INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL)

NCC/NERC CONTRACT HF3/08/01
ITE PROJECT T07014a1
Annual report to Nature Conservancy Council

BIRDS AND POLLUTION

Part 1 Organochlorines and mercury in predatory birds
2 Sparrowhawk survey
3 Organochlorines and mercury in peregrine eggs
4 Organochlorines and mercury in merlin eggs
5 Organochlorines and mercury in gannet eggs
6 PCBs in puffins
7 Rodenticides in barn owls

I NEWTON, A ASHER, A A BELL, P FREESTONE, M C FRENCH, M B HAAS, M P HARRIS, D LEACH, G POLWARTH & I WYLLIE

Monks Wood Experimental Station
Abbots Ripton
HUNTINGDON
Cambs PE17 2LS

August 1988

NCC. CSD REPORT

869

DOCUMENT	CSD REPORT NO. 869
TITLE	Birds and pollution. Annual report. £YEAR 1988
AUTHOR	NEWTON, I., and others
ORGANISATION	Institute of Terrestrial Ecology
ABSTRACT	Covers organochlorines and mercury in predatory birds; sparrowhawk survey; organochlorines and mercury in peregrine, merlin and gannet eggs; PCBs in puffins; rodenticides in barn owls.
CONTRACT	As report title.
NOTES	36 pages. NCC Research Contract HF3/03/01. Related Reports Nos. 543,584,667,762
FICHE	1 fiche

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Part 1 Organochlorines and mercury in predatory birds

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1 ORGANOCHLORINES AND MERCURY IN PREDATORY BIRDS

1.1 Introduction

The main objective of this work was to analyse the carcasses of predatory birds, supplied by members of the public, in order to continue the monitoring of organochlorine and metal residues in livers. The chemicals of interest included DDE (from the insecticide DDT), HEOD (from the insecticides aldrin and dieldrin), PCBs (polychlorinated biphenyls from industrial products) and Hg (mercury mainly from agricultural and industrial sources). A full account of the total findings during 1963-85 was given in Newton et al (1986), and of the findings for 1986 in Newton et al (1987). Only the results obtained since that date are given here.

1.2 Results

During 1987, the livers from 150 birds were analysed, including those from 25 kestrels, 66 sparrowhawks, 17 herons, 7 kingfishers, 28 great-crested grebes and 7 others. These totals included some birds which had died in earlier years, but which were analysed in 1987. The results from all these birds are listed in Table 1, and the geometric means for each chemical from the main species (1987 specimens only) are given in Table 2. The number of grebes is so high because we received 23 that had been drowned during work on a reservoir in Surrey. Their organochlorine contents were not obviously different from those in other species.

Notably high results included a level of 137 ppm PCB in a kestrel from Kent, a level of 9 ppm of Hg in a kestrel from Orkney (a site with high Hg levels in merlins, Newton & Haas 1988), a level of 87 ppm PCB in a sparrowhawk from Devon, and levels exceeding 10 ppm of mercury in five sparrowhawks. Levels up to 58 ppm mercury were found in herons, and up to 48 ppm in grebes, but these species usually contain more mercury than the others.

Six significant differences in geometric mean values were found between the 1987 and 1986 results, out of 20 comparisons (Table 3). They included a decline in the DDE, HEOD and PCB levels in sparrowhawks, a rise in the mercury levels in sparrowhawks, and a decline in the PCB levels in herons and kingfishers.

It is impossible to say whether these differences reflected real changes in exposure.

1.3 Conclusions

In general, these recent findings confirm a continuing contamination of the study species with organochlorines and mercury. Although the levels of all the chemicals involved (except PCBs) have declined somewhat over the whole study period from 1963, there has been no substantial drop in the levels of any chemical since the EEC regulations came into effect from 1983. Further monitoring is desirable.

1.4 References

NEWTON, I. & HAAS, M.B. 1988. Pollutants in merlin eggs. Brit. Birds 81: 258-269.

NEWTON, I., HAAS, M.B., WYLLIE, I., LEACH, D.V., FREESTONE, P. & GORE, D.J. 1986. Birds and Pollution (Part 1). Natural Environment Research Council contract report to the Nature Conservancy Council. Abbots Ripton: Institute of Terrestrial Ecology.

NEWTON, I., BELL, A.A., FREESTONE, P., FRENCH, M.C., HAAS, M.B., HARRIS, M.P., LEACH, D.V., OSBORN, D., POLWORTH, G. & WYLLIE, I. 1987. Birds and Pollution (Part 1). Natural Environment Research Council contract report to the Nature Conservancy Council. Abbots Ripton: Institute of Terrestrial Ecology.

Table 1. Levels of organochlorines (ppm in wet weight) and mercury (ppm in dry weight) in the livers of predatory birds analysed between April 1987 and March 1988. ND=none detected.

