DIOXINS, FURANS AND AHH-ACTIVE PCB CONGENERS
IN EGGS OF TWO GULL SPECIES
FROM THE WESTERN MEDITERRANEAN.

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ABSTRACT
Polychlorinated biphenyls, dibenzodioxins and dibenzofurans were analysed in eggs of a protected gull species, the Audouin’s Gull (Larus audouinii) and compared to those of the Yellow-legged Gull (Larus cachinnans), both breeding in the Western Mediterranean (Ebro Delta and Medes Islands, respectively). Differences in concentrations as well as in congener profiles reflected differences in both habitat and diet of the two species. Levels of AHH-active PCB congeners were lower in Yellow-legged Gull (0.4-1.6 µg/g d.w.) than in Audouin’s Gull eggs (1.2-33.9 µg/g d.w.). These concentrations, expressed in international toxic equivalence factors (I-TEQ/g d.w.), were on average 24 times higher in the Audouin’s gull. I-TEQ levels due to dioxins were also higher in this species by a factor of ca. 7. I-TEQ levels related to PCBs resulted 90-230 times higher than those of dioxins and furans. Thus, AHH-inducing PCBs might represent even higher toxicological hazards than dioxins and furans to some populations of seabirds. The necessity of assessing the impact of these compounds in rare and protected species is pointed out.

INTRODUCTION
Polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) are highly toxic compounds able to induce multiple diseases, mostly mediated by the Aryl Hydrocarbon Hydrolase (AHH) (Safe, 1990). Recently, evidence for a similar mode of action has been found for non-, mono- and some di-ortho-substituted polychlorobiphenyls (PCBs) (McKinney et al., 1985; Safe et al., 1985; McFarland and Clark, 1989; de Voogt et al., 1990). Their toxicological properties can be compared by expressing their concentration as I-TEQ (International Toxicity Equivalency Factors), relative to the most toxic compound (TEF=1), the 2,3,7,8-TCDD. Qualitative and quantitative differences on the degree of toxicity, will depend on the congener structure and the species (Safe, 1990).

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AHH-active compounds are widely distributed in the environment and are common contaminants found in fishes and birds, especially in areas submitted to high PCB pollution (Stalling et al., 1985; Smith et al., 1990; Tillitt et al., 1991). The bioaccumulation of PCBs, PCDDs and PCDFs in bird populations produces different toxic effects (Peakall, 1975), such as the interference of vitamine A and tyroid hormone metabolism, which results in a decline of embryonic development and mating behaviour (Murk et al., 1994). These effects have been already observed in several bird populations such as the colonial waterbirds of the Great Lakes in Canada (Gilbertson and Fox, 1977; Kubiak, 1989; Tillitt et al., 1992; Giesy et al., 1994) or in the Great Cormorants from the Netherlands (van der Berg et al., 1994). Eggs provide a useful means of systematic monitoring in seabird populations and can be used as indicators of the pollution of the marine ecosystems (Walker, 1990; Pastor et al., 1995). Moreover, egg pollutant concentrations enable the assessment of hazards faced by embryos during development.

FIGURE 1- Audouin's and Yellow-legged Gulls main breeding colony in Catalunya, Spain.
The Audouin’s gull is a fish-eating bird classified as "rare" in the IUCN Red List of Threatened Animals (IUCN, 1993) with its world main breeding site in the Ebro Delta (Figure 1) (Oro and Martínez-Vilalta, 1992). The occurrence of high concentrations of dioxins and furans has been reported in sediments from the Western Mediterranean (Tolosa, 1993) and important levels of PCBs were detected in eggs of this species (Pastor et al., 1995). Thus, the first aim of this paper was to assess the presence and levels of AHH-active PCB congeners, dioxins and furans in order to ascertain whether these pollutants may constitute a risk for this Audouin’s Gull population.

On the other hand, concentrations and profiles of AHH-active compounds in Audouin’s Gull eggs are compared with those of another gull with different ecology, the Yellow-legged Gull (Larus cachinnans), to ascertain the role that habitat and feeding habits amy play on the bioaccumulation of these compounds. The Yellow-legged Gull is an scavenging seabird (the Mediterranean form of the Herring Gull (Larus argentatus) which, when breeding at Medes Islands (Figure 1), feeds mainly at refuse dumps (Bosch et al., 1995). The Audouin’s Gull diet at the Ebro Delta relies almost exclusively on fish, mainly clupeids (Ruiz et al., in press).

