliform	–	–	–	–	–	–	–	–	–	–	–
	F. Coliform	–	–	–	–	–	–	–	–	–	–	–
	F. Strepto.	–	–	–	–	–	–	–	–	–	–	–
1 March 1978	T. Coliform	–	–	–	–	–	–	–	–	–	–	–
	F. Coliform	–	–	–	–	–	–	–	–	–	–	–
	F. Strepto.	–	–	–	–	–	–	–	–	–	–	–
17 April 1978	T. Coliform	–	–	–	–	–	–	–	–	–	–	–
	F. Coliform	–	–	–	–	–	–	–	–	–	–	–
	F. Strepto.	–	–	–	–	–	–	–	–	–	–	–
15 May 1978	T. Coliform	280	20	7	33	7	3	4	10	4	130	57
	F. Coliform	0	0	0	0	0	0	0	0	0	2	0
	F. Strepto.	13	1	0	0	1	2	4	1	0	40	11
5 June 1978	T. Coliform	–	–	–	–	–	–	–	–	–	–	–
	F. Coliform	–	–	–	–	–	–	–	–	–	–	–
	F. Strepto.	20	1	1	0	0	4	0	0	0	40	6
3 July 1978	T. Coliform	100	78	188	50	25	22	50	66	11	77	25
	F. Coliform	0	0	0	0	0	0	0	0	0	0	0
	F. Strepto.	3	2	1	20	1	3	0	33	84	600	52
7 August 1978	T. Coliform	85	83	64	73	81	46	50	101	120	175	251
	F. Coliform	0	0	0	0	0	0	0	0	0	0	0
	F. Strepto.	102	81	89	12	59	45	69	78	78	435	421
4 September 1978	T. Coliform	56	7	73	73	9	0	6	0	6	1	1
	F. Coliform	0	0	0	0	0	0	0	0	0	0	0
	F. Strepto.	120	4	43	43	4	5	10	6	16	9	19

Table 3

Shellfish Multiple Sampling

Total Coliforms, Faecal Coliforms and Faecal Streptococci

Date / Sampling Point	Parameters	Sea Water No./100 ml			Sediments No./100 gr			Shellfish in situ No./100 gr		
		12	13	14	12	13	14	12	13	14
23 May 1977	T. Coliform	13	6	0	240	23	70	60	130	60
	F. Coliform	0	0	0	0	0	0	0	0	0
	F. Strepto.	0	0	0	0	0	40	0	0	0
20 June 1977	T. Coliform	23	460	23	2400	1500	430	2100	230	230
	F. Coliform	0	0	0	0	0	0	0	0	0
	F. Strepto.	0	0	0	0	0	0	0	0	0
18 July 1977	T. Coliform	43	43	23	1500	430	2400	930	230	230
	F. Coliform	4	23	4	90	0	0	40	230	90
	F. Strepto.	23	43	23	390	640	280	230	230	430
August 1977	T. Coliform	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-
18 September 1977	T. Coliform	2	0	2	2400	340	3500	80	330	1700
	F. Coliform	0	0	0	40	0	0	0	0	0
	F. Strepto.	0	0	0	5400	0	2200	0	0	2200
October 1977	T. Coliform	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-
January 1978	T. Coliform	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-
February 1978	T. Coliform	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-
6 March 1978	T. Coliform	0	0	0	260	1300	790	2400	2400	230
	F. Coliform	0	0	0	20	50	130	210	930	40
	F. Strepto.	0	0	0	0	220	460	4600	1500	0
April 1978	T. Coliform	-	-	-	-	-	-	-	-	-
	F. Coliform	-	-	-	-	-	-	-	-	-
	F. Strepto.	-	-	-	-	-	-	-	-	-
16 May 1978	T. Coliform	0	0	20	110	0	20	50	170	90
	F. Coliform	0	0	0	0	0	0	0	110	90
	F. Strepto.	0	0	0	0	0	0	0	0	0
6 June 1978	T. Coliform	240	3	4	1200	30	0	40	40	0
	F. Coliform	0	0	0	750	0	0	0	0	0
	F. Strepto.	93	0	0	430	0	0	0	0	0
4 July 1978	T. Coliform	48	0	15	230	0	0	930	0	0
	F. Coliform	7	0	0	40	0	0	0	0	0
	F. Strepto.	43	0	0	90	0	0	0	0	0
8 August 1978	T. Coliform	2400	7	4	0	0	0	0	0	0
	F. Coliform	0	4	0	0	0	0	0	0	0
	F. Strepto.	1200	0	0	0	0	0	0	0	0

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Introduction:

Pathogenic bacteria and viruses are discharged in large numbers into the sea through sewage outfalls, posing a potential health risk to consumers of shellfish bred in adjacent waters or to bathers at contaminated beaches. Although enteric bacterial concentration is rapidly reduced in the sea as a result of dilution and other factors, it has been demonstrated that the pathogens can survive long enough in sufficiently high concentration to lead to disease transmission via bathers swimming at contaminated beaches.

The introduction of uniform standards and test procedures are an essential aspect of marine pollution control. This uniformity has recently been achieved through the UNEP/WHO Mediterranean pollution monitoring and coastal programmes, in which the Environmental Health Laboratory in Israel is an active participant.

In the last five years, the Environmental Health Laboratory initiated the following projects:

a) Analysis of coastal water quality data in the Tel Aviv region during 1963-76. This included bacteriological testing and statistical analysis in co-operation with the Felix Public Health Laboratory of the Ministry of Health, Tel Aviv.

b) Field and laboratory studies on the die-away kinetics of coliforms and enteric viruses in coastal waters.

c) Development of sensitive methods for enteric virus detection in large volumes of sea-water.

Area(s) studied:

In accordance with the MED VII Plan, during the study period routine bacteriological tests were made on samples taken at three (3) main beaches designated as sampling stations. All were in Tel Aviv. About 50 per cent of the samples were also examined for enteroviral content. In addition, occasionally, samples were taken from most of the other Tel Aviv area beaches for purposes of comparison of bacteriological and viral content. (See map number 1).

At a point about 880 metres out to sea, the untreated sewage of Tel Aviv is discharged into the sea through a pipe. The closest beaches are the Tel Baruch beach, No.6, just north of the Reading power plant sewage outfall and Nachshon, No. 8a, and Hilton, No. 8b, beaches which are in the south. (The results from Stations 8a and 8b were unified under one heading. These two stations were combined for data collection purposes because they are very close to each other and provided few samples). Station No. 5, which is further north of the sewage outfall, was selected as a control station. It should be noted that there are other points at which sewage enters the sea. One major source is the Yarkon River, into which cities further inland release their sewage. Another smaller outlet outlet is at Feingold Street, No. 13b, and near Bassa, No. 14a, both of which are to be closed down.

Data on wind velocity and direction, temperature and conductivity were collected for the above-mentioned beaches. The mean wind velocity was 10 and the wind direction generally was from south to north. The temperature of the beaches studied are tabulated in table 1. This table shows the range as 17 - 27°C, with the summer-time mean as 25°C. The mean for the remaining months was 20°C. For the purpose of this study the summer-time was defined as the months of May to October, inclusive. The conductivity for these stations is presented in table 2. The mean for the entire year was 47 millimho. However, it should be noted that the summer-time mean was slightly higher (49 millimho).

Material and methods:

For the measurements of all the parameters, the methods used were those recommended by the project in "Guidelines for Health Related Monitoring of Coastal Water Quality", WHO (Copenhagen, 1977). Because these guidelines do not recommend viral tests, the organic flocculation methods for concentrating and testing viruses in sea-water were developed in our laboratory. These tests yielded a mean virus recovery of 63 per cent with seeded polio virus in 35 litre samples of sea-water.

Results and their interpretation:

The primary data have been recorded in the data forms submitted. In addition to the wind velocity, wind direction, temperature and conductivity, the following parameters were also measured: total coliform (number/100 ml.); faecal coliform (number/100 ml.); faecal streptococci (number/100 ml); and enterovirus (pfu/l.). Due to the limited number of samples tested, it was not possible to gauge each parameter's effect (including seasonal changes). Therefore, only coliform and viral count have been tabluated as requested. (See tables 3-6).

From these tables, the following can be seen.

1. The mean value of the coliform count is lower in the summer than in the reamining months (presented as "Others" in the tables). This was true at all stations but one (table 4, Station No. 8).

2. The percentage of positive enterovirus samples in the summer was 25 per cent in contrast to 70 per cent in the remaining months. This same trend was seen for the coliform.

3. If we compare table 6 to table 3, 4, 5, we observe an interesting finding. About 30 per cent of the positive enterovirus samples were found on beaches for which, in contrast, the bacterial pollution level was within the accepted "safe beach" range.

The correlation analysis between the various bacteria and the enteroviruses are presented in figures 1-3, with the details of the regression line. The presentation in these figures is based on data that are additional to the information in tables 3-6. A significant correlation was found between total coliform v. faecal coli, total coliform v. faecal streptococci and faecal coli v. faecal stretococci.

The mean ratio of positive enteric virus samples v. other positive samples was as follows:

(a) enteric viruses v. total coliform = 1 : 3.0×10^6

(b) enteric viruses v. faecal coliforms = 1 : 8×10^6

(c) enteric viruses v. faecal streptococci = 1 : 4.3×10^4

A total of 15 different enteroviruses were identified, including types of Poliovirus, Echovirus and Coxsackie virus (figure 4). In the sea, total coliforms and faecal coliforms were shown to have more rapid die-away rates than enteroviruses. The die-away rate of the faecal streptococci more closely paralleled that of the enteroviruses (figure 5).

Only two of the beaches surveyed (numbers 5 and 8) met the accepted interim microbiological quality criteria. Their mean values were under 50 faecal coliforms/100 ml. Beach number 6, however, failed to meet the criteria. Its mean value was 174 faecal coliform/100 ml.

Conclusions:

(1) In general, the number of enteric bacteria are reduced in the sea relatively more rapidly than enteroviruses.

(2) Faecal streptococci displayed a die-away rate similar to that of enteroviruses.

(3) A wide range of enteroviruses can be detected in the sea at a distance of up to five kilometres from the sewage discharge point in the sea-water.

(4) The microbiological concentration level in the sea was low in the summer as compared to the remaining months. Apparently, this is due to increased summer-time daylight and solar radiation which affects the micro-organism die-away rate.

Table 1

SEA TEMPERATURE IN SITU - SURFACE (°C)				
SAMPLING POINT	Country Club 5	Tel Baruch 6	Hilton & Nachshon 8	All Points
SAMPLE VALUES				
Date				
26.10.77	--	23.0	23.0	23.0
02.11.77	25.0	--	--	25.0
23.11.77	--	--	22.2	22.2
22.01.78	18.0	18.0	--	18.0
02.02.78	--	17.5	16.5	17.0
14.02.78	--	--	17.0	17.0
15.03.78	18.0	18.0	--	18.0
03.04.78	--	21.0	19.5	20.3
11.04.78	--	--	20.0	20.0
02.05.78	20.0	--	--	20.0
29.05.78	--	22.0	24.0	23.0
21.06.78	25.0	25.0	25.0	25.0
28.07.78	27.0	27.0	27.0	27.0
16.08.78	27.0	27.0	27.0	27.0
03.09.78	27.0	27.0	27.0	27.0
Mean values				
Summer	25.2	25.2	25.5	24.6
Others	18.0	18.6	19.0	19.7
Total	23.4	22.6	22.6	21.9
St. Deviations				
Summer	3.0	2.2	1.8	2.7
Others	0	1.6	2.3	2.8
Total	4.0	3.9	3.9	3.7

Table 2

CONDUCTIVITY - SURFACE (Millimho)				
SAMPLING POINT	Country Club 5	Tel Baruch 6	Hilton & Nachshon 8	All Points
SAMPLE VALUES				
Date				
22.01.78	47.0	47.5	--	47.3
02.02.78	--	44.9	44.5	44.7
14.02.78	--	--	44.3	44.3
15.03.78	44.9	45.0	--	45.0
03.04.78	--	42.5	47.5	45.0
11.04.78	--	--	49.0	49.0
02.05.78	48.2	--	--	48.2
29.05.78	--	52.5	52.8	52.7
28.07.78	48.0	47.0	47.0	47.3
16.08.78	47.5	48.0	48.0	47.8
Mean values				
Summer	47.9	49.2	49.3	49.0
Others	45.9	45.0	46.3	45.9
Total	47.1	46.8	47.6	47.1
St. Deviations				
Summer	0.4	2.9	3.1	2.5
Others	1.5	2.0	2.3	1.9
Total	1.3	3.2	2.9	2.6

Table 3

TOTAL COLIFORMS - SURFACE (NO./100 ML)								
SAMPLING POINT	Country Club 5		Tel Baruch 6		Hilton & Nachshon 8		All Points	
SAMPLE VALUES								
Date								
26.10.77	--		10		0		3.2	
02.11.77	60		--		--		60.0	
23.11.77	--		--		10		10.0	
22.01.78	20		380		--		85.1	
02.02.78	--		$6.0x10^{4}$		40		1513.6	
14.02.78	--		--		10		10.0	
15.03.78	$8.9x10^{3}$		980		--		2754.2	
03.04.78	--		$7.4x10^{3}$		250		1318.3	
11.04.78	--		--		500		500.0	
02.05.78	5		--		--		5.0	
29.05.78	--		200		150		147.9	
21.06.78	120		$1.7x10^{3}$		500		457.1	
28.07.78	70		$4.3x10^{3}$		24		190.5	
16.08.78	360		$1.1x10^{3}$		250		457.1	
03.09.78	42		420		10		54.9	
Log mean values								
Summer	57.5		436.5		40.7		74.1	
Others	218.8		3630.8		55.0		186.2	
Total	95.5		1000.0		46.8		166.0	
St. Deviations								
Summer	4.9		8.5		10.5		7.1	
Others	25.8		9.5		6.1		9.5	
Total	9.2		10.2		7.6		7.5	
Distribution		PC		PC		PC		PC
0 - 100	5	62	1	10	6	55	12	41
101 - 1000	2	25	4	40	5	45	11	40
+ 1000	1	13	5	50	0	0	6	19

Table 4

FAECAL COLIFORMS - SURFACE (NO./100 ML)								
SAMPLING POINT	Country Club 5		Tel Baruch 6		Hilton & Nachshon 8		All Points	
SAMPLE VALUES								
Date								
26.10.77	--		0		0		0	
23.11.77	--		--		0		0	
22.01.78	20		--		--		20.0	
02.02.78	--		$5.2x10^4$		10		537.0	
14.02.78	--		--		0		0	
15.03.78	$4.6x10^3$		530		--		1513.6	
03.04.78	--		$5.1x10^3$		40		446.7	
11.04.78	--		--		150		150.0	
02.05.78	5		--		--		5.0	
29.05.78	--		90		80		83.2	
21.06.78	80		700		30		117.5	
28.07.78	70		$1.7x10^3$		20		131.8	
16.08.78	210		750		130		263.0	
03.09.78	33		330		10		46.8	
Log mean values								
Summer	45.7		173.8		20.0		36.3	
Others	302.0		5248.1		15.7		52.5	
Total	77.6		537.0		18.1		43.7	
St. Deviations								
Summer	4.1		15.1		5.6		7.6	
Others	46.6		10.0		8.5		20.5	
Total	8.5		19.5		6.1		12.0	
Distribution		PC		PC		PC		PC
0 - 100	5	72	2	22	9	82	16	59
101 - 1000	1	14	4	44	2	18	7	26
+ 1000	1	14	3	34	0	0	4	15

Table 5

FAECAL STREPTOCOCCI - SURFACE (NO./100 ML)

SAMPLING POINT	Country Club 5		Tel Baruch 6		Hilton & Nachshon 8		All Points	
SAMPLE VALUES								
Date								
02.02.78	--		$2.5x10^4$		0		158.4	
14.02.78	--		--		0		0	
15.03.78	$1.2x10^3$		130		--		389.0	
03.04.78	--		$1.2x10^3$		20		154.8	
11.04.78	--		--		80		80.0	
02.05.78	13		--		--		13.0	
29.05.78	--		330		130		208.9	
21.06.78	40		190		50		72.4	
16.08.78	120		38		20		44.7	
03.09.78	18		180		6		26.9	
Log mean values								
Summer	32.4		144.5		29.5		46.8	
Others	1200.0		1584.9		39.8		60.3	
Total	67.6		398.1		13.8		53.7	
St. Deviations								
Summer	2.7		2.5		3.7		2.8	
Others	--		14.1		2.6		10.5	
Total	6.2		8.1		6.5		5.6	
Distribution		PC		PC		PC		PC
0 - 100	3	60	1	14	7	88	11	55
101 - 1000	1	20	4	57	1	12	6	30
+1000	1	20	2	29	0	0	3	15

Table 6

ENTEROVIRUS - SURFACE (PFU/L)				
SAMPLING POINT	Country Club 5	Tel Baruch 6	Hilton & Nachshon 8	
SAMPLE VALUES				
Date				
26.10.77	--	--	2/70	
02.11.77	0/85	--	--	
23.11.77	--	--	0/85	
22.01.78	1/50	4/70	--	
02.02.78	--	--	0/85	
14.02.78	--	--	1/85	
15.03.78	7/85	8/50	--	
03.04.78	--	7/80	7/80	
02.05.78	0/85	--	--	
29.05.78	--	0/85	0/85	
				All Points
No. of Positive	PC	PC	PC	PC
	2 50	3 75	3 50	8 57
No. of Negative				
	2 50	1 25	3 50	6 43

Figure 1: Correlation between coliforms and viruses found at beaches

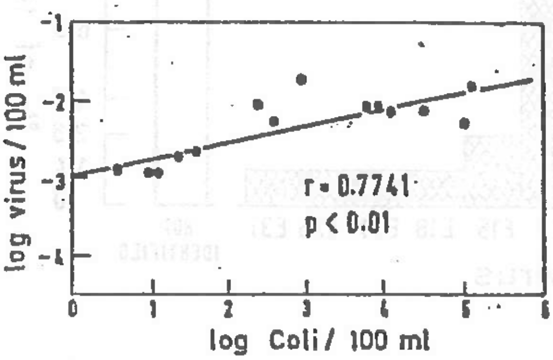


Figure 2: Correlation between faecal coli and viruses found at beaches

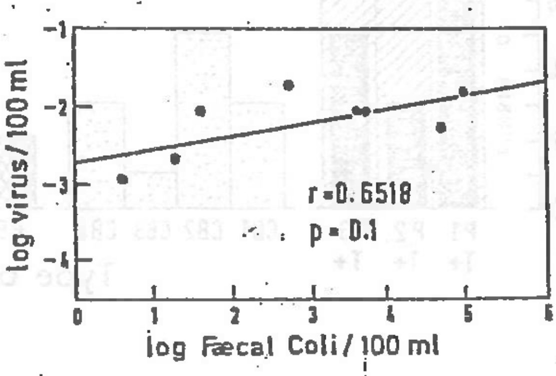


Figure 3: Correlation between faecal streptococci and viruses found at beaches

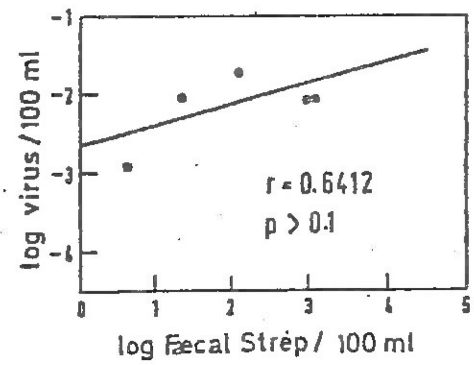


Figure 4: Types of viruses found at beaches

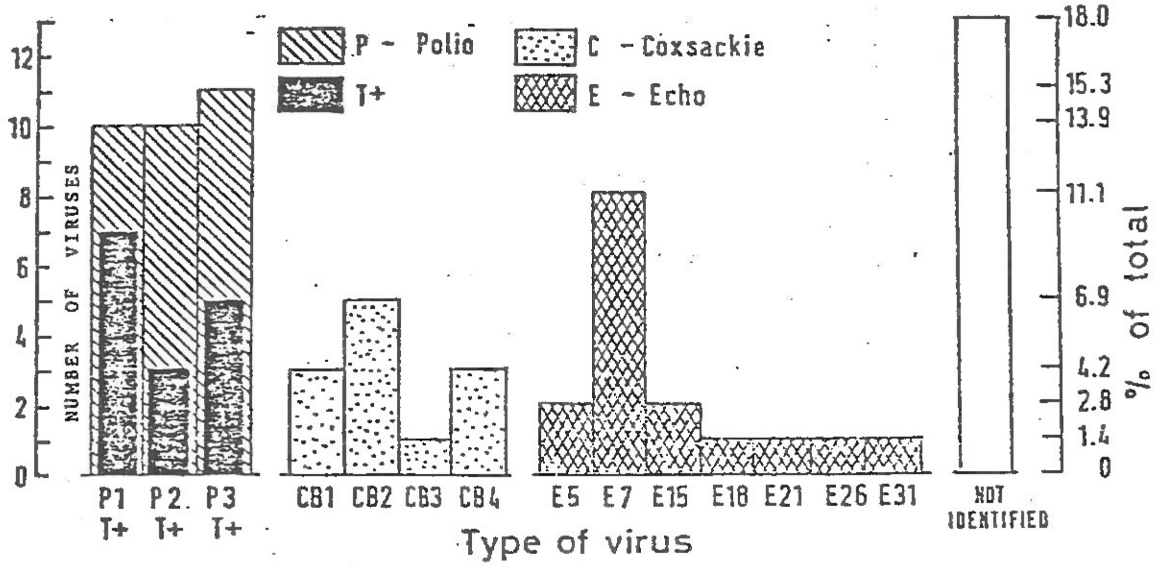
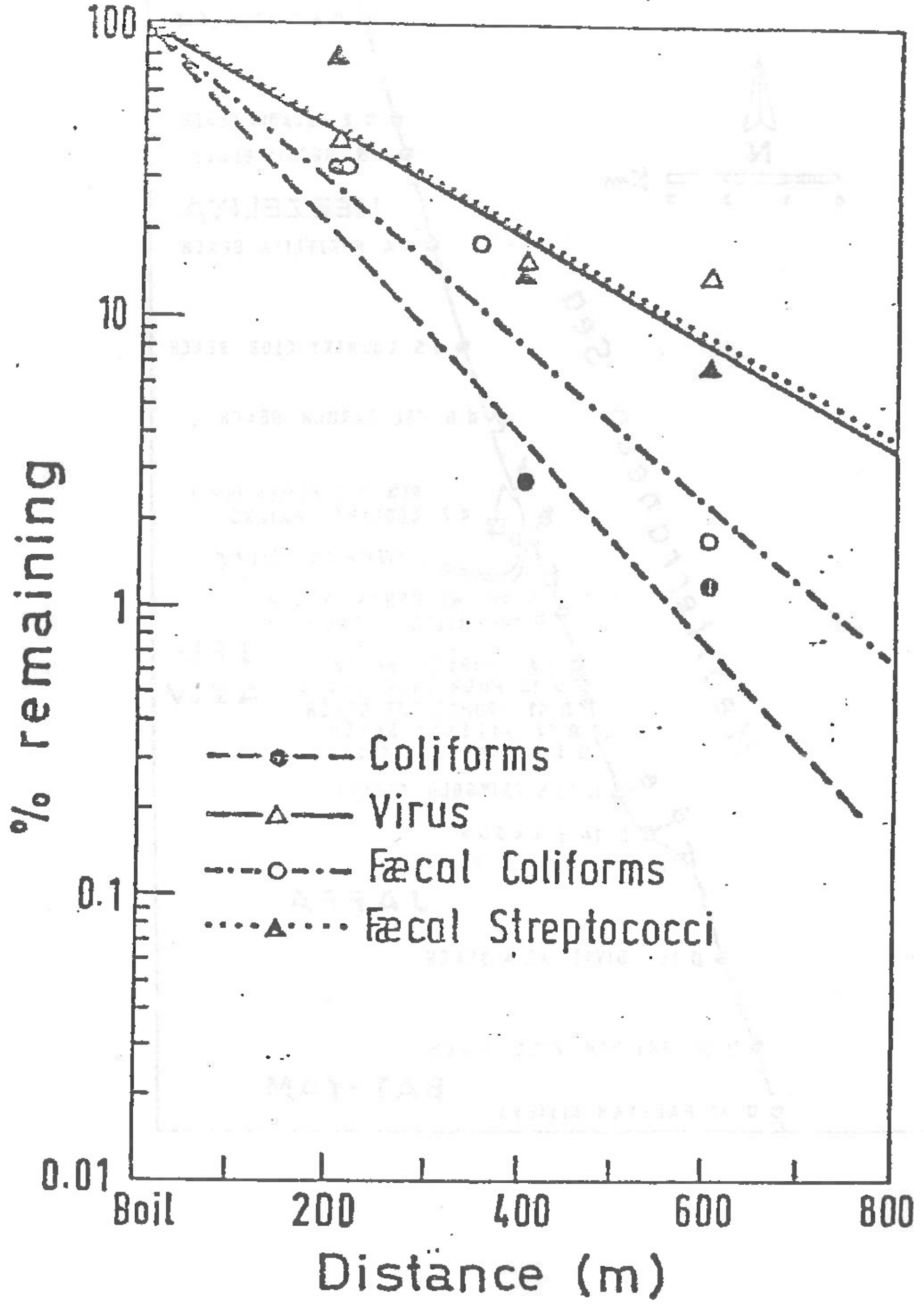
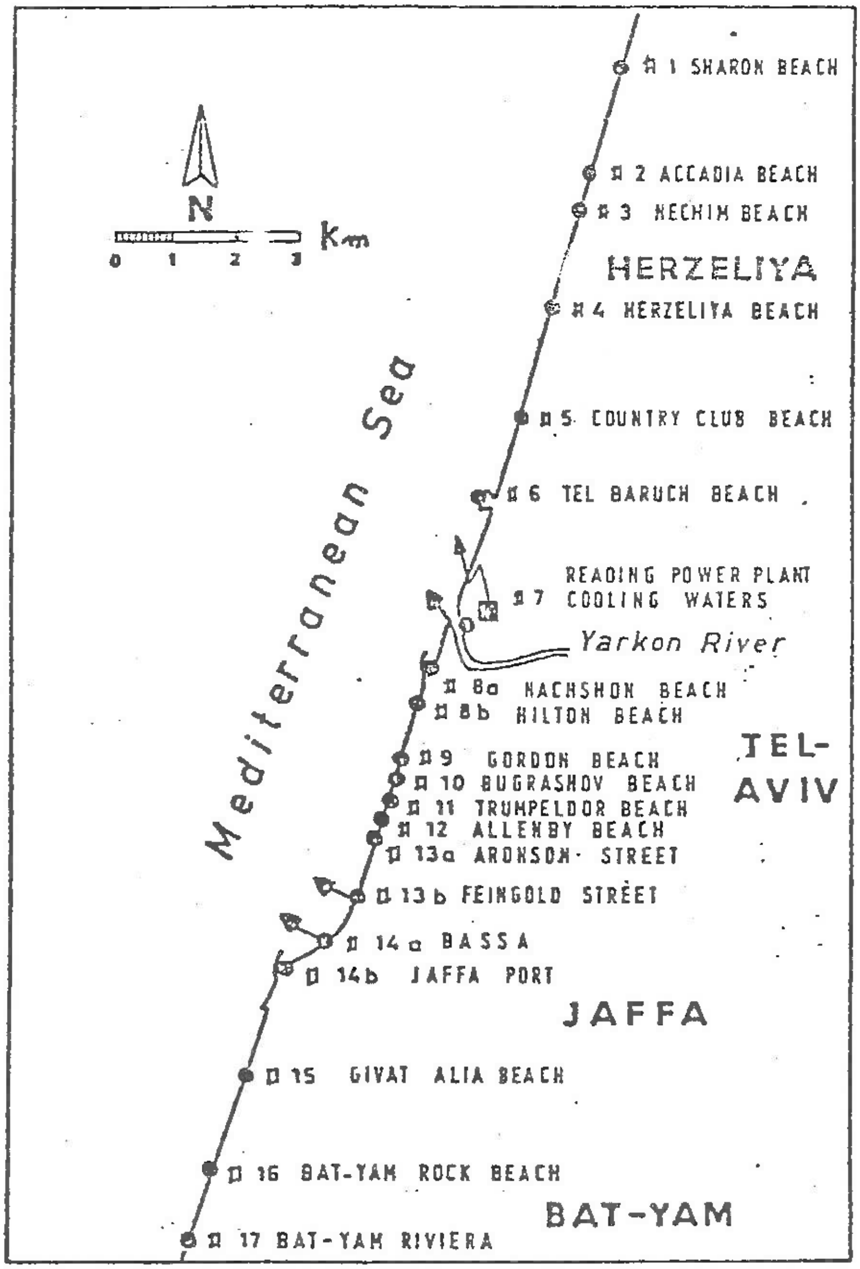


Figure 5: Disappearance of enteric microorganisms at various distances from the point of discharge



Map no. 1: Tel Aviv's Coastal Region in which samples were taken



Participating Research Centre: Environmental and Water Resources Engineering Division
Technion City - Israel Institute of Technology
HAIFA
Israel

Principal Investigator: N. BURAS/Y. KOTT

Introduction:

In recent years a number of studies on the recovery and survival of pathogens in sea-waters have indicated the presence of Salmonellae as well as enteric viruses in coastal waters, even when the coliforms densities were low. The pathogens survived for long periods of time in wastewater and their concentration was usually higher in sediment than in sea-water. As the coliform bacteria (the indicators of pollution) are relatively sensitive to the marine environment, the question arose whether it would not be advisable to use a more suitable organism as indicator of pollution in the marine environment.

Previous studies carried out in the laboratory showed that E. coli bacteriophages were more resistant than E. coli bacteria to marine environmental conditions. It was proposed therefore to study and compare the recovery of coliform bacteria, of Salmonellae, E. coli B bacteriophages and human enteric viruses from various coastal waters and sediment samples.

Area(s) studied:

For this study three sampling points were chosen, all located in the Haifa Bay: one at the southern entrance to Haifa, in a residential area (location I) (see attached map), the second in the eastern part of the Bay, in the centre of the industrial area (location II) and the third in an unpolluted area along the sea shore.

Sampling point 1 (location I), at the Tirat Hacarmel outfall (10,000 people community) where mainly treated domestic wastewater is discharged into the sea. The wastewater treatment consists of settling in an Imhoff Settling Tank, and collection into two oxidation ponds. The retention time in each of the ponds is four days. (A total of eight days). The flow rate of the effluent into the sea is 2,000 m^3/day. Frequently, when the quantity of the incoming wastewater is too large, it is made to by-pass the treatment plant and is reintroduced directly into the effluent channel which is discharged into the sea.

The area surrounding the outfall consists of consolidated sand dunes; the beach is sandy and smooth.

The currents at the sampling point flow in a south-east direction. The ground water in the area is in the form of a shallow aquifer.

Sampling point II (location II) is in the eastern part of the Haifa Bay, at the mouth of the Kishon River (see attached map) in the centre of the industrial area.

Feeding the Kishon River are: (1) secondary effluent of the Haifa Treatment Plant. The flow of the effluent is at a rate of 30,000 m^3/day (more than three times the original volume of the river, (2) wastes from a textile factory (mainly dyes), (3) wastes from petrochemical factories, (4) wastes from an oil refinery.

The surrounding land consists of sandy soil. The ground water is a shallow aquifer.

Being heavily polluted the Kishon River does not constitute a water resource. It flows into the sea and as a result the whole area is heavily polluted.

Sampling point III (location III) is an unpolluted sea shore, situated north of the first sampling point. The surrounding area consists of consolidated sand dunes. The beach is sandy.

At location III a number of points have been sampled:

This summer, contrary to usual custom, the effluent has been used for the irrigation of cotton crops. As a result wastewater (or effluent) has not been discharged into the sea during the summer months. The discharge into the sea has been resumed during the month of September. The samples examined at location I have been collected therefore between the end of September and the end of December.

Monthly sampling at all points will continue throughout the year.

Before choosing location I as the sampling point, a number of additional locations have been tested. They are all situated in the vicinity of Tirat Hacarmel (location I) and have very similar characteristics. The results obtained have been summarized in table 2.

Samples were collected as follows:

(a) From the wastewater discharge,

(b) 50 m. north of the outfall, and

(c) 50 m. south of the outfall into the sea.

At each point, water and sediment samples were collected.
The samples were brought immediately to the laboratory and tested.

Material, methods and parameters measured:

Tests for recovery of the following organisms were performed on each sample:-

1. Coliform bacteria

2. Faecal coliform bacteria

3. Salmonellae

4. Bacteria that grow on nutrient agar

5. E. coli bacteriophages

6. Human enteric viruses

On a number of samples the presence of Vibrio parahaemolyticus was also tested. The tests for the recovery of coliforms and faecal bacteria were included.

1. Filtration on membrane filters (growth on MFC medium with incubation at 35°C and 44.5°C).

2. MPN multiple tube fermentation (presumptive and confirmed) and growth of Ec medium with incubation temperature at 44.5°C for faecal coliform bacteria.

3. Enrichment of tetrathionate and selenite medium for the recovery of Salmonellae.

4. Standard plate count on nutrient agar.

5. MPN-phage for the recovery of E. coli B bacteriophages.

6. Concentration of sea-water samples on membrane filters and elution with 3 per cent beef extract for the recovery of human enteric viruses.

7. Direct inoculation of wastewater samples for the recovery of human enteric viruses.

Results and their interpretation:

The results obtained are summarized in tables 1 and 2, they show:

1. In the clean "control" point (location III) bacteria were recovered on the nutrient agar Petri dish. Their number was low (see table 1). Coliform bacteria were recovered in very small numbers. No faecal coliform bacteria, Salmonellae or human enteric viruses were recovered. No E. coli bacteriophages were found.

In addition to the Tirat Hacarmel discharges (location I) two smaller wastewater outfalls at Shikmona and Bat-Galim were examined and the results obtained at all three points are summarized in table 2. Shikmona turned out to be the least polluted of the three sampling points. The number of coliform bacteria recovered from the sediment was higher than in the water above. The standard plate count was also higher in the sediment than in the sea-water (table 2). No Salmonellae were recovered at this sampling point.

At the Bat Galim point the number of coliform bacteria increased with the distance from the discharging point. This may be due to the direction of the current. Salmonellae were recovered from the discharging wastewater and bacteriophages of E. coli B were recovered in all the samples.

At the Tirat Hacarmel sampling point the number of coliform bacteria in the discharging wastewater was high: 3.3 x 107/100 ml. The results obtained by membrane filtration were lower than by the MPN fermentation tube method. The number of E. coli bacteriophages were 3.3 x 106/100 ml a concentration usually found in wastewater.

Salmonellae were isolated, and the strains recovered were: S. typhimurium, S. infantis, S. emek. The number of bacteria (SPC) and coliform bacteria was higher in the sediment than in the sea-water.

The number of E. coli bacteriophages was usually higher in the sediment (figure 4) than in the water above, and the ratio coliform bacteria-E. coli bacteriophages was smaller than in the wastewater. Salmonellae and viruses were recovered from all the wastewater samples tested. No Salmonellae and no human enteric viruses were recovered from the water samples or sediment. Additional data need to be collected during the warm months of the year to allow conclusions to be drawn.

In comparing the efficiency of recovery of coliform bacteria by the MPN method and membrane filtration method, no definite conclusions could be drawn (figure 1). In some instances the recovery was higher by the filtration method especially in the sediment,(samples 1, 9, 10); in others it was higher by the MPN method (sample 14, 15), the recovery of faecal coliform being generally higher by the MPN than by the filtration method.

The concentration of coliform bacteria was higher in the sediment south of the outfall than in the water at the same sampling point. In the water, the concentration of coliform bacteria was higher north of the outfall (figure 3).

It is well know that oysters found in polluted waters concentrate viruses (infectious hepatitis virus). Since fish living and growing in polluted waters might concentrate bacteria as well as viruses in their organs, and might therefore constitute public health hazards, it is important to study the recovery of enteric bacteria (indicator as well as pathogen) E. coli bacteriophages and human enteric viruses from various organs of fish grown in the vicinity of domestic wastewater outfalls into the sea.

Preliminary studies on the recovery of bacteria and viruses from organs of fresh water fish grown in polluted waters have been carried out. The results obtained showed that no bacteria were found in various organs prior to their introduction into the polluted waterpond. At the end of two months growth period in wastewater, polluted water coliform bacteria were recovered from all the organs of the fish. Their concentration ranged between 10^1/gr (in meat and liver) to 10^7/gr in the contents of the digestive tract.

A similar situation might occur in the vicinity of the wastewater outfall into the sea and therefore fish growing in the area might constitute a public health hazard both to fish and man.

It is planned therefore to test fish found in the vicinity of the sampling points and determine the concentration of coliform bacteria, Salmonellae, E. Coli bacteriophages and human enteric viruses in their various organs.

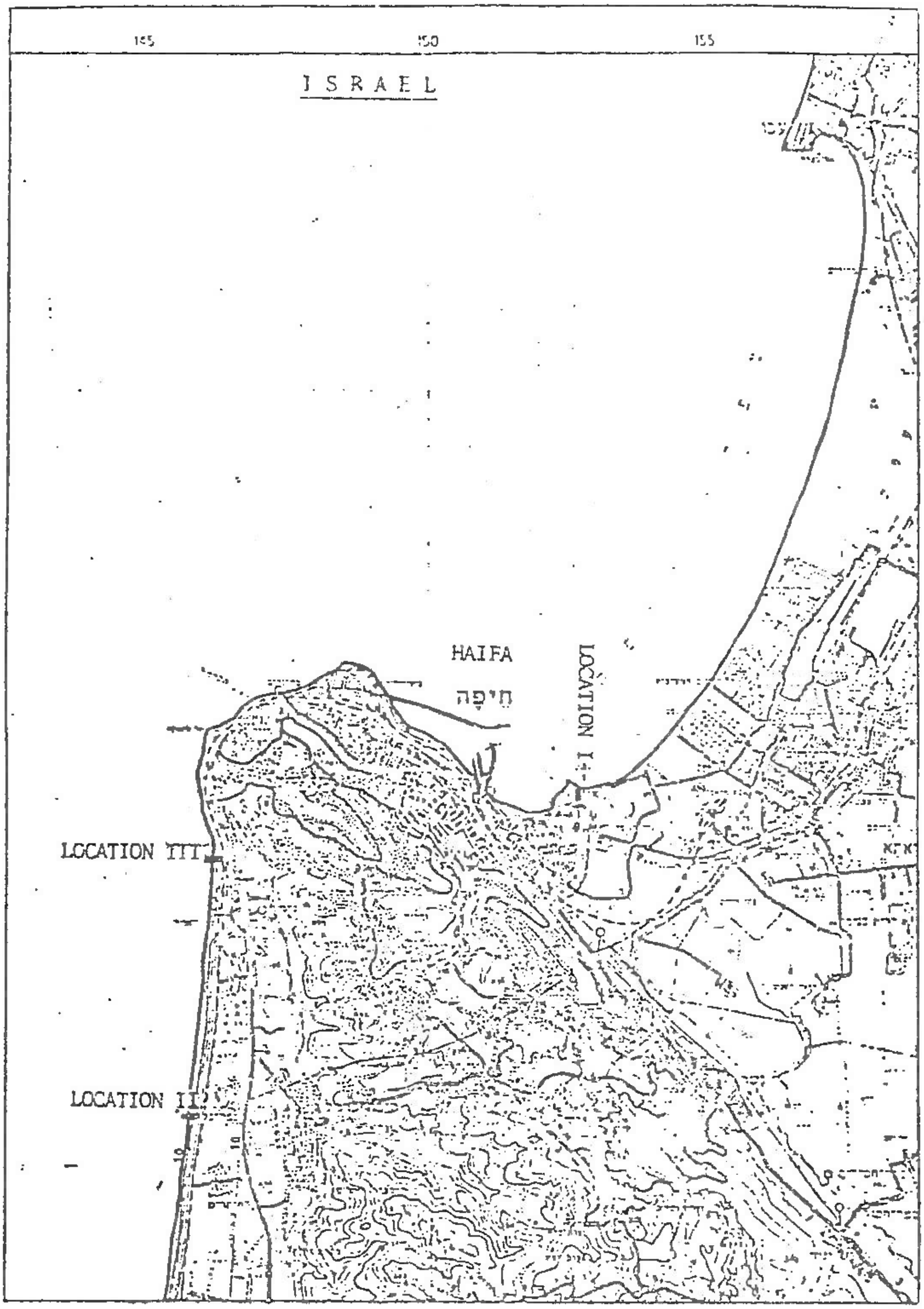

145
150
155
ISRAEL
HAIFA
חיפה
LOCATION I
LOCATION III
LOCATION II

Table 1: Recovery of bacteria, E. coli bacteriophages and human enteric viruses from clean sea-water and sediment samples

Shikmona Location III	MPN/100 ml		Membrane Filtration /100ml			Standard plate count /ml	*Salmonella*	Human enteric viruses
	Coliform	Faecal coliform	Coliform	Faecal coliform	*E. coli* B phage			
1. Water	0	0	0	0	0	12	0	0
Sediment	2	0	1	0	0	95	0	0
2. Water	2	0	2	0	0	60	0	0
Sediment	4	0	5	0	0	106	0	0
3. Water	2	0	2	1	0	55	0	0
Sediment	4	0	6	3	0	100	0	0

Table 2: Recovery of bacteria, E. coli bacteriophages and human enteric viruses from sea-water and sediment in the vicinity of a wastewater outfall

Location	MPN/100ml		Membrane filtration/100ml			Standard plate count /ml	*Salmonella*	Human enteric viruses
	Coliform	Faecal coliform	Coliform	Faecal coliform	*E. coli* B phage			
1. Shikmona Water	4.9×10^2	6.8×10	1.3×10^3	1.8×10^2	11	4.0×10^2	0	
LocationIII Sediment	1.3×10^3	3.3×10^2	3.0×10^4	3.7×10^3	10	4.5×10^4	0	
2. Bat Galim Wastewater outlet	1.6×10^5	1.0×10^4	9.5×10^4	9.0×10^4	2.4×10^4	1.7×10^6	++	+
3. Bat Galim South 25m. from sewage outlet	5.4×10^2	1.0×10^2	3.0×10^2	1.0×10^2	70	5.0×10^3		
4. Bat Galim South 50m. from wastewater discharge	2.4×10^4	1.5×10^3	2.5×10^4	2.0×10^4	110	7.0×10^3		

Table 2 (contin.)

Location	MPN/100ml		Membrane filtration/100ml			Standard plate count /ml	*Salmonella*	Human enteric viruses
	Coliform	Faecal coliform	Coliform	Faecal coliform	*E. coli* B phage			
5. Bat Galim 100m. south of wastewater discharge	$3.3x10^4$	$2.9x10^3$	$3.0x10^4$	$2.5x10^3$	27	$5.8x10^3$		
6. Tirat Hacarmel Location II Wastewater discharge	$3.3x10^7$	$1.7x10^7$	$4.0x10^5$	$3.9x10^3$	$3.3x10^6$	$2.2x10^6$	+++	
7. Tirat Hacarmel Location II 50m. north water	$4.9x10^3$	$4.9x10^3$	$3.0x10^3$	$1.1x10^3$	$4.9x10^2$	$5.9x10^3$		
8. Sediment	$2.0x10^4$	$2.0x10^2$	$1.0x10^4$	1.0x10	$1.1x10^3$	$3.0x10^3$		
9. Tirat Hacarmel Location II 50m. south Water	$7.9x10^3$	$3.3x10^3$	$1.0x10^3$	$2.4x10^2$	$4.0x10^2$	$3.5x10^2$		
10. Sediment	$3.3x10^3$	$2.3x10^3$	$2.3x10^5$	$4.8x10^4$	$7.9x10^3$	$1.5x10^5$		
11. Tirat Hacarmel Location II Wastewater discharge Water	$6.8x10^6$	$4.0x10^6$	$2.5x10^7$	$7.6x10^5$	$2.2x10^5$	$2.9x10^6$	+++	+
12. Tirat Hacarmel Location II 50m. north Water	$4.9x10^2$	$2.3x10^2$	$7.1x10^2$	24	68	$1.5x10^3$		
13. Tirat Hacarmel Location II Sediment	$7.9x10^2$	$4.9x10^2$	$8.0x10^2$	$1.0x10^2$	$2.4x10^2$	$3.0x10^3$		
14. Nahsholim B 50m south Water	$4.9x10^2$	$4.0x10^2$	$5.3x10^2$	2.8x10	$1.3x10^2$	$4.0x10^3$		
15. Nahsholim B Sediment	$6.8x10^3$	$4.0x10^3$	$3.0x10^3$	$1.0x10^3$	$7.9x10^2$	$1.5x10^4$		

Fig. 1

RECOVERY OF COLIFORMS FROM SEA WATER AND SEDIMENT IN THE VICINITY OF WASTEWATER OUTFALL. (MPN)

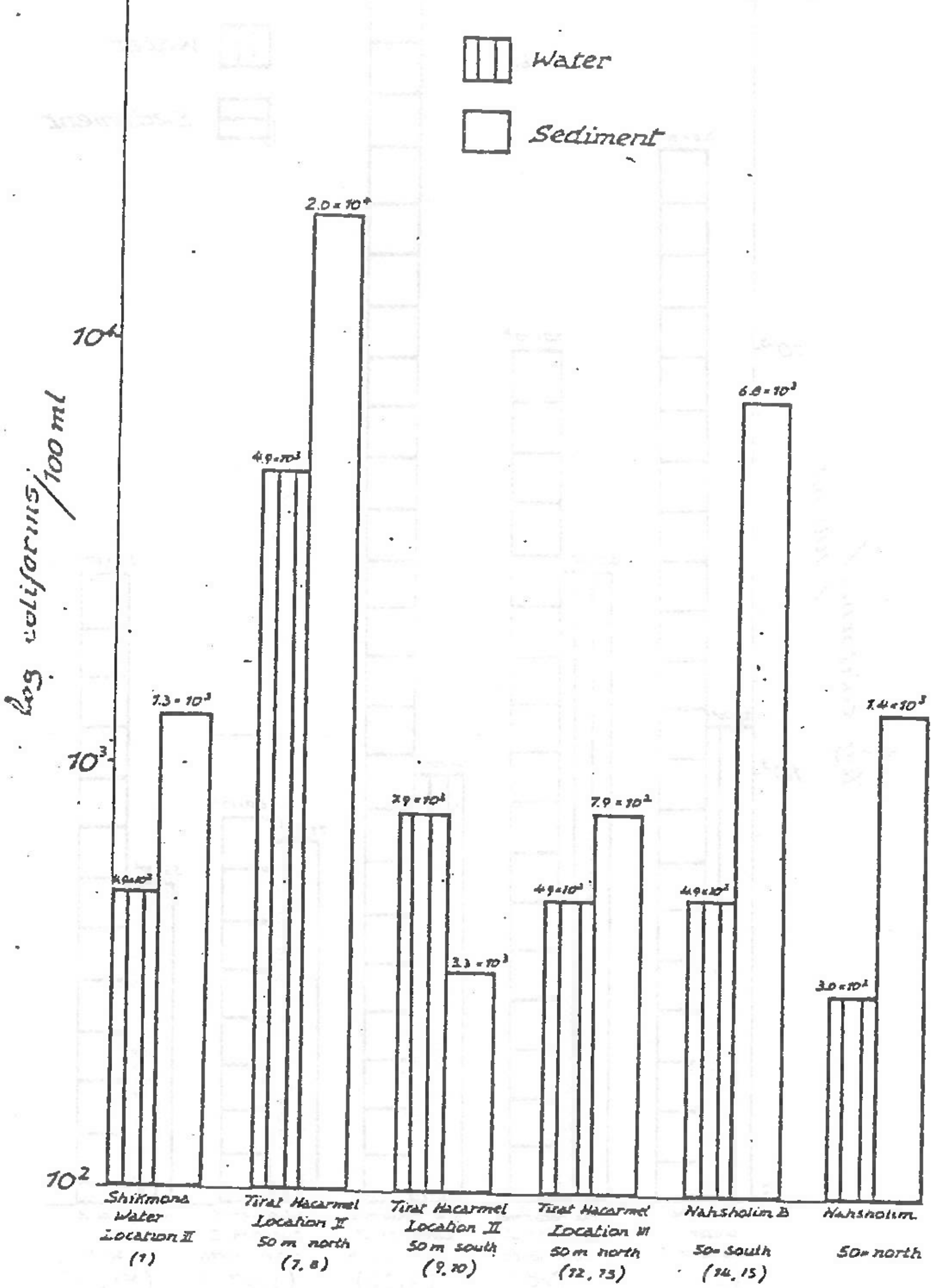


FIG. 2 RECOVERY OF COLIFORMS (MEMBRANE FILTRATION) FROM SEA WATER AND SEDIMENT IN THE VICINITY OF WASTEWATER OUTFALL

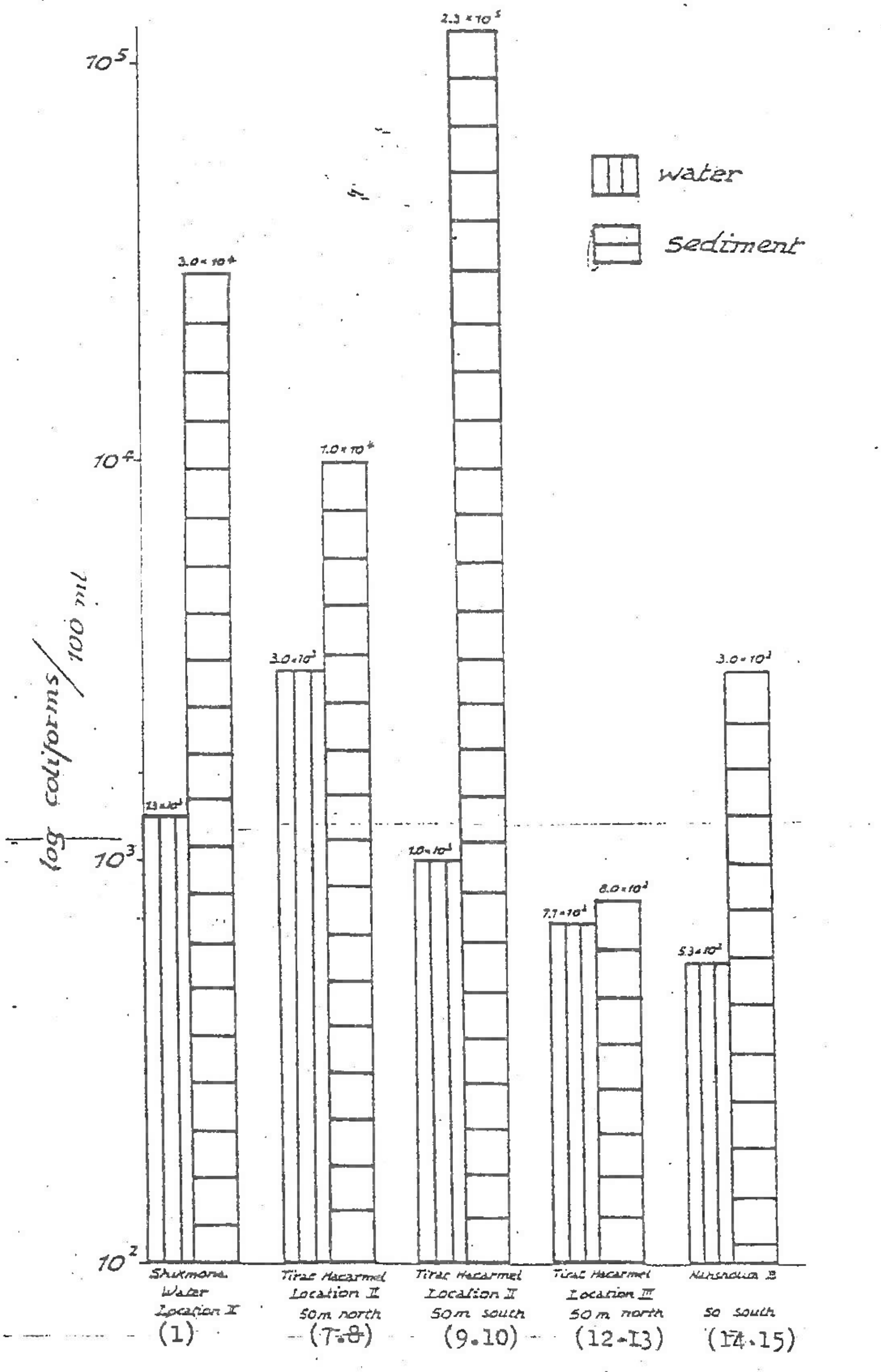
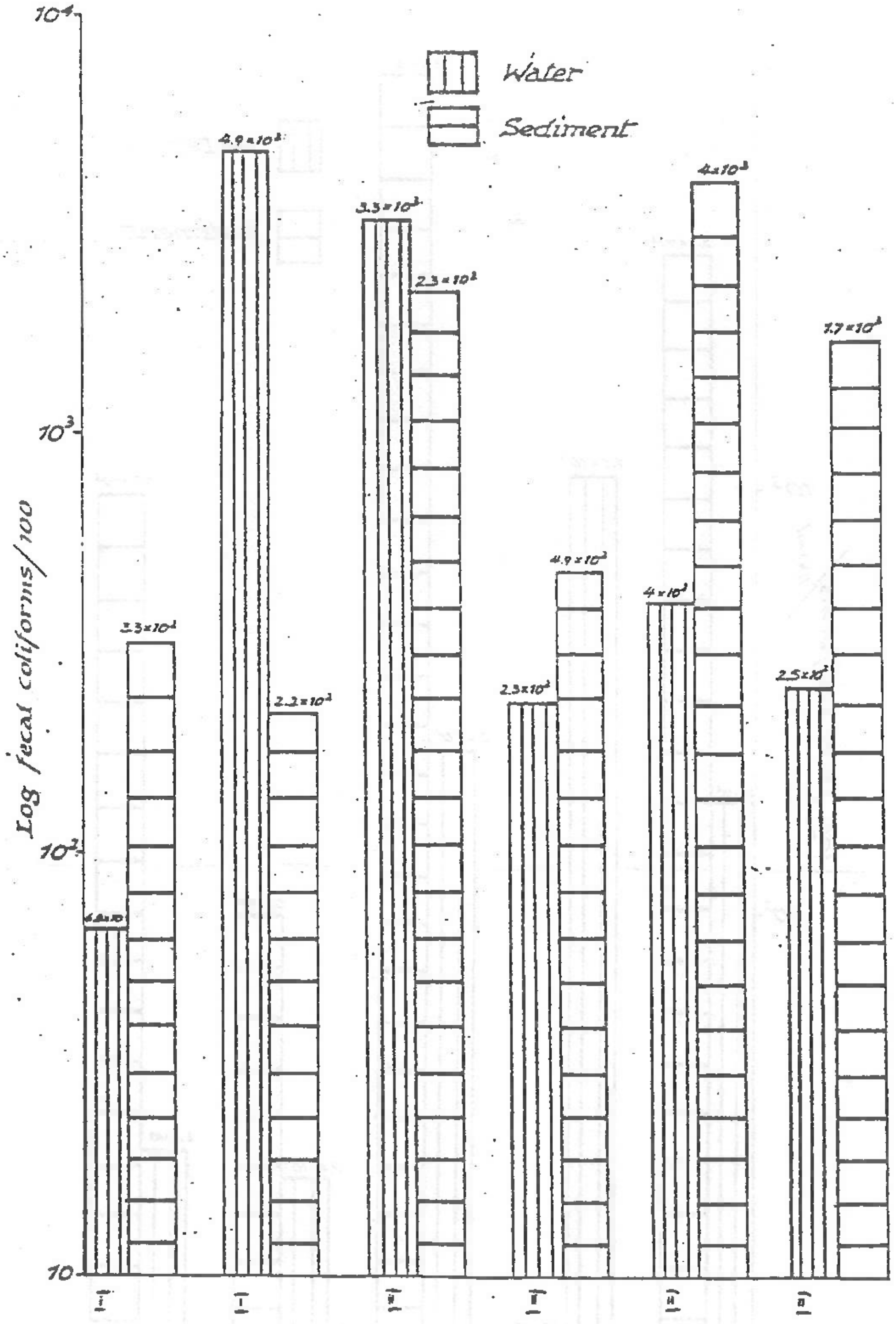
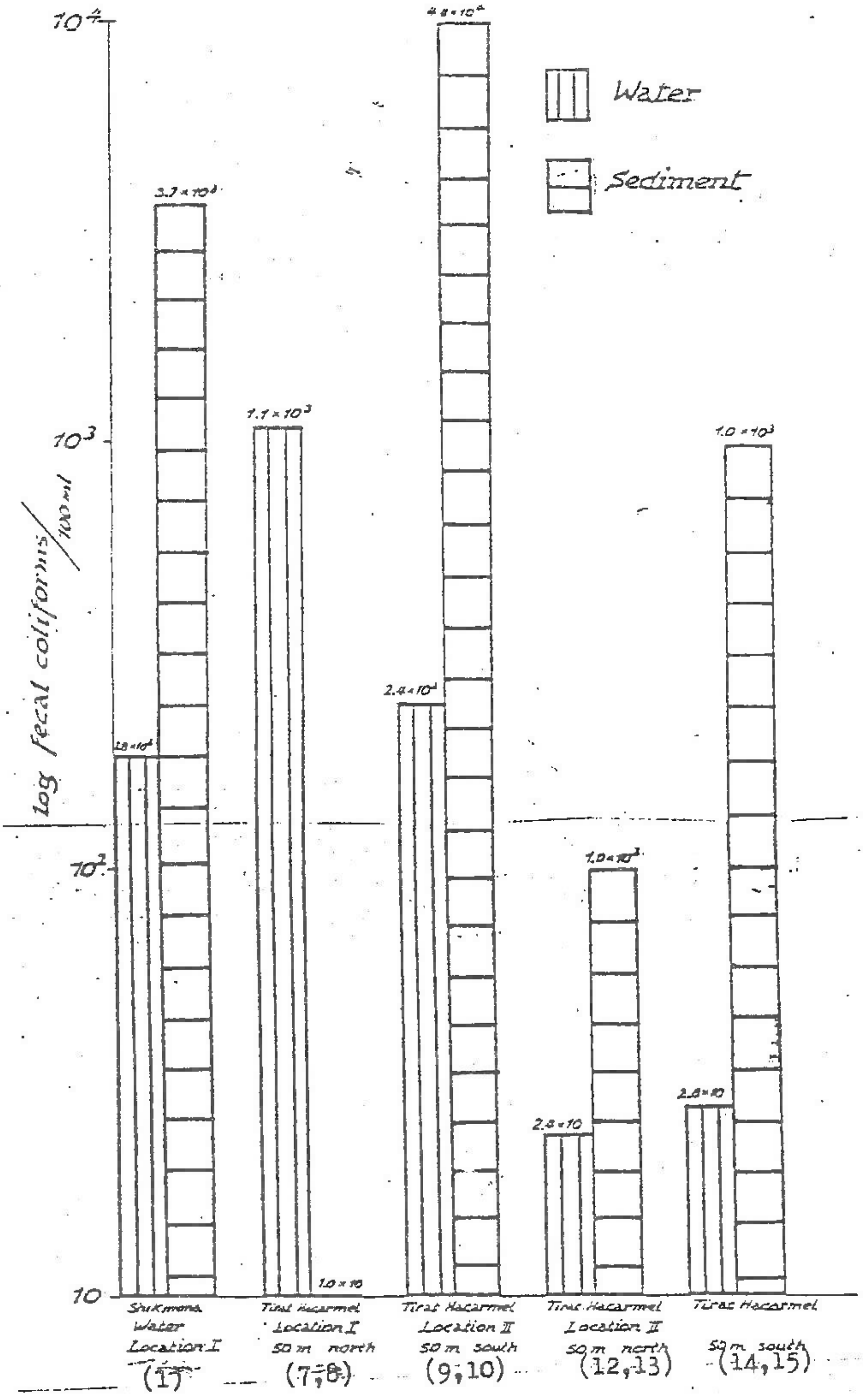


FIG. 3 RECOVERY OF FECAL COLIFORM FROM SEA WATER AND SEDIMENT IN THE VICINITY OF WASTEWATER OUTFALL



MPN of fecal Coliforms

FIG. 4 RECOVERY OF FECAL COLIFORM (MEMBRANE FILTRATION) FROM SEA WATER AND SEDIMENT IN THE VICINITY OF WASTEWATER OUTFALL



Participating Research Centre: Public Health Laboratory
Public Health Department
HAIFA
Israel

Principal Investigator: R. SELIGMANN

Introduction:

Approximately 20 bathing beaches were monitored monthly during the summer using the following parameters:

1967-1977: total and faecal coliforms
1967-1977: total heterotrphic bacteria
1970,1973: Salmonellae
1971,1974,1977: V. parahaemolyticus and V. alginolyticus
3 winter months and 6 summer months 1977: faecal streptococci

Area(s) studied:

The area studied is on the approximately 90 km long shoreline from Rosh Hanikra, the most northern sampling point in the Northern District, to Givat Olga, the most southern point in the Haifa District.