Spec. no.	Date found	County	Age	Sex	pp'-DDE	HEOD	PCBs	Hg
Kestrel (Falco tinnunculus)								
8884	Jan 87	Clyde	J	F	ND	ND	1.01	ND
8886	Jan 87	Herts	A	M	0.45	0.53	4.83	ND
8891	Jan 87	Kent	J	F	3.21	0.66	5.60	1.27
8970	Jan 87	Kent	J	M	28.44	1.58	137.18	1.27
8935	Feb 87	Hants	A	M	0.63	0.39	7.93	0.96
8954	Mar 87	NW Yorks	J	F	0.09	0.31	0.84	0.84
8955	Apr 87	Essex	J	F	38.72	0.86	8.53	1.22
8965	Apr 87	Staffs	J	M	1.17	ND	0.68	0.44
8968	Apr 87	Warwicks	J	F	0.17	0.30	0.37	0.30
9097	Apr 87	Perths	J	F	0.12	0.09	2.00	1.20
8992	Jul 87	Leics	A	M	0.46	0.46	1.13	1.01
8993	Jul 87	Herts	J	F	ND	0.17	2.59	0.67
8994	Jul 87	Suffolk	J	M	18.47	0.41	1.79	4.48
8996	Jul 87	Hunts	J	F	4.18	1.25	ND	2.19
8998	Jul 87	N'hants	J	F	0.36	0.42	1.49	1.13
8997	Aug 87	Surrey	A	F	0.44	0.26	4.91	0.53
8999	Aug 87	Norfolk	J	F	0.13	0.69	ND	0.75
9011	Aug 87	Salop	J	M	ND	0.31	1.67	2.72
9017	Aug 87	Norfolk	J	F	0.84	0.37	0.81	2.69
9032	Sep 87	Cambs	J	M	3.56	0.94	2.16	1.62
9047	Oct 87	Lincs	J	F	0.54	0.31	0.84	1.21
9155	Oct 87	Orkney	J	M	0.18	0.30	3.46	9.28
9100	Nov 87	Hunts	J	F	1.89	0.36	0.78	2.00
9135	Nov 87	Wilts	A	M	0.23	0.47	0.81	0.29
9144	Dec 87	Norfolk	J	F	0.08	0.12	1.38	0.63
Sparrowhawk (Accipiter nisus)								
9026	Apr 77	Aberdeens	A	F	47.85	5.52	65.93	12.48
9027	Feb 81	K'c'bright	J	F	1.99	0.40	2.73	3.76
9151	Aug 84	Midlothian	J	M	1.56	0.96	2.03	ND
9163	85	Moray	A	M	23.88	0.43	19.66	12.85
9164	Sep 85	Moray	J	M	0.67	0.08	0.27	1.42
9113	Dec 85	Surrey	A	F	10.11	0.94	18.26	2.25
9122	May 86	SW Yorks	A	M	13.29	1.12	45.11	3.42
9107	Aug 86	Inverness	J	F	1.00	0.12	1.02	2.63
9030	Aug 86	Fife	J	M	0.42	0.21	0.33	2.31
8898	Jan 87	K'c'bright	A	F	2.13	0.46	7.41	3.58
8917	Feb 87	Surrey	J	F	0.51	0.28	5.31	1.12
8936	Jan 87	Oxon	A	M	2.45	0.40	4.76	2.21
8918	Feb 87	Sussex	-	F	2.69	0.60	6.05	2.53
8933	Feb 87	W'morland	A	M	12.19	3.01	12.23	11.00
8941	Feb 87	Berwick	A	M	2.14	0.31	4.52	3.26
8964	Feb 87	E Ross	A	M	5.29	0.19	10.21	15.15
8937	Mar 87	Peebles	A	M	17.95	2.37	10.76	6.08

Table 1 (contd)

8944	Mar 87	W'morland	A	F	1.44	0.33	0.46	5.64
8948	Mar 87	Cambs	J	M	13.78	0.69	5.08	2.79
8949	Mar 87	Kent	J	F	8.35	1.05	9.88	2.90
8951	Mar 87	N'hants	J	F	0.87	0.11	0.34	3.58
8952	Mar 87	Herefs	A	M	0.93	0.76	0.47	3.39
8953	Mar 87	Hants	A	M	7.40	0.30	42.97	2.68
8957	Apr 87	Devon	J	F	12.83	ND	86.98	8.16
8958	Apr 87	Sussex	A	F	3.50	0.67	2.42	3.34
8960	Apr 87	Staffs	J	M	1.16	0.22	2.89	2.28
8962	Apr 87	Surrey	A	F	7.73	0.74	3.07	3.52
8963	Apr 87	Kent	A	F	1.23	0.10	0.18	4.34
8973	May 87	Wilts	A	M	0.95	0.13	1.18	4.43
8977	May 87	Berks	A	M	11.98	0.68	22.39	13.69
9043	May 87	N'hants	J	M	1.90	0.34	1.96	3.67
8982	Jun 87	Derbys	A	M	0.72	0.07	3.11	1.52
9000	Aug 87	Durham	J	F	ND	ND	0.35	1.52
9003	Aug 87	Aberdeens	J	F	0.11	0.06	0.68	1.10
9004	Aug 87	Cambs	A	F	0.67	0.09	0.28	0.91
9006	Aug 87	Somerset	J	F	0.37	0.10	5.25	1.08
9007	Aug 87	Hunts	J	M	1.06	0.22	1.06	0.86
9008	Aug 87	Hunts	J	F	0.45	ND	0.59	1.07
9009	Aug 87	Berks	J	F	ND	ND	0.35	1.11
9012	Aug 87	Derbys	J	M	ND	ND	0.37	2.28
9013	Aug 87	Somerset	J	F	1.01	0.13	0.44	1.52
9016	Aug 87	Brecon	J	F	1.65	0.37	1.15	0.74
9044	Aug 87	Glos	J	M	2.27	0.88	4.98	4.22
9106	Aug 87	Sutherland	J	M	0.48	0.11	0.36	4.88
9018	Sep 87	N'hants	J	F	0.25	ND	0.47	0.77
9019	Sep 87	Cardigan	J	F	0.13	0.11	0.82	4.17
9021	Sep 87	Cheshire	J	M	0.51	0.28	1.42	0.77
9024	Sep 87	Brecon	J	F	0.47	0.09	0.41	3.37
9045	Sep 87	Glos	J	M	0.35	0.14	0.36	3.75
9109	Sep 87	E Ross	J	F	0.43	0.05	0.61	4.41
9108	Sep 87	E Ross	J	F	0.20	0.11	0.41	2.93
9042	Oct 87	Argyll	J	F	0.06	0.12	0.56	1.71
9046	Oct 87	Salop	J	F	0.36	0.11	0.39	0.87
9048	Oct 87	Aberdeens	J	M	15.16	0.10	3.96	3.02
9052	Oct 87	Suffolk	A	M	1.73	0.29	0.39	0.71
9152	Oct 87	E Lothian	J	M	6.20	0.92	2.26	2.61
9168	Oct 87	Berwick	J	M	1.80	0.34	2.48	4.14
9130	Nov 87	N'hants	J	M	0.57	0.30	0.46	1.22
9131	Nov 87	N'hants	J	M	0.38	0.08	0.72	0.50
9153	Nov 87	Midlothian	J	M	ND	ND	0.35	0.67
9169	Nov 87	-	J	F	0.29	0.20	0.67	1.29
9132	Dec 87	Dorset	J	M	3.54	0.38	6.88	6.20
9141	Dec 87	W'morland	J	F	0.68	0.30	1.24	4.15
9143	Dec 87	Sutherland	J	F	0.29	ND	0.29	4.65
9170	Dec 87	-	-	F	0.64	0.21	5.12	1.60
9171	- 87	E.Lothian	A	M	5.12	0.53	28.42	2.32
Peregrine falcon (*Falco peregrinus*)								
8921	Jan 87	Banff	A	M	1.75	0.27	3.22	0.62
9165	Jan 87	Inverness	A	F	26.24	0.98	292.34	6.80
8995	Jul 87	I of Man	J	F	ND	0.35	0.36	1.11