MATERIALS AND METHODS
Sample collection
Audouin’s and Yellow-legged Gull eggs were collected in the Ebro Delta and in the Medes Islands, respectively, during the breeding season of 1992. To collect recently-laid fresh eggs, daily brief visits in the early morning were performed. Once found, the new egg was removed and substituted by a dummy egg to avoid alteration in the laying process. Fresh eggs were stored frozen until analysis.

Sample preparation
The content of nine and ten eggs from Audouin’s and Yellow-legged Gulls, respectively, was removed, weighed, homogenized and dried at 60°C until constant weight. Subsamples of egg dried contents were then extracted in a Soxhlet apparatus with n-hexane : dichloromethane (4:1) for 18 h. The lipid content was determined by weight of the dry extract residue. All samples were handled individually.

Coplanar PCBs analysis
The analysis of coplanar PCBs was carried out according to a procedure developed in our laboratory (Pastor et al., 1993). Briefly, the extract was cleaned-up by vigorous shaking with neat sulphuric acid (98%) for about 3 min. The clean extract was injected by a 400 µl loop (Rhodine, Cotati, CA, USA) into a Hypercarb (Shadom Scientific, Warrington, UK) porous graphitic carbon (7 um particle size) LC column (50 x 4.7 mm I.D.). n-Hexane was used as eluent at a flow rate of 3 ml/min delivered by a Model 64 high-pressure pump (Knauer, Bad-Homburg, Germany) coupled to a UV-detector set a 254 nm (Kanuer). In this way, coplanar PCBs (IUPAC Nos. 81, 77, 126 and 169) were collected in the fraction between 25 and 110 ml and concentrated to 500 µl.
Two μl of each fraction were injected into a Hewlett-Packard (Palo Alto, CA, USA) Model 5890 capillary gas chromatograph equipped with 63Ni electron capture detector coupled to a Hewlett-Packard Model 7673A automatic sampler. A 30 m DB-5 fused silica capillary column (J&W Scientific, Folsom, CA, USA) was programmed from 60 to 300 °C at 6 °C/min, the final temperature being maintained for 10 min. Helium was used as carrier gas at a flow rate of 30 cm/min. The injector and detector were maintained at 270° C and 300° C, respectively. PCBs were quantified using external standard calibrations purchased from Promochem (Wesel, Germany).

Dioxin analysis
The samples were cleaned-up according to the method described by Liem et al. (1988), including the use of Carbosphere and activated alumina column chromatography. After evaporation of the solvent, the residues were reconstituted in 50 ul of toluene containing the appropriate syringe standard, 13C6-TCDD. Two μl of these final extracts were injected into the GC-MS.

Analysis were performed with high resolution gas chromatography-mass spectrometry (Autospec GCMS, VG Analytical, Manchester U.K.) with multiple selected ion recording at a mass resolution of 5000:1. Samples were separated on a nonpolar capillary GC column (HP-Ultra-2.60 m x 0.22 mm ID), according to the method described by Liem et al. (1988).

RESULTS
Levels
The concentrations of non-ortho, mono and di-ortho PCBs were analysed in eggs of both species are given in Table 1. Global levels are 10 times higher in Audouin's Gull eggs. PCB levels range from non detectable (PCB 81, 169 and 128) to the low μg/g level in the Audouin's Gull (PCB 157, 138, 153, 170 and 180). The coefficient of variation ranges from 60 to 100% in Audouin's Gull and from 44 to 100% for the Yellow-legged Gull, indicating high intra-specific variability in both cases.

Dioxins and furans were measured in three eggs of each species (Table 2). Consistently with the above results, Audouin's Gull eggs show higher dioxin and furan levels than the Yellow-legged Gull eggs (dioxins: 126.66 ± 26.70 and 71.87 ± 35.65 pg/g d.w.; furans: 14.01 ± 3.67 and 7.24 ± 1.5 pg/g d.w., respectively). In all cases, the OCDD was the most abundant congener. The most toxic congener, the 2,3,7,8-TCDD, was found in eggs of both species with concentrations of 12.66 ± 3.15 and 1.43 ± 0.40 pg/g d.w., respectively. The coefficient of variation for all congeners ranged from 8 to 71% in Audouin's Gull eggs and from 15 to 51% in the Yellow-legged Gull eggs.
TABLE 1- Concentration (in ng/g d.w.) of non-, mono- and di-orthosubstituted PCBs in eggs from Audouin’s and Yellow-legged Gull. I-TEF is expressed in pg of I-TEQ/g d.w.

