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
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4 Pollutants in merlin eggs and their effects on breeding
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6 Puffins and PCBs

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Monks Wood Experimental Station
Abbots Ripton
HUNTINGDON
Cambs PE17 2LS

August 1987

C O N T E N T S

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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 only the results obtained since that date are given here.

1.2 Results

During 1986, the livers from 231 birds were analysed, including those from 65 kestrels, 79 sparrowhawks, 50 herons, 8 kingfishers, 11 great-crested grebes and 18 others. These totals included some birds which had died in earlier years, but which were analysed in 1986. Nonetheless for the three main species, these totals represent a major increase on any previous year. The results from all these birds are listed in Table 1, and the geometric means for each chemical from the main species (1986 specimens only) are given in Table 2.

Six significant differences in geometric mean values were found between the 1986 and 1985 results, out of 20 comparisons (Table 3). They included an increase in the mean HEOD value for sparrowhawks, increases in mean PCB values for kestrel, sparrowhawk and kingfisher, and a decrease in the mean mercury value for kestrel and sparrowhawk.

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 sharp drop in the levels of any chemical since the EEC regulations came into effect from 1983. Further monitoring is desirable.

1.4 Reference

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.

Table 1. Levels of organochlorines (ppm in wet weight) and mercury (ppm in dry weight) in the livers of predatory birds analysed between April 1986 and March 1987. ND=not detected.

Spec. no.	Date found	County	Age	Sex	pp'-DDE	HEOD	PCBs	Hg
Kestrel (Falco tinnunculus)								
8598	Nov 85	Surrey	J	M	1.25	2.01	3.34	0.41
8468	Dec 85	Sussex	J	M	0.37	0.73	1.93	0.59
8470	Dec 85	NE Yorks	J	F	ND	0.57	0.69	ND
8475	Dec 85	Kintyre	J	M	ND	0.46	1.58	1.37
8482	Dec 85	Stirling	J	F	0.54	0.55	2.20	0.36
8486	Dec 85	Cumberland	A	F	0.39	0.51	4.27	3.05
8484	Jan 86	Cards	J	M	0.59	0.56	3.14	1.98
8488	Jan 86	-	A	M	0.39	0.39	3.26	0.53
8502	Feb 86	Isle of Man	A	M	1.79	2.36	0.97	2.55
8513	Feb 86	Leics	A	M	7.84	0.75	1.00	1.22
8516	Feb 86	Cornwall	J	F	0.53	0.52	0.69	ND
8519	Feb 86	Cheshire	-	-	0.88	0.66	5.14	2.93
8544	Feb 86	Middlesex	A	F	6.09	2.75	11.34	2.84
8551	Mar 86	E.Sussex	J	M	2.26	ND	1.47	1.37
8554	Mar 86	Fife	J	M	0.70	0.74	10.57	1.69
8564	Mar 86	Herts	J	F	0.73	0.61	2.54	1.41
8578	Mar 86	Herts	A	M	2.09	0.88	2.45	3.70
8585	Mar 86	Worcs	J	F	146.15	1.88	3.40	3.69
8600	Mar 86	Leics	J	M	0.43	0.22	3.75	1.63
8624	Apr 86	Norfolk	A	F	3.73	0.72	5.45	ND
8627	Apr 86	Devon	A	M	ND	ND	ND	ND
8628	Apr 86	Suffolk	J	M	8.95	0.42	6.48	2.12
8629	Apr 86	Kent	J	F	15.46	0.57	3.90	1.86
8630	Apr 86	N'hants	A	M	3.34	0.92	3.58	0.84
8637	Apr 86	SE Yorks	J	F	10.39	2.64	12.29	3.22
8667	Apr 86	Leics	A	M	2.00	ND	2.40	ND
8644	May 86	Norfolk	J	F	31.50	6.09	10.81	3.64
8668	May 86	Hunts	A	M	1.32	2.60	2.28	0.59
8695	Jun 86	Beds	J	F	2.45	2.64	7.04	4.38
8727	Jun 86	Kent	A	M	2.48	0.44	0.71	0.31
8708	Jul 86	SE Yorks	J	F	1.23	1.44	6.99	ND
8709	Jul 86	Dorset	J	F	0.66	0.74	5.33	ND
8710	Jul 86	Bucks	J	F	0.46	0.56	1.20	1.39
8712	Jul 86	Hunts	J	F	3.85	1.36	9.26	0.52
8713	Jul 86	Herts	J	F	ND	0.71	3.61	ND
8716	Jul 86	Suffolk	J	M	0.57	0.57	ND	0.87
8763	Jul 86	Aberdeens	J	F	1.79	0.69	4.61	2.49
8719	Aug 86	Lincs	J	F	4.53	1.84	1.12	1.81
8720	Aug 86	SW Yorks	J	F	1.09	0.88	7.57	0.48
8722	Aug 86	SE Yorks	J	F	0.49	0.80	2.63	0.76
8723	Aug 86	Lancs	J	F	1.64	1.00	1.20	1.10
8734	Aug 86	Notts	J	F	1.76	1.05	4.37	1.05
8735	Aug 86	K'c'bright	A	M	ND	ND	4.73	0.56
8736	Aug 86	N'hants	A	M	0.78	0.58	2.17	2.37
8747	Aug 86	Warwicks	A	F	0.78	ND	ND	0.44

Table 1 (contd)

8748	Aug 86	Suffolk	J	F	1.00	0.50	1.12	ND
8754	Aug 86	Leics	J	F	ND	ND	0.75	ND
8756	Aug 86	Kent	A	M	0.79	0.39	ND	0.16
8761	Sep 86	Leics	A	F	ND	0.26	1.76	0.92
8762	Sep 86	Leics	J	F	0.81	0.79	6.20	1.04
8766	Sep 86	Norfolk	J	M	1.16	1.09	4.36	ND
8768	Sep 86	Hunts	J	F	1.51	0.76	13.92	1.30
8771	Sep 86	Surrey	J	F	0.45	ND	ND	1.21
8772	Sep 86	Lincs	J	F	1.03	0.67	1.24	0.58
8782	Sep 86	Norfolk	A	F	29.10	0.45	ND	ND
8795	Sep 86	Herts	J	F	ND	0.42	0.73	0.20
8907	Sep 86	Essex	J	M	0.97	0.69	7.76	1.07
8803	Oct 86	N'hants	J	F	0.34	0.46	3.93	ND
8807	Oct 86	Cambs	J	F	0.47	0.45	ND	0.36
8813	Oct 86	Kent6	J	F	ND	ND	2.82	ND
8848	Nov 86	Hunts	A	F	0.23	0.34	0.57	ND
8864	Dec 86	N'hants	A	M	0.44	0.57	3.49	ND
8872	Dec 86	Devon	J	M	0.85	0.73	3.32	0.37
8875	Dec 86	Wiltshire	J	-	1.01	0.30	2.87	0.21
8879	Dec 86	Lincs	J	M	0.72	0.66	5.58	0.15

Sparrowhawk (<u>Accipiter nisus</u>)

8558	May 81	Stirling	J	M	10.51	1.49	8.90	6.90
8490	Aug 85	Merioneth	J	M	1.61	0.78	5.27	2.17
8614	Aug 85	Sussex	A	F	24.76	2.42	17.83	1.33
8469	Dec 85	Herefs	J	F	3.24	0.70	6.58	0.97
8472	Dec 85	Surrey	A	M	10.93	2.94	22.53	1.00
8510	Dec 85	Perth	J	M	1.40	0.37	0.96	2.80
8485	Jan 86	Oxon	A	F	28.39	9.63	21.99	1.33
8508	Feb 86	Leics	A	F	0.97	0.56	4.27	2.26
8526	Feb 86	Lincs	A	M	1.73	0.61	5.02	0.23
8535	Feb 86	Fife	J	M	10.24	0.65	3.95	2.62
8541	Mar 86	Lincs	A	F	2.95	1.29	11.01	2.72
8557	Mar 86	Ayr	J	M	9.81	1.87	16.17	10.20
8561	Mar 86	Midlothian	J	M	6.88	0.87	6.94	2.29
8573	Mar 86	Berks	J	F	1.42	1.04	7.47	2.90
8574	Mar 86	Herts	J	F	4.70	2.25	18.06	1.44
8580	Mar 86	Salop	A	F	1.25	0.62	7.61	1.11
8583	Mar 86	Herts	A	F	34.25	2.59	19.78	2.48
8604	Mar 86	Glos	A	F	4.20	1.06	2.76	1.83
8605	Mar 86	Perth	A	F	1.51	0.40	5.63	7.52
8606	Mar 86	Suffolk	A	F	2.00	0.60	6.18	1.86
8671	Mar 86	Bucks	A	F	6.04	2.96	4.94	3.16
8609	Apr 86	Dorset	A	F	2.24	0.69	5.98	1.78
8613	Apr 86	K'c'bright	A	F	13.98	2.09	16.03	21.30
8615	Apr 86	Denby	A	F	1.05	0.61	4.60	3.65
8617	Apr 86	Midlothian	J	F	1.35	0.80	6.47	1.90
8623	Apr 86	Kent	J	M	251.50	8.75	137.75	1.21
8626	Apr 86	W Lothian	A	F	18.78	1.42	10.20	4.08
8633	Apr 86	Wilts	A	M	39.85	5.05	30.75	3.31
8642	Apr 86	Lincs	J	F	27.81	12.96	10.95	3.07
8673	Apr 86	Dorset	J	M	0.88	0.55	3.90	4.41
8653	Apr 86	Montgomery	-	M	7.08	1.41	13.62	5.84

Table 1 (contd)