Table 1 (contd)

Long-eared owl (Asio otus)

8930	Feb 87	Oxon	-	F	0.41	0.28	2.40	ND
8934	Feb 87	N'hants	-	M	2.00	1.40	13.69	1.32
8946	Mar 87	Pembroke	-	F	0.79	0.09	0.54	0.92
8976	May 87	E Yorks	A	F	17.81	1.24	39.75	3.85

Heron (Ardea cinerea)

9029	Feb 79	Perths	A	F	49.76	2.32	118.66	35.88
8643	Apr 86	Lincs	A	M	0.77	0.34	15.22	8.71
8896	Jan 87	SE Yorks	J	F	5.59	5.64	12.72	6.33
8905	Jan 87	Sussex	J	F	2.39	0.66	8.52	6.79
8910	Jan 87	Essex	J	F	0.32	0.27	7.63	4.59
8916	Feb 87	Fife	J	M	13.13	10.81	6.28	58.10
8925	Feb 87	Cambs	J	F	8.59	1.32	10.22	25.80
8932	Feb 87	Essex	J	M	5.62	2.15	9.80	42.00
8947	Mar 87	Salop	J	F	3.00	0.72	7.13	10.80
8975	May 87	Fife	J	-	0.27	ND	0.46	7.42
8981	Jun 87	Carmarthen	J	M	0.11	0.10	ND	11.40
9010	Aug 87	N'hants	J	-	0.27	0.25	0.38	4.10
9049	Oct 87	Wilts	A	F	0.56	0.13	0.31	5.01
9051	Oct 87	Derbys	J	F	1.84	10.44	12.77	26.89
9098	Nov 87	Hunts	J	F	0.28	0.19	0.41	10.24
9136	Dec 87	Glamorgan	J	F	4.01	2.50	23.80	52.08
9140	Dec 87	Beds	A	M	0.36	0.12	0.25	9.31

Great crested grebe (Podiceps cristatus)

9054	Dec 86	Surrey	J	M	10.02	0.44	8.53	15.04
9055	"	"	A	M	17.69	0.29	11.91	26.74
9056	"	"	J	M	12.66	0.97	8.68	29.41
9057	"	"	J	M	9.21	0.44	13.68	18.38
9058	"	"	J	M	20.73	0.52	14.47	16.34
9059	"	"	J	M	5.04	ND	0.91	19.91
9060	"	"	J	F	2.11	0.64	5.16	25.00
9061	"	"	A	F	11.40	0.88	9.60	18.98
9062	"	"	A	M	30.60	0.14	1.75	31.66
9063	"	"	J	F	9.12	0.39	4.11	12.41
9064	"	"	A	F	8.27	0.29	5.00	16.14
9065	"	"	A	M	5.41	0.15	2.08	28.08
9066	"	"	A	F	3.86	ND	1.01	25.74
9067	"	"	A	M	25.14	0.91	19.86	13.93
9068	"	"	A	F	4.26	0.15	4.90	16.81
9069	"	"	A	M	38.44	0.57	11.40	13.37
9070	"	"	A	F	32.78	0.61	25.08	16.34
9071	"	"	A	M	8.90	0.22	7.22	21.01
9072	"	"	A	F	31.93	0.46	15.61	14.71
9073	"	"	J	F	2.45	0.06	0.41	17.73
9074	"	"	J	F	2.37	ND	2.50	13.54
9075	"	"	J	M	4.20	ND	2.42	17.23
9076	"	"	J	F	4.12	ND	1.34	16.01
8901	Jan 87	Lancs	A	F	2.31	0.73	11.11	3.06
8978	May 87	Suffolk	A	M	1.22	ND	0.26	47.54
8988	Jun 87	Hunts	A	M	1.01	ND	0.19	47.58
9101	Nov 87	Lancs	A	M	18.31	0.29	116.39	3.22
9137	Dec 87	Essex	J	M	0.39	ND	0.31	2.47

Table 1 (contd)

Kingfisher (*Alcedo atthis*)

9103	Aug 85	Dumfries	J	M	0.40	0.61	2.40	2.97
8920	Feb 87	Herts	A	M	0.88	0.71	3.75	1.66
8966	Feb 87	Salop	A	M	1.23	1.04	0.81	2.39
8985	Jun 87	Herts	J	M	0.11	0.38	0.50	2.70
8986	Jun 87	Hunts	J	M	2.04	0.96	ND	7.63
8987	Jun 87	N'hants	J	M	ND	0.22	0.62	1.30
8991	Jul 87	Essex	A	M	2.40	1.28	0.51	1.22

Table 2. Geometric mean levels of pollutants in the various species in Table 1, but for 1987 specimens only.

