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Ecological study of gas fields in the northern Adriatic

10. Organic pollutants

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In the part of the northern Adriatic that is destined for exploitation of gas (IVANA field), research was carried out in March 1986 to determine the level of pollution of marine environment with specific organic pollutants so that the actual state could be determined as a basis for further research.

To estimate the level of pollution of sea water, marine organisms and sediments with organic pollutants in the IVANA field, the contents of dissolved organic matter, polycyclic aromatic hydrocarbons (PAH), chlorinated hydrocarbons and volatile phenols were analyzed.

The research focused on the qualitative and quantitative determining of polyaromatic hydrocarbons in different media that could be endangered during future exploitation.

10.1. INTRODUCTION

The waters of the northern Adriatic are constantly reached by pollution with oil and oil derivatives - since a well known fact is - that oil is one of the main cargoes in the Adriatic trade. Intensive maritime activities in the northern Adriatic are also a permanent source of pollution for the waters of this area. Pouring of bilge waters and washing of tanks are particularly dangerous.

Highly developed industry and agriculture in northern Italy results in large quantities of waste waters entering the northern Adriatic via the Po River and other north Italian rivers that also reach the area of the northern Adriatic. Of the pollutants the most important are: pesticides from the group of halogenized hydrocarbon derivatives, polychlorinated biphenyls (PCBs), heavy metals, anion detergents and phenol compounds. Also the industrial and tourist facilities located on the western coast of Istria add to the excessive quantities of organic matter in the northern Adriatic.

A well known fact is that oil is a mixture of a series of chemical compounds that may be classified in groups, the most important being: n-paraffins, cyclic alcanes, polycyclic aromatic compounds and residual oils. As there is no unique method for determining the aforementioned groups of compounds, because of the high toxicity and persistence, polycyclic aromatic hydrocarbons (PAH) have been chosen as indicators of the level of pollution of marine ecosystems with oil and oil derivatives.

Phenol compounds are significant and are widely used in many fields of human activities. They are present in waste waters of a series of industrial plants, primarily in the oil, coal, natural gas industries and waste waters of cellulose, paper, paints, textile, pesticide industries.

However, it is possible to identify phenol compounds in household waste waters as well, therefore they are both indicators of urban and industrial sea water pollution. The greater part is mainly decomposed in water through microbiological processes, but the reduced quantity of phenol in sea water is also the result of photosynthetic activity, adsorption, oxidative polymerization and dilution. At any rate the concentration of phenol substances completes the picture of the level of sea water pollution with organic pollutants (BUIKEMA et al., 1979).

The dissolved organic matter in sea water is one of the factors that may indicate the level of productivity of a certain area.

Polychlorinated biphenyls as well as DDT and its metabolites fall into the group of highly ecotoxic substances. The fact that their use has lately been decreasing does not eliminate the need for constant monitoring in the marine ecosystem, both because of the mentioned toxicity - highly pronounced mutageneous potential and the quantities in sea water.

10.2. MATERIAL AND METHODS

In the area of the IVANA field four sampling stations (1, 2, 3 and 4) were chosen for collecting samples of sea water, sediments and organisms during 1986 (Fig. 1.2. in Preface).

Mussels *(Mytilus galloprovincialis)* were collected from the foot of the research oil-drilling platform PANON at the location in the IVANA field, whereas the fish *(Mullus barbatus)* were collected by trawl catch.

10.2.1. Polyaromatic hydrocarbons in sea water

The standard method for collecting samples from the depth of 1 m was applied. Double extraction was performed on the ship with 2 x 25 ml n-hexane and a few grams of anhydrous sodium sulfate were added to remove excess water. Extracts evaporated to a volume of 1 ml were purified on column of silica gel. Eluation of unpolar substances was done with 10 ml n-hexane. Fluorescence intensity was measured at 360 nm, with excitation wavelength 310 nm, with a spectrofluorimeter PERKIN-ELMER 3000 equipped with an adequate printer. The results were expressed in chrysene equivalents (IOC/UNESCO, 1984.).

