Can starling eggs be useful as a biomonitoring tool to study organohalogenated contaminants on a worldwide scale?

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1. Introduction

order to characterise the sampling sites (rural/urban) and potential contamination sources of OHCs. Each starling population was characterised as resident or migratory based on information provided by the local researchers, although this was not based on detailed studies (Table 1). Sampling sites were located both in urban and rural areas, but most sampling locations were characterised as rural (Table 1). Urban sampling locations were closely located to a city or densely populated area. Rural sampling locations were characterised by agricultural activities (e.g. crop production, horticulture).

A homogenised sample of approximately 0.5 g whole egg (without eggshell) was weighed, mixed with anhydrous Na_2SO_4 and spiked with internal standards (ε-HCH, CBs 46 and 143, BDEs 77 and 128). Extraction was carried out with 100 ml hexane/acetone (3:1, v/v) in an automat Soxhlet extractor (Büchi, Flawil, Switzerland) in hot extraction mode for 2 h. The lipid content was determined gravimetrically on an aliquot of the extract (105 °C, 1 h), while the rest of the extract was cleaned on a column filled with ~8 g acidified silica and eluted with 15 ml hexane and 10 ml dichloromethane. The eluate was concentrated to 100 µl under a gentle nitrogen stream and transferred to an injection vial. In all samples, concentrations of 23 PCB congeners (CBs 28, 31, 52, 74, 95, 99, 101, 105, 110, 118((C)22U os 1C, 11,, 11,

were situated in Europe, differences in contamination levels were also investigated among the European sampling locations. Post hoc tests (Tukey HSD) were performed if there were significant differences among the sampling locations. To compare the congener profiles among the sampling sites we conducted principal component analysis (PCA) on standardised data. Principal components (PCs) with eigenvalues above 1 were considered to account for a significant contribution to the total variance according to the latent root criterion (Hair et al., 1998). Factor loadings and factor scores were determined and used in interpreting PC patterns. Compounds with factor loadings greater than 0.65 on any PC were considered significant and were discussed. The first two PCs were used for the statistical analyses. We have included OHC data of both starling species in the same statistical analyses, as European starlings and spotless starlings are closely related species with similar ecology and behaviour (Eens and Pinxten, 1999). In addition, mean % lipids did not differ significantly between eggs of European and spotless starlings (One-way ANOVA: $F_{1,13} = 0.28$; $p = 0.61$), with a mean lipid percentage of 7.79 ± 0.71% (Table SI-1 in the Supporting information). Furthermore, excluding data of spotless starlings from the statistical analysis did not have any effect on the results. Data in the text and figures are represented as mean ± standard error.

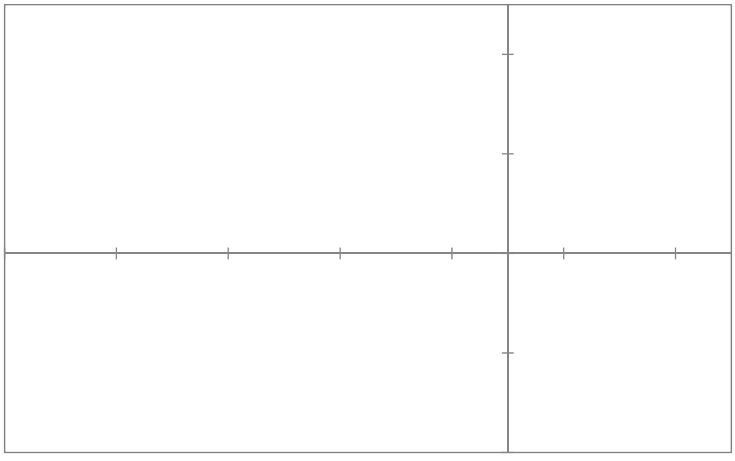
3. Results

3.1. Egg concentrations and profiles of PCBs

Sum PCB concentrations ranged from 78 ± 26 ng/g lw in eggs from Australia to 2900 ± 1300 ng/g lw in eggs from USA (Fig. 1a).

in Italy compared to Spain (ES1; $p = 0.07$), New Zealand ($p = 0.09$) and USA ($p = 0.09$). HCB concentrations also differed significantly among the European sampling locations ($F_{10,67} = 2.21$; $p = 0.03$). However, post hoc tests revealed no significant differences between any of the locations (Tukey HSD: $p > 0.05$). In contrast, HCH concentrations did not differ significantly among the different sampling locations (all sampling locations: $F_{14,91} = 1.26$; $p = 0.25$; European locations: $F_{10,67} = 1.43$; $p = 0.19$).

CHLs ranged from 2.8 ± 0.6 ng/g lw in New Zealand to 2500 ± 1300 ng/g lw in USA (Fig. 1f). CHL concentrations differed significantly among the sampling locations ($F_{14,91} = 3.47$; $p < 0.001$). CHLs were significantly higher in eggs from the USA compared to all other sampling locations (Tukey HSD: $p < 0.002$; Fig. 1f). For Europe, CHL concentrations were significantly higher inrinoc0505.428422663c7457521.51001refq9.93716



and in biota, although it has been banned in most developed countries for more than 25 years. In general, contamination with OCPs may be related to the local historical usage of OCPs and the different usage of land (

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