

Organochlorine and Mercury Residues in Peregrine Falcon Eggs in France

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As in many other parts of the world (United Kingdom, Scandinavia, North America) populations of peregrine falcons (Falco peregrinus) have decreased dramatically in France since 1960.

Several studies, particularly those of RATCLIFF & BOGAN in the United Kingdom, have shown the important role played by organochlorine pesticide residues, namely DDT and its main metabolite DDE, in the diminution of this species.

As with many predatory birds, organochlorine pesticides and polychlorinated biphenyls (PCBs) accumulate in the peregrine falcon via the food chain, and they exert long-term effects on reproduction by causing sterility and decreased shell-thickness resulting mainly from enzymatic induction.

In 1965, the "Peregrine Falcon Project" was established to save the peregrine falcon populations by a steady control of the nesting sites and through repopulation. One can, in effect, obtain two successive egg layings when one removes the first. The second laying is generally more productive than the first, which will be artificially incubated but which proves to be quite often sterile.

In context of this operation, numerous sterile eggs were available for analysis. This allowed us to determine the contamination levels by organochlorine pesticides, PCBs, and mercury, as well as to evaluate their effects on the population decline of peregrine falcons in France.

MATERIALS AND METHODS

Sample collection. Eggs were collected between 1974 and 1978 in the nesting sites controlled by the "P.F. Project" in the Monts Jura (East of France) and did not hatch in incubators.

In 1978 and 1979, sterile eggs of peregrine falcon raised under captivity were also analyzed. Eggs were deep-frozen until analyzed. Analyses were performed on the total content of the eggs without the shells).

Methods of analyses. The method for organochlorine residues was that previously published by KECK & RAFFENOT (1979). The analytical method for mercury has been described by CUMONT (1971).

RESULTS

The results, expressed as ppm fresh weight in the total eggs, are presented in the following tables 1 through 5

The nesting sites are identified by a code (A1, B1...) and cannot be precisely geographically described in order to prevent poaching.

Table 1. Contamination levels (expressed as ppm/fresh weight) of organochlorine residues in peregrine falcon eggs in the years 1974 and 1975.

Sites	1 9 7 4		1 9 7 5			
	DDE	PCB	HCB	HCH (total)	DDE	PCB
A ₁	27	160	-	-	-	-
A ₂	-	-	1.9	0.073	22	0.94
	-	-	2.2	0.10	37	1.2
A ₃	-	-	0.14	0.10	2.6	0.12
			0.068	0.093	0.90	0.067
			0.32	0.27	9.6	0.11
B ₁	1.4	3.5	0.21	0.14	3.5	0.16
	8.3	0.77	0.17	0.19	2.6	1.0
	10	0.97	-	-	-	-
B ₂	-	-	0.058	0.038	1.5	0.096
C ₁	28	23	-	-	-	-
	3.4	9.4	-	-	-	-

DISCUSSION

On the whole, the contamination levels appear to be very high especially for DDE and total PCBs. DDE levels often reach 30 to 40 ppm and PCB levels are often as high as 50 to 60 ppm. The $\frac{\text{DDE}}{\text{PCB}}$ ratio seems quite constant, generally around 1/2. Nevertheless, for the 1974-75 samples, the levels of DDE are often higher than PCBs which appear moderate in comparison with the following year. The other organochlorine residues (HCb, HCH, DDT, heptachlor epoxide, dieldrin) are far lower, especially for the last two years. However, significant levels of HCB were found in the samples which were the most contaminated by DDE and PCBs.

Thus, the contamination by PCBs is largely predominant, together with high levels of DDE. This feature was noted in most contamination studies, for example in the Furans river which is located near to the nesting sites (KECK & RAFFENOT 1979).

These high levels in the eggs of peregrine falcon may be related to failure to reproduce.

Table 2.. Contamination levels (expressed as ppm/fresh weight) of organochlorine residues in peregrine falcon eggs in the years 1976-1977.

Sites	1 9 7 6				1 9 7 7		
	HCB	HCH	DDE	PCB	HCB	DDE	PCB
A ₂	0.98	0.21	10	72	2.5	37	120
	4.4	0.67	38	180	2.9	0.63	120
A ₄	4.9	0.78	33	34	-	-	-
B ₁	0.028	0.12	14	21	2	56	73
	0.31	0.076	3.3	5.5	-	-	-
	0.82	0.95	30	45	-	-	-
	4.3	1.0	35	79	-	-	-
B ₂	-	-	-	-	0.70	9.7	22
B ₃	0.020	-	0.26	0.47	0.78	14	38
	0.010	-	0.080	0.29	-	-	-
	0.052	-	0.44	1.9	-	-	-
	0.53	0.31	7.7	21	-	-	-
B ₄	5.2	1.3	60	180	-	-	-
	1.4	0.038	6.0	62	-	-	-
	1.0	0.28	29	56	-	-	-

Table 3. Contamination levels (expressed as ppm/fresh weight) of organochlorine residues in peregrine falcon eggs in 1978 (wild birds). HE-D: Heptachlor epoxide and Dieldrin.