10.2.2. Volatile phenols in sea water

Determining the concentration of volatile phenols was done in the surface and bottom sea water layer. On the site, samples were preserved in a $CuSO_4$ solution, whereas in the laboratory the distillation and spectrophotometry were performed with a 4-aminoantipirin solution, after adjusting the pH value to 10. Colored complex was extracted with chloroform, and the extinction was measured at a wavelength of 460 nm, on the fluorescence spectrophotometer PYE UNICAM 600. The values of phenol substances are expressed in phenol equivalents (STANDARD METHOD, 1967).

10.2.3. Dissolved organic matter in sea water

The sea water sample was filtered through the membrane filter of 0.45 (m. In the aliquot part of the sample, dissolved organic matter was oxidized in an acid medium with excess of bichromate and presence of H_gSO_4. The excess of bichromate was retitrated with ferro-ammonium sulfate solution. The quantity of dissolved organic matter is equivalent to the quantity of used bichromate and is expressed in mg O_2, that is, mg of organic carbon (MICHEL, 1972.).

10.2.4. Polyaromatic hydrocarbons in sediments

The analytical procedure consists of the following steps: freeze drying, saponification with KOH and methanol on reflux for 2 hours, extraction with n-penthane and after reduction to 1 ml, fractions separation was made on an acid alumina column: alcanes (I fraction), aromatic with a lower number of condensed benzene rings (II fraction) and higher polyaromatic fraction (III fraction). The elution of the first fraction was performed with n-pentane, the second with pentane and dichloromethane (7:3) and the third with dichloromethane. Following evaporation, aromatic fractions were purified on a silica gel column, with eluted PAH n-hexane (IOC/UNESCO, 1982).

The continuous emission spectra of the lower and higher aromatic fractions were scanned and the peak was measured at 360 nm, the excitation wavelength being 310 nm. The spectrofluorimeter PERKIN-ELMER 3000 was used.

10.2.5. Polyaromatic hydrocarbons in marine organisms

From 10 - 20 samples of mussels, the fleshy part was separated and homogenized in a "Waring" blender, then freeze dried. Similarly, from some 10 samples of striped mullet fillets were separated, then homogenized and freeze dried.

The analytical procedure consisted of saponification with 6N NaOH solution during 18 hours at the temperature of 30°C. The mixture was extracted with di-ethyl ether (5 x 10 ml), the separation and purification were achieved simultaneously on a column (30 x 1cm) of acid alumina (150 mesh) and silica gel (100-200 mesh). The elution of three fractions was made: n-alcanes with 20 ml n-hexane, lower aromatic with 20 ml mixture of n-hexane and dichloromethane (9:1); and higher aromatic fraction with 40 ml mixture of n-hexane and dichloromethane (8:2).

All applied solvents were redistilled. The silica gel was distilled by Soxlet apparatus with n-hexane and deactivated with 2% water. The alumina was heated for 20 hours at a temperature of 400°C and after cooling off to room temperature deactivated with 5% water.

The instrument for determining PAH content in marine organisms was the same as applied for determining PAH content in sediments. Results were expressed in chrysene equivalents (IOC/UNEP/CSIC, 1984).

10.2.6. Chlorinated hydrocarbons in sediment

Sediment samples collected at the IVANA field or nearby were freeze dried and extracted with n-hexane in a Soxlet apparatus during 8 hours. For sample purification, a deactivated alumina column (5% water) was used. The sulfur present in the sample was eliminated by extraction with KCN solution. Separation of polychlorinated biphenyls from chlorinated insecticides was performed on a silica gel column, and the sample was then analyzed by gas chromatography (METHODOLOGY MANUAL, 1982).

10.2.7. Chlorinated hydrocarbons in organisms

Organic matter was extracted with n-hexane in a Soxlet apparatus during 8 hours. After evaporating, unwanted components were eliminated by adding H_2SO_4. The separation of PCBs from DDT and its metabolites was done on a silica gel column. The first fraction eluted with hexane contains PCBs. The second fraction eluted with benzene contains DDT, DDE and DDD.

All samples were analyzed by gas chromatography (METHODOLOGY MANUAL, 1982).

10.3. RESULTS AND DISCUSSION

10.3.1. Polyaromatic hydrocarbons in sea water

The analysis of PAH values dissolved and dispersed in sea water reveals uniform values from 0.14 $\mu g/dm^3$ (chrysene), which presents the limiting value for the applied method. Considering the significant variability of such substances in sea water, such low values are not surprising, in spite of the intensive maritime activity and inflow of these pollutants either via the Po River or Istra coastal region.