Species	pp'-DDE	HEOD	PCBs	Hg
<u>Kestrel</u>				
Mean	0.44	0.27	1.38	0.80
SD	1.07	0.66	0.83	0.67
Range within 1 SE	0.27-0.72	0.20-0.37	0.94-2.02	0.58-1.09
<u>Sparrowhawk</u>				
Mean	1.01	0.18	1.70	2.42
SD	0.71	0.62	0.65	0.34
Range within 1 SE	0.82-1.25	0.14-0.21	1.39-2.06	2.18-2.68
<u>Heron</u>				
Mean	1.25	0.50	2.09	12.58
SD	0.67	0.78	0.96	0.39
Range within 1 SE	0.84-1.86	0.31-0.79	1.18-3.69	9.97-15.9
<u>Great crested grebe</u>				
Mean	1.83	0.05	1.82	8.88
SD	0.62	0.92	1.24	0.67
Range within 1 SE	0.96-3.47	0.02-0.12	0.51-6.51	4.47-17.6
<u>Kingfisher</u>				
Mean	0.42	0.65	0.41	2.25
SD	0.93	0.29	0.86	0.29
Range within 1 SE	0.18-1.02	0.49-0.86	0.18-0.92	1.71-2.97

Table 3. Comparison of geometric mean residue levels (log values) from birds collected in 1987 and 1986; t-values are shown. Minus values indicate a decrease from 1986.

	pp'-DDE	HEOD	PCBs	Hg
Kestrel				
	t_{82}=-1.27	t_{82}=-1.15	t_{82}=-0.27	t_{82}=+1.91
Sparrowhawk				
	t_{131}=-4.35***	t_{131}=-7.39***	t_{131}=-4.75***	t_{131}=+2.64**
Heron				
	t_{55}=-1.32	t_{55}=-0.70	t_{55}=-2.65**	t_{55}=-0.55
Great crested grebe				
	t_{35}=-0.84	t_{35}=-1.30	t_{35}=-0.66	t_{35}=-1.15
Kingfisher				
	t_{12}=-2.03	t_{12}=-0.83	t_{12}=-2.59*	t_{12}=+1.27

Notes: Non-detected values were taken as 0.01 for all residues.
* significance of difference P<0.05; ** P<0.01; *** P<0.001

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BIRDS AND POLLUTION

Part 2 Sparrowhawk Survey

A A BELL

Monks Wood Experimental Station
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August 1988

2 SPARROWHAWK SURVEY

2.1 Introduction

The sparrowhawk Accipiter nisus suffered a marked population decline in the late 1950s, following the widespread introduction of cyclodiene pesticides in agriculture. Since 1964, in each of seven study areas, potential territories have been checked periodically for occupation and breeding success. In this way, it was hoped to find whether sparrowhawks were recovering in numbers, following successive restrictions in cyclodiene use. The East Midlands area was the only one found to be devoid of breeding hawks at the outset of the study, and it remained so until the first evidence of summering birds was found in 1982, with breeding first confirmed two years later. The area was surveyed again in 1987, and the findings are summarised in Tables 4 and 5.

2.2 Results

Fifteen potential territories were searched in June and July, including all the six sites used since breeding resumed in 1984. Three of the six were deserted again after only 1-2 years' occupation, although an adult male was hunting in one. The other three, all of which successfully fledged some young in 1986, were reoccupied. Although one failed, progressing only to the stage of an incomplete nest, two produced broods of four young (Table 5). A third brood of four was found in a new site, and continued the trend of breeding suddenly occurring in territories with no prior indication of sparrowhawk presence.

Other reports and observations confirm that this area is steadily being reoccupied by sparrowhawks, most of which are breeding successfully. Consideration could be given to stopping this survey after 1988.

TABLE 4. Occupation of sparrowhawk territories in the East Midlands study area, 1987.

Total potential territories checked	15
Number with successful nests	3
Number with failed nests	1
Number with no nest, but other signs	5
Number of territories with old nests	6

TABLE 5. Occupation and success of seven sparrowhawk territories in the East Midlands study area.
S = successful nest; F = failed (incomplete) nests.
Numbers show young fledged.

Site No.	1984	1985	1986	1987
1	S/1+	-	-	-
2	S/1+	F/0	-	-
3		S/4	-	-
4		S/1	S/1	S/4
5			S/2	S/4
6			S/1	F/0
7				S/4

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BIRDS AND POLLUTION

Part 3 Organochlorines and mercury in peregrine eggs

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Monks Wood Experimental Station
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3 ORGANOCHLORINES AND MERCURY IN PEREGRINE EGGS

3.1 Introduction

The findings from all peregrine eggs analysed between 1961 and 1986 are summarised in Newton & Haas (in press), and those from eggs analysed in 1987 are given in Table 6. The latter exclude eggs analysed in that year by Dr. J. A. Bogan, which are not yet available to us.

3.2 Results

The results from the 19 additional eggs add little to the findings from previous years, except to confirm a continuing contamination of peregrines with organochlorines and mercury. All the values found were within the range of previous figures, and the eggs from coastal sites continued to show some of the highest levels of PCB and mercury. An egg from Co. Waterford contained the highest level of PCB with 30 ppm in wet weight, while another egg from that area contained 22 ppm PCB in wet weight and 2.3 ppm mercury in dry weight.

