Landesanstalt für Umwelt, Messungen und Naturschutz Baden-Württemberg

Organohalogen Compounds in the Eggs of Peregrine Falcons and Other Wild Bird Species in Baden-Württemberg – Present State and Time Trend

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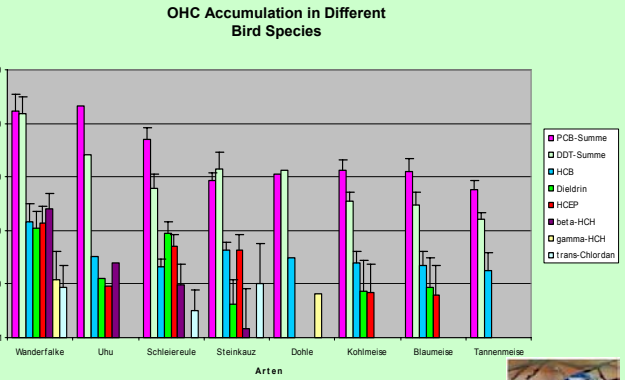
Introduction

Organohalogen compounds (OHC) are known to seriously pollute the environment and to cause considerable damage to living organisms including humans. These lipophilic and persistent pollutants accumulate in birds' eggs and can thus be detected in the environment. The UNEP (2003) has established birds' eggs as suitable bioindicators to monitor persistent pollutants (POPs) in the terrestrial ecosystem.

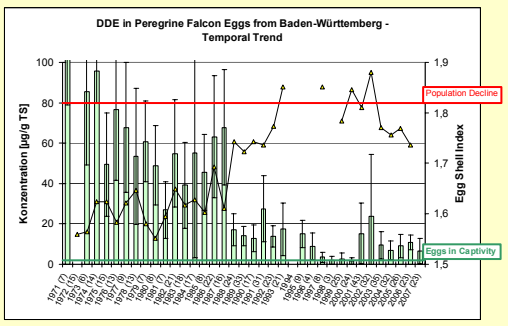


OHC Accumulation

Earlier studies (UWSF, 2006) have shown that OHC are accumulated in the terrestrial avian food chain in the order:

Peregrine Falcon > Eagle Owl > Barn Owl > Little Owl ≈ Jackdaw > Great Tit ≈ Blue Bonnet > Coal Tit

This demonstrates the Peregrine falcon's exposed position in the food web and its outstanding suitability as a bioindicator.

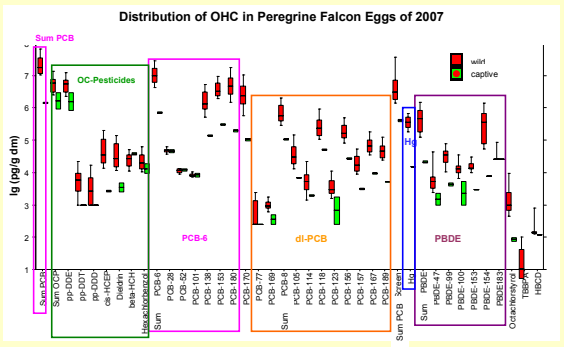


DDE Temporal Trend

As a result of bans of their use, the concentrations of DDT/DDE, Heptachloroepoxide (HCEP), Hexachlorobenzene (HCB), Hexachlorocyclohexane (HCH) and polychlorinated biphenyls (PCB) have decreased considerably from their levels in the 1970s. The DDE-decline was accompanied by an increase in eggshell thickness (yellow triangles) to normal values.
DDT/DDE are known to disrupt the calcium metabolism causing the thinning of eggshells and thereby a diminished breeding success. Thus, the banning of DDT (in 1972 in Western Germany) in conjunction with unremitting efforts of private ornithologists (Working Community for the Protection of Peregrine Falcons, AGW) throughout the past four decades were instrumental for the survival of the Peregrine falcon as a species (UWSF, 2007).

OHC Found in Peregrine Falcon Eggs in 2007

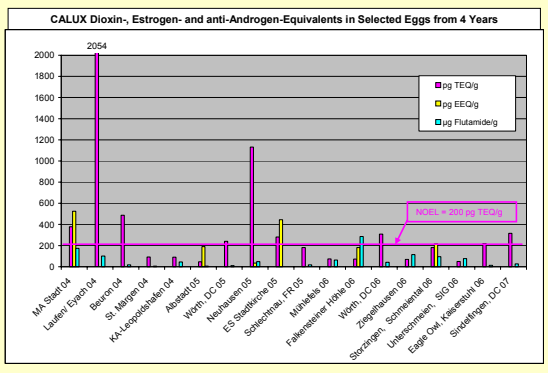
Of 88 analytes searched for, 51 could be detected in last year's eggs. PCBs and total DDT, which consists of the DDT-metabolite DDE to >99%, were found as the two main pollutants in the Peregrine eggs.