According to some global assessments, the total annual oil and oil derivatives input in the Mediterranean is from 0.5 - 1 million t, the greatest part coming from land sources (45%), maritime activity (35%), precipitation (10%), and the remaining 10% from natural sources (UNEP, 1977). According to the report of the US Academy of Sciences (PICER, 1977) in 1976 about 187 000 t of oil and oil derivatives entered the Adriatic. Based on these calculations, the greatest part of pollution in the Adriatic is caused by maritime activity and amounts to about 89 000 t or 47% , urban and industrial waste waters and fresh-water inflows 60 000 t (32%), and the atmosphere and other sources account for about 39 000 t (21%).

If the results on PAH concentrations in sea water in the IVANA field are compared to results from other research, there is a great similarity in the measured values of PAH concentration (WORK REPORT, 1985; DUJMOV and SUČEVIĆ, 1989).

Large-scale research carried out in the entire Mediterranean shows that the greatest part of measurements with concentrations above 0.4 µg/dm3 are characteristic of waters of the central and western part of the basin (IOC/UNESCO, 1981). In the coastal regions much higher PAH concentrations were recorded. Thus, in the coastal waters of Turkey the measured values range from 0.5 - 3.5 µg/dm3 with a mean value of 1.5 µg/dm3 (chrysene) (SUNAY et al. 1982). In the area of Alexandria (WAHBY and EL DEEB, 1980) the PAH concentrations in sea water samples range from 0.65 - 41.1 µg/dm3 (chrysene), whereas MIMICOS (1980) cites the concentrations near some islands and ports in Greece of 0.6 - 28.3 µg/dm3 Louisiana crude oil equivalents.

10.3.2. Volatile phenols in sea water

The results of research of the concentrations of volatile phenols from the IVANA field are given in Table 10.1.

Table 10.1. Concentrations of volatile phenols in sea water samples (IVANA field), in $\mu g/dm^3$ phenol

Station	surface	bottom
1	4.4	3.8
2	4.6	4.2
3	7.7	5.1
4	4.8	4.7

The measured concentrations of volatile phenols in the IVANA field, in samples from March 1986, range from 3.8 -7.7 µg/dm3.

Slightly higher quantities of phenol substances were determined at station 1., located in the northern part of the IVANA field, whereas the values from other stations are rather uniform. Somewhat increased concentrations of volatile phenols in the surface layer, that were recorded at all stations, are typical for the vertical distribution of phenols in the open sea.

For the northern Adriatic there are relatively few data on the distribution of volatile phenols, and the available data are 10 or more years old, concerning only the narrow area along the Istra coast (JARDAS and MUNJKO, 1974).

Comparison of phenol concentrations from the IVANA field with those from other locations in the Adriatic, shows that the measured concentrations from the open sea of the northern Adriatic are considerably lower than those measured in the central and southern Adriatic (DUJMOV, 1984).

10.3.3. Dissolved organic matter in sea water

Results of the quantity of dissolved organic matter in sea water from the area of the IVANA field are shown in Table 10.2.

The quantity of dissolved organic carbon at research stations range from 0.82 - 2.17 mg C/dm3. The minimum value of 0.82 mg C/dm^3 was recorded at station 4 in the surface layer, and the maximum value of 2.17 mg C/dm^3 was recorded at station 2 in the bottom layer. The arithmetic mean for all stations and both levels was 1.58 mg C/dm^3. The mentioned values of salinity and temperature indicate that the layers

Table 10.2. Quantity of dissolved organic carbon in the surface and bottom sea water layer in mg C/dm^3, IVANA, March 1986.

station	layer	conc. O_2	conc.	temp.	sal.
		mg O_2/dm^3	C.org.	°C	psu
1	surface	3.6	1.35	11.38	38.64
	bottom	7.6	2.84	10.05	38.65
2	surface	5.2	1.94	10.82	38.74
	bottom	5.8	2.17	10.34	38.69
3	surface	4.0	1.49	10.79	38.71
	bottom	4.8	1.79	9.51	38.69
4	surface	2.2	0.82	10.78	38.72
	bottom	3.4	1.27	9.73	38.70

are well mixed. Slightly higher values of dissolved organic carbon were recorded in the bottom layer, which suggests the presence of significant bacterial activity on the surface of the sea water sediment, which is in agreement with the results of the vertical distribution of phenols described earlier.