8778	Apr 86	E Ross	J	M	18.12	1.15	8.53	2.96
8792	Apr 86	Berks	A	M	10.64	1.90	13.51	1.58
8861	Apr 86	Midlothian	A	F	8.68	2.31	3.47	4.36
8927	Apr 86	Shetland	A	F	21.90	2.11	12.71	20.70
8649	May 86	Wilts	A	M	4.06	0.92	16.97	3.42
8658	May 86	Somerset	A	F	3.20	1.37	13.12	2.42
8669	May 86	Hunts	A	F	99.85	5.55	36.15	2.67
8670	May 86	Bucks	A	F	3.19	1.08	9.82	4.24
8674	May 86	Devon	J	M	4.93	1.53	7.31	2.30
8725	May 86	Hants	A	F	12.90	1.83	10.49	2.55
8726	May 86	Notts	A	F	36.35	17.90	38.50	3.00
8728	May 86	N'hants	A	M	1.88	0.51	3.77	2.12
8648	May 86	Sussex	A	F	40.49	2.67	23.33	15.90
8699	Jun 86	Cheshire	-	M	2.01	0.79	13.06	1.08
8806	Jun 86	Inverness	A	M	2.19	0.35	1.17	1.63
8711	Jul 86	Worcs	J	M	1.42	0.30	4.69	0.44
8732	Aug 86	Monmouth	J	F	0.42	0.43	1.62	1.11
8733	Aug 86	Cambs	J	M	0.71	ND	1.46	0.15
8737	Aug 86	I of Wight	J	M	12.00	1.55	12.36	5.41
8746	Aug 86	Merioneth	J	F	0.77	0.41	3.60	3.30
8749	Aug 86	Hants	J	M	1.88	0.85	6.67	1.60
8750	Aug 86	Herts	J	F	0.43	0.47	12.80	ND
8753	Aug 86	SE Yorks	J	F	0.94	1.08	52.53	0.12
8755	Aug 86	Leics	J	M	2.40	0.91	11.06	0.23
8863	Aug 86	Oxon	A	F	2.47	0.69	4.35	0.75
8894	Aug 86	N'hants	J	F	0.42	0.42	4.37	ND
8759	Sep 86	Warwicks	J	F	0.78	1.20	21.93	2.09
8769	Sep 86	Pembs	A	M	1.72	0.21	ND	0.12
8777	-	Inverness	A	F	1.60	0.58	2.40	1.52
8785	Sep 86	Norfolk	J	F	1.17	0.29	0.83	ND
8796	Sep 86	Cheshire	-	F	0.27	0.20	ND	ND
8919	Sep 86	Cumberland	J	M	19.41	7.19	19.22	18.80
8801	- 86	Lewis	A	F	21.54	4.26	23.89	23.40
8809	Oct 86	Sussex	J	F	0.58	0.32	2.12	0.65
8853	Oct 86	K'c'bright	J	M	0.84	0.41	2.50	3.83
8860	Oct 86	Midlothian	J	M	0.43	0.32	1.20	0.36
8846	Nov 86	Dorset	A	F	0.80	0.28	0.66	ND
8847	Nov 86	Warwicks	J	F	0.31	0.28	2.30	ND
8849	Nov 86	Dorset	J	M	0.61	0.29	2.04	1.11
8855	Nov 86	Berks	A	M	0.55	0.27	2.60	0.61
8869	Nov 86	Herts	A	F	43.75	4.31	61.62	ND
8868	Dec 86	Staffs	-	-	9.74	3.23	11.32	3.10
8871	Dec 86	Hants	A	F	11.77	2.89	31.20	4.52
8874	Dec 86	Wilts	A	F	3.53	1.08	11.37	0.65
8877	Dec 86	Durham	J	F	0.51	0.27	3.62	1.40
8887	Dec 86	W'morland	A	F	12.03	2.26	12.41	2.60
8904	Dec 86	Norfolk	A	M	2.15	0.45	4.11	1.04
8938	Dec 86	Dorset	A	M	3.07	1.01	5.43	0.84

Peregrine falcon (Falco peregrinus)

8466	Nov 85	Shetland	J	F	0.41	0.28	2.40	12.00
8786	Sep 86	Pembs	A	M	44.80	41.50	276.60	1.34
8859	Nov 86	Perth	A	F	0.71	ND	0.91	0.19

Table 1 (contd)

Merlin (Falco columbarius)

8858	Nov 84	Cumberland	A	M	2.59	0.55	7.70	0.69
8800	May 86	Lewis	J	F	1.41	0.52	5.61	2.31
8773	Aug 86	Skye	J	F	2.57	0.82	9.32	3.50
8862	Aug 86	MW Yorks	J	M	1.01	0.43	4.75	0.38
8926	Aug 86	Shetland	J	M	0.24	0.20	2.64	6.16

Long-eared owl (Asio otus)

8582	Mar 86	SW Yorks	A	F	0.35	0.29	3.02	0.14
8620	Apr 86	Wilts	A	F	14.55	1.21	10.93	3.37
8621	Apr 86	Orkney	A	F	0.45	ND	2.94	0.86
8639	Apr 86	Shetland	A	F	429.46	7.41	25.27	1.04
8646	May 86	N'berland	A	F	1.69	0.46	5.05	0.13
8857	Nov 86	Lincs	A	F	1.24	0.36	5.22	ND
8870	Nov 86	Lincs	A	F	21.77	2.24	22.59	1.30
8929	Nov 86	Shetland	A	F	1.67	0.28	1.52	0.84
8928	Dec 86	Shetland	A	F	0.63	0.39	7.26	0.17
8931	Dec 86	Lincs	A	F	0.30	0.22	2.82	0.69

Heron (Ardea cinerea)

8741	Apr 85	Cards	A	F	2.92	0.92	8.20	23.20
8480	Dec 85	Somerset	A	F	0.77	7.77	1.59	38.74
8483	Jan 86	Aberdeens	A	M	0.85	0.24	0.97	9.50
8489	Jan 86	Berks	J	M	3.95	1.86	7.95	11.18
8603	Jan 86	Norfolk	J	-	10.58	1.46	10.06	53.50
8499	Feb 86	Cumberland	A	M	3.73	0.64	5.02	22.56
8503	Feb 86	Cheshire	J	F	3.01	1.08	5.73	17.76
8505	Feb 86	Isle of Man	J	M	3.66	0.27	1.70	15.79
8507	Feb 86	Bucks	J	F	4.55	0.58	18.50	62.28
8509	Feb 86	E Ross	J	F	7.53	0.50	3.23	49.56
8512	Feb 86	Warwicks	J	F	9.25	3.47	75.14	23.55
8515	Feb 86	Essex	J	F	8.09	0.35	2.58	46.75
8522	Feb 86	Lancs	J	M	8.70	1.42	12.95	12.75
8530	Feb 86	Cheshire	A	M	4.48	2.58	15.68	148.68*
8536	Feb 86	Beds	J	M	11.29	2.19	27.53	27.96
8542	Mar 86	Worcs	A	F	1.86	0.42	0.52	4.93
8567	Mar 86	Norfolk	A	F	29.24	2.16	37.43	34.06
8568	Mar 86	Norfolk	A	M	0.25	0.17	0.51	7.31
8584	Mar 86	Worcs	J	-	9.17	1.97	18.88	20.61
8586	Mar 86	Glos	J	M	12.67	1.47	9.54	32.12
8587	Mar 86	Worcs	A	M	82.74	29.44	208.15	15.93
8588	Mar 86	Worcs	A	M	7.16	1.87	26.74	8.13
8610	Mar 86	Devon	A	F	1.09	0.54	6.08	4.58
8619	Apr 86	Lancs	A	M	10.16	3.71	30.57	49.40
8652	Apr 86	Oxon	A	M	20.35	14.95	87.90	78.80
8816	Apr 86	Argyll	A	F	0.14	ND	0.43	5.68
8657	May 86	Cheshire	J	M	0.52	0.47	3.32	1.96
8660	May 86	Somerset	A	M	15.80	24.40	36.10	131.00
8666	May 86	Herts	A	F	0.61	0.41	1.81	7.21
8696	May 86	Worcs	A	F	31.50	15.00	66.00	207.00
8829	May 86	Argyll	A	M	0.93	0.36	6.81	19.23
8704	Jun 86	Anglesey	J	F	0.66	ND	9.86	6.68

Table 1 (contd)

8816	Apr 86	Argyll	A	F	0.14	ND	0.43	5.68
8657	May 86	Cheshire	J	M	0.52	0.47	3.32	1.96
8660	May 86	Somerset	A	M	15.80	24.40	36.10	131.00
8666	May 86	Herts	A	F	0.61	0.41	1.81	7.21
8696	May 86	Worcs	A	F	31.50	15.00	66.00	207.00
8829	May 86	Argyll	A	M	0.93	0.36	6.81	19.23
8704	Jun 86	Anglesey	J	F	0.66	ND	9.86	6.68
8830	Jun 86	Angus	A	F	1.20	0.28	3.69	31.82
8844	J/O 86	Angus	J	-	0.34	0.27	5.69	5.46
8705	Jul 86	Essex	J	M	0.80	0.60	3.96	2.86
8714	Jul 86	Aberdeens	J	M	0.44	0.36	5.34	4.50
8717	Aug 86	Hants	J	F	0.97	0.63	4.58	7.00
8740	Aug 86	Cards	J	F	2.09	0.97	7.51	5.46
8745	Aug 86	Carms	J	F	1.39	0.96	3.87	12.50
8783	Sep 86	Pembs	J	F	6.26	1.32	14.73	43.90
8787	Sep 86	Hants	J	M	ND	ND	3.32	6.88
8832	Oct 86	Argyll	J	-	0.26	0.21	4.80	2.68
8798	Oct 86	Pembs	J	F	0.70	0.43	4.25	1.43

