

## Pesticide residues in Cory's Shearwater eggs (*Calonectris d. diomedea*)

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**Abstract** — Deserted eggs of Cory's Shearwater from a colony off Crete were analyzed for chlorinated hydrocarbon content. Substantial concentrations of DDE and PCBs were found. High concentrations of DDE are correlated with those of PCBs. Almost at the top of the Mediterranean food chain, Cory's Shearwater is a good bioindicator for the Mediterranean.

### Introduction

Pollution of the Mediterranean is a question of special concern, because it is quite cut off from the oceans and human waste of any sort can accumulate more rapidly here than out in the open seas. In order to monitor the state of the Mediterranean, pelagic species should be studied whose distribution covers not only the whole Mediterranean, but reaches way out into the Atlantic so as to establish a basis for comparison. Cory's Shearwater (*Calonectris diomedea*) is certainly suitable for such bio-monitoring because it is widely distributed and almost at the top of the food chain. The Atlantic subspecies *borealis* breeds off Madeira and on the Canary and Selvagem Islands, while the Mediterranean subspecies *diomedea* breeds in colonies on small rocky islands from the Columbretes off Spain or the Chafarinas off Morocco in the west to the Greek and Turkish islands in the east. The wintering area of Cory's Shearwaters is in the southern Atlantic where they stay from November to February and where the environmental burden should be low in comparison to that of the Mediterranean. In March they re-enter the Mediterranean through the Strait of Gibraltar and proceed to their breeding island or its vicinity immediately. Here they spend two months before the pair produces a single egg (weight 70-85 g) at the end of May. Females are at least 5 years old before they lay their first egg and may well reach an age of more than 20 years. Their food consists of small fish, fish spawn, cephalopods and crustaceans. They search the surface of the sea in pursuit of their food over an area probably greater than 100 km x 100 km. They typically stay more than 1 km off the coast, so that they do not visit lagoons,

river mouths, or marshes, and are never seen at garbage dumps inland (Cramp and Simmon: 1979, Wink *et al.* 1982, Zammit and Borg 1986). We undertook a study of chlorinated hydrocarbons in Cory's Shearwater eggs.

### Material and Methods

We studied a population of Cory's Shearwater on a small island off Crete for more than 15 years; we now know more than 300 nest sites in crevices which are accessible to an investigator, and we checked them for abandoned eggs in June 1990, '91 and '92. Eggs with a punctured shell were collected. These accidents may perhaps happen when both adults are moving in the crevice and the egg hits a stone. Apparently abandoned cold eggs with undamaged shells were left in place because in the past we found some cases where an egg was left alone for a complete day, but a chick hatched later on in July. ('Egg chilling' is a common phenomenon among the Procellariiformes (Warham 1990)). Only if such eggs were unattended for 3 consecutive days were they considered as truly abandoned. The samples (Table 1) were obtained in two weeks of field work per season. From our 15 years of experience with the island, we can say that quite a few of these eggs stem from irregularly occupied, untypical nests, so we suggest that the sample may be biased towards young birds.

Egg contents were later analyzed in the laboratory for pesticide residues by capillary gas chromatography according to standard procedures as described in Hädrich *et al.* (1992). Concentrations were calculated on the basis of the egg's dry weight.

Table 1 - Residue concentrations of chlorinated hydrocarbons in 20 eggs of Cory's Shearwater from Crete (in mg/kg dry weight).