Few works have been published on the quantity of dissolved organic matter, especially concerning the Adriatic. According to our unpublished data, the values from the IVANA field are 2-5 times lower than concentrations measured in the Kaštela Bay, which is in agreement with the division of the Adriatic in productive zones by Buljan (BULJAN and ZORE-ARMANDA, 1971, pp. 207-209).

In the open sea of the Mediterranean, the concentrations of dissolved organic carbon range from 0.2-0.7 mg C/dm3 (BANOUB and WILLIAMS, 1972) and from 1.8-2.2 mg C/dm^3 (SKOPINTSEV et al., 1966) whereas in the North Sea they range from 2.19-7.55 mg C/dm^3 (DUURSMA, 1961).

As the main source of dissolved organic matter in sea water is excretion and decomposition of phytoplankton, it is expected that during the period of blooming, usually in the summer months, the concentrations of dissolved organic matter will also increase.

10.3.4. Polyaromatic hydrocarbons in sediments

Values of the content of polyaromatic hydrocarbons in sediments in the IVANA field are presented in the following table:

Table 10.3. PAH concentrations in sediment samples expressed in chrysene equivalents (µg/g dry sediment) IVANA field, March 1986.

station	lower PAH fraction	higher PAH fraction
1	0.22	ND
2	0.23	ND
3	0.19	ND
4	0.28	ND

The main characteristic of sediments in the IVANA field is a great uniformity of collected data ranging from 0.19 - 0.28 µg/g dry sediment. Another feature of the studied area is the

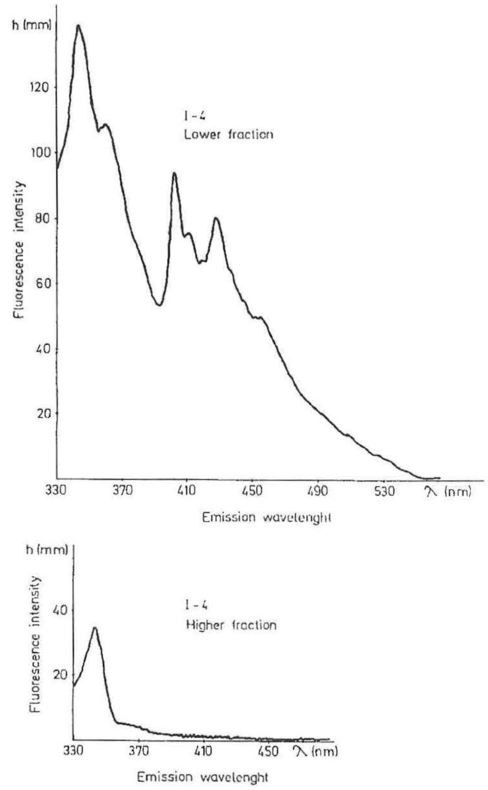

Fig. 10.1 Characteristic emission spectra lower and higher aromatic fractions of sediment extract sampled at station I-4

absence of higher polyaromatic compounds (Fig. 10.1.). Emission spectra show a great similarity in the configuration of fluorigram. This implies that the entire area of the IVANA field is under the influence of the same source of pollution, that is, there is no indication of local or partial pollution of the studied area.

Considering the various sources of PAH in the marine ecosystem - petrochemical, pyrolytical, diagenetical and other sources- there was an attempt to determine characteristic absorption maximums through emission spectra of lower and higher aromatic fraction, thus in such a way to point out to the origin and dominant source of pollution. So, the petrochemical PAH, when scanning emission spectra, appears at wavelengths of 340-380 nm. Pyrolytical PAH are represented by benzo(a)pyren and show characteristic peaks at wavelengths of 405 and 425 nm. PAH originating from diagenesis have an absorption maximum at wavelengths over 440 nm. All the mentioned absorption maximums are characteristic for hexane as a solvent and for excitation wavelength of 310 nm.

The absorption maximum at all fluorigrams of lower aromatic fraction was at wavelength of 360 nm, which indicates pollution with crude oil and oil derivatives. The emission spectra also show the presence of aromatic compounds with 5 benzene polycondensed rings of the benzo(a)pyren type, that indicates pollution of sediments with waste, resulting from incomplete combustion of liquid and solid fuels (ashes, combustion gases, washing out grounds after forest fires).