<table>
<thead>
<tr>
<th>Congener</th>
<th>Levels ng/g d.w.</th>
<th>I-TEQ pg/g d.w.</th>
<th>Levels ng/g d.w.</th>
<th>I-TEQ pg/g d.w.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-ortho PCBs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>81</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>0.1 ± 0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>77</td>
<td>0.3 ± 0.3</td>
<td>3 ± 3</td>
<td>0.1 ± 0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>126</td>
<td>3.8 ± 3.9</td>
<td>377 ± 390</td>
<td>0.2 ± 0.1</td>
<td>19 ± 10</td>
</tr>
<tr>
<td>169</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td><strong>Mono-ortho PCBs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>105</td>
<td>319 ± 191</td>
<td>319 ± 191</td>
<td>14 ± 9</td>
<td>14 ± 9</td>
</tr>
<tr>
<td>118</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>49 ± 23</td>
<td>49 ± 23</td>
</tr>
<tr>
<td>157</td>
<td>1627 ± 1400</td>
<td>1627 ± 1400</td>
<td>13 ± 11</td>
<td>13 ± 11</td>
</tr>
<tr>
<td>158/16</td>
<td>392 ± 275</td>
<td>392 ± 275</td>
<td>12 ± 5</td>
<td>12 ± 5</td>
</tr>
<tr>
<td><strong>Di-ortho PCBs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>128</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>137</td>
<td>135 ± 92</td>
<td>3 ± 2</td>
<td>14 ± 12</td>
<td>0.3 ± 0.2</td>
</tr>
<tr>
<td>138</td>
<td>1884 ± 1132</td>
<td>38 ± 23</td>
<td>276 ± 78</td>
<td>3 ± 2</td>
</tr>
<tr>
<td>153</td>
<td>3696 ± 2767</td>
<td>74 ± 55</td>
<td>238 ± 117</td>
<td>5 ± 2</td>
</tr>
<tr>
<td>170</td>
<td>1352 ± 972</td>
<td>27 ± 19</td>
<td>95 ± 49</td>
<td>2 ± 1</td>
</tr>
<tr>
<td>180</td>
<td>2867 ± 2175</td>
<td>57 ± 43</td>
<td>209 ± 103</td>
<td>4 ± 2</td>
</tr>
<tr>
<td>194</td>
<td>889 ± 585</td>
<td>18 ± 2</td>
<td>77 ± 34</td>
<td>1 ± 1</td>
</tr>
<tr>
<td><strong>SUM</strong></td>
<td>13166 ± 8817</td>
<td>2934 ± 2433</td>
<td>897 ± 420</td>
<td>123 ± 66</td>
</tr>
</tbody>
</table>

**Congener profiles**

PCB profiles are quite similar for both species (Figure 2), being PCB 153 the most abundant congener, followed by PCBs 180 and 138. However, considerable differences can be observed in relation to the mono-ortho PCBs. In the case of the Audouin’s Gull, the PCB 157 congener is the most abundant congener whereas the PCB 118 is the predominant in Yellow-legged Gull.

From the 17 more toxic dioxin and furan congeners, 15 have been detected in Audouin’s Gull eggs with the lack of the 1,2,3,7,8-PnCDD and the 1,2,3,7,8,9-HxCDF and 16 in the Yellow-legged Gull eggs with the single lack of the 1,2,3,7,8,9-HxCDF (Figure 3). OCDD is the most abundant congener in both species followed by hexa- and heptachlorodibenzofurans. A higher percentage of tetra- and penta-chlorodibenzodioxins is observed in Audouin’s Gull.
TABLE 2- Concentration (in pg/g d.w.) of dioxins and furans in 3 eggs from Audouin's Gull and 3 of Yellow-legged Gull. I-TEF expressed in pg of I-TEF/g d.w.