Description of the coast: North District - at Rosh Hanikra Control Station (C 1) and the bathing beaches Shave Zion (Nos. 1, 2) small rock formations reach the coast. Haifa District - the bathing sites at Hof Hacarmel (Nos. 3 & 4), Givat Olga (Nos. 5 & 6), and the Control Station at Caesarea (C2) are on flat sandy beaches.

Material and methods:

Total and faecal coliforms

a) MED VII reference methods

b) Membrane filter procedure, M-endo broth, according to Standard Methods for the Examination of Water and Wastewater, APHA 1975, subculture of up to 5 colonies into EC broth, incubation at 44.5°C/24 hours.

c) Multiple tube technqiue (MPN) according to APHA.

Faecal streptococci

Membrane filter procedure according to APHA; colonies were often confirmed by biochemical tests.

Salmonellae and Shigella

a) Tetrathionate broth incubated at 35°C/24 hours and 48 hours, subculture on BG-agar and SS-agar, incubated at 35°C/24 hours and 48 hours, isolation of suspicious colonies for biochemical and serological examinations.

b) Dulcitol-Selenite broth incubated at 41.5°C/24 hours and 48 hours, subculture on MacConkey and SS-agar, after incubation at 35°C/24 hours and 48 hours isolation of suspicious colonies for further tests.

V. parahaemolyticus and V. cholerae

a) Membrane filter procedure, filter transferred to TCBS medium, incubated at 34°C/24 hours isolation of suspicious colonies for biochemical tests.

b) Sediment after centrifugation spread to TCBS-agar, further examination as (a).

BOD_5

Dissolved oxygen was measured by Azide modifiction of Iodometric method (APHA - 1975).

Settleable matter

Determined in Imhoff cone and reported as ml/l (APHA - 1975).

Total suspended matter

APHA - 1975.

Results and their interpretation:

Total and faecal coliforms

Measured by 3 methods, all samples conformed to the requirements for bathing waters (Council of the European Communities). Total faecal coliforms/100 cc numbered less than 100 in 95 per cent of the samples.

Faecal streptococci

The Council of the European Communities allows 100/faecal streptococci/100 cc. 95 per cent of the samples contained less than 50 enterococci/100 cc. Two samples exceeded the approval limit: 120 enterococci/100 cc. were isolated from one sample in June (Control Station C.1) and 130 enterococci/100 cc from the other in August (Station 4).

Pathogenic organisms

Salmonellae, Shigella and Cholera were negative in all cultures. V. parahaemolyticus were isolated from 5 bathing beaches (nos. 2,3,4,5 and 6) and from one of the Control Stations (C2). The strains were sent to the United Kingdom for serotypisation and the Kanagawa test.

Naaman River

BOD_5: 20 - 25 mg/l O_2
T. S. M. : 140-276 mg/l
Settleable matter: 0 ml/l.

Kishon effluents

BOD_5: 317 - 408 mg/l O_2
T. S. M. : 86 - 228 mg/l
Settleable matter: 0 ml/l

Conclusions:

Quality of coastal waters

As in previous years, the quality of recreational waters at our approved bathing beaches proved highly satisfactory.

Quality of rivers and effluents

In our experience, the two mandatory parameters, BOD_5 and settleable solids, although most informative, are insufficient for the assessment of the pollution in rivers and effluents. We propose the measurement of three more parameters: pH, COD and total suspended matter.

Methodology

Based on the examination of 250 marine and 50 drinking water samples, we recommend not to use the MFC medium at 35°C for the determination of total coliforms. The M.endo broth proved to be far superior.

We refrain from drawing more conclusions. We expect the field and laboratory data compiled from all the institutions participating in MED VII will serve conclusively the objectives of the project.

All samples collected during the summer, including those pertaining to MED VII and 180 samples from 15 other bathing beaches, were examined for the determination of total and faecal coliforms by three methods (see above). For an optimal evaluation of the results obtained by other methods, in addition to the compulsory methods of MED VII, which were applied in our and other institutes we suggest that appropriate recording sheets be prepared. The data on these additional sheets should be studied as part of the information recorded on the relevant MED VII data forms or, if from samples not in the framework of MED VII, they should be analysed independently.

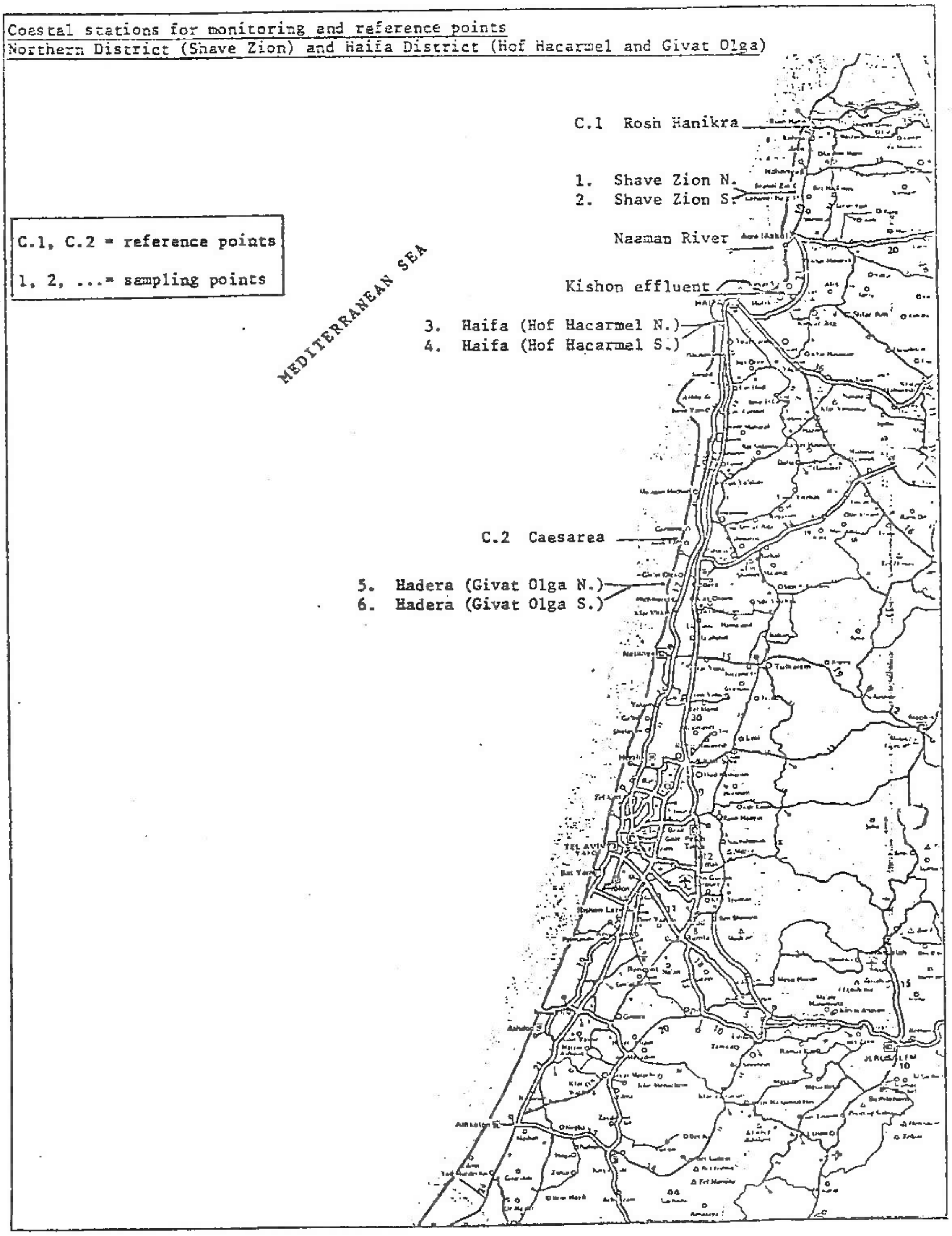
Table 1: Range and median of indicator bacteria isolated from coastal water Haifa and Northern Districts of Israel - summer 1978

Sampling point	No. of samples	Total coliforms		Faecal coliforms		Faecal streptococci	
		range	median	range	median	range	median
Bathing beaches:							
1. Shave Zion, north	10	0 - 40	0	0 - 20	1	0 - 60	0
2. Shave Zion, south	10	0 - 25	0	0 - 15	2	0 - 50	0
3. Hof Hacarmel, north	10	0 -100	0	0 - 18	0.5	0 - 6	1
4. Hof Hacarmel, south	10	0 -150	1.5	0 -200	1	0 -130	0
5. Givat Olga, north	8	0 - 30	0	0 - 6	0	0 - 2	0
6. Givat Olga, south	8	0 - 3	0	0 - 10	1	0 - 75	2
Control stations:							
C.1 Rosh Hanikra	9	0 - 60	0	0 - 34	4	0 -120	20
C.2 Caesarea	7	0 - 40	0	0 - 50	0	0 - 4	0

Table 2: Mean value and standard deviation of indicator bacteria in coastal water Haifa and Northern Districts in Israel - summer 1978

Sampling point	No. of samples	Total coliforms (MF endo broth)		Faecal coliforms (m-FC 44.5°C)		Faecal streptococci (MF, KF - Agar)	
		mean	S.D.	mean	S.D.	mean	S.D.
Bathing beaches:							
1. Shave Zion, north	10	2.7	4.4	3.0	3.0	3.0	5.0
2. Shave Zion, south	10	1.9	3.7	3.0	3.0	2.0	4.0
3. Hof Hacarmel, north	10	2.9	6.1	2.0	3.0	2.0	2.0
4. Hof Hacarmel, south	10	3.1	5.0	3.0	6.0	3.0	5.0
5. Givat Olga, north	8	1.4	2.0	2.0	2.0	1.0	1.0
6. Givat Olga, south	8	1.1	1.5	2.0	2.0	3.0	5.0
Control stations:							
C.1 Rosh Hanikra	9	3.5	5.1	3.0	3.0	14.0	23.0
C.2 Caesarea	7	2.1	4.2	2.0	4.0	- 1.0	2.0

Remarks: - Summer = mid-May to mid-October
- "zero" result was considered "one"


Coastal stations for monitoring and reference points
Northern District (Shave Zion) and Haifa District (Hof Hacarmel and Givat Olga)
C.1 Rosh Hanikra
1. Shave Zion N.
2. Shave Zion S.
Naaman River
Kishon effluent
3. Haifa (Hof Hacarmel N.)
4. Haifa (Hof Hacarmel S.)
C.1, C.2 = reference points
1, 2, ... = sampling points
MEDITERRANEAN SEA
C.2 Caesarea
5. Hadera (Givat Olga N.)
6. Hadera (Givat Olga S.)
TEL AVIV YAFO
JERUSALEM

Participating Research Centre: The Dr. A. Felix Public Health Laboratory
Ministry of Health
TEL AVIV
Israel

Principal Investigator: Y. YOSHPE-PURER

Introduction:

The coastal water of the Central and Southern part of Israel has been monitored since 1963, employing the MPN method for coliforms and since 1975 for faecal coliforms as well. In 1968 membrane filtration with Endo broth was also carried out for the Tel-Aviv area, and compared to the MPN method.

Area(s) studied:

The length of the coastline covered by the MED VII project is about 90 km. The three areas selected for monitoring are the most populated ones along theis coast, namely Nathania in the North, Tel-Aviv in the centre and Ashquelon in the South. Two sampling points were examined at each of these beaches (points 1-6) plus one control point near Nathania and one near Ashquelon. The land surrounding all beaches is mainly sand. Surface or ground water reaches the sea only on rainy days in the winter.

Material and methods used:

Total coliforms - membrane filtration with mFC medium, incubated at 35°C and MPN method with lactose broth, confirmed on MacConkey agar.

Faecal coliforms - a) membrane filtration with mFC medium incubated at 44.5°C. b) MPN method by inoculating the positive tubes of the total coliform test into E.C. broth, incubating at 44.5°C and observing for gas production in 24 hours.

Enterococci - membrane filtration with KF medium.

Salmonellae - Filtration of 500 ml water through membrane filters which were immersed in selenite broth and incubated at 37°C. Plating on brillant green agar and MacConkey agar after 24 and 48 hours incubation. Suspicious colonies were separated and examined biochemically and serologically.

Vibrio parahaemolyticus - a) Enrichment of 10 ml portions in salt colistin broth (Sakazaki) and salt broth (3 per cent NaCl) at 37°C and 42°C respectively and plating on TCBS.

b) Plating of sediment of 10 ml waters after centrifugation and 0.1-0.4 ml of specimen directly on TCBS agar incubated at 37°C.

c) Membrane filtration of 100 ml water and incubation of membrane in salt broth then plating or placing the filter directly on TCBS agar.

d) Biochemical testing of suspect colonies, compared to two reference strains.

Winds and currents - these were not considered since the number of samples was small and all monitoring was done in the forenoon hours of the summer (end of June to end of October).

Results and their interpretation:

Between the last week in June and the last week in October the beaches of Nathania and Ashquelon (points 1, 2, 5 and 6) were examined nine times and the beach of Tel-Aviv (points 3 and 4) eight times, giving a total of 70 samples. According to the present standard in Israel (up to 2 400 coliforms per 100 ml in 80 per cent of the samples) all beaches were very satisfactory. At the Nathania beach the number of total and faecal coliforms ranged from 0 to 150 per 100 ml. In Tel-Aviv the range was 0-210 per 100 ml and in Ashquelon, 0 to 370 per 100 ml. The number of Enterococci was also low (0 to 240 per 100 ml). Salmonellae and Vibrio parahaemolyticus were not isolated. About 500 colonies from 200 samples were examined (including beaches not in the project) and none of them complied with the biochemical criteria for V. parahaemolyticus.

The control points were not free of coliforms, as expected, but their number was low, reaching 80/100 ml in the northern point on 2 occasions only. In the southern point four of the nine tests were positive, reaching 100/100 ml on one occasion and 160/100 ml on another.

Comparison of the MPN with the membrane filtration method showed a fairly good correlation (r=0.8), when the results on the filters could be read distinctly. With m-FC medium at 35°C the results were dubious and on several occasions not even legible when too many pink colonies were present on the filter. Many of these pink colonies were confirmed as non-lactose fermenters. When compared on the basis of percentage of total number of samples examined, the results were as follows:

	Comparable results (%)	Higher results by MF (%)	Higher results by MPN (%)
Total coliforms*	49	20	23
Faecal coliforms	54	12	34

* In six samples (eight per cent) the filters were not legible (NR).

Conclusions:

It is difficult to draw conclusions on such a limited number of examinations (70) and more samples should be examined by several mthods for evaluation of the results.

In the experience of the Institute the membrane filtration with m-FC medium is good for faecal coliforms at 44.5°C at least as far as reading the results is concerned. For total coliforms at 35°C it is not recommended since the blue-green colonies of the coliforms are often obscured by dense growth of other bacteria many of them non-lactose fermenters.

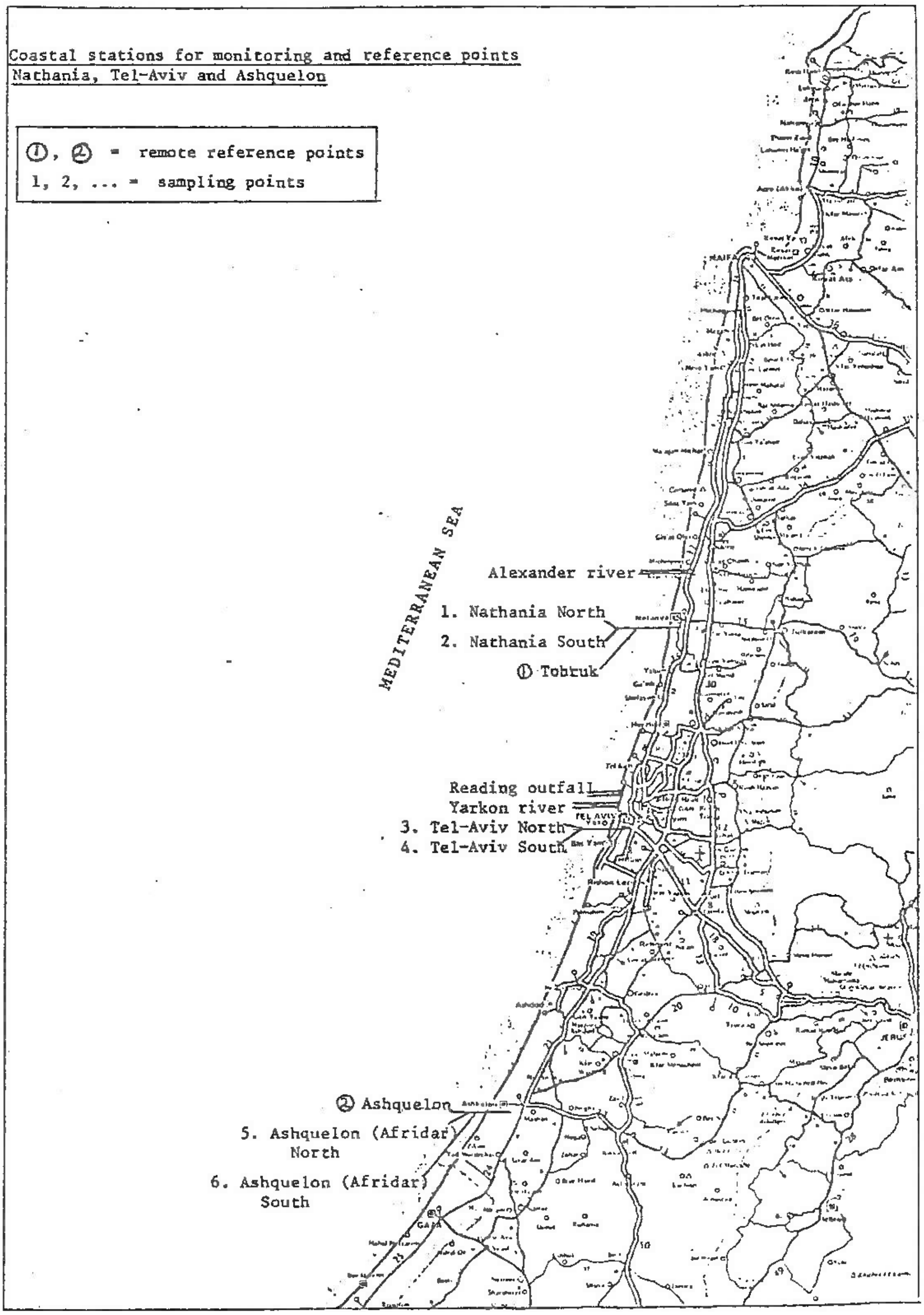

Coastal stations for monitoring and reference points
Nathania, Tel-Aviv and Ashquelon
①, ② = remote reference points
1, 2, ... = sampling points
MEDITERRANEAN SEA
HAIFA
Alexander river
1. Nathania North
2. Nathania South
① Tobruk
Reading outfall
Yarkon river
TEL AVIV
3. Tel-Aviv North
4. Tel-Aviv South
② Ashquelon
5. Ashquelon (Afridar) North
6. Ashquelon (Afridar) South
GAZA

Table 1: Mean values and standard deviation of indicator organisms/100 ml (MF) in coastal water of central and southern Israel during the summer of 1978

Point no.	Total coliforms		Faecal coliforms		Faecal streptococci	
	mean*	S.d.	mean*	S.d.	mean*	S.d.
1. Nathania North	27	7	18	6	17	5
2. Nathania South	13	8	9	6	12	8
3. Tel-Aviv North (Gordon beach)	27	6	16	4	10	7
4. Tel-Aviv South	47	6	18	8	13	9
5. Ashquelon North	17	8	7	9	8	8
6. Ashquelon South	24	8	6	6	7	5
7. Control point N. (near Nachania)	13	5	4	3	11	5
8. Control point S. (near Ashquelon)	5	9	3	7	6	6

*Values of 0 were taken into consideration as 1, with log 0.

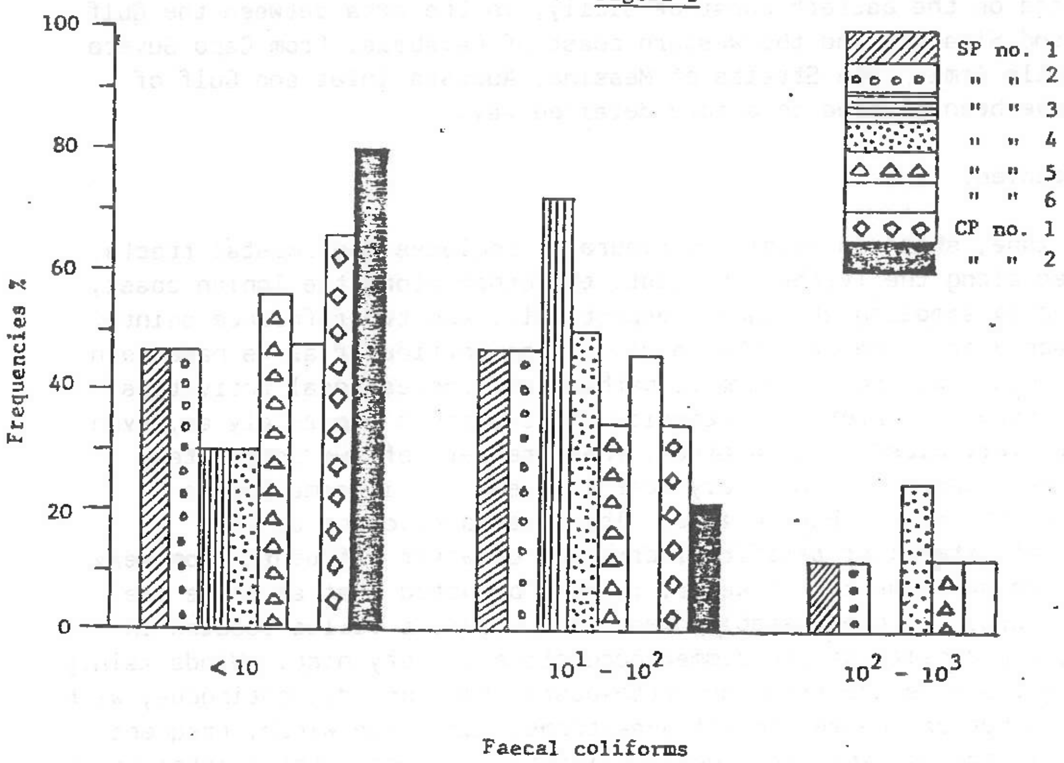
The number of data is too low to draw statistically valid conclusions and it seems to me that the following presentation is more meaningful.

Table 2: Correlation between the mandatory parameters

Point no.	r TC : FC	r TC : FS	r FC : FS
1	0.995	-0.013	-0.003
2	0.889.	0.348	0.401
Nathania (1 & 2)	0.988		
3	0.823	0.061	0.336
4	0.748	0.278	-0.126
Tel-Aviv			
(Gordon beach) (3 & 4)	0.763		
5	0.993	-0.187	-0.178
6	0.540	0.805	0.159
Ashquelon			
(Afridar beach)(5 & 6)	- 0.790		
Control 1 (Nathania)	0.485	-0.293	-0.299
Control 2 (Ashquelon)	0.924	-0.362	-0.408
All points (N = 69)	0.929		

There is a good correlation between the total coliforms and faecal coliforms when the number of samples is adequate, but no correlation between any of them and the number of faecal streptococci. This is quite understandable since we are dealing with different organisms that vary greatly in their susceptibility to environmental conditions and rate of survival.

Figure 1



Salmonella, V. parahaemolyticus and V. cholerae were not found.

Participating Research Centre: Institute of Hydrobiology and Fish Culture
University of Messina
MESSINA
Italy

Principal Investigator: S. GENOVESE

Introduction:

The Institute of Hydrobiology has for a long time been carrying out intense research activity in order to evaluate the pollution rate in coastal and brackish Sicilian and Calabrian waters. Research started in 1964 and has concentrated on the eastern coast of Sicily, in the area between the Gulf of Patti and Siracusa and the western coast of Calabria, from Capo Suvero to Capo delle Armi. The Straits of Messina, Augusta inlet and Gulf of Milazzo have been studied in a more detailed way.

Area(s) studied:

The study zone, shown in detail in figure 1, includes two coastal tracts, one located along the Tyrrhenian coast, the other along the Ionian coast, with 12 and 14 sampling stations, respectively, and two reference points, one for each zone, 1 km from the coast. These particular areas have been selected because during the summer, bathing and recreational activities take place here. We prefer to describe the two zones separately as, even if they are very close to each other, they are part of two compeletely different environments. Only very scarce scientific information is available about the Tyrrhenian zone. There is no evidence of the occurrence of natural or artificial draining of water effluents from very limited urban settlements. However, it must be noted that as there are many (nine) urban bathing establishments and numerous villas located in this zone, the density of the summer population is very high. Winds mainly influencing the zone are from the north-east; they are discontinuous, with brief gusts, but can cause violent sea-storms. Southern winds, frequent and strong in the Messina area, only indirectly influence the coastal tract examined.

There is quite extensive information concerning the Ionian zone as the Straits of Messina have long been the object of study by various oceanographic disciplines because of their strong tidal currents and the consequent hydrological and biological processes. However, much of this research has little to do with the present project and we intend to summarize only what is known about the microbiological features of the Messina Straits, based on research carried out by the Institute of Hydrobiology in the period 1964-1978.

Drains of varied capacity, flood and torrent spillways, waste waters coming from urban settlements, with varying pollution loads, either due to the number of inhabitants, or in proportion to the discontinuous and variable town water supply, are discharged along the coasts of the Messina Straits.

When these waters reach the sea, the main alternating currents and the more complex littoral counter-currents distribute the pollution load irregularly. There is evidence that currents may disperse waters with heavy faecal flora content to zones not directly polluted just as, in the same way, it may occur that as a result of the dispersion, areas receiving sewage wastes are free from faecal pollution. The Straits' central axis itself is practically free from polluting phenomena and it is possible that the currents might act as an important self-depuration factor.

In this area the shore entrance is free and there are no recreational facilities. However, it should be noted that, from 1970, along almost all the Ionian coast between Messina and Capo Peloro, which includes the zone under study, bathing has been forbidden by a municipal injunction, as the faecal coliform rate exceeds the current Italian norm allowed. It should also be added that a new sewage system with a treatment plant is about to be constructed near Capo Peloro. There are two sewage outlets in this zone, one at Pace Village corresponding to station 17, and the other at S. Agata village close to station 25. Immediately to the north of the study zone there are four other sewers and two more to the south. All drains are of small capacity, receiving refuse waters from the houses close to them. The study zone includes the Pace torrent between stations 15 and 16 and the Guardia torrent in close proximity to station 23. Immediately to the north of our stations are the torrents S. Agata and Papardo. As to the wind system, easterly and southerly winds blow in the Straits, where they reach their greatest velocity; the north-east wind is the most prevalent but is of moderate strength and blows mainly during the summer. There are occasional west winds of short duration.

Material and methods used:

As requested for this study, methods in which filter membranes are used on a single culture medium at different temperatures have been adopted. In this respect it might be pointed out that the filter membrane technique with different media for faecal and total coliforms has been used for a long time in our microbiological laboratory with very good results. Comparative tests have been carried out, and the single medium at two temperatures was maintained in order to apply unified methods, even if some uncertainties arose about the results obtained with the recommended method.

Results and their interpretation:

From the results obtained to date it is impossible to draw general conclusions without the winter surveys, from which we expect to have useful indications regarding the relations between faecal flora and hydrological parameters. Table 1 shows the distribution in frequency classes of the microbiological data collected and the different pollution rate of the two zones examined is clearly indicated.

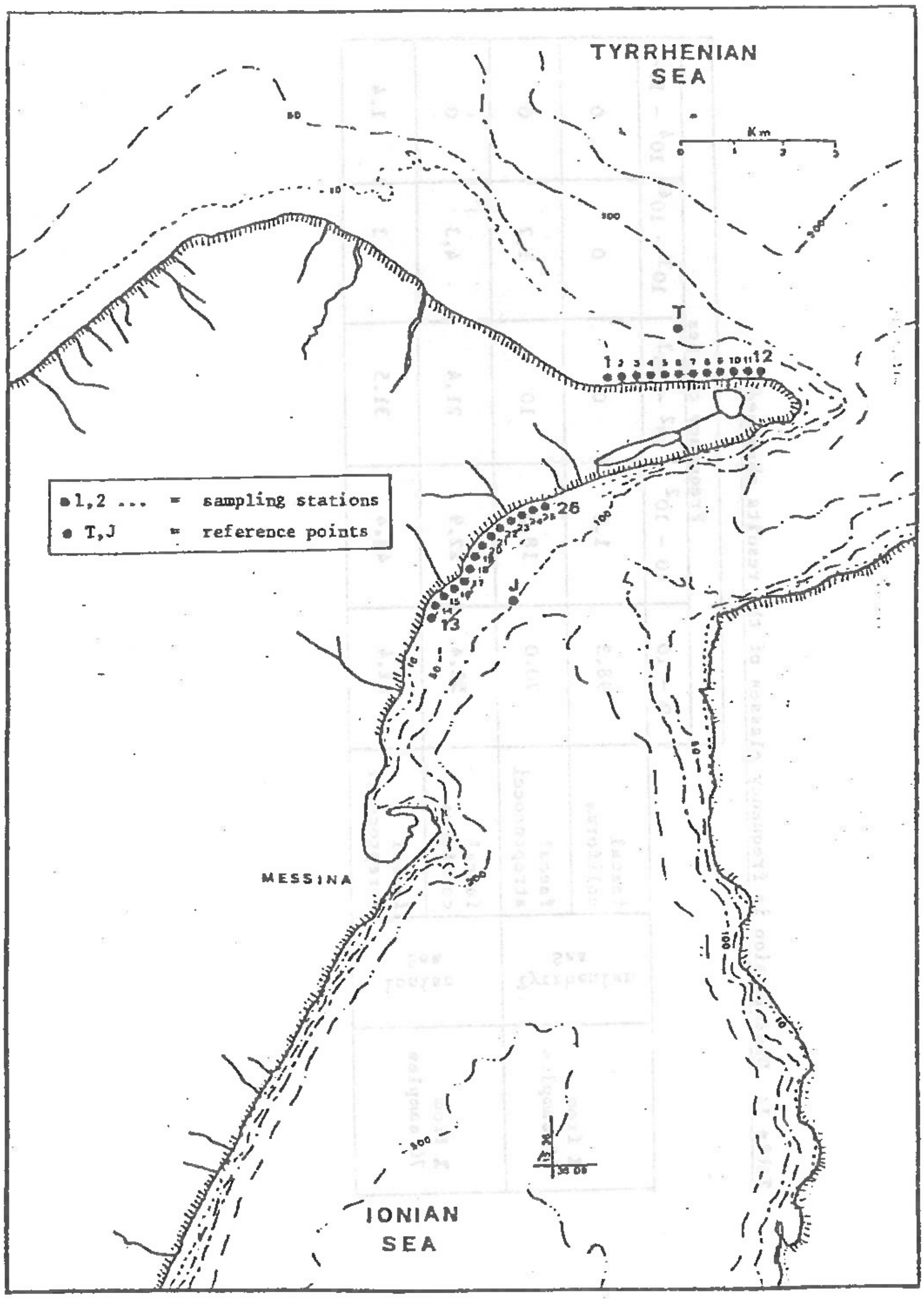
In the Tyrrhenian zone there are no signifcant pollution sources. In fact, only faecal coliforms up to a maximum of 12/100 ml have sometimes been noted. Streptococci distribution in these waters, because of their longer survival time in sea-water, shows that there may be pollution by sewage waters, but it does not seem direct or constant. A maximum value of 5.2 x 10^3 streptococci/100 ml near the shore compares with 2.6 x 10^3 obtained on 17 August at 1 km from the shore. Most of the values were less than 100 streptococci/100 ml.

As regards the Ionian Sea, the present pollution level is clearly shown by faecal coliform numbers that are rarely absent and reach a maximum of 1.8 x 10^3/100 ml. Streptococci seem to follow the same development. Only in three water samples of 100 ml were these micro-organisms not observed; this pollution index, even at 1 km from the shore, has reached values of 10^3, and the maximum obtained (30 June 1978) near the coast, was of 1.3 x 10^4 streptococci/100 ml.

Conclusions:

It is possible to state that the Tyrrhenian coastal tract present a good quality level while in the Straits of Messina area the pollution rate observed gives rise to problems for recreational purposes.

Figure 1



TYRRHENIAN SEA
Km
0 1 2 3
T
1 2 3 4 5 6 7 8 9 10 11 12
26
13
J
● 1,2 ... = sampling stations
● T,J = reference points
MESSINA
IONIAN SEA

Table 1: Distribution in frequency classes of the results obtained

			Frequency classes				
			0 - 10	10 - 10^2	10^2 - 10^3	10^3 - 10^4	10^4 - 10^5
% from 60 samples	Tyrrhenian Sea	faecal coliforms	98.3	1.7	0	0	0
		faecal streptococci	70,0	18.3	10	1.7	0
% from 70 samples	Ionian Sea	faecal coliforms	51.4	22.9	21.4	4,3	0
		faecal streptococci	21.4	41.4	31.5	4.3	1.4

Participating Research Centre: Centre for Study and Research in Sanitary Engineering
Institute of Water Supply and Waste Disposal
University of Naples
NAPLES
Italy

and

Zoological Station of Naples
NAPLES

Principal Investigator: L. MENDIA

Introduction:

The constant sampling in the Gulf of Naples begun in 1976 has been regularly continued at the Naples Zoological Station together with the Sanitary Egnineering Centre (Institute of Water Supply and Wastes Disposal) from September 1977 until today.

Work has begun in 1976 in collaboration with Dr. Lilian M. Evison of the Department of Civil Engineering, University of Newcastle upon Tyne.

Samples of sea-water were taken at frequent intervals in the Bay of Naples from Nisida to the harbour of S. Lucia. The sampling points were selected so that both unpolluted and polluted waters could be investigated in order to make a comprehensive analysis of the coastal water quality.

Area(s) studied:

The sea stretch between Nisida and St. Lucia harbour was monitored in the framework of the MED VII pilot for recreational coastal water control. Along this area 40 stations were located. Two reference points were chosen: station no.102 (Rotonda Diaz) for locations 109 to 87; and station No.76 (Villa Beck) for locations 86 to 64.

Two sampling stations (Bacoli and Coroglio) located in the Gulf of Pozzuoli, were chosen for shellfish monitoring activities. Moreover shellfish samples collected in the market were analyzed.

The two maps (figure 1 and figure 2) give details on the selected areas.

Material and methods used:

Sea-water samples were collected by boat at a distance of approximately 10 m from the shore. At each point triplicate samples were taken.

(1) 500 ml in a sterile bottle for bacteriological analysis

(2) 250 ml sample, immediately fixed for D.O. analysis

(3) 125 ml sample for salinity determination.

In addition water temperature and "Secchi disc" readings were measured at the same sites. Air temperature, wind direction and wind speed were also measured at the reference points using an anemometer.

Biological tests

All samples were analysed by membrane filtration using 47 mm diameter membrane filters, 0.45 u pore size. For every sample three different volumes of water (1, 10, 100 ml) were filtered in tripilicate for three different analyses: one set was analysed for coliforms, one set for E. coli and one set for faecal streptococci.

Coliform counts (37°C for 20 hours) - Membrane enriched teepol broth.

E. coli counts (44°C for 20 hours) - Membrane faecal coliforms agar.

Faecal Streptococci counts (44°C for 48 hours) - Slanetz and Bartley agar.

Shellfish monitoring:

MPN method was followed for enumerating total coliforms, faecal coliforms and Escherichia coli, in the shellfish flesh according to the directives fixed by the working group at the meeting held in Rome on the 4th - 7th April 1978.

Shellfish growing was analyzed according to the MF method, utilizing the same media described above.

Enterococci and heterotrophic bacteria were detected with the PP method as described in the Guidelines.

The analyses on shellfish were performed adding to the samples four times the diluent equivalent to the flesh weight.

Results and discussion:

The results of the analysis of superficial water samples are summarized in tables 1 and 2; the following comments may be made:

(1) The coliform count is generally higher than the E. coli count. The enterococci count invariably gives the lowest count values in respect of the others.

(2) The dissolved oxygen concentration for the various samplings is more or less near saturation; for seven samples among the 25, the D. O. is less than 90 per cent but always higher than 63 per cent.

(3) The majority of samples present salinities in the range 36.4-37.8. Seven samples show salinities between 33.9 and 35.9 (table 1).

Table 1 shows the results obtained during various periods of time at three different stations, as follows: (1) (point 64) at the outfall of Coroglio; (2) (point 76) and authorized bathing place; and (3) (point 101) an unauthorized bathing place.

It is possible to note that at point 64 (polluted water), even during meteorological changes, the values of E. coli remain the same. These values are higher than the standard ones; in fact they are in the order of 104. It is clear that the sewage coming from the outfall is not influenced by external conditions. It is in fact diluted very slowly as is proved by the samples collected along the coast (see also table 2 from points 64 to 74). At point 76 (an authorized bathing place) it has been noted that the values of E. coli are lower than the standard ones. Higher counts are generally noted when wind strength increases and it exceeds 10 m/sec. At point 101 (an unauthorized bathing place) the values of E. coli are very high only when the current comes from the east. The strength of the current influences the dispersion of the sewage from the S. Giovanni outfall. Without the influence of this current, the values of E. coli are in accordance with the standard.

Table 2 gives the results of sample collection during two days in summer 1978 - 20 sampling points each day (in total 45 points). The values measured during these two days are significative of the water quality of the sampling points. In fact the results obtained are more or less the same as those of sample collections during other periods of the year at the same points.

Analyses carried out on shellfish and shellfish water growing areas showed higher microbial values for stations No.1 than for station No.2 (Coroglio and Bacoli, respectively). However also in this case, when particular metereological and hydrographic conditions happened (such as currents coming from the east) a reverse condition was registered. This was the case, for example, at X4, where higher values, at least for total coliforms, were observed in samples collected at Bacoli.

Conclusions:

The m-FC medium for total coliforms detection was unsuitable. Pink colonies often influenced large areas on the membranes; as a result, the development of lactose fermenter colonies was not always appropriate.

Teepol broth was more suitable for total coliform detection.

More observations on local conditions must be undertaken in future monitoring work.

Table 1

Point 64 - near the collector of Coroglio (polluted water)

Date	Wind	Water temp. (°C)	D.O. (%)	Salinity (%)	Coliforms (/100 ml)	*E. coli* (/100 ml)	Enterococci (/100 ml)
13.6.78	9 km/h	22	87	36.436	1.23×10^5	4.7×10^4	1.3×10^4
26.6.78	3 km/h	23	63.8	-	2.52×10^4	4.08×10^4	1.7×10^3
11.7.78	0.5 m/sec	22	100	33.94	7×10^5	3×10^5	2.6×10^4
17.7.78	calm	24	85	35.16	1.06×10^4	3×10^5	2.4×10^4
21.7.78	5 m/sec	24	95	37.45	2.4×10^5	1.3×10^3	4.7×10^3
26.7.78	calm	23	90	36.87	7.5×10^5	3.1×10^5	3.1×10^3
9.11.78	calm	17.5	83	35.63	TNTC	TNTC	5.7×10^3
21.11.78	calm	17.7	94	35.47	TNTC/1 ml	TNTC/1 ml	3900

Point 76 - authorized bathing place (unpolluted water)

Date	Wind	Water temp. (°C)	D.O. (%)	Salinity (%)	Coliforms (/100 ml)	*E. coli* (/100 ml)	Enterococci (/100 ml)
13.6.78	9 km/h	22	100	37.24	1.08×10^3	7.2×10^2	4
26.6.78	3 km/h	23	68	36.68	2×10^3	3.28×10^3	6.8×10^2
11.7.78	0.5 m/sec	22	118	37.15	3	0	0
17.7.78	calm	24	108	37.21	0	0	0
21.7.78*	5 m/sec	24	>100	37.45	33	3	0
26.7.78	calm	23	105	37.51	12	12	2
9.11.78	calm	17.5	95	37.80	206	28	1
21.11.78	calm	17.7	95	37.67	TNTC	52	152

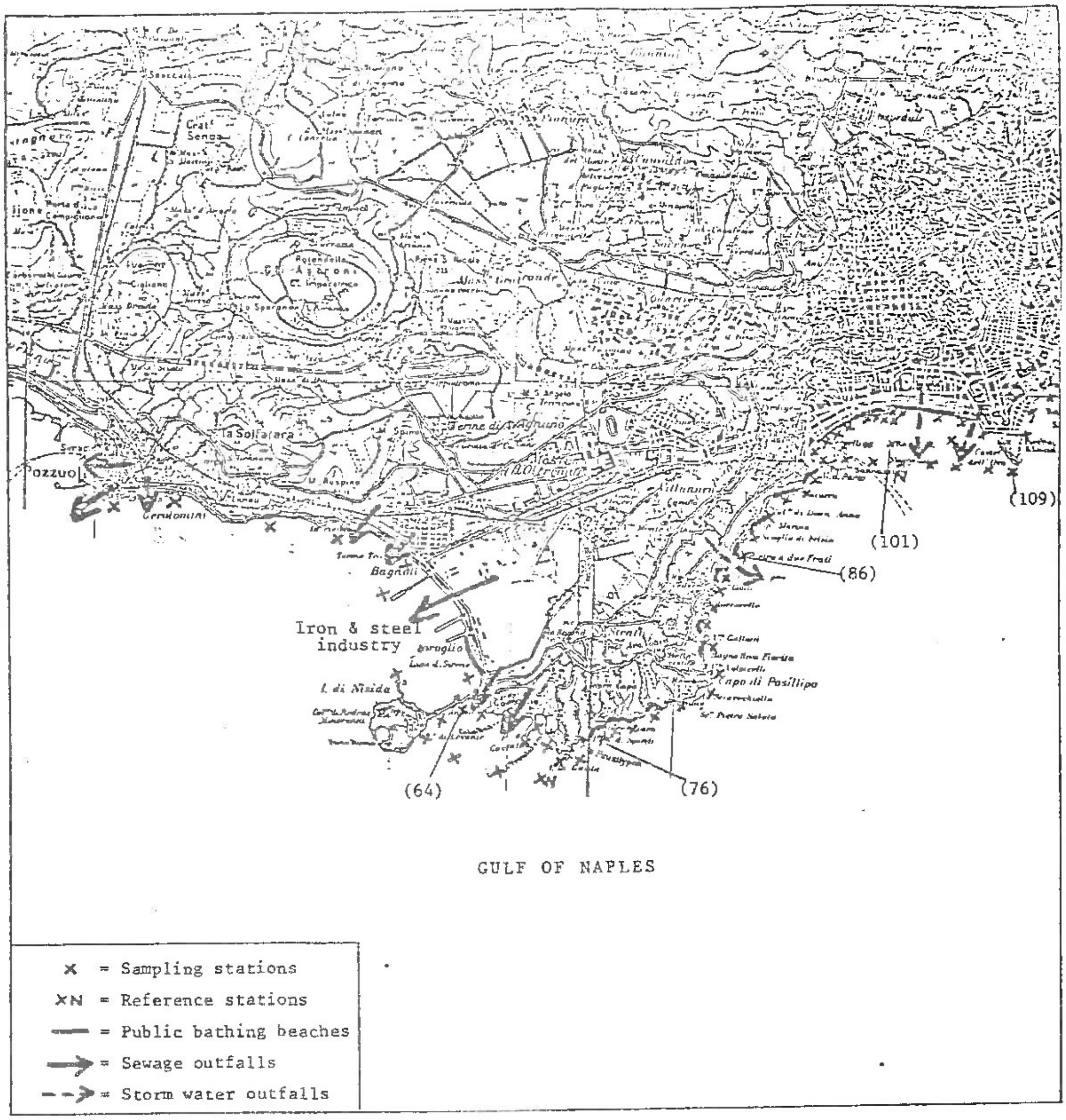
Point 101 - Rotonda Diaz - unauthorized bathing place

Date	Wind	Water temp. (°C)	D.O. (%)	Salinity (%)	Coliforms (/100 ml)	*E. coli* (/100 ml)	Enterococci (/100 ml)	Current
6.6.78	-	-	121	35.74	3.2×10^4	1.58×10^4	60	east
20.6.78	2 km/h	23	104	36.61	30	0/10 ml	0	west
6.7.78	calm	24	99	36.87	43	32	1	west
13.7.78	calm	23	104	35.96	$>1 \times 10^4$	$>1 \times 10^4$	8×10^3	east
20.7.78	3 m/sec	25	77	35.21	6×10^4	7×10^4	6×10^3	east
24.7.78	2 m/sec	23.5	130	36.99	9×10^2	1×10^2	10	east
28.7.78	calm	23.5	106	37.40	1×10^2	10^2	10	west
15.11.78	calm	17	89	37.84	18	3	1	west
6.12.78	-	15	94	37.68	760	19	1	west

* *Salmonella* test negative

Table 2: Results of monitoring in forty sampling points during two days of summer 1978

Date	Point	Wind	Water temp. (°C)	D.O. (%)	Salinity (%)	Coliforms (/100 ml)	E. coli (/100 ml)	Enterococci (/100 ml)
13.6.78	64	2 km/h	23	87	36.43	1.23×10^5	4.7×10^4	1.3×10^4
"	65	"	"	83	36.33	6.5×10^4	5.4×10^4	9×10^2
"	66	"	"	66	33.60	2.8×10^4	3.3×10^4	3.3×10^4
"	67	"	"	90	36.33	3.4×10^3	2.3×10^3	19
"	68	"	"	91	36.65	1.95×10^3	1.66×10^3	4
"	69	"	"	91	36.91	2.52×10^3	1.77×10^3	3
"	73	"	"	91	36.96	3.4×10^3	1.28×10^3	1
"	74	"	"	95	37.20	2×10^3	1.2×10^3	2
"	75	"	"	90	37.22	2.5×10^3	1.21×10^3	4
"	76	"	"	100	37.26	1.08×10^3	7.2×10^2	4
"	77	"	"	95	37.19	610	410	2
"	78	"	"	101	37.25	650	560	2
"	79	"	"	95	37.29	710	560	7
"	80	"	"	102	37.31	120	80	0
"	81	"	"	90	37.32	1.29×10^3	82	1
"	82	"	"	105	37.37	280	54	0
"	83	"	"	85	37.77	TNTC	TNTC	3
"	84	"	"	101	37.33	10	2	0
"	85	"	"	98	37.35	6	6	0
"	86	"	"	100	37.32	6	6	0
20.6.78	109	2 km/h	25	106	36.84	10	0	0
"	108	"	"	105	36.63	0	0	0
"	107	"	"	107	36.63	0	0	0
"	106	"	"	107	36.62	0	0	0
"	105	"	"	107	36.62	0	0	0
"	104	"	"	101	36.61	0	0	0
"	103	"	"	114	36.59	10	10	0
"	102	"	"	105	36.62	30	0	0
"	100	"	"	104	36.60	10	10	0
"	99	"	"	101	36.59	10	0	0
"	98	"	"	104	36.61	0	10	0
"	97	"	"	106	36.62	10	0	0
"	93	"	"	104	36.61	6	4	0
"	92	"	"	103	36.84	12	0	0
"	91	"	"	101	36.82	0	10	0
"	90	"	"	106	36.86	20	0	0
"	89	"	"	97	36.87	30	0	0
"	88	"	"	102	36.87	0	0	0
"	87	"	"	107	36.87	10	0	0


Pozzuoli
La Solfatara
Bagnoli
Iron & steel industry
I. di Nisida
Capo di Posillipo
(64)
(76)
(86)
(101)
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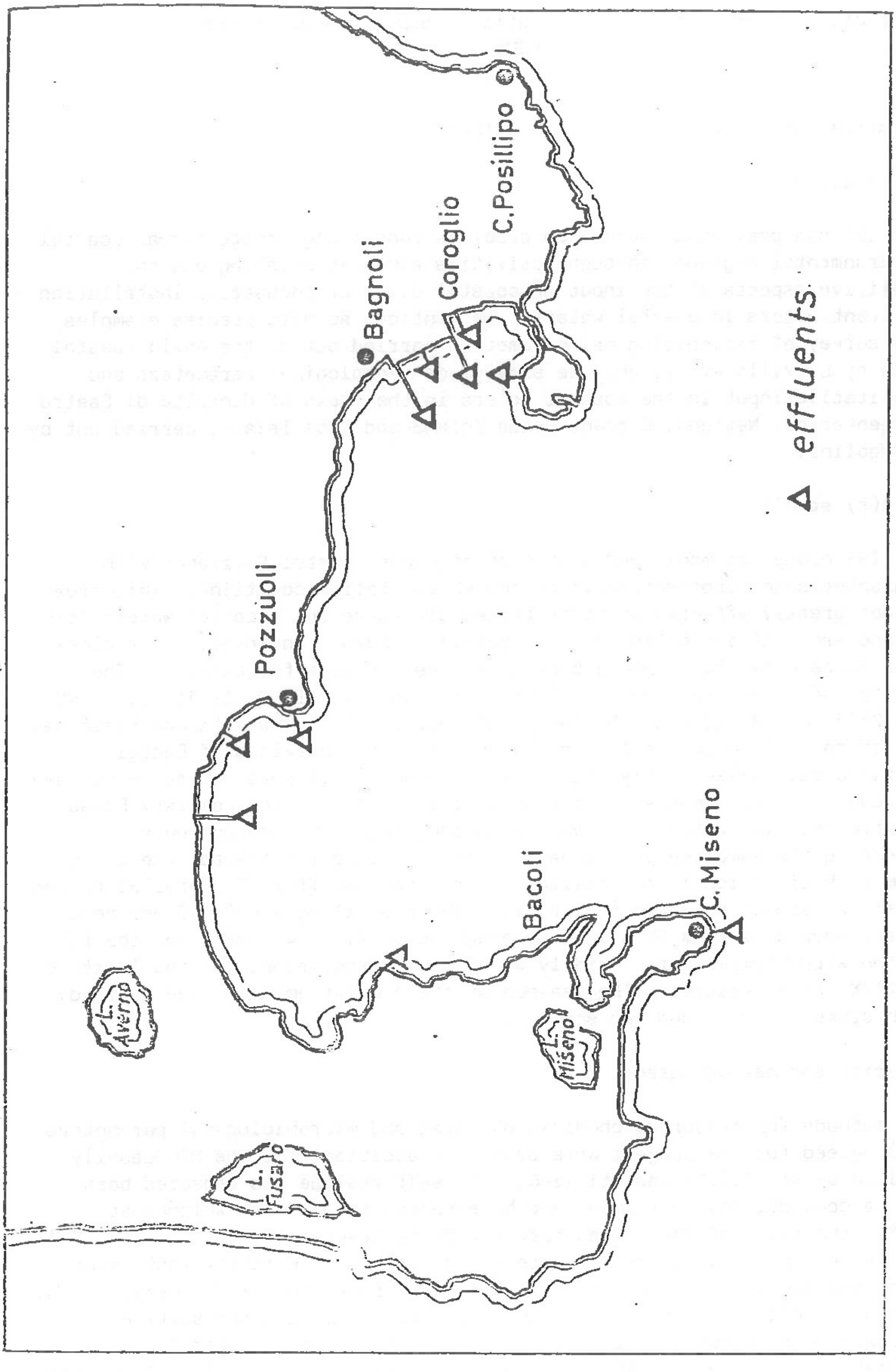
GULF OF NAPLES
× = Sampling stations
×N = Reference stations
= Public bathing beaches
= Sewage outfalls
= Storm water outfalls


C.Posillipo
Coroglio
Bagnoli
Pozzuoli
Bacoli
C.Miseno
L. Averno
L. Miseno
L. Fusaro
effluents

Participating Research Centre: Istituto Superiore di Sanita
ROME
Italy

Principal Investigator: L. VILLA

Introduction:

The ISS has previously worked on problems concerning Mediterranean coastal environmental hygiene, through activities aimed at pointing out the qualitive aspects of the input of coastal civil or industrial installation effluent waters in coastal waters. We mention, as more precise examples, the survey of microbiological parameters carried out in the Anzio coastal area by L. Villa et al. and the surveys of hydrological parameters and qualitative input in the coastal waters in the areas of Montalto di Castro (Argentario), Nettuno, Circeo, Ponza Island and Elba Island, carried out by G. Ugolini.

