shortly after being trapped for falconry. Significant amounts of PCB were present in Arctic peregrines only a few months old (Nos. 5 and 6), but higher residues were present in a second year Arctic bird (No. 2) and exceptionally high residues were present in an adult trapped in California (No. 4). In birds 2 and 4 the total lipid reserves were very low, and in both the brain concentrations of DDE and PCB were high, perhaps at toxic levels. Fat mobilization during reproduction or in times of starvation or stress could be expected to cause significant changes in the internal distribution of chlorinated hydrocarbons. Steroid hydroxylase activity in the liver might increase at this time. Dieldrin concentrations were lower than in the peregrines analysed in Britain, but DDE concentrations were approximately comparable[24].

Table 2 presents the results of analyses of peregrine prey species, remains of which were collected at eyries in Baja California, Mexico. With the exception of the remains of one mourning dove (*Zenaidura macroura*) and of three fish bats (*Pizonyx vivesi*), prey material found at four eyries consisted of sea birds. Of these, the eared grebe (*Podiceps caspicus*) and the black petrel (*Loomelania melania*) constituted 32 and 25 per cent, respectively, of the remains.

Black petrels, like other petrels and shearwaters (Table 3), contained especially high concentrations of both DDT and PCB. Reproductive success in this population of peregrines seems to be subnormal. In 1968 no pairs were observed to hatch or fledge more than a single young. In the past, two to four young, the number normally produced by healthy peregrines[26,27], were raised by each pair (L. W. Walker, personal communication). The thickness of fragments of a peregrine eggshell, with its membrane, collected in 1968 below an eyrie where one young hatched, was 0·24 mm, a decrease of 34 per cent from the mean thickness of 0·34 mm ± 0·015 mm (95 per cent confidence level) in twenty-three eggs collected in the area before 1947 (D. Anderson and J. Hickey, personal communication). The region is wilderness, with little or no human interference, and is remote from sources of pollution.

In California, numbers of breeding peregrines have been reduced by at least 80 per cent in recent years. The remaining few pairs, however, seem to be reproducing normally and rear, when undisturbed, between two and four young each year. They are found, like most of the surviving pairs in Great Britain[11-24], in a relatively uncontaminated region and seem to be feeding on birds which contain low concentrations of chlorinated hydrocarbons. A pair which fledged three young in 1968 fed chiefly on passerines and columbiformes during the breeding season. Both prey groups are relatively uncontaminated (M. N. K., R. W. R. and S. G. H., in preparation). A clutch of eggs collected in this region weighed as much as the eggs obtained in pre-war years, whereas other peregrine eggs from California collected since the Second World War have been thin-shelled (ref. 2, and D. W. Anderson, J. Hickey and R. F. Christensen, in preparation). Despite official protection the surviving birds are still subjected to shooting by sportsmen and to harassment at the eyries. If these could be effectively reduced the population might yet survive.

In Table 3 are presented the results of analyses of marine and terrestrial birds and of three species of freshwater fishes for PCB and DDT content and concentration. From the ratio of total DDT to PCB, it is apparent that regional fallout patterns exist. In most of the birds from San Francisco Bay which have been analysed, including peregrine falcons (Table 1) and eggs of the western gull, the Caspian tern and the black-crowned night heron (Table 3), the ratio was between one and two. Another black-crowned night heron egg had a typically "ocean" profile, suggesting that the adult female had wintered along the coast. In most of the birds from the Farallon Islands, which are 27 miles west of the Golden Gate Bridge, this ratio was between 2 and 5. In the Gulf of Panama, where PCB contamination might come from the Canal Zone and industrial areas in Panama City, the ratio is between 1 and 2 (Table 3).

In the Gulf of California, a region relatively remote from the sources of either DDT or PCB contamination, the ratio was in most cases approximately 9 or 10. This was true in the egg of the peregrine falcon (Table 1), in all of the black petrels and least petrels analysed, in the Craveri's murrelets (Table 2), in five of six osprey eggs and in six of seven western gull eggs (Table 3). Among the exceptions the fish bat, with low concentrations of both DDT and PCB, was the most divergent, with a ratio of 43 (Table 2). It is not clear whether this reflects differences between avian and mammalian physiology or a fundamental difference in feeding habits. The other exceptions include species which are present in the area only during the breeding season (Table 2).

