

Organochlorine Pesticide Residues in Fish from Southern Italian Rivers

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Extensive use of pesticides in agricultural and municipal fields contributed all over the world to an effective increase of production and to a limitation of the vector injuries to health.

However the large quantities of synthetic chemical products employed to achieve these purposes have resulted in an extended environmental pollution, especially worrying about the organochlorine insecticides that are very persistent and suspected of cancerogenicity. For these reasons, this group of pesticides has been banned or strongly restricted in many countries including Italy, where just Lindane and Endosulfan are now allowed in agriculture, representing only 7% of the annual use of synthetic pesticides (FAO,1985).

In order to control the amount of contamination of surface water from organochlorine pesticides, some surveys were carried out in northern and central Italy (Galassi & Gandolfi,1981; Cantoni et al.,1985; Cozzani & Di Pietrogiacomio, 1985; Forneris et al.,1986), but information regarding situation in southern Italy is not available. The purpose of this study was to evaluate the occurrence and the magnitude of chlorinated pesticide aquatic pollution in southern Italy by the analysis of some permanent freshwater fish species.

MATERIALS AND METHODS

Sampling of fish came from four rivers in continental southern Italy, running through the Abruzzi, Lazio, Campania and Basilicata regions: Garigliano, Volturno, Calore and Sele. Garigliano, Volturno and Sele rivers flow into Tirrenian sea, while Calore river flows into Volturno (Figure 1). Length, width of watershed, mean

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dues were weighed to determine the sample lipid content. They were then redissolved in petroleum ether (100ml) and aliquots corresponding to ≤ 3 g of lipid were extracted and cleaned up according to the A.O.A.C. (1980) procedure for organochlorine pesticide residue analysis in fish. The cleaned extracts were concentrated to 1 ml by Kuderna-Danish evaporator. Concentrates were analysed on a Perkin-Elmer Sigma 3B gas-chromatograph equipped with electron capture detector (^{63}Ni) and interfaced with a Spectra-Physic Mod.4270 integrator. A 6 ft x 1/4" I.D. packed glass column of 1.5 OV-17 + 1.95 QF₁ on 80-100 Chromosorb W-HP was used for separation.

Table 2. Common and taxonomic names of fish collected in the survey.

Common Name	Taxonomic
Black bullhead	<i>Ictalurus melas</i>
Bleak	<i>Alburnus alburnus alborella</i>
Chub	<i>Leuciscus cephalus cabeda</i>
Common Carp	<i>Cyprinus carpio</i>
Eel	<i>Anguilla anguilla</i>
Tench	<i>Tinca tinca</i>

The monitored organochlorines were Aldrin; Dieldrin; Endosulfan; Heptachlor; Heptachlor epoxide; Lindane; o-p'DDT; p-p'DDT; o-p'DDD; p-p'DDD; o-p'DDE; p-p'DDE. The quantitative determinations were based on comparison of the peak areas obtained from the samples with those obtained from the reference standard solutions. The sensitivity of the method was not less than 5 ng/g for the studied compounds. Results of the analysis of fish samples are reported in ng/g on wet-weight basis. DDT isomers and metabolites are summarized as Σ DDT.

RESULTS AND DISCUSSION

Concentration and prevalence of detected organochlorines are listed in Table 3. Quantifiable residues of Aldrin, Heptachlor epoxide and DDT group were found in 100% of the fishes from Garigliano river; Lindane in 88%; Dieldrin in 63%; Heptachlor in 21% while Endosulfan was never detected. Mean concentrations of DDT group compounds ranged from 18 ng/g (carp) to 153 ng/g (chub), those of the other organochlorines from 5 to 20 ng/g. The lowest amount of residues was found in common carp, at 37 ng/g, the highest in chub and tench, at 173 ng/g.