Area(s) studied:

The ISS group has monitored a stretch of coast (Castel Porziano) with characteristics representative of the whole Italian coastline. This area is not greatly affected by concentrated discharge but receives waters from inland areas of inhabited land and parkland areas. Moreover, it is close to a large city (Rome) whose population use the area for bathing. The stretch of coastline examined (Castel Porziano, 41°41' N, 12°31' E; 41°40' N, 12°32' E) is delimited by two water courses, Fosso Focetta and Fosso del Tellinaro. Fosso del Tellinaro originates in the parkland of Castel Porziano and collects only rain water. Moreover, it does not reach the sea because it is frequently obstructed at the mouth. On the contrary Fosso Focetta receives water from domestic discharges. The sea currents affecting the sampling points have an off-shore course towards the coast from a SW direction in the daylight hours and come from SE, parallel to the coast, at sunset and dawn (figure 1). The prevailing winds (40 per cent) in the area blow from SW with an average velocity of 4.5 m/s, and the rate of the water temperature, jointly with solar irradiation, for the latitude of 41°N, were measured. The sea-bed on the 3 m bathometric line is sandy with areas of rock, mud and seaweed.

Material and methods used:

The methods for measuring chemical physical and microbiological parameters (MF) agreed for the project were used. In addition, for the MPN usually applied by the I.S.S. was utilized. The salt residue was measured both with a conductivity instrument and by evaporation and then weighed at 180°C, the ratio of the values obtained being practically constant; therefore, salinity is usually determined by the conductivity instrument using the above ratio and, from time to time, as a control, by evaporation. Pathogenic organisms such as Salmonellae, bacteriophages and sulfite reducers were detected at the beach. Chlorophyll was detected according to the method indicated by UNESCO (UNESCO publication Centre, 1969, "Monograph on oceanographic methodology-I. Determination of photosynthetic pigments in seawater"). Occasionally phytoplankton was examined and counted. Additional chemical parameters related to possible eutrophication were analysed: ammonium; nitrite ion; phosphate ion. Moreover, hydrogen sulphide was investigated in some samples.

Results and their interpretation:

The results of microbial parameters obtained are presented in the form of histograms (figures 2, 3, 4). The number of samples carried out is not yet sufficient to analyse and correlate the microbiological parameters with marine biological factors. In future development of our activities it is proposed to analyse and statistically evaluate possible correlation between various parameters (environmental and analytical). At present we noted a correlation between precipitations and variations in the microbiological parameters. All the other observations are presented in the form of histograms (figures 5 to 10).

Conclusions:

A longer period of observations is still needed to acquire homogeneous data.

As a general rule MF values are about 1/10 of the MPN figures in respect to faecal coliforms. We have followed the directives fixed for MED VII for detection of total coliforms. However, we have not noted differences between results obtained on Endo-broth and those on mFC-broth (37°C). This last medium was used in a preliminary step of this project. No correlation was found between Salmonellae recovery and high coliform counts. This finding has to be duly considered when the discussion will be open on the criteria to be established from the epidemiological point of view.

Bacteriophages were detected in water samples and in sediment samples also in absence of their hosts. The counts in sediment samples were always higher than in correspondent water samples.

The analyses followed for detecting possible eutrophication of the stretch of coast under examination were negative. In fact most of the samples exhibited values under 150 cells/ml (see figure 10).

Variations of bacteriological populations were noted in connection with relevant precipitations; these probably drain all the surrounding land.

For the future a study for detecting currents typical of the zone should be developed and an appropriate survey of the hydrodynamic condition at the time of the sampling has to be executed.

These observations could help in gathering appropriate data.

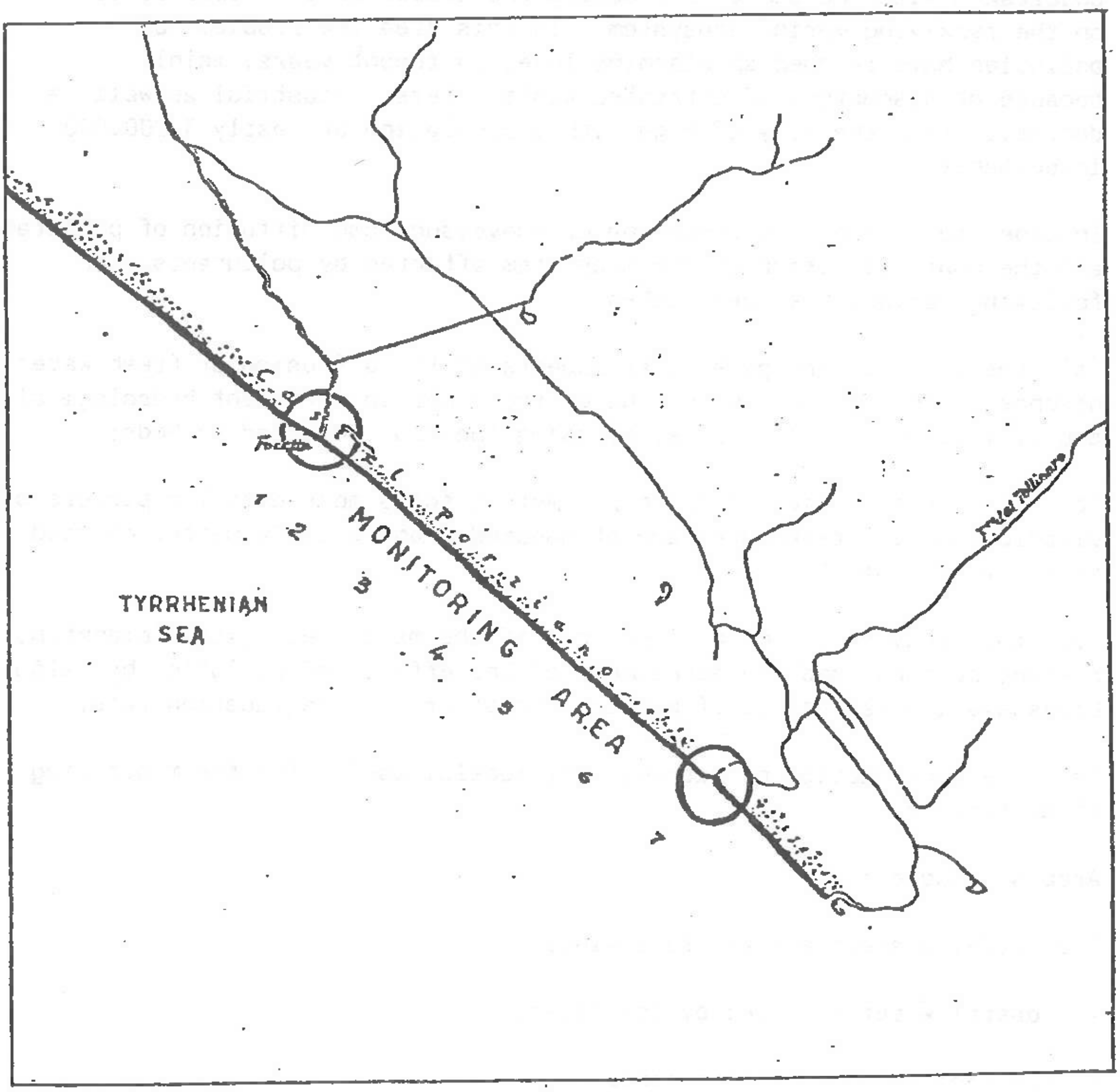
List of publications:

M. BOEDDU., VILLA, L. and VOLTERRA. L. (1977). State of Pollution on Italian coast (Summer 1976). Annali Sclavo 19, 1-4.

FILETICI, E., GIRALDI, V. and VOLTERRA. L. (1977). Enterophages comme organismes indicateurs de pollution. Rev.Int.Océanographie Médical. 47, 151-154.

FILETICI. E. and VOLTERRA. L. Inquinamento di origine terrestre convoliato in mare da corpi idrici: rassegna bibliografica. L'Ing. Mod. in press.

Figure 1



Participating Research Centre: Institute for Water Research - CNR
ROME
Italy

Principal Investigator: T. LA NOCE

Introduction:

An interdisciplinary programme of experimental investigations has been undertaken with the aim of evaluating the impact of the Tiber river on the receiving marine ecosystem. In this area the problems of pollution have reached an alarming level in recent years, mainly because of discharges of untreated waste waters, industrial as well as domestic, from the city of Rome with a population of nearly 3,000,000 inhabitants.

In order to examine the phenomena of conveyance and diffusion of pollutants, and the characteriztion of the ecosystem affected by pollutants, the following actions have been taken:

(a) the study of the particular aspects of the diffusion of fresh water discharged through the two mouths of the Tiber in different hydrological and climatological conditions, by using the most advanced methods;

(b) the determination of basic parameters for a more detailed picture of the distribution of fresh water and of suspended and soluble matter carried by the river into the sea;

(c) the study of the main components of the marine ecosystem (plankton, nekton, benthos) and the assessment of the effects of pollution by "algal bioassays", measurements of biomass and of organic degradation rate;

(d) the construction of mathematical models, useful for the monitoring of operations.

Area(s) studied:

The surveyed areas are the following:

- coastal water affected by the Tiber;

- the final stretch of the Tiber;

- other outlets, close to the Tiber mouths, either natural or artificial.

The main local currents and the main surface distribution of salinity, found during the period of field observation, are reported in figure 1; this led to the conclusion that the area, mostly affected by river discharges, spreads mainly to the north of the river mouths.

Taking the objectives of the MED VII projects into account, the parameters listed in table 1 have been determined. The location of sampling points is reported in figure 1. In ten of them, in collaboration with the Institute of Hygiene, University of Rome, bacteriological examinations, including total coliforms, faecal coliforms and faecal streptococci, were performed.

The surface samples were collected in all stations 1, 3, 23, 24, 25, 26. The frequency of sampling and measurement was fortnightly during 1976 and seasonal during 1977 and 1978.

Material and methods used:

The samples collected during the cruises of the vessel IRSAMARE were stored in polyethylene bottle at 4°C, filtered through 0,45 u millipore filters as soon as possible and analyzed within one day after collection. The analytical methods used for the determination of nitrites, ammonia and orthophosphates were those reported by Strickland and Parsons. Reactive silicates were determined by the method reported in the FAO manual.

Chlorophyll "a" (Ch-a) was measured both by the acetone extraction method and by direct florescence measurements on in vivo cells using continuous ship-board monitoring techniques. The measurement of turbidity was performed by Secchi disc. Salinity, temperature and pH were determined respectively by conductivity meter, bucket thermometer and pH meter. As far as bacteriological parameters were concerned, the MPN method was adopted.

Results and conclusions:

The results concerning the evaluation of eutrophication conditions in the zone farther away from fluvial influence (st. 7, 27, 30, 31, 33) shows a situation which is typical of the oligotrophic feature of Mediterranean waters.

Due to the Tiber influence, the inshore coastal stations show higher values of N and P. In particular, station 1, having the highest nutrients' levels, is characterized by values typical of waters with a tendency to eutrophycation.

As far as the bacteriological data are concerned, the majority of the stations observed, including those 7°N off Ostia and 21°N off Ladispoli, both located 1 mile from the coast, show values which are under the limit established by the accepted interim microbiological quality criteria.

Only the area closest to the river mouths (st. 1, 2, 3, 12, 34 and 35) is characterized by a level of bacteria which is higher than the above mentioned limits.

With a view to a more effective utilization of the data obtained, it was necessary to treat them by using computer facilities. In this respect, a programme has been set up, whereby the collected data can easily be submitted to variability and correlation analysis.

In such a way, it will be possible to study the correlation among the several parameters with a view to reducing the number and frequency of measurements and also to calculate some functions useful for the integration of the results. In tables 2, 3, 4 and 5 are reported the mean values, the standard deviations, the number of data collected from January 1976 to December 1978 and the correlation analysis between the mandatory parameters of the MED VII Project.

List of publications:

PAGNOTTA, R. and PUDDU, A. (1978). "Chlorophyll distribution in the coastal waters surrounding the Tiber River mouth, determined by using a flourometer" (in Italian with summary in English) Inquinamento 7/8 35-39.

BLUNDO, C., LA NOCE, T., PAGNOTTA, R., PETTINE, M. and PUDDU, A. "Distribution of nutrients off the mouth of the Tiber River and its relationships with biomass" in press.

Figure 1: Sampling stations and behaviour of mean surface salinity

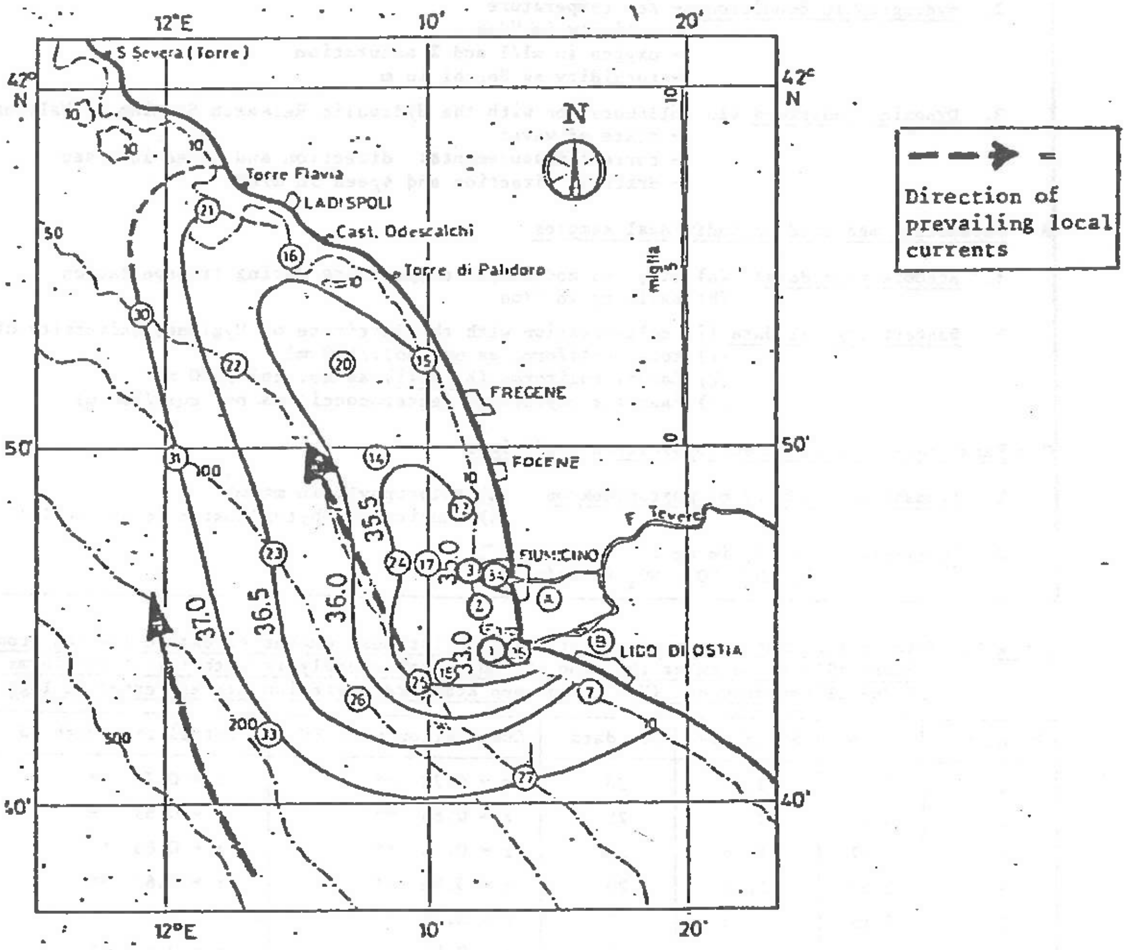


Table 1: Parameters measured for the compulsory and optional parts of the programme

A - Parameters describing general conditions in the monitoring area at the time of sampling

1. Meteorological conditions (data supplied by Italian Air Force Meteorological Service):
   - wind direction and velocity

2. Hydrographic conditions:
   - sea temperature
   - salinity in °/oo
   - oxygen in ml/l and % saturation
   - turbidity as Secchi in m

3. Dynamic conditions (in collaboration with the Hydraulic Research Station of Wallingford, UK):
   - state of waves
   - current measurements: direction and speed in m/sec
   - drifts: direction and speed in m/sec

B - Parameters measured on individual samples

1. Accompanying data: (a) air, sea and sample temperature during transportation
   (b) salinity in °/oo

2. Bacteriological data (in collaboration with the Institute of Hygiene, University of Rome):
   (a) total coliforms as no. col./100 ml
   (b) faecal coliforms (E. coli) as no. col./100 ml
   (c) faecal streptococci (enterococci) as no. col./100 ml

C - Parameters applied to eutrophication conditions

1. Biomass and density of phytoplankton: (a) chlorophyll in mg/m^3
   (b) density of phytoplankton in no. cells/l

2. Nutrients: (a) PO_4 in mg/m^3
   (b) NH_3, NO_2, NO_3 in mg/m^3

Table 2: Total coliforms: mean values, standard deviations, number of data collected from January 1976 to December 1978 and its correlation analysis with faecal coliforms (FC) and faecal streptococci (FS) - mean and standard deviation are expressed in logs

Point no.	Mean	Stand.dev.	No. data	Correlation with FC	Correlation with FS
1	5.46	1.86	28	r = 0.72 **	r = 0.72 **
3	4.02	1.90	26	r = 0.84 **	r = 0.59 **
7	1.57	1.46	13	r = 0.76 **	r = 0.66 **
12	2.55	1.72	20	r = 0.88 **	r = 0.63 **
21	0.15	0.35	10	r = 0.33	-
23	2.16	2.01	23	r = 0.84 **	r = 0.82 **
24	2.57	2.67	8	r = 0.91 **	r = 0.87 **
25	1.84	1.93	22	r = 0.92 **	r = 0.82 **
26	0.93	1.39	11	r = 0.65 *	-
34	3.97	1.31	14	r = 0.93 **	r = 0.50

*significance level 95%

**significance level 99%

Table 3: Faecal coliforms: mean values, standard deviations, number of data collected from January 1976 to December 1978 and its correlation analysis with total coliforms (TC) and faecal streptococci (FS) - mean and standard deviation are expressed in logs

Point no.	Mean	Stand.dev.	No. data	Correlation with TC	Correlation with FS
1	4.39	1.96	28	r = 0.72 **	r = 0.54 **
3	2.93	2.18	26	r = 0.84 **	r = 0.71 **
7	0.69	0.97	13	r = 0.76 **	r = 0.70 **
12	1.85	1.57	20	r = 0.89 **	r = 0.57 **
21	0.05	0.15	10	r = 0.33	-
23	1.34	1.94	23	r = 0.84 **	r = 0.88 **
24	1.74	2.55	8	r = 0.91 **	r = 0.95 **
25	1.14	1.78	22	r = 0.92 **	r = 0.91 **
26	0.24	0.79	11	r = 0.65 *	-
34	3.24	1.1	14	r = 0.93 **	r = 0.54 *

Table 4: Faecal streptococci: mean values, standard deviations, number of data collected from January 1976 to December 1978 and its correlation analysis with total coliforms (TC) and faecal coliforms (FC) - mean and standard deviation are expressed in logs

Point no.	Mean	Stand.dev.	No. data	Correlation with TC	Correlation with FC
1	2,26	1.18	28	r = 0.72 **	r = 0.54 **
3	1,65	1.49	26	r = 0.59 **	r = 0.71 **
7	0,17	0.45	13	r = 0.66 *	r = 0.70 *
12	0.43	0.63	20	r = 0.63 **	r = 0.57 **
21	-	-	-	-	-
23	0.72	1.31	23	r = 0.82 **	r = 0.88 **
24	0.77	1.18	8	r = 0.95 **	-
25	0.56	1.08	22	r = 0.82 **	r = 0.91 **
34	1.67	1.18	14	r = 0.50	r = 0.54 *

Table 5: Relationship between the mandatory parameters at each station (TC = total coliforms, FC = faecal coliforms, FS = faecal streptococci)

Point no.	TC = x, FC = y	TC = x, FS = y	FC = x, FS = y
1	y = 0.76x + 0.26	y = 0.46x - 0.24	y = 0.33x + 0.82
3	y = 0.96x - 0.94	y = 0.46x - 0.20	y = 0.49x + 0,22
7	y = 0,51x - 0.10	y = 0.20x - 0.15	y = 0.32x - 0,06
12	y = 0.80x - 0.20	y = 0.23x - 0.16	y = 0.23x + 0.001
21	y = 0.14x + 0,03	-	-
23	y = 0.81x - 0.40	y = 0.53x - 0.43	y = 0.60x - 0.08
24	y = 0.87x - 0.47	y = 0.39x - 0.22	y = 0.44x - 0.00
25	y = 0,85x - 0,42	y = 0.46x - 0.29	y = 0.55x - 0.07
26	y = 0.37x - 0.11	-	-
34	y = 0,78x + 0.16	y = 0.44x - 0.05	y = 0.56x - 0.21

* significance level 95%

** significance level 99%

Participating Research Centre: Institute of Hygiene
University of Genoa
GENOA
Italy

Principal Investigator: S. DE FLORA

Introduction:

A large body of investigations has been devoted to the study of the hygienic conditions of sea-water and of seafood, including the monitoring of specific areas, particularly in the Tyrrhenian Sea. However, some chemical aspects of sea-water pollution and of the marine fauna were also investigated outside the Mediterranean Sea and even in remote areas, e.g. in the Caribbean Sea, in the Indian Ocean, etc. Our activity included the study of physical (e.g. radioactivity), chemistry (including also heavy elements) and microbiological aspects. Particular attention was given to the problem of the virological monitoring of water and marine sediments.

Area(s) studied:

The areas studied were the Tuscany littoral, Elba, Gorgona and Capraia Isles, Calambrone and Cecin rivers (latitude 43°35' N-42° 40'N, longitude 9°45' E - 10°33' E).

The prevailing local currents flow from south to north. However, the direction of the flow is sometimes reversed close to the coastline.

A total of 247 monitoring stations was examined.

Total heterotrophic bacteria were checked by the pour plate method after 48 hours at 35°C in plate count agar. Faecal streptococci were determined by the membrane filter method of m-Enterococcus agar. Total coliforms and E. coli were determined by the multiple tube fermentation method, as follows: presumptive test in lauryl tryptose broth at 35°C (5 tubes/dilution) and confirmatory tests in brillant green lactose bile broth at 35°C and 44°C, respectively.

The MPN method was used instead of the suggested MF method for two reasons.

(a) the MPN method is compulsory in Italy for the monitoring of bathing areas, and therefore is currently used in our laboratory and in those of collaborating institutions;

(b) we have not as yet received (September 1978) the filtration apparatus which was to be kindly supplied by WHO. Comparative assays of the MF and MPN methods will be carried out after receipt of this apparatus.

Results and their interpretation:

The results of the virological investigations, together with similar data collected from other areas of the Northern Tyrrhenian Sea, have provided information on the extent and quality of the viral pollution of surface and bottom seawater and of marine sediments. Moreover, these data have been analyzed to assess the correlation between animal viruses and the bacteriological indicator of pollution in the marine environment (references 1 and 2).

A summary of the results of part of the bacteriological monitoring is given in figures 1 to 4, where an evaluation of the pollution load is expressed in terms of E. coli (mean values) in the coastal areas.

The pollution of sea-water along the Tuscany littoral (figure 1) appears to be highly variable and greatly influenced by the discharge of sewage effluents in coastal areas facing Leghorn port and town and other urban settlements, some of which receive considerable numbers of tourists in the summer season. A very heavy polluted load is provided by the so-call "Fossi" (network of sewage drainage canals of the ancient Leghorn). (See sampling stations in figures 1, 2, 3 and 4 of the Tuscany littoral). However, at some stations the pollution load was lower than expected because the pollution sources, such as small water-courses, were frequently obstructed prior to discharge into the sea. At other stations, the pollution load in multiple samplings was extremely variable, due to the intermittent flow of sewage outlets. In many case, most bathing areas were found to be below the threshold limit fixed by Italian sanitary authorities (100 E. coli in 100 ml sea-water).

The situation appears to be satisfactory in the coastal areas surrounding the Elba Isle (figure 2), with few exceptions in localized water bodies receiving sewage effluents from the major urban settlements and tourist resorts of this island. In Capraia Isle (figure 3) polluted waters could be detected only inside the boat basin, along the wharf, whereas in Gorgona Isle (figure 4) only clean waters could be detected.

Additional technical aspects will be discussed in more detail in the final report when all data gathered have been comprehensively analysed.

However, the bacteriological monitoring showed rather peculiar figures in a coastal area (latitude 43 22' 40 " N, longitude 10 26'13" E) receiving untreated wastes from an industry producing soda and a number of other chemicals. These alkaline and warm industrial wastes, carrying large amounts of calcareous matter, are combined with domestic sewage prior to discharge into the sea. Concentration of total coliforms and E. coli was far lower than expected, both in wastewater samples and in the recipent sea-water body. Moreover, the numbers of coliforms were unusually and considerably lower than those of faecal streptococci, which represented a large proportion of total heterotrophic bacteria and heavily polluted the whole coastal area under study.

These atypical figures suggested a possible selective inactivation of micro-organisms in the industrial waste water. Such a hypothesis was supported by the results of additional laboratory investigations concerning the survival under various conditions of three bacteria (E. coli, Streptococcus faecalis and S. typhi), of a virus (type 1 poliovirus, strain LSc2ab) and a viral antigen (hepatitis B surface antigen or HB Ag). We completed a multidisciplinary study in this area, including aerial photographic tests, physical parameters of water, particle size analysis of sediments and mutagencity of waste water.

Conclusions:

The results presented above, including the microbiological survey of an extensive area of the Tyrrhenian Sea, show a general picture of the pollution load of domestic sources in the monitored area.

Peculiar interaction phenomena between enteric organisms and pollutants of industrial sources have also been investigated and related to their effects in the marine environment. The definite detailed results of our monitoring programme will become available at the end of the MED VII pilot project.

Figure 1

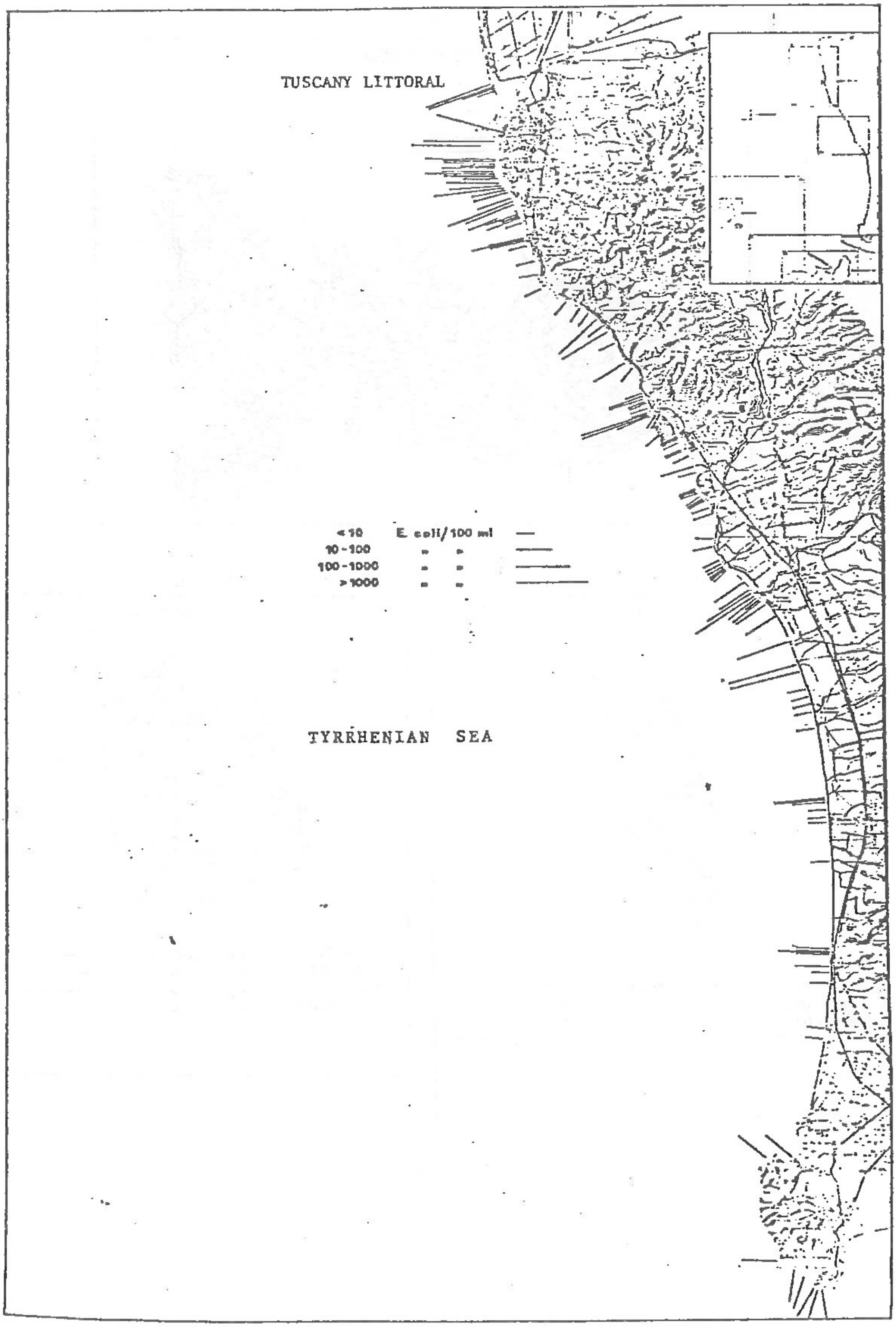

TUSCANY LITTORAL
< 10 E. coli/100 ml
10 - 100 " "
100 - 1000 " "
> 1000 " "
TYRRHENIAN SEA

Figure 2

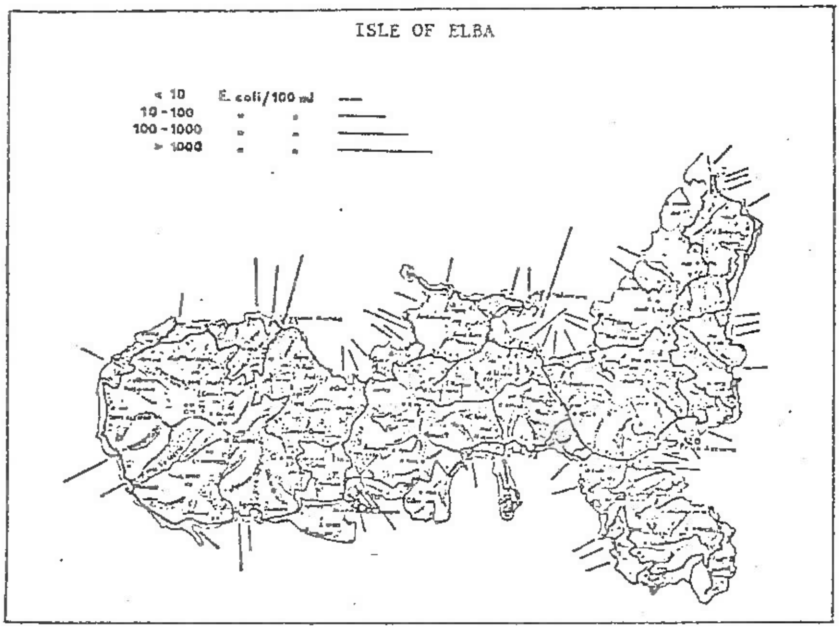


Figure 3

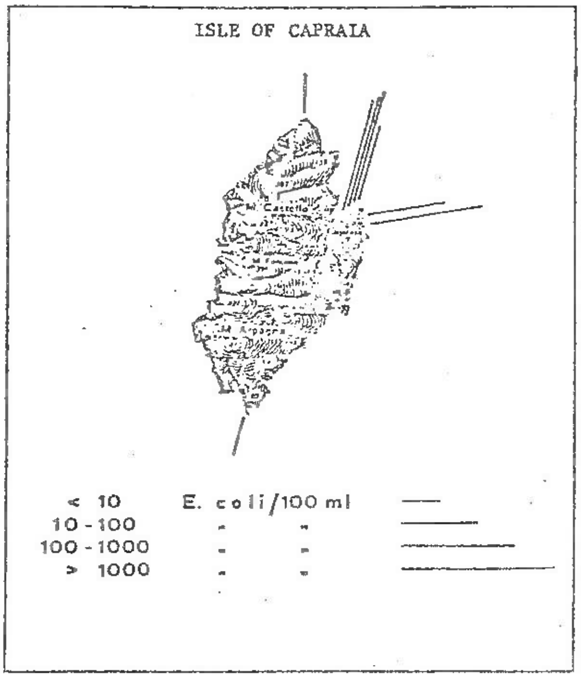
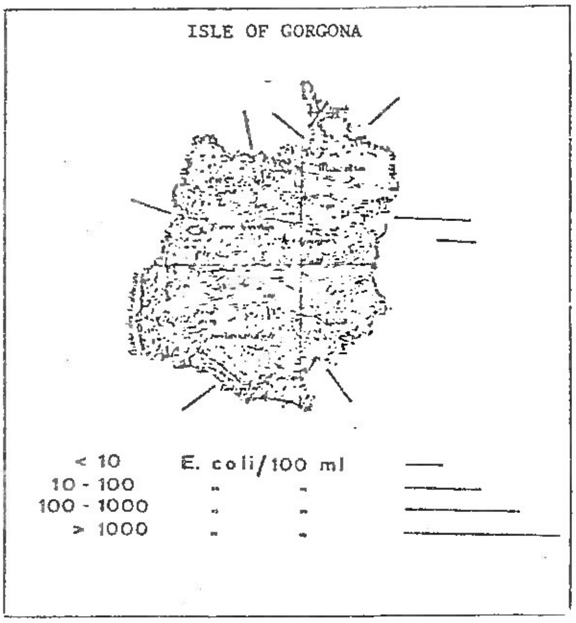


Figure 4



Participating Research Centre: Institute of Hygiene
University of Trieste
TRIESTE
Italy

Principal Investigator: L. MAJORI

Introduction:

The research activity of the Institute of Hygiene of the University of Trieste within the framework of project MED VII, started in 1978. It participates in an integration of numerous other research activities in the field of marine pollution, from the microbiological as well as from the chemical point of view, which was initiated in 1970.

Area(s) studied:

The study area is shown in the attached map (figure 1). The urban and industrial quarters, the outfalls from domestic and industrial wastes, the recreational areas, the rivers and the currents are clearly indicated on the map. The distribution of the sampling points is shown in figure 2. The 55 sampling stations are located along the coast as well as along a line perpendicular to the coast and at a decreasing distance from the beach (10 m, 500 m, 1000m, 1500m).

Material and methods used:

Pretreatment: the determination of ammonia, NO_3, NO_3, dissolved P are executed on the filtered sample by the filter membrane with pores of 0.45 um diameter.

Temperature, conductivity and salinity are measured by an induction salinometer with a sounding probe for recording temperatures at each point.

Dissolved oxygen is determined by the Winkler method modified according to Alsterberger. Total coliforms are determined by the filtration method using m-Endo agar incubated at 37°C (24 hours). Faecal coliforms are determined by the same method with m-FC agar incubated at 44.5°C (24 hours). Enterococcus is determined by the same method with m-enterococcus agar at 37°C (48 hours).

In some sampling points an analysis for qualitive detection of Salmonellae was undertaken.

Monitoring of shellfish has also been performed detecting the following parameters: total coliforms, faecal coliforms, enterococci and qualitative determination of Salmonellae.

Results and their interpretation:

Part of the results concerning the physico-chemical parameters appears in figures 3, 4, 5, 6, 7, 8, 9 and 10. Figures 11 and 12 give respectively a tentative evaluation of the quality of coastal seawaters of the Gulf of Trieste based on E. coli and Enterococci counts and the Italian legislation.

Table 1 gives the summarized results of the microbiological monitoring of the coastal seawater of the Gulf of Trieste for the period May 1978 - April 1979. Tables 2 and 3 gives the similar results for the period May 1978 to September 1978 and for October 1978 to April 1979. Tables 4 and 5 gives the frequency distribution respectively for faecal coliforms and for enterococci.

The areas where pollution is the greatest are limited to the Bay of Muggia (points 10 and 11) and to some of the points along a line orginating in the Bay (points 14, 15 and 16).

Two polluted zones are found south of the Barcola outfall and in the Duino area respectively.

The presence of Salmonellae strains has been confirmed at points 11 and 15 in spite of a low faecal coliform density.

Conclusions:

From the preliminary results described above, we can conclude that there are two areas of high concentrations of pollution, both chemical and bacteriological

The former area is located along the northern dispersion line originating in the Bay of Muggia, into which most of the municipal sewage and the harbour waste from the city of Trieste is discharged.

The latter is located in the northern section of the Gulf section off the town of Duino and is probably due to a defective sewage network and to occasional pollution from other human settlements in the neighbouring touristic areas.

Figure 1

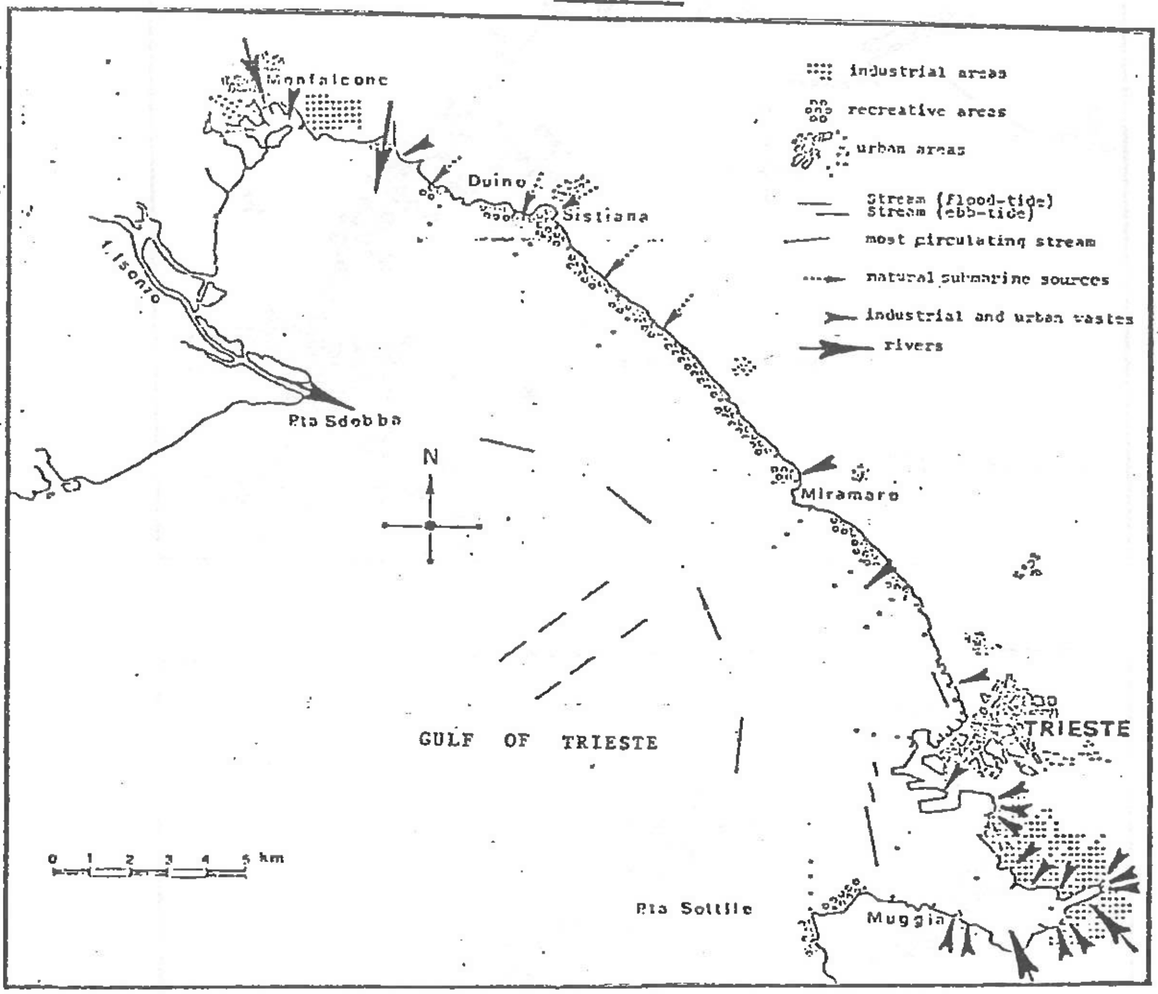

Monfalcone
Duino
Sistiana
I. Isonzo
Pta Sdobba
N
Miramare
TRIESTE
GULF OF TRIESTE
0 1 2 3 4 5 km
Pta Sottile
Muggia
industrial areas
recreative areas
urban areas
Stream (flood-tide)
Stream (ebb-tide)
most circulating stream
natural submarine sources
industrial and urban wastes
rivers