Toxic Effects

Several OHC are still found in very high concentrations and exert a potential health risk. Limit values for foodstuffs are exceeded up to 1000fold in the eggs. PCBs were identified as most critical, because they are the only class of compounds exceeding the threshold of dioxin-like effects in birds of prey like the osprey, and in chickens (200 pg WHO TEQ/g dry matter, UWSF, 2006).

Like polychlorinated dibenzodioxins and –furans (PCDD/F), the coplanar PCBs bind to the Ah-receptor and induce cytochrome P450 isozymes of the steroid- and xenobiotic-metabolism. Dioxin-like effects include a metabolic disruption of the hormonal balance, immunotoxicity, liver-toxicity, embryo-toxicity and tumor promotion. Non-coplanar PCBs are known for their affinity to the estrogen-receptor eliciting agonistic (the lower chlorinated congeners) or antagonistic effects (the higher chlorinated congeners such as 138, 153, 170, 180, 194, 199 and 203 as well as some important PCB-metabolites). This rule of thumb seems to hold true for the polybrominated diphenyl ethers (PBDE) as well (UWSF, 2007).

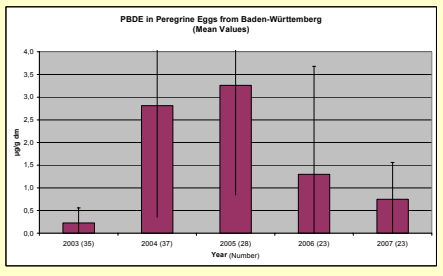


Receptor Binding Studies Via Cell Test

Eighteen Peregrine eggs were selected from the years 2004 to 2007 and analyzed via the dioxin responsive chemically activated luciferase expression bioassay (DR CALUX®). The bio-assay results (ranging from 44 to 2055 with a mean of 364 pg dioxin TEQ/g dm) confirm the earlier chemical analyses (19 eggs from the years 2000 to 2003 ranging from 149 to 954 with a mean of 397 pg dioxin TEQ/g dm). Similar bioassays were performed with estrogen and androgen responsive cells, respectively (ER CALUX® and AR CALUX®). The results are reported as 17β-estradiol or flutamide equivalents in the egg samples. No glucocorticoid and thyroid hormone-like activity was detected in the samples nor in a chicken egg serving as reference. Further work correlating bioassay results with chemical analyses is planned with the aim to establish the cell tests as a screening method.

PBDE Temporal Trend

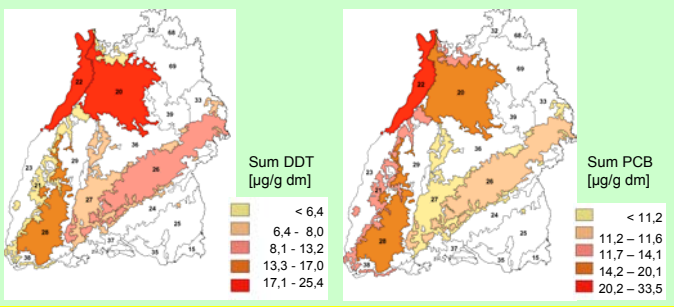
Polybrominated diphenylethers (PBDEs) have been measured in Peregrine eggs since 2003. After an initial sharp rise by a factor of 14, their levels seem to be declining in the years after 2005.



Regional Distribution of Main Pollutants

A regional comparison of the DDT- and PCB-pollution identifies the Kraichgau/Stromberg and the Northern Upper Rhine Valley (ecoregions 20 and 22) because of their population density and the mountain ranges (ecoregions 26 and 28) because of their elevation above sea level as the most polluted regions (darker areas).

The influence of the altitude can be explained with the global distillation theory: Persistent chemicals are distributed world-wide by evaporation and long range transport and accumulate by freezing out at the poles and at mountain ranges (GAIA, 2004).



Conclusions

- Further research is necessary to develop adequate criteria for a reliable assessment of the human health and ecological risk caused by environmental OHC such as PCBs, DDE, and PBDE, and their metabolites.
- The preliminary bioassay results are to be repeated and to be correlated with the chemical analyses in order to establish the CALUX cell tests for screening.
- Despite the decline in OHC concentrations in the past decades, the Peregrine population of Baden-Württemberg is still at risk through OHC in their environment. Therefore, the egg monitoring should continue, and measures to reduce the contamination should be considered where appropriate.

References:
GAIA 13(3), 176-185 (2004); **UNEP** workshop to develop a global monitoring programme to support the effectiveness evaluation of the Stockholm Convention, Geneva, Switzerland, 24-27 March 2003; **UWSF** 18(4), 228-241 (2006); **UWSF** 19(2), 75-82 (2007)