Aldrin, Heptachlor epoxide and DDT group compounds were detected in 100% of fishes from Volturno river

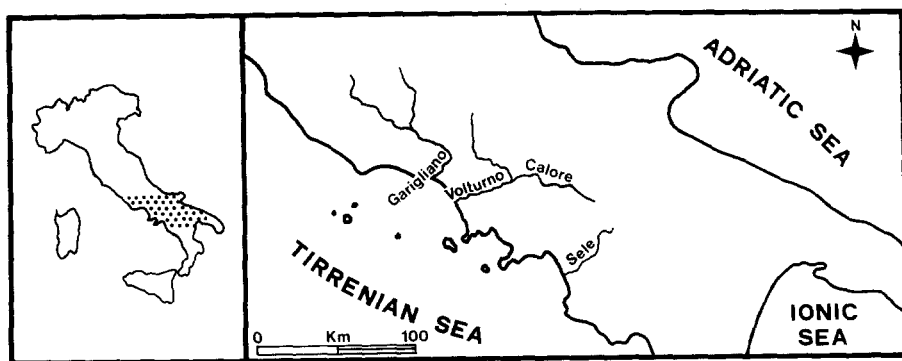


Figure 1. Southern continental Italy showing the location of Garigliano, Volturno, Calore, and Sele rivers.

flows of rivers and prevalent activities in the lands they pass through are summarized in Table 1. Catching of fish occurred near the outfalls during the flood period, in March-June of 1986.

Fish species were selected according to their representativeness and plentifulness. Common and taxonomic names of collected species are reported in Table 2.

Table 1. Description of the rivers considered in the survey.

River	Length Km	Watershed ha	Mean flows m ³ /sec	Prevalent Activities
GARIGLIANO	158	499,200	130	Agriculture
VOLTURNO	175	556,000	72	Agric.+Municipal+Ind.
CALORE	118	305,800	32	Agric.+Municipal+Ind.
SELE	74	324,000	60	Agriculture

Soon after their capture, fishes were wrapped in aluminum foil, stored in ice and taken to the laboratory, where they were classified and selected for the analysis on the basis of their species and weight. The weight of fish specimens employed in the survey ranged between 50 and 200g.

A composite sample of each species was prepared blending together the muscular tissue of almost three specimens of similar weight, and mixing 30 g of the homogenate with anhydrous Na₂SO₄. The samples were then extracted with petroleum ether in a Soxhlet extractor for six hours, collecting the extracts in tared flasks. After evaporation of the solvent to dryness,

Table 3. Muscular-tissue, wet-weight concentration (ng/g) of organochlorine residues in fish from southern Italy*

Location and species	Analysed samples	Compound											Total*** other	ΣDDT+ total other
		Aldrin Dieldrin Endosulfan Heptachlor Heptachlor epoxide Heptachlor Lindane ΣDDT												
GARIGLIANO														
Black bullhead	15	(100)	(63)	---	(21)	(100)	(88)	(100)				40	90	
Bleak	12	20	5	ND	10	10	5	50				35	125	
Chub	9	5	ND**	ND	ND	10	5	153				20	173	
Common carp	9	5	ND	ND	ND	5	ND	18				19	37	
Eel	18	20	5	ND	ND	5	7	136				43	173	
Tench	9	5	ND	ND	ND	5	7	42				17	59	
VOLTURNO														
Black bullhead	12	(100)	(52)	---	(70)	(100)	(87)	(100)				54	138	
Bleak	12	30	ND	ND	ND	5	5	105				40	145	
Chub	12	6	ND	ND	6	12	7	83				27	114	
Common carp	9	5	ND	ND	5	10	5	27				25	52	
Eel	15	31	5	ND	5	11	16	84				68	152	
Tench	9	5	10	ND	ND	5	ND	41				20	61	
CALORE														
Black bullhead	9	(100)	(100)	(24)	(78)	(100)	(100)	(100)				32	127	
Bleak	15	39	5	ND	ND	8	5	127				57	184	
Chub	9	8	5	ND	5	16	5	85				39	124	
Common carp	9	6	5	5	5	7	6	21				34	55	
Eel	15	5	7	ND	5	10	5	128				32	160	
Tench	6	5	5	5	5	10	5	17				35	52	
SELE														
Black bullhead	9	(13)	(13)	(22)	(35)	(100)	(87)	(100)				40	173	
Bleak	15	ND	10	ND	5	15	5	133				26	145	
Chub	12	ND	ND	8	5	5	8	119				18	94	
Common carp	9	ND	ND	ND	ND	10	8	76				5	56	
Eel	15	ND	ND	ND	ND	5	ND	51				5	118	
Tench	9	ND	ND	ND	ND	5	5	113				13	48	

* Numbers in parentheses represent frequency of occurrence for each compound and ΣDDT in all samples from each river.