Figure 2

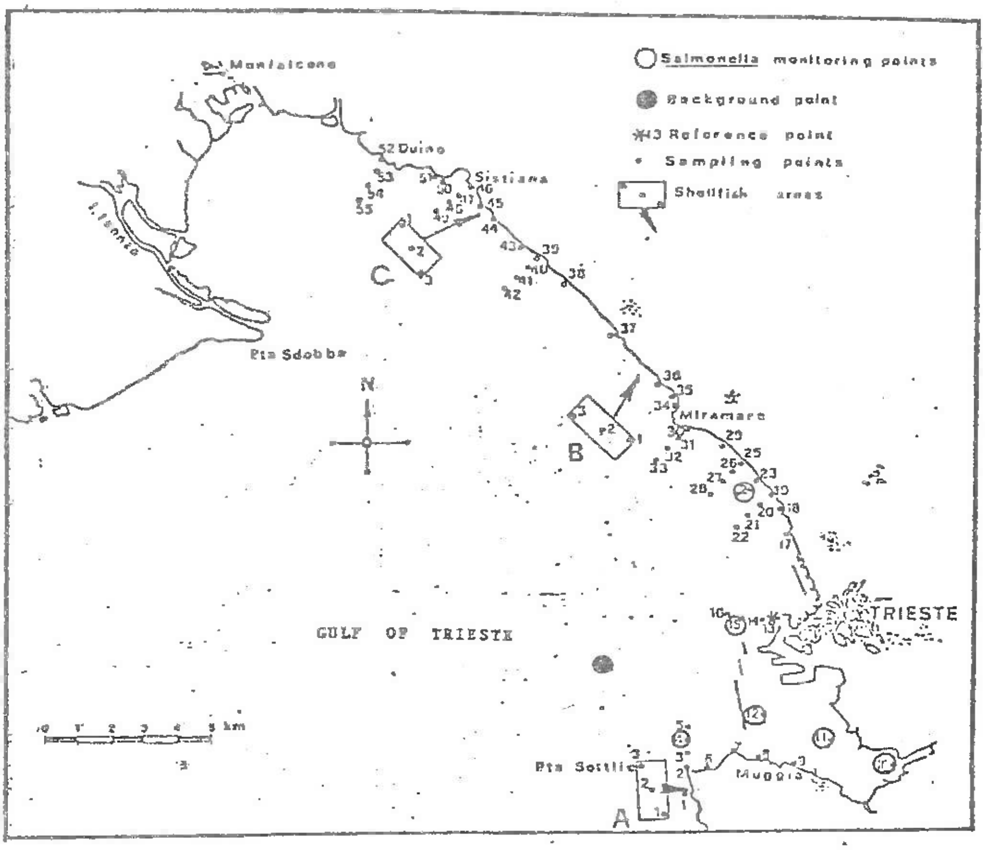


Figure 3

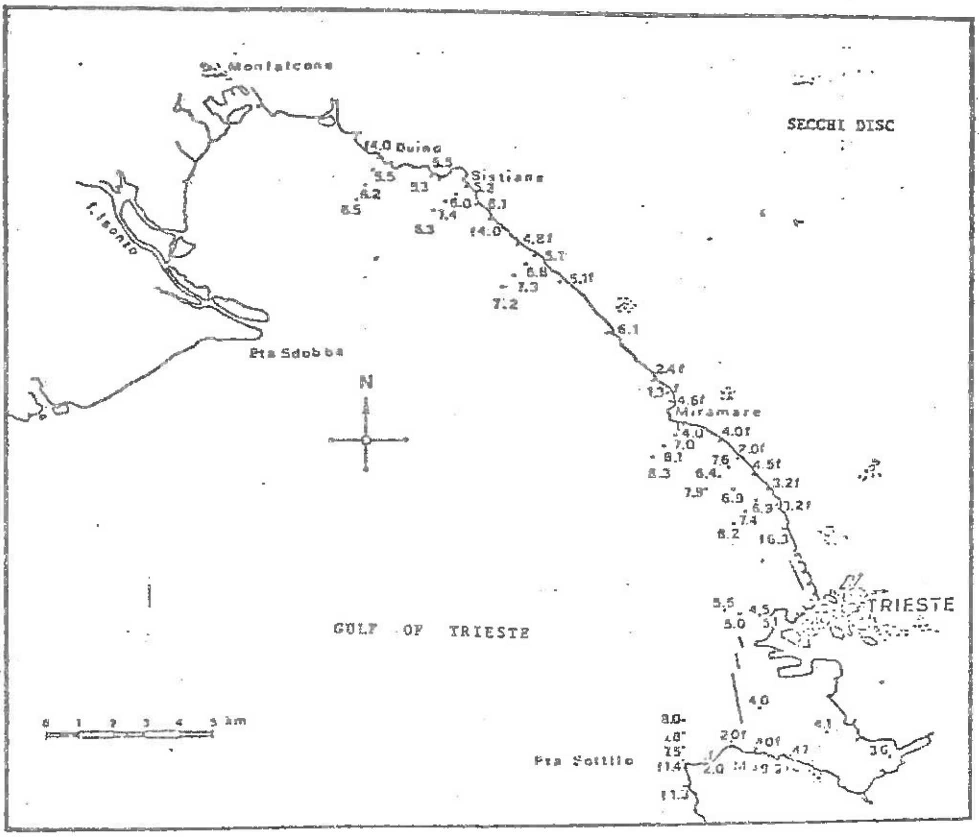


Figure 4

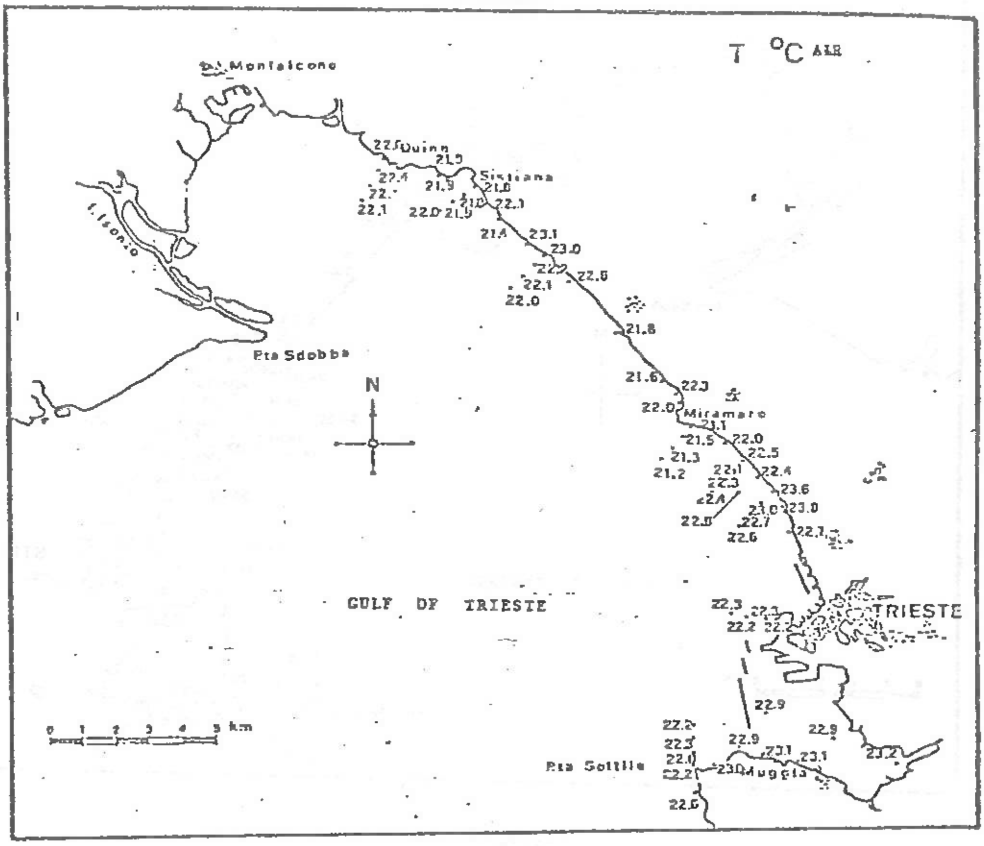


Figure 5

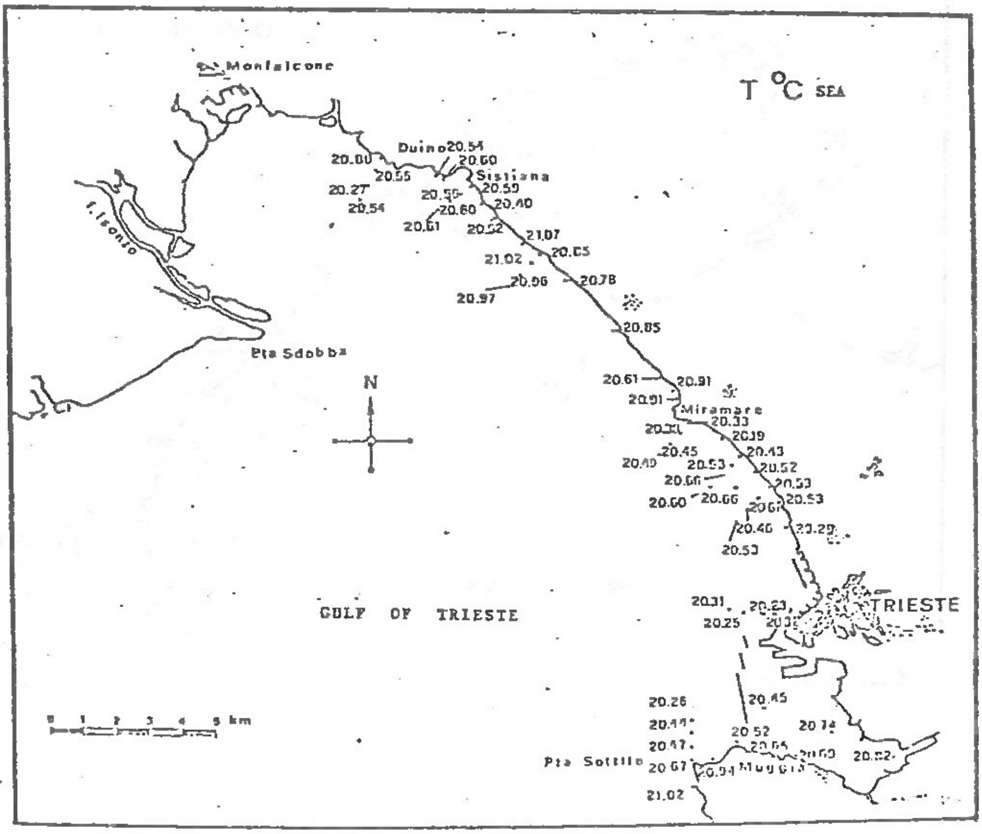


Figure 6

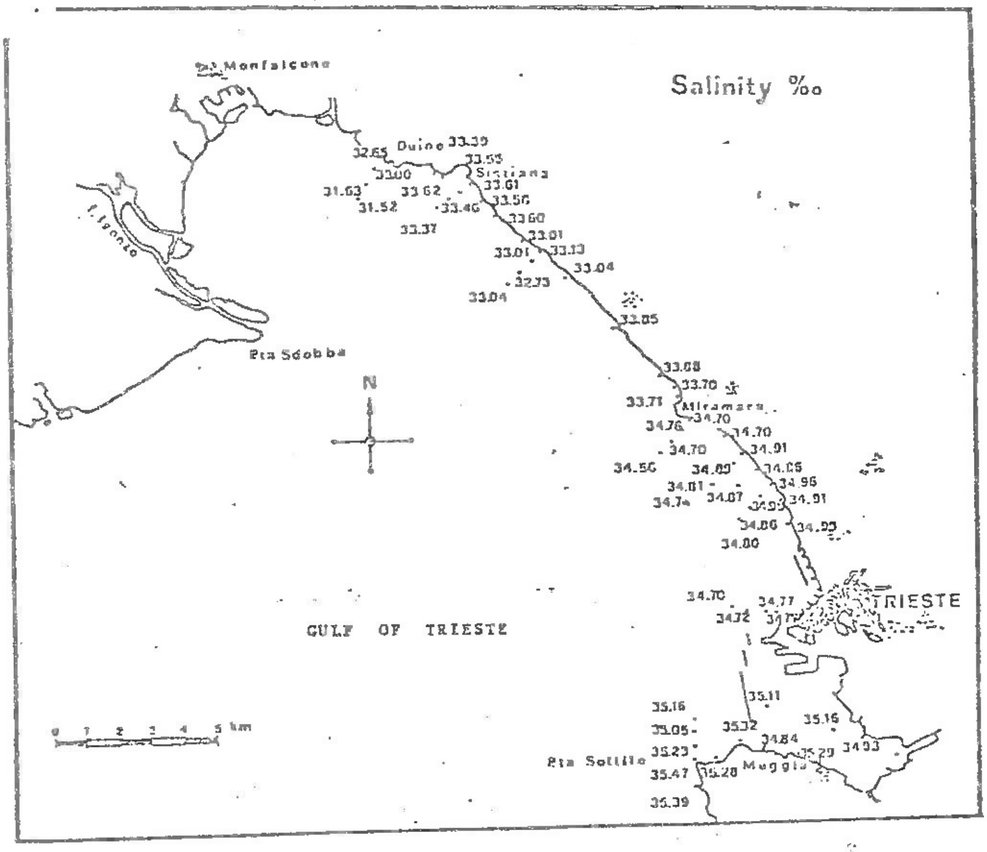


Figure 7

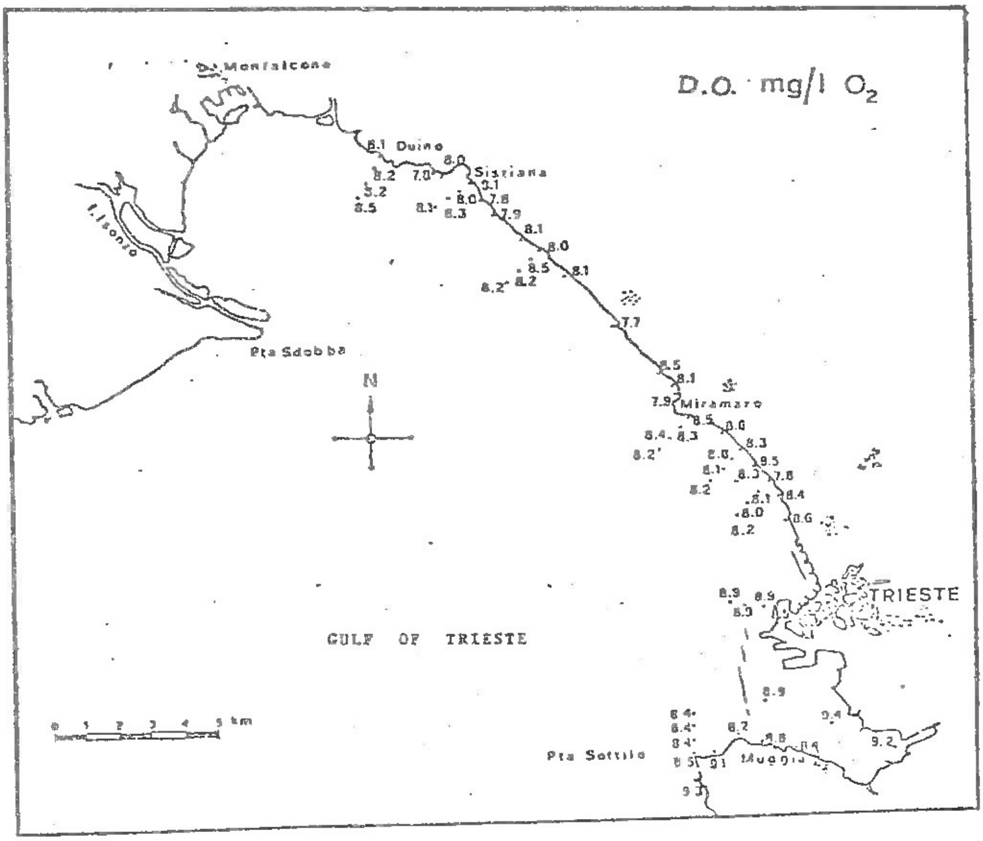


Figure 8

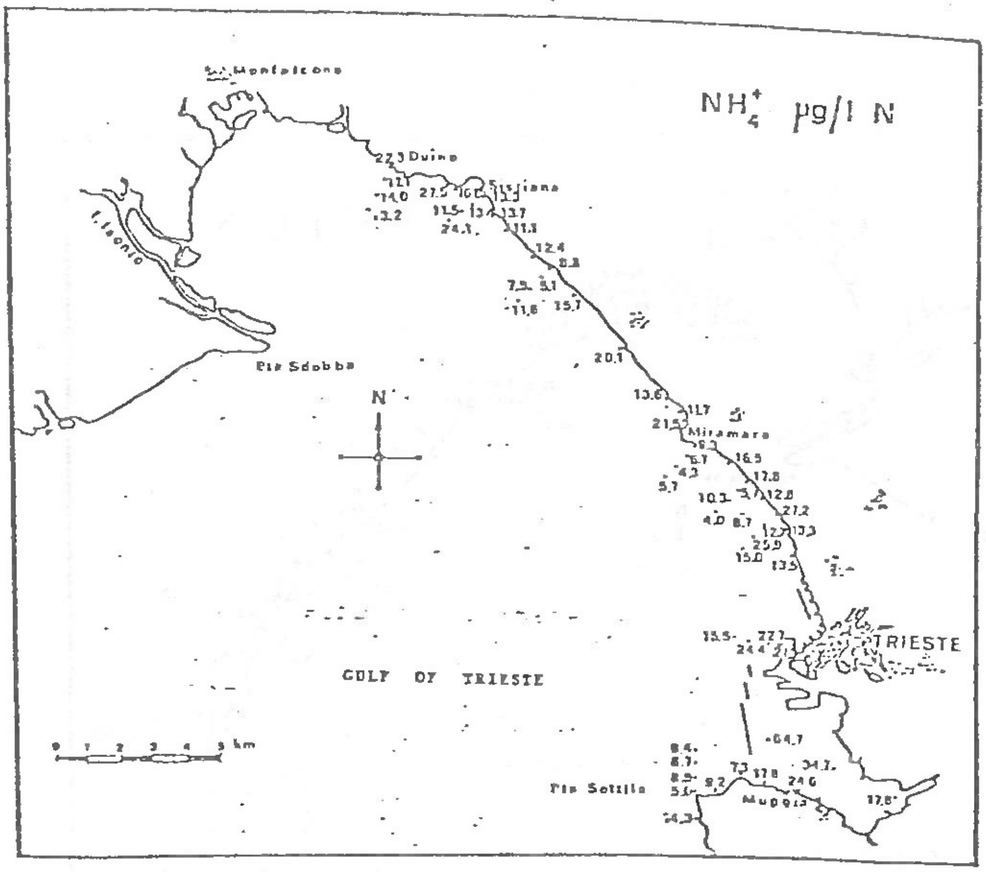


Figure 9

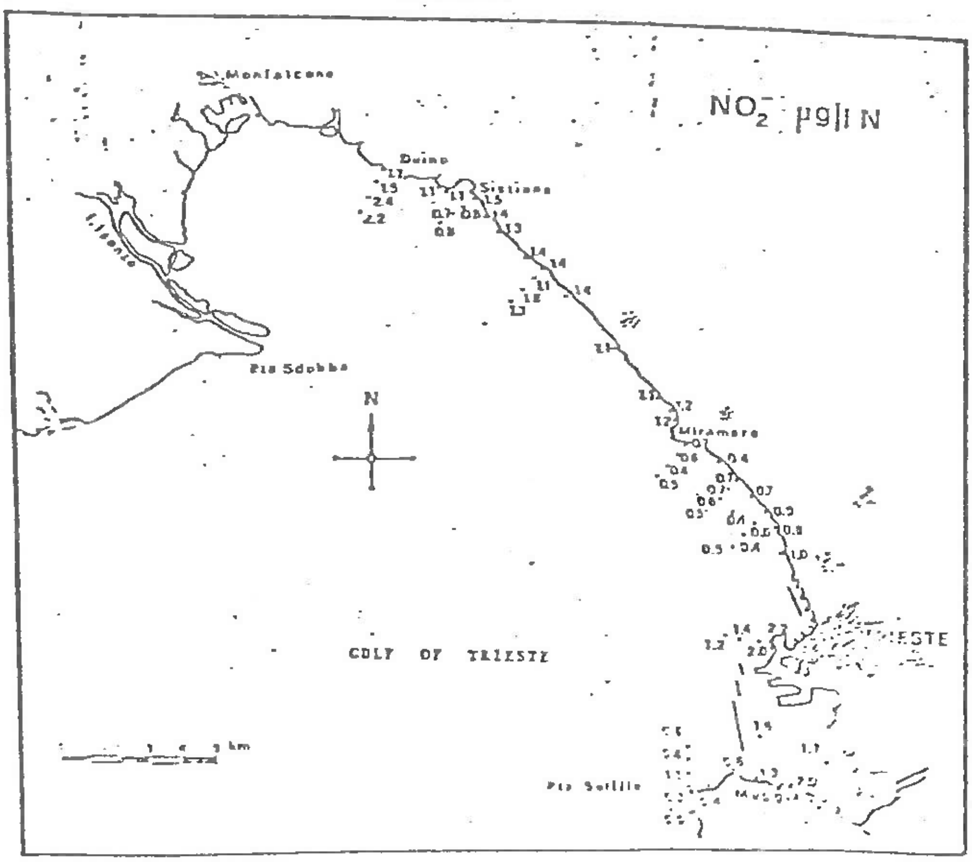
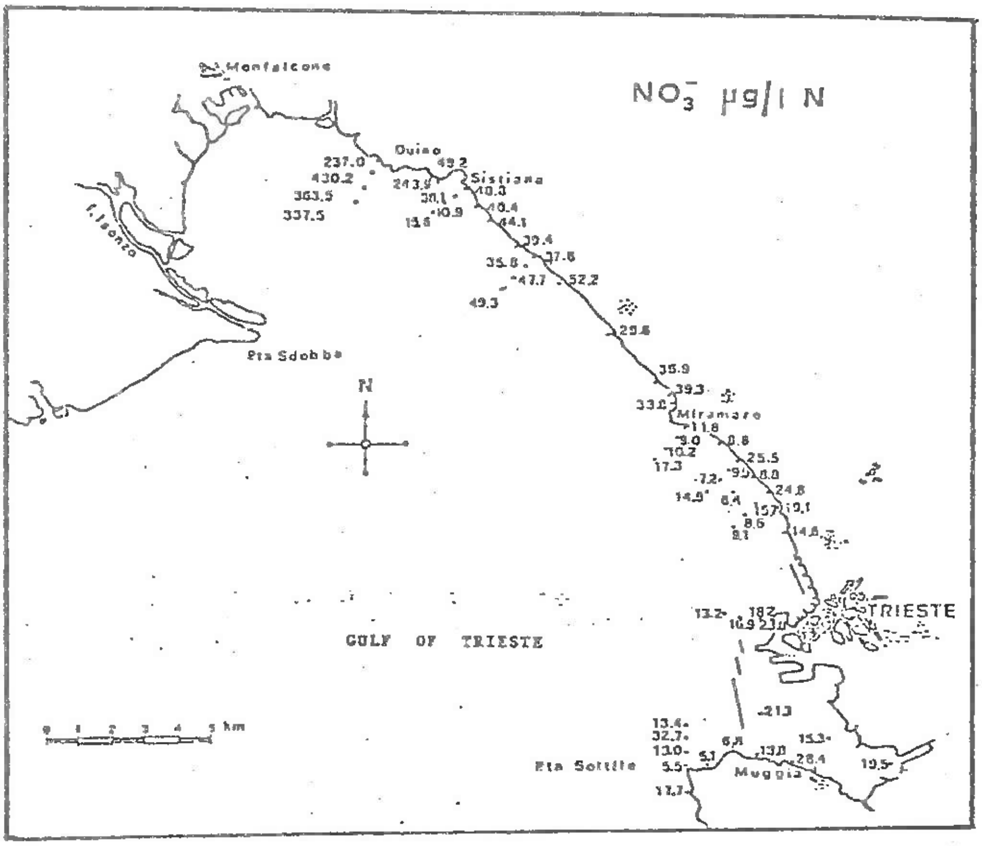


Figure 10


Monfalcone
NO_3^- µg/l N
Duino
Sistiana
I. Isonzo
Pta Sdobba
N
Miramare
TRIESTE
GULF OF TRIESTE
0 1 2 3 4 5 km
Pta Sottile
Muggia

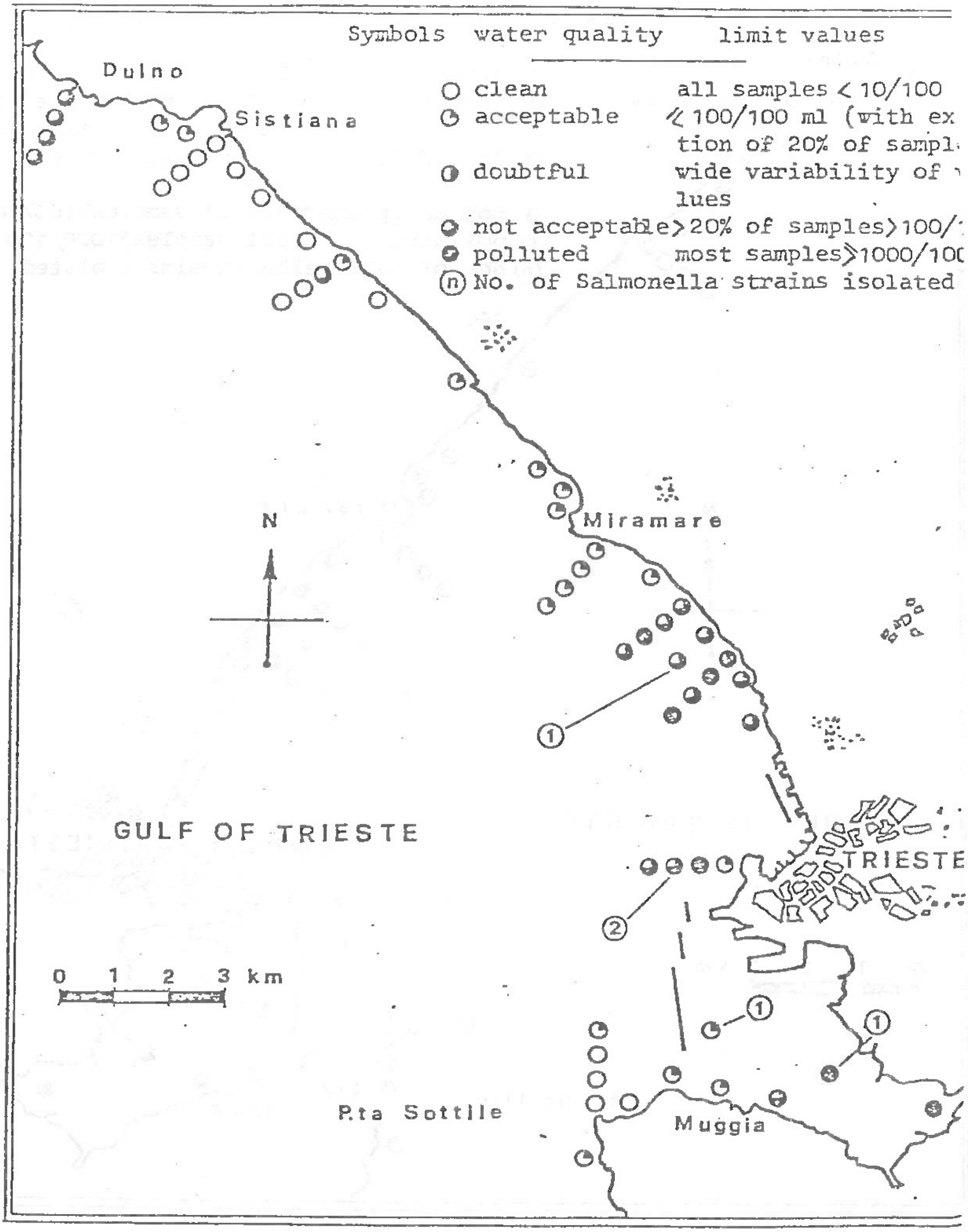


Fig. 11 - Tentative evaluation by means of Escherichia coli counts the quality of coastal seawaters of the Gulf of Trieste. (May 1978 - April 1979).

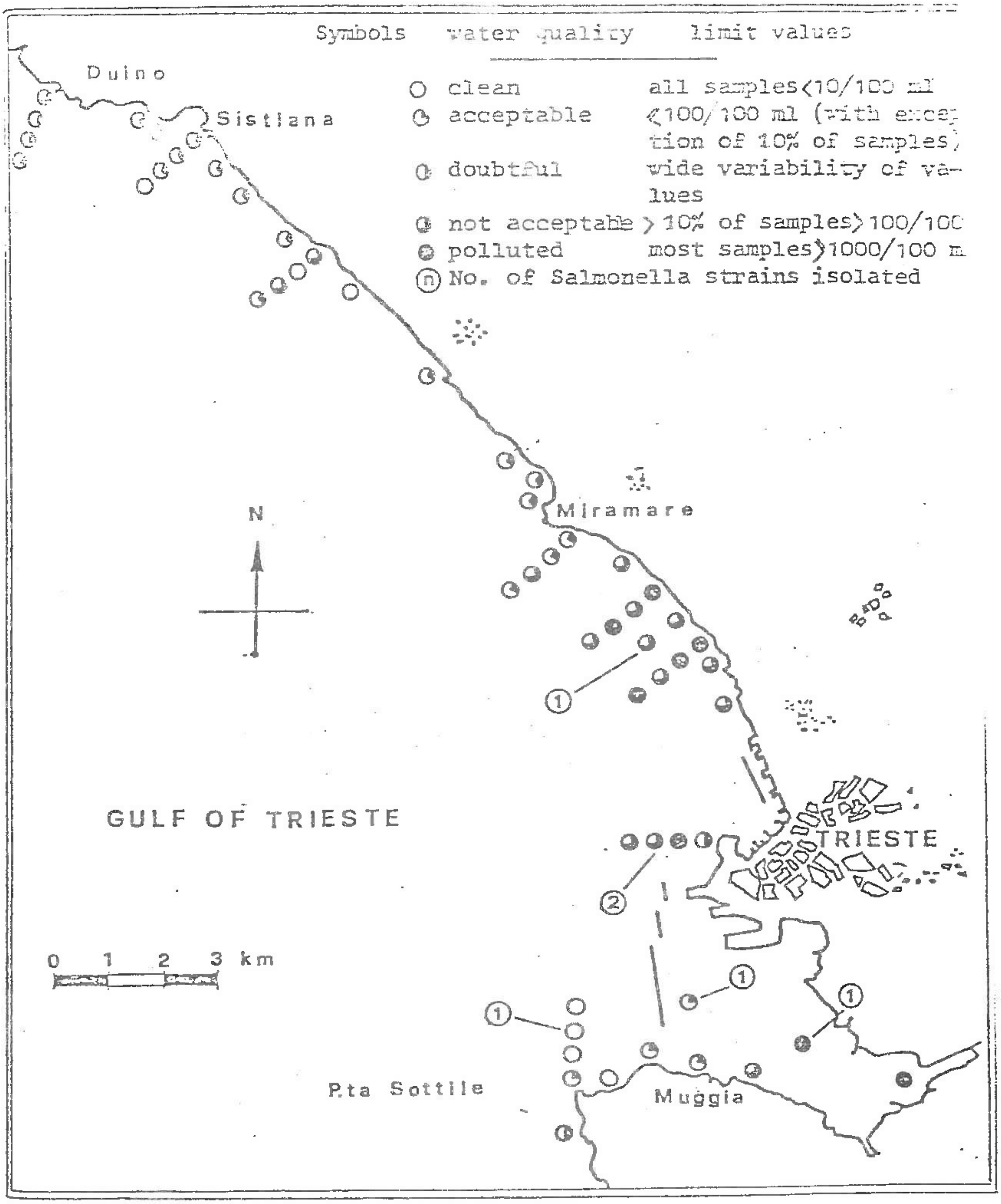


Fig. 12 - Tentative evaluation by means of enterococcal counts of the quality of coastal seawaters of the Gulf of Trieste. (May 1978 - April 1979).

Table N°1 - Summarized data on microbiological monitoring of coastal seawater of the Gulf of Trieste : distribution of microbial counts by the indicated parametric values (May 1978-April 1979).

Station	No. of samplings	TOTAL COLIFORMS/100 ml				FAECAL COLIFORMS/100 ml				ENTEROCOCCI/100 ml				SALMONELLA /5 l	
		<1	1-100	101-10^3	>10^3	<1	1-100	101-10^3	>10^3	<1	1-100	101-10^3	>10^3	pos.	neg.
1	11	2	8	1	0	4	6	1	0	3	7	0	1		
2	11	2	9	0	0	5	6	0	0	2	8	1	0		
3	11	3	6	2	0	7	4	0	0	7	4	0	0		
4	11	4	7	0	0	5	6	0	0	4	7	0	0		
5	11	3	5	1	2	6	4	1	0	2	9	0	0	1	10
6	11	3	6	1	1	6	5	0	0	7	4	0	0		
7	11	0	8	2	1	2	8	1	0	1	10	0	0		
8	11	0	9	1	1	5	6	0	0	4	7	0	0		
9	10	0	3	4	3	2	3	4	1	0	5	5	0		
10	11*	0	2	5	3	2	6	1	2	1	8	1	1	0	11
11	11	0	4	3	4	3	3	3	2	1	8	3	1	1	10
12	11	1	4	5	1	3	6	2	0	4	7	0	0	1	10
13	11	0	7	1	3	1	9	1	0	1	8	0	2		
14	11	0	3	3	5	0	5	4	2	0	6	3	2		
15	11	1	3	4	3	1	4	5	1	1	6	4	0	2	9
16	11	1	3	3	4	5	2	3	1	4	3	3	1		
17	11	1	3	2	5	1	5	4	1	2	4	4	1		
18	10	1	6	2	1	5	2	3	0	2	4	2	2		
19	11	1	5	1	4	3	3	0	5	2	3	2	4		
20	11	2	4	2	3	5	2	1	3	5	2	1	3		
21	11	3	5	2	1	5	4	1	1	3	5	2	1		
22	11	4	2	3	2	5	4	0	2	3	5	1	2		
23	11	1	7	2	1	5	4	1	1	4	3	3	1		
24	11	2	4	3	2	3	4	4	0	4	5	1	1	1	10
25	11	0	7	2	2	3	5	2	1	2	6	1	2		
26	11	2	7	1	1	6	3	1	1	4	5	1	1		
27	11	3	6	0	2	5	4	0	2	7	2	0	2		
28	11	3	6	1	1	7	3	0	1	6	4	0	1		
29	11	0	7	3	0	3	7	1	0	2	7	2	0		
30	11	2	7	2	0	5	6	0	0	5	4	2	0		
31	11	2	7	2	0	6	4	1	0	5	5	0	1		
32	10	0	9	0	1	6	3	0	1	3	5	1	1		
33	11*	7	3	0	0	6	5	0	0	8	3	0	0		
34	10	3	6	1	0	4	6	0	0	2	8	0	0		
35	11	4	3	4	0	5	6	0	0	4	6	1	0		
36	11	1	5	5	0	2	9	0	0	2	9	0	0		
37	11	2	6	3	0	5	6	0	0	8	3	0	0		
38	11	2	7	2	0	4	7	0	0	6	5	0	0		
39	10	2	6	0	2	7	2	1	0	6	2	2	0		
40	11*	5	5	0	0	8	3	0	0	7	4	0	0		
41	11	6	3	0	2	7	2	1	1	6	3	1	1		
42	11*	6	4	0	0	8	3	0	0	6	5	0	0		
43	11	3	7	1	0	6	5	0	0	5	6	0	0		
44	10	2	7	1	0	7	3	0	0	4	5	1	0		
45	11	2	8	1	0	9	2	0	0	6	4	1	0		
46	11	3	6	0	0	6	5	0	0	3	7	1	0		
47	11	3	8	0	0	9	2	0	0	5	5	1	0		
48	11	3	8	0	0	9	2	0	0	5	6	0	0		
49	11	4	7	0	0	9	2	0	0	5	6	0	0		
50	11	1	7	3	0	6	5	0	0	5	6	0	0		
51	11	0	5	5	1	3	7	1	0	2	9	0	0		
52	11	0	2	5	4	1	6	3	1	0	9	2	0		
53	11	3	0	3	5	3	3	2	3	3	8	0	0		
54	11	2	1	4	4	2	7	2	0	3	7	0	1		
55	10	2	3	3	2	4	3	3	0	3	6	1	0		

* One total coliforms count not done.

Table N° 2 - Summarized data on microbiological monitoring of coastal seawater of the Gulf of Trieste: distribution of microbial counts, by the indicated parametric values (May-September 1976).

Station	No. of samplings	TOTAL COLIFORMS/100 ml				FAECAL COLIFORMS/100 ml				ENTEROCOCCI/100 ml				SALMONELLA /5 l	
		<1	1-100	101-10^3	>10^3	<1	1-100	101-10^3	>10^3	<1	1-100	101-10^3	>10^3	pos.	neg.
4	5	0	4	1	0	1	3	1	0	1	3	0	1		
2	5	0	5	0	0	1	4	0	0	1	4	0	0		
3	5	1	3	1	0	2	3	0	0	3	2	0	0		
4	5	1	4	0	0	1	4	0	0	1	4	0	0		
5	5	0	2	1	2	2	2	1	0	3	2	0	0	0	5
6	5	2	2	1	0	2	3	0	0	5	0	0	0		
7	5	0	4	1	0	1	4	0	0	1	4	0	0		
8	5	0	4	1	0	2	3	0	0	2	3	0	0		
9	5	0	1	3	1	1	0	4	0	0	1	4	0		
10	5	0	1	3	1	0	3	1	1	0	4	1	0	0	5
11	5	0	2	3	2	1	3	0	1	1	4	0	0	1	4
12	5	0	1	3	1	1	4	0	0	2	3	0	0	0	5
13	5	0	3	1	1	0	5	0	0	1	4	0	0		
14	5	0	1	1	3	0	2	1	2	0	4	1	0		
15	5	1	1	1	2	0	1	3	1	0	4	1	0	2	3
16	5	0	2	1	2	1	2	1	1	2	2	1	0		
17	6	1	3	1	1	1	5	0	0	2	4	0	0		
18	5	1	4	0	0	3	2	0	0	1	4	0	0		
19	6	1	3	0	2	2	2	0	2	2	2	1	1		
20	6	1	3	1	1	3	2	0	1	3	2	0	1		
21	6	2	3	1	0	4	2	0	0	2	3	1	0		
22	6	3	1	2	0	3	3	0	0	2	3	1	0		
23	6	1	5	0	0	4	2	0	0	4	2	0	0		
24	6	1	3	0	2	2	3	1	0	3	3	0	0	0	6
25	6	0	4	2	0	2	3	1	0	2	3	1	0		
26	6	1	5	0	0	5	1	0	0	5	2	0	0		
27	6	3	3	0	0	4	2	0	0	6	0	0	0		
28	6	1	4	1	0	5	1	0	0	4	2	0	0		
29	6	0	4	2	0	2	4	0	0	2	4	0	0		
30	6	1	4	1	0	3	3	0	0	4	2	0	0		
31	6	1	4	1	0	5	1	0	0	4	2	0	0		
32	5	0	5	0	0	4	1	0	0	3	2	0	0		
33	6	4	2	0	0	4	2	0	0	5	1	0	0		
34	6	3	3	0	0	3	3	0	0	2	4	0	0		
35	6	3	2	1	0	3	3	0	0	3	3	0	0		
36	6	0	2	4	0	1	5	0	0	1	5	0	0		
37	6	1	2	3	0	2	4	0	0	5	1	0	0		
38	6	1	3	2	0	2	4	0	0	5	1	0	0		
39	6	1	4	0	1	4	4	1	0	5	1	0	0		
40	6	3	3	0	0	5	1	0	0	5	1	0	0		
41	6	2	3	0	1	4	1	0	1	4	1	0	1		
42	6	3	2	0	1	4	2	0	0	3	3	0	0		
43	6	3	2	1	0	4	2	0	0	3	3	0	0		
44	5	1	3	1	0	3	2	0	0	3	2	0	0		
45	6	1	5	0	0	6	0	0	0	2	2	0	0		
46	6	3	3	0	0	3	3	0	0	3	3	0	0		
47	6	2	4	0	0	5	1	0	0	4	1	1	0		
48	6	2	4	0	0	5	1	0	0	3	3	0	0		
49	6	1	5	0	0	5	1	0	0	3	3	0	0		
50	6	0	5	1	0	4	2	0	0	4	2	0	0		
51	6	0	3	2	1	1	4	1	0	2	4	0	0		
52	6	0	2	2	2	1	4	0	1	0	5	0	0		
53	6	2	0	0	4	2	1	3	0	2	4	0	0		
54	6	1	1	1	3	1	3	2	0	2	4	0	0		
55	5	1	2	1	1	3	0	2	0	2	3	0	0		

Table N° 3 – Summarized data on microbiological monitoring of coastal seawater of the Gulf of Trieste: distribution of microbiol counts by the indicated parametric values (October 76–April 79).

Station	No of samplings	TOTAL COLIFORMS/100 ml <1	1–100	$101-10^3$	$>10^3$	FAECAL COLIFORMS/100 ml <1	1–100	$101-10^3$	$>10^3$	ENTEROCOCCI/100 ml <1	1–100	$101-10^3$	$>10^3$	SALMONELLA/5 l pos.	neg.
1	6	2	4	0	0	3	3	0	0	2	4	0	0		
2	6	2	4	0	0	4	2	0	0	1	4	1	0		
3	6	2	3	1	0	5	1	0	0	4	2	0	0		
4	6	3	3	0	0	4	2	0	0	3	3	0	0		
5	6	3	3	0	0	4	2	0	0	4	2	0	0	1	5
6	6	1	4	0	1	4	2	0	0	2	4	0	0		
7	6	0	4	1	1	1	3	2	0	0	6	0	0		
8	6	0	5	0	1	2	4	0	0	2	4	0	0		
9	5	0	2	1	2	1	3	0	1	0	4	1	0		
10*	6	0	1	2	2	2	3	0	1	1	4	0	1	0	6
11	6	0	2	2	2	2	0	3	1	0	4	1	1	0	6
12	6	1	3	2	0	2	0	4	0	2	2	2	0	1	5
13	6	0	4	0	2	1	4	1	0	0	4	0	2		
14	6	0	2	2	2	0	3	3	0	0	2	2	2		
15	6	0	2	3	1	1	3	2	0	1	2	3	0	0	6
16	6	1	1	2	72	4	0	2	0	2	1	2	1		
17	5	0	0	1	4	0	0	4	1	0	0	4	1		
18	5	0	2	2	1	2	0	3	0	1	0	2	2		
19	5	0	2	1	2	1	1	0	3	0	1	1	3		
20	5	1	1	1	2	2	0	1	2	2	0	1	2		
21	5	1	2	1	1	1	2	1	1	1	2	1	1		
22	5	1	1	1	2	2	1	0	2	1	2	0	2		
23	5	0	2	2	1	1	2	1	1	0	1	3	1		
24	5	1	1	3	0	1	1	3	0	1	2	1	1	1	4
25	5	0	3	0	2	1	2	1	1	0	3	0	2		
26	5	1	2	1	1	1	2	1	1	0	3	1	1		
27	5	0	3	0	2	1	2	0	2	1	2	0	2		
28	5	2	2	0	1	2	2	0	1	2	2	0	1		
29	5	0	3	2	0	1	3	1	0	0	3	2	0		
30	5	1	3	1	0	2	3	0	0	1	2	2	0		
31	5	1	3	1	0	1	3	1	0	1	3	0	1		
32	5	0	4	0	1	2	2	0	1	0	3	1	1		
33*	5	3	1	0	0	2	3	0	0	3	2	0	0		
34	4	0	3	1	0	1	3	0	0	0	4	0	0		
35	5	1	1	3	0	2	3	0	0	1	3	1	0		
36	5	1	3	1	0	1	4	0	0	1	4	0	0		
37	5	1	4	0	0	3	2	0	0	3	2	0	0		
38	5	1	4	0	0	2	3	0	0	1	4	0	0		
39	4	1	2	0	1	3	1	0	0	1	1	2	0		
40*	5	2	2	0	0	3	2	0	0	2	3	0	0		
41	5	4	0	0	1	3	1	1	0	2	2	1	0		
42*	5	2	2	0	0	4	1	0	0	3	2	0	0		
43	5	0	5	0	0	2	3	0	0	2	3	0	0		
44	5	1	4	0	0	4	1	0	0	1	3	1	0		
45	5	1	3	1	0	3	2	0	0	2	2	1	0		
46	5	2	3	0	0	3	2	0	0	0	4	1	0		
47	5	1	4	0	0	4	1	0	0	1	4	0	0		
48	5	1	4	0	0	4	1	0	0	2	3	0	0		
49	5	3	2	0	0	4	1	0	0	2	3	0	0		
50	5	1	2	2	0	2	3	0	0	1	4	0	0		
51	5	0	2	3	0	2	3	0	0	0	5	0	0		
52	5	0	0	3	2	0	2	3	0	0	3	2	0		
53	5	1	0	3	1	1	2	2	0	1	4	0	0		
54	5	1	0	3	1	1	4	0	0	1	3	0	1		
55	5	1	1	2	1	1	3	1	0	1	3	1	0		

* One total coliforms count not done.

Table 4. – Frequency distribution for faecal coliform counts as related to major areas and to seasons.

Stations	No. of samples	Season	% samples with counts/100 ml of		
			≤ 100	$101 - 10^3$	$> 10^3$
1 – 15	75	S	78.9	14.7	6.7
	89	W	79.8	16.8	3.4
16 – 28	76	S *	90.7	3.9	5.3
	66	W	51.5	25.7	22.7
29 – 55	159	S	93.1	5.7	1.2
	133	W	92.5	6.8	0.7
All stations	310	S *	89.1	7.4	3.5
	288	W	79.5	13.5	6.9

Table 5. - Frequency distribution for enterococcal counts as related to major areas and to seasons.

Stations	No. of samples	Season	% samples with counts/100 ml of		
			≤ 100	101 - 10^3	> 10^3
1 - 15	75	S	89.3	9.3	1.3
	89	W	85.4	7.9	6.7
16 - 28	76	S *	90.8	6.6	2.6
	66	W	45.4	27.3	27.3
29 - 55	159	S	98.7	0.6	0.6
	133	W	86.5	11.3	2.2
All stations	310	S *	94.5	4.2	1.3
	288	W	76.4	13.5	10.1

Participating Research Centre: Centre de Recherche marine
Conseil national de la Recherche Scientifique
BEYROUTH
Liban

Principal Investigator: F.S. GHORRA/H.H. KOUYOUMJIAN

Introduction:

Work along MED VII lines has been conducted in Lebanon for the past decade, although very few of the findings have been published. Among those published, we generally observe a lack of systematic approach, and a general absence of comparability basically due to different methodologies used.

Area(s) studied:

The area studied falls within the following co-ordinates: 35°38'E, 34°01'N (Maameltein-north of Beirut) and 35°28'E, 33°50'N (Khalde-south of Beirut).

Off the coast of Lebanon the major currents fall within the current pattern of the Eastern Mediterranean. The current in our area has a value which varies between 0.2 and 1.4 knots. Figure 1 gives all the important aspects of this current and is based on unpublished data supplied by T. Goedicke. Figure 2, which is also partially based on Goedicke's work, gives information about rivers and other major outfalls which fall within the general area of study.

A total of about 40 stations are sampled for bacteriological analyses. These are divided as follows: three control stations, seven under influence of discharge points, and 30 regular.

Material and methods used:

Due to the lack of instrumentation and other facilities at the Centre, not all analyses were carried out using the MF method. This was intended to be remedied, but, due to the situation in Lebanon, this transition has been delayed. Eventually the MF method will be used in all bacteriological analyses. The bacteriological parameters studied were: total coliforms, faecal coliforms, faecal streptococci, Vibrio and Clostridium.

The basic methodology is based on the Guidelines prepared by WHO for this purpose.

Of the other relevant parameters, the following are regularly observed: air temperature, water temperature, salinity, pH, waves, wind, visual observation of floating pollutants and garbage on the coast.

Results and their interpretation:

Based on the results obtained for our station throughout the sampling period, these are some of the very general observations:

pH range: 7.13 - 8.28

water temperature: 13°C - 29°C

salinity: 33.72 - 41.12 ‰

At this stage we are unable to present all our data, properly analysed and tabulated.

These are the extreme values and are not indicative of the general mean. They compare favourably with past records. Water temperature was generally colder during 1977. Normally temperatures do not fall below 15°C.

As far as wind and drift are concerned, they tend to concentrate floating material on the coast particularly to the north of Beirut.

As far as bacteriological results are concerned, unfortunately they have not been analysed in detail due to lack of communication between the two principal investigators as a result of the very difficult circumstances we were facing.

Table 1 gives some bacteriological results. For the purpose of this summary report, a few (three) stations representative of the area studied are selected and results reported. They are also compared with three control stations and one station which is known to be influenced by a nearby sewer. It is apparent that all values are below international standards and are under the interim standard set by WHO for the Mediterranean. It must be noted here that almost all sampling operations were conducted after storms and heavy seas. Similarly, we wish to report that so far no vibrios have been isolated from our samples.

Conclusions:

All values fall within internationally accepted limits. Unfortunately, bacteriological parameters were not studied during the summer season due to the temporary cessation of our activities.

Table 1

Station no.	Water temp. (°C)	Salinity (‰)	pH	*E. coli*	Total coli	*Strep. faecalis*
39	18.0 ± 5.0	38.41 ± 0.17	8.13 ± 1.70	20 ± 31	337 ± 113	I
40	20.7 ± 2.0	38.45 ± 0.27	8.14 ± 0.04	I	158 ± 90	37 ± 23
41	21.1 ± 2.6	39.08 ± 0.60	8.18 ± 1.79	12 ± 5	224 ± 106	57 ± 26
11	21.1 ± 1.5	39.21 ± 0.28	8.18 ± 0.02	21 ± 8	360 ± 78	38 ± 14
29	20.8 ± 2.0	39.45 ± 0.36	8.14 ± 1.50	3 ± 2	163 ± 50	52 ± 29
37	20.8 ± 2.0	38.42 ± 0.16	8.11 ± 0.28	69 ± 58	732 ± 311	40 ± 22
17	21.1 ± 1.48	35.37 ± 4.28	7.78 ± 0.12	50 ± 30	515 ± 235	67 ± 36

N.B.
- stations 39, 40 and 41 are control stations
- stations 11, 29 and 37 are normal stations
- station 17 is under the influence of a domestic sewer
- the standard error of each number is also given in the table
- I = insignificant
- all bacterial counts are per 100 ml of sea-water

Figure 1

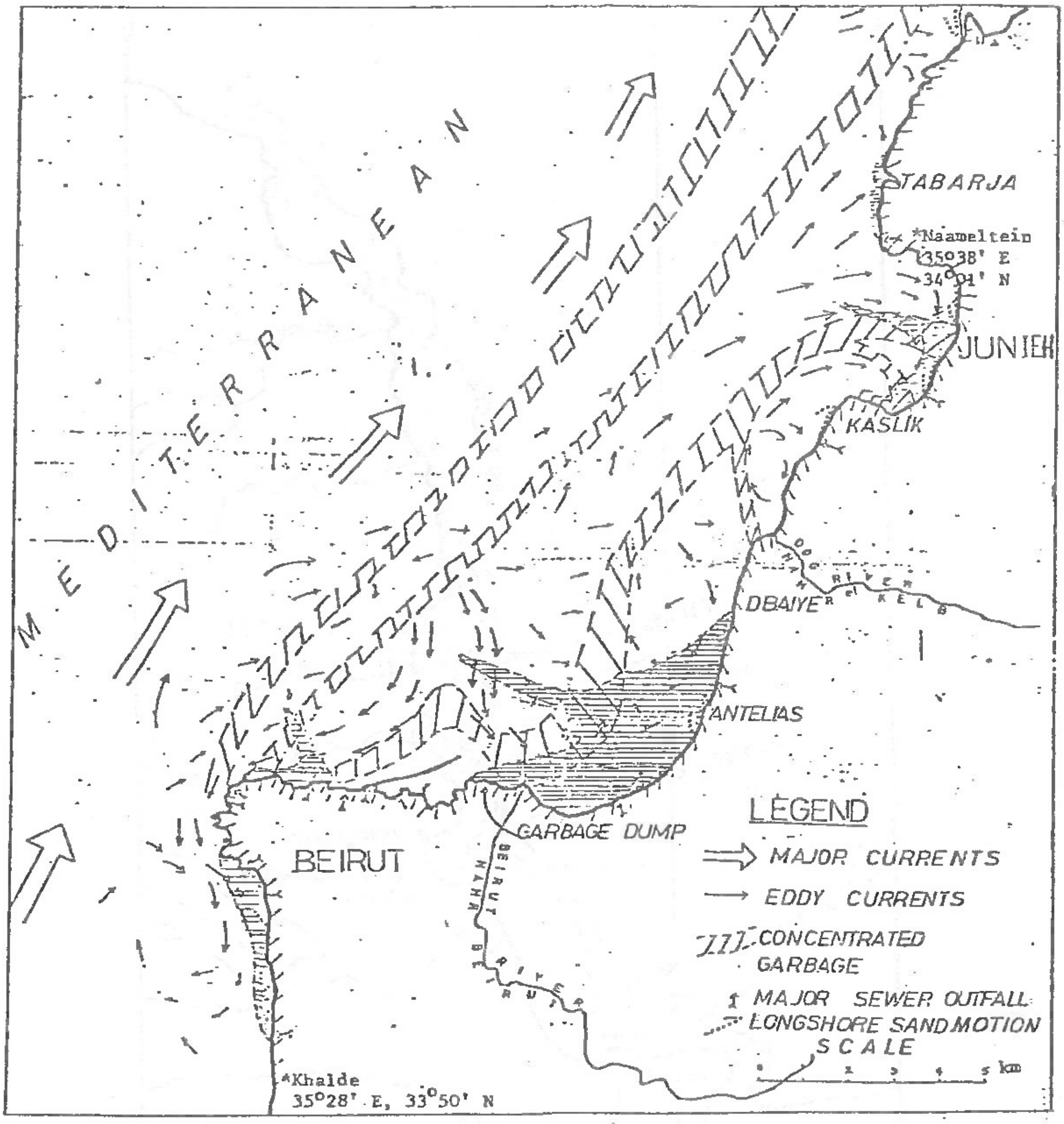
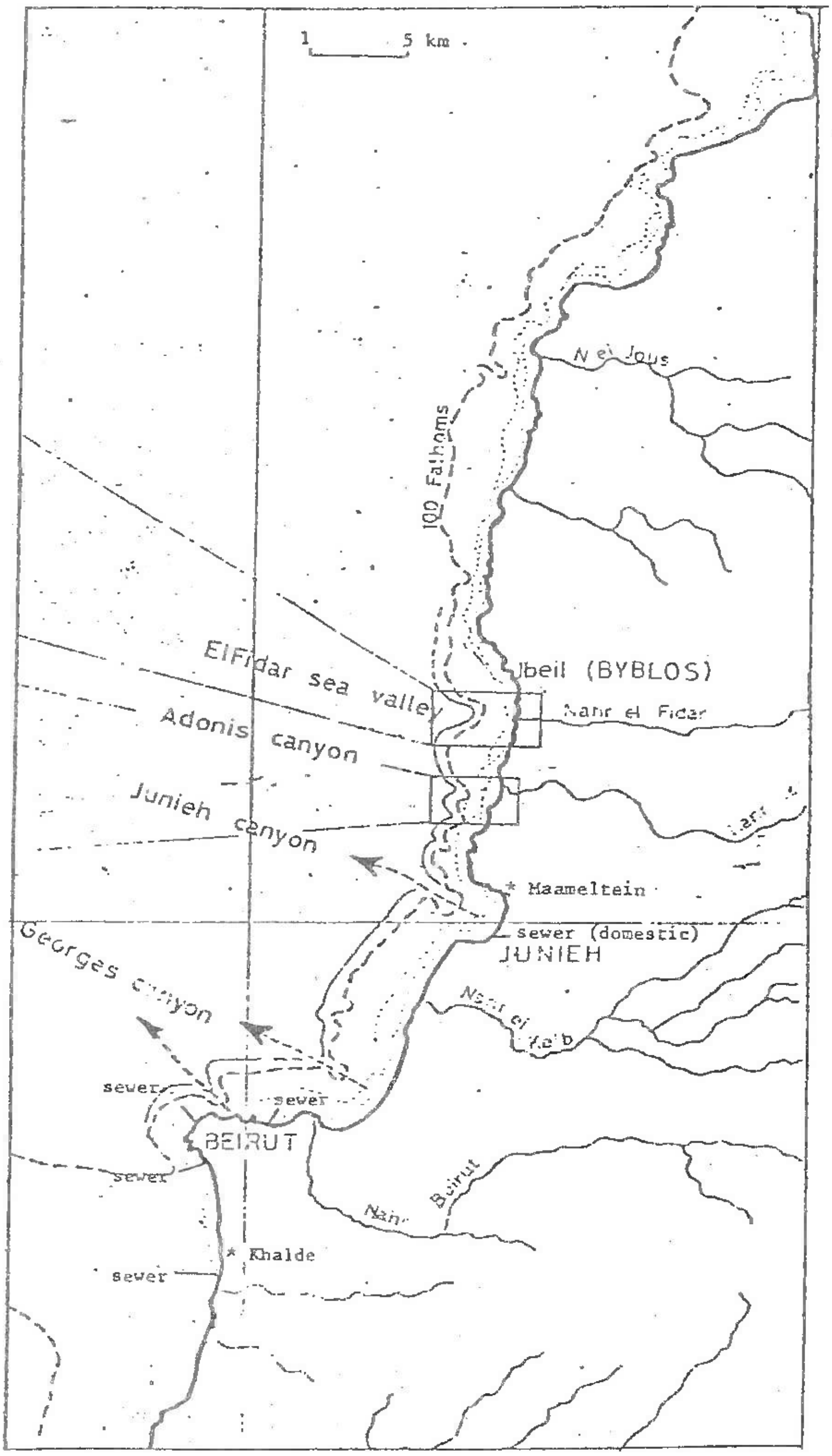

MEDITERRANEAN
TABARJA
*Naameltein
35°38' E
34°01' N
JUNIEH
KASLIK
DBAIYE
ANTELIAS
GARBAGE DUMP
BEIRUT
LEGEND
MAJOR CURRENTS
EDDY CURRENTS
CONCENTRATED GARBAGE
MAJOR SEWER OUTFALL
LONGSHORE SAND MOTION
SCALE
km
*Khalde
35°28' E, 33°50' N

Figure 2


1 5 km
N el Jous
100 Fathoms
Jbeil (BYBLOS)
ElFidar sea valley
Nahr el Fidar
Adonis canyon
Junieh canyon
Maameltein
sewer (domestic)
JUNIEH
Georges canyon
sewer
sewer
BEIRUT
sewer
Nahr Beirut
Khalde
sewer

Participating Research Centre: Public Health Laboratory
Department of Health
VALLETTA
Malta

Principal Investigator: L.J. SPITERI

Introduction:

Health inspectors submit samples of sea-water routinely to the Health Department Laboratory. Recreational waters are given special importance during the bathing season (May-September). Sites which are liable to contamination due to sewage overflow are examined at least weekly during the bathing season. Bathing is prohibited when counts are constantly greater than 1000 E. coli per 100 ml.

Areas studied

The attached map (figure 1) shows the sampling sites, which are as follows:

San Lucian (reference area- clean)

Rinella (reference area near sewage outfall) - since August 1978 a submarine outfall has been installed at Wield Ghammieq

3, 4, 5 and 6: Ghadira - after heavy rainfall in winter, overflow of an adjacent sewer is possible with contamination with faecal organisms.

Length of coastline: 2 km.

Description of Ghadira Bay: No waste water outlets. Occasional overflow of public sewer after heavy storms may contaminate bay. No solid waste dumping sites on shores or offshore. Prevailing local current - north easterly. Area is sandy. Meteorological data is that applicable to Malta as a whole. Rocky hills on either side. Some cultivated patches. Various types of soil, mainly in isolated pockets. Storm water enters coastal area during N. E. wind periods.

Main recreational season June-September. Two hotels near beach area, two restaurants adjoining beach. Densely utilized during summer. Main urban settlement (Mellieha) does not discharge its wastes into area. No industrial development in area. Whole beach constitutes bathing area. Monitoring to be carried out 10 m from shoreline at points indicated on map.

Materials and methods used:

The bacteriological tests include total coliforms, faecal coliforms and faecal streptococci by MF. MPN is carried out in parallel as well as on other beaches.

The selected parameters which have been measured are:

surface temperature
salinity
visual appearance of beach
state of waves
wind direction
the bacteriological tests include: total coliforms
faecal coliforms
faecal streptococci

Results and their interpretation:

Figures obtained by MF were tabulated and mean values, standard deviation and distribution were obtained according to seasonal variations as shown in Tables 1, 2 and 3.

The number of coliforms in samples is much higher than that of enterococci and the number of faecal coliforms is between the above two.

Sixteen beaches in Malta and three beaches in Gozo cover practically the whole bathing areas used during the summer period in Malta and Gozo (see table 4). Only St. Paul's Bay area fails the accepted interim microbiological criteria (100 E. Coli/100 ml and no more than 10%, of at least ten consecutive samples should exceed 1000 E. Coli/100 ml).

This area now has a new sewage system and better results are expected in the future.

The results obtained clearly show the importance of wave heights, currents and contamination from sewage overflow.

On the whole, higher counts are registered by the MPN method than by the MF.

Conclusions and suggestions for continuation of work

Local legislation against the selling of shellfish as well as the prohibition of bathing in polluted areas have helped against the incidence of intestinal diseases in Malta. The incidence of typhoid has declined by 75% during 1978.

Work will continue and monitoring along the above accepted lines will ensure that bathing areas in Malta will be clean according to the accepted interim microbiological quality criteria.

Table 1: Total coliforms - No./100 ml; sampling point - Mellieha Bay

Sample values	Point 3		Point 4		Point 5		Point 6		All points	
Date (1978):										
7.2	4		42		0		0		11.50	
27.2	0		0		6		4		2.50	
7.3	57		4		0		2		15.75	
23.5	0		75		60		3		34.50	
5.7	0		0		40		2400		610	
25.7	16		96		10		26		37	
8.8	40		57		1320		2400		954.25	
12.9	6		266		48		176		124	
Mean values										
Summer	15.50		104.75		354.5		1250.50		431.31	
Others	15.25		30.25		16.5		2.25		16.06	
Total	15.38		67.50		185.5		626.38		223.69	
Standard deviations										
Summer	17.62		114.50		643.87		1328.74		430.24	
Others	27.90		53.33		29.14		1.71		13.48	
Total	21.60		87.97		459.00		1096.29		358.71	
Distributions - P.C.	No.	%	No.	%	No.	%	No.	%	No.	%
0 - 100	8	100	7	87.5	7	87.5	5	62.5	5	62.5
101 -1000	0	0	1	12.5	1	12.5	1	12.5	3	37.5
> 1000	0	0	0	0	0	0	2	25.0	0	0

Table 2: Faecal coliforms - No./100 ml; sampling point - Mellieha Bay

Sample values	Point 3		Point 4		Point 5		Point 6		All points	
Date (1978):										
7.2	2		42		2		0		11.5	
27.2	0		0		6		0		1.5	
7.3	34		4		0		2		10.0	
23.5	0		75		9		3		21.75	
5.7	0		0		3		47		12.50	
25.7	4		6		5		7		5.50	
3.8	5		57		516		720		324.50	
12.9	2		146		17		60		56.25	
Mean values										
Summer	2.75		52.25		135.25		208.50		99.69	
Others	9		30.25		4.25		1.25		11.19	
Total	5.88		41.25		69.75		104.88		55.44	
Standard deviations										
Summer	2.22		67.53		253.91		341.59		151.55	
Others	16.69		35.33		4.03		1.50		8.31	
Total	11.52		51.26		180.39		249.65		110.05	
Distributions - P.C.	No.	%	No.	%	No.	%	No.	%	No.	%
0 - 100	8	100	7	87.5	7	87.5	7	87.5	7	87.5
101 - 1000	0	0	1	12.5	1	12.5	1	12.5	1	12.5
> 1000	0	0	0	0	0	0	0	0	0	0

Table 3: Faecal streptococci - No./100 ml; sampling point - Mellieha Bay

Sample values	Point 3		Point 4		Point 5		Point 6		All points	
Date (1978):										
7.2	1		104		1		0		26.50	
27.2	1		0		13		2		4	
7.3	0		0		1		1		0.5	
23.5	0		24		22		1		11.75	
5.7	1		0		3		7		2.75	
25.7	10		20		12		5		11.75	
3.8	5		70		118		48		60.25	
12.9	18		13		8		38		19.25	
Mean values										
Summer	8.5		25.75		35.25		24.5		23.50	
Others	0.5		32.0		9.25		1.0		10.69	
Total	4.5		28.88		22.25		12.75		17.10	
Standard deviations										
Summer	7.33		30.64		55.29		21.76		25.41	
Others	0.58		49.32		10.21		0.82		11.54	
Total	6.44		38.16		39.34		19.00		19.51	
Distributions - P.C.	No.	%	No.	%	No.	%	No.	%	No.	%
0 - 100	8	100	7	87.5	7	87.5	8	100	8	100
101 - 1000	0	0	1	12.5	1	12.5	0	0	0	0
> 1000	0	0	0	0	0	0	0	0	0	0

Table 4: Sea-water - bacteriological data MPN (1 January - 30 September 1978)

Area	E. coli 0-100 in 100 ml	E. coli 101 - 1000	E. coli in excess of 1000/100 ml
Malta			
Armier	17	6	3
Ghadira	94	11	1
St Paul's Bay Area	402	119	129
Sliema Area	450	11	2
Valletta	123		
Xghira	58	2	
Delimara	36	1	
M'Xlokk Area	66		
Wied iz-Zurrieq	26	1	
Ghar Lapsi	15		
St Thomas Bay	39		
Ghajn Tuffieha	43		
M'Scala	90	1	1
Salina Bay	41		
Bahar ic-Caghaq	22		
B'Bugia Area	221	7	3
Gozo			
M'Forn	37		
Xlendi	36		
Ramla	17		

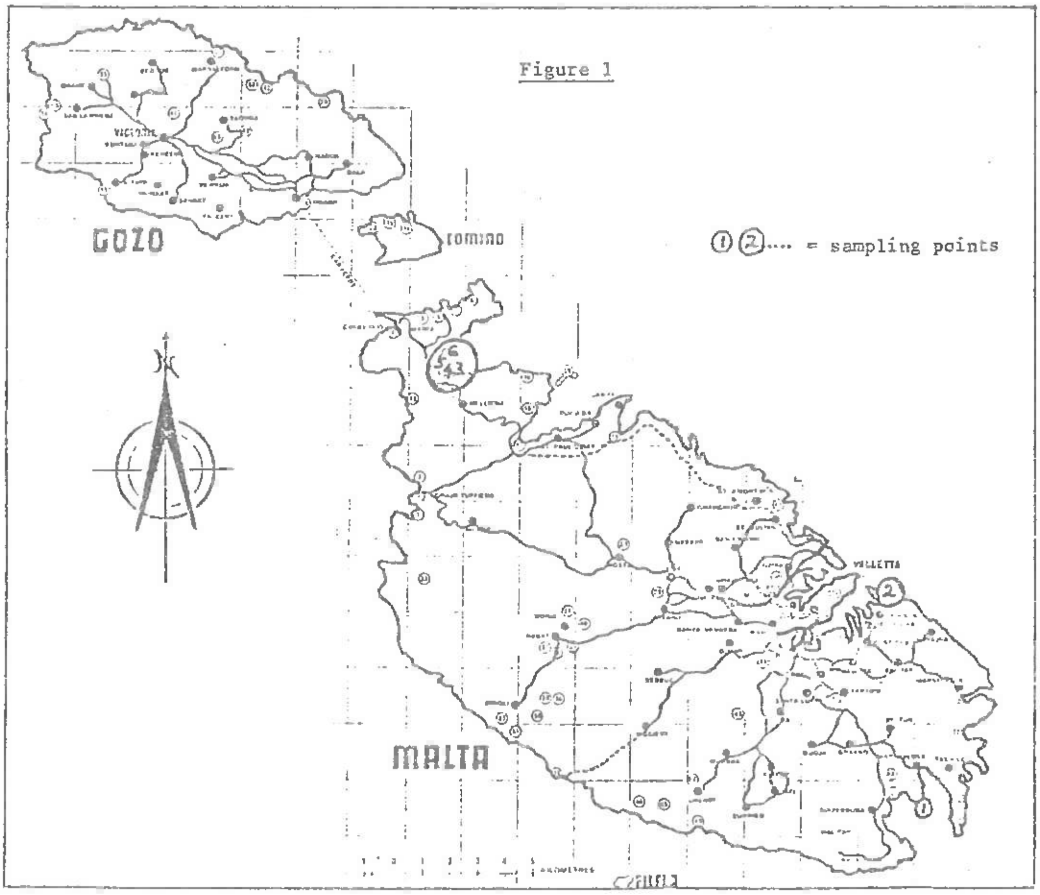


Figure 1

Centre de Recherche Participant : Institut National d'Hygiène
Ministère de la Santé Publique
RABAT
Maroc

Chercheur Principal : N. Benmansour

Aucun rapport a été soumis.

Centre de Recherche Participant: Centre Scientifique de Monaco
MONTE CARLO
Principauté de Monaco

Chercheur Principal: R. VAISSIERE

Introduction:

Le Laboratoire de Microbiologie et d'Etudes des Pollution Marines a été créé en 1967. Il se compose de scientifiques de formation différente qui se sont spécialisés dans la surveillance des polluants en milieu marin et dans l'étude de leurs effets sur les écosystèmes côtiers.

Les prélèvements d'eau de mer, comme la mesure des composants physiques, chimiques et biologiques de ce milieu, sont devenus des activités de routine du laboratoire qui a, en outre, étudié les conditions hydrologiques de la région et la diffusion des eaux polluées par utilisation des traceurs (Rhodamine, photographies aériennes). Une méthode automatique d'analyses des détergents anioniques a également été mise au point.

Zone(s) étudiée(s):

Depuis 1977, et par conséquent pendant les trois années du projet MED POL VII, la totalité des eaux côtières de la Principauté est soumise à surveillance. Trois kilomètres de côte à vocation balnéaire ou portuaire sont contrôlés à partir de l'analyse d'échantillons d'eau de mer prélevés régulièrement tout au long de l'année en douze stations fixes (fig. 1).

Matériel et méthodes:

Les méthodes d'analyse utilisées pour cette surveillance sont identiques à celles décrites par l'OMS, les analyses bactériologiques étant conduites par filtration sur membrane. La filtration est effectuée à bord du bateau immédiatement après le prélèvement.