Table 6. Residue levels (organochlorine ppm wet weight; mercury ppm dry weight) and shell-indices for peregrine eggs analysed in 1987. ND=none detected.

Year	County	Shell index	pp'-DDE	HEOD	PCBs	Hg
NORTHERN ENGLAND						
1987	Northumberland	1.88	0.96	0.12	2.53	0.86
	Cumbria	1.88	1.31	ND	0.57	0.53
	Cumbria	1.59	1.39	0.06	2.40	0.99
	Cumbria	1.77	0.72	0.10	2.60	0.57
	Cumbria	1.56	5.88	0.21	5.14	2.42
	Cumbria	1.60	1.48	0.05	3.59	1.00
SOUTHERN SCOTLAND						
1987	Dumfries	1.94	0.59	0.07	0.22	0.59
CENTRAL AND EASTERN HIGHLANDS						
1986	Perth	2.04	0.48	ND	0.43	0.49
1987	Grampian	1.83	0.52	ND	0.63	0.56
	Grampian	1.92	ND	ND	0.51	0.26
	Grampian	2.00	1.40	ND	0.58	0.39
IRELAND						
1987	Co. Waterford	1.93	3.05	0.22	21.88	2.25
	Co. Waterford	1.71	2.36	ND	4.29	0.38
	Co. Waterford	1.57	5.90	0.52	21.80	0.91
	Co. Waterford	1.59	4.73	0.17	30.07	1.13
	Co. Waterford	1.62	2.25	0.32	2.91	0.89
	Co. Waterford	1.52	4.08	0.37	14.73	0.81
	Co. Wexford	1.51	2.79	0.09	0.40	0.32
	Co. Wexford	1.77	2.76	0.16	9.57	0.71

ND = None detected

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BIRDS AND POLLUTION

Part 4 Organochlorines and mercury in merlin eggs

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4 ORGANOCHLORINES AND MERCURY IN MERLIN EGGS

4.1 Introduction

In the report for last year, we gathered together all the results available for merlin eggs analysed in Britain during 1963-86, and these were later published as a paper (Newton & Haas 1988). The results from eggs analysed in 1987 are given in Table 7.

4.2 Results

The results from these additional eggs add little to the findings from previous years, except to confirm a continuing contamination of merlins with organochlorines and mercury. In general, merlins contain higher levels of all these chemicals than do any other of the British raptors. The extreme in 1987 was an egg from Northumberland which contained no less than 202 ppm DDE, 54 ppm HEOD and 463 ppm PCB in ~~wet~~ lipid weight, and 7.3 ppm mercury in dry weight. The HEOD level was one of the highest recorded since the study began.

Table 7. Residue levels (organochlorine ppm in lipid; mercury ppm in dry weight) and shell-indices for merlin eggs analysed in 1987.
C=clutch size; F=brood size; ND=none detected.

Year	County	C	F	Shell index	pp'-DDE	HEOD	PCBs	Hg
WALES								
1987	Merioneth	4	0	1.15	61.64	2.74	130.14	1.72
	Merioneth	4	0	1.06	88.68	2.83	80.19	0.80
	Cardigan	5	0	1.15	88.61	15.84	353.96	6.00
	Denby	2	0	1.18	73.46	1.90	20.85	1.82
	Montgomery	4	2	1.13	104.68	3.40	81.70	2.79
	Merioneth	4	3	1.19	27.35	ND	10.26	3.58
	Merioneth	3	0	1.06	57.89	1.40	35.44	2.53
NORTHUMBERLAND								
1987		-	-	1.09	204.35	6.25	17.12	4.27
		-	-	1.22	202.06	53.61	462.89	7.53
		-	-	0.97	54.74	7.33	221.98	4.52
		-	-	1.18	88.04	7.66	51.20	2.03
		-	-	1.09	62.94	16.08	34.97	2.38
		-	-	1.26	44.77	20.92	64.44	2.31
		-	-	1.06	136.16	18.08	103.95	2.51
GALLOWAY AND SOUTHERN UPLANDS								
1987	Borders	2	0	-	159.53	8.56	24.12	4.70
	Galloway	4	2	1.20	77.78	2.02	46.97	5.31
	Galloway	-	-	1.39	27.44	1.14	15.79	3.69
	Borders	4	0	0.97	142.07	3.05	23.17	2.07
	Lothian	4	3	1.08	182.29	4.69	33.33	2.65
	Lothian	5	2	1.04	82.30	2.65	46.46	5.45
HIGHLANDS								
1982	Grampian	3	2	1.20	114.16	1.37	12.79	0.82
	Grampian	4	2	1.15	47.08	3.51	21.35	0.80
	Grampian	5	4	1.00	114.33	8.66	58.51	1.60
	Grampian	4	2	1.01	92.79	5.86	43.69	2.63
	Grampian	5	3	1.00	142.14	3.68	141.14	2.75
1987	Grampian	4	1	1.02	178.92	1.81	27.71	1.98
	Inner Hebs.	4	0	1.38	42.96	2.52	136.82	9.73
	Inner Hebs.	4	2	1.18	63.75	5.83	82.92	9.61
	Inner Hebs.	4	3	1.15	34.52	ND	9.14	2.45
	Grampian	5	3	1.25	110.31	3.05	34.73	2.70
	Banff	4	0	0.94	141.73	14.17	159.45	4.34
	Perths	5	3	1.12	106.16	7.19	13.01	1.41
	Perths	-	3	1.15	65.65	6.11	30.92	1.08
	Perths	5	4	1.20	79.49	1.92	17.63	2.16
	Perths	-	0	1.12	55.70	4.03	19.13	7.63
	Aberdns	4	2	1.03	189.15	32.55	77.36	4.18
	Aberdns	5	0	-	65.71	7.35	9.80	1.68
	Grampian	5	3	1.21	52.78	1.98	16.67	2.14
ORKNEY								
1987		-	-	-	197.23	8.32	76.55	3.81

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BIRDS AND POLLUTION

Part 5 Organochlorines and mercury in gannet eggs

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5 ORGANOCHLORINES AND MERCURY IN GANNET EGGS

5.1 Introduction

As part of a long-standing programme, gannet eggs were collected in 1987 from Ailsa Craig, Bass Rock and St. Kilda, and analysed for organochlorines and mercury.