There is no commercial application for benzo(a)pyren, it is insoluble in sea water and is easily adsorbed in particles of clay or some other organic substance (detritus), and settles on the surface of sea water sediments. Upon reaching the sea bottom the decomposition of benzo(a)pyren is very poor, especially in the conditions of reduced light, oxygen and temperature (IRPTC, 1978).

For a clearer picture of the condition of sediment pollution with PAH in the northern Adriatic, some values connected with different parts of the Adriatic and the Mediterranean will be presented. The PAH values in the central Adriatic are slightly higher and range from 0.47 - 1.67 µg/g dry sediment chrysene equivalents (DUJMOV and SUČEVIĆ, 1990). In the sediments collected along the eastern coast of Spain the PAH values range from 2-66 µg/g dry sediment (as Kuwait crude oil, ALBAIGES et al. 1982a). If the mentioned data are calculated in chrysene equivalents, they range from 0.76-2.5 µg/g dry sediment. In sediments of the coastal area of Marseille and Monaco (MILLE et al., 1982) the PAH concentrations range from 3.7-402 µg/g dry sediment. The concentrations in the area between Cyprus and Turkey range from 0.04-0.68 µg/g dry sediment (SUNAY et al., 1982).

10.3.5. Polyaromatic hydrocarbons in marine organisms

The analysis of PAH values in shells (mussel, *Mytilus galloprovincialis*) collected from the research platform PANON and fish (striped mullet, *Mullus barbatus*) caught in the area of the IVANA field, are presented in the following table:

Table 10.4. PAH concentrations in samples of shells (mussel Mytilus galloprovincialis*) and fish (striped mullet,* Mullus barbatus*) from the waters of the IVANA field expressed in µg/kg dry weight chrysene equivalents*

sample	lower PAH fract.	higher PAH fract.	total
shell (*Mytillus g.*)	4.06	0.30	4.36
fish (*Mullus b.*)	0.41	0.28	0.69

Fig. 10.2. shows the emission spectra of lower and higher aromatic fraction of fish extracts, where the domination of PAH with 2-4 benzene rings is visible both in the lower and higher aromatic fraction. The dominant PAH in the fish *Mullus barbatus* originates from petrochemical sources.

Emission spectra of lower and higher aromatic fraction of shell extracts are shown in

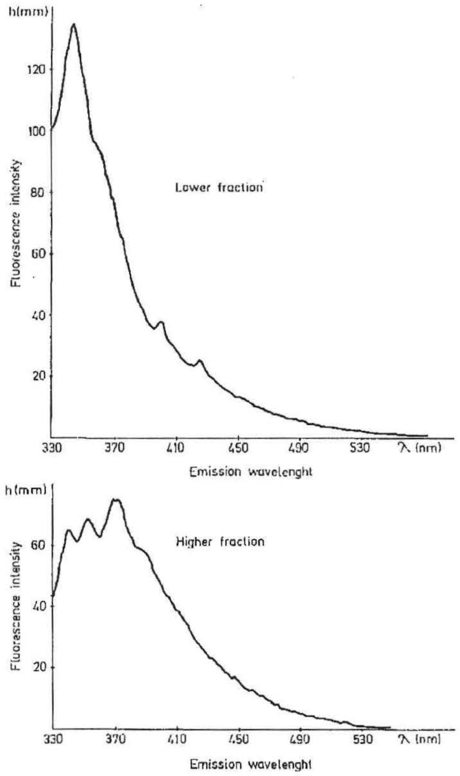

Fig. 10.2. Characteristic emission spectra lower and higher aromatic fraction of fish extracts (Mullus barbatus)