<table>
<thead>
<tr>
<th></th>
<th>AUDOUIN'S GULL</th>
<th></th>
<th>YELLOW-LEGGED GULL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TEF</td>
<td>Levels</td>
<td>1-TEQ</td>
<td>Levels</td>
</tr>
<tr>
<td><strong>Dioxins</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,3,7,8-TCDD</td>
<td>0.1</td>
<td>12.66 ± 3.15</td>
<td>12.66 ± 3.15</td>
<td>1.33 ± 0.12</td>
</tr>
<tr>
<td>1,2,3,7,8-PnCDD</td>
<td>0.5</td>
<td>11.49 ± 3.60</td>
<td>5.75 ± 1.80</td>
<td>1.04 ± 0.13</td>
</tr>
<tr>
<td>1,2,3,4,7,8-HxCDD</td>
<td>0.1</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>1,2,3,6,7,8-HxCDD</td>
<td>0.1</td>
<td>5.81 ± 1.74</td>
<td>0.58 ± 0.17</td>
<td>2.37 ± 0.55</td>
</tr>
<tr>
<td>1,2,3,7,8,9-HxCDD</td>
<td>0.1</td>
<td>1.79 ± 0.33</td>
<td>0.18 ± 0.03</td>
<td>0.69 ± 0.09</td>
</tr>
<tr>
<td>1,2,3,4,6,7,8-HpCDD</td>
<td>0.01</td>
<td>9.09 ± 1.66</td>
<td>0.09 ± 0.02</td>
<td>8.36 ± 2.17</td>
</tr>
<tr>
<td>OCDD</td>
<td>0.001</td>
<td>85.82 ± 16.26</td>
<td>0.09 ± 0.02</td>
<td>58.07 ± 32.59</td>
</tr>
<tr>
<td><strong>Total dioxins</strong></td>
<td></td>
<td>126.66 ± 28.70</td>
<td>19.34 ± 5.19</td>
<td>71.87 ± 35.65</td>
</tr>
<tr>
<td><strong>Furans</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,3,7,8-TCDF</td>
<td>0.1</td>
<td>1.43 ± 0.40</td>
<td>0.14 ± 0.04</td>
<td>0.30 ± 0.06</td>
</tr>
<tr>
<td>1,2,3,7,8-PnCDF</td>
<td>0.05</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>0.16 ± 0.03</td>
</tr>
<tr>
<td>2,3,4,7,8-PnCDF</td>
<td>0.5</td>
<td>2.21 ± 1.06</td>
<td>1.11 ± 0.17</td>
<td>0.50 ± 0.10</td>
</tr>
<tr>
<td>1,2,3,4,7,8-HxCDF</td>
<td>0.1</td>
<td>1.47 ± 0.71</td>
<td>0.15 ± 0.07</td>
<td>0.76 ± 0.06</td>
</tr>
<tr>
<td>1,2,3,6,7,8-HxCDF</td>
<td>0.1</td>
<td>2.06 ± 1.06</td>
<td>0.21 ± 0.11</td>
<td>0.98 ± 0.21</td>
</tr>
<tr>
<td>1,2,3,7,8,9-HxCDF</td>
<td>0.1</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>2,3,4,7,8,9-HxCDF</td>
<td>0.1</td>
<td>2.53 ± 0.37</td>
<td>0.25 ± 0.04</td>
<td>1.08 ± 0.14</td>
</tr>
<tr>
<td>1,2,3,4,6,7,8-HpCDF</td>
<td>0.01</td>
<td>1.76 ± 0.39</td>
<td>0.02 ± 0.00</td>
<td>1.45 ± 0.27</td>
</tr>
<tr>
<td>1,2,3,4,7,8,9-HpCDF</td>
<td>0.01</td>
<td>0.81 ± 0.13</td>
<td>0.01 ± 0.00</td>
<td>0.48 ± 0.34</td>
</tr>
<tr>
<td>OCDF</td>
<td>0.001</td>
<td>1.72 ± 0.26</td>
<td>&lt;0.01</td>
<td>1.53 ± 0.29</td>
</tr>
<tr>
<td><strong>Total furans</strong></td>
<td></td>
<td>14.01 ± 1.88</td>
<td>1.88 ± 0.39</td>
<td>7.24 ± 1.50</td>
</tr>
<tr>
<td><strong>Total PCDD/DPs</strong></td>
<td></td>
<td>140.67 ± 30.50</td>
<td>21.33 ± 5.58</td>
<td>79.13 ± 36.15</td>
</tr>
</tbody>
</table>

Toxicity
The PCB levels have been expressed as international toxicity equivalents (I-TEQ: pg TEF/g d.w.) according to the toxic equivalence factors proposed by Safe (1990): 0.1 for congener 126, 0.05 for 169, 0.01 for 77, 1x10^-3 for mono-ortho PCBs and 2x10^-5 for di-ortho PCBs. Values found for the Audouin's Gull are about 24 times higher than those for the Yellow-legged Gull (2934 ± 2433 and 123± 66 pg TEF/g d.w., respectively).
Levels of I-TEQ for dioxins and furans are better indicators of the degree of toxicity to which these species are exposed, since differences in concentration are caused by the least-toxic congener, the OCDD. When concentrations are expressed as pg I-TEF/g d.w., the 2,3,7,8-TCDD becomes the most important congener, reaching about a half of the TEQ values in both species. Levels of I-TEF for PCB range between 140 and 403 times those of the PCDD/DF in Audouin’s Gull and Yellow-legged Gull, respectively.