5.2 Results

The levels of DDE and HEOD were less than 1 ppm in all eggs, levels of PCB were somewhat higher (up to about 10 ppm in wet weight), while levels of mercury were up to 4.7 ppm in dry weight (Table 8). Mean HEOD and Hg levels were significantly higher at St. Kilda than at the other colonies, and mean PCB levels were significantly lower at Ailsa Craig than at the other colonies (Table 9).

Compared with results from 1985 eggs from the same colonies, significant declines were apparent in the PCB level at Ailsa Craig and in the shell-index at Bass Rock, while significant increases were apparent in the HEOD and PCB level at St. Kilda and the mercury level at Bass Rock (Table 10).

It is impossible to say whether these differences represent real changes in exposure, especially as the levels of organochlorines were relatively very low.

Table 8. Residues of organochlorines (ppm wet weight) and mercury (ppm dry weight) in the eggs of gannets (Sula bassana), 1987. ND=None detected.

Colony	Shell-index	pp'-DDE	HEOD	PCBs	Hg
AILSA CRAIG					
	2.86	0.15	ND	0.48	3.51
	2.80	0.29	0.23	1.11	1.68
	3.07	0.37	0.19	1.98	1.94
	2.98	0.38	0.29	2.70	3.17
	2.90	0.29	0.20	1.34	2.60
	2.58	0.34	0.19	2.97	3.14
	3.04	0.15	0.12	0.25	3.31
	2.74	0.27	0.30	1.85	4.66
	2.77	0.14	0.13	0.44	3.19
	3.02	0.34	0.34	2.38	3.64
Mean*	2.88	0.26	0.15	1.19	2.97
SD	0.16	0.17	0.44	0.38	0.13
Range within 1 SE	2.83-2.93	0.16-1.13	0.11-0.21	0.90-1.56	2.70-3.27
BASS ROCK					
	2.78	0.75	0.36	7.35	1.79
	3.02	0.76	0.30	7.36	2.17
	2.81	0.10	0.12	1.36	2.45
	2.69	0.63	0.31	5.71	3.09
	2.96	0.29	ND	2.96	1.88
	2.94	0.43	0.15	8.75	2.24
	2.87	0.11	ND	1.26	1.82
	2.87	0.34	0.15	3.68	1.94
	2.67	0.31	0.14	3.36	1.71
	2.93	0.24	ND	3.23	1.73
Mean*	2.85	0.32	0.08	4.34	2.05
SD	0.12	0.31	0.65	0.34	0.08
Range within 1 SE	2.82-2.89	0.26-0.41	0.05-0.13	3.40-5.55	1.93-2.17
ST KILDA					
	2.67	ND	0.73	10.56	2.31
	3.07	0.24	0.18	3.82	1.95
	3.23	0.62	1.94	8.20	2.36
	2.26	0.23	1.09	3.74	1.83
	2.83	0.63	1.15	6.38	2.34
	2.77	0.29	0.46	1.89	2.83
	3.16	0.48	1.34	5.55	1.72
	3.43	3.20	1.56	3.93	1.67
Mean*	2.93	0.32	0.86	4.89	2.09
SD	0.37	0.71	0.34	0.23	0.08
Range within 1 SE	2.80-3.46	0.18-0.56	0.66-1.14	4.05-5.93	1.96-2.24

*Means: arithmetic for shell index; geometric otherwise.

Difference between Ailsa Craig and Bass Rock significant for PCBs ($t_{18}=3.49$, $P<0.01$) and Hg ($t_{18}=3.33$, $P<0.01$); between Ailsa Craig and St. Kilda for HEOD ($t_{16}=4.00$, $P<0.01$), PCBs ($t_{16}=4.00$, $P<0.01$) and Hg ($t_{16}=2.90$, $P<0.05$).

Table 9. Comparison of geometric mean residue levels (log values) and shell indices (arithmetic mean) in 1987 gannet eggs between three sites, Ailsa Craig, Bass Rock and St. Kilda. Figures show t-values, with significance levels (*P<0.05, **P<0.02, ***P<0.001).

Site	Shell Index	pp DDE	HEOD	PCBs	Hg
Ailsa Craig/Bass Rock	t_{18}=-0.47	t_{18}=-0.81	t_{18}= 1.1	t_{18}=-3.49**	t_{18}= 3.33**
Ailsa Craig/St. Kilda	t_{16}=-0.39	t_{16}=-0.39	t_{16}=-4.00**	t_{16}=-4.00**	t_{16}= 2.90**
Bass Rock/St. Kilda	t_{16}=-0.65	t_{16}= 0.001	t_{16}=-4.05***	t_{16}=-0.37	t_{16}=-0.22

Table 10. Changes in geometric mean residue levels (log values) and shell index (arithmetic mean) in 1987 gannet eggs from those collected from the same sites in 1985. Figures show t values with significance levels (*P<0.05, **P<0.02, ***P<0.001). Minus values indicate a decrease from 1985.