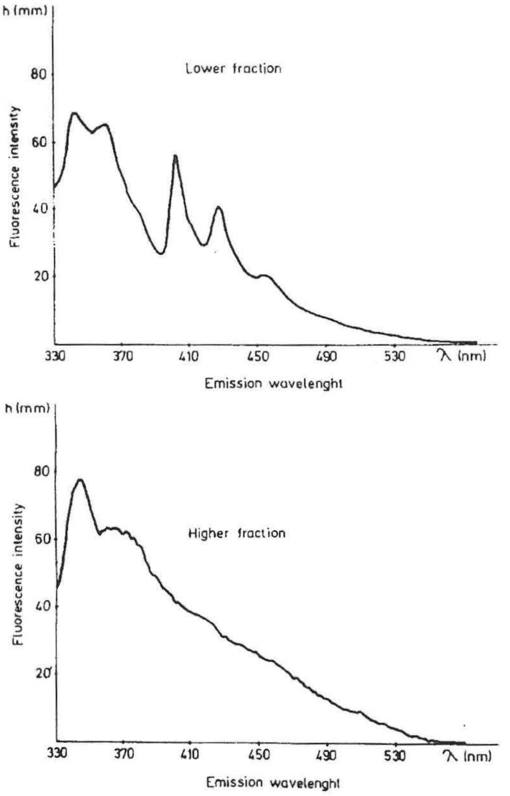

Fig. 10.3. Characteristic emission spectra lower and higher aromatic fractions of shell-fish extracts (Mytilus galloprovincialis)

Fig. 10.3. In the lower aromatic fraction there is an absolute domination of PAH with 2-3 rings, showing the influence of petrochemical waste waters. There is also a clearly expressed presence of benzo(a)pyren peak - indicator of sea water pollution with pyrolytical products.

They are also recorded in the higher aromatic fraction as a dominant part of PAH with 2-4 rings. All this indicates that the shells from the foot of the oil-drilling platform PANON mainly contained low PAH concentrations.

Certain PAH concentrations in the fish Mullus barbatus are in agreement with other research carried out in the Adriatic (Work report, 1985; DUJMOV and SUČEVIĆ, 1989).

In the northeastern part of the Mediterranean the PAH concentrations in the same fish ranged from 0.04-7.3 μg/g dry tissue (chrysene equivalents) (SUNAY et al., 1982).

It is interesting to mention that the PAH concentrations in mussels from an oil-drilling platform located about 30 km from the Spanish coast were higher for an order of magnitude than those in this paper (ALBAIGES et al., 1982b).

10.3.6. Chlorinated hydrocarbons in sediments

When assessing the level of pollution of a certain area, the sediment measurements are considered more relevant than those from the water column. This is true because of the more stable conditions in sediments, thus the constancy of the system is more pronounced. Also the accumulating effect in sediments is emphasized because of the process of depositing many pollutants from the marine environment. Although the DDT compound and PCBs are widespread in marine ecosystems, and can be detected at a distance of a few hundred kilometers from the site of use, however the concentrations of chlorinated insecticides (DDT, TDE, DDE and dieldrin) in the area of the IVANA field are often below the level of sensitivity of applied methods.

The range of concentrations of chlorinated insecticides (Σ-DDT) are relatively low and range from 0.03-0.11 ng/g dry sediment (Work report, 1985). Considering the determined concentrations of DDT and its metabolites, not only in the IVANA field but wider, it is difficult to show the source of pollution with chlorinated insecticides in the northern Adriatic (Work report, 1988).

PCBs in sediments from the IVANA field is generally present in quantities higher for an order of magnitude than those of Σ-DDT, ranging from 0.45-1.42 ng/g dry sediment (Work report, 1985). None of the values from samples were below the level of sensitivity of the applied gas chromatography method.

In the Lagoon of Venice the mean values of concentrations of the mentioned compounds were: DDT=3.3, PCB = 8.3 ng/g (FOSSATO, 1982), whereas the content of PCB compounds in sediments from the North Sea according to the authors KNICKMEYER and STEINHART (1988) are almost within the same limits as those from our experimental work, ranging from 0.5 - 1.4 ng/g.

10.3.7. Chlorinated hydrocarbons in marine organisms

Results of analysis of Σ-DDT in organisms from the northern Adriatic as a result of the ex-Yugoslav and Italian cooperation reveal relatively low values. The Σ-DDT values in different benthic organisms (sea cucumber, sponge, starfish, sea urchin, coral) ranged from 0.10 *(Corbula gibba)* to 5.25 ng/g *(Marthatserias glacialis)* (Work report, 1985).