Great crested grebe (<u>Podiceps cristatus</u>)

8672	Sep 85	Lancs	A	F	0.54	ND	ND	6.21
8474	Oct 85	I of Bute	J	F	2.12	ND	1.59	8.19
8518	Feb 86	Cards	A	M	2.53	0.35	1.44	5.92
8529	Feb 86	Norfolk	A	F	50.02	6.09	24.60	16.13
8562	Feb 86	Lancs	A	M	ND	ND	ND	4.90
8565	Mar 86	NE Yorks	J	F	9.60	0.65	10.64	11.20
8794	Mar 86	Beds	A	F	0.80	ND	4.73	11.28
8663	Apr 86	Lancs	A	M	1.56	0.39	8.74	8.06
8698	Jun 86	Notts	-	M	16.68	3.18	36.88	8.59
8804	Oct 86	Somerset	J	F	ND	ND	0.53	1.35
8867	Dec 86	N'hants	A	F	ND	ND	ND	3.66

Kingfisher (<u>Alcedo atthis</u>)

8493	Jan 86	Hants	A	M	0.37	0.45	1.17	0.44
8506	Feb 86	Notts	A	F	0.38	0.81	0.37	10.96
8779	Sep 86	N'hants	A	M	2.16	1.24	12.27	2.50
8780	Sep 86	Somerset	J	M	1.20	1.03	6.15	1.16
8781	Sep 86	Somerset	J	F	0.71	1.87	7.22	0.58
8784	Sep 86	Wilts	A	M	1.62	6.04	8.57	0.78
8815	Oct 86	Glos	J	F	0.98	1.99	8.41	ND
8888	Dec 86	Surrey	A	F	0.51	1.89	2.15	1.59

* Specimen number 8530 also contained 8.36 ppm hexachlorobenzene

Table 2. Geometric mean levels of pollutants in the various species in Table 1, but for 1986 specimens only.

Species	pp'-DDE	HEOD	PCBs	Hg
Kestrel				
Mean	0.65	0.31	1.56	0.32
SD	1.17	1.03	0.88	0.95
Range within 1 SE	0.46-0.93	0.23-0.42	1.20-2.03	0.24-0.42
Sparrowhawk				
Mean	3.53	0.96	6.32	1.22
SD	0.66	0.57	0.65	0.83
Range within 1 SE	2.95-4.22	0.83-1.12	5.31-7.53	0.97-1.52
Heron				
Mean	2.37	0.63	7.55	15.34
SD	0.85	0.97	0.60	0.52
Range within 1 SE	1.74-3.21	0.45-0.90	6.07-9.38	12.7-18.5
Great crested grebe				
Mean	0.31	0.05	1.46	6.48
SD	1.94	1.65	1.35	0.32
Range within 1 SE	0.07-0.37	0.01-0.18	0.52-4.13	5.06-8.31
Kingfisher				
Mean	0.82	1.45	3.72	0.75
SD	0.29	0.33	0.53	0.87
Range within 1 SE	0.65-1.04	1.11-1.90	2.41-5.73	0.37-1.53

Table 3. Comparison of geometric mean residue levels (log values) from birds collected in 1986 and 1985; t-values are shown. Minus values indicate a decrease from 1985.

	pp'-DDE	HEOD	PCBs	Hg
Kestrel				
	t_{108}=+0.47	t_{76}=-1.7	t_{108}=+3.46***	t_{99}=-3.54***
Sparrowhawk				
	t_{134}=+1.06	t_{134}=+4.86***	t_{110}=+6.76***	t_{132}=-5.05***
Heron				
	t_{69}=-1.04	t_{69}=+0.20	t_{45}=+1.28	t_{69}=-1.33
Great crested grebe				
	t_{24}=-0.73	t_{24}=+1.20	t_{24}=-0.19	t_{24}=-1.81
Kingfisher				
	t_{13}=-0.20	t_{17}=+0.16	t_{14}=+2.61*	t_{8}=-1.48

Notes: Zero values for pp'-DDE and HEOD were taken as 0.001, for PCBs and mercury as 0.01.
* significance of difference P<0.05; *** P<0.001.

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BIRDS AND POLLUTION

Part 2 Sparrowhawk Survey

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August 1987

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 devoid of breeding hawks from the outset of the study until 1982, when the first evidence of surviving birds was found. In order to monitor the increasing recolonisation, surveying was again confined to this area in 1986. Results, from the programme's inception, are summarised in Table 4.

2.2 Results

Searching of 30 potential territories began in early May, and continued until mid-August in the expectation that fledged young would still be evident. The number of territories showing signs of sparrowhawk occupation had increased by only one over 1985, and again three nests were found, but only one of these was in a previously occupied site. All produced young, but broods were small, and clutch-depletion through breakage was confirmed in one nest.

The four known breeding-sites used in the previous two seasons, the total since recolonisation began, were checked for evidence of further occupation. Repeated searching of one confirmed the presence of a female hawk, evidently resident, but not breeding; a second showed only the signs of a hunting bird; a third was unoccupied; and only the last site held another nest, close by the original. This nest was located during construction, and it eventually contained three eggs, with no evidence of loss, but it produced only a single fledgling. A nest was also found early in the season in a fresh site, which later held five eggs. These were soon depleted to three, with one egg confirmed broken, and the nest produced only two fledglings. Another nest was discovered late in the season in a site where only a single fledgling was present (Table 5).

The females at each of the nests were all seen to be adults, ie at least two years old, and two were occupying new sites with no recent history of sparrowhawk occupation. Even though the progeny of the first recorded nests, in 1984, would now be two-year olds, perhaps breeding for the first time, one might expect such vacant sites to have shown some prior evidence of occupation by locally-reared, but non-breeding, first-year birds. However, at this stage immigration may be a more important element of the recolonisation than recruitment of locally-bred birds (Newton & Haas 1984).

The erratic occupation of sites and poor breeding success manifest since the partial recolonisation, although still based on a small sample, closely resembles the situation formerly persisting in some of the other study areas, notably Anglesey, during 1964-70. This was a period of more intensive organochlorine use, when clutch-depletion and small broods were frequent (Cooke et al 1979). Improvement in breeding success was confirmed there only in 1983 when site occupation was still low (Bell 1984).

2.3 Discussion

At the start of the study, in 1964, the sparrowhawk had already ceased to breed in the East Midlands study area, following its sudden national decline in the late 1950s. Even so, 15% of potential territories then surveyed were found to hold old nests, still surviving from earlier years. These were all in coniferous woods, and were easily identified, but others were undoubtedly overlooked in much of the broadleaved woodland forming the majority of the search area, where such nests are less distinctive. The original coniferous territories are now unsuitable, which is probably why all the recent nests have been in broadleaved habitat.

The first consistent evidence of sparrowhawk recolonisation of the area, in 1982, prompted the speculation that perhaps 20% of the woodlands might ultimately become occupied by breeding birds. This was based on the level of occupation found in a survey in 1942, prior to pesticide use, when 13% of territories were found to be occupied (Bell 1984). After only three seasons since resumed breeding was confirmed, the annual total is now 10%, but the continuing absence of birds from other suitable woods, together with the erratic occupation of territories already used, indicates that recovery is still incomplete. It remains to be seen whether the population continues to grow, or whether feeding restrictions in a greatly modified landscape might limit the population at a lower level.

2.4 References

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Table 4. Occupation of Sparrowhawk territories in the East Midlands study area, 1964-86. In years not listed, no search was made.

	'64	'65	'66	'67	'70	'71	'79	'82	'83	'84	'85	'86
Total potential territories checked	20	2	2	16	6	6	19	20	25	26	30	30
Number with successful nests	0	0	0	0	0	0	0	0	0	2	2	3
Number with failed nests	0	0	0	0	0	0	0	0	0	0	1	0
Number with no nest, but other current signs	0	0	0	0	0	0	0	3	2	3	5	6
Number of territories with old nests	3	0	0	0	0	0	0	0	0	0	2	4
Percentage of territories with old nests	15	0	0	0	0	0	0	0	0	0	6.7	13.3

Table 5. Occupation and success of six sparrowhawk territories in the East Midlands.
S = successful nest; F = failed (incomplete) nest.
Numbers show young fledged.

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

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BIRDS AND POLLUTION

Part 3 Organochlorines and mercury in peregrine eggs

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3 ORGANOCHLORINES AND MERCURY IN PEREGRINE EGGS

3.1 Introduction

In the report for last year, we gathered together the results of analyses of Peregrine eggs obtained since the previous compilation by Ratcliffe (1980). We also assessed the long-term trends in residues, finding significant declines in DDE and HEOD but not in PCBs. The results from eggs analysed since then are given in Table 6. They include some eggs collected in earlier years, but not previously analysed.

3.2 Results

The results from these 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 Shetland contained the highest levels of both chemicals, with 12.2 ppm PCB in wet weight and 4.6 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 1986. C-coastal site; ditto marks indicate eggs from the same clutch.