Résultats et leur interprétation:

Les eaux usées de Monaco et des agglomérations voisines sont rassemblées depuis juillet 1971 dans un collecteur principal qui débouche en un point situé provisoirement à 450 m. de la côte et 47 m. de profondeur. Quatre petites rivières traversent la Principauté. Deux d'entre-elles débouchent directement en mer, l'une dans le coin nord du port, l'autre à la frontière est. Les deux autres ont été canalisées et se déversent dans le réseau d'assainissement. Afin de décharger ce réseau des crues passagères, un déversoir d'orage a été placé à proximité du raccordement de ces cours d'eau avec le réseau, il débouche à 30 m. de profondeur à 500 m. de la côte.

Les conditions hydrologiques diffèrent suivant que l'on s'intéresse aux masses d'eaux superficielles ou de fond.

En surface règne un régime complexe résultant des effets de trois composants essentiels :

- la topographie côtière : son effet sur la circulation générale des eaux de la mer Ligure conduit à des courants anticycloniques côtiers:

- le vent dont l'action devient prépondérante lorsque celui-ci est bien établi;

- les petits accidents côtiers : pointes digues, terre-plein, entrée de Port qui peuvent protéger certaines zones, ou provoquer des dépressions et conduire ainsi à l'accumulation de polluants et à des mouvements d'eau particuliers d'ampleur limitée.

Au fond, le courant montre une tendance à se déplacer en sens inverse de la couche d'eau superficielle soumise à l'action du vent mais n'atteint jamais l'orientation opposée comme cela est nettement observé dans les circulations océaniques. Un décalage plus ou moins important existe entre ces deux directions, il résulte de la topographie du fond et de la côte.

Enfin, les eaux marines de Monaco sont caractérisées entre la fin avril et le début octobre par une thermocline saisonnière. L'isotherme de valeur la plus élevée qui la délimite se situe au-dessus de 50 mètres de profondeur alors que l'isotherme 15°C peut atteindre le niveau 75 mètres.

Les quatre tableaux saisonniers, (fig. 2, 3, 4 et 5), rassemblent de façon synthétique les résultats obtenus durant le projet MED POL VII.

Afin d'augmenter le nombre d'observations, toutes les analyses effectuées entre 1975 et 1978 (soit environ 7100) ont été prises en compte dans l'élaboration de ce tableau.

Les résultats ont été séparés en sept groupes répondant aux conditions de vent le jour du prélèvement et ordonnés en classes définies suivant une croissance logarithmique :

Classes	Valeurs	Classes	Valeurs
1	< 2	5	55 à 167
2	2 à 6	6	167 à 500
3	6 à 19	7	> 500
4	19 à 55		

Les tableaux regroupent la fréquence des différentes classes en fonction de la station et de la direction du vent.

Conclusions:

On constate que les résultats acquis au cours du projet MED POL VII ne diffèrent pas de ceux obtenus depuis juillet 1972 (date de l'immersion du collecteur principal).

L'analyse de six ans de contrôle de la qualité des eaux marines de Monaco (cf. Boisson M., Vaissière R., Schommers E., Séméria J.) a montré que l'immersion du collecteur principal a créé dans les eaux superficielles un cycle annuel des polluants. Ce cycle se compose d'une phase hivernale (octobre à avril) et d'une phase estivale (mai à septembre).

En hiver, la concentration des polluants en surface s'explique par les conditions hydrologiques du jour du prélèvement. L'éloignement du point de rejet ayant l'effet prépondérant par rapport au gradient thermique.

En été, l'amélioration de la qualité des eaux côtières provient principalement de l'existence de la thermocline saisonnière au-dessus de l'orifice du collecteur principal. Cependant des variations accidentelles des conditions météorologiques et les modifications thermiques des masses d'eau qui en résultent, peuvent conduire à des concentrations de polluants en surface selon un schéma analogue à celui de la phase hivernale.

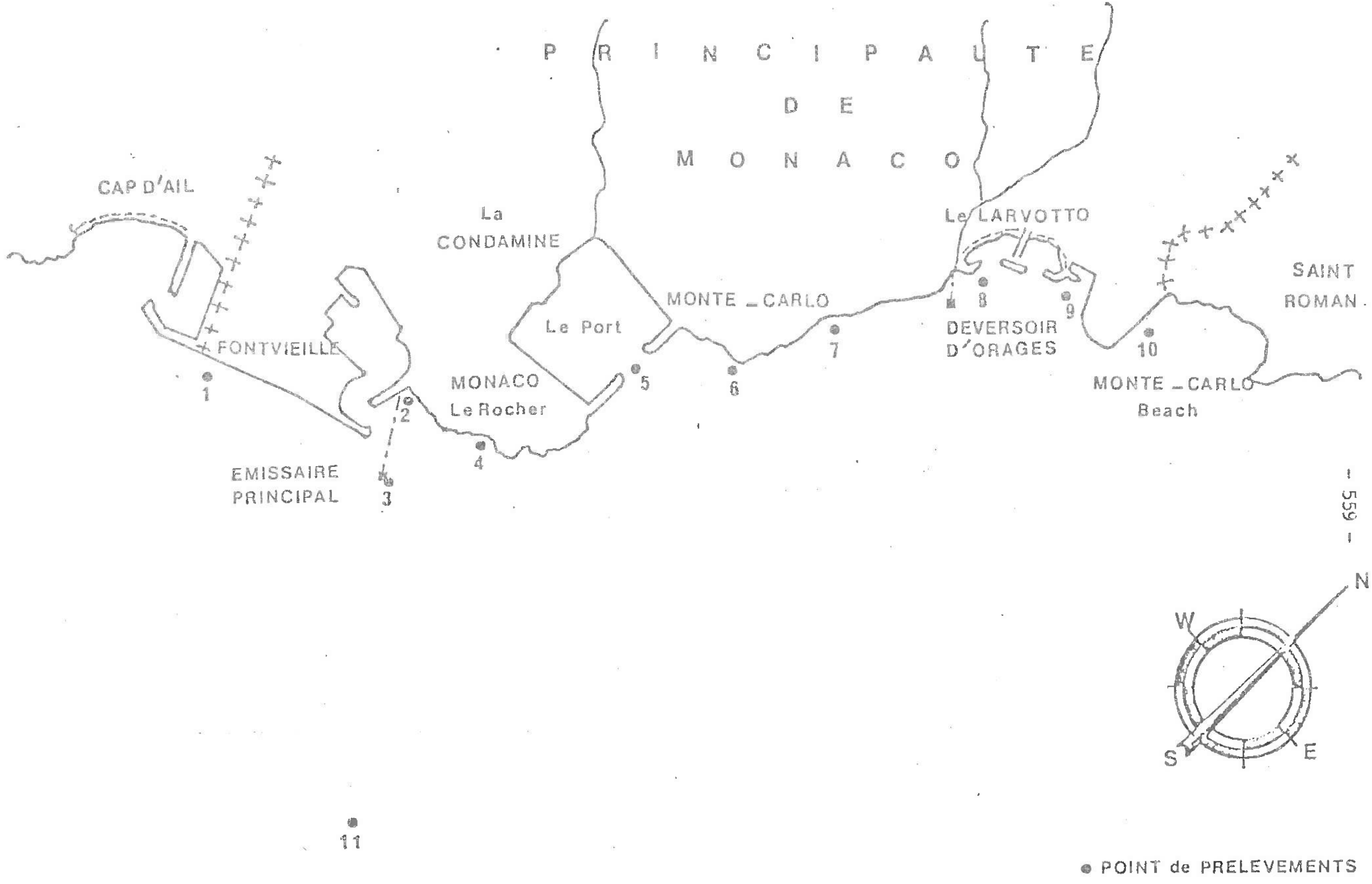
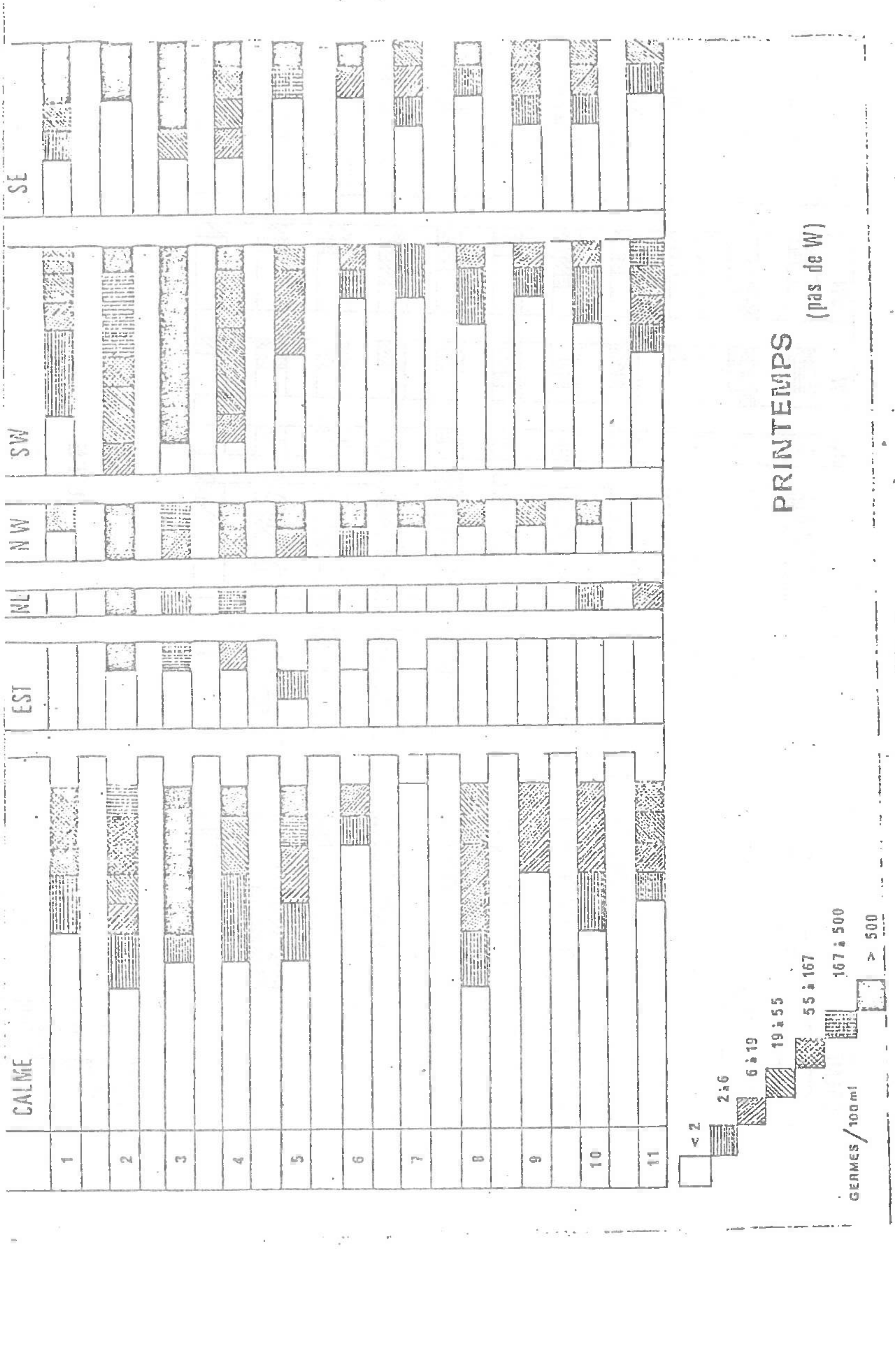
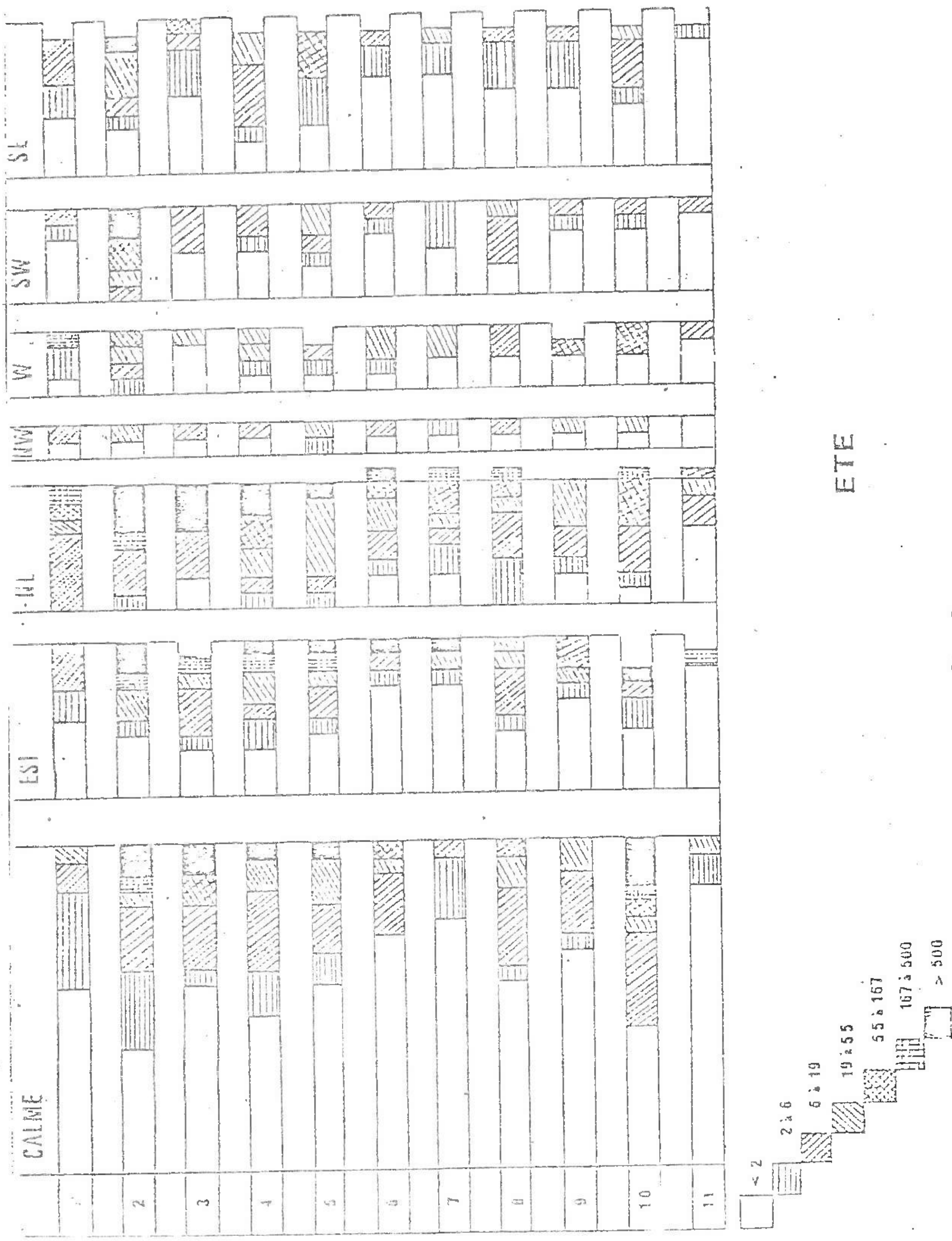

PRINCIPAUTE
DE
MONACO
CAP D'AIL
FONTVIEILLE
1
EMISSAIRE
PRINCIPAL
2
3
La
CONDAMINE
MONACO
Le Rocher
4
Le Port
5
MONTE _ CARLO
6
7
Le LARVOTTO
8
DEVERSOIR
D'ORAGES
9
10
MONTE _ CARLO
Beach
SAINT
ROMAN
N
W
E
S
11
POINT de PRELEVEMENTS

Fig. 1



PRINTEMPS (pas de W)

Fig. 2


CALME
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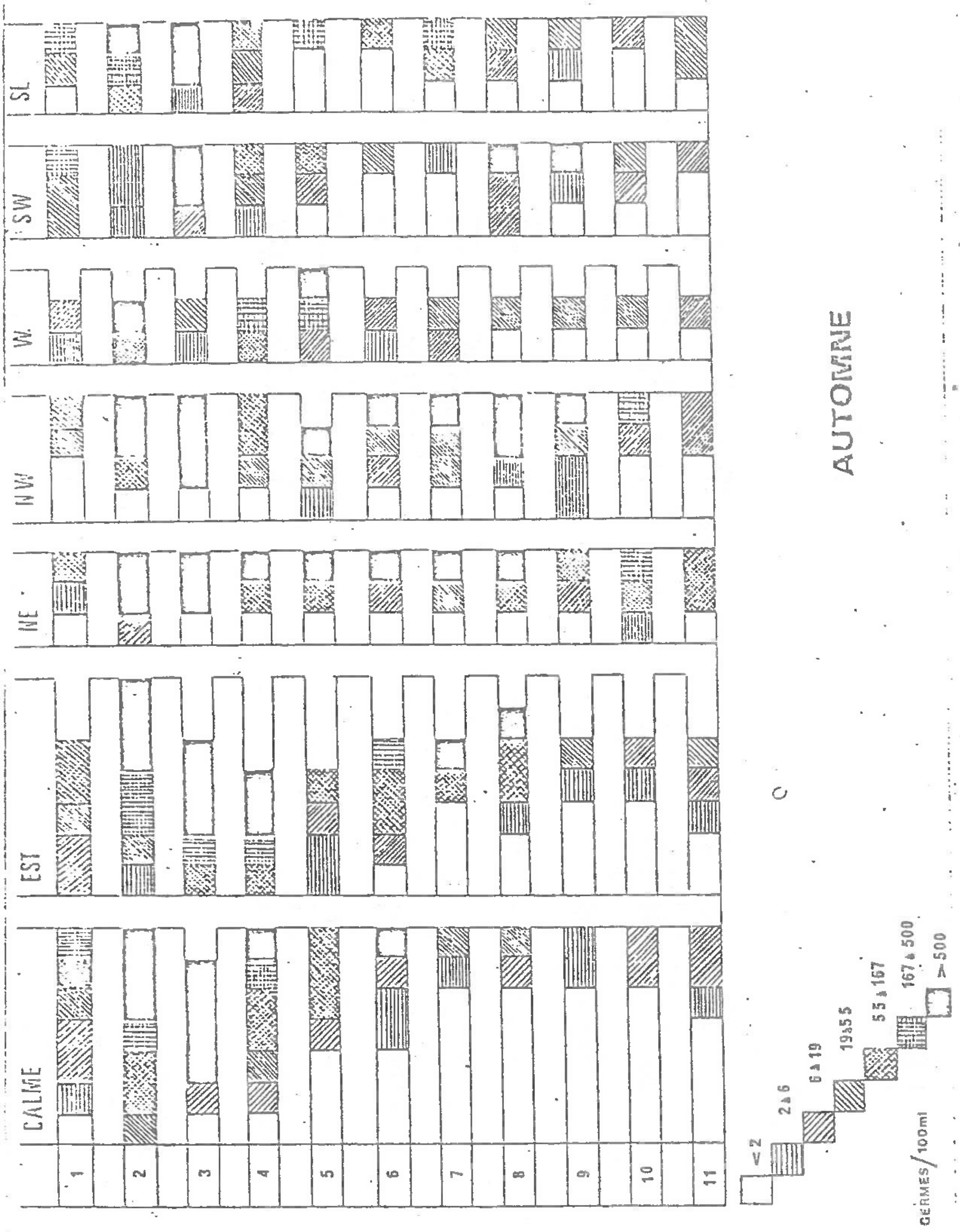
< 2
2 à 6
6 à 19
19 à 55
55 à 167
167 à 500
> 500

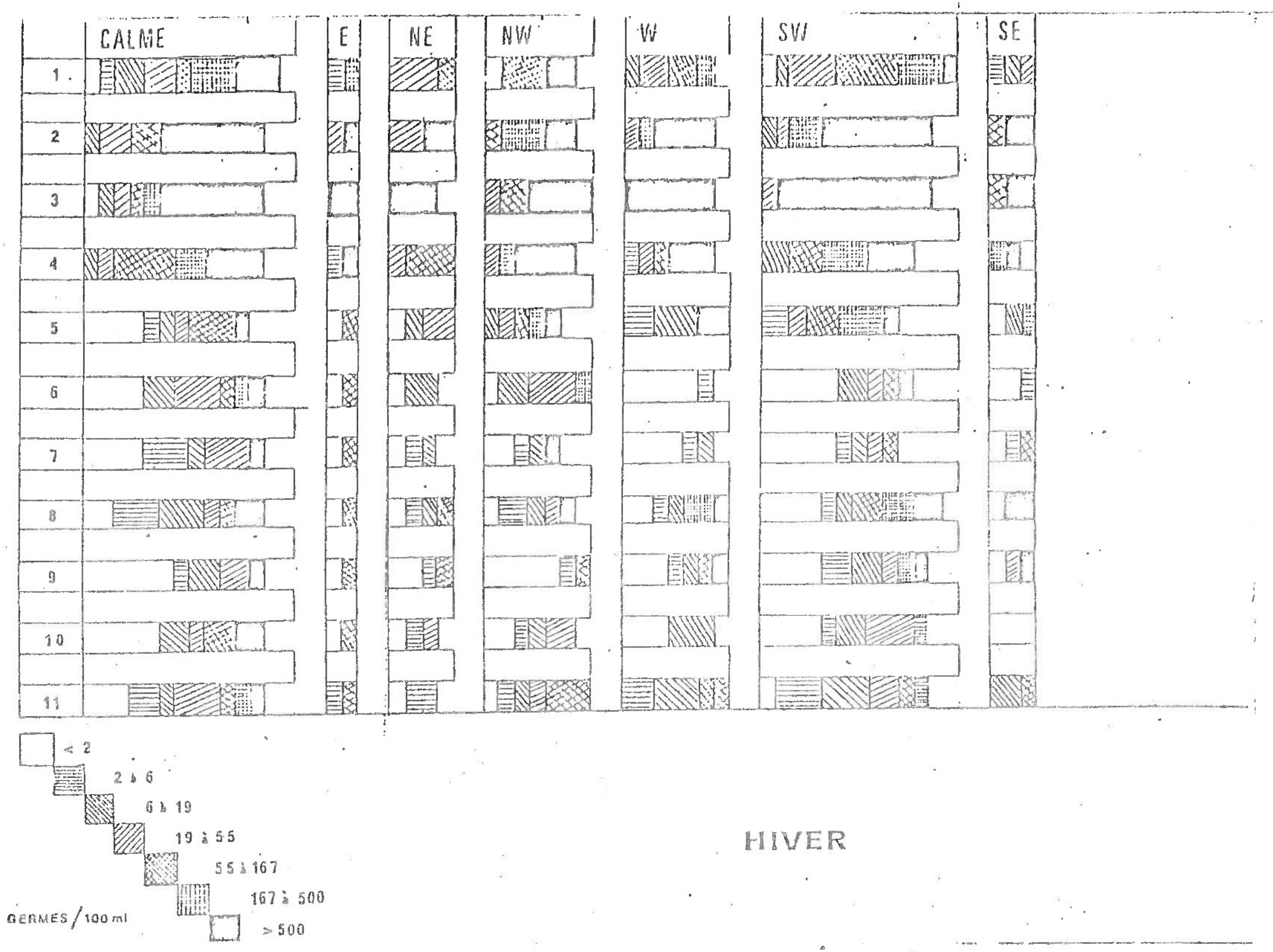
ETE

Fig. 3



AUTOMNE

Fig. 4


CALME
E
NE
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SW
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1.
2
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6
7
8
9
10
11
< 2
2 à 6
6 à 19
19 à 55
55 à 167
167 à 500
> 500
GERMES / 100 ml

HIVER

Fig. 5

Participating Research Centre: Jefatura Provincial de Sanidad
MALAGA
Espana

Principal Investigator: R. MUJERIEGO

Introduction:

Coastal water quality has been a subject of concern to the local authorities of Malaga for several years. Public and private interests to preserve the attractive touristic and recreational coastal resorts, internationally known as the "Costa del Sol", have prompted numerous attempts to evaluate the degree of pollution at the most frequented beaches.

A systematic study was planned and carried out during the 1976 summer season by the provincial public health authorities. However, administrative limitations, coupled with the long distances involved (148 km), resulted in a limited though realistic picture of the recreational water quality.

Area(s) studied:

The 130 sampling stations considered in the 1976 summer session study were initially intended to be used for the monitoring programme called for by the MED VII pilot project agreement. However, in view of (a) the inaccessibility of some areas to holiday makers, (b) the great differences in public attendance at various beaches, and (c) the technical and material limitations of the Institutions, a series of natural beaches were selected at which to carry out the 1977 summer season monitoring programme.

This was considered a more adequate alternative, capable of producing statistically significant and representative results by having each sampling station analysed approximately once every ten calendar days.

The study includes 36 sampling stations located on 18 km of coast east and west of Malaga City, six sampling stations at the main beaches of Marbella and three reference stations at the town of Maro, located on the eastern provincial border.

Attached is a map showing the location of the sampling area (Figure 1).

Materials and methods used:

The microbiolgocal method used throughout this study has been the Most Probable Number technique, instead of the Membrane Filtration method required in document EHE/76.1. The reasons for this change were: (1) the MPN method is the official method routinely applied at the institution, (2) the laboratory technicians are trained to perform the MPN method and (3) the lack of filtration apparatus to perform the MF method at the time.

The "Guidelines for health related monitoring of coastal water quality" were used as reference material throughout the study. The epidemiological survey carried out during the 1977 summer season was essentially in agreement with the criteria contained in "Health criteria and epide miological studies related to coastal water pollution", though this publication was only made available once the questionnaires had been produced.

A comparative study between MPN and MF methods for analysing total coliforms and faecal coliforms was planned for the 1978 summer season utilizing the filtration equipment and culture media sent by UNEP/WHO. However, because of administrative constraints it has not been possible to carry out that study, and only a few sampling stations have been monitored during the 1978 summer season.

There has been practically no monitoring of shellfish, because of the real scarcity of such species in the area. However, it soon became apparent that some fish species, sardines in particular, should be given attention as a really significant indicator for microbiological pollution of marine life.

Results and their interpretation:

From the work carried out until now the following results can be pointed out:

Climatic conditions were particularly abnormal during the 1977 summer season. Results for the same period in 1978 reveal a behaviour much closer to normal summer conditions.

Wind regime was similarly abnormal during the 1977 summer season, giving rise to frequent periods of rough sea conditions and bringing sea-water surface temperature down to as low as 17°C. Information available for the 1978 summer season reveals a behaviour closer to normal conditions, with more frequent periods of calm waters.

It is possible to assert the presence of a coastal current regime parallel to the coast that behaves somehow independently from the wind regime.

It was not possible to detect a defined thermocline formation in the vicinity of the submarine outfalls discharge area during the 1977 summer season.

The most frequently used method of waste water disposal within the pilot zone is through submarine outfalls. Raw waste water is generally discharged through one km long submarine outfalls ending in a single port diffuser, located at approximately 20 m depth.

Waste water effluents are mostly of domestic origin with minor industrial contributions discharging at sea through the Guadalhorce river. Waste water flows are largest during the summer season due to the very important national and international tourist influx.

A significant portion of the wastewater flow coming from the city of Malaga is still discharged directly into the west side of the new harbour area. Plans are underway to construct a new submarine outfall provided with a waste water pretreatment station and a multiport diffuser discharging at 30 m depth.

The bacteriological quality of coastal recreational waters relates quite well to the proximity and characteristics of waste water disposal sites. Experimental results show the presence of a few grossly polluted areas as well as others with a minor degree of pollution.

A comparative analysis of total coliforms and E. coli counts reveals an inconsistent recovery of E. coli. A known reason for that result is the repeatedly observed appearance of Klebsiella microorganisms on the confirmatory agar plates that makes the isolation of E. Coli impossible, in spite of the apparent metallic sheen.

The more spectacular effect of waste water disposal at sea is the formation of visible patches of a yellowish scum 2-3m in width, located within a larger 5-10 m wide oily slick and ranging from a few hundred metres to a few kilometres in length.

Calculated values for waste water initial dilution achieved by submarine outfalls was close to 100: 1.

There is evidence that passenger and cargo ships docking at Malaga harbour dispose of their solid and liquid wastes by dumping at sea, particularly while at the waiting areas outside the harbour, with water quality impairment at the nearby beaches.

Results available from the epidemiological survey reveal that: (a) skin, eyes, ear and nose infections are the most frequent public health ailment among bathers and (b) an increasing number of people are becoming concerned with the impairment of coastal water quality.

Microbiological results from different beaches were statistically analysed by graphical methods. Both total coliform and faecal coliform follow quite well a log-normal probability distribution. Their statistical parameters are summarized in Table 1.

Four statistical parameters hae been considered for total coliforms, namely: TC50, concentration not exceeded by 50% of the samples, TC80, concentration not exceeded by 80% of the samples, TC90, concentration not exceeded by 90% of the samples, and σg, geometric standard deviation. (σg = ln TC84 - ln TC50).

Three statistical parameters have been considered for faecal coliform concentrations, namely, FC50 and FC90, concentrations not exceeded by 50 and 90% of the samples respectively, and σg, geometric standard deviation (σg = ln FC84 - ln FC50). This expression of the standard deviation is considered more illustrative of the phenomenon under study than its corresponding value in terms of coliform concentration.

A preliminary analysis of the data (not included here) reveals a wide variation of the TC/FC ratio, mainly due to low faecal coliform countings. Some of the factors responsible for this fact are indicated in Item 9 hereabove.

It is believed that faecal coliform countings were notably reduced by several analytical interferences. Strictly speaking, all of the beaches surveyed did comply with both the present interim microbiological quality criteria (FC50 = 100 FC/100 ml, FC90 = 1000 FC/100 ml) and the Spanish coastal water quality standards (FC50 =200 Fc/100 ml, FC90 = 1000 FC/100 ml).

However, inspection of total coliform statistical parameters together with visual inspection of the beaches seems to indicate that some of the beaches were in fact not satisfactory from the microbiological point of view. If the widely used aesthetic criteria developed in 1943 at Los Angeles, California, beaches of TC80 = 1000 TC/100 ml is considered as reference, 11 out of 17 beaches could not be considered as aesthetically satisfactory. This is more in agreement with repeated visual appearance of the water mass at the sampling stations.

Conclusions:

From the above results the following conclusions can be drawn:

The relative contribution of submarine outfalls has to be recognized in improving recreational water quality in the coastal areas studied. Furthermore, they represent a short-term solution capable of integration into a more advanced waste water treatment scheme that could be built once additional funds are available.

There is a need for a more adequate design and operation of submarine outfalls within the study area. Recent developments in sanitary engineering practice may be capable of offering more satisfactory solutions than those adopted in some cases for reasons of apparent economy and time constraints.

Considerable improvement of coastal water quality in the study area could be obtained through a suitable combination of pretreatment stages to remove floatable material coupled with an increased initial dilution of waste water by means of a well designed multiport diffuser located at an adequate distance from the coast.

Unless positive action is taken on the waste water disposal methods currently employed, recreational water quality will continue to deteriorate with the resulting effects on local, national and international opinion, particularly as far as tourism is concerned.

There is a real need in all branches of local government, municipal as well as public health authorities, for an active participation in all aspects of coastal water quality management. Adequate numbers of trained personnel should be assigned to carry out management and monitoring tasks. Among the new aspects to be considered are the consequences of the recent ratification of the Barcelona Convention and the two protocols.

List of Publications

Recreational Coastal Water Quality Effects on Public Health. Rafael Mujeriego et al. Presented at the Workshop on Marine Pollution Control in the Mediterranean held at Antalya, Turkey, organized by ICSEM/UNEP. November-December 1978.

Figure 1: General map of the MED VII pilot zone of Malaga

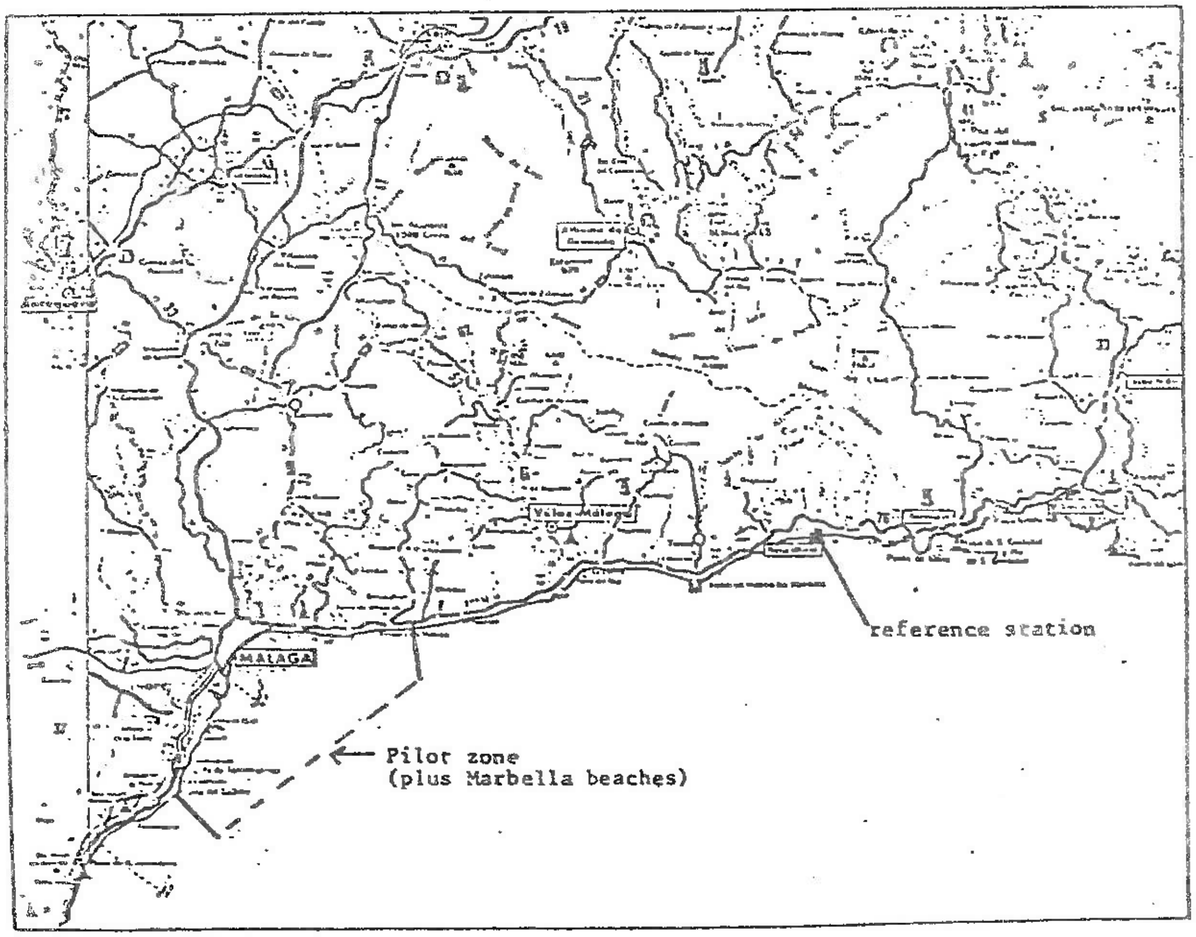


TABLE I. STATISTICAL ANALYSIS OF MICROBIOLOGICAL COASTAL WATER QUALITY (*)
MED-VII PILOT ZONE OF MALAGA. JULY AUGUST AND SEPTEMBER 1977

BEACH	NUMBER SAMPLES	TOTAL COLIFORMS — Total coliforms/ 100 ml: TC50	TC80	TC90	σ_g	FECAL COLIFORMS — Fecal coliforms/100 ml: FC50	FC90	σ_g
N 1	12	30	170	380	2.01	1	11	1.65
R 1	16	5	200	1500	4.38	2	14	1.56
R 2	32	450	5800	25000	2.97	8	44	1.37
R 3	24	140	1800	7000	3.00	7	110	2.09
MA 1	18	800	4000	30000	2.53	4	57	2.01
MA 2	11	50	180	340	1.48	7	30	1.08
MA 3	8	24	250	900	2.77	6	200	2.71
MA 5	17	1000	20000	80000	3.44	18	150	1.64
MA 6	16	1500	9400	24000	2.12	45	700	2.10
MA 7	20	500	8500	36000	3.32	8	220	2.71
MA 9	28	2800	12000	26000	1.79	12	360	2.65
MA 10	14	2700	22500	70000	2.43	15	78	1.28
MA 11	51	410	5800	22500	3.17	6	90	2.14
MA 12	27	350	2800	8200	2.46	16	380	2.42
M 3	37	190	750	1500	1.61	16	130	1.61
M 4	11	15	68	150	1.77	3	25	1.80
E 1	9	70	10000	-	-	1	45	3.52

(*) TC50, for example, represents the total coliform concentration per 100 ml that is not surpassed in more than 50% of the samples.
$\sigma_g = \ln TC84 - \ln TC50$ or $\sigma_g = \ln FC84 - \ln FC50$

Participating Research Centre: Jefatura Provincial de Sanidad
TARRAGONA
Espana

Principal Investigator: R. MUJERIEGO

Introduction:

Coastal water quality has been a subject of concern to local authorities in Tarragona for several years. Public and private interests to preserve the attractive touristic and recreational coastal resorts, widely known as the "Costa Dorada", have prompted several attempts to evaluate the degree of pollution at the most frequented beaches.

The development in the early 1970s of a large petrochemical industry complex in the vicinity of Tarragona city made evident the need for renewed involvement of public health authorities in environmental health matters. In spite of increasingly active participation in the waste water disposal permit granting system, Tarragona's public health authorities are fully aware of the need for systematic and continuous monitoring of industrial and municipal discharges into nearby coastal water.

Area(s) studied:

The area studied covers most of the 210 km of provincial coastline from Cunit in the north to Ampolla in the south, near the Ebro river delta.

Considering (a) the inaccessibility of some areas to holiday makers, (b) the great differences in public attendance at various beaches and (c) the institutional constraint of having to monitor simultaneously water supply quality at most of the 72 coastal camping-sites, hosting more than 50 000 people, a series of natural beaches was selected to carry out the monitoring programme for the MED VII pilot project. This was considered a realistic alternative capable of producing statistically significant and representative results by having each station analysed once every calendar week.

The area covers a total of 27 sampling stations of which one is a reference station. It is expected to increase the number of sampling stations during the next year, according to budgetary allocations.

Attached are maps on which the sampling stations have been identified along with other relevant information (figures 1, 2 and 3).

Materials and method used

The microbiological method used throughout this study has been the Membrane Filtration technique, as required by document EHE/76.1. This has been made possible by utilizing the filtration equipment and culture media supplied by UNEP/WHO. The parameters systematically measured during the 1978 season were total coliforms (TC), faecal coliforms (FC) and faecal streptococci (FS). Simultaneously, a comparative study between MPN and MF methods for total coliforms and E. coli has been carried out during the present summer season. "Guidelines for Health Related Monitoring of Coastal Water Quality" has served as reference material throughout the study.

There is a great interest in the proposed training sessions for MED VII participants as an excellent opportunity for discussing the many observations made when performing several of the new analytical techniques at the laboratory, in particular the membrane filtration method for microbiological examination of water.

Information contained in "Health Criteria and Epidemiological Studies Related to Coastal Water Pollution" along with experience gained at the pilot zone of Malaga were used in preparing the new questionnaire employed during the epidemiological survey carried out among recreationists at selected beaches of Tarragona.

Results and their interpretation:

Some preliminary and qualitative results among others are as follows:

Fishing and shellfish collection represent perhaps one of the most popular and significant recreational activities along the coast of Tarragona. Preliminary results from microbiological examination of fish and shellfish specimens reveal the importance of further monitoring of these species, as far as Public Health is concerned. A year-long study programme is under way to evaluate their microbiological and chemical quality.

The most frequently used method of wastewater disposal within the pilot zone is through submarine outfalls. Raw municipal wastewater is generally discharged through a 1-km long outfall ending in either a single port or a multi-port diffuser, located at approximately 20 m depth..

Wastewater effluents at most of the coastal areas are of domestic origin. However, there is an important and rapidly growing petrochemical industry complex near Tarragona City that disposes of its wastewater through a series of submarine outfalls of various lengths and functional characteristics.

There is evidence that cargo ships, especially oil tankers, docking at Tarragona harbour and at the several oil terminals dump their solid and liquid wastes at sea, particularly while at the waiting areas outside the harbour, with the consequent impairment of the nearby beaches.

Further analysis of the collected microbiological data included:

Statistical analysis by graphical methods of microbiological results from different beaches. Both total coliform and faecal coliform follow quite well a log-normal probability distribution. Their statistical parameters are summarized in Table I.

Four statistical parameters have been considered for total coliforms, namely: TC5, concentration not exceeded by 50% of the samples, TC80, concentration not exceeded by 80% of the samples, TC90, concentration not exceeded by 90% of the samples, and σg, geometric standard deviation. (σg = ln TC 84 - ln TC50).

Three statistical parameters have been considered for faecal coliform concentrations, namely FC50 and FC90, concentrations not exceeded by 50 and 90% of the samples respectively, and σg, geometric standard deviation (σg = ln FC84 - ln FC50).

This expresison of the standard deviation is considered more illustrative of the phenomenon under study than its corresponding value in terms of coliform concentration.

Statistical analysis of faecal streptococci are not completed yet.

A preliminary analysis of the data reveals a wide variation of the TC/FC ratio, mainly due to low faecal coliform countings. Some of the factors responsible for this fact are indicated in this summary final report.

It is believed that faecal coliform countings were notably reduced by several analytical interferences. Strictly speaking, only 5 out of 27 beaches surveyed do not comply with both the present interim microbiologcial quality criteria (FC50 = 100 FC/100 ml), FC90 = 1000 FC/100 ml) and the Spanish coastal water quality standards (FC50= 200 FC/100 ml, FC 90 = 1000 FC/100 ml).

However, inspection of total coliform statistical parameters, together with visual inspection of the beaches, seems to indicate that additional beaches were in fact not satisfactory from the microbiological point of view.

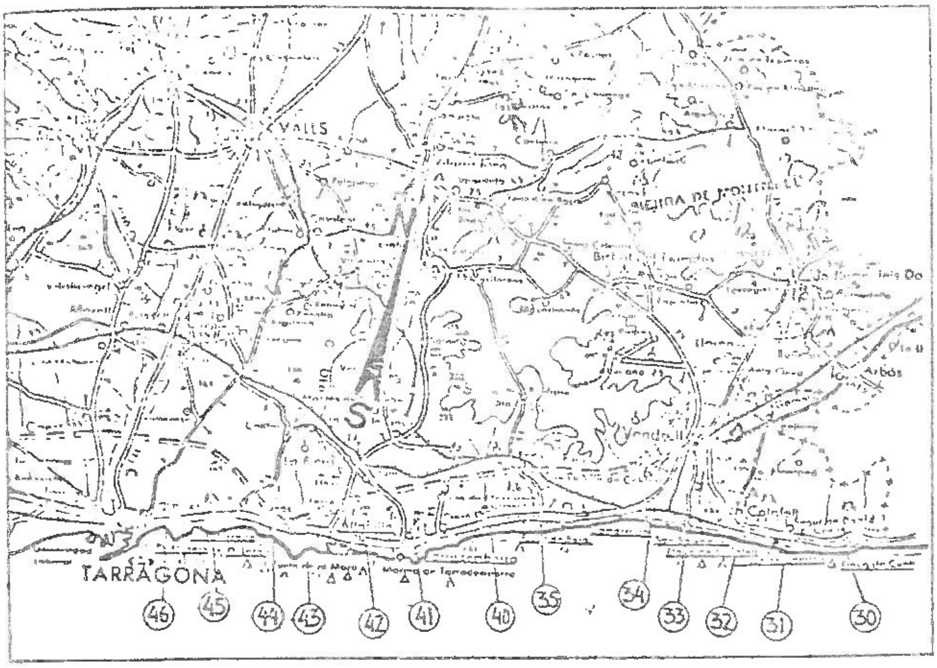
Conclusions:

There is a need for a more adequate design and operation of submarine outfalls within the study area. Specifically, a compulsory and effective monitoring programme to evaluate the mass emission rates of important pollutants should be included in each disposal permit. Otherwise, there is no practical way of knowing the flow and the characteristics of the effluents .

Considerable improvement of coastal water quality in the study area could be obtained through a suitable combination of (a) some pretreatment stage to remove floatable materials, (b) an adequate waste water initial dilution and (c) an adequate distance for protecting natural shellfish growing areas.

There is a real need in all branches of local government, municipal as well as public health, for active participation in all aspects of coastal water quality management. Adequate numbers of trained personnel should be assigned for carrying out management and monitoring tasks. Among the new aspects to be considered are the legal consequences of the recent ratification of the Barcelona Convention and the two protocols.

Figure 1: MED VII pilot zone of Tarragona, subzones 3 and 4



(30) (31)..... = sampling stations

Figure 2: MED VII pilot zone of Tarragona, subzones 5 and 6

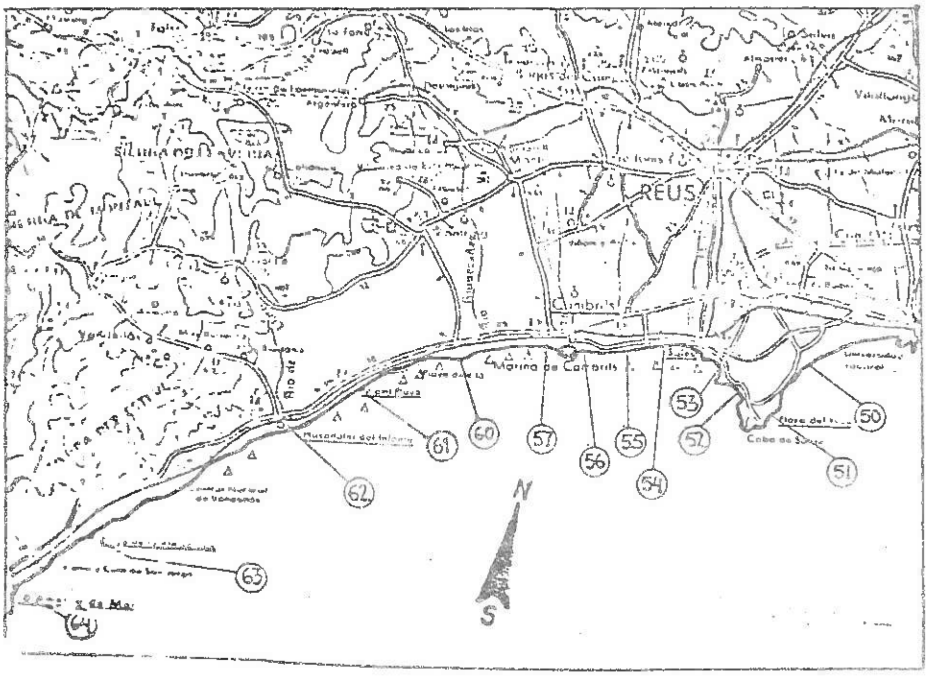
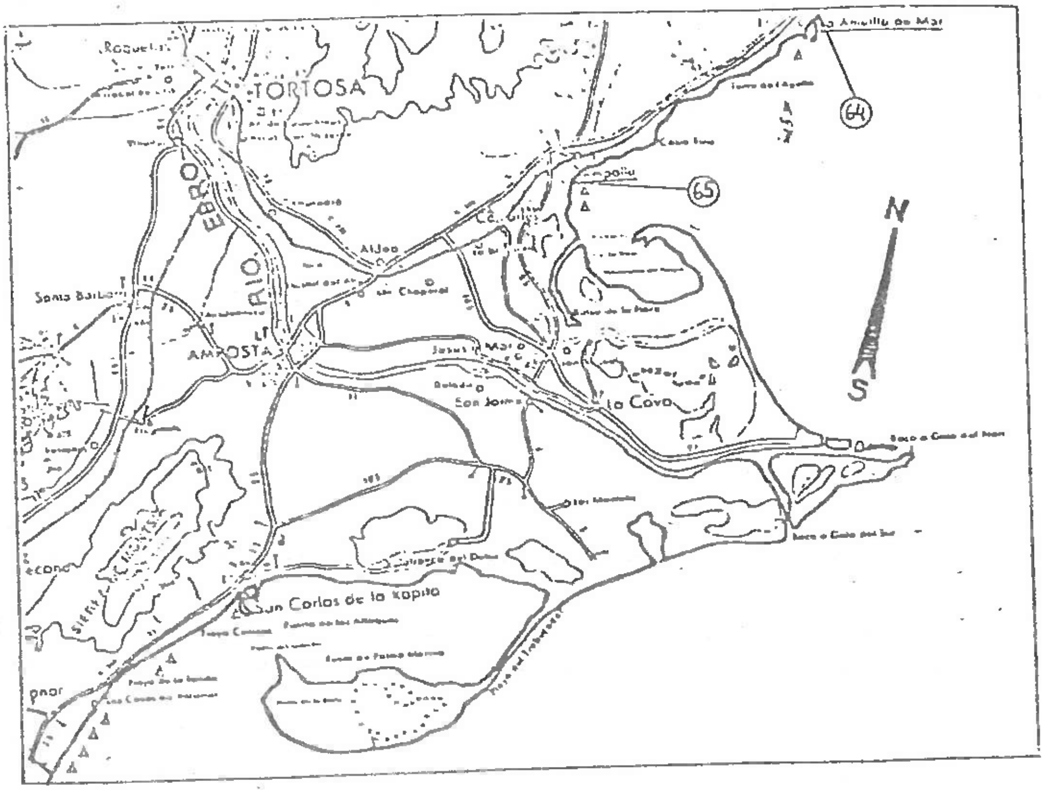


Figure 3: MED VII pilot zone of Tarragona, subzone 6



Participating Research Centre: Marine Biological Station
Institute of Biology
University of Ljubljana
PORTOROZ
Yugoslavia

Principal Investigator: M. LENARCIC

Introduction:

Since 1971 the investigations of bacterial indicators of faecal pollution (such as total coliforms, faecal coliforms, etc.) have been performed as part of the pollution research programme, including complex studies on the quality of coastal water, of Marine Biological Station, Portoroz.

The results obtained by the monitoring programme have been presented at some symposiums, meetings, and in publications and reports.

We started the new monitoring programme in 1977 as a part of UNEP/ WHO Project MED VII.

Area(s) studied:

Our programme on coastal water quality monitoring covered the area of the Yugoslav side of the Gulf of Trieste which is the most northern part of the North Adriatic, i.e. coastal waters along S. R. Slovenia. The length of our coastline is about 35 km, including two shallow and closed bays: Koper Bay and Piran Bay. The average depth is 20 m.

The coastal hinterland, made of flysch sandstone is discharging into the coastal sea important amounts of fine sediments and nutrients. Therefore both turbidity and primary productivity are quite high. Koper Bay is the most polluted part of the area. It is polluted directly by domestic waste discharge (non-treated) via outfalls and by the river Rizana (average flow $1 m^3/sec$) which is polluted by industrial and domestic wastes. The town of Koper is situated on its coast (20.000 inhabitants) with its port (for chemicals and different cargoes, 2-3 million tons/year). On the coast of the same bay is the town of Izola (17.000 inhabitants) with its food industry (figure 1).

Piran Bay is practically unpolluted. It receives the river Dragonja (average flow $0.5 m^3/sec$) which is slightly polluted by domestic wastes. The town of Piran is situated there (10.000 inhabitants). The shores of Piran Bay are intensively used as recreational areas and sorrounded by many hotels (15.000 beds). Domestic waste waters treated by primary treatment plant are discharged through the underwater outfall 3 450 m off-shore ($0.1 m^3/sec$ average flow) plus two small outfalls which are located 100-200 m off-shore (Figure 2).

To monitor the sanitary quality of coastal waters used for bathing, twenty-seven representative coastal stations (10 m off-shore in surface waters - 0.5 m) were selected in the recreational waters along our coastline. Seven additional open water stations at different distances offshore were also monitored as reference stations (at different depths - 5 m, 10 m, 15 m, 20 m). The main sources of pollution (rivers Dragonja and Rizana), and main outfalls were included in our programme and twelve stations selected.

The shell-fish culture at Strunjan was chosen for monitoring.

Materials and methods

The membrane filtration technique and media, as described in Guidelines for Health Related Monitoring of Coastal Water Quality, WHO/UNEP, Copenhagen 1977, were used as bacteriological parameters.

The standard methods as described in Strickland and Parsons (1968) and Grasshoff (1976) manuals were used as other parameters.

Results and their interpretation:

The following parameters were monitored at all stations:

- total coliforms
- faecal coliforms
- faecal streptococci
- salinity
- water and air temperatures

At the reference stations (which are also the points of the Marine Biological Station's systematic monitoring programme) complex investigations into the whole pelagic ecosystem and its bioproductivity were performed. The parameters are:

- hydrographic: temperature, salinity, oxygen, pH
- bioproductivity: nutrients, phytoplankton biomasses (chlorophiles)

Surface-sea temperature measured in waters along S. R. Slovenia varied: 7.99°C (January 1978), - 23.75°C (July 1978) and at the bottom temperature 9.03°C (January 1978), 19.80°C (August 1978).

Oxygen values were in the range of 6.90 mg/ml (October 1978) and 9.51 mg/ml (March 1978) at the surface sea-water, and at the bottom 5.85 mg/ml (November 1978) and 9.48 mg/ml (March 1979).

Salinity ranges were 33.52°/₀₀ (July 1978) - 37.29°/₀₀ (January 1979) at the surface and 36.04°/₀₀ (October 1978), 38.17°/₀₀ (January 1979) at the bottom.

pH variations were in the range 8.24 (in the summer) to 8.52 (in the winter) at the surface and 8.18 - 8.52 at the bottom. In the estuaries of the rivers Rizana and Dragonza values were in the range of 8.15 - 8.58 at the bottom and 7.75 - 8.32 at the surface.

In a one-year period (March 1978-March 1979) nutrients concentration values were in the range: 5.06 - 37.72 mg NO $3/m^3$, 0.92-30.36 mg NO $2/m^3$, 8.50 - 100.64 mg NH $3/m^3$, 5.80 - 66.50 mg PO_4/m^3 and 5.27 - 27.59 mg P-tot/m^3 at the surface and 31.00-261.02 mg NO $3/m^3$, 2.76 - 57.50 mg NO $2/m^3$, 10.03-80.75 mg NH $3/m^3$, 2.85 - 37.05 mg PO_4/m^3, 2.17 - 27.28 mg P-tot/m^3 at the bottom.

The minimal concentrations of NO_2 and NO_3 were recorded in the summer and the maximal concentrations recorded in winter, but maximal NH_4 trations were measured in the winter and minimal NH_4 concentrations in spring. Maximal concentration of PO_4 were detected in the winter.

The nutrients concentrations were higher in the Bay of Koper, close to the main outfall area and in the estuaries of Rizana and Dragonza. The measurements were varied in the Bay of Koper: 0.00 3-2194.80 mg NO_3/m^3, 4.60 - 69.00 mg NO $2/m^3$, 27.20 - 460.70 mg NH $3/m^3$ and up to 228.70 mg PO_4/m^3 and at the surface of the Rizana up to 2322.52 mg NO $3/m^3$ and the Dragonja up to 2366.54 mg NO $3/m^3$.

The horizontal distribution of dissolved organic nitrogen was uni formly in the range of 11.20-722.40 mg N/m^3. The highest concentra tions were detected in the Bay of Koper, close to the main outfall area (up to 1733.40 mg N/m^3).

Chlorophyll concentrations varied from 0.00 (below detection of the method) up to 6.51 ug/l, registered during the bloom of Sceletonema costatum in March 1978. In general, three sharper peaks were recorded from March to April 1978, from May to June 1978 and from November to December 1978.

The report represents results of investigations into bacterial indicators of faecal pollution from November 1977 to April 1979. Sampling and analysing were done eleven times during November 1977 to April 1979- six months in the winter season (November, February, April 1977/78 and 1978/79) and five times in the summer season (every month from May to September 1978).

Altogether 515 seawater samples were collected as follows:

262 samples were taken at points chosen as coastal stations (recreational water, public beaches), at a distance approximately 10 m off-shore.

144 samples were taken near the main sources of pollution (26 samples at rivers Rizana and Dragonza), and 118 samples at main outfalls.

109 samples were taken at reference stations which were selected at a relatively unpolluted site, 1 - 2 Nm off-shore.

Results obtained by all bacteriological analyses (number of total coliforms, faecal coliforms, faecal stareptococci) were evaluated as mean values for winter and summer months, respectively (Table 1).

These results (see table 1) show that serious faecal pollution in the coastal sea along S. R. Slovenia is confined to only one zone in the Bay of Koper, exactly at the main direct outfall- Stations A, A1, A2 (load 20.000 - 30.000 eqv. units), where high concentrations of bacteria were found (max. 310.000 faecal coliforms/100 ml). But their number decreased rapidly with distance from the source of pollution towards the open sea.