In sea birds from the Pacific the ratio was usually between 5 and 10 (Table 3). PCB was not found in eggs

Table 2. PCB AND DDT IN PREY SPECIES OF PEREGRINE FALCONS IN THE GULF OF CALIFORNIA

| Species* | N | DDT (μg) | DDT (p.p.m.) | Percentage DDE | PCB (μg) | PCB (p.p.m.) | DDT/PCB |
|---|---|---|---|---|---|---|---|
| Eared grebe (32) | | | | | | | |
| Whole body | 3 | — | 0·28, 0·26, 12·1 | 97 | NM† | | — |
| Black petrel (25) | | | | | | | |
| Whole body | 3 | 310 (265–1,344) | 9·2 (W) | 81 | — | 1·0 (W) (0·90–1·14) | 9·2 |
| Least petrel (6) | | | | | | | |
| Whole body | 3 | 99 | 8·2 (W) | 88 | — | 0·85 (W) | 9·8 |
| Eggs | 2 | 30 (23–37) | — | 84 | 3·1 (1·2–5·0) | — | 10 |
| Fish bat (3) | | | | | | | |
| Whole body | 7 | 25 (15–31) | 0·72 (W) | 92 | 0·58 (0·45–1·06) | 0·02 (W) | 43 |
| Craveri's murrelet (2) | | | | | | | |
| Eggs (one clutch) | 2 | 230‡ (222–238) | 99 (L) | 80 | — | 4·5 (L) | 9·7 |
| Whole body, adult | 1 | 27·1 | 0·31 (W) | 85 | — | 0·039 (W) | 7·9 |
| Whole body, adult | 1 | 295 | 2·4 (W) | 85 | — | 0·26 (W) | 9·2 |
| Elegant tern (1) | | | | | | | |
| Eggs | 3 | 15·5 (9·6–24·3) | 5·0 (L) | 90 | — | 1·3 (L) (0·8–2·6) | 3·8 |
| Heermann's gull (1) | | | | | | | |
| Eggs | 3 | 105 (94–278) | 48 (L) | 95 | — | 8·1 (L) (3·5–11·3) | 5·9 |

Content in μg of whole bodies and eggs; concentrations in p.p.m. wet weight (W) or lipid weight (L).

* All specimens were collected in the vicinity of four peregrine eyries in Baja California. Numbers in parentheses are the number of remains of each prey species which were found at the eyries. Also found were remains of one cormorant (*Phalacrocorax* sp), one red phalarope (*Phalaropus fulicarius*), one northern phalarope (*Lobipes lobatus*) and one mourning dove (*Zenaidura macroura*), but local specimens of these species were not analysed. Eggs of least petrels, elegant terns and Heermann's gulls were from different clutches. Eared grebe: *Podiceps caspicus*; black petrel: *Loomelania melania*; least petrel: *Halocyptena microsoma*; fish bat: *Pizonyx vivesi*; Craveri's murrelet: *Endomychura craveri*; elegant tern: *Thalasseus elegans*; Heermann's gull: *Larus heermanni*.

† Not measured. Interfering peaks on chromatograms.

‡ Both eggs also contained 0·08 p.p.m. dieldrin (lipid weight) and 0·17 p.p.m. endrin (lipid weight).