Pesticides Layings	HCB	HCH	DDE	TDE	DDT	HE-D	PCB
A ₄ eggs	1 1.3	0.13	42	0.11	0.05	ND	90
	2 0.57	0.12	26	0.10	0.02	0.014	68
	offspring 0.03	0.09	7.0	0.07	0.13	ND	19
B ₅	1 0.27	0.16	4.0	0.09	0.08	0.24	6.8
	2 0.02	0.01	6.1	0.05	0.01	ND	8.6
	3 0.30	0.08	3.1	0.01	0.01	0.02	2.9
A ₅	1 0.48	0.01	4.0	0.05	0.18	ND	18
	2 1.6	0.01	35	0.42	ND	0.01	66
B ₃	1 0.03	0.08	7.4	0.01	0.009	0.01	12
	2 0.03	0.13	0.79	0.01	0.02	0.02	3.7
offspring	0.08	0.17	13	0.34	0.12	0.05	18

Table 4. Contamination levels (expressed as ppm/fresh weight) of organochlorine residues in falcon eggs in 1978 (captive birds).

		HCB	HCH	DDE	TDE	DDT	HE-D	PCB
	eggs							
	1	0.17	0.25	1.01	0.06	0.07	0.066	4.8
Laying	2	0.37	0.09	0.83	0.06	0.08	0.091	5.5
n° 1	3	0.19	0.04	0.58	0.09	0.015	0.016	5.0
	4	0.04	0.06	0.49	0.04	ND	ND	4.9
	5	0.03	0.13	0.79	0.01	0.022	0.020	3.7
	1	0.02	0.16	0.43	0.02	0.033	0.058	2.3
Laying	2	ND	0.16	0.81	0.02	0.029	0.020	3.5
n° 2	3	0.01	0.07	1.7	1.2	0.5	0.16	7.2
eggs	1	0.05	0.21	0.22	0.05	0.017	0.078	5.8
of	2	0.10	0.04	0.29	0.06	0.013	ND	7.1
Lanner	3	0.02	0.02	0.11	0.008	0.007	0.069	3.8
Falcon	4	0.007	0.006	0.04	0.02	0.023	0.024	1.0
offspring		0.05	0.08	0.68	0.04	0.010	0.084	1.2

Table 5. Contamination levels (expressed as ppm/fresh weight) of mercury in peregrine falcon eggs.

1974 {		wild birds		1978 {		captive birds	
Mercury	1974	1978		1978		1978	
Sites		Sites Wild birds		Sites Captive birds			
A ₁	-	Eggs		Laying of cap- tive falcon couple	N° eggs		
		1	0.25			1	0.007
A ₂	-	A ₄	2 0.16			2	0.007
	-	Offspring	0.10			3	0.009
						4	0.007
A ₃	-	1	0.19	Laying of cap- tive falcon couple	N° eggs	5	0.005
		B ₅ eggs	2 0.20			1	-
		3	0.28			2	0.009
B ₁	0.32					3	-
	0.29	A ₅ eggs	1 -				
	0.24	2	0.19	Laying of cap- tive falcon couple	N° eggs	1	0.007
B ₂	-	B ₃ eggs	1 0.38			2	0.010
		2	-			3	0.014
						4	0.031
C ₁	-	offspring	0.310			offspring	0.030

Nevertheless, there are wide variations between eggs from different couples and for those from the same couple and variations in different years of sampling. The maximum levels are 60 ppm DDE and 181 ppm PCB in eggs from the site B4 (year 1976) whose couple was but weakly productive (one offspring per year). These levels appear to be as high or even higher than those reported in other countries : LINCER et al. (1970) found average levels of 27 ppm of DDE in eggs of peregrine falcons from Alaska ; ENDERSON (1966) reported 18 to 28 ppm DDE in eggs from Northern Canada. In England, RATCLIFFE (1970) found similar levels in thin-shelled eggs. Despite these very high levels, we did not always observe abnormalities in reproduction, except for the sterile couple A1 which produced abnormal eggs.

The levels of mercury (0.1 to 0.3) are quite moderate and of the same order of magnitude as those established in Canada by FIMREITE et al. (1970).

Moreover, the abundance of prey could have favored the increase of the falcon, since populations of starlings, pigeons and other migrating species have increased in the past several years.

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