Year	County	Shell index	HEOD	pp'-DDE	PCBs	Hg
WALES						
1977	Caernavonshire	1.37	1.00	2.50	4.00	1.25
	Caernavonshire	1.69	0.30	1.20	1.00	0.43
1980	Merionethshire	1.55	0.98	4.44	3.63	1.18
	Pembrokeshire (C)	1.72	0.61	1.02	5.01	1.46
NORTHERN ENGLAND						
1972	Yorkshire	1.53	0.70	2.00	2.00	2.61
1975	Westmorland	-	3.81	2.79	5.37	ND
1978	Co. Durham	1.69	0.10	2.00	0.50	0.39
1980	Cumberland	1.96	1.04	1.99	2.15	0.64
1986	Cumberland	1.82	ND	0.86	1.89	ND
	Cumberland	1.48	0.70	2.63	2.39	ND
	Cumberland	1.80	0.40	2.56	0.99	0.81
SOUTHERN SCOTLAND						
1977	Ayrshire	1.68	0.10	2.00	2.00	0.09
	Peebles	1.91	0.20	0.90	0.50	0.06
	Ayrshire	1.80	0.10	0.40	1.00	ND
	Ayrshire	1.42	0.10	4.00	3.00	-
1980	Kirkcudbrightshire	2.00	0.50	2.20	3.34	1.28
	"	1.85	0.35	4.44	1.74	1.13
	Wigtownshire (C)	1.76	0.28	3.39	4.65	1.03
	Kirkcudbrightshire	1.43	1.09	6.96	7.99	0.95
CENTRAL AND EASTERN HIGHLANDS						
1972	Inverness-shire	-	0.02	0.80	1.00	ND
1985	Moray	1.93	0.89	1.34	4.98	0.14
1986	Aberdeenshire	1.66	0.39	0.91	0.60	ND
	Aberdeenshire	1.97	0.08	0.11	ND	ND
	Perthshire	1.79	0.41	1.91	0.35	ND
	Argyll	1.70	ND	2.75	1.09	ND
	Perthshire	1.57	ND	ND	0.13	ND
	Aberdeenshire	1.57	0.29	0.64	1.40	0.16
	"	1.76	0.09	0.27	1.89	0.19
	"	-	0.06	0.45	0.54	0.09
	"	1.53	0.08	0.61	0.68	ND
	Banff	1.58	0.17	0.34	0.87	ND

Table 6 (contd)

	Banff	1.54	0.26	0.67	1.48	0.48
	Perthshire	1.52	0.17	7.94	2.13	ND
	"	1.61	0.15	4.46	1.40	0.08
	Perthshire	1.85	0.12	0.68	0.42	0.17
	Moray	2.07	ND	1.27	0.63	ND
NORTH & WEST HIGHLANDS						
1978	West Ross	1.53	0.50	0.90	25.00	1.31
1986	Shetland (C)	1.44	0.28	3.48	12.24	4.62
IRELAND						
1986	Co. Waterford (C)	1.62	0.30	6.85	8.73	0.18
	"	1.45	0.20	6.40	9.74	1.30
	Co. Waterford (C)	1.48	0.10	1.63	0.97	0.79
	Co. Waterford (C)	-	0.13	1.52	3.45	0.62

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BIRDS AND POLLUTION

Part 4 Pollutants in merlin eggs and their effects on breeding

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4 POLLUTANTS IN MERLIN EGGS AND THEIR EFFECTS ON BREEDING

4.1 Introduction

In view of the declining status of the merlin Falco columbarius in Britain (Bibby & Nattrass 1986, Newton et al 1986), we have continued to analyse addled and deserted eggs for pollutant residues. The findings from eggs collected to 1980 were given in Newton et al (1982), and in this paper we summarise the results obtained to 1986 and re-examine some aspects on the enlarged samples. The chemicals involved included DDE (from the insecticide DDT), HEOD (from the insecticides aldrin and dieldrin), PCBs (polychlorinated biphenyls from industrial products) and mercury (mainly from agricultural and industrial sources). We demonstrate for the first time a relationship between breeding success and mercury levels in eggs.

As in previous studies, the eggs were collected by observers in different parts of Britain, and sent to Monks Wood Experimental Station for analysis. Organochlorine residues were calculated as parts per million (ppm) in egg lipid, and mercury as ppm in dry weight. Shell-indices, reflecting shell thickness, were calculated as shell weight (mg)/shell length x breadth (mm) (Ratcliffe 1967). In total, eggs from 173 clutches were examined during 1964-86, but the results from no more than one egg per clutch were used in any of the following calculations (see Newton et al 1982 for further details of procedure). The mean lipid content of merlin eggs was 6.2% and the mean dry matter was 20.0%. So the organochlorine values given below could be converted to a fresh weight basis by dividing them by 17, and the mercury values by dividing them by 5.

4.2 Results

The merlin remains the most heavily contaminated of the British raptors. The eggs examined during 1981-86 had geometric mean levels of about 100 ppm DDE, 5 ppm HEOD and 50 ppm PCBs in lipid, and 2 ppm mercury in dry weight. These levels were considerably higher than those in contemporary peregrine F. peregrinus eggs from the same regions (Figure 1). The two species share much the same habitat, and both eat birds. However, relative to their body weights the smaller merlin has a greater daily food intake than the peregrine, and this could at least partly explain the difference in residue burdens.

The mean shell-index of merlin eggs obtained 1981-86 was 1.102 ± 0.010, some 12% less than the pre-DDT value of 1.256.

4.2.1 Geographical patterns in residues

As yet no merlin egg examined in Britain has been free of pollutants, and every egg analysed during 1981-86 contained measurable residues of all four chemicals. For each chemical, regional variation was apparent (Figures 2-5). The pesticides generally tended to be present at lower levels in eggs from the north of Britain than further south: DDE levels were lowest in eggs from Orkney & Shetland, and HEOD levels in eggs from Orkney. PCBs showed no obvious north-south trend. Mercury has been measured only since 1980, and the levels in eggs from Orkney and Shetland were strikingly higher than those from the rest of

Britain. The two eggs obtained from Hebridean Islands also had high mercury levels, with 5.0 ppm recorded from Mull and 4.1 ppm from Lewis.

Shell-indices were generally higher in the north of Britain than further south, as expected from the pattern in DDE, the main causal agent of shell thinning (see later).

Eggs laid by two captive females, fed largely on day-old chicks of domestic fowl, had much lower residues than eggs from wild merlins, with about 1.2 and 1.4 ppm HEOD, 0.9 and 1.6 ppm DDE, 2.2 and 2.3 ppm PCB, and 0.1 and 0.1 ppm mercury. These eggs also had shell-indices that were close to the pre-DDT mean at 1.26. Evidently the domestic fowl chicks were very much less contaminated than the wild prey eaten by merlins.

4.2.2 Time trends in residues and shell-indices

Since the 1960s, when the first merlin eggs were analysed, the residues of all three organochlorines have declined significantly (Figure 6). The decline was more marked in HEOD than in DDE and PCBs. Over the same period, shell-indices improved (Figure 7). In assessing these national trends, eggs from Orkney and Shetland were excluded, because they had somewhat different residue levels than eggs from the rest of the country, and were represented only in recent years. No trend in mercury was apparent in the short period that levels were measured.

4.2.3 Significance of residues

The number of young raised by individual merlin pairs (productivity, Pr) was negatively correlated with the levels of mercury in their eggs. On a linear regression analysis:

$Pr = 2.487 - 1.369 \log Hg$, $r = 0.28$, $N = 55$, $P<0.04$.

This relationship still held after excluding the eggs from Orkney and Shetland, which had the highest levels of mercury. Its significance did not therefore depend largely on eggs from these islands. Inspection of the data showed that productivity fell markedly in clutches where mercury exceeded 3 ppm. Only two (11%) out of 18 clutches with less than 3 ppm mercury failed to produce young, compared with 18 (49%) out of 37 with more than 3 ppm mercury ($\chi^2 = 5.8$, $P<0.02$).

In contrast, productivity showed no significant relationship with the levels of DDE, HEOD and PCBs in eggs. Moreover, when these chemicals were included in a multiple regression analysis with mercury, they explained no more of the variance in brood size than did mercury alone. In other words, no evidence was found that the organochlorines (at the levels found) had any influence on productivity. This was in line with earlier findings, based on eggs collected in 1971-80 (Newton et al 1982).

As in previous studies (Hodson 1975, Newton et al 1982), shell-indices were negatively correlated with DDE levels. The relationship was linear with DDE on a log scale, and a revised equation based on all available eggs was as follows:

Shell-index = 1.30 - 0.10 log DDE, $r = 0.31$, $N = 168$, $P<0.0001$

The intercept value of 1.30, indicating the shell-index with 1 ppm DDE, was close to the pre-DDT mean shell-index of 1.26.

Shell-indices showed no significant correlation with HEOD, PCB or mercury. Moreover, when these other chemicals were incorporated in a multiple regression analysis, they explained no more of the variance in shell-index than did DDE alone. This was also in line with previous findings on merlins and other raptors (Newton et al 1982, Newton 1979), and with experimental evidence implicating DDE as the primary cause of shell thinning (Cooke 1973).

4.3 Discussion

The recent results indicate a continuing widespread contamination of British merlins with organochlorine and mercury residues, together with widespread shell thinning. However, progressive reductions in the use of DDT, aldrin and dieldrin over the years (Newton & Haas 1984), and almost no usage since 1983, seem to have been accompanied by reductions in residues of DDE and HEOD in merlin eggs and by a slight improvement in shell-indices.

A slower decline of DDE compared to HEOD in the eggs was presumably because DDE is more persistent in the physical and biotic environment than is HEOD, and was also used in quantity until a later date (Cutler 1981, Sly 1981, 1986, Newton & Haas 1984). The continuing high levels of PCBs parallels the situation in British peregrines and sparrowhawks Accipiter nisus and presumably results because some PCBs are even more persistent than DDE, and their manufacture and use continues.

