

## Organochlorine Contamination in Three Species of Diurnal Raptors in León, Spain

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The purpose of this paper is to give new data on the levels of organochlorine pesticides residues in birds of prey collected in the province of Leon, in the North-West of Spain.

This study was undertaken to determine organochlorine residual levels in tissues and organs (muscle, liver, kidney, fat and brain) of 9 diurnal raptors, including kestrel, *Falco tinnunculus*, L., sparrow hawk, *Accipiter nisus*, L. and red kite, *Milvus milvus*, L.

The use of organochlorine pesticides has been restricted because of their persistence in the environment and potential for environmental impact. Even with the restrictions on their use in this country, organochlorine pesticides residues are present in animal population in the province of Leon (Sierra *et al.*, 1984, Sierra and Santiago, in press) due to their slow rate of degradation (Edmundson, 1972, Nash and Woolson, 1967).

### MATERIALS AND METHODS

A total of 35 samples of muscle, liver, kidney, brain and fat were obtained from 4 kestrels, 3 sparrow hawks and 2 red kites.

Portions of about 4 grams were taken from liver, muscle and kidney and the whole of the brain was removed for organochlorine residues analysis. The weight of perivisceral fat samples was variable depending on the body fat reserves. It was only possible to obtain 5 samples of fat (2 of them were from kestrels, 2 from sparrow hawks and 1 from red kites). All samples were frozen to -20°C until analyses could be conducted.

Each sample was individually homogenized (Ahmad, 1979). Subsequent extraction and clean-up were the same as those described by Richardson *et al.*, 1971.

TABLE 1.- Average, range (in ppm/wet weight) and incidence percent of organochlorine pesticides in sparrow hawks.

	KIDNEY	LIVER	BRAIN	FAT	MUSCLE
1	0.510 0.393-0.607 100	0.385 0.078-0.991 100	0.642 0.352-1.207 100	0.829 0.563-1.094 100	0.341 0.341 100
2	0.027 0.017-0.036 66.67	0.203 0.004-0.597 100	0.059 0.008-0.109 66.67	0.216 0.216 50	0.012 0.012 100
3	0.014 0.014 33.33	0.035 0.035 33.33	0.019 0.008-0.030 66.67	0.285 0.285 100	0.028 0.028 100
4	— — —	— — —	— — —	0.009 0.009 50	— — —
5	0.400 0.400 33.33	0.139 0.007-0.270 66.67	0.031 0.031 33.33	1.068 0.174-1.961 100	0.047 0.047 100
6	0.445 0.445 33.33	0.364 0.364 33.33	0.130 0.042-0.217 66.67	17.338 17.338 50	— — —
7	0.541 0.541 33.33	— — —	— — —	— — —	— — —
8	1.922 1.415-2.429 66.67	0.368 0.150-0.492 100	0.035 0.012-0.057 66.67	4.543 3.896-5.189 100	9.969 9.969 100
9	5.152 1.842-9.099 100	7.543 1.147-18.62 100	3.388 0.177-9.028 100	48.588 31.14-66.03 100	7.381 7.381 100
10	1.323 0.234-2.412 66.67	0.583 0.036-1.129 66.67	0.057 0.022-0.091 66.67	8.557 6.469-10.64 100	— — —

1:  $\alpha$ -HCH; 2: Lindane; 3: Heptachlor-epoxide; 4: Aldrin; 5: Endrin  
 6: Dieldrin; 7: o,p'-TDE; 8: p,p'-TDE; 9: p,p'-DDE; 10: p,p'-DDT

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TABLE 2.- Average, range (in ppm/wet weight) and incidence percent of organochlorine pesticides in red kites.

	KIDNEY	LIVER	BRAIN	FAT	MUSCLE
1	0.010	0.020	0.450	—	—
	0.010	0.013-0.026	0.162-0.738	—	—
	100	100	100	—	—
2	0.006	0.007	0.011	0.437	0.005
	0.006	0.007	0.010-0.011	0.437	0.005
	100	50	100	100	100
3	—	—	0.056	—	—
	—	—	0.034-0.078	—	—
	—	—	100	—	—
4	—	—	0.014	—	—
	—	—	0.014	—	—
	—	—	50	—	—
5	0.005	—	0.103	2.035	—
	0.005	—	0.103	2.035	—
	100	—	50	100	—
6	0.155	0.099	0.017	0.197	0.013
	0.155	0.077-0.120	0.016-0.018	0.197	0.013
	100	100	100	100	100
7	0.020	—	0.077	0.124	—
	0.020	—	0.025-0.129	0.124	—
	100	—	100	100	—
8	0.665	0.018	0.152	2.684	—
	0.665	0.018	0.025-0.279	2.684	—
	100	50	100	100	—
9	0.028	0.875	0.056	—	0.208
	0.028	0.112-1.638	0.018-0.093	—	0.208
	100	100	100	—	100
10	2.496	0.160	1.610	0.762	0.063
	2.496	0.160	1.610	0.762	0.063
	100	50	50	100	100