Table 3. PCB AND DDT IN THE GLOBAL ECOSYSTEM

| Species | N | Total DDT (μg) | Total DDT (p.p.m.) | Percentage DDE | PCB (μg) | PCB (p.p.m.) | DDT/PCB |
|---|---|---|---|---|---|---|---|
| White crappie (1) | 1 | — | 1·83 (W) | 6 | — | 0·004 (W) | 475 |
| Black crappie (2) | 1 | — | 2·10 (W) | 6 | — | 0·003 (W) | 690 |
| Bluegill (3) | 1 | — | 5·5 (W) | 6 | — | 0·005 (W) | 1,200 |
| Adelie penguin (4) Eggs | 5 | 0·76 (0·59–1·04) | 0·128 (L) | 74 | < 0·044 μg/egg | | > 18 |
| Western grebe (5) Breast muscle | 1 | — | 26·4 (W) | 5 | — | 0·098 (W) | 270 |
| Fulmar (6) A | 1 | — | 0·41 (W) | 76 | — | 0·06 (W) | 9 |
| B | 1 | — | 3·4 (W) | 69 | — | 0·34 (W) | 10 |
| C | 1 | 10,475 | 17·5 (W) | 96 | 3,900 | 6·5 (W) | 2·7 |
| Pink-footed shearwater (7) | 1 | 2,000 | 9·0 (W) | 93 | 277 | 0·42 (W) | 7·2 |
| Sooty shearwater (8) A | 1 | — | 12·3 (W) | 94 | — | 1·2 (W) | 10 |
| B | 1 | — | 10·5 (W) | 80 | — | 0·9 (W) | 12 |
| C | 1 | 1,265 | 2·3 (W) | 65 | NM | | |
| Slender-billed shearwater (9) | 1 | — | 32·0 (W) | 92 | — | 2·1 (W) | 15 |
| Ashy petrel (10) | 3 | 2,158 (1,644–2,826) | 59·3 (W) | 95 | 380 (298–482) | 9·8 (W) | 5·5 |
| Brown pelican (11) Eggs, Panama | 6 | 59 (18–183) | 11·5 (L) | 61 (47–78) | 23·1 (15–30) | — | 1·55 (0·97–3·2) |
| Eggs, Baja California | 2 | 53 (47–59) | 10·0 (L) | 81 | 10·4 (9·0–11·7) | — | 5·5, 4·0 |
| Frigate-bird (12) eggs, Panama | 3 | 9·0, 8·7, 30·0 | — | 88 | 8·4, 5·7, 34·0 | — | 1·1, 1·5, 0·9 |
| Brown booby (13) eggs, Panama | 4 | 20·8 (16·4–24·5) | 8·2 (L) | 89 | 12·2 (6·5–18·9) | 4·6 (L) | 1·7 |
| Brandt's cormorant (14) eggs | 17 | 326 | — | 91 | 113 | — | 2·9 |
| Pelagic cormorant (15) eggs | 2 | 128 (125–130) | — | 90 | 62 (48–75) | — | 2·1 |
| Cinnamon teal (16) | 1 | 4,340 | 10·9 (W) | 70 | — | 0·91 (W) | 12 |
| White-tailed kite (17) Eggs, clutch A | 4 | 11·6 (9·8–12·9) | 0·70 (W) | 77 | 6·4 (5·5–7·8) | — | 1·8 |
| Unhatched egg B | 1 | 5·1 | 0·36 (W) | 82 | 0·84 | — | 6·0 |
| Unhatched egg C | 1 | 5·3 | 0·35 (W) | 73 | 3·6 | — | 1·5 |
| Clutch D | 2 | 8·3/egg | — | 82 | 4·3/egg | — | 2·0 |
| Clutch E | 3 | 10·2/egg | 9·0 (L) | 57 | 4·0/egg | — | 2·4 |
| Clutch F | 4 | 31·9/egg | — | 80 | 3·8/egg | — | 8·5 |
| Cooper's hawk (18) | 1 | 8,500 | 85·2 (W) | 90 | — | 6·3 (W) | 4·0 |
| Golden eagle (19) egg | 1 | 150 | 2·0 (W) | 98 | 17·5 | 0·28 (W) | 8·5 |
| Osprey (20) eggs, Baja California | 6 | 127 (30–204) | 55 (L) | 85 | 7·3, 3·0, 103, 24, 7·0, 19 | — | 8·5, 10·1, 1·3, 11·2, 9·7, 11·1 |
| Merlin (21) | 1 | 495 | 2·9 (W) | 94 | 55·4 | 0·30 (W) | 12·7 |
| American kestrel (22) Whole body, adult | 1 | 5·1 | 0·044 (W) | 99 | 3·7 | 0·031 (W) | 1·4 |
| Eggs, two clutches | 6 | 2·4/egg | 0·20 (W) | 93 | 1·0/egg | 0·09 (W) | 2·3 |
| Black-crowned night heron (23) Egg | 1 | 541 | — | 89 | 330 | — | 1·6 |
| Egg | 1 | 359 | — | 99 | 23 | — | 16 |
| Western gull (24) Eggs, San Francisco Bay, three clutches | 4 | 803 (632–1,123) | — | 85 | 806 (580–1,310) | — | 1·0 |
| Eggs, Farallon Is., ten clutches | 10 | 412 ± 102 | — | 89 | 136 ± 56 | — | 3·0 |
| Eggs, Baja Calif., seven clutches | 7 | 335 ± 230 | — | 97 | 45 ± 30 | — | 9·1, 10·5, 5·0, 12·3, 10·6, 10·7, 10·5 |
| Forster's tern (25) eggs | 2 | 665 (598–732) | — | 89 | 114 (91–137) | — | 5·8 |
| Caspian tern (26) Eggs, San Francisco Bay | 2 | 1,269 (1,216–1,322) | — | 89 | 805 (660–950) | — | 1·7 |
| Eggs, San Diego Bay | 5 | 1,430 (991–2,420) | — | 88 | 1,010 (550–1,600) | — | 1·4 |
| Red phalarope (27) | 1 | — | 0·78 (W) | 79 | — | 0·10 (W) | 8 |
| Common murre (28) eggs | 6 | 1,945 (932–2,521) | 151 (L) | 90 | 558 (364–1,010) | 45 (L) | 3·5 |
| Cassin's auklet (29) | 1 | — | 5·9 (W) | 98 | — | 0·16 (W) | 36 |
| Ancient murrelet (30) | 1 | — | 0·76 (W) | 90 | — | 0·15 (W) | 5 |
| Rhinoceros auklet (31) | 1 | — | 2·7 (W) | 97 | — | 0·36 (W) | 8 |
| Mourning dove (32) | 2 | 12·9, 33·1 | 0·19 (W) | 77, 93 | Not detected | — | — |
| Barn owl (33) Eggs, one clutch | 3 | 27·7/egg | 1·25 (W) | 95 | 10·4/egg | 0·47 (W) | 2·7 |
| Eggs, one clutch | 2 | 143/egg | 6·8 (W) | 96 | 14·4/egg | 0·68 (W) | 10 |
| Meadowlark (34) | 2 | 21·2, 465 | 0·18, 3·3 (W) | 77, 93 | 2·5, 28·1 | — | 8·4, 15·9 |