Interestingly, those merlins breeding in the Scottish Highlands, where pesticide use has been slight and localised, were as heavily contaminated with organochlorines and mercury as were those from further south. This was presumably because a large proportion of the Highland merlins, together with their various prey species, spend the winter in more contaminated areas.

The greater levels of mercury in the Orkney and Shetland birds may have reflected a greater dependence on waders, compared to merlins elsewhere. Considering the year-round abundance of waders on these and other Scottish islands, the merlins living there might well be expected to take more waders overall. Analyses at Monks Wood Experimental Station have shown that waders generally contain much more mercury than do the songbirds which form the bulk of the merlins' diet. Waders probably accumulate their mercury in contaminated estuaries.

The finding of a relationship between brood size and mercury levels in merlin eggs was new and unexpected. Because of the high levels, it was on the Scottish islands where the effects of mercury would be felt most strongly. The lowest level found there (4 ppm) was associated in the regression equation with mean productivity of 1.7 young per laying pair, and the highest level (10 ppm) with a mean productivity of 1.1 young per laying pair. This compares with a figure of 2.5 young expected under 1 ppm mercury. Interestingly, the mercury levels found in island merlin eggs were within the range found in experiments to reduce the hatchability of pheasant Phasianus colchicus eggs. Such levels were recorded as 1.3-2.0 ppm wet weight (= 6.5-10 ppm dry weight) in a Swedish study (Borg et al 1969) and as 0.5-1.5 ppm wet weight (= 2.5-7.5 ppm dry weight) in a Canadian study (Fimreite 1971).

There were probably two reasons why no relationship was found between productivity and either shell-indices or organochlorine residue levels. First, the pesticide residues have now become so low that at most they probably affected a small proportion of the merlins studied; and secondly, many other factors besides pollutants cause reductions in productivity. These other factors were not usually known to us, so we could not take them into account in the analysis. Thus the lack of a significant relationship between productivity and organochlorine levels cannot be taken to indicate that British merlins are now free of the adverse effects of these chemicals. It does indicate, however, that these pollutants are no longer paramount in determining nest success in the areas involved. Any influence the organochlorines might have is overweighed by that of other factors, including mercury in part of the population. Clearly more information is desirable from the island nesting merlins, and not only from Orkney and Shetland.

4.4 Acknowledgements

We are grateful to all the observers who contributed eggs for analysis, in particular, C.J. Bibby, D. Doody, A. Heavisides, G. Horne, B. Little, E. Meek, D. Okill, A.D. Payne, S.J. Petty and G. Rebecca. Chemical analyses were done mainly by D. Leach.

4.5 Summary

1. Up to 1986 British Merlins continued to show widespread contamination with organochlorine pesticides, PCBs and mercury. Shell thinning was also widespread.

2. On a national scale, organochlorine residues in eggs declined during the period 1964-86, and shell-indices improved.

3. Geographical variation was apparent in the egg residues of all the chemicals examined, and eggs from Orkney and Shetland contained much more mercury than did those from elsewhere.

4. The number of young raised by breeding Merlins was inversely related to the levels of mercury in their eggs. In contrast, organochlorines had no obvious influence on nest success. This was partly because organochlorine levels in most eggs were too low in the years concerned, and probably also because other factors (including mercury in some regions) had much greater influence on success.

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Figure 1. Comparison of pollutant levels in eggs of merlins (M) and peregrines (P) collected in Britain during 1981-86. The figures show geometric mean levels and standard deviations, based on 122 eggs of merlin and 189 of peregrine.

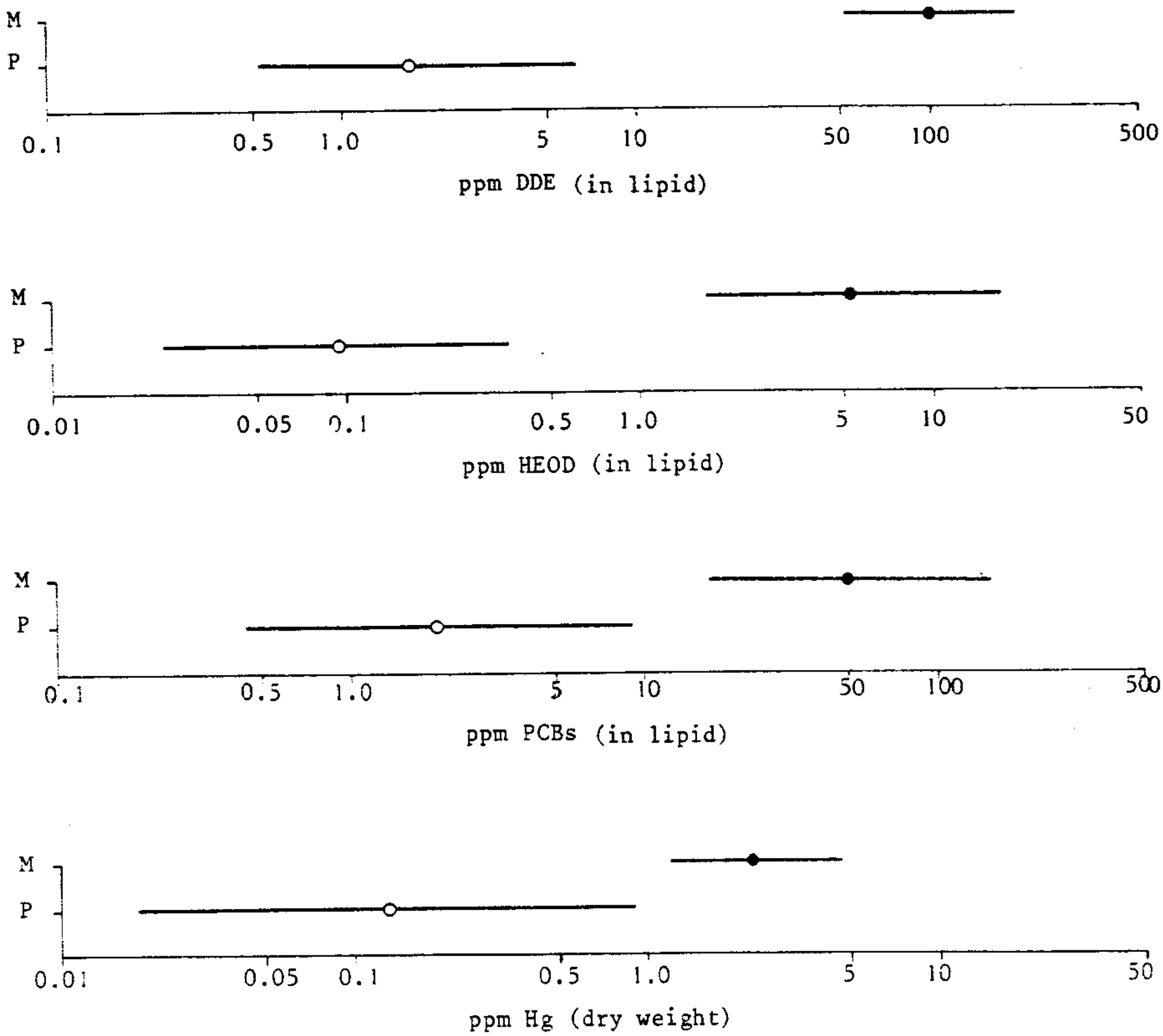


Figure 2. DDE levels in merlin eggs from different regions, 1981-86. Arrows show positions of geometric mean levels. On analysis of variance, significant regional variation was found: $F_{6,116} = 5.90$, $P<0.0001$.