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6: Dieldrin; 7: o,p'-TDE; 8: p,p'-TDE; 9: p,p'-DDE; 10: p,p'-DDT

TABLE 3.- Average, range (in ppm/wet weight) and incidence percent of organochlorine pesticides in kestrels.

	KIDNEY	LIVER	BRAIN	FAT	MUSCLE
1	0.456	0.255	0.343	1.368	1.266
	0.216-0.735	0.053-0.455	0.078-0.929	0.583-2.153	1.122-1.410
	100	75	100	100	100
2	—	0.024	0.015	—	0.156
	—	0.012-0.035	0.003-0.019	—	0.079-0.232
	—	100	100	—	100
3	1.132	0.031	0.033	2.040	0.183
	0.589-2.042	0.003-0.080	0.012-0.051	0.284-3.795	0.139-0.226
	75	100	100	100	100
4	0.217	0.048	0.030	0.654	0.074
	0.140-0.371	0.043-0.053	0.018-0.038	0.654	0.020-0.127
	75	50	75	50	100
5	0.027	0.010	0.016	—	0.054
	0.013-0.040	0.010	0.016	—	0.054
	50	25	25	—	50
6	—	0.151	0.005	—	0.046
	—	0.009-0.292	0.005	—	0.046
	—	50	25	—	50
7	0.288	—	—	0.691	—
	0.288	—	—	0.691	—
	25	—	—	50	—
8	0.028	0.006	0.012	—	—
	0.028	0.006	0.012	—	—
	25	25	25	—	—
9	0.238	0.063	0.046	2.889	0.149
	0.124-0.320	0.011-0.161	0.007-0.092	1.668-4.110	0.032-0.266
	100	75	100	100	100
10	0.045	0.015	0.057	1.250	0.091
	0.028-0.064	0.007-0.022	0.057	0.483-2.017	0.013-0.168
	75	50	25	100	100

1:  $\alpha$ -HCH; 2: Lindane; 3: Heptachlor-epoxide; 4: Aldrin; 5: Endrin  
6: Dieldrin; 7: o,p'-TDE; 8: p,p'-TDE; 9: p,p'-DDE; 10: p,p'-DDT

A florasil column conditioned for 24 hours at 130°C was used to remove interfering substances and to separate the pesticides in two fractions.

The eluates were concentrated for analysis by electron capture gas chromatography, which was performed on a Hewlett Packard gas chromatograph fitted with a nickel 63 electron capture detector.

The chromatographic parameters were: 1.- Columns: (a) 6 feet long and 1/4 inch inside diameter, containing a 1.5% coating of OV-17/1.95% of QF-1 on 100-120 mesh chromsorb W (AW/DMCS) and (b) 3.8% of SE-30 on 80-100 mesh chromsorb W (AW/DMCS). 2.- Carrier gas: 5% argon-methane at a flow rate of 25 ml/min. 3.- Operating temperatures: Inlet, 250°C; Detector, 300°C; Column (a) 200°C and Column (b) 180°C.

In order to identify the pesticides and quantify the residual levels, we have compared the problem solutions with a standard solution containing the following pesticides:  $\alpha$ -HCH, lindane, heptachlor-epoxide, aldrin, dieldrin, endrin, o,p'-TDE, p,p'-TDE, p,p'-DDE and p,p'-DDT.

#### RESULTS AND DISCUSSION

The incidence percent of organochlorine pesticides in the five types of samples and the mean residue levels and ranges (in parts per million, ppm, by weight of wet sample) are given in Tables 1 to 3.

Our results show that sparrow hawk is the most contaminated species.

$\alpha$ -HCH was present in all the samples of organs and tissues analyzed in these raptors. We have obtained identical results in earlier studies in buzzards (Sierra *et al.*, 1984). The incidence percent detected for lindane, dieldrin and heptachlor-epoxide was similar to those reported by Joiris *et al.*, 1979, in liver, stomach content and muscle samples: 80% for lindane, 60% for dieldrin and 50% for heptachlor-epoxide.