	DDE	HEOD	PCBs	Hg	Shell Index
Ailsa Craig					
	t_{18}= -2.01	t_{18}= -1.86	t_{18}= -2.78**	t_{18}= 3.03**	t_{18}= 0.85
Bass Rock					
	t_{20}= -0.25	t_{20}= -2.04	t_{20}= 1.87	t_{20}= 1.46	t_{17}= -3.73**
St. Kilda					
	t_{12} = 0.18	t_{12} = 5.95***	t_{12}= 2.69**	t_{6}= -0.48	t_{12} = 0.12

Note: As variances were unequal, degrees of freedom were calculated.

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BIRDS AND POLLUTION

Part 6 PCBs in Puffins

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6 PCBs IN PUFFINS

6.1 Introduction

Ten puffins were collected from the Isle of May in 1987, as a final sample in the study of PCB levels following a dosing experiment (Harris & Osborn 1981).

6.2 Results

PCB was present at relatively low level in all the birds, and in almost all the tissues examined (Table 11). The brain of one bird contained a relatively high level (7 ppm) as did the muscle of another (9 ppm) and the kidney of a third (6 ppm). The levels were similar to those found in other recent years. A full assessment of findings will be given in the report for next year.

6.3 Reference

HARRIS, M.P. & OSBORN, D. 1981. Effect of a polychlorinated biphenyl on the survival and breeding of puffins. J. Appl. Ecol. 18: 471-479.

Table 11. PCB residues (mg/kg) in tissues of puffins (Fratercula arctica) from the Isle of May, 1987.

Bird	Brain	Muscle	Fat	Liver	Kidney
87/01	0.71	0.99	16.13	1.09	0.28
87/02	0.90	0.37	20.94	0.24	0.50
87/03	0.42	0.37	16.25	0.63	0.81
87/04	0.51	0.38	NS	0.53	5.98
87/05	0.37	0.79	15.74	0.37	0.43
87/06	0.83	9.04	21.59	ND	0.30
87/07	0.94	0.66	7.97	2.21	0.31
87/08	7.03	1.90	0.21	13.61	4.92
87/09	0.91	1.14	0.98	0.35	0.65
87/10	0.35	3.13	ND	1.39	0.38

ND = none detected, <0.01 mg/kg.
NS = no sample

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BIRDS AND POLLUTION

Part 7 Rodenticides in Barn Owls

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August 1988

7 RODENTICIDES IN BARN OWLS

7.1 Introduction

The development of resistance by rats to the rodenticide warfarin has led to the development of other, more potent, anticoagulants for use in rodent control. Two main chemicals are in current use, namely difenacoum (from 1974) and brodifacoum (from 1984), the latter restricted to use inside buildings. These 'second generation' rodenticides have been found to cause secondary poisoning of rodent predators (Mendenhall & Pank 1980), and have been suspected as contributing to the decline of barn owl populations in parts of Britain (Shawyer 1987). For this reason, we placed advertisements in bird journals, requesting barn owl carcasses for analysis. All carcasses were requested, irrespective of mode of death. Together with other carcasses, which had been received in previous years as part of the pesticide monitoring programme, we had a total of 78 bodies for analysis, mostly from the years 1985-87.

7.2 Methods

On receipt at Monks Wood Experimental Station, carcasses were stored deep frozen until the whole livers were required for analysis. The method of analysis was basically that of Hunter (1985), modified in minor respects. Liver samples were extracted with chloroform-acetone, and the extracts were cleared of fat using Bond Elut columns. The concentrated samples from the columns were then analysed on a Varian HPLC, using a MCH-5N micropack column and spectrofluorometer, against a standard for each compound. When brodifacoum or difenacoum were detected, a recovery test was done to validate the estimate. The lower limit of detection for both compounds was around 0.002 ppm, but varied slightly according to the weight of the liver sample.

7.3 Results

The findings are summarised in Table 12. Only 4 specimens (5%) contained residues of the rodenticides concerned: two had brodifacoum alone, one had difenacoum alone, and the fourth had both compounds. All four owls were from areas of known warfarin resistance in rats, and within known centres of 'second generation' anticoagulant use (Shawyer 1980). They formed about 25% of birds received from such areas.

Two of the four owls with rodenticide residues showed marked haemorrhaging around the heart. However, haemorrhaging was of little value as a diagnostic aid, because many of the other owls examined had died of collisions, which also caused internal bleeding.

7.4 Discussion

The results confirm unequivocally that barn owls exposed to rodenticide residues in the British countryside can retain such residues within their bodies. On the information available, however, it is impossible to say whether such residues were sufficient to kill the four birds involved. The only published figure we can find of a lethal level in a bird carcass is the 0.2$\mu g\ g^{-1}$ found in the whole body (minus head, feet and feathers) of a screech owl <u>Otus asio</u> (Merson et al 1984). This figure is not comparable with the liver levels quoted in Table 12. The work of Mendenhall & Pank (1980) implied that more than one rodent contaminated with difenocoum or brodifacoum would be needed to kill an owl.

The appearance of brodifacoum in three barn owls need not have implied illegal outside use of the chemical, because dying rodents might leave buildings and, in some situations, barn owls will almost certainly attack prey within buildings. After ingestion of the poison, death of the rodents may be delayed up to three weeks and sublethal levels of brodifocoum will persist for up to several months (Rammell et al 1984).

The fact that three of the four contaminated birds were from the most recent specimens need not imply poor persistence of these chemicals in carcasses, because the fourth contaminated bird had been preserved for three years since February 1985 before its liver was analysed. The trend could, however, indicate a growing rodenticide problem for owls, which only future work could confirm.