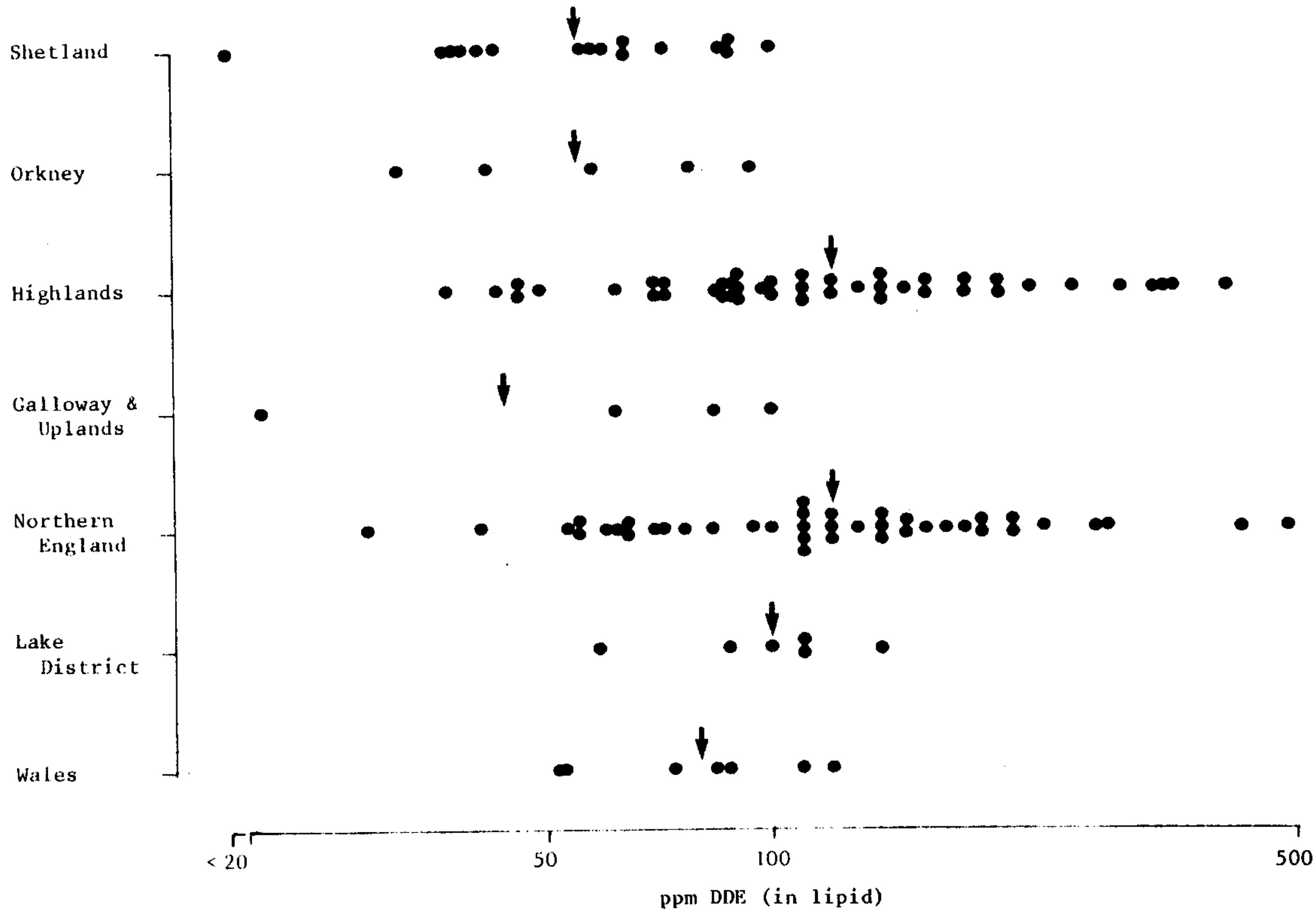


Figure 3. HEOD levels in merlin eggs from different regions, 1981-86. Arrows show positions of geometric mean levels. On analysis of variance, significant regional variation was found: $F_{6,116} = 4.14$, $P<0.0008$.

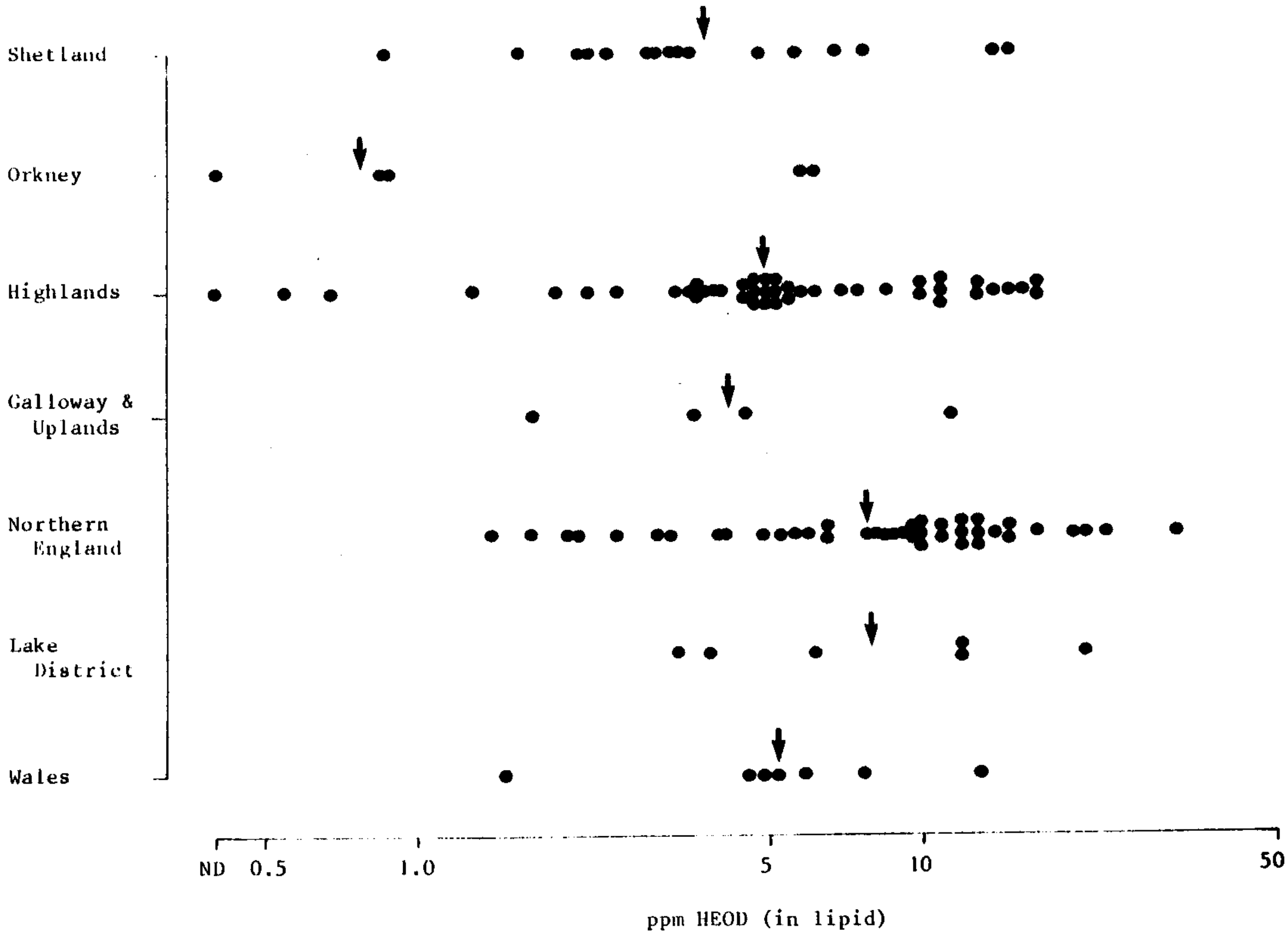


Figure 4. PCB levels in merlin eggs from different regions, 1981-86. Arrows show positions of geometric mean levels. On analysis of variance, significant regional variation was found: $F_{6,116} = 6.15$, $P<0.0001$.

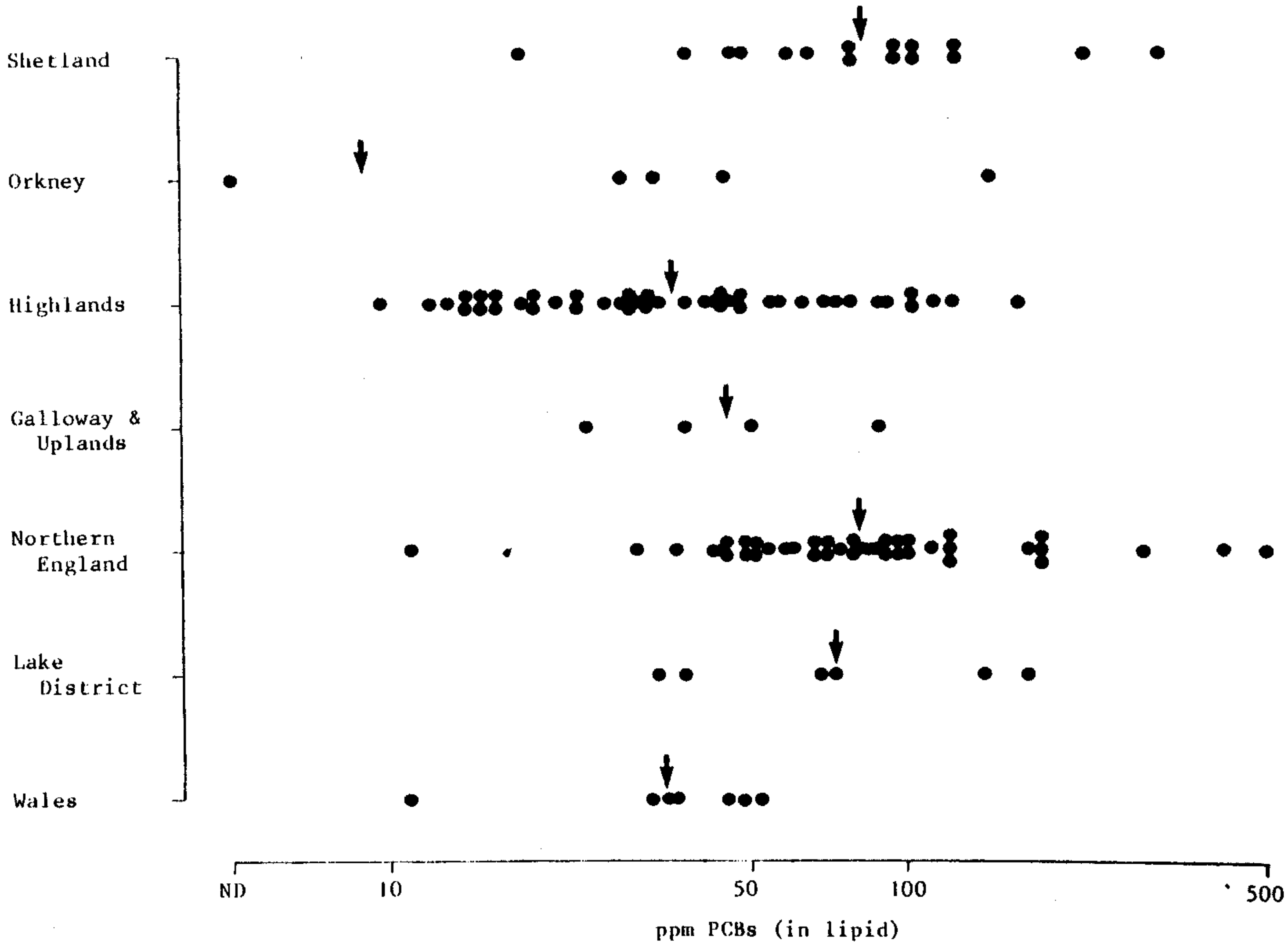


Figure 5. Mercury levels in merlin eggs from different regions, 1981-86. Arrows show positions of geometric mean levels. On analysis of variance, significant regional variation was found: $F_{6,112} = 16.41$, $P<0.0001$.