Content in μg and concentrations in p.p.m. wet weight (W) or lipid weight (L).

Unless otherwise specified, analyses were of whole bodies. Endrin and dieldrin were identified on the basis of retention times on both *QF*-1 and *DC*-200 columns.

1. *Pomoxis annularis*, 234 g, Clear Lake, Lake Co., Calif., May 1968.
2. *Pomoxis nigromaculatus*, 212 g, Clear Lake, Lake Co., Calif., May 1968.
3. *Lepomis macrochirus*, 229 g, Clear Lake, Lake Co., Calif., May 1968.
4. *Pygoscelis adeliae*, Cape Crozier, Antarctica, October 1967.
5. *Aechmophorus occidentalis*, Clear Lake, Lake Co., Calif., May 1968.
6. *Fulmarus glacialis*. *A* and *B*: Monterey Bay, Calif., November 1, 1966. *C*: Point Reyes, Calif., December 1967. Fulmars breed in Alaska.
7. *Puffinus creatopus*. Breeds in Chile. Collected in May 1968, in the Gulf of California.
8. *Puffinus griseus*. Breeds in New Zealand and Chile. *A* and *B*: Monterey Bay, November 1, 1966. *C*: Gulf of California, May 1968. NM, Not measured, interfering peaks.
9. *Puffinus tenuirostris*. Breeds in Australia. Monterey Bay, December 1966.
10. *Oceanodroma homochroa*. Farallon Islands, Calif., May 1968.
11. *Pelecanus occidentalis*. Panama eggs were collected on Isla Pacheca and Isla Pachequilla, Gulf of Panama, February 1968. One egg contained 0·06 p.p.m. dieldrin and 0·06 p.p.m. endrin, another contained 0·16 p.p.m. dieldrin and 0·07 p.p.m. endrin (lipid weight). Baja California eggs were collected at Bahia de los Angeles, March 1968. One egg contained 0·24 p.p.m. dieldrin and 1·18 p.p.m. endrin (lipid weight).
12. *Fregata magnificens*. Isla Pacheca, Panama, February 1968.
13. *Sula leucogaster*. Isla Pacheca and Isla Pachequilla, Panama. February 1968. Two eggs were analysed for dieldrin and endrin. Dieldrin: 0·08, 0·16 p.p.m.; endrin: 0·06 and 0·011 p.p.m. (lipid weight).
14. *Phalacrocorax penicillatus*. Farallon Islands, May 1967.
15. *Phalacrocorax pelagicus*. San Mateo Co., Calif., May 1967.
16. *Anas cyanoptera*. San Diego, April 1968. Adult male.
17. *Elanus leucurus*. *A*: Contra Costa Co., Calif., April 1968. *B* and *C*: Contra Costa Co., May 1968, two and three young raised, respectively. *D*: Abandoned, Contra Costa Co., May 1967. *E* and *F*: Destroyed nests, Contra Costa Co., March 1968.