There are some other smaller direct outfalls in the Bay of Koper but they have little effect on public beaches their influence being limited in time and place.

In Piran Bay there is an underwater outfall discharging primarily treated domestic waste waters. The investigations at the outfall (3450 m off-shore), Station C show almost no influence, except at the bottom (depth 20 m) near the diffuser.

There is another small outfall 200 m off-shore in the town of Piran (Station E) which is near a public beach (Station 17) but this also has little influence on the water quality.

Another slight factor contributing to the pollution is the river Rizana flowing into the Bay of Koper and the Dragonza flowing into the Bay of Piran.

The counts at all stations showed lower values than 1000 faecal coliforms/100 ml except at the stations Zusterna (Station 5), Izola (Station), Valdoltra (Station 2) and Ankaran (Station 3). As to station 5, the values obtained could be attributed to the effect of the main outfall from Koper as described above, and most probably to the influence of the smaller outfall near the station. The results from Stations 2, 3 and 8 could be attributed to the effect of the smaller outfall of sewage a few metres off-shore.

The ratios of total coliforms and faecal coliforms and of faecal coliforms and faecal streptococci are shown in Table 3. The computed ratios are varied dependent on the distances of the stations from direct sources of contamination.

Monitoring of shell-fish and culture areas

Our monitoring programme also included investigations on shellfish grown in the experimental shellfish aquaculture farm of mussels Mytilus galloprovincialis in Strunjan Bay (see attached map - Figure 1).

Shellfish and shellfish-growing water sampling was done at the same time. The frequency of sampling and analysing was monthly, from July 1977 to April 1979. The parameters measured were: total coliforms and faecal coliforms. The multiple test tube method was used for shellfish and shellfish-growing water analyses (see Guidelines for Health Related Monitoring of Coastal Water Quality, WHO/UNEP, 1977).

The results of these investigation are shown in table 4.

Considering the recommended interim (WHO, document ICP/RCE 206 (8), Rome, April 1978) 13 samples out of 24 (total number of shellfish flesh samples) fell into the range of 0-2 faecal coliforms/g, 6 samples into the range of 3 - 10 faecal coliforms/g, and 5 samples contained more than 10 faecal coliforms/g of shellfish flesh.

Conclusions:

Taking into the consideration the recommended interim criteria (WHO, document ICP/CEP 209/A (2) 1), Athens, 1977) we can underline in our conclusions that only 9 out of 262 samples taken at public beaches contained more than 1000 faecal coliforms/100 ml while 203 samples were in the range of 0-100 faecal coliforms/100 ml. That means that most of our public beaches could be considered as highly satisfactory bathing areas.

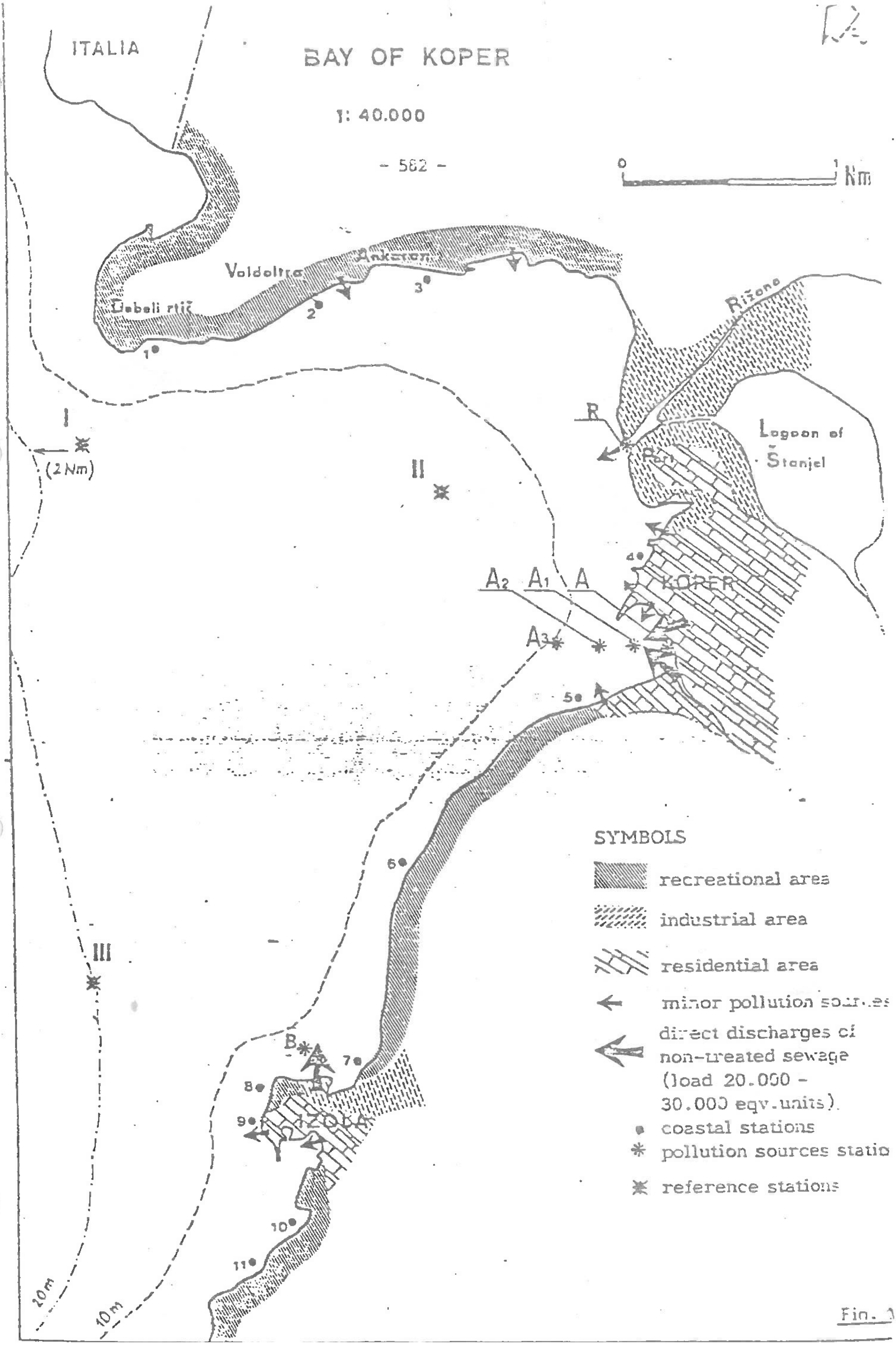

BAY OF KOPER
1: 40.000
0
1 Nm
ITALIA
Valdoltra
Ankaran
Debeli rtič
1
2
3
Rižana
R
Port
Lagoon of Štanjel
I
(2 Nm)
II
A2
A1
A
A3
KOPER
4
5
6
III
B
7
8
9
IZOLA
10
11
20 m
10 m
SYMBOLS
recreational area
industrial area
residential area
minor pollution sources
direct discharges of non-treated sewage (load 20.000 - 30.000 eqv. units)
coastal stations
pollution sources statio
reference stations

Fig. 1

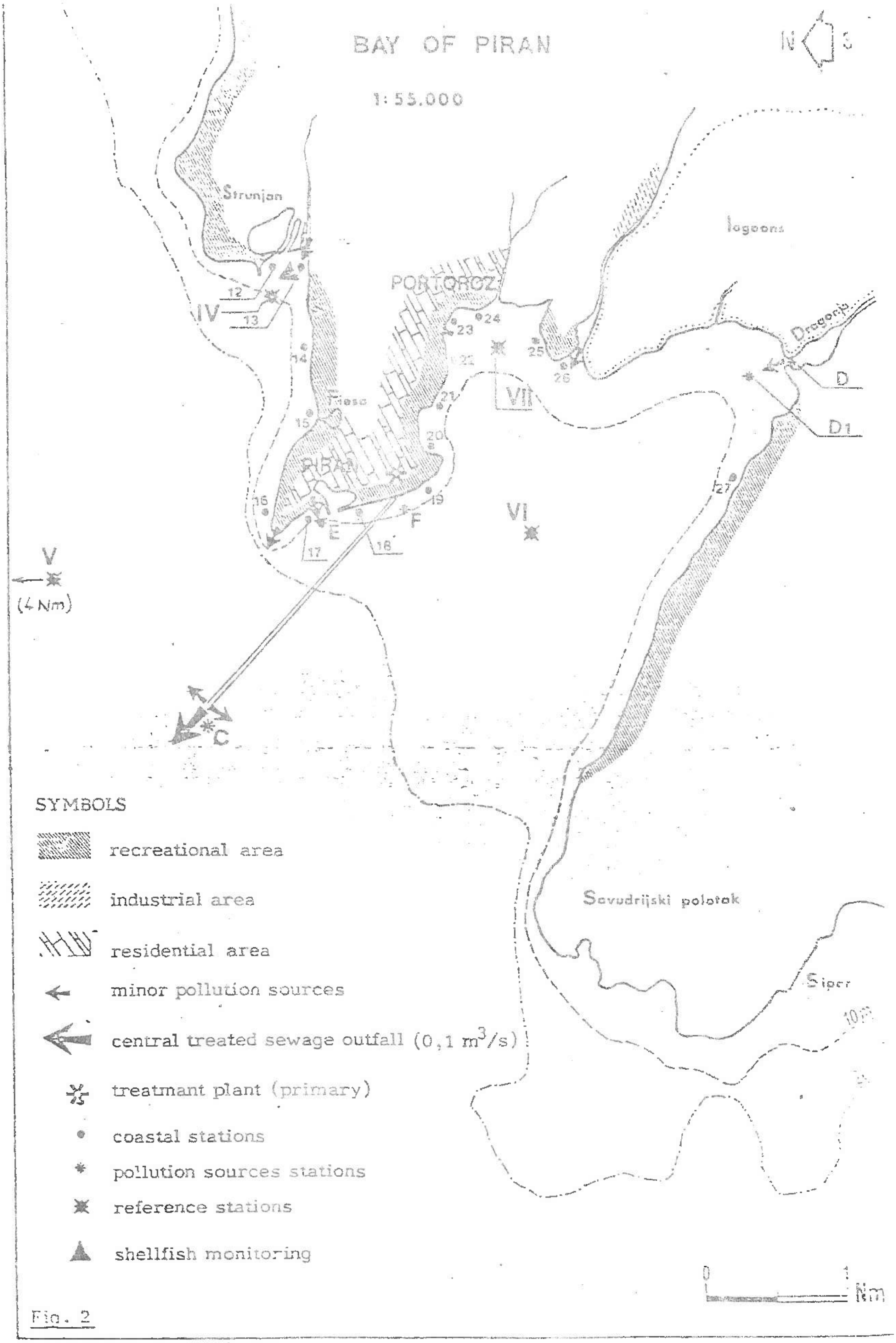

BAY OF PIRAN
1:55.000
N
S
Strunjan
PORTOROZ
lagoons
Dragonja
Fiesa
PIRAN
IV
V
(4 Nm)
VI
VII
C
D
D1
E
F
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
Savudrijski polotok
Sipar
10m
SYMBOLS
recreational area
industrial area
residential area
minor pollution sources
central treated sewage outfall (0,1 m³/s)
treatmant plant (primary)
coastal stations
pollution sources stations
reference stations
shellfish monitoring
0
1
Nm

Fig. 2

List of monitoring stations in the coastal sea along S.R.Slovenija (Yugoslav

Gulf of Triest (North Adriatic)

Recrational waters.

(swimming areas, coastal stations, 10 - 20 m from shoreline)

Station symbols	Locality Terms
1	Debeli rtič
2	Valdoltra
3	Ankaran
4	Koper
5	Žusterna
6	Rex
7	Izola - camping
8	Izola - public beach
9	Izola - light house
10	Simonov zaliv
11	Belveder
12	Strunjan - public beach
13	Strunjan - " "
14	Pacug
15	Fiesa
16	Piran - hotel "Punta"
17	Piran - hotel "Piran"
18	Piran - public beach
19	Bernardin - hotel "Emona"
20	Bernardin - public beach
21	Portorož - store-house
22	Portorož - hotel "Riviera"

Station symbols	Locality Terms
23	Portorož - public beach
24	Lucija
25	Seča - camping
26	Seča - "Ribič"
27	Kanegra

Pollution point sources

Rivers

R	Rižana - outflow
D	Dragonja - outflow
D1	Dragonja - estuary 500 m from outflow

Outfalls

A	Koper - main direct discharge of non-treated sewage, at the point of discharge
A1	100 m off the point of discharge
A2	250 m off " " (0.5 m, 5 m)
A3	1000 m " " (0.5 m, 5 m, 10 m)
~~B~~	~~Izola - main direct discharge of non-treated sewage~~
C	Piran - UW outfall of treated sewage
E	Piran - outfall at "Punta"
F	Piran - outfall at "Salvetti" (Meteoric waters only)

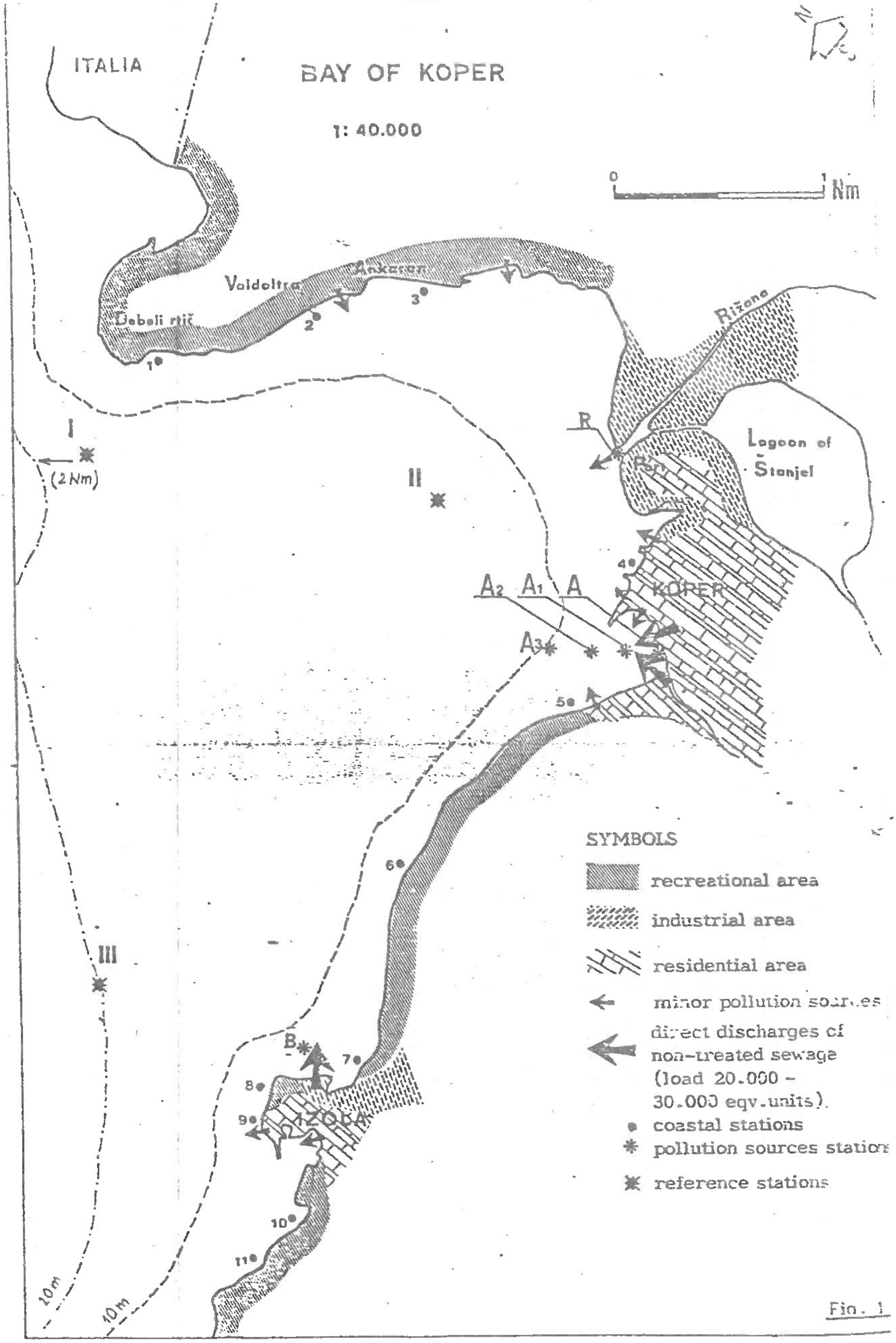

ITALIA
BAY OF KOPER
1: 40.000
0
1
Nm
Valdoltra
Ankaran
Debeli rtič
Rižana
R
Lagoon of
Štanjel
Port
I
(2 Nm)
II
A2
A1
A
A3
KOPER
B
IZOLA
III
20m
10m
SYMBOLS
recreational area
industrial area
residential area
minor pollution sources
direct discharges of
non-treated sewage
(load 20.000 -
30.000 eqv.units).
coastal stations
pollution sources station
reference stations

Fig. 1

Table: 1 Bacterial indicators of faecal pollution expressed in mean values for winter and summer months

Station depth/m	SUMMER mean values/100 ml* Total coliforms	Faecal coliforms	Faecal streptococci	WINTER mean values/100 ml* Total coliforms	Faecal coliforms	Faecal streptococci
1	17.8 ± 8.2	8.6 ± 9.4	6.4 ± 6.5	23.3 ± 3.0	19.0 ± 5.3	17.8 ± 3.4
2	62.6 ± 14.6	19.8 ± 15.7	14.3 ± 14.8	13.8 ± 7.2	9.6 ± 8.5	4.9 ± 3.3
3	73.1 ± 2.2	56.2 ± 6.8	13.1 ± 13.1	24.4 ± 6.1	12.7 ± 4.6	3.2 ± 3.6
4	55.5 ± 3.1	33.9 ± 2.5	31.3 ± 2.5	72.8 ± 4.3	30.5 ± 3.2	3.7 ± 1.4
5	902.6 ± 8.1	347.0 ± 6.4	161.6 ± 5.5	439.2 ± 35.3	174.4 ± 51.3	157.1 ± 24.5
6	n. d.	n. d.	n. d.	43.3 ± 2.2	14.5 ± 1.7	8.7 ± 2.2
7	26.4 ± 9.7	11.3 ± 4.4	28.3 ± 4.0	40.6 ± 1.8	35.5 ± 3.3	80.5 ± 2.5
8	1665.5 ± 13.2	932.9 ± 14.6	468.3 ± 4.2	89.1 ± 9.0	42.0 ± 14.8	35.6 ± 2.6
9	41.5 ± 9.2	16.9 ± 17.1	18.0 ± 5.4	107.0 ± 14.1	64.8 ± 12.1	58.8 ± 4.9
10	5.4 ± 10.1	2.7 ± 6.6	3.8 ± 5.5	12.3 ± 5.6	4.2 ± 5.3	10.2 ± 5.9
11	5.0 ± 5.0	1.8 ± 1.7	1.3 ± 1.5	16.3 ± 3.0	4.8 ± 2.3	5.5 ± 1.7
12	7.5 ± 9.0	4.2 ± 4.7	5.1 ± 3.1	27.0 ± 8.6	10.7 ± 7.6	15.5 ± 2.7
13	8.8 ± 5.6	3.6 ± 4.4	2.4 ± 3.3	31.1 ± 12.1	6.7 ± 5.9	5.8 ± 2.5
14	8.8 ± 1.4	2.8 ± 2.8	1.4 ± 1.6	n. d.	n. d.	n. d.
15	3.9 ± 4.2	3.3 ± 4.4	3.1 ± 3.5	5.9 ± 6.5	1.5 ± 2.1	1.8 ± 2.6
16	3.1 ± 4.8	2.2 ± 3.1	2.5 ± 2.6	6.0 ± 2.4	2.0 ± 3.3	2.3 ± 6.6
17	3.0 ± 2.7	1.8 ± 2.8	1.5 ± 2.4	43.2 ± 4.6	17.1 ± 5.7	11.4 ± 9.6
18	3.0 ± 9.4	3.1 ± 9.6	5.1 ± 7.3	2.4 ± 3.5	4.9 ± 3.5	3.9 ± 1.4
19	17.4 ± 21.8	15.4 ± 15.7	12.5 ± 11.6	12.5 ± 3.4	3.7 ± 5.3	6.7 ± 4.4

List of monitoring stations in the coastal sea along S.R.Slovenija (Yugoslav. Gulf of Triest (North Adriatic)

Recrational waters:
(swimming areas, coastal stations, 10 – 20 m from shoreline)

Station symbols	Locality Terms
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14	Pacug
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16	Piran – hotel "Punta"
17	Piran – hotel "Piran"
18	Piran – public beach
19	Bernardin – hotel "Emona"
20	Bernardin – public beach
21	Portorož – store-house
22	Portorož – hotel "Riviera"

(Table 1 - page 3)

Station depth/m	SUMMER mean values/100 ml[x] Total coliforms	Faecal coliforms	Faecal streptococci	WINTER mean values/100 ml[x] Total coliforms	Faecal coliforms	Faecal streptococci
VI/15	3.0 ± 3.7	1.7 ± 3.4	1.6 ± 2.9	2.7 ± 1.8	0.0 ± 0.0	2.4 ± 2.3
VII/0.5	2.1 ± 3.5	0.0 ± 0.0	0.0 ± 0.0	105.8 ± 5.4	4.0 ± 2.7	10.6 ± 4.0
R/0.5	5628.6 ± 2.3	841.6 ± 2.4	276.6 ± 2.1	1293.6 ± 1.9	274.0 ± 1.6	171.6 ± 1.6
D/0.5	33.1 ± 2.9	15.7 ± 4.6	8.4 ± 5.3	38.4 ± 3.9	9.8 ± 8.6	5.1 ± 3.0
D1/0.5	6.5 ± 4.3	2.4 ± 3.5	5.0 ± 6.4	12.9 ± 5.9	2.8 ± 4.2	6.2 ± 5.1
A/0.5	111837.6 ± 4.1	44410.2 ± 9.4	21213.8 ± 7.7	200045.4 ± 4.7	62783.6 ± 6.3	23201.7 ± 5.3
A1/0.5	4580.1 ± 4.5	2519.9 ± 4.3	1724.2 ± 2.4	23342.5 ± 2.5	8062.1 ± 3.5	4187.0 ± 2.3
A2/0.5	131.1 ± 12.9	15.8 ± 12.4	92.1 ± 4.7	323.1 ± 10.1	213.2 ± 14.0	97.4 ± 13.9
A2/5	25.7 ± 4.4	18.1 ± 5.2	11.6 ± 1.8	80.1 ± 2.[illegible]	50.9 ± 2.0	52.7 ± 1.5
A3/0.5	40.4 ± 34.1	17.0 ± 23.0	56.4 ± 10.1	407.9 ± 6.5	140.0 ± 9.4	217.7 ± 5.3
A3/10	117.3 ± 10.0	11.3 ± 13.6	14.0 ± 2.7	17.1 ± 13.2	7.9 ± 11.3	14.6 ± 4.2
C/0.5	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	3.0 ± 4.5	[illegible].8 ± 3.8	2.0 ± 2.2
C/10	1.6 ± 2.0	0.0 ± 0.0	1.6 ± 2.0	1.6 ± 1.7	1.2 ± 1.4	1.8 ± 2.8
C/20	151.0 ± 8.3	71.8 ± 5.8	28.0 ± 6.1	52.9 ± 3.9	19.8 ± 12.2	13.0 ± 3.6
E/0.5	3.2 ± 3.4	2.6 ± 3.1	6.4 ± 5.7	49.2 ± 8.4	12.2 ± 9.4	13.9 ± 7.1
E/10	262.7 ± 6.6	160.1 ± 4.9	89.2 ± 3.0	102.9 ± 3.3	51.8 ± 5.1	22.1 ± 4.7
F/0.5	37.4 ± 159.9	20.2 ± 57.8	38.1 ± 39.6	123.6 ± 10[illegible].8	80.5 ± 88.4	43.8 ± 45.4

[x] mean values and standard deviation expressed as antilog.

n. d. = not determined

Reference stations off-shore

Station symbols	Coordinates	Station Depth (m)
I	45° 36,2' 13° 39,8'	20 m
II	45° 33,6' 13° 43,7'	15 m
III	45° 33,3' 13° 39,3'	18 m
IV	45° 30,3' 13° 32,8'	10 m
V	45° 35,4' 13° 27,0'	20 m
VI	45° 30,3' 13° 34,0'	16 m
VII	45° 30,6' 13° 35,0'	10 m

(Table 2)

Stations depth/m	less than 100		more than 1000	
	All samples	Bathing season samples (1978)	All samples	Bathing season samples (1978)
26	90.9	100.0	0.0	0.0
27	100.0	100.0	0.0	0.0
I/0.5	100.0	100.0	0.0	0.0
I/20	100.0	100.0	0.0	0.0
II/0.5	70.0	100.0	10.0	100.0
II/15	100.0	100.0	0.0	0.0
III/0.5	77.8	100.0	0.0	0.0
III/18	100.0	100.0	0.0	0.0
IV/0.5	100.0	100.0	0.0	0.0
V/0.5	100.0	100.0	0.0	0.0
V/20	100.0	100.0	0.0	0.0
VI/0.5	100.0	100.0	0.0	0.0
VI/15	100.0	100.0	0.0	0.0
VII/0.5	100.0	100.0	0.0	0.0

(Table 1 – page 2)

Station depth/m	SUMMER mean values/100 ml^x Total coliforms	Faecal coliforms	Faecal streptococci	WINTER mean values/100 ml^x Total coliforms	Faecal coliforms	Faecal streptococci
20	16.0 ± 3.7	6.5 ± 6.0	3.8 ± 4.1	50.3 ± 2.9	10.5 ± 5.0	9.5 ± 3.7
21	9.5 ± 6.7	7.4 ± 8.1	7.5 ± 7.1	46.1 ± 3.1	7.1 ± 7.8	6.5 ± 5.3
22	263.7 ± 2.4	125.4 ± 1.3	35.9 ± 2.4	22.7 ± 2.7	8.3 ± 2.6	8.2 ± 3.5
23	7.4 ± 5.2	6.3 ± 6.3	6.5 ± 5.8	10.0 ± 8.7	13.5 ± 11.1	14.7 ± 6.5
24	n. d.	n. d.	n. d.	n. d.	n. d.	n. d.
25	15.3 ± 5.5	12.1 ± 5.6	6.1 ± 5.6	12.5 ± 4.8	4.2 ± 6.2	4.2 ± 3.6
26	17.2 ± 3.8	6.4 ± 7.2	3.9 ± 4.9	38.9 ± 11.5	12.1 ± 5.7	3.6 ± 2.2
27	3.3 ± 5.3	2.1 ± 2.9	1.7 ± 1.8	6.7 ± 5.2	1.2 ± 1.6	0.0 ± 0.0
I/0.5	1.1 ± 1.4	0.0 ± 0.0	0.0 ± 0.0	3.9 ± 5.4	1.6 ± 2.2	2.0 ± 2.7
I/20	1.3 ± 1.5	0.0 ± 0.0	0.0 ± 0.0	2.3 ± 2.5	1.1 ± 1.4	1.3 ± 1.5
II/0.5	3.7 ± 2.8	1.6 ± 1.6	5.3 ± 6.0	71.5 ± 23.2	35.2 ± 36.8	7.0 ± 29.4
II/1[illegible]	4.0 ± 4.0	0.0 ± 0.0	4.6 ± 4.9	4.3 ± 2.9	1.7 ± 2.8	1.8 ± 2.1
III/0.5	1.4 ± 2.0	1.2 ± 1.6	1.4 ± 2.0	8.3 ± 39.0	14.3 ± 22.1	11.1 ± 19.6
III/18	2.9 ± 4.4	2.0 ± 4.9	2.3 ± 4.4	3.8 ± 2.7	1.5 ± 2.2	2.8 ± 2.3
IV/0.5	1.7 ± 2.5	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
V/0.5	1.1 ± 1.4	0.0 ± 0.0	1.4 ± 1.7	2.4 ± 2.7	1.1 ± 1.4	0.0 ± 0.0
V/20	1.3 ± 1.9	0.0 ± 0.0	1.1 ± 1.4	1.3 ± 1.5	0.0 ± 0.0	0.0 ± 0.0
VI/0.5	0.0 ± 0.0	0.0 ± 0.0	1.5 ± 2.3	3.4 ± 1.7	1.4 ± 1.8	2.0 ± 2.0

Table: 4 Data on faecal contamination of mussel - cultures in Strunjan during 1977 to 1979

		GROWING WATER		MUSSEL	
Date of sampling	Temp. °C	Total coliforms n/100 ml	Faecal coliforms n/100 ml	Total coliforms n/100 g	Faecal coliforms n/100 g
27.7.77	24.5	9	0	430	150
16.8.77	25.2	0	0	230	0
8.9.77	23.5	9	4	430	30
6.10.77	17.5	0	0	430	90
25.11.77	14.3	0	0	930	430
27.12.77	12.0	0	0	30	0
29.1.78	8.0	93	21	4600	430
17.2.78	7.8	460	150	1500	0
11.4.78	11.1	23	0	90	0
9.5.78	17.4	0	0	390	230
9.5.78	17.4	0	0	4600	430
14.6.78	17.5	0	0	2400	430
14.6.78	17.5	0	0	430	430
11.7.78	21.6	29	93	24000	24000
25.7.78	23.7	0	0	46000	9300
2.8.78	23.6	15	15	160	160
18.9.78	21.7	40	0	930	90
6.10.78	18.6	0	0	11000	4500
7.11.78	15.5	0	0	150	150
8.12.78	11.1	4	4	930	930
9.1.79	9.2	0	0	91	91
6.2.79	9.2	43	15	14000	4600
6.3.79	8.8	0	0	230	91
5.4.79	11.0	0	0	1500	1500

Participating Research Centre: Center for Marine Research
"Rudjer Boskovic" Institute
ROVINJ
Yugoslavia

Principal Investigator: D. FUKS

PILOT PROJECT: MED POL VII

Introduction:

The first steps to develop a methodology for the study of microbiological parameters relevant to the quality of coastal waters were taken at the Centre in 1972.

Systematic monitoring of the sanitary quality of recreational beaches and shellfish-growing waters started in 1973 at a limited number of selected stations in the vicinity of Rovinj, using a few basic parameters such as total and faecal coliforms, BOD, basic chemical, physical and meteorological factors. Since then this monitoring programme has evolved considerably and resulted in a number of publications and reports.

Today, regular surveys made by the Centre cover large areas of the Northern Adriatic, in particular along the western and eastern coast of the Istrian peninsula and the Bay of Rijeka. The number and type of parameters studied in these areas have also increased and diversified, and at present the Centre is successfully carrying out complex studies on the quality of coastal waters at the request of the Government (i.g. MED VII), local authorities and industry.

Area(s) studied:

The Bay of Rijeka, as well as the western and eastern coast of the Istrian peninsula, were selected to investigate systematically the quality of the recreational waters as the Centre's contribution to MED VII.

The Bay and the eastern coast of Istria are surrounded by limestone mountains with steep slopes, which continue under the sea, while the western coast of Istria is surrounded by relatively shallow waters. The shoreline is in most cases rocky.

One of the surface waters entering the area is the small river Rjecina (average flow 20 m^3/s), which is heavily polluted by domestic and industrial wastes originating from Rijeka. The other surface water entering the region (river Mirna) is relatiely clean and carries on average 60 m^3/s of water. The waters of the Northern Adriatic, including the coastal waters of western Istria, are influenced by the northern Italian rivers, in particular the river Po (stations 6 and 7).

Owing to the specific characteristics of the region, there are numerous underwater wells in the vicinity of the coastline, their content of water depending on the amount of rain falling over the adjacent mainland. During heavier rainfall the stormwater entering the Bay is considerable. The average annual precipitation in the area is 1 400 mm/m^2.

The shores of the area are used intensively as an almost all-year-round recreational zone, which, in the peak of the season, can accommodate up to 250 000 tourists a day.

The town of Rijeka, situated in the Bay, is one of the largest Yugoslav coastal cities (160 000 inhabitants) and its harbour (8 million tons/ year) is one of the most important in the country. There are a large number of activities in the city itself and in its surroundings: an airport terminal, shipyards, refineries, coking plant, petrochemical, paper, textile, machine and tool industries, etc.

The sanitary quality of the recreational waters of the area has been systematically monitored at 27 coastal stations (not more than 10 m from the shoreline), grouped in four regions (figures 1, 2, 3, 4 and 5) since the summer of 1976.

Materials and methods used:

The operational document for the MED VII project (document EHE/76.1) and the Guidelines for Health Related Monitoring of Coastal Water Quality (WHO, Copenhagen, 1977) were strictly applied in carrying out the work described.

Results and their interpretation:

The following parameters were monitored regularly at all stations: total coliforms, faecal coliforms, faecal streptococci, dissolved oxygen, BOD_5, pH, salinity, temperature and atmospheric conditions. In addition, at the eight open water stations, nutrients, primary productivity and currents were measured.

The comparative analysis of the data obtained in the four selected regions (Figure 1) shows that there exists a significant difference between the stations of these regions. As expected, stations located closer to the land-based sources of pollution, i.e. sewage outfalls, revealed a higher degree of coastal pollution when measured by the indicators used in this study.

The recorded variations of sea and air temperature at the various stations were closely related to the climatological and meteorological conditions of the area. At some stations (i.e. station no. 8) these parameters were also modified by the amount of fresh water entering the sea in the vicinity of these stations, directly from land or through underwater wells. In general, between September and February, when the measurements were made, the temperature of the air was lower than that of the sea. The surface sea temperature varies between 9.0°C (January 1978, station no. 23) and 27.6°C (July 1977, station no. 27).

As a result of uneven inflow of surface waters and fresh waters from underwater wells, the salinity of the sea surface showed great variations at most of the stations.

Salinity ranges recorded at stations in the region of Rijeka showed a particularly wide variation (19.35°/$_{oo}$ - 37.43°/$_{oo}$ for all stations of the region with the exception of station no. 8 where salinity occasionally dropped to 4.20°/$_{oo}$). Salinity variations at the West Istrian stations were in the range 26.44°/$_{oo}$ - 37.89°/$_{oo}$.

Owing to the high buffer capacity of the sea-water, pH values were in the range of 8.00 - 8.40. Exceptionally low values were found only at stations (e.g. station No. 8) heavily influenced by coastal waste discharge where a minimum pH of 7.40 was recorded.

Oxygen saturation of sea-water was regularly close to 100%, with occasionally slightly lower saturation at stations in the Rijeka region, due to the amount of oxygen-consuming organic waste.

The mean biochemical oxygen demand was somewhat lower at the stations along the West Istrian coast (0.8 - 1.3 mg O_2/l) than at the stations in the region of Rijeka (1.3 - 1.6 mg O_2/l). The highest recorded value for BOD 5 was at station No 6 (5.1 mg O_2/l).

The mean values for total coliforms, faecal coliforms and faecal streptococci are listed in Table 1.

The majority of stations (except stations no. 4 and 8) in the region of Rijeka showed significantly lower values during the summer season than during the remainder of the year. High mean values during the out-of-season period indicate the certain influence of meteorological and hydrological conditions on the state of pollution in this area.

Higher mean values noted during the summer season, compared with those noted during other seasons at the majority of stations along the West Istrian coast, indicate the increase in coastal pollution due to the growing number of summer tourists accommodated at hotels and other facilities along the coast.

Although the concentration of total coliforms might not be the best indicator for contamination of sea-water with faecal material, results obtained in our survey (table 1) show good correlation with the location of outfalls bringing into the sea either faecal material or material enhancing the survival and reproduction of micro-organisms in the area.

Faecal coliforms (E. coli) were measured at all stations as one of the most sensitive indicators of the degree of sewage pollution and sewage dispersion around points of sewage discharge.

Highly satisfactory bathing areas should show E. coli (faecal coliforms) counts of consistently less than 100 per 100 ml, and to be considered acceptable, bathing waters should not give counts consistently greater than 1 000 E. coli per 100 ml. No more than 10% of at least 10 consecutive samples collected during the bathing season should exceed 1 000 E. coli per 100 ml.

Taking these criteria into account, stations nos. 1 and 7 are beyond the acceptable limits set for recreational waters (more than 10% of samples having 1 000 FC/100 ml). However, it should be noted that during the bathing season all these stations could be considered as "acceptable". None of the stations can be considered as highly satisfactory from a recreational standpoint (table 2).

The computed ratios of faecal coliforms and faecal streptococci (FC/FS) for stations nos 1-8 are between 2.3 and 5.4 indicating that they are under the direct influence of human faecal material.

Results obtained at stations in the Pula region indicate their high recreational quality, although the computed FC/FS ratios (0.5-2.3) show occasional influence of contamination with human faecal materials from sources that are not in the vicinity of the stations.

Stations in the region of Porec show somewhat higher faecal coliform values, some of them occasionally exceeding (not in the bathing season) the 1 000 FC/100 ml. Two of six examined beaches can be considered as "highly satisfactory bathing areas". The FC/CS ratios indicate that none of the stations is under the direct influence of human faecal contamination.

Stations in the Umag region have never exceeded the 1 000 faecal coliforms/100 ml and had a low FC/FS ration (0.1 - 1.8). Three stations of six examined beaches can be considered as highly satisfactory from a recreational standpoint.

Table 3 gives the period of sampling and the number of analyses per stations in the controlled areas.

The correlation between total coliforms and faecal coliforms on 27 stations examined, are presented in table 4. If "the 0.01 level" is used as a criterion of significance, a good correlation was then found between TC and FC for stations Nos. 1-7, 10, 11, 16-22, 24-27. No correlation between TC and FC was found for stations Nos. 9, 12, 14, 23. One could speculate that the correlation dropped with the degree of pollution.

Seasonal variations of the number of faecal coliforms caused by the influence of NE and S. winds on the spreading of pollution in coastal water are presented in table 3. Due to the lack of significant number of data with the same meteorological conditions only stations Nos. 1-8 were analysed.

The S. wind (in Rijeka Bay) has driven back sewage released from the outlet to the shore and caused higher mean values at all stations (summer and the remaining part of year).

The NE wind has removed pollution from the seashore and caused significantly lower mean values at all stations (except No. 8).

Significantly higher mean values were found for stations Nos. 1-6 influenced by S. wind.

Conclusions:

The survey of recreational waters in four selected regions of the North Adriatic (Figure 1) revealed the correlation between the sanitary (recreational) quality of waters at selected stations and the vicinity of land-based sources of contamination.

The region of Rijeka is influenced by pollutants and some of the stations of this region are close to the limit set for "acceptable" bathing waters. The stations surveyed in the other three regions (Pula,Porec, Umag) are clean (or sporadically slightly polluted) and none of the nineteen controlled beaches can be considered as highly satisfactory from a recreational standpoint, although some of surveyed stations are occasionally influenced by indirect pollution from land-based sources.

List of Publications

D. FUKS: Sanitary Quality of Coastal Waters of Rovinj (in Croatian, with English summary), M. Sc. Thesis, University of Zagreb 1974.

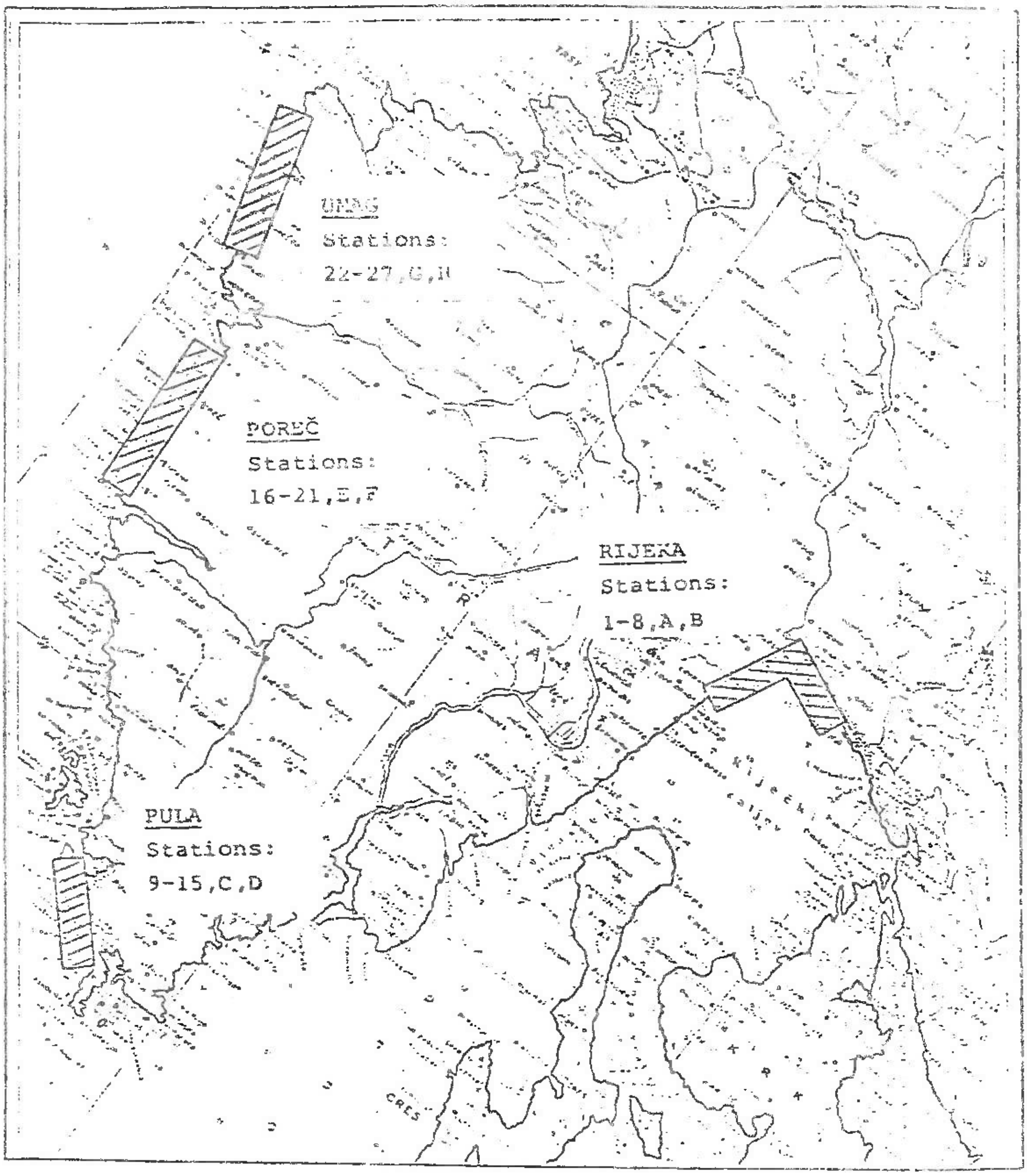
K. HARDT-JURICEV: Sanitary Quality of Coastal Water from Rovinj, to Novigrad (in Croatian, with English summary), M. Sc. Thesis, University of Zagreb, 1975.

D. FUKS and Z. FILIC: Microbiological Quality Control of Shellfish Growing Waters and Elimination of Bacteria by Mussel Mytilus galloprovincialis Lmk. Ichthyologia, 9 (1977) 101-106.

D. FUKS: Cruises of the RV "Vila Velebita" in the Kvarner Region of the Adriatic Sea. III. Concentration of Total Bacteria and Total Coliforms and the Biological Oxygen Demand. Thalassia Yugosl. 8/2, in press.

D. FUKS and S. KECKES: Variability of certain Microbiological and Environmental Water Quality Indicators in Coastal Recreational Waters off the West Istrian Coast, Yugoslavia. Thalassia Jugosl. 13/1 (1977).

Figure 1: Area studied in the framework of MED VII



Note: Sampling stations are grouped in indicated regions named after the vicinity of the largest town.

Table 1: Mean values and their standard deviations for total coliforms, faecal coliforms and faecal streptococci in samples taken at examined stations (data separated in "summer" and "other" (season) columns)

Stations	Total coliforms n/100 ml		Faecal coliforms n/100 ml		Faecal streptococci n/100 ml	
	Summer	Others	Summer	Others	Summer	Others
1	138.9* ± 7.1*	289.1 ± 6.7	69.3 ± 6.8	147.4 ± 9.8	35.2 ± 7.0	92.5 ± 8.9
2	94.2 ± 10.5	207.6 ± 8.8	44.7 ± 11.2	112.6 ± 9.8	43.6 ± 9.1	53.1 ± 9.9
3	75.3 ± 5.2	239.3 ± 5.4	27.4 ± 7.0	69.6 ± 6.6	19.7 ± 5.0	39.2 ± 9.7
4	56.6 ± 10.0	58.8 ± 10.4	30.8 ± 10.3	25.1 ± 10.3	41.1 ± 7.2	18.5 ± 11.1
5	72.5 ± 7.3	124.9 ± 4.4	34.0 ± 7.2	98.5 ± 4.2	10.4 ± 7.2	15.7 ± 7.5
6	46.7 ± 6.2	136.4 ± 6.1	21.0 ± 5.9	90.9 ± 6.6	13.2 ± 7.6	47.7 ± 8.3
7	192.0 ± 4.7	257.3 ± 6.1	69.8 ± 5.1	131.5 ± 9.3	25.6 ± 7.8	50.2 ± 12.7
8	315.0 ± 3.3	304.2 ± 4.4	178.9 ± 3.6	113.1 ± 4.2	71.1 ± 5.8	62.8 ± 5.9
A	5.8 ± 10.2	75.5 ± 6.8	1.8 ± 3.3	65.9 ± 6.1	4.2 ± 7.9	49.0 ± 20.2
B	7.9 ± 5.2	91.1 ± 4.7	2.6 ± 3.3	46.1 ± 2.5	2.1 ± 3.2	46.1 ± 6.8
9	7.8 ± 7.2	2.3 ± 7.8	3.6 ± 5.6	1.4 ± 2.4	4.4 ± 7.5	2.7 ± 5.8
10	4.0 ± 4.1	1.4 ± 3.1	2.5 ± 2.8	1.2 ± 1.7	3.0 ± 5.6	2.4 ± 3.8
11	13.4 ± 9.2	2.3 ± 4.7	8.1 ± 6.2	1.8 ± 4.1	8.1 ± 3.9	3.3 ± 6.5
12	33.9 ± 5.4	10.7 ± 5.3	9.7 ± 5.6	4.5 ± 3.7	19.9 ± 7.9	3.3 ± 4.7
13	5.7 ± 5.3	1.1 ± 1.3	3.2 ± 4.3	1.3 ± 2.6	4.3 ± 6.2	2.1 ± 3.5
14	4.7 ± 3.9	1.7 ± 2.6	1.9 ± 2.3	1.0 ± 1.0	3.6 ± 4.4	1.6 ± 2.0
15	2.4 ± 4.5	1.4 ± 2.4	1.3 ± 1.7	1.1 ± 1.4	3.5 ± 3.9	1.7 ± 2.7
C	2.6 ± 5.3	1.0 ± 1.0	2.8 ± 4.9	1.0 ± 1.0	3.2 ± 6.2	1.0 ± 1.0
D	1.9 ± 2.8	1.0 ± 1.0	1.3 ± 5.9	1.0 ± 1.0	1.4 ± 2.2	1.0 ± 1.0
16	110.6 ± 8.4	44.3 ± 8.0	80.0 ± 6.5	30.5 ± 6.9	87.3 ± 5.5	27.4 ± 7.4
17	73.1 ± 16.8	2.7 ± 3.9	39.1 ± 12.2	1.3 ± 2.0	50.7 ± 11.8	3.5 ± 6.2
18	28.9 ± 2.3	2.5 ± 2.9	7.4 ± 6.5	1.3 ± 2.3	38.7 ± 3.9	5.1 ± 4.1
19	13.9 ± 5.5	6.9 ± 8.5	5.2 ± 5.0	2.9 ± 6.9	40.6 ± 3.7	5.3 ± 7.1
20	32.1 ± 6.4	22.4 ± 9.4	8.8 ± 8.9	9.4 ± 11.1	16.9 ± 9.6	21.3 ± 8.6
21	20.0 ± 4.1	9.9 ± 5.4	10.5 ± 3.7	2.7 ± 5.7	14.6 ± 6.4	4.6 ± 4.8
E	1.0 ± 1.0	2.0 ± 4.2	1.0 ± 1.0	1.9 ± 2.8	1.8 ± 1.9	1.2 ± 1.4
F	3.1 ± 5.8	1.2 ± 1.4	2.8 ± 5.0	1.0 ± 1.0	6.4 ± 4.5	1.0 ± 1.0
22	30.0 ± 4.7	3.5 ± 5.9	14.7 ± 6.5	2.3 ± 4.9	15.8 ± 5.1	2.3 ± 2.9
23	6.3 ± 5.1	9.1 ± 5.4	2.5 ± 3.7	5.5 ± 4.4	2.8 ± 3.7	3.7 ± 4.9
24	40.9 ± 7.3	26.0 ± 14.3	22.9 ± 8.1	14.3 ± 7.6	16.6 ± 4.5	30.0 ± 8.8
25	6.3 ± 4.4	16.2 ± 5.1	3.4 ± 3.8	11.9 ± 5.8	2.7 ± 3.9	12.7 ± 3.5
26	10.7 ± 7.6	6.7 ± 3.6	5.8 ± 5.9	3.3 ± 4.4	5.3 ± 4.8	4.3 ± 3.4
27	10.3 ± 6.2	26.6 ± 8.1	4.6 ± 5.8	11.8 ± 7.8	7.9 ± 4.9	17.4 ± 9.5
G	3.2 ± 3.9	1.7 ± 2.5	1.9 ± 3.5	1.0 ± 1.0	1.8 ± 4.0	1.4 ± 1.9
H	3.1 ± 4.9	2.0 ± 3.3	1.3 ± 1.4	1.6 ± 1.7	1.6 ± 1.7	1.4 ± 1.9

* Log transformed data

Table 2: Distribution of faecal coliforms and evaluation of stations according to interim criteria, FC/FS ratio

Stations	Samples (%) exceeding limits of -				
	100 faecal coliforms/100 ml		1000 faecal coliforms/100 ml		Ratio
	Total	Summer	Total	Summer	FC/FS
1	41.5	37.5	12.2	8.2	3.2
2	43.9	50.0	7.3	0.0	3.1
3	26.8	25.0	9.8	4.2	3.4
4	29.2	33.3	4.9	4.2	2.3
5	28.9	21.7	5.3	4.3	5.4
6	25.0	13.0	5.0	0.0	3.2
7	35.0	26.1	15.0	8.7	5.4
8	62.5	69.6	7.5	4.3	3.5
A	20.0	0.0	0.0	0.0	0.6
B	20.0	0.0	0.0	0.0	0.9
9	4.2	7.7	0.0	0.0	0.6
10	0.0	0.0	0.0	0.0	0.7
11	8.3	15.4	0.0	0.0	1.5
12	4.2	7.7	0.0	0.0	2.3
13	0.0	0.0	0.0	0.0	0.8
14	0.0	0.0	0.0	0.0	0.5
15	0.0	0.0	0.0	0.0	0.6
C	0.0	0.0	0.0	0.0	0.7
D	0.0	0.0	0.0	0.0	0.6
16	30.4	50.0	4.3	0.0	1.7
17	17.4	33.0	0.0	0.0	0.9
18	4.3	8.3	0.0	0.0	0.8
19	4.3	0.0	0.0	0.0	0.7
20	4.3	8.3	4.3	0.0	2.0
21	0.0	0.0	0.0	0.0	1.1
E	0.0	0.0	0.0	0.0	1.0
F	0.0	0.0	0.0	0.0	0.9
22	10.5	18.2	0.0	0.0	1.3
23	0.0	0.0	0.0	0.0	1.4
24	26.3	36.4	0.0	0.0	1.8
25	5.3	0.0	0.0	0.0	1.6
26	0.0	0.0	0.0	0.0	1.1
27	10.5	9.1	0.0	0.0	0.8
G	0.0	0.0	0.0	0.0	0.7
H	0.0	0.0	0.0	0.0	0.9

Participating Research Centre : Institute for Oceanography and Fisheries
SPLIT
Yugoslavia

Principal Investigator: S. SOBOT

Introduction:

The rather wide range of activities of the Institute for Oceanography and Fisheries in Split covers research into the pollution problem of the coastal water of the central and southern parts of the Adriatic Sea. We would like to report here on the two largest projects carried out recently: "Protection of the Human Environment in the Yugoslav Adriatic Region" and "Monitoring of Coastal Water Quality (Vir-Konavle)".

Area(s) studied:

Under the MED VII programme, the Institute for Oceanography and Fisheries undertook the monitoring studies in four areas (Zadar, Split, Ston and Dubrovnik). As the quality of the coastal water itself was the object of this programme, it was carried out in zones of intensive recreational activities, extensive shipping traffic, discharges of waste waters and shellfish-breeding areas. In most cases these zones are surrounded by limestone mountains. The shoreline is mainly rocky and intensively used for recreation.

The Zadar (approximately 50 000 inhabitants) and the Split areas (approximately 200 000 inhabitants) are under the influence of industrial and domestic waste waters, while the Dubrovnik area (approximately 40 000 inhabitants) is more or less affected by domestic waste waters only. The Stone area is slightly influenced by the M. Ston waste waters (approximately 200 inhabitants). Usually the waste waters of these areas are untreated before their discharge into the sea and they are taken out to sea by submarine pipes to a greater or smaller distance from the coast.

The currents measured were fastest, for the most part, in winter periods and slowest in spring summer periods. As to the layers, the currents were found to be faster in bottom layers than in surface layers.

The Zadar area shows the widest annual range of temperature (12.26°C), while the Dubrovnik area shows the narrowest range (9.17°C). In the course of a year variations of temperature are normal having minimal values in winter periods and maximal ones in summer periods.

As to salinity, its narrowest range was observed in the Zadar area (1.28°/₀₀)while other areas had a wider range: Dubrovnik (5.12°/₀₀), Split (6.4°/₀₀) and Ston (10.71°/₀₀). For the most part minimal salinity values were found in winter periods and maximal ones in summer periods. The analysis of sediments showed that all bottom zones consist of clayey and loamy sand.

Due to the domestic waste waters in the Split area, the nutrient values are somewhat higher, as well as the quantities of phytoplankton, and therefore eutrophication is observed. The phytoplankton community was mainly characterized by the prevalence of diatoms with relative abundance in the limits from 59 to 83%.

Materials and methods used:

The methods recommended by MED VII were applied (operational document, EHE/76.1, WHO, Geneva, project were applied (the operational document, EHE/76.1, WHO, Geneva, 1976). Nutrients were measured by autoanalyser, both salinity and temperature were determined by the conductivity method and oxygen was determined by the standard Winkler method.

Results and their interpretation:

The following parameters have been monitored:

Total coliforms faecal coliforms faecal streptococci total heterotrophic bacteria meteorological conditions hydrographic conditions dynamic conditions structure of sediment nutrients density of phytoplankton visual observation

The degree of pollution with regard to the bacteria varied a great deal in different areas as well as in different seasons.

In the Zadar area, the town itself is being polluted heavily, especially the town port (stations 2, 3, 4 and 5). Other zones in this area are in a fairly good condition for the time being.

In Split, as well as in Zadar, the town itself is again heavily polluted (town and port). Thus the adjacent recreational zones are being affected by it (stations 1, 3 and 4). Other zones are still suitable for recreation.

The recreational zone in the Ston area (station 1) is under the slight influence of faecal contaminated water (sea-side resort Klek-Neum).

The quality of the sea-water at the shellfish-breeding area is entirely adequate for the purpose. The bacteriological analyses of shellfish have confirmed this.

In the Dubrovnik area the influence of faecal contaminated water was observed in the vicinity of the port of Gruz and the town port (stations 2 and 5). Other zones in this area are suitable for recreation.

The primary data of E. coli are classified according to winds (wind direction in degrees). Their calculated mean and standard deviation are tabulated in tables 1 and 2. For adequate statistical interpretation, however, more observations (primary data) are needed.

Conclusions:

The results obtained so far indicate that all the analysed recreational waters are within the accepted interim microbiological quality criteria, but the sites near the harbour are to a certain degree affected by faecal pollution. Thus some recreational zones near Split and Zadar are affected by the faecal water from the town ports.

Our suggestion for continuation of this work is to eliminate all parameters not so relevant for this purpose. It is sufficient to monitor parameters such as microbiological, meteorological and dynamic conditions.