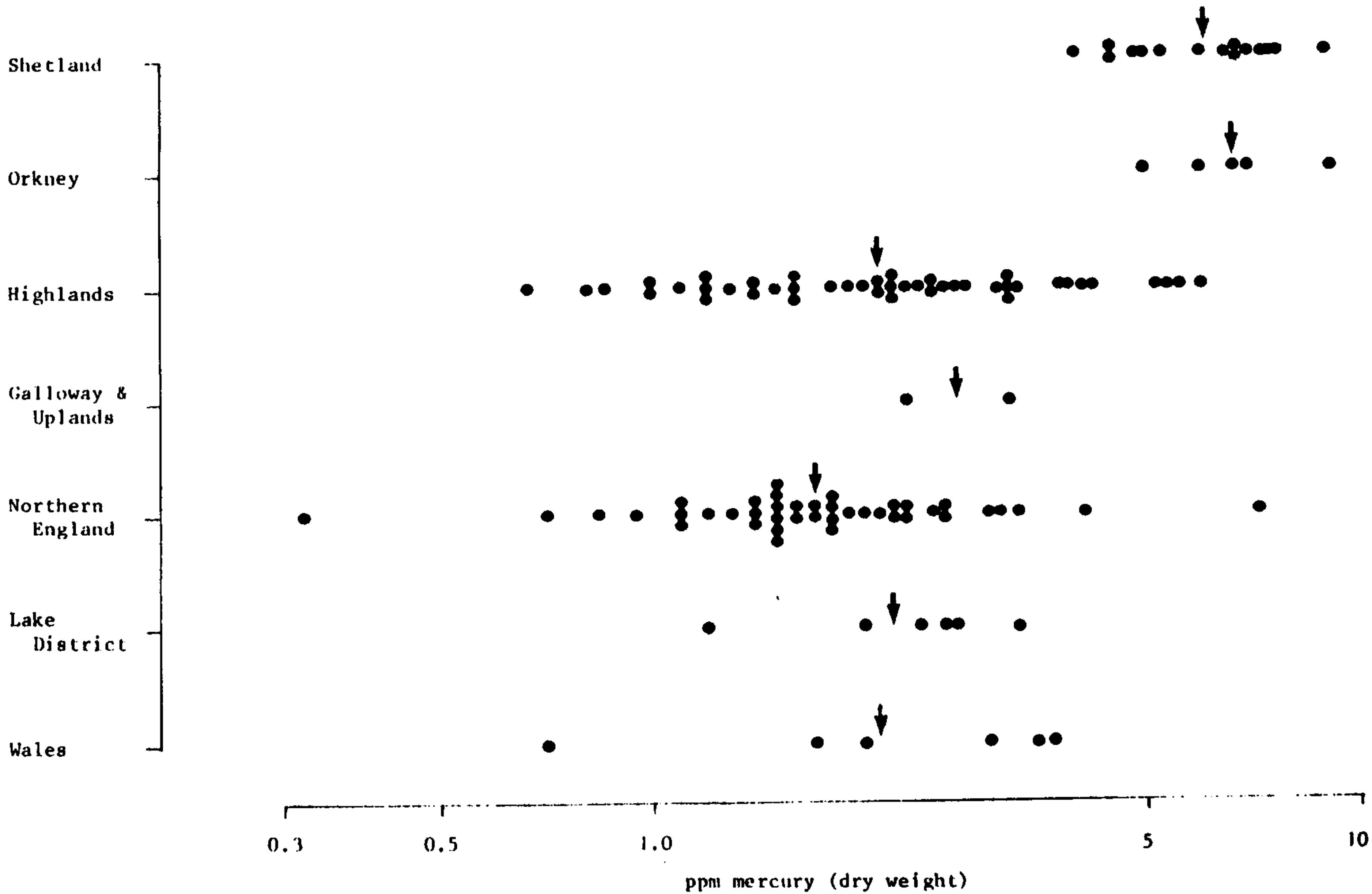


Figure 6. Time trends in the organochlorine levels of British merlin eggs (Orkney & Shetland excluded). On a linear regression of residue level on year, significant declines were found in the levels of all three chemicals.

Log DDE = 2.278 - 0.012 year, $r = 0.24$, $P<0.001$;
Log HEOD = 1.312 - 0.027 year, $r = 0.30$, $P<0.0001$;
Log PCB = 2.305 - 0.028 year, $r = 0.38$, $P<0.0001$.

In all these equations, 1963 is taken as year 1.

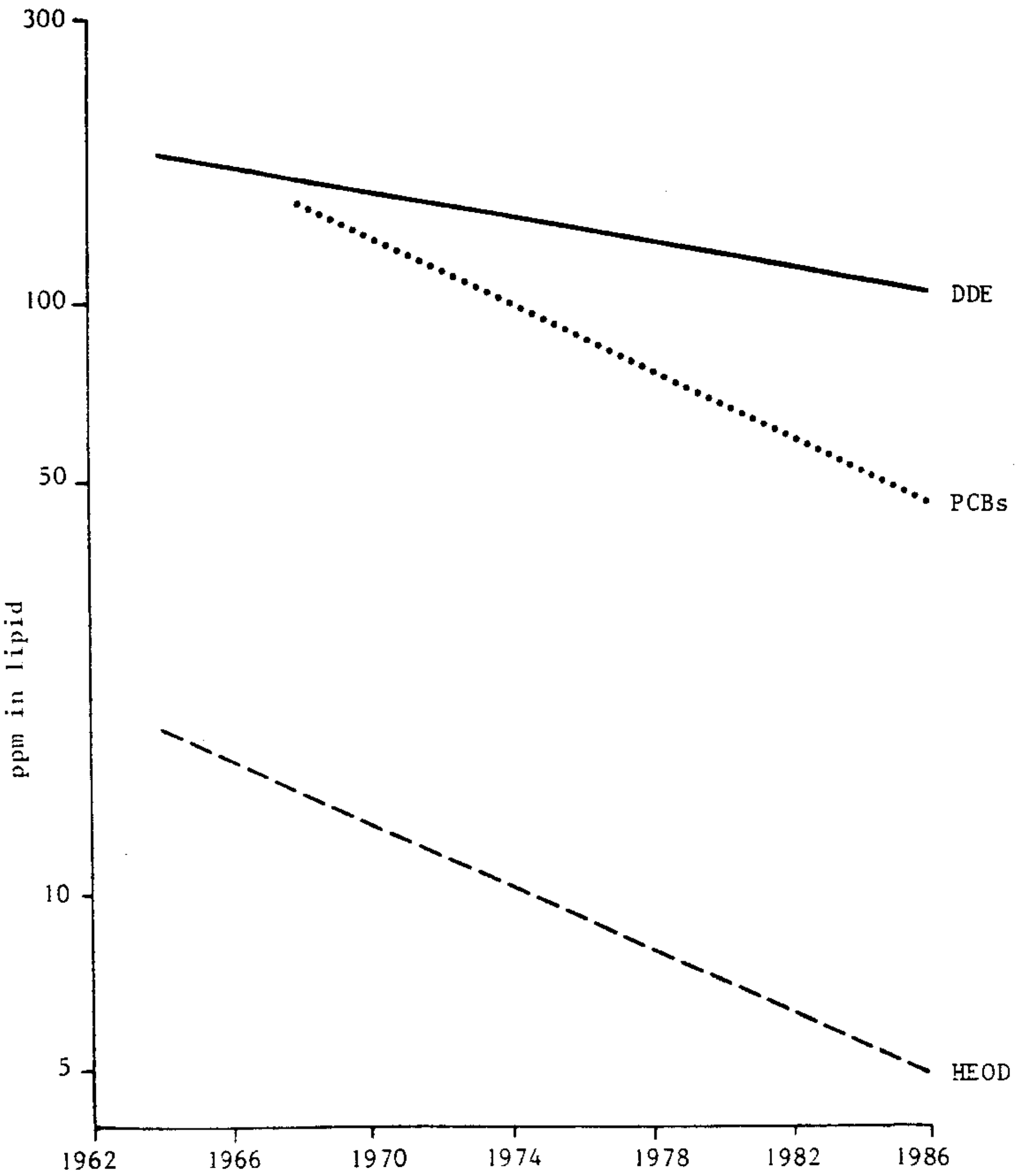
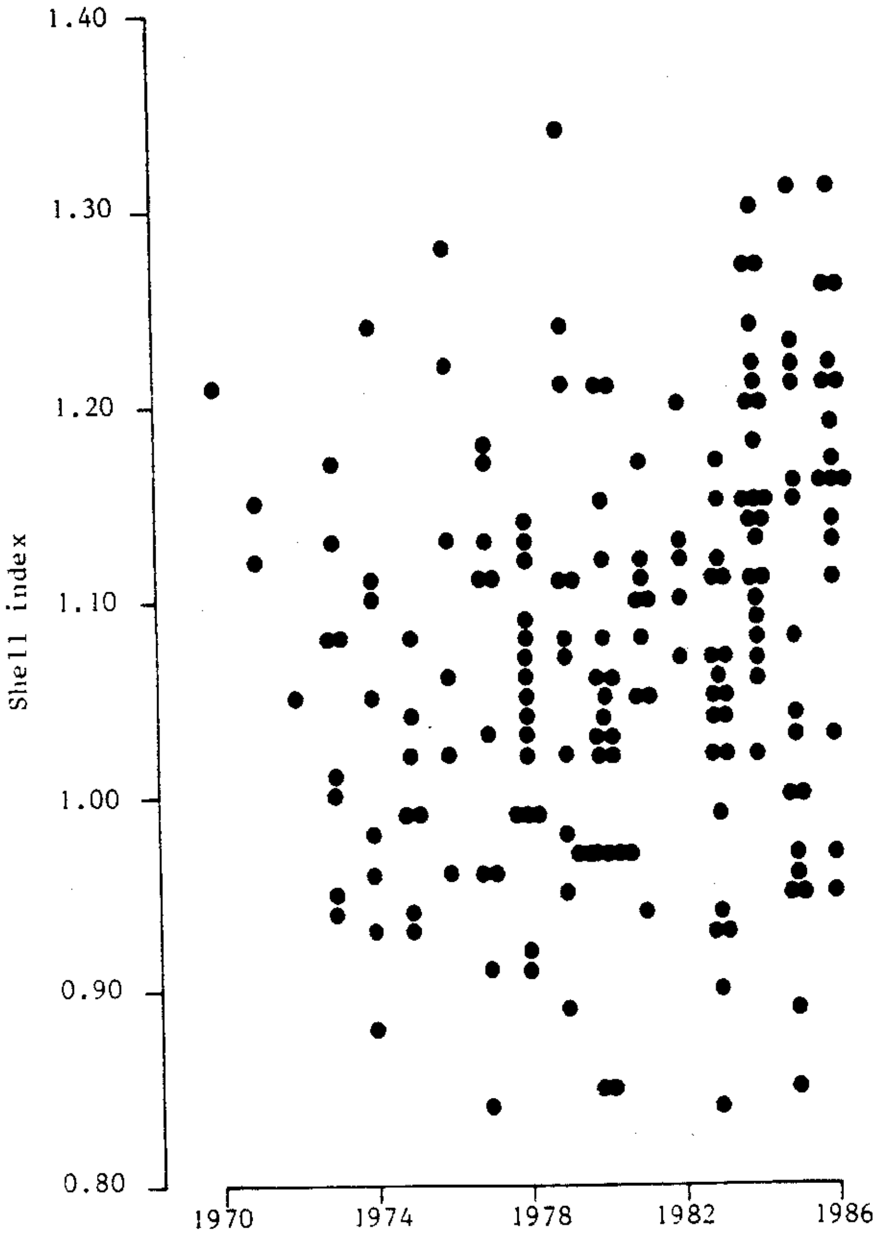