Table 3 (continued)

18. *Accipiter cooperii*. Balboa Park, San Diego, February 1968. First year female, died of trichomoniasis.
19. *Aquila chrysaetos*. San Luis Obispo Co., Calif., April 1968. Unhatched egg in nest where one young was raised. Egg also contained 4·7 µg of dieldrin, 1·9 µg of heptachlor epoxide, but no endrin.
20. *Pandion haliaetus*. Gulf of California, March 1968. One egg also contained 0·10 p.p.m. dieldrin and 0·25 p.p.m. endrin (lipid weight).
21. *Falco columbarius*. Immature, Utah, December 1967.
22. *Falco sparverius*. Adult was killed on road, Mendocino Co., Calif., December 1967. Eggs from Davis, California, 1968.
23. *Nycticorax nycticorax*. Eggs from different clutches, San Francisco Bay, May 1967.
24. *Larus occidentalis*. Standard errors, 95 per cent confidence limits.
25. *Sterna forsteri*. San Diego Bay, May 1967.
26. *Hydroprogne caspia*, 1967.
27. *Phalaropus fulicarius*. Monterey Bay, November 1, 1966.
28. *Uria aalge*. Farallon Islands, May 1967.
29. *Ptychoramphus aleuticus*. Farallon Islands, April 1968.
30. *Synthliboramphus antiquum*. Monterey Bay, November 1, 1966.
31. *Cerorhinca monocerata*. Monterey Bay, November 1, 1966.
32. *Zenaidura macroura*. San Diego, July 1968.
33. *Tyto alba*. Clutch A from Contra Costa Co., Calif., March 1968. Clutch B from Yolo Co., Calif., April 1968.
34. *Sturnella neglecta*. Davis, Calif., December 1967.

of the Adelie penguin from Cape Crozier, Antarctica. In these, however, the amount of DDT was very low; with a DDT:PCB ratio of 18, no PCB would have been detected. A larger amount of fat material from Antarctic organisms, which would contain more DDT, would therefore have to be analysed before concluding that PCB has not yet reached the Antarctic.

Individuals of species resident in industrial areas have, as expected, higher PCB levels than individuals of the same species from more remote regions. Analysis of ten eggs from ten clutches of the western gull from the Farallon Islands showed an average PCB content of 136 ± 55 µg (95 per cent confidence level). PCB content of four eggs from three clutches from an island in San Francisco Bay averaged 805 µg with a range from 580 to 1,310 (Table 3). Seven eggs from seven clutches in the Gulf of California contained 45 ± 30 µg of PCB. The DDT content of the eggs from the Farallons was not significantly different from that of the Baja California eggs.

Birds from the Gulf of California also contain dieldrin and endrin (Tables 2 and 3), but the number of analyses is as yet insufficient to compare their relative abundance with that of DDT and PCB. Despite the inability of the Shell Chemical Company to find any chlorinated hydrocarbons in the Gulf of California and at the mouth of the Colorado River[25], which drains into the Gulf, it is likely that some do enter from the Colorado River and from agricultural areas in western Mexico. A significant fraction, however, must come from the atmosphere[26], and air transport best explains the presence of PCB in remote areas. In extracts from the Gulf of California one PCB compound was present in relatively small concentrations. This compound is readily degraded by ultraviolet light irradiation in laboratory experiments, and may therefore be selectively degraded in the atmosphere. Although PCB is not soluble in water, it has a low but finite vapour pressure[27]. Incineration of materials containing PCB would greatly increase the rate of entry into the atmosphere. PCB is used in the manufacture of many industrial products, so the high amounts found in San Francisco Bay, Puget Sound[3] and San Diego Bay presumably result from direct discharge of industrial wastes into these waters and from local fallout.

The presence of PCB in the few land birds and fresh-water fish analysed indicates that it is also distributed among continental ecosystems in North America. Peregrines could therefore acquire PCB, as well as the other chlorinated hydrocarbons, over all their global range. No PCB residue data are available for prey species from the Atlantic, but compounds which seem to be PCB have been isolated from seals[28]. A second year male peregrine spent the winter of 1967–68 on Isla Pacheca, Panama, where the pelican, booby and frigate-bird eggs of Table 3 were collected. The Cooper's hawk which was analysed, a species which also preys upon birds, contained high residues of both DDT and PCB (Table 3). Cooper's hawks have declined in eastern North America and in some regions have produced thin-shelled eggs (D. Anderson and J. Hickey, personal communication). Several species of raptors do not accumulate high amounts of the organo-chlorine compounds (Table 3), a result of the very low residue levels usually found in their prey. American kestrels and barn owls are common residents of California cities. The white-tailed kite, which was near extinction 40 years ago in California, is now abundant in areas where insecticide use is intense, yet because it preys primarily upon the short-lived and herbivorous vole, *Microtus*, the species accumulates very little DDT or PCB (Table 3).