Figure 1

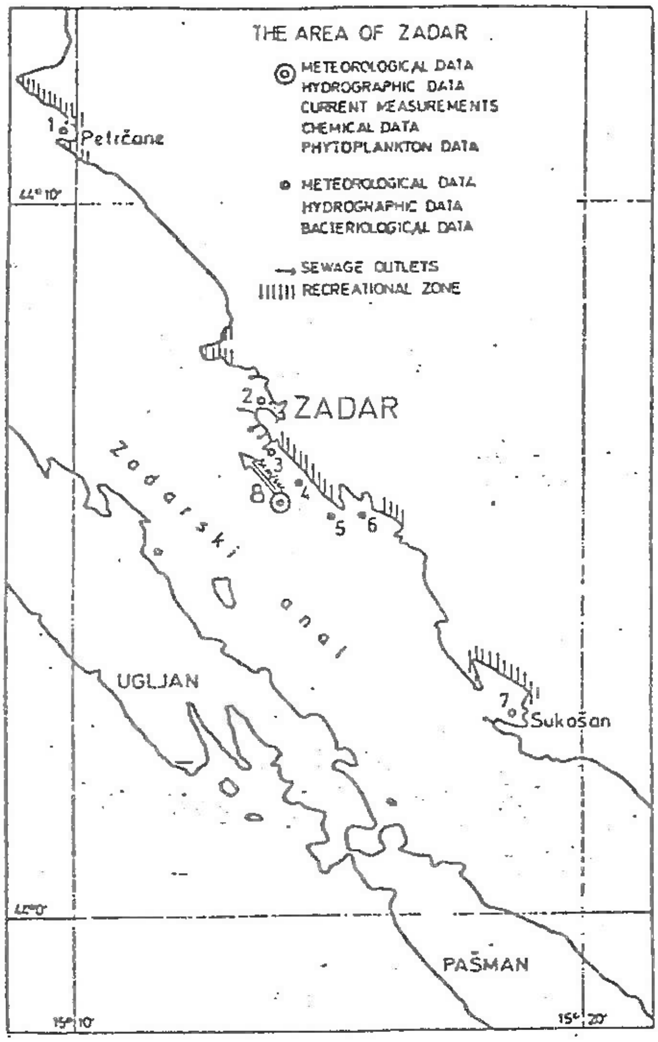


Figure 2

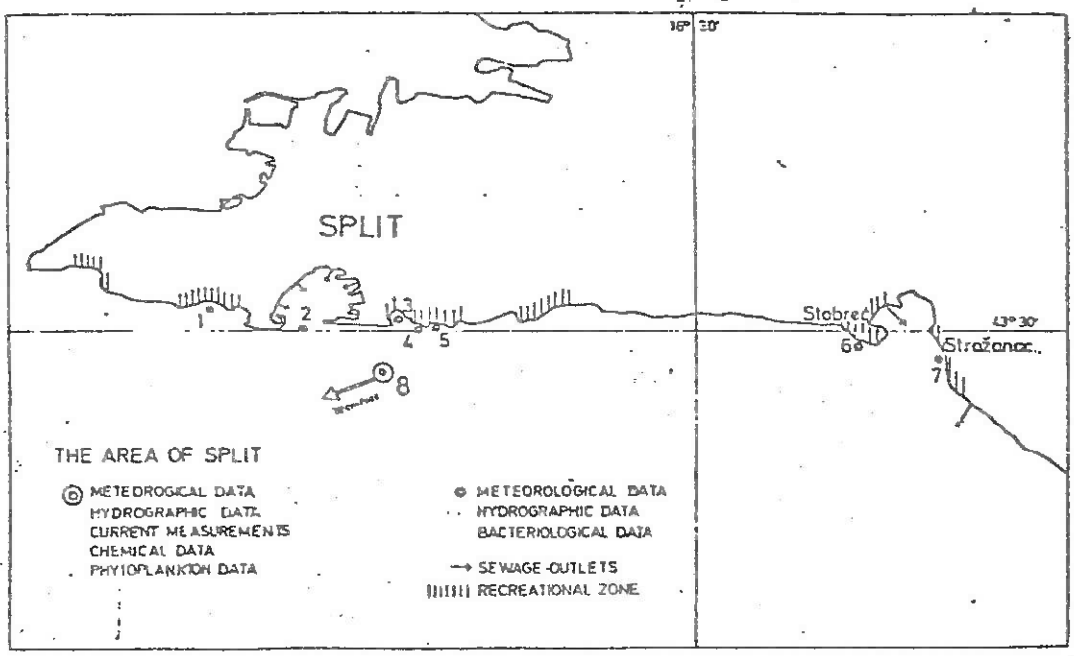


Figure 3

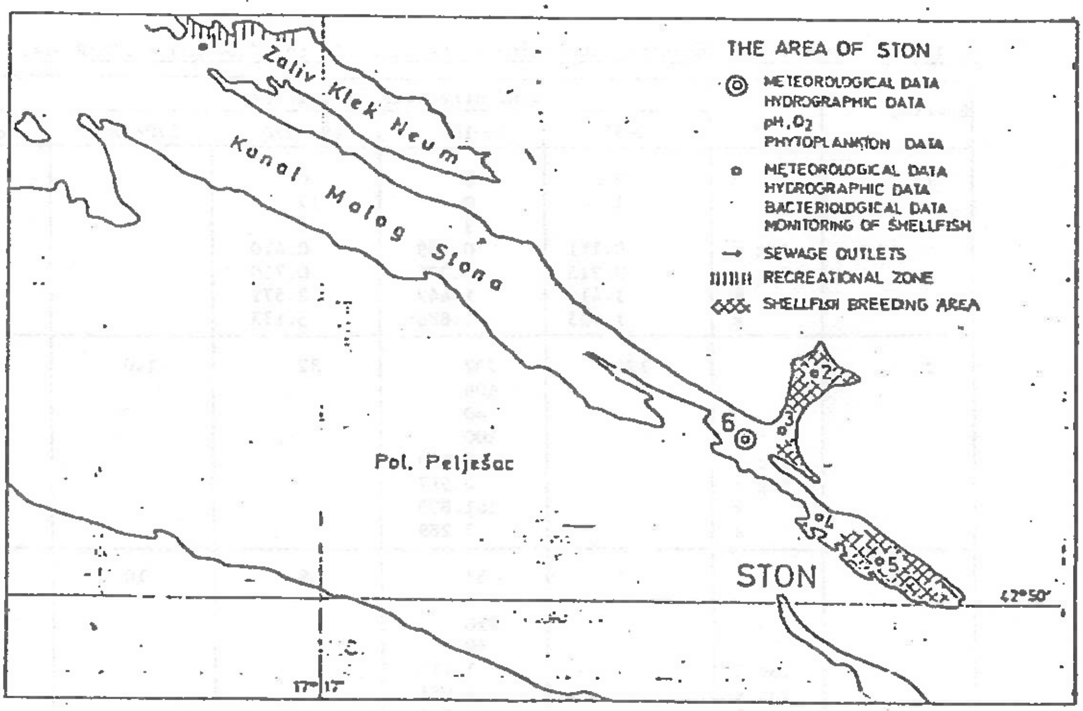


Figure 4

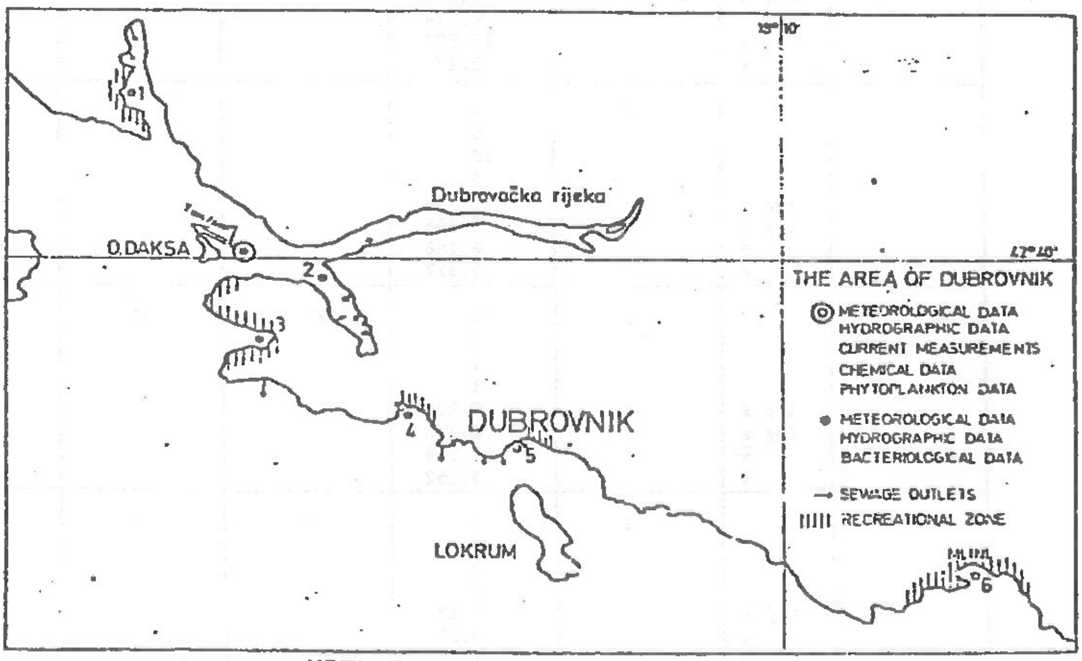


Table 1.a: Individual location tabulation of results (E. coli/100 ml) - ZADAR area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1		2	3	0		11
		1	0	17		1
			1	1		
	log $\bar{x}$	0.151	0.159	0.410		0.521
	log s	0.213	0.276	0.710		0.736
	$\bar{x}$	1.414	1.442	2.571		3.317
	s	1.633	1.886	5.133		5.450
2		124	282	32	140	94
			608			15
			40			550
			100			
	log $\bar{x}$		2.209			1.963
	log s		0.517			0.782
	$\bar{x}$		161.828			91.833
	s		3.289			6.053
3		5	51	6	10	28
			4			30
			910			40
			40			
	log $\bar{x}$		1.718			1.509
	log s		0.966			0.082
	$\bar{x}$		52.201			32.285
	s		9.247			1.208
4		28	100	6	6	50
			2			10
			28			1
			28			
	log $\bar{x}$		1.299			0.900
	log s		0.714			0.854
	$\bar{x}$		19.907			7.943
	s		5.176			7.145
5		3	4	2	7	4
			6			3
			10			10
			6			
	log $\bar{x}$		0.790			0.693
	log s		0.365			0.273
	$\bar{x}$		6.166			4.932
	s		2.317			1.876
6		5	10	47	11	0
			1			1
			1			1
			1			
	log $\bar{x}$		0.250			
	log s		0.500			
	$\bar{x}$		1.778			
	s		3.162			
7		2	1	0	2	2
			0			0
			0			4
			6			
	log $\bar{x}$		0.195			0.301
	log s		0.389			0.301
	$\bar{x}$		1.565			1.999
	s		2.449			1.999

Table: 2 Relative frequencies (%) of the counts of faecal coliforms listed in accordance with interim criteria, i.e. less than 100 faecal coliforms/100 ml and more than 1000 faecal coliforms/100 ml

Stations depth/m	less than 100		more than 1000	
	All samples	Bathing season samples (1978)	All samples	Bathing season samples (1978)
1	81.8	80.0	0.0	0.0
2	77.8	80.0	9.1	20.0
3	81.8	80.0	9.1	20.0
4	80.0	80.0	0.0	0.0
5	45.4	40.0	36.4	20.0
6	100.0	100.0	0.0	0.0
7	90.9	100.0	0.0	0.0
8	33.3	20.0	33.3	60.0
9	63.6	80.0	0.0	0.0
10	100.0	100.0	0.0	0.0
11	100.0	100.0	0.0	0.0
12	90.9	100.0	0.0	0.0
13	100.0	100.0	0.0	0.0
14	100.0	100.0	0.0	0.0
15	100.0	100.0	0.0	0.0
16	100.0	100.0	0.0	0.0
17	72.7	100.0	0.0	0.0
18	100.0	100.0	0.0	0.0
19	90.0	80.0	0.0	0.0
20	100.0	100.0	0.0	0.0
21	100.0	100.0	0.0	0.0
22	50.0	20.0	0.0	0.0
23	90.9	100.0	0.0	0.0
24	n. d.	n. d.	n. d.	n. d.
25	100.0	100.0	0.0	0.0

Table: 3 The correlation between total coliforms and faecal coliforms (TC/FC) and between faecal coliforms and faecal streptococci (FC/FS)

Stations	Ratio TC/FC	Ratio FC/FS	Stations depth/m	Ratio TC/FC	Ratio FC/FS
1	1.58	0.94	I/0.5	4.67	0.82
2	3.58	1.44	I/20	6.00	0.67
3	0.66	14.55	II/0.5	1.14	5.14
4	2.27	1.10	II/15	5.64	0.17
5	1.73	2.79	III/0.5	2.25	0.93
6	n.d.	n.d.	III/18	1.50	0.86
7	5.34	0.26	IV/0.5	5.00	0.00
8	1.44	5.09	V/0.5	6.00	0.43
9	1.58	2.63	V/20	8.00	0.00
10	2.09	0.60	VI/0.5	2.71	0.37
11	4.26	1.15	VI/15	2.88	0.59
12	2.40	1.46	VII/0.5	35.64	0.33
13	7.59	1.98	R/0.5	5.89	2.73
14	4.83	3.00	D/0.5	1.64	2.71
15	1.38	1.25	D1/0.5	3.65	0.33
16	2.76	0.40	A/0.5	2.44	2.36
17	2.55	0.10	A1/0.5	1.91	2.62
18	0.90	1.41	A2/0.5	1.97	1.59
19	1.49	1.80	A2/5	1.66	1.46
20	2.60	1.61	A3/0.5	2.70	1.25
21	1.69	1.42	A3/10	2.61	3.24
22	2.63	2.44	C/0.5	1.38	2.62
23	1.54	0.37	C/10	4.00	0.21
24	n.d.	n.d.	C/20	2.63	3.97
25	1.50	1.85	E/0.5	2.03	0.90
26	5.46	4.16	E/10	2.27	2.88
27	8.39	1.64	F/0.5	7.39	2.90

Table 1.b: Individual location tabulation of results (E. coli/100 ml) - SPLIT area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1			6	38		40
			80	0		0
			0	130		26
				14		
	log $\bar{x}$		0.894	1.210		1.007
	log s		0.957	0.899		0.876
	$\bar{x}$		7.830	16.217		10.132
	s		9.053	7.916		7.515
2			64	780		5
			820	20		10
			33	290		104
				332		
	log $\bar{x}$		2.080	2.294		1.239
	log s		0.938	0.698		0.691
	$\bar{x}$		120.089	196.863		17.325
	s		8.672	4.885		4.905
3			6	74		10
			380	10		18
			10	38		2
				2		
	log $\bar{x}$		1.453	1.188		0.852
	log s		0.982	0.693		0.494
	$\bar{x}$		28.355	15.340		7.114
	s		9.603	4.927		3.119
4			2	5		2
			48	26		11
			13	54		0
				31		
	log $\bar{x}$		1.032	1.334		0.447
	log s		0.679	0.445		0.536
	$\bar{x}$		10.766	21.599		2.802
	s		4.772	2.784		3.435
5			6	4		20
			9	23		7
			10	32		0
				238		
	log $\bar{x}$		0.911	1.461		0.715
	log s		0.117	0.728		0.660
	$\bar{x}$		8.143	28.932		5.192
	s		1.310	5.340		4.572
6		33	4	20	45	22
			4			2
			64			1
						6
	log $\bar{x}$		1.003			0.605
	log s		0.695			0.465
	$\bar{x}$		10.079			4.031
	s		4.957			2.919
7		67	9	52	22	40
			5			21
			6			22
						10
	log $\bar{x}$		0.810			1.317
	log s		0.131			0.247
	$\bar{x}$		6.463			20.734
	s		1.351			1.764

Table 1.c: Individual location tabulation of results (E. coli:100 ml) - STON area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1		20	13	18	0	0
		2		2		
				4		
				0		
				0		
	log $\bar{x}$	0.801		0.432		
	log s	0.707		0.524		
	$\bar{x}$	6.325		2.702		
	s	5.095		3.340		
2		0	0	1	0	0
		0		0		
				0		
				0		
				1		
3		0	0	0	6	1
		0		0		
				0		
				1		
				2		
	log $\bar{x}$			0.060		
	log s			0.135		
	$\bar{x}$			1.149		
	s			1.363		
4		0	0	5	1	0
		0		0		
				0		
				0		
				0		
	log $\bar{x}$			0.140		
	log s			0.313		
	$\bar{x}$			1.380		
	s			2.054		
5		0	0	2	9	0
		0		0		
				0		
				0		
				0		
	log $\bar{x}$			0.060		
	log s			0.135		
	$\bar{x}$			1.149		
	s			1.363		

Table 1.d: Individual location tabulation of results (E. coli/100 ml) - DUBROVNIK area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1	 log x̄ log s x̄ s	0 0	0 2 14 7 0.573 0.518 3.742 3.296	10	2	2 48 0.991 0.976 9.798 9.461
2	 log x̄ log s x̄ s	88 36 1.750 0.274 36.285 1.881	5 30 18 37 1.250 0.390 17.778 2.455	108	55	6 450 1.716 1.356 51.962 21.177
3	 log x̄ log s x̄ s	2 3 0.389 0.125 2.449 1.332	0 0 2 1 0.075 0.151 1.189 1.415	13	2	2 1 0.151 0.213 1.414 1.633
4	 log x̄ log s x̄ s	1 15 0.588 0.832 3.873 6.786	2 14 0 2 0.437 0.494 2.736 3.116	100	2	40 1 0.801 1.133 6.325 13.578
5	 log x̄ log s x̄ s	1 39 0.796 1.125 6.245 13.337	6 66 60 1 1.094 0.874 12.415 7.480	146	14	250 22 1.870 0.746 74.162 5.577
6	 log x̄ log s x̄ s	0 14 0.573 0.810 3.742 6.463	0 30 5 1 0.544 0.704 3.500 5.056	116	48	7 7 0.845 0.000 7.000 0.000

Table 2.a: Mean values and standard deviations (MF/100 ml) for E. coli - ZADAR area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1	$\bar{x}$ s	1.414 1.633	1.442 1.886	2.571 5.133		3.317 5.450
2	$\bar{x}$ s		161.828 3.289			91.833 6.053
3	$\bar{x}$ s		52.201 9.247			32.285 1.208
4	$\bar{x}$ s		19.907 5.176			7.943 7.145
5	$\bar{x}$ s		6.166 2.317			4.932 1.876
6	$\bar{x}$ s		1.778 3.162			
7	$\bar{x}$ s		1.565 2.449			1.999 1.999

Table 2.b: Mean values and standard deviations (MF/100 ml) for E. coli - SPLIT area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1	$\bar{x}$ s		7.830 9.053	16.217 7.916		10.132 7.515
2	$\bar{x}$ s		120.089 8.672	196.863 4.885		17.325 4.905
3	$\bar{x}$ s		28.355 9.603	15.340 4.927		7.114 3.119
4	$\bar{x}$ s		10.766 4.772	21.599 2.784		2.802 3.435
5	$\bar{x}$ s		8.143 1.310	28.932 5.340		5.192 4.572
6	$\bar{x}$ s		10.079 4.957			4.031 2.919
7	$\bar{x}$ s		6.463 1.351			20.734 1.764

Table 2.c: Mean values and standard deviations (MF/100 ml) for E. coli - STON area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1	x̄ s	6.325 5.095		2.702 3.340		
2						
3	x̄ s			1.149 1.363		
4	x̄ s			1.380 2.054		
5	x̄ s			1.149 1.363		

Table 2.d: Mean values and standard deviations (MF/100 ml) for E. coli - DUBROVNIK area

Station		Wind direction in degrees				
		0-90	90-180	180-270	270-360	no wind
1	x̄ s		3.742 3.296			9.798 9.461
2	x̄ s	36.285 1.881	17.778 2.455			51.962 21.177
3	x̄ s	2.449 1.332	1.189 1.415			1.414 1.633
4	x̄ s	3.873 6.786	2.736 3.116			6.325 13.578
5	x̄ s	6.245 13.337	12.415 7.480			74.162 5.577
6	x̄ s	3.742 6.463	3.500 5.056			7.000 0.000

MED POL VIII : BIOGEOCHEMICAL STUDIES OF SELECTED POLLUTANTS IN THE OPEN WATERS OF THE MEDITERRANEAN (IAEA/IOC/UNEP)

MED POL VIII : ETUDES BIOGEOCHIMIQUES DE CERTAINS POLLUANTS AU LARGE DE COTES DE LA MEDITERRANEE (AIEA/COI /PNUE)

Centre de Recherche participant: Centre des Faibles Radioactivités
Laboratoire mixte CNRS-CEA
GIF-SUR-YVETTE
France

Chercheur principal: R. CHESSELET

Introduction

Les études ici présentées sur le contenu en métaux des aérosols et des particules en suspension ont été entreprises pour déterminer le rôle de la matière particulaire dans le transport des métaux vers les océans et à l'intérieur de ces eaux. Ces études sont complémentaires au travail exécuté par le Laboratoire AIEA à Monaco, dont le compte rendu se trouve dans une autre partie de ce rapport.

Zones étudiées

A. Zone comprise entre Nice (France) et Calvi - Carte des stations pour l'étude des particules marines - (carte 1).

B. Zone d'étude de la chimie des aérosols marins.
Carte no. 2.

Methodologie*

Etude des particules marines.

L'eau de mer, prélevée à différentes profondeurs à l'aide de bouteilles Niskin PVC (30 l) est filtrée sur des membranes nuclépores de porosité 0,4 um, qui collectent plus de 95% de la matière en suspension. Al, Fe, Cu, Pb, Zn, Cd, As sont dosés par spectrométrie d'absorption atomique sans flammer par voie électro- thermique.

Etude des prélèvements atmosphériques

Les aérosols marins sont collectés par filtration d'air sur papier filtre Whatman de diamètre 7 cm. Ce type de filtre est choisi en raison de sa grande efficacité de filtration (> 99%) et de sa faible teneur en impureté chimique. La méthode d'analyse est la même que celle utilisée pour les particules marines.

Méthodologie analytique

Le dosage des métaux (Cu, Pb, Zn, Fe, Al, Cd, As) nécessite une solubilisation préalable des particules recueillies sur filtre par une attaque dite "à la bombe". Ensuite les métaux, en raison de leur très faible concentration sont dosés par une méthode de très haute sensibilité

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* Les méthods de prélèvement et d'analyse sont les mêmes que celles utilisées dans l'Atlantique, en prenant des précautions extremes contre les contaminations accidentelles (Annexe 1).

et qui autorise le micro-échantillonnage : il s'agit de la spectrométrie d'absorption atomique par voie électro-thermique. Au tableau 1 sont présentées des caractéristiques essentielles de cette méthode analytique appliquée au dosage du Cu, Pb, Cd, As, Zn, Fe, Al, dans les particules en suspension dans l'océan.

Afin de s'assurer de la fiabilité de nos dosages, de nombreux contrôles de la justesse ont été effectués à l'aide de standards de référence du N.B.S., de la méthode des ajouts dosés et par une autre méthode lorsque cela était possible (activation neutronique pour Al, Fe, Zn, As, dilution isotopique pour Pb, méthode des hydrures pour As).

Resultats et interpretation

Chimie des particules marines

Les concentrations des éléments Al, Fe, Cn, Pb, Zn, Cd, As sont données aux tableaux

Discussion

Les concentrations de Matière Totale Particulaire collectée sont d'environ 10 ug/l, elles sont très voisines des concentrations de matière totale en suspension que nous observons dans l'Atlantique et le Pacifique.

Les concentrations de Al, élément qui peut être considéré comme indicateur des concentrations des alumino-silicates (1-2-3-4-6) sont du même ordre de grandeur quelle que soit la station (Al = 100 ng/l). Cette concentration est très proche de la concentration d'Al mesurée sur l'ensemble des prélèvements GEOSECS dans l'Atlantique et le Pacifique. Il a été montré que pour ces deux océans les concentrations en Al sont en partie gouvernées par un flux atmosphérique d'origine continentale.

Bien que l'on observe un certain gradient des concentrations moyennes pour les métaux trace étudiés entre la station proche de la côte du Sud de la France (Station 1) et la Station 3, les valeurs moyennes des concentrations de ces éléments sont très voisines des concentrations moyennes de ces éléments à l'échelle de l'Atlantique et du Pacifique.

Un certain nombre d'échantillons ont été pris à des profondeurs quasiment identiques et d'autre part certains filtres proviennent d'échantillons provenant d'une même bouteille. Cette étude a été faite dans le but d'étudier la variabilité des concentrations.

La variabilité que nous constatons ici (tableaux 1-2-3) est d'un facteur 2.4 moyenne : variabilité qui est exactement semblable à celle observée sur 500 échantillons dans le programme C.F.R.-G E O S E C S.

Cette variabilité ne peut pas être prise comme une indication d'une contamination accidentelle ou d'une erreur d'analyse.

Quand on considere les moyennes observées pour chaque station et pour chacun des éléments (Al-Fe-Cu-Pb-Zn-Cd) on observe une diminution de la côte vers le large (de la station 1 vers la station 3).

Ce gradient suggère l'existence d'un effet lié à la proximité du talus continental. Cet effet se superposerait à l'apport atmosphérique et les résultats seront discutés dans la section suivante.

Les figures 1, 2, 3, 4 donnent les concentrations en fonction de la profondeur. On constate que la variabilité dont nous avons fait état au paragraphe 3 se retrouve à toutes les profondeurs et aux trois stations. D'autre part, on n'observe aucun accroissement ou diminution marqué avec la profondeur, ce qui suggère que nous nous trouvons en présence de particules marines appartenant au "bruit de fond" particulaire de l'océan. Cette donnée est en accord avec celle qui a été établie à l'échelle de l'océan au cours du programme GEOSECS. Il semble que pour le Pb, on observe à la station 1, dans les eaux de surface, une très grande concentration qui pourrait avoir pour origine l'influence de la pollution locale.

Discussion des Facteurs d'Enrichissement

Il est d'usage afin de permettre des comparaisons d'exprimer les concentrations en éléments-traces dans la matière particulaire, que ce soit sous forme de particules marines ou d'aérosols, sous forme de Facteurs d'Enrichissement.

Nous avons adopté ici le mode de calcul généralement admis :

Nous comparons les abondances relatives de ces éléments à leur abondance relative moyenne de la croûte terrestre, en prenant l'aluminium comme élément de référence. On obtient ainsi pour chaque élément un Facteur d'Enrichissement :

$$F_{E\,\text{croûte}} = \frac{(X/Al)_{\text{particule}}}{(X/Al)_{\text{croûte}}}$$

Les Facteurs d'Enrichissement en Fe, Cu, Pb, Cd, Zn ainsi calculés sont donnés dans les figures 5-6.

On constate que les F_E ainsi calculés sont trop élevés (> 10) pour que les concentrations des métaux en traces (Cu, Pb, As, Cd, Zn) puissent être expliquées par leurs abondances moyennes dans les particules d'origine détritique continentale.

Dans les figures 5-6 on a fait figurer les valeurs moyennes de l'enrichissement dans les particules de l'Atlantique Nord (4-2).

La comparaison qui est alors possible montre que les F_E sont très proches de ceux observés pour l'Atlantique (7). Pour des raisons de commodité sur les figures 5-6 n'ont pas été figurées les fourchettes des F_E observés dans l'Atlantique. Il n'en demeure pas moins que pour le Fe, le Cu et le Pb ces Enrichissements ont tendance à être supérieurs en Méditerranée dans la région étudiée, à ceux observés dans l'Atlantique.

Discussion de l'origine de l'enrichissement

Etant admis qu'il a été démontré à l'échelle de l'Atlantique que l'apport atmosphérique exerce un certain contrôle sur la chimie des particules marines, on peut tenter de calculer de la même façon que l'on a opéré dans l'Atlantique le flux des particules en suspension dans l'étude présentée ici et comparer les valeurs de ces flux à ceux qui ont été présentés pour l'Atlantique Nord. Cette comparaison figure au tableau 5. Pour calculer ces flux on a utilisé une vitesse de chute des particules de 80 m/an, fondée sur la distribution des tailles des particules observées dans l'Atlantique, à partir de comparaisons de mesures effectuées au Coulter-Counter entre la Méditerranée et l'Atlantique. Il semble qu'il n'y ait pas de différence dans les distributions de taille entre les particules de Méditerranée et d'Atlantique. On peut donc considérer cette vitesse de chute comme valable pour le site de la Méditerranée. Il nous parait significatif à l'examen du tableau 5 que les flux calculés en Méditerranée au cours de cette étude soient 2-3 fois supérieurs à ceux de l'Atlantique Nord alors que le flux d'Al est pratiquement identique.

Cette valeur du flux des éléments-traces comprenant la famille des métaux lourds en Méditerranée peut être considérée comme une première indication de l'influence de la pollution sur la chimie des particules marines. Il faut cependant rappeler ici que nous avons pu montrer que les flux d'origine volcanique pouvaient entrer en compétition avec les flux anthropogéniques (5). La deuxième partie de l'étude portant sur la chimie de l'aérosol marin devrait permettre de répondre à la question soulevée dans la première partie de cette étude.

Une étude limitée de la chimie des particules en Méditerranée démontre l'existence d'anomalies (enrichissements) dans la chimie des métaux Cu, Pb, Cd, Zn et peut-être Fe, associés à la matière particulaire en suspension. Cependant les concentrations et les Enrichissements observées sont du même ordre de grandeur que ceux qui ont été observés à grande échelle dans l'Atlantique et le Pacifique, il semble donce que la chimie des métaux en traces dans la Méditerranée obéisse à des lois identique à celles qui régissent leur chimie à l'échelle de l'océan global.

	Al	Fe	Cu	Pb	Zn	Cd	As
Detection limit	$5\ 10^{-10}$ g	$5\ 10^{-11}$ g	$5\ 10^{-11}$ g	10^{-11} g	$5\ 10^{-12}$ g	10^{-11} g	10^{-10} g
Sensibility $\Delta C / \Delta A$	$3\ 10^{-10}$	$2\ 10^{-11}$	$2\ 10^{-11}$	$0{,}5\ 10^{-11}$	$2\ 10^{-12}$	$0{,}4\ 10^{-11}$	$0{,}5\ 10^{-10}$
Precision	10 %	10%	10 %	5 - 10 %	10 %	10 %	10 - 15 %

Table 1

STATION 1

Sample	DEPTH (m)	T.S.M. µg/1	Al ng/1	Fe ng/1	Cu ng/1	Pb ng/1	Zn ng/1	Cd ng/1
Ko 005	250	13,9	242	1097	<0,1	155,4	26,8	3,2
Ko 105	250	33,2	375	2125	8	106,8	27,4	1,3
Ko 003	300	6,4	103	262	<0,1	14,1	16,3	1,7
Ko 002	350	12,9	128	977	14,8	11,1	4,0	2,7
Ko 104	350	19,6	242	2011	63,4	31,7	23,4	1,6
Ko 008	910	20,9	275	1217	29,1	64,8	15,1	1,4
Ko 009	1660	5,4	70	337	8,2	10,8	13,1	1,3
Ko 010	1670	8,9	98	942	28,2	17,2	17,7	1,1
Ko 001	1680	18	54	2640	34,2	69,0	4,0	4,0
Ko 006	1680	9,5	43	1097	15,4	35,4	15,4	4
Geometric Mean		14,8	128	1029	20	34,5	13,7	2

TABLE 2

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STATION 3

Sample	DEPTH (m)	T.S.M. µg/l	Al ng/l	Fe ng/l	Cu ng/l	Pb ng/l
Ko 208	50	49	113	108	17,6	17,4
Ko 209	290	24,5	344	710	44,8	34,5
Ko 210	300	10,5	82	630	24,8	13,7
Ko 306	500	12,7	80	161	1,7	7,3
Ko 307	510	6,8	103	278	55,7	70,3
Ko 305	790	9,8	171	470	13	14,6
Ko 401	1080	5,5	80	170	1,7	4,6
Ko 308	1090	3	51	398	0,3	10,3
Ko 309	1100	9,6	57	478	22,3	8,2
Ko 310	1490	5	59	450	61	11,2
Ko 303	1500	7,1	74	158	3,4	7,5
Ko 302	1880	2,3	40	347	1,4	6,2
Ko 301	1890		26	172	13,4	3,5
Geometric Mean		12,1	79	248	8,4	11,2

TABLE 3

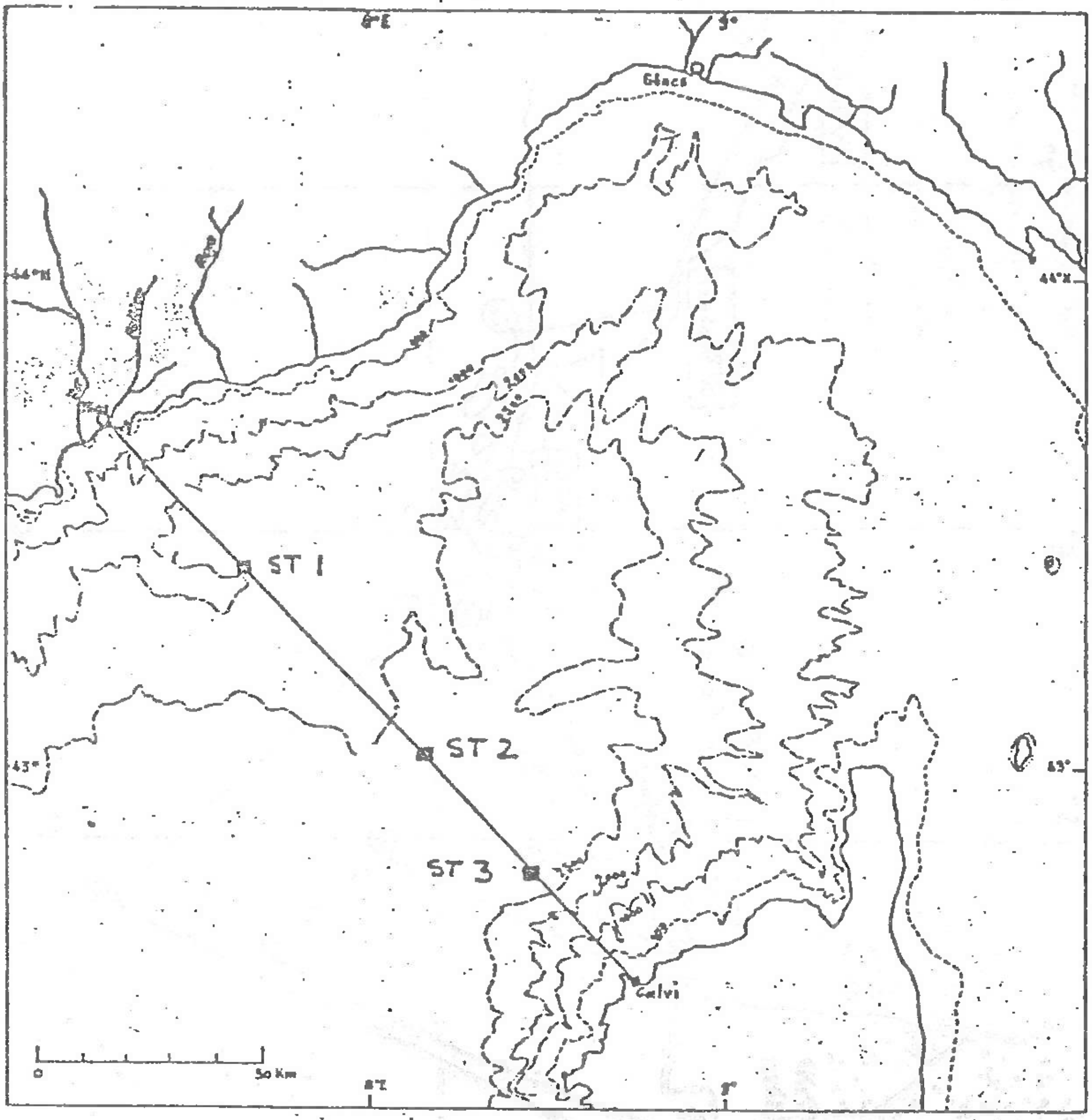
STATION 2

Sample	DEPTH (m)	T.S.M. µg/1	Al ng/1	Fe ng/1	Cu ng/1	Pb ng/1	Zn ng/1	Cd ng/1
Ko 109	50	46,5	86	172	<0,1	17,5		0,9
Ko 103	490	11,6	124	520	12,2	6,5	12,2	0,6
Ko 106	500	7,3	78	662	10,5	12,5	13,1	1,1
Ko 110	700	≤5	97	348	39	24,8		0,9
Ko 202	700	5	161	1020	40	48,5		0,9
Ko 102	880	10,9	150	348	0,9	16,1	15,1	0,3
Ko 101	980	9,3	107	148	12,2	5,1	13,1	0,6
Ko 108	1500	4,1	93	588	22,8	36,2	18,8	
Ko 207	2000	7,9	140	93	7,4	3,9		0,5
Ko 205	2370	≤3	120	498	26	30,5		0,7
Ko 204	2380	6,8	143	421	14	9,8		0,4
Ko 203	2390	3,9	54	441	15	11,9		0,6
Geometric Mean		11,2	107	364	13,1	14,2		0,6

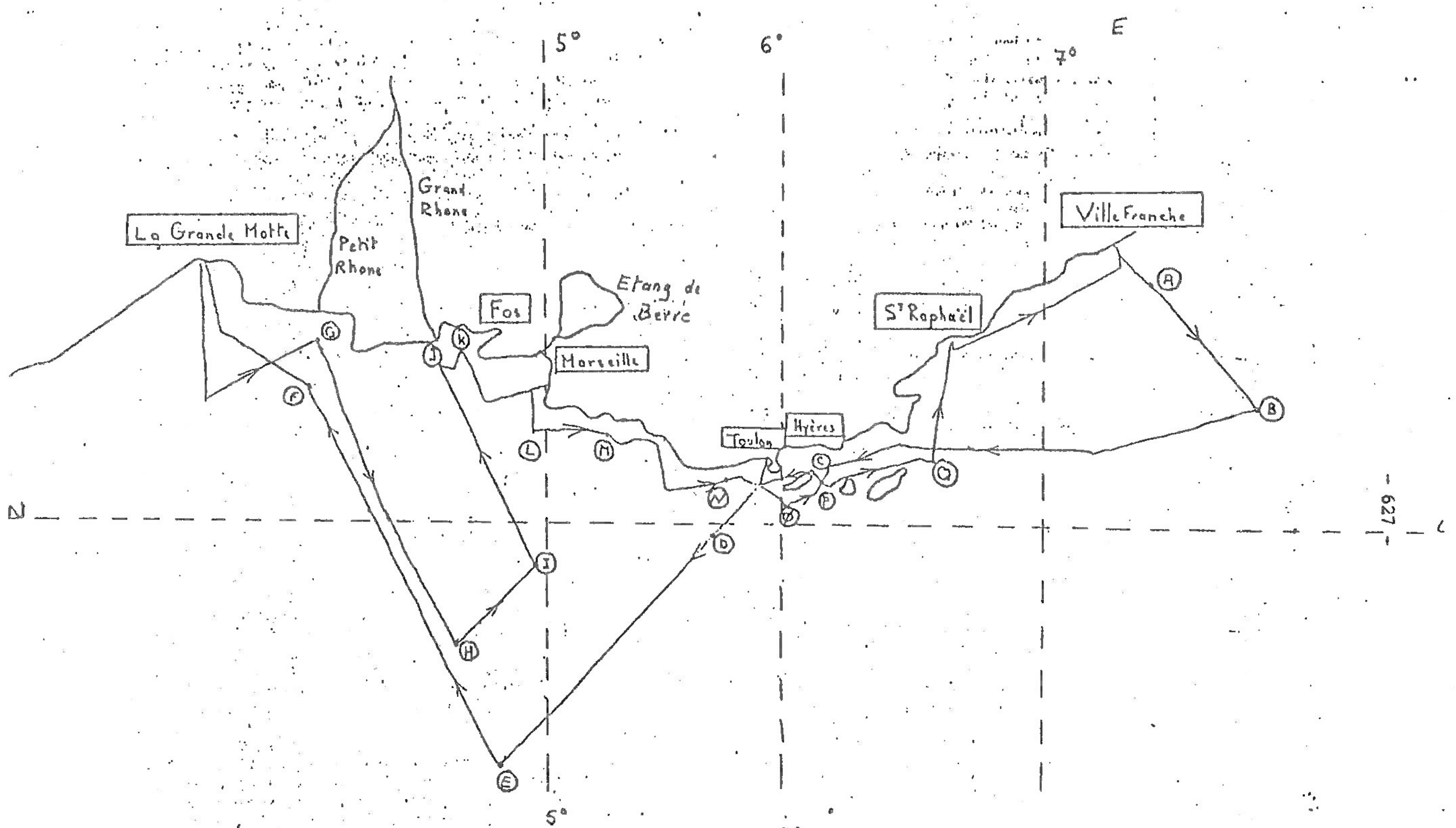
TABLE 4

Φ 10^{-4} g/m²/an	Al	Fe	Cu	Pb	Cd
MEDITERRANEAN this study	86	291	10	11	0.5
NORTH ATLANTIC (c.f.r - cnrs 1977)	90	160	2.4	7	0.1

Table 5



Carte 1


E
5°
6°
7°
La Grande Motte
Petit Rhone
Grand Rhone
Fos
Etang de Berre
Marseille
Toulon
Hyères
St Raphaël
Ville Franche
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
N

Carte n° 2

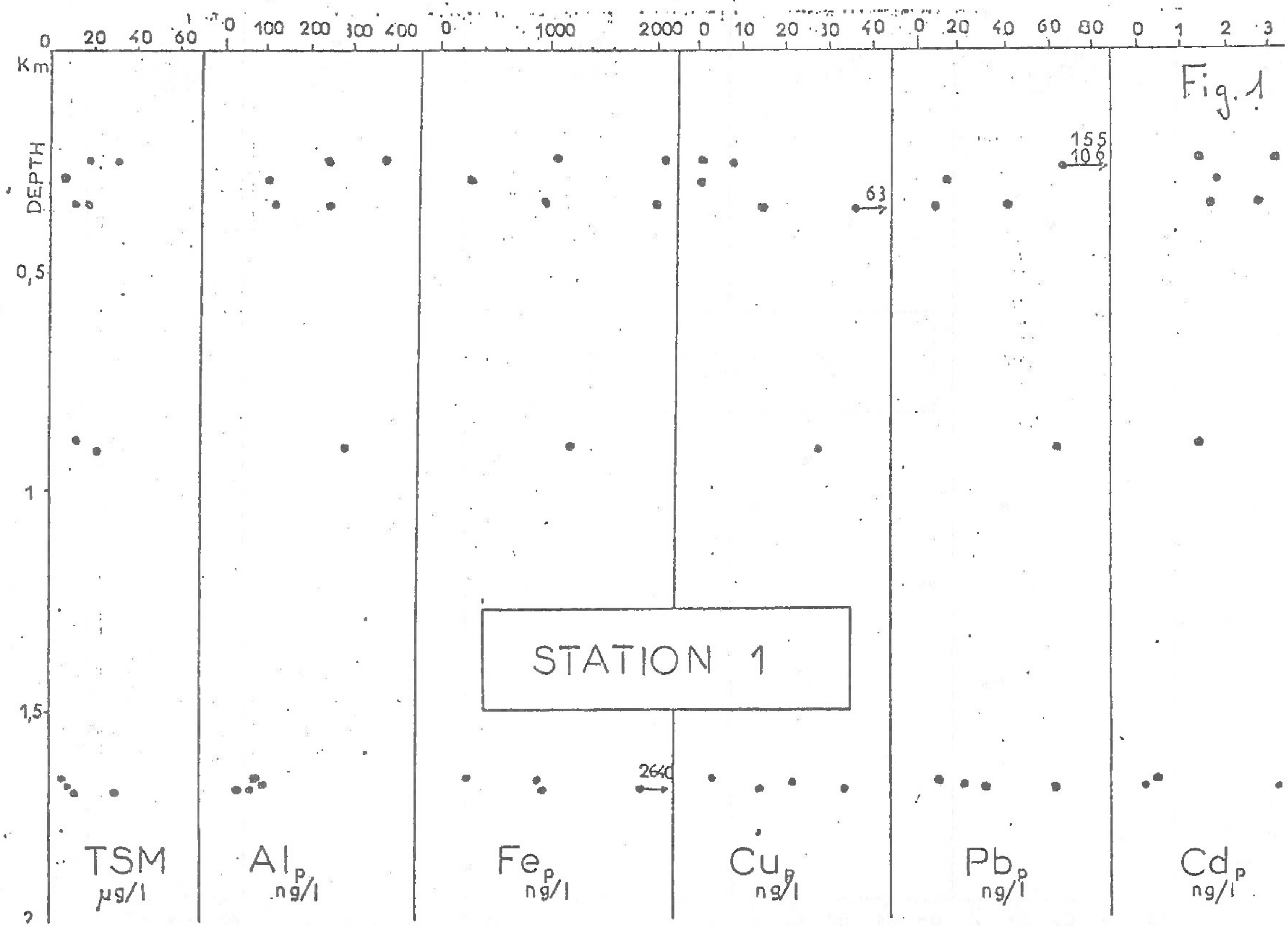


Fig. 1
STATION 1
Km
DEPTH
0,5
1
1,5
2
0 20 40 60
0 100 200 300 400
0 1000 2000
0 10 20 30 40
0 20 40 60 80
0 1 2 3
155
106
63
2640
TSM µg/l
Al p ng/l
Fe p ng/l
Cu p ng/l
Pb p ng/l
Cd p ng/l

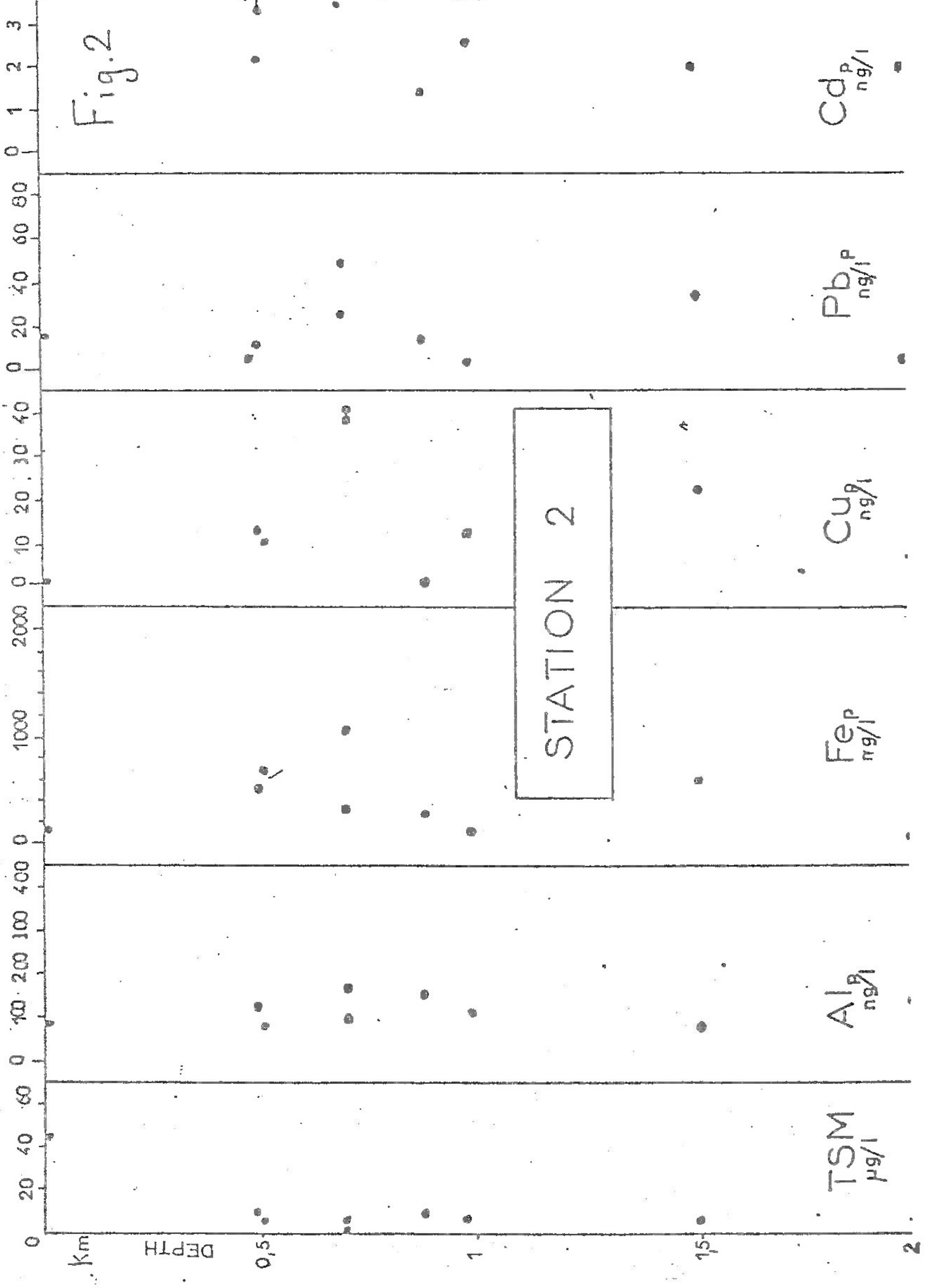


Fig.2
STATION 2
Cd P ng/l
Pb P ng/l
Cu P ng/l
Fe P ng/l
Al P ng/l
TSM µg/l
DEPTH
km
0,5
1
1,5
2

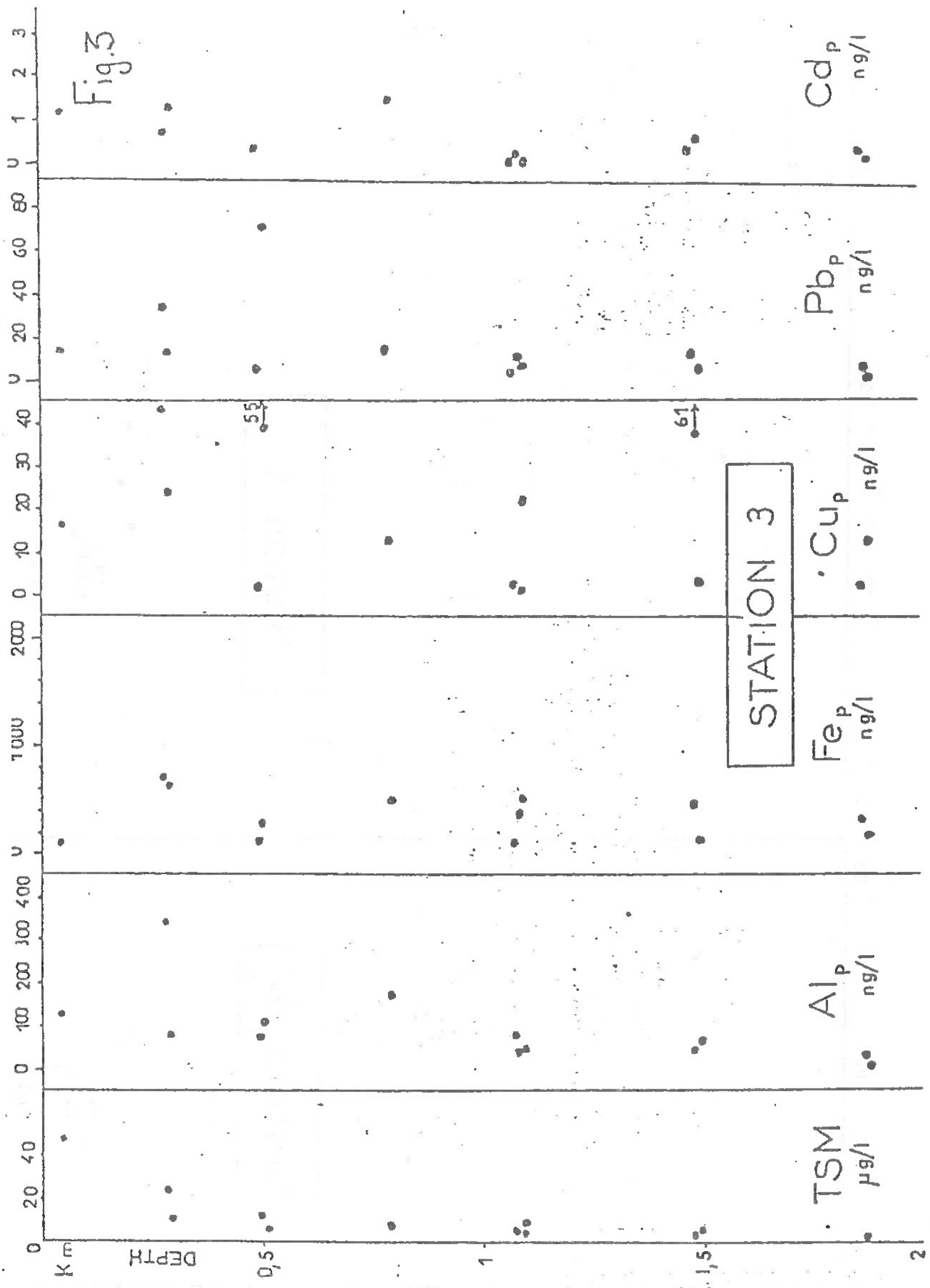


Fig.3
STATION 3
Cd p ng/l
Pb p ng/l
Cu p ng/l
Fe p ng/l
Al p ng/l
TSM µg/l
Km
DEPTH
0,5
1
1,5
2
55
61

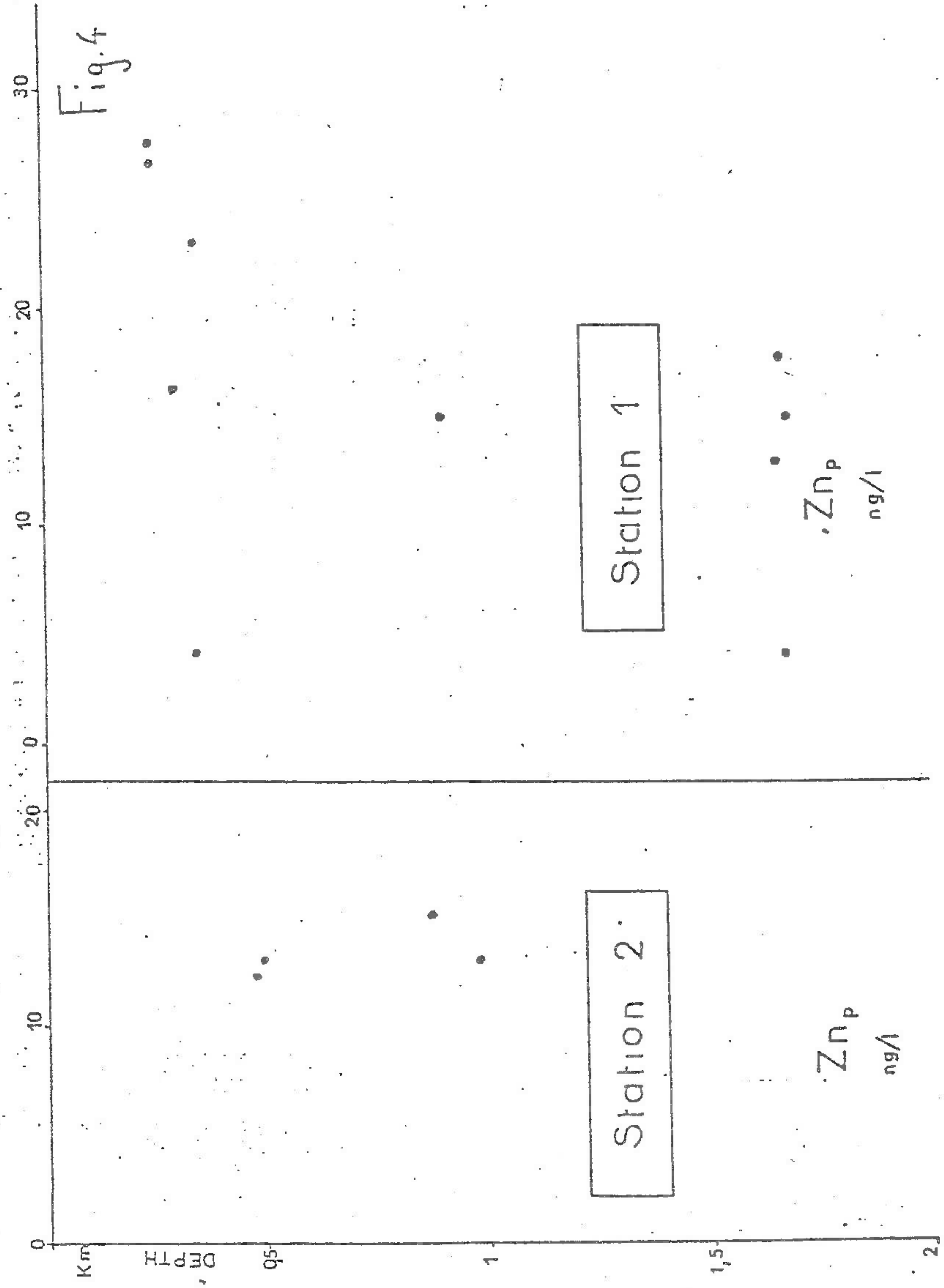

Station 1
Station 2
Zn_p
ng/l
Zn_p
ng/l
DEPTH
Km
0
0,5
1
1,5
2
0
10
20
30
0
10
20