Figure 7. Time trends in shell-indices of British merlin eggs (Orkney & Shetland excluded). On a linear regression of shell-index on year, a significant increase was found:
shell-index 0.978 + 0.006 year, r = 0.24, P<0.005.



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 5 Wildlife mortality incidents

D OSBORN, M C FRENCH & D V LEACH

Monks Wood Experimental Station
Abbots Ripton
HUNTINGDON
Cambs PE17 2LS

August 1987

5 WILDLIFE MORTALITY INCIDENTS

5.1 Greylag geese on Loch Spynie

In November 1986, part of the bank of Loch Spynie, Aberdeenshire, gave way, releasing water and exposing new areas of bank. Soon afterwards large numbers of greylag geese Anser anser died. NCC officers examined the birds and found that the majority had lead pellets in their gizzards. There were up to 50 pellets in each bird and at least 75% of pellets were found to be gunshot, the remainder being fishing weights.

Six birds were examined and analysed at Monks Wood Experimental Station. These birds were found to be emaciated and to contain lead shot in their gizzards. They also had levels of lead in their tissues which indicated that they died of lead poisoning (Table 7). Between 14 November and 18 December 1986, 285 geese died and in late January 1987 another 30+ bodies were found. No other birds were seen to be involved in the incident and no further deaths were reported. The banks of the Loch were repaired and the water has risen to near its former height. Evidently, the lowering of the water level made available to the geese lead shot which had previously been too deep for them to reach.

5.2 Common terns from Stoke

Tissues from two common terns Sterna hirundo were received from the MAFF laboratories at Shrewsbury in September 1986. They were sent to MAFF by an Environmental Health Officer who had been using rodenticides at the Garden Festival, Stoke, and was concerned that the birds may have died as a result. No other species were involved.

Post-mortem examinations and cultures which were taken gave no clue to the cause of death in the terns, although one bird had no fat reserves and an enlarged spleen. Both birds had empty gizzards.

We have no capability to analyse for rodenticides at the present time, but the levels of other chemicals in the tissues are given in Table 8. The only finding of note was the high level of cadmium in the kidney of one bird.

5.3 Herring gulls from Kent

Tissues were received from two herring gulls Larus argentatus which had died on the north Kent coast in the Higher Saltings area. The birds had diarrhoea, were gasping for breath and had varying degrees of paralysis. The same symptoms occur in hundreds of birds in this area each year, mostly in the period August-October. Veterinary Investigation Officers at ADAS (Wye, Kent) were unable to find evidence of any specific disease during post-mortem examination and from cultures taken at the time.

The results of our chemical analyses are shown in Table 9. Both birds had high cadmium levels in the kidney, and in one bird the level was exceptionally high.

Table 7. Lead levels (ppm dry weight) in greylag tissue

Bird number	Liver	Kidney	Bone
1	30.8	495.0	140.0
2	56.1	72.4	20.6
3	61.4	86.2	112.0
4	175.0	62.8	54.6
5	102.0	153.0	871.0
6	112.0	268.0	40.8

Table 8. The results of tissue analyses on two common terns

Sample number	Tissue	Pb	Cd	Hg	HEOD	DDE	PCB
1	Kidney	ND	22.50	0.07	0.05	0.15	1.87
2	Liver	ND	1.92	0.17	0.07	0.37	2.20

Metal results expressed as ppm dry weight
Organochlorine results expressed as ppm wet weight

LOD Pb <0.326 µg in solution

Table 9. The results of tissue analyses on two herring gulls

Sample	Tissue	Pb	Cd	Hg	HEOD	DDE	PCB
1	Liver	ND	1.63	1.15	0.05	0.24	4.20
2	Liver	ND	1.98	1.17	0.14	0.32	3.65
3	Kidney	ND	62.80	0.53	-	-	-
4	Kidney	ND	19.00	1.28	0.78	1.48	7.25

Metal results expressed as ppm dry weight
Organochlorine results expressed as ppm wet weight

LOD Pb <0.326 µg in solution.

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Metal results expressed as ppm dry weight
Organochlorine results expressed as ppm wet weight

LOD Pb <0.326 µg in solution.

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BIRDS AND POLLUTION

Part 6 Puffins and PCBs

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Cambs PE17 2LS

August 1987

6 PUFFINS AND PCBs

6.1 Introduction

As expected, none of the dosed or control puffins could be collected in the 1986 breeding season on the Isle of May. In place of these birds, ten puffins from the general population were collected for monitoring purposes. This alternative procedure had already been agreed with NCC.

6.2 Methods

Methods of obtaining tissue samples have been described in previous reports. The analytical method was basically the same as that used throughout the study, but the details have altered in the last two years in a way that may have improved the detection of low concentrations of PCBs.

6.3 Results

Table 10 shows the PCB levels identified in the tissues of the ten birds. Residues in the fat were little different from those found in recent years, ranging from nil detected (<0.5 mg/kg) to 29.1 mg/kg wet weight. Detectable residues of PCBs were found in the majority of other tissues. This contrasts sharply with the results for tissues other than fat that were obtained in the middle years of the study, after the PCB dose was lost from the birds. In this period PCBs were detected only rarely in tissues other than fat (Osborn et al 1986). The recent results for liver, kidney, muscle and brain were similar to those found in the past two years.

As in earlier years, many data were collected from these birds on residues other than PCB. These data can be summarised as follows:

Organochlorine pesticide residues:

HEOD: Detected in all but one sample. Residues were highest in fat; range: 1.8-3.4 mg/kg.

DDE: Detected in all but five samples. Residues were highest in fat; range: 1.8-3.9 mg/kg.

Metal residues:

Mercury and cadmium concentrations were similar to those obtained in previous years (Osborn 1979).

It is proposed to analyse these additional data at the end of the current contract, and summarise the results then.

6.4 References

OSBORN, D. 1979. The significance of metal residues in wild animals. Proc. int. Conf. Management and Control of Heavy Metals in the Environment, London, 187-190. Edinburgh: CEP Consultants.

OSBORN, D., HARRIS, M.P. & LEACH, D.V. 1986. Birds and Pollution (Part 6). Natural Environment Research Council contract report to the Nature Conservancy Council. Abbots Ripton: Institute of Terrestrial Ecology.

TABLE 10. PCB residues (mg/kg) in tissues of puffins from the Isle of May, 1986.

Bird	Fat	Liver	Kidney	Muscle	Brain
86/01	4.9	1.8	ND	2.0	2.8
86/02	16.5	6.5	1.4	ND	1.6
86/03	10.7	3.1	1.8	2.8	3.8
86/04	ND	4.6	1.1	2.9	2.9
86/05	29.1	5.7	No sample	5.7	3.5
86/06	25.0	0.6	8.7	4.3	3.2
86/07	18.8	3.2	7.0	4.4	6.9
86/08	27.6	5.4	4.8	3.1	4.7
86/09	29.4	3.9	9.8	6.4	4.6
86/10	19.2	3.7	10.6	4.7	2.8

ND = none detected, <0.5 mg/kg.