year	nest no.	HCB	Lindan	cis HCE	pp-DDE	PCB 138	PCB 153	PCB 180	PCB total*
1990	786 E	0.035	n.d.	0.026	9.16	1,714	2.934	2.057	24.75
1991	634	0.013	n.d.	n.d.	2.99	0.57	1.02	0.69	8.4
"	—	0.015	n.d.	n.d.	9.46	0.69	1.20	0.75	9.7
"	616	n.d.	n.d.	n.d.	5.37	0.67	1.29	0.92	10.7
"	743	0.019	n.d.	n.d.	5.02	0.86	1.37	1.03	12.1
"	976	0.011	n.d.	n.d.	4.46	0.70	1.61	1.13	12.9
"	740	0.013	n.d.	n.d.	16.23	1.22	2.28	1.19	17.0
"	D11	0.013	n.d.	n.d.	26.32	2.28	3.62	2.74	32.0
"	—	0.02	n.d.	n.d.	22.83	3.77	8.49	6.54	70.9
1992	646	n.d.	n.d.	n.d.	1.48	0.28	0.62	0.52	5.4
"	827	n.d.	n.d.	n.d.	2.40	0.39	0.61	0.55	5.9
"	721 NE	n.d.	n.d.	n.d.	2.53	0.30	0.83	0.64	6.8
"	616	n.d.	n.d.	n.d.	1.85	0.47	0.90	0.65	7.5
"	976	n.d.	n.d.	n.d.	4.01	0.70	1.20	0.77	9.8
"	681	n.d.	n.d.	n.d.	4.08	0.67	1.11	0.98	10.4
"	650 W	n.d.	n.d.	n.d.	3.27	0.59	1.30	0.92	10.5
"	674	n.d.	n.d.	n.d.	2.68	0.63	1.37	1.07	11.6
"	698	n.d.	n.d.	n.d.	2.51	0.48	1.26	1.39	12.3
"	817 B	n.d.	n.d.	n.d.	5.85	0.80	1.59	1.25	13.7
"	740	n.d.	n.d.	n.d.	6.34	0.84	1.95	1.65	16.9

Table 2 - Residue concentrations of chlorinated hydrocarbons in eggs of three bird species from the same island (in mg/kg dry weight)

	HCB	Lindan	cis-HCE	pp-DDE	PCB 138	PCB 153	PCB 180	PCB total*	Reference
Cory's Shearwater (Mean, n = 18)				4.98	0.70	1.36	1.01	11.5	Table 1
Yellow-legged Gull (n = 1)				12.11	1.00	1.44	0.81	11.7	Hádrich pers. comm
Eleonora's Falcon (Mean, n = 14)	0.007	0.001	0.023	5.28	0.04	0.14	0.09	1.0	Wink <i>et al</i> 1991

\* PCB total calculated as Arochlor 60, in order to allow comparison with data in former publications.

## Results

A single deserted egg was analyzed for a first test in 1990. As this egg showed a high level of PCB, more detailed investigations were carried out in 1991 and 1992 (Table 1). While Lindan and cis-HCE could not be detected, the concentration of PCB was relatively high (mean =  $11.5 \pm 4.5$  mg/Kg, n = 18). The two eggs from 1991 with the highest concentrations are not included in the calculation of the average for reasons of pattern coherency. The level of DDE, a derivative of DDT, was also substantial (mean =  $4.98 \pm 3.5$  mg/kg, n = 18).

The data suggest that high levels of DDE are correlated with high levels of PCB.

## Discussion

The presence of PCB indicates industrial contamination, whereas DDE residues point to agricultural activities. These organochlorine compounds are easily distributed in the environment and enter the sea through sewage or rivers or can directly derive from sea vessels (in the case of PCBs) or can stem from the atmosphere. Since PCBs and

DDE accumulate in the food chain, they are regularly found in all kinds of shorebirds in varying amounts. But the high level found in Cory's Shearwater off Crete is a reason for special concern, particularly since the mountainous island of Crete has little industry and not much farm land. Thus the data should reflect the pollution of the Mediterranean in general. For further comparison, data from the same island for the Yellow-legged Gull (*Larus cachinnans*) and Eleonora's Falcon (*Falco eleonora*) are given in Table 2. In the Falcon eggs the contamination levels are lower than those for the gull and especially the PCB levels are lower than those for the two sea species. Since the falcons feed on passerine birds and insects it seems that these terrestrial species have been spared most of the PCB burden. We therefore assume that not only Cory's Shearwaters and Yellow-legged Gulls but probably all Mediterranean sea and shorebirds are critically affected (Bourne *et al.* 1980).

Three nests contained failed eggs with similar pesticide concentrations in consecutive years (no. 616, 976, 740 in Table 1). We assume that because these nests were quite exposed to daylight the same relatively young and inexperienced female was involved each year. We have no direct evidence for pesticide related breeding failures, hatching success being 84% and fledging success 82%. The organochlorine data of 2 eggs collected off Crete in 1983 (Renzoni *et al.*, 1986) fit well with the data of Table 1. The highest concentrations found in our study are comparable to data from Majorca. When all available Mediterranean data are considered,

PCB levels are 2 to 25 times higher than those from the Atlantic (Renzoni *et al.* 1986). Although no pesticide related breeding failures of Cory's Shearwater occurred, the high levels of PCB and DDE are a reason for concern about the environmental condition of the Mediterranean.

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