** ND=Not detectable.

***As sum of mean concentration of each compound.

too, at mean levels up to 30 ng/g (Aldrin); up to 11 ng/g (Heptachlor epoxide) and up to 105 ng/g (Σ DDT); Dieldrin was found in 52% of the samples, in a range of concentrations from 5 to 11 ng/g; Heptachlor in 70%, up to 20 ng/g; Lindane in 87%, up to 16 ng/g. As in fishes from Garigliano river, all the samples from Volturno river didn't contain appreciable amounts of Endosulfan. Range of total residues was 52-152 ng/g.

Detectable levels of Aldrin, Dieldrin, Heptachlor epoxide, Lindane and DDT group pesticides were present in 100% of the fishes from Calore river. Mean concentrations of residues of DDT compounds ranged between 17 ng/g (tench) and 128 ng/g (eel), those of the other organochlorines between 5 and 39 ng/g. Endosulfan was detected in 24% of the analysed samples, that is in common carp and in tench specimens, at mean levels of 5 ng/g. Total residue amounts in fish from Calore river varied from 52 ng/g (tench) to 184 ng/g (bleak).

In the fishes collected from Sele river, residues of Heptachlor epoxide and DDT group had a prevalence of 100%, with mean concentrations amounting respectively to 5-15 ng/g and to 35-133 ng/g; Lindane was present in 87% of the samples, at mean levels of 5-8 ng/g; Heptachlor in 35%, at 5 ng/g; Endosulfan in 22%, at 8 ng/g; Aldrin and Dieldrin were found only in black bullhead specimens (prevalence 13%) at 5-10 ng/g. The combined residue amounts in fish from Sele river varied from 48 ng/g (tench) to 173 ng/g (black bullhead).

As a comment on the results we can observe that DDT group and Heptachlor epoxide are the compounds found more frequently in all the collected fishes, while the lowest prevalence was that of Endosulfan. Residue levels of DDT exceeded in any case the combined concentrations of the other pesticides, in all the fishes from all the sampling locations. Among the analysed fish species, the lowest residue levels have been observed in common carp and in tench. The prevalence of the monitored organic contaminants was quite higher in fishes from Calore river than from Garigliano, Volturno and Sele rivers. It may reflect a disproportion between the scarcity of the Calore flow and the amount of waste waters discharged from metropolitan areas and industrial developments in addition to the agricultural drainage systems in the river watershed, as pointed out in previous surveys (Del Prete et al., 1978; Amodio et al., 1984). A comparison between our results and those obtained in other Italian regions is not easy, for the differences in sampled species, in river characteristics, in monitored compounds and in expression of analytical results, calculated on the basis of lipid content of the fish. However, the

prevalence of the DDT group residues in freshwater fish from northern and central Italy was confirmed (Cozzani & Di Pietrogiacomio, 1985; Cantoni et al., 1985).

About analogous surveys carried out in United States, although it is difficult a comparative analysis of the results for the above mentioned reasons and for the differences in dimensions of lands, rivers and agricultural developments, nevertheless it can be observed that total DDT residue levels found in our survey are much lower than those detected by Winger et al. (1984) in fishes from Apalachicola river in Florida (from 300 to 1170 ng/g), while Dieldrin and Eptachlor epoxide residue concentrations are quite similar (10-20 ng/g). Moreover, a comparison between our results and those reported by Martin & Hartman (1985) shows a good agree in content of DDT compounds in common carp from Alamosa (CO), Arrowood (ND) and Union Slough (IA) (5-44 ng/g), while quite different are the results about other monitored organochlorines, much lower in prevalence and in concentrations than those in our survey. These differences may result from the smaller dimensions of collected fishes in addition to the different conditions of the study.

On the basis of our survey it can be concluded that the analysis of permanent freshwater fish species from rivers in southern Italy demonstrates a quite low level of pollution by organochlorine pesticides, which never exceeded the levels recommended by the U.S. National Academy of Sciences and U.S. National Academy of Engineering (1972) for the protection of aquatic life. It is possible, moreover, to deduce a good observance of limitations in agricultural employ of chlorinated pesticides.

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