The mean residue levels of DDT and related compounds (o,p'-TDE, p,p'-TDE, p,p'-DDE and p,p'-DDT) detected in sparrow hawks were 8 times higher than those indicated by Joiris *et al.*, 1979.

p,p'-DDE was detected at high concentrations in all the organs and tissues samples, specially in fat in which the average for this pesticide was 48.6 ppm. The accumulation of important levels of DDE in this species can be explained because birds are included in its diet.

However, the residual levels of p,p'-DDE detected in liver samples are lower than those reported by Newton *et al.*, 1982. These authors found more than 100 ppm of p,p'-DDE in liver samples of sparrow hawks collected in England, U.K. The highest

concentration we have detected was 18.6 ppm. Juillard *et al.*, 1978, detected 195 ppm of p,p'-DDE in liver samples from sparrow hawks collected in Lausanne (Switzerland), this concentration is more than 25 times higher than ours (7.5 ppm).

The red kite was the species least contaminated. The bibliographic references found about this species are limited. Joiris *et al.*, 1974, detected in liver and muscle samples a burden of organochlorine pesticides of 0.63 ppm; this amount is similar to 0.69 ppm obtained by us averaging the residual levels detected in both types of samples. The mean residue levels of DDT and related compounds, 0.62 ppm, are higher than those reported by these authors, 0.26 ppm.

The residual levels detected in organs and tissues of red kite are not very high and this fact is probably due to diversified feeding.

Compared to the other two species, kestrels had intermediate mean residue levels.

Joiris *et al.*, 1979 and Juillard *et al.*, 1978, indicate organochlorine pesticide residual levels in this species higher than ours. Newton *et al.*, 1982, found more than 100 ppm of p,p'-DDE and dieldrin in liver samples of kestrels collected in England, U.K. The higher concentrations we have detected were 0.29 ppm for dieldrin and 0.16 ppm for p,p'-DDE.

However, heptachlor-epoxide was detected in every sample of liver, brain, muscle and fat and in 75% of kidney samples. In a similar way, high incidence percent of this pesticide was also indicated by Lavaur de and Arnold, 1977, in several species of birds in France.

#### REFERENCES

- Ahmad N (1979) Cleanup of biological samples for determining p,p'-DDT and its metabolites. *J Assn Offic Anal Chem* 62: 1150-1154
- Edmundson WF (1972) Pharmacology of DDT the background. In: Davies JE, Edmundson WF (eds) *Epidemiology of DDT*. Futura Publishing Co, Inc, Mount Kisco NI, 9-25
- Joiris C (1974) La contamination par pesticides organochlorés des oiseaux de proie en Belgique. *Semaine d'Etude Agriculture et environnement*, September, Gremloux, Belgique, 479-483
- Joiris C, Delbeke K, Martens E, Lauwereys M, Vercruysse A (1979) PCB and organochlorine pesticides residues in birds of prey found dead in Belgium from 1973 to 1977. *Gerf Gierv* 69:319-337
- Juillard M, Praz JC, Etournaud A, Beaud P (1978) Données sur la contamination des rapaces de Suisse Romande et de leurs œufs par les biocides organochlorés, les PCB et les métaux lourds. *Nos Oiseaux* 34:189-206

- Lavour E de, Arnold A (1977) Pesticides et faune sauvage: resultats des analyses toxicologiques effectuées sur le gibier de 1974 a 1976. *Phytiatrie-Phytopharmacie* 26:159-168
- Nash RG, Woolson CA (1967) Persistence of chlorinated hydrocarbon insecticides in soils. *Science* 157:224-227
- Newton I, Bell AA, Wyllie I (1982) Mortality of sparrow hawks, Accipiter nisus, and kestrels, Falco tinnunculus. *Br Birds* 75:195-204
- Richardson A, Robinson J, Crabtree AN, Baldwin MK (1971) Residues in fish, wildlife and stuaries. *Pestic Monitor J* 4:169-176
- Sierra M, Gallego A, Terán T, Santiago D (1984) Niveles de residuos de  $\alpha$ -HCH, p,p'-DDE y p,p'-DDT en tejidos de ratonero común (Buteo buteo, L.) capturados en la provincia de León. *Revista de Toxicología* 1:67-73
- Sierra M, Santiago D (in Press) Organochlorine pesticide levels in barn owls collected in Leon, Spain
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