For comparative reasons, the range of Σ-DDT concentrations in some organisms from the area of the central Adriatic (east coast) will be presented. In the fish *Mullus barbatus* it ranges from 0.3-50 ng/g, whereas in shellfish *Mytilus galloprovincialis* Σ-DDT ranges from 0.3-18.3 ng/g (DUJMOV et al., 1978). The content of Σ-DDT in organisms collected along the Italian coast of the Adriatic Sea - fish, *Engraulis enchrasicholus, Mullus barbatus* and *Thunnus thynnus thynnus* and shellfish *Mytilus galloprovincialis* and crabs *Carcinus maenas* and *Nephrops norvegicus* - ranged between 2.6 ng/g *(Nephrops norvegicus)* to as much as 207 ng/g in the tuna *(Thunnus t.t.)* (FOSSATO and CRABOLEDA, 1981). Also the values of Σ-DDT from analysis of similar organisms from other locations in the Mediterranean (French Riviera, Aegean Sea, Sicilian Basin, Tyrrhenean Sea) are higher than those from the northern Adriatic (ARNOUX et al. 1981; KILIKIDIS et al. 1981; SALIHOGLU et al. 1981; CONTARDI et al. 1983).

PCBs concentrations in the same organisms as those where Σ-DDT was determined range between 0.10 ng/g wet tissue in shellfish *Corbula gibba*, to 29.59 ng/g that was recorded in the sponge *Porifera indet* (Work report, 1985).In organisms collected along the Italian coast, the greatest PCBs concentrations were found in samples of fish *Mullus barbatus* (from 66-211 ng/g wet tissue) and *Thunnus t.t.* (344 ng/g) whereas the shellfish *Mytilus galloprovincialis* was slightly less contaminated with PCBs (41-100 ng/g wet tissue) (FOSSATO and CRABOLEDDA, 1981).

10.4. CONCLUSION

The concentrations of polyaromatic hydrocarbons (PAH) in sea water are at the level or below the level of sensitivity of applied analytical methods, so the recorded PAH values are characteristic for clean areas.

The concentrations of phenol compounds are considerably lower than the concentrations measured along the eastern coast of the Adriatic. At any rate, at the time of sampling the studied area was not significantly polluted with urban or industrial waste waters.

The values of dissolved organic matter are in agreement with the division of the Adriatic in productive zones according to BULJAN (1971).

PAH concentrations in sediments are within the limits of values of moderately polluted areas. The minimum pollution originates from pyrolytical and petrochemical sources.

PAH concentrations in fish samples are, as in sediments, minimum and originate from petrochemical sources. Shells from the PANON platform show higher PAH values due to the waste waters from the platform itself. PAH of petrochemical and pyrolytical-sources are dominant. The recorded PAH values cannot be indicative for the IVANA field.

Concentrations of chlorinated insecticides are low, frequently below the level of sensitivity of applied method. This presumably is the consequence of the fact that DDT has not been widely applied for the last 15 years. On the other hand, PCBs are present in quantities higher for an order of magnitude than those of DDT.

Contents of chlorinated insecticides and PCBs in organisms are slightly higher than those in sediment.

A comparison of the concentration of organic pollutants in the IVANA field with other locations in the Adriatic and Mediterranean shows that the studied area can be classed among cleaner seas.

Small differences in the spatial distribution of measured organic pollutants, indicate that the minimum pollution of sea water, sediments and organisms is a result of global pollution.

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Ekološka studija plinskih polja u sjevernom Jadranu

Organska zagađivala

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KRATKI SADRŽAJ

Na području sjevernog Jadrana, koje je predviđeno za eksploataciju plina (polje IVANA), u ožujku 1986. godine je provedeno određivanje stupnja zagađenosti morske sredine sa specifičnim organskim zagađivalima, kako bi se odredilo tzv. "nulto stanje" kao osnova za daljnja istraživanja.

Da bi se procijenio nivo onečišćenja morske vode, morskih organizama i sedimenata s organskim zagađivalima na polju IVANA, analiziran je sadržaj otopljene organske tvari, policikličkih aromatskih ugljikovodika (PAH), kloriranih ugljikovodika i hlapivih fenola.

Težište istraživanja postavljeno je na kvalitativnom određivanju poliaromatskih ugljikovodika u različitim medijima posebno organizmima kao što su školjke i ribe koji bi mogli biti ugroženi kod buduće eksploatacije.