Fig.4

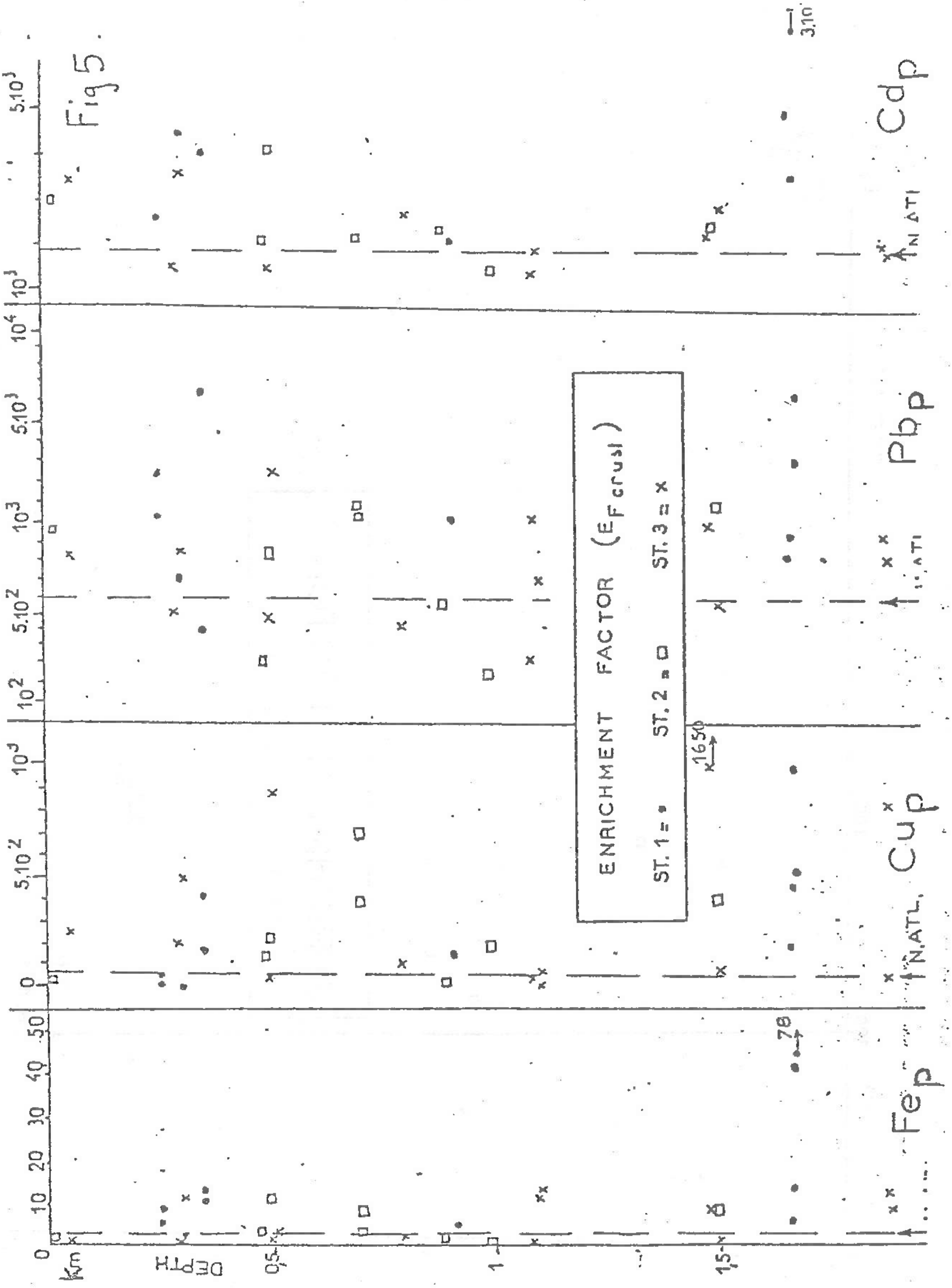


Fig 5
ENRICHMENT FACTOR (E F crust)
ST. 1 = •
ST. 2 = □
ST. 3 = x
Fe p
Cu p
Pb p
Cd p
DEPTH
Km
N.ATL.
1650
78

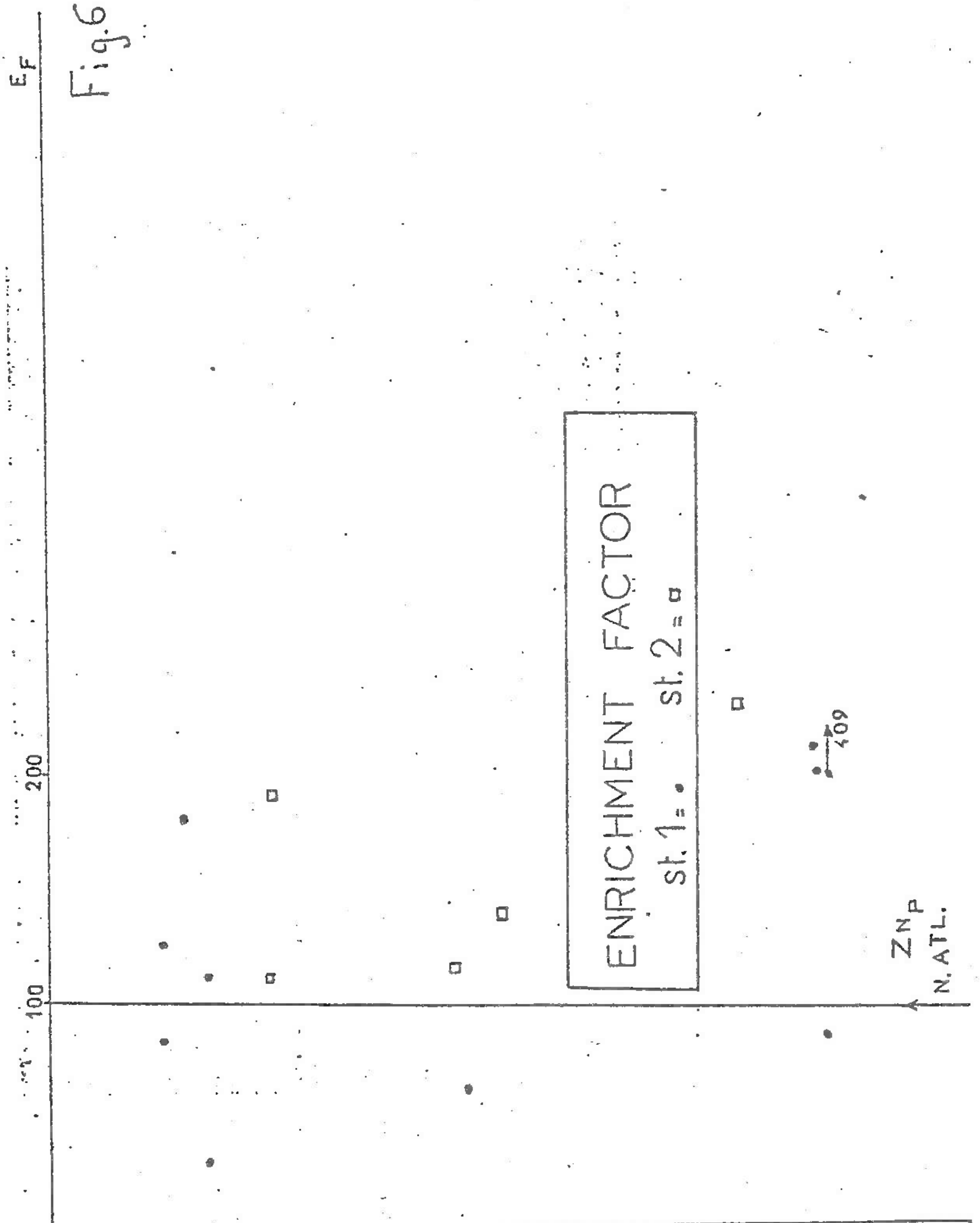

ENRICHMENT FACTOR
St. 1 = •   St. 2 = □
E_F
100
200
409
Zn_P
N. ATL.
DEPTH
Km
0
0,5
1
1,5
2

Fig.6

Participating Research Centre: Nuclear Research Center "Demokritos",
Department of Chemistry
Nuclear and Radiochemical Analysis Laboratory
ATHENS
Greece

Principal Investigator: C. PAPADOPOULOU

Introduction:

In our laboratory studies of trace elements in the marine environment have been initiated in 1963. Since then 20 papers have been published on this subject.

The project "Biogeochemical studies of selected pollutants in the open waters of the Mediterranean" had two aims:

(a) The determination of Vanadium, Arsenic and other trace elements which are potential pollutants in organisms of well defined foodchains in order to acquire information on present levels of these elements and their possible biomagnification through foodchains.

(b) The determination of trace elements in particulate products of zooplankton in order to estimate the role of pelagic organisms in vertical transport of these elements.

Area(s) studied:

Scomber japonicus colias specimens were collected from the area South of Andros island on 30 August 1977. Specimens of Trachurus mediterraneus were collected South of Karystos, Evia island, on 22 August 1977 and Skiathos Island on 28 September 1977. Plankton samples were also collected from Skiathos Island simultaneously with the Trachurus m. specimens (see attached map).

All three areas are typically oligotrophic areas of the Aegean Sea with salinities ranging from about 37.4 / to 39.2 / and temperatures from about 14.2°C to 25.6°C.

In order to compare the levels of trace elements in marine organisms, sampling was performed in two areas: the Aegean Sea, a relative unproductive region of the Mediterranean and the more productive western Mediterranean.

Our laboratory has collaborated in this project with the International Laboratory of Marine Radioactivity in:

(a) Analyzing samples from the western Mediterranean. The following determinations have been performed: for Zn, Co, Cs, Se, Rb, 38 samples; for As 28; for V 44; for Ag 20; for Sc and Sb 11; for Cr 4 and for Fe 3. Dr. C. Papadopoulou and D. Zafiropoulos have also participated in the "Hayes" cruise from Piraeus to Corsica (June 1977).

(b) Sampling and analyzing plankton and fish from the Aegean Sea. The pelagic foodchain: plankton collected with nets of different mesh size, and the pelagic fish Trachurus mediterraneus as well as Scomber japonicus colias were sampled and determination of As, V, Se, Co, Cs, Zn and Rb was performed.

Material and methods:

Neutron Activation Analysis was used for the determination of all trace elements studied.

Results and their interpretation:

Arsenic and Vanadium concentrations in the flesh and liver of Trachurus m. are shown in table 1. Arsenic values in the flesh of Trachurus m. ranged from 3.9 to 9.2 ug/g whereas a composite liver sample was found to have 14.1 ug/g. There is a considerable variation (standard deviation 30 per cent) of As concentrations due to individual differences between specimens. Arsenic concentrations are higher in fish collected from Skiathos Island (74 ug/g) than in fish collected from Karystos (3.5 ug/g).

Vanadium concentrations in the flesh of Trachurus m. ranged from 0.071 to 0.15 ug/g. Individual variation is also considerable (28 per cent S.D.). Coccentrations of As and V in the flesh and liver of Scomber j.c. are shown in table 2. Mean As values are 8 and 15 ug/g in the flesh and liver of Scomber j.c. respectively. Individual variation is somewhat lower (25 per cent S.D.).

Vanadium mean values are 0.014 and 0.024 ug/g in the flesh and liver of Scomber j.c. respectively. Individual variation is quite high (47 per cent S.D.). Cocnentrations of Zinc, Co, Se, Cs and Rb in the flesh and liver of Trachurus m. are shown in table 3. Mean values for the flesh of Skiathos specimens are: Zn 19 ug/g, Co 0.030 ug/g, Se 2.9 ug/g, Cs 0.067 ug/g and Rb 0.032 ug/g. For Karystos specimens mean values are: Zn 29 ug/g, Co 0.027 ug/g, Se 2.1 ug/g, Cs 0.027 ug/g and Rb 0.024 ug/g.

Zn and Co concentrations show a quite high individual variation (50 per cent S.D.) whereas Se, Cs and Rb show somewhat lower individual variation (25 per cent, 20 per cent and 16 per cent respectively).

Specimens caught from Karystos have similar concentrations of Co and Se, slightly higher concentrations of Zn and lower concentrations of Cs and Rb.

Table 4 shows concentrations of Zn, Co, Se, Cs and Rb in the flesh of Scomber j.c. Mean values are: ZN 24 ug/g, Co 0.027 ug/g, Se 3.0 ug/g, Cs 0.041 ug/g and Rb 0.23 ug/g. Individual variation for Zn and Co is 25 per cent S.D., for Se 27 per cent, Cs 12 per cent and Rb 35 per cent S.D.

Concentrations of As, Zn, Co, Se, Cs and Rb in the flesh of Scomber j.c. compare very well with those in Trachurus m. whereas V values for Trachurus m. are one order of magnitude higher than those of Scomber j.c.

Se and Cs concentrations in the liver of Scomber j.c. are comparable to those found in the liver of Trachurus m. whereas Zn and Co values are two times higher in Trachurus m. (table 5).

Rb values are higher for the liver of Trachurus m. than for liver of Scomber j.c. (mean of 3 specimens 0.19 ug/g).

As, Zn, Co and Se accumulates preferably in the liver of both fish species. Cs and Rb concentrations are about the same in flesh and liver.

Concentrations of As, Zn, Co, Se, Cs, Rb and V in plankton and Trachurus m. are shown in table 6.

Assuming that the plankton samples of different sizes and Trachurus m. represent different levels of a foodchain, no trend of "foodchain magnification" can be observed.

As, Zn, Cs and V concentrations decrease in higher food level, whereas Se concentrations are constant and Co shows no trend at all.

Conclusions:

Arsenic concentrations found in Scomber j.c. and Trachurus m. are in relatively good agreement with those reported in Pagellus Erythrinus, Gobius niger and Sargus annularis from both polluted and non-polluted waters of the Aegean Sea.

Zn, Co, Se and Cs concentrations in the flesh and liver of the two fish studied are also in good agreement. Comparing values found in this study with values obtained from previous work of our Laboratory for Pagellus erythrinus, Sargus annularis, Gobius niger and Mullus barbatus, and taking into consideration the differences in ecology and feeding habits wer can observe that differences in concentrations are relatively small.

Single specimen analysis is indispensable in trace element analysis of fish for a statistical treatment of results. Variations between specimens of the same species from the same station were found to range from 8 up to 50 per cent (standard deviation of the mean).

The absence of "foodchain magnification" is not surprising. In fact Zn shows a decrease of one order to magnitude and V an increase of two orders of magnitude with increasing food level. The hypothesis of foodchain magnification is based on the theory of foodchain. It is clear that defining a pelagic foodchain is very complex and difficult. Stomach analysis of the Trachurus m. specimens caught from Skiathos Island showed that their food consisted of gastripod, decapod and ostracod larvae and copepods. The presence of fish scales also indicated that Trachurus m. were also feeding on small clupeids.

To the best of our knowledge data concerning V concentrations in fish from the Aegean Sea were non-existent up to now. There is a need of a more extensive study of V levels in various fish species, and from different sea areas.

TABLE 1

Arsenic and Vanadium concentrations in *Trachurus mediterraneus* (ug/g, dry)

SAMPLE	As(1)	V(2)
Skiathos Island (flesh)		
1	4.0	0.11 ±0.01
2	8.7	0.083±0.008
3	6.0	0.15 ±0.01
4	9.2	0.071±0.009
5	9.2	0.069±0.008
7	5.0	0.074±0.007
10	7.3	0.120±0.009
13	6.7	0.089±0.008
14	8.1	0.086±0.007
Mean	7±2	0.095±0.027
Liver	14.1(3)	-
Karystos		
1	3.9	-
2	3.1	-
3	3.6	-
Mean	3.5±0.4	-

(1) Analytical standard deviations for As are up to 10 per cent
(2) ± Overall standard error of the counting technique
(3) Composite from 14 specimens

TABLE 2

Arsenic and Vanadium concentrations in *Scomber japonicus colias* from Andros island (ug/g dry)

	As(1)		V(2)	
SAMPLE	Flesh	Liver	Flesh	Liver
5	4.4	15.1	-	-
6	6.4	14.3	<0.01	-
7	11.4	25.5	<0.007	-
8	6.8	14.3	0.014±0.006	-
9	-	-	0.011±0.006	-
24	9.2	15.0	0.018±0.005	0.020±0.002
26	-	-	0.013±0.005	-
27	9.6	13.5	-	-
28	8.8	13.6	<0.007	-
29	7.3	9.7	<0.008	-
30	9.7	13.2	-	0.028±0.008
Mean	8±2	15.±4	0.014±0.003	0.024

(1) Analytical standard deviations for As are up to 10 per cent
(2) ± Overall standard error of the counting technique

TABLE 3

Trace element concentrations in Trachurus mediterraneus (ug/g dry± standard deviation)

SAMPLE	Zn	Co	Se	Cs	Rb
Skiathos (flesh)					
1	20±0.8	0.030±0.003	1.8±0.1	0.066±0.066	0.35±0.07
2	25±0.9	0.026±0.002	4.2±0.2	0.077±0.005	0.28±0.05
3	27±1.0	0.042±0.003	2.2±0.1	0.019±0.005	0.34±0.06
4	42±1.5	0.037±0.003	3.8±0.2	0.073±0.006	0.25±0.06
5	22±0.8	0.019±0.002	2.8±0.1	0.081±0.005	0.29±0.04
6	23±0.9	0.020±0.002	3.5±0.2	0.086±0.006	0.37±0.05
7	20±0.7	0.022±0.002	2.6±0.1	0.066±0.004	0.33±0.04
8	9±1.5	0.024±0.002	2.7±0.1	0.060±0.004	0.26±0.03
9	5±1.4	0.031±0.002	3.1±0.1	0.069±0.004	0.38±0.04
10	10±1.7	0.028±0.002	2.5±0.1	0.071±0.004	0.26±0.03
11	11±2.0	0.024±0.002	2.0±0.1	0.057±0.004	0.32±0.04
12	14±2.1	0.056±0.003	2.5±0.1	0.066±0.004	0.40±0.05
13	20±2.1	0.069±0.003	3.3±0.1	0.061±0.004	0.35±0.04
14	16±2.0	0.040±0.002	2.4±0.1	0.042±0.003	0.35±0.03
Mean	19±9	0.030±0.014	2.9±0.7	0.067±0.012	0.39±0.05
Liver	154±5.0	0.75±0.03	35±1.3	0.048±0.003	0.38±0.08
Karystos (flesh)					
2	22±1.6	0.030±0.009	2.7±0.1	0.035±0.003	-
3	31±1.0	0.020±0.001	1.5±0.1	0.021±0.001	0.19±0.02
4	34±1.2	0.030±0.002	2.1±0.1	0.024±0.002	0.28±0.02
Mean	29±6	0.027±0.006	2.1±0.6	0.027±0.007	0.94±0.06

TABLE 4

Trace elements in the flesh of *Scober japonicus colias* from Andros (ug/g, dry± standard deviation)

SAMPLE	Zn	Co	Se	Cs	Rb
5	11±0.6	0.014±0.002	2.2±0.1	0.037±0.003	0.25±0.04
6	28±1.2	0.024±0.003	2.8±0.1	0.045±0.004	0.18±0.05
7	23±1.0	0.024±0.002	2.5±0.1	0.051±0.003	0.28±0.04
8	25±1.0	0.034±0.003	2.4±0.1	0.046±0.003	0.26±0.04
9	21±1.0	0.027±0.003	2.3±0.1	0.035±0.003	0.26±0.05
10	20±0.9	0.032±0.003	3.1±0.1	0.041±0.004	0.26±0.05
24	39±1.6	0.022±0.003	2.1±0.1	0.036±0.004	0.25±0.05
26	22±1.1	0.035±0.004	4.2±1.0	0.036±0.003	-
27	20±1.0	0.034±0.004	4.3±1.0	0.039±0.003	0.16±0.06
28	26±1.3	0.018±0.003	3.1±0.7	0.039±0.003	0.10±0.05
29	25±1.2	0.027±0.003	3.7±0.9	0.046±0.003	0.22±0.06
30	26±1.3	0.027±0.003	3.8±0.9	0.041±0.002	0.31±0.06
Mean	24±6	0.027±0.007	3.0±0.8	0.041±0.005	0.23±0.08

TABLE 5

Trace element concentrations in the liver of *Scober japonicus colias* from Andros (ug/g, dry± standard deviation)

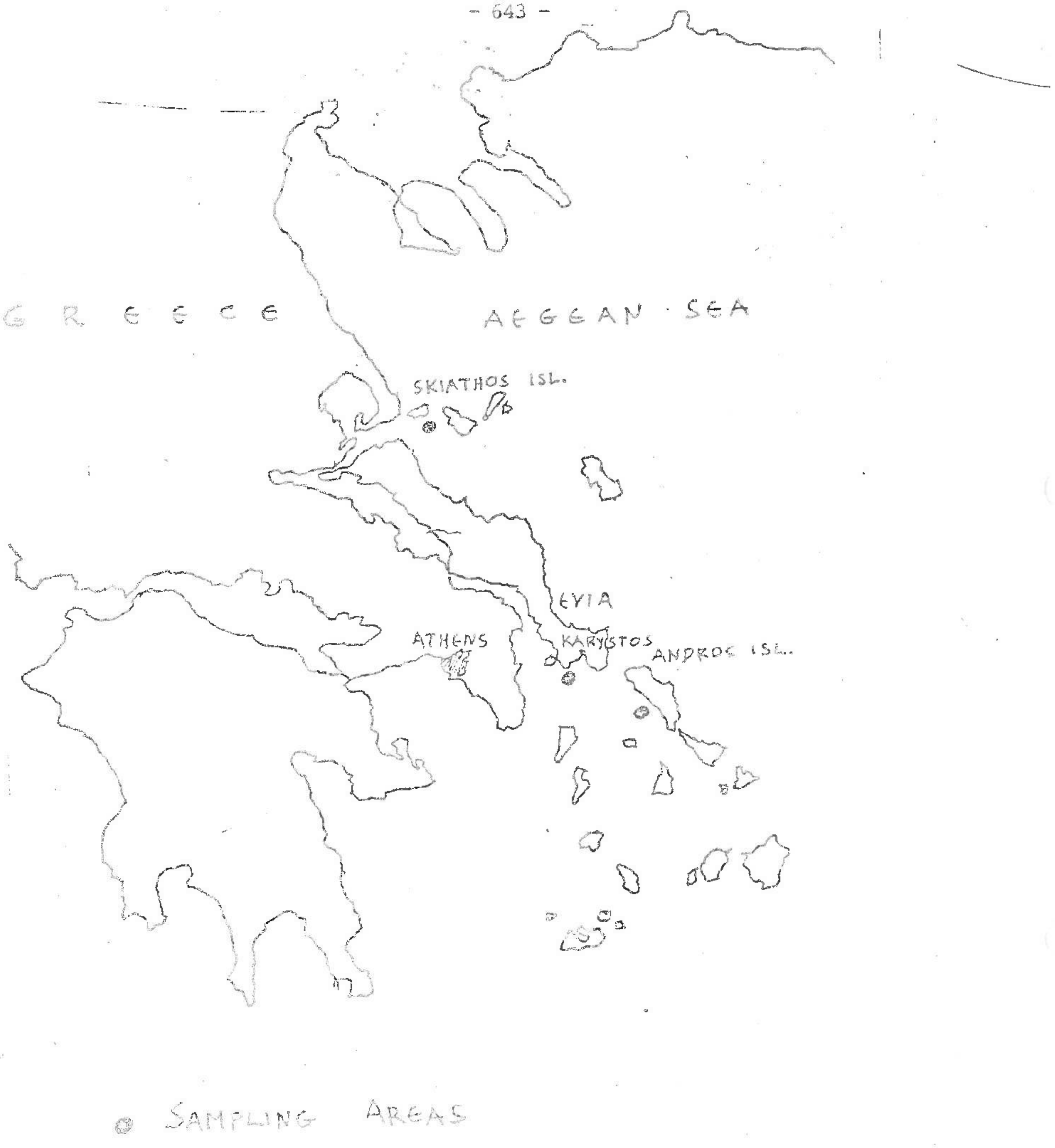
SAMPLE	Zn	Co	Se	Cs
5	66±2	0.17±0.01	30±1.1	0.020±0.004
6	77±3	0.26±0.01	32±1.2	0.026±0.004
7	97±3	0.28±0.01	36±1.3	0.038±0.004
8	86±3	0.40±0.02	33±1.2	0.020±0.008
9	85±3	0.34±0.02	25±1.0	0.032±0.004
10	91±3	0.29±0.02	45±2.0	0.024±0.005
24	98±3	0.36±0.02	33±2.1	0.031±0.004
25	97±6	0.61±0.07	56±2.7	0.070±0.010
26	89±6	0.42±0.05	43±2.0	0.047±0.008
27	87±6	0.46±0.05	45±2.2	0.058±0.009
28	84±6	0.23±0.04	31±1.5	0.055±0.009
29	103±6	0.58±0.06	50±2.5	0.060±0.010
30	91±6	0.49±0.05	46±2.3	0.040±0.005
Mean	89±9.7	0.38±0.12	39±9	0.040±0.017

TABLE 6

Trace element concentrations in plankton and *Trachurus mediterraneus* (ug/g, dry± standard deviation)

SAMPLE	As(2)	Zn	Co	Se	Cs	Rb	V(3)
60u net sample	18	-	-	-	-	-	-
250u net sample	18	162±5	0.060±0.002	2.0±0.3	0.99±0.035	0.32±0.08	11.1±0.4
600u net sample	7.7	119±4	0.36±0.014	2.2±0.3	0.37±0.013	-	4.6±0.2
Euphasia kronii	5.4	77±3	0.17±0.07	1.8±0.3	0.55±0.020	0.17±0.05	1.62±0.03
Trachurus m. (flesh)(1)	7±2	19±9	0.030±0.014	2.9±0.7	0.067±0.012	0.32±0.05	0.095±0.02

(1) For Zn, Co, Se, Cs and Rb mean of 14 specimens analyzed, for As and V mean of 9 specimens
(2) Analytical standard deviations for As are up to 10 per cent
(3) Overall standard error of the counting technique


GREECE
AEGEAN SEA
SKIATHOS ISL.
EVIA
ATHENS
KARYSTOS
ANDROS ISL.
SAMPLING AREAS

Participating Research Centre: Department of Physiology and Biochemistry
The Old University
MSIDA
Malta

Principal Investigator: J. V. BANNISTER

Area(s) studied:

Mullets of the species (Mugil cephalus) were obtaaned from the coast around Malta.

Material and methods:

Species of about 120 mm length were caught live by means of nets and were acclimated for two months in a large tank filled with continuously running sea water. The fish were fed pelleted food containing 80 per cent protein.

After the acclimation period species were placed in tanks contaminated with 0.5 ppb or 1.0 ppb chlorinated hydrocarbons. The contaminants used were DDt, Aldrin and PCB. The chlorinated hydrocarbons were obtained from Analabs Inc. Species were contaminated with either of these chlorinated hydrocarbons.

At the end of the contamination period, the contaminated mullets were disected and pooled samples of brain, kidney, eyes, heart, liver, gills, skin, stomach, red and white muscle were obtained. The deposition of chlorinated hydrocarbons in these tissues was estimated according to the following procedure.

The combined organs were weighed and homogenised in a 10 per cent mixture of petroleum ether with a Kolbe homogeniser. The petroleum ether solution was concentrated to 20 ml by rotary evaporation. This solution was extracted thrice with 10 ml acetonitrile previously saturated with hexane. The three fractions of acetonitrile extracts were combined and diluted with 250 ml of 10 per cent sodium chloride solution previously depleted of any contaminants with hexane. The aqueous acetonitrile solution was extracted thrice with 50 ml of n-hexane. The three fractions were combined and concentrated by rotary evaporation (temperature 50°C) up to 5-10 ml and Na_2SO_4 solid added. The solution was now ready for Florisil treatment. The purification for elusion was done on a small column, filled with dried Florisil activated at 130°C overnight (Dimensions of the column = internal diameter 8 mm filled up to 5-7 cm, elutant n-hexane 20-25 ml). The solution was concentrated to 2-3 ml.

The separation of PCB from other chlorinated hydrocarbons was carried out on silica gel. The silica gel is heated to 200°C overnight. The internal column diameter is 10 mm, and the column was filled up to 20 cm. After having introduced the concentrated solution, the PCB is first eluted with 40-50 ml of n-hexane. DDT and the other hydrocarbons were afterwards collected with 40-50 ml of benzene. The hexane and benzene solutions were concentrated to a constant volume (2-5 ml) for analysis.

Results and their interpretation:

Pesticide levels are to be measured by an instrument which detects both changed and unchanged pesticides. Yet since this apparatus was out of order during the period of analysis, samples are to be analyzed as soon as this instrument is serviced.

Currently under investigation is the clearance rate of chlorinated hydrocarbons by mullets. Preparations are also in hand so that similar experiments to those being carried out on mullets can be started on the mussels (Mytilus galloprovincialis).

Participating Research Centre: International Laboratory of Marine Radioactivity - - IAEA
MONACO VILLE
Monaco

Principal Investigator: D. ELDER/S. W. FOWLER/R. FUKAI

Introduction

The overall philosophy of MED VIII has been twofold. First, to gather as much information as possible on inputs, levels and fluxes of pollutants in all major components of the open Mediterranean in order that a general model of the biogeochemical cycles of these substances can be elaborated. Second, these data are intended to supplement and enhance those presently being gathered on levels in selected marine species in the coastal areas.

The marine biogeochemical cycle of a given pollutant can be conceptualized as outlined diagramatically in figure 1.

The approach used in MED VIII has been to measure a suite of heavy metals and organochlorine compounds in the prime components shown in figure 1.

Baseline measurements were made on samples collected during five oceanographic cruises during the period 1977-1979. In addition, determination of trace elements in marine aerosols and particulate matter in sea water were carried out by the Centre des Faibles Radioactivités, CNRS, France.

The biokinetic behaviour of arsenic, vanadium, nickel and PCBs in various marine organisms was examined in order to gain information on the fluxes of these substances once they enter biological cycles.

Vertical flux studies of pollutants were undertaken by utilizing both in situ measurements and analyses of freshly-produced biogenic particulates which account for a large fraction of the particulates trapped at depth using sediment traps.

Heavy metals in sea water and sediments

The results of the measurements of heavy metals on open Mediterranean surface waters are summarized in table 1.

Since far more than half of the samples were below the detection limit for Cu measurements and approximately half of those were below the detection limit for Cd measurements, the average values for these metals represent only the upper limits of the average concentrations. In these cases comparisons between different zones in the Mediterranean are less meaningful. However, the grand averages for the Mediterranean of these metals, <0.33 ug/l for Cu and <0.13 ug/l for Cd, appear to be similar to the values given for oceanic waters by other investigators in this field. There was no correlation between the appearance of high Cu values and high Cd values.

The average concentration of Zn tends to differ from one zone to another; values are higher in the northwestern Mediterranean and Aegean basins and lower in the Tyrrhenian and south Levantine basins, despite the large associated uncertainties. The grand average for the Mediterranean of Zn tends to be lower than the values given in the references cited above.

The zonal differences in the distribution of Hg are not clear from the average concentrations presented in table 1 due to large associated uncertainties. It appears, however, that average concentrations are lower in the southwestern Mediterranean and south Levantine basins. The grand average of Hg is lower than the values given in some references for the Atlantic and Pacific by various investigators, but similar to or slightly higher than those given by others. Our values are definitely higher than those reported for the western Pacific by investigators in Japan.

The vertical distribution of selected trace metals in off-shore sediments was studied in two core samples taken in 1978 from 500 m and 1000 m depth off Villefranche. Selected trace metals such as Mn, Cu, Zn, Pb, etc. were measured in several vertical sections of each core. For the Pb measurements various pretreatment procedures were applied to differentiate between the different chemical forms of Pb so that total organic Pb, alkyl Pb, etc. could be distinguished. The vertical distribution of these different chemical forms of Pb within the cores indicates that Pb in the upper parts of the sediment cores is introduced anthropologically (the Pb concentration decreases from the surface of the sediments to 6-8 cm depths for both sediment cores and the concentration of Pb at the surface in the 500 m core is higher than that in the 9epper 1000 m core Considering the sedimentation rate in the area of study and the vertical distribution of Pb within the sediments there appears to be a downward migration of certain forms of Pb in the sediments.

Trace elements in biota

During the period 1975-1977 pelagic organisms ranging in size from plankton to tuna were sampled throughout the Mediterranean and analyzed for selected heavy metals. Large zooplankton and small nekton from both western and eastern basins were sorted according to individual species thus allowing realistic comparisons to be made between levels in similar species inhabiting different areas. One example is given in table 2 which shows the levels of several metals in euphausiid zooplankton from four regions of the Mediterranean. In general, although occasional high concentrations were noted, the levels encountered in the majority of the organisms were not too unlike those reported for pelagic species from other oceanic regions.

Chlorinated hydrocarbons in biota

Pelagic species from the central and wastern basins of the Mediterranean Sea were surveyed for PCBs and DDT. Residue levels in mixed microplankton from two cruises, which traversed the same general region of the eastern Mediterranean, show some clear differences. PCBs were significantly higher in samples from St. 3a and 6a taken aboard the Atlantis II (table 3). A careful examination of possible sources of contamination suggested that the observed differences may be real.

The ranges of residue concentrations in euphausiids (9.8 to 110 ppb dry for PCB and 2.5 to 115 ppb for DDT) were similar to those measured in mixed plankton. Euphausiids from the eastern basin had higher DDT/PCB ratios than those of the central region. This is due to a greater relative decrease in DDT levels compared to PCB concentrations in going from the central to the eastern region. A pelagic tunicate, P. atlanticum, sampled at one station in the Ionian Sea contained far less PCB and DDT than similar sized individuals from the Levantine basin. Different sized mesopelagic fish, M. glaciale, sampled from a single population, displayed a trend towards increasing DDT/PCB and DDE/PCB ratios with increasing size of fish. Finally, the relatively high levels of chlorinated hydrocarbons (PCB = 660 ppb; DDT = 127 PPB) found in the amphipod Anchylomera blossevillei, may be typical for this group of organisms.

Tuna muscle contained concentrations of PCB and DDT ranging from 8 to 90 ng/g dry and 2.4 to 50 ng/g dry, respectively. Gut contents, which were primarily composed of euphausiids, contained levels (PCB = 67 - 383 ng/g; DDT = 57 - 198 ng/g) which corresponded to those in tuna muscle.

Levels of organochlorine compounds in selected macrozooplankton and nekton as well as mixed microzooplankton have been compared with those in similar species from other oceanic areas. Although the data are sparse, PCBs in macrozooplankton and nekton do not appear to differ significantly from concentrations in similar species measured elsewhere. In the case of microzooplankton there was a trend towards slightly lower values in these organisms.

Vertical flux of trace metals and chlorinated hydrocarbons

Samples of sedimenting particles were collected off the coast by means of sediment traps. Examination of the material showed that zooplankton fecal pellets comprised a relatively large fraction of the total sample. Fluxes of these particulates ranged from 0.40 to 0.77 g $m^{-2}d^{-1}$ over a four-month period. Levels of heavy metals (cd, Cu, Zn, Fe and Mn) in biogenic particulates were high and compared favourably with concentrations of the same elements in freshly-produced biogenic detritus collected immediately over the traps. Clearly, sinking biogenic debris will be instrumental in effecting the downward vertical transport of these metals in certain areas of the Mediterranean.

The same samples discussed above were analyzed for chlorinated hydrocarbons. Table 4 shows that PCB levels were relatively high in the sinking particulates with flux averaging about 100 ug PCB $m^{-2}y^{-1}$ in this area. These measurements compare very well with independent estimates of the same order made by measuring PCBs in sections of sediment cores taken from the same region. These studies underscore the importance of sinking biogenic particulate matter in removing PCBs from the upper layers of the water column and transporting them to depth.

Biokinetic studies

The behaviour and fate of arsenic and vanadium in Mediterranean species was examined in controlled laboratory experiments utilizing radiotracers and stable element techniques. Over a concentration range from approximately 2 to 100 g/l arsenic uptake in the Mediterranean mussel (Mytilus galloprovincialis) and shrimp (Lysmata seticaudata) was dependent upon the arsenic concentration in sea water. Most of the arsenic accumulated was in muscle tissue, and it was taken up by mussels more rapidly at higher temperatures. The increased rate of molting at higher temperature made a temperature effect study difficult. Arsenic uptake was inversely related to salinity in both species and As concentrations on a whole-body weight were higher in smaller than in larger individuals.

Preliminary studies with phytoplankton show that arsenate is rapidly metabolized to a lipid extractable form. Using Dunaliella as the primary producer in a three component food chain it was shown that this lipid.J .Lsoluble arsenic is transferred efficiently to a herbivore (Artemia salina), and subsequently to a carnivorous shrimp. It also appears that Artemia and shrimp cannot mobilize inorganic arsenic into the lipid fraction; arsenate absorbed directly from sea water by these organisms is converted largely to arsenite.

Vanadium-48 and stable vanadium were used to study the uptake from water and elimination of vanadium in four benthic invertebrates - mussels, shrimp and crabs. The highest concentration factor (= 30) was noted in mussels after three weeks' exposure. Over a concentration range from approximately 2 to 100 ug V/l, uptake in mussels and shrimp was dependent upon the vanadium concentration in sea water. Uptake in mussels and shrimp appeared to be independent of temperature over a range of 13°C to 24°C but was slightly increased at low salinity (19‰). Vanadium behaves differently from arsenic in that the majority of vanadium (> 90%) becomes fixed to shells of mussels and crustaceans suggesting that surface adsorption plays a strong role in the bioaccumulation of this element. Both radiotracer experiments and stable element data showed that byssus threads of mussels rapidly accumulated vanadium to high levels. Because of the remarkable ability of byssal threads to take up this element, some consideration might be given to using this tissue as a biological monitor for measuring changes in vanadium levels in the natural environment.

Chlorinated hydrocarbon biocycling

Several different experiments were designed to assess the bioaccumulation potential, tissue distribution and depuration of PCB available from water, food and sediments. In order to test the bioavailability of sediment-bound PCB, comparisons were made of the accumulation of a mixture from sediments and from water by benthic worms. Uptake from sediments was dose-dependent, attaining equilibrium concentration factors of approximately 3 to 4 after two months. Subsequent PCB elimination rates were concentration-dependent, with higher initial loss rates evident in the worms containing higher

levels of PCBs. Accumulation of PCBs from water was much more rapid; concentration factors reached approximately 800 after only two weeks. Estimates were made of the relative importance of sediments and water as a source of PCBs to worms exposed to these contaminants in the natural environment. Calculations based on experimentally derived PCB concentration factors and ambient PCB levels in sediments and water suggest that compared to water, sediments contribute the bulk of these compounds to the worms.

The influence of uptake pathway on PCB accumulation and tissue distribution was examined by allowing shrimp to accumulate DP-5 from either food or sea water and analyzing their tissues during a period of one month. Regardless of the uptake pathway the relative tissue distribution was similar. The viscera which includes the hepatopancreas reached the highest levels. Concentrations of PCB in viscera were over an order of magnitude higher than those in exoskeleton and muscle suggesting that surface sorption plays a minor role in the accumulation of PCB from water by shrimp. Despite the fact that PCBs were rapidly absorbed into internal tissues, molted exoskeletons contained significant amounts of these compounds. Concentration factors in molts as high as 10^3 to 10^4 clearly illustrate the importance of crustacean molting as a process for redistributing PCBs in the marine environment. These experiments demonstrate the ease with which PCBs are transferred from the environment to benthic shrimp.

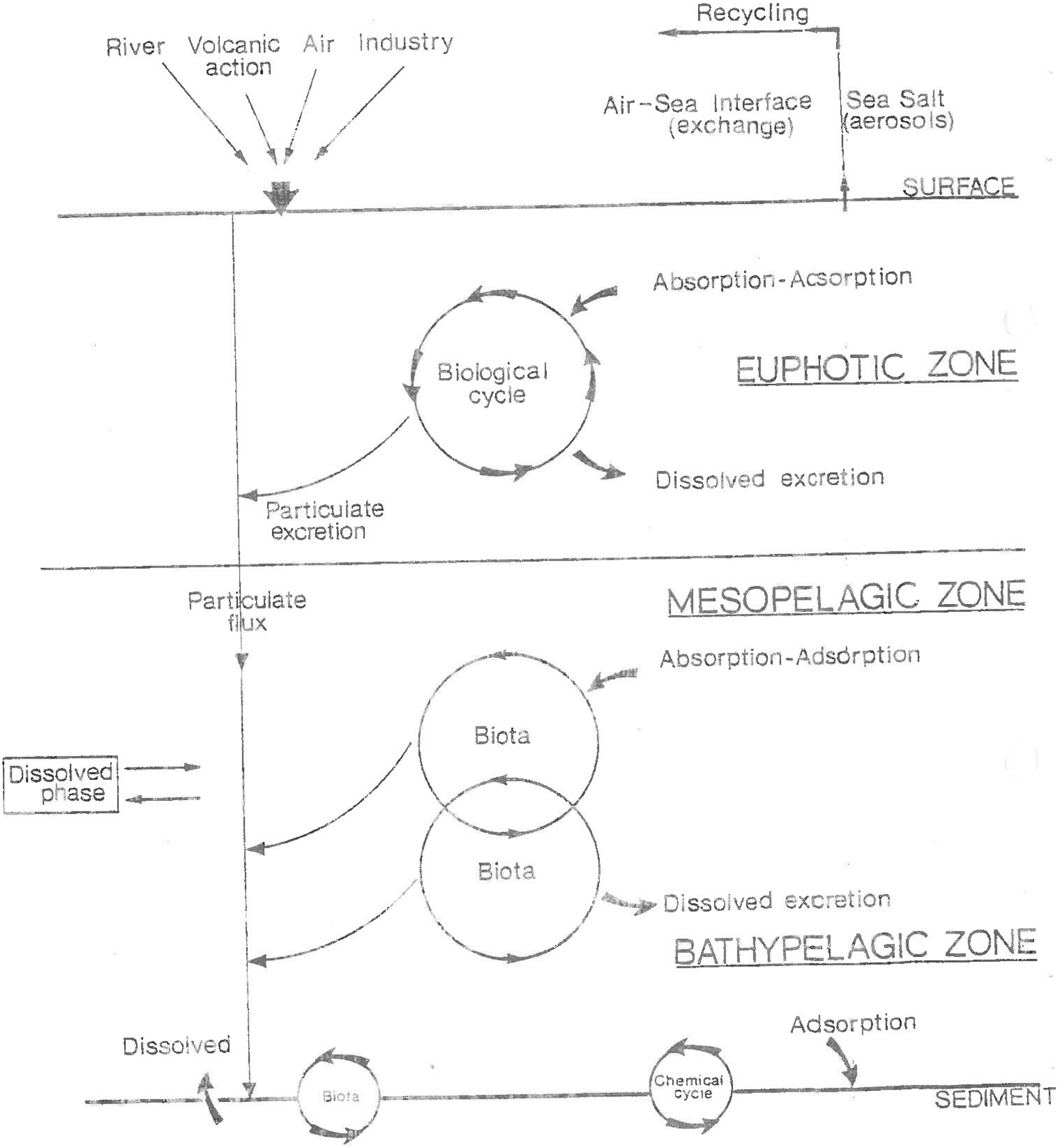

Recycling
River
Volcanic action
Air
Industry
Air-Sea Interface (exchange)
Sea Salt (aerosols)
SURFACE
Absorption-Acsorption
Biological cycle
EUPHOTIC ZONE
Dissolved excretion
Particulate excretion
MESOPELAGIC ZONE
Particulate flux
Absorption-Adsorption
Biota
Dissolved phase
Biota
Dissolved excretion
BATHYPELAGIC ZONE
Adsorption
Dissolved
Biota
Chemical cycle
SEDIMENT

Fig. 1

Table 1. Average concentrations of copper, zinc, cadmium and mercury in various zones of the Mediterranean sea

	Zone	Cu n*	Cu µg/l**	Zn n*	Zn µg/l**	Cd n*	Cd µg/l**	Hg n*	Hg ng/l**
II	N.W. Med.	34	<0.4±0.2 (<0.04-5.8)	34	2.7±0.4 (0.02-10)	33	<0.15±0.03 (<0.02-0.70)	7	20± 3 (8-32)
III	S.W. Med.	13	<0.10±0.04 (<0.04-0.60)	13	1.2±0.5 (0.02-6.0)	13	<0.11±0.04 (<0.02-0.51)	14	14±2 (5 - 30)
IV	Tyrrhenian	9	<0.18±0.08 (<0.04-0.62)	9	0.9±0.3 (0.02-2.3)	9	<0.11±0.04 (<0.02-0.33)	10	26±4 (10 - 40)
VI-VII	Ionian-Central	6	< 0.7±0.4 (<0.04-2.5)	6	1.8±0.9 (0.02-5.7)	6	<0.15±0.09 (<0.02-0.57)	6	30±10 (5 - 80)
VIII	Aegean	4	<0.3±0.1 (<0.04-0.64)	4	3 ± 1 (0.9-5.8)	4	<0.07±0.02 (<0.02-0.12)	3	40±20 (15-80)
X	S.Levantin	4	<0.04±0.01 (<0.04)	4	0.9±0.2 (0.3-1.3)	4	<0.04±0.03 (<0.02-0.11)	4	16 + 2 (12-20)
	Grand average	70	<0.33±0.09 (<0.04-5.8)	70	2.0±0.2 (0.02-10)	69	<0.13±0.02 (<0.02-0.70)	44	22±3 (5-80)

* n = No. of samples measured.

** = Uncertainties are expressed in terms of standard errors. Ranges are given in brackets.

Table 2. Trace metals in euphausiids (*Euphausia* sp.) from the open Mediterranean Sea. Values in parentheses represent samples of *Meganyctiphanes norvegica*.

Region	Station	Range of size (cm)	As	V	Zn	Co	Cs	Ag	Se	Sb	Rb	Sc	Fe	Hg*
			µg/g dry											
Eastern	A-3a		49.9	<0.06	58	0.20	0.18	2.7	7.2	0.050	0.11	0.005	150	
	A-6a		33.8	0.24	107	0.24	0.23		4.6		0.31			
	S-2		33.7		100	0.15	0.60		4.0		0.25			
	S-3		38.4		123	0.15	0.43		4.2		0.65			
	S-4		47.2	0.84	140	0.26	0.16	0.92	2.3	0.046	0.08	0.040	80	0.028
Ionian Sea	H-4(≈1)			0.37										
	H-4(1.5-2)													0.148
	H-14(≈ 1)		56.9		84	0.15	0.12		3.6		0.32			0.100
	H-14(1.5-2)													0.192
	H-14			(<0.07)	(39)	(0.06)	(0.06)	(0.16)	(2.9)		(0.27)			(0.092)
Tyrrhenian Sea	H-23(≈1)		20.0	0.48	120	0.23	0.29	2.3	2.9	0.031	0.17	0.038	191	0.076
	H-23(1.5-2)													0.178
	H-37(>2)		34.9	1.24	57	0.19	0.26	1.7	3.5	0.040	0.11	0.013		0.239
	H-37			(1.10)	(144)	(0.25)	(0.08)		(3.3)		(0.38)			
Northwestern	CS-46		29.6	0.23	39	0.23	0.33	1.2	3.4	0.050	0.11	0.070		0.189

* analyzed by AAS

Table 3. Chlorinated hydrocarbon residues in microplankton collected in the eastern Mediterranean during two cruises in 1977.

Cruise	Station†	PCB (DP-5)	µg/Kg dry* pp'DDT	pp'DDD	pp'DDE	ΣDDT/PCB
Atlantis II (4/77)	1	30	7.1	2.4	2.7	0.40
	3a	100	8.7	1.1	3.6	0.13
	6a	230	20	3.1	8.9	0.14
Shikmona (7/77)	1	35	6.9	12	13.6	0.92
	2	19	17	58	9.9	4.57
	3	22	9.4	2.7	2.5	0.66
	4	15	6.2	6.2	6.8	1.25

† Stations refer to those in Fig. 1

* Dry weight averaged 11% of wet weight

Table 4 ESTIMATES OF PCB FLUX IN THE LIGURIAN SEA

Date	Particulate PCB µg/Kg dry	Mass Flux $g\ m^{-2} d^{-1}$	PCB Flux $\mu g\ m^{-2} y^{-1}$
6/78	650	0.77	183
7/78	300	0.64	70
8/78	710	0.40	104
10/78	200	0.77	56
		$\bar{X}$	= 103

Participating Research Centre: Instituto de Investigaciones Pesqueras
BARCELONA
Spain

Principal Investigator: A. BALLESTER

Scientific results

The aim of the present project was the establishment of the biocynetical uptake of V and Ni by marine organisms.

Preliminary considerations resulted in the selection of *Pseudomonas* sp. as representative for typical marine bacteria, *Dunaliella* sp. for phytoplankton, *Mytilus edulis* for invertebrates, *Penaeus kerathurus* for crustacea and *Solea solea* for fish.

The primary sources of V and Ni for *Pseudomonas* and *Dunaliella* were appropriate culture mediums enriched with solutions of one or both elements.

An outstanding and most interesting part of the experiment was the reproduction of a natural trophic chain:

bacteria mussels fish / crustacea

The transfer of V and Ni from bacteria to mussels was performed by means of previously contaminated bacteria and phytoplankton. The resulting concentration factors for a 15 days-culture-time were the following:

Pseudomonas	*Dunaliella*
cf V = 0.5	cf V = 2.9
cf Ni = 6.0	cf Ni = 12.5

Pseudomonas were able to develop in cultures containing very high concentrations of V (50 ppm) and Ni (10 ppm) whereas inhibitory effects were detected for *Dunaliella* at 50 ppm of V and 2.5 ppm of Ni.

The concentration factor in the secondary trophic transfer (*Pseudomonas* to *Mytilus edulis*) was very low for a feeding time of 1 day; namely:

cf V = 0.08
cf Ni = 0.21

The concentration factor in the terciary trophic transfer (*Mytilus edulis* to *Penaeus kerathurus* and *Solea solea*) was even lower than the secondary one for a feeding time of 19 days:

Mytilus edulis	to	Solea solea
cf V muscular		tissues = 0.001
cf V liver		= 0.012

Mytilus edulis	to	Penaeus kerathurus
cf V mixed soft tissues		= 0.004

More interesting results were gathered by direct V and Ni contamination of mussels; i.e. using POLIKARPOV'S terminology, "direct absorption" from the water. In fact, the concentration factors resulting from severe experimental conditions were very high (table 1).

TABLE 1

V Enriched sea water (ppm)	Time (days)	Mean V content of mussels (ppm)	Cf
10	1	8	0.8
10	2	20	2.0
50	1	9	0.2
50	2	24	0.5
100	1	269	2.7
100	2	357	3.6

The results shown in table 1 seem to demonstrate the existence of a critical concentration in the enriched sea water culture between 50 and 100 ppm of V.

The sudden increase from 0.20 - 0.47 (at 50 ppm) to 2.69 - 3.57 (at 100 ppm) allows us to introduce the above mentioned hypothesis. In order to gain further knowledge on the "critical concentration" and its determination, a new series of experiments were conducted. Their results are shown in table 2.

TABLE 2

V Enriched sea water (ppm)	Time (days)	Mean V content of mussels (ppm)	Cf
50	1	16	0.3
60	1	23	0.4
70	2	142	1.0
80	1	76	0.9
90	1	250	2.8
100	1	650	6.5

Direct absorption of Ni

A series of observations in mussel - cultures (*Mytilus edulis*) containing 1, 2, 5, 10 and 100 ppm of Ni were conducted in a similar As for the determination of the V direct absorption pathway. After 4 days the level of incorporated Ni was that shown in table 4.

TABLE 4

Ni concentration in enriched s/w culture (ppm)	Time (days)	Ni concentration in soft tissues of mussels (w/w)	Cf
1	4	6	6
2	4	9	9
5	4	14	3
10	4	34	3
100	4	52	1

Somewhat contrary to the observations made in the V experiment, the Cf of a culture containing 150 ppm of Ni (0.5) is of the order of one tenth lower than in cultures containing 0 to 1 ppm Ni (mean value of 4.3).

The meaning of this difference is not clear yet, nevertheless some physiological implications must be assumed; namely that the V cultures are more toxic at a 100 ppm level (excretion mechanisms excluded). In order to know the V concentration in natural systems, two species of sea fish (<u>Mullus barbatus</u> and <u>Pagellus erythrinus</u>) and sediments were collected and analyzed. Analytical values and cf's are shown in table 5.

TABLE 5

V in organism	V in sea water (g/l)	V in dorsal muscle	Cf
Mullus barbatus	0.7×10^{-6}	0.02 ppm	30
Pagellus erythrinus	0.7×10^{-6}	0.05 ppm	70
Sediments	0.7×10^{-6}	28.00 ppm	3.8×10^{4}

We want to point out that the V content of Mullus barbatus conspicoos, a benthic organism feeding in high V contaming sediments is lower than in Pagellus erythrinus.

Though we agree that this experiment is not absolutely complete (effects of the variability under experimental conditions were not considered), the results seem to be consistent since the mean cf/day for 50 ppm V in the first experimental series was 0.33 and 0.32 in the second one; between 60 and 70 ppm V results in a cf increase by a factor of three (0.32 to 1.0); at 80 and 90 ppm V the cf increases abruptly (0.95 to 2.80) and; between 90 and 100 ppm V the cf increases further (2.80 to 6.50).

Up to now we lack evidence about how physiological changes (including deteriorated excretion mechanisms) can affect the equilibrium factors of organism absorption and V culture content - when V concentrations exceed certain levels.

Ni uptake from Ni enriched sea water by bacteria and microalgae

As for Vanadium, we checked the biocynetics of Ni uptake through trophic and direct absorption pathways.

Experiments were performed using Ni enriched sea water and selected organisms. Pseudomonas sp and Dunaliella sp were chosen as representive of bacterial and phytoplanktonic populations respectively.

Preliminary experiments showed that the minimum inhibitory levels of Ni for both organisms were: 100 ppm for Pseudomonas and 2.5 ppm for Dunaliella. The concentration factors for a feeding time of 20 days were 6 and 12.5 respectibility. Table 3 summarizes experimental conditions and results.

TABLE 3

Organism	Ni concentration s/n enriched culture (ppm)	Time (days)	Ni concentration in organisms	Cf (20 days)
Pseudomonas ps	5	20	30	6
Dunaliella	1	20	12	12

Discussion

Our results are in agreement with Polikarpov's statement that the majority of marine organisms concentrate more radionuclides (and that includes trace metals) by direct absorption from the water rather than by feeding. In consequence our results suggest that food chain transfer may be disregarded - in general - as the main factor in bioaccumulation and transfer of vanadium.

The rapid enrichment of vanadium observed in mussel shells over soft parts may be explained by invoking two different pathways in the incorporation of vanadium: 1) by biochemical mechanisms for soft tissues; 2) by physiochemical processes involving, perhaps, calcium carbonate as the prime matrix for concentration.

The analysis of two species of marine fishes show only moderate levels of vanadium in their tissues even though they live in sediments containing high levels of vanadium. This is to be expected if - as stated before - food chain transfer of vanadium is negligible in marine organisms.

Finally, it is noteworthy that the results from this preliminary study have encouraged us to continue both systematic environmental sampling and laboratory experiments which should help clarify the mechanisms involved in the direct absorption of Vanadium and Nickel from water.