Experience elsewhere in the world suggests that these new rodenticides could pose a serious threat to owl populations. In Malaysia, an estimated 90% decline of barn owl numbers on an oil palm estate coincided with the replacement of warfarin with coumachlor and brodifacoum for rat control (Duckett 1984). Similarly, in Virginia, screech owl mortality occurred in an orchard where brodifacoum was applied to control voles. An analysis of one owl carcass revealed extensive haemorrhaging, and the presence of brodifacoum residues (Merson et al 1984). In Britain, several local reports of barn owl mortality were associated with use of difenacoum (4 cases), brodifacoum (4 cases) or bromadioline (1 case) in the period 1982-85; in each bird examined, haemorrhaging was apparent, but no chemical analyses were done (Shawyer 1987). Clearly, further work is needed on this potential problem.

7.5 References

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Table 12. Levels of rodenticides (ppm in wet wt) in the livers of barn owls (*Tyto alba*). ND=None detected.

No.	Date Found	County	Age	Sex	Brodifacoum	Difenacoum
8791	Oct 83	Argyll	J	F	ND	ND
8593	Nov 83	Lincs	A	F	ND	ND
9116	Dec 83	Wilts	-	M	ND	ND
8790	Jan 84	Wilts	1Y	M	ND	ND
8276	Apr 84	Hunts	1Y	F	ND	ND
8429	Aug 84	Dyfed	J	F	ND	ND
9117	Sep 84	Cornwall	J	F	ND	ND
9126	Oct 84	Cambs	J	M	ND	ND
8594	Jan 85	Suffolk	A	F	ND	ND
8161*	Feb 85	Notts	A	M	0.314	ND
8164	Feb 85	Beds	1Y	M	ND	ND
8176	Feb 85	Wilts	1Y	F	ND	ND
8233	Feb 85	Suffolk	1Y	M	ND	ND
8596	Feb 85	Wilts	-	-	ND	ND
8204	Mar 85	Borders	A	F	ND	ND
8222	Mar 85	W. Sussex	A	M	ND	ND
8241	Mar 85	Cambs	A	F	ND	ND
9115	Mar 85	Yorks	-	M	ND	ND
8264	Apr 85	Dorset	1Y	M	ND	ND
8431	Apr 85	Lincs	A	M	ND	ND
8342	Aug 85	Salop	J	M	ND	ND
8497	Oct 85	Devon	-	F	ND	ND
9118	Oct 85	Yorks	1Y	F	ND	ND
8454	Nov 85	Lincs	J	M	ND	ND
8459	Nov 85	Dorset	A	M	ND	ND
9124	Nov 85	Cambs	J	F	ND	ND
9128	Nov 85	Leics	1Y	F	ND	ND
8471	Dec 85	Gwynedd	A	F	ND	ND
8477	85	Oxon	A	F	ND	ND
8498	Jan 86	Devon	1Y	M	ND	ND
8592	Jan 86	Hunts	-	F	ND	ND
8500	Feb 86	Cheshire	A	F	ND	ND
8501	Feb 86	Devon	A	M	ND	ND
8504	Feb 86	IOW	1Y	M	ND	ND
8533	Feb 86	N'hants	A	M	ND	ND
8547	Feb 86	S'Clyde	1Y	M	ND	ND
8701	Feb 86	Wilts	A	M	ND	ND
9114	Feb 86	Lincs	A	F	ND	ND
8549	Mar 86	Borders	1Y	F	ND	ND
8559	Mar 86	D & G	1Y	M	ND	ND
8563	Mar 86	Devon	-	-	ND	ND
8570	Mar 86	Wilts	-	M	ND	ND
8577	Mar 86	Suffolk	A	F	ND	ND
8612	Apr 86	Lancs	A	M	ND	ND
8618	Apr 86	Hants	1Y	F	ND	ND
8625	Apr 86	-	1Y	F	ND	ND
8645	May 86	Lincs	A	M	ND	ND

8650	May 86	Lancs	-	F	ND	ND
8651	May 86	Lancs	A	F	ND	ND
8703	Jun 86	Bucks	A	F	ND	ND
8730	Aug 86	D & G	J	M	ND	ND
8742	Aug 86	Wilts	A	F	ND	ND
8752	Sep 86	Kent	J	M	ND	ND
8797	Oct 86	Wilts	J	M	ND	ND
8850	Nov 86	Cambs	1Y	F	ND	ND
8851	Oct 86	Sussex	J	F	ND	ND
8873	Dec 86	Herts	A	M	ND	ND
8902	Dec 86	Norfolk	A	F	ND	ND
8908	Dec 86	Essex	A	F	ND	ND
8854	86	Dyfed	J	M	ND	ND
8899	Jan 87	S. Glam	A	M	ND	ND
8903	Jan 87	Suffolk	1Y	M	ND	ND
8912	Jan 87	Norfolk	A	F	ND	ND
8940	Feb 87	Essex	1Y	M	ND	ND
9119	Feb 87	Cambs	A	F	ND	ND
8945	Mar 87	Kent	A	M	ND	ND
9105*	Nov 87	Salop	A	F	ND	0.005
9134	Dec 87	Gwent	J	M	ND	ND
9133	87	Salop	A	F	ND	ND
9148	Jan 88	Kent	A	M	ND	ND
9150	Jan 88	Dyfed	1Y	M	0.041	0.062
9174	Jan 88	Lincs	A	M	ND	ND
9189	Feb 88	Lothian	A	M	ND	ND
9192	Feb 88	Cambs	1Y	F	ND	ND
9195	Feb 88	Devon	A	F	ND	ND
9197	Feb 88	Berks	A	F	ND	ND
9200	Feb 88	Yorks	1Y	M	ND	ND
9217	Feb 88	Kent	A	F	0.404	ND

*Haemorrhage around heart