Previous work[13] has shown that both DDT and dieldrin induce hepatic enzymes in the pigeon which, in an *in vitro* preparation, increase the metabolism of progesterone and testosterone. This work has now been extended to study the metabolism of oestradiol by enzymes induced by *p,p'*-DDE, technical DDT (Dupont) and PCB ('Aroclor 1262'). The experimental procedure previously described[13] was followed except that the chlorinated hydrocarbons were injected intramuscularly rather than given orally, and in the separation of oestradiol and its metabolites the solvent system used was the upper layer of a mixture of benzene:heptane:methanol:water 7:3:8:2. The strips were monitored with an autographic strip scanner. The profiles obtained for the various inducing agents are shown in Fig. 1. It will be noted that the profiles of the metabolites obtained after enzyme induction using DDE and DDT are identical, but that a different metabolite is produced by the enzyme induced by PCB. The amount of metabolites formed was calculated from the radioactivity of the peaks. The results obtained are given in Table 4.

Table 4. INCREASE OF OESTRADIOL METABOLISM BY PIGEON LIVER HOMOGENATES FROM BIRDS TREATED WITH VARIOUS CHLORINATED HYDROCARBONS

| | Amount of polar metabolites formed in mµmoles |
|---|---|
| Control | 29·2 ± 6·5 |
| DDE (40 mg/kg) | 76·2 ± 13·1 |
| DDT (40 mg/kg) | 93·1 ± 11·2 |
| PCB (20 mg/kg) | 190·0 ± 10·5 |

Each figure is the average with standard deviation of a group of four birds. In all cases 500 mµmoles of oestradiol-6,7-T (500 mCi/mmole) was present in the incubation mixture. Incubation time 30 min, weight of microsomal fraction used 300 mg. All chlorinated hydrocarbons were injected intramuscularly into the pectoral muscle 7 days before death.

Body concentrations of 40 p.p.m. of *p,p'*-DDE significantly increased the rate of oestradiol degradation by the induced enzymes in the experimental conditions. On a weight basis the PCB preparation had an oestradiol degrading potential approximately five times that of *p,p'*-DDE or technical DDT. Both DDE and PCB, which are apparently the most abundant of the chlorinated hydrocarbon pollutants in the global ecosystem, have therefore the capacity to produce sublethal physiological effects in birds.

Studies on the activity of induced enzymes in the rat at various times after a single injection of DDT or dieldrin have been made by Ghazal *et al.*[29]. He found that it took 70 days for the activity to fall to half its maximum value in the case of DDT and 15 days in the case of dieldrin. Experiments with dieldrin on pigeons

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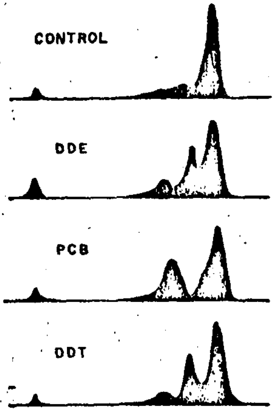


**Fig. 1.** Chromatographic separation of oestradiol and its metabolites. The large peak is unaltered oestradiol.

show that only a quarter of maximum activity remains after a month. Thus there is evidence that the effects of these induced enzymes can persist over a long period of time although more studies are needed to determine the steroid degrading potentials of livers of those species contaminated with chlorinated hydrocarbons. The profile of the metabolites should be some indication of the history of exposure to chlorinated hydrocarbons.

The reductions in eggshell thickness and eggshell weight increase the chances of egg breakage[33-38], and water retention, which affects hatching success[40-41], might be impaired. The environment in which birds now exist is therefore no longer the same as that in which they evolved; it is unlikely that any species has the genetic capacity to meet the selection pressures resulting from the abrupt environmental change which has produced the thin eggshells. The peregrine falcon is a species long highly revered and respected. G. H. Thayer[42] has described it as "the embodiment of noble rapacity and lonely freedom". An irony therefore exists in the fact that the peregrine may be the first species to be extirpated by global contamination.

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