DISCUSSION

Levels

Among several Mediterranean water-birds, the fish-eating birds used to exhibit the highest amounts of total PCBs (Focardi et al., 1988), because an additional trophic level transfer increases the potential of bioaccumulation (Giesy et al., 1994). Accordingly, higher levels of AHH-active PCBs, dioxins and furans were found in Audouin’s Gull than in Yellow-legged Gull eggs. Differences in concentrations between specialized feeders (such as fish-eating birds) and scavenging species (i.e. the Yellow-legged Gull) can be enhanced by the fact that enzymic detoxifying systems seem to be deficiently developed in the fist ones (Walker, 1990).

Both gulls exhibit about one order of magnitude more dioxins than furans. In the Herring Gull (Larus argentatus), a higher rate of metabolization for furans than for dioxins has been observed (Giesy et al., 1994). Alternatively, other authors refer to a different availability of these compounds through the diet (Stalling et al., 1985; Smith et al., 1990). In this sense, a selective accumulation of dioxins and furans takes place in fishes, which also exhibit larger elimination rate constants for PCDFs than for PCDDs (Loonen et al., 1994).

A large intra-specific variability in PCBs and PCDD/DF concentrations is found in both Audouin’s and Yellow-legged Gull eggs. Levels of these compounds and their biological effects measured in the Common Tern and the Great Cormorant also showed a great variability, thus pointing out the importance of measuring individual levels (Murk et al., 1994) as well as the need for enlarging sample sizes (Pastor et al., 1995).

Profile distribution

Among the non-ortho PCBs, only the PCB 77 and 126 were detected in the eggs of both gull species. The persistence of coplanar PCBs depends on the position of the chlorine atoms. The absence of adjacent nonchlorinated ortho and meta carbons on at least one biphenyl ring, appears to be essential for the metabolism of coplanar PCBs (Tanabe et al., 1987; Borlakoglu and Haegle, 1991; Porte and Albaigés, 1993). The composition of these congeners in animals tissues suggests that the PCB 77 is the most degradable, the PCB 169 is the most metabolically stable and the PCB 126 exhibiting a moderate persistence. However, the PCB 169 has not been detected in our gull species. The percentage of the more toxic congener, the PCB 126, was 93% and 67% of total PCBs in Audouin’s and Yellow-legged Gull eggs respectively, thus suggesting a biomagnification through the trophic web.
FIGURE 2- Distribution in percentage of PCBs, dioxins and furans grouped by number of chlorine substitutions in eggs from Audouin’s and Yellow-legged Gulls.
There are two principal sources of dioxins and furans in the environment: chemical production residues and combustion processes. Generally, the major source of these compounds is the production of chemically manufactured chlorinated organic compounds (PCBs, PCP and herbicides) and the production of paper (Fletcher and McKay, 1993). In the resident area of these gulls, several sources of dioxins and furans should be taken into account: municipal waste incinerators, paper mill effluents, leachates from landfill (Jiménez et al., 1992; Casanovas et al., 1994), the production of chlorinated organic compounds, and the use of the herbicide 2,4-D and PCB formulations (de Voogt and Brinkman, 1989). Marine sediments from Barcelona coast, placed between the two breeding areas, show a typical profile of dioxins and furans coming from a chemical (e.g. pentaclorophenol) rather than those from combustion sources (Tolosa, 1993).

Pentachlorophenol (PCP) contains low amounts of tetra- and penta-CDD/DFs and high concentrations of hexa-, hepta-, and OCDD/DFs (Firestone et al., 1972; Hagenmaier and Brunner, 1987). In commercial mixtures of PCBs, PCDFs predominates, especially the tetra-, penta- and hexa-CDFs (Ballschmitter et al., 1986). The herbicide, 2,4-D contains low chlorinated dioxins, predominating the 2,3,7,8-TCDD (Rappe, 1980).

The pattern of dioxins and furans in both gulls agrees well with a PCP source. However, low chlorinated dioxins and furans are higher in the Audouin’s Gull than in the Yellow-legged Gull (Figure 1). The 2,3,7,8-TCDD together with the 2,3,7,8-TCDF and 2,3,4,7,8-PCDF are the major PDCD and PCDF components found in fishes (Stalling et al., 1987; van der Berg et al., 1987; Rappe, 1989; Muir et al., 1990) meanwhile 1,2,3,7,8-PCDD seems to be present in all the biological samples (Rappe et al., 1987). Therefore, the relatively high levels of these congeners in Audouin’s Gull eggs could be related to its feeding habits as it has been observed in other fishing-birds, like the Great Cormorant (Van der Berg et al., 1992). The most abundant congener determined is the OCDD followed by HpCDD and HxCDD in both species. Besides the fact that they are hardly metabolised and biomagnified through the trophic web, other factors such as a selective retention of PCDD and PCDF in the female body during the yolk formation has been determined in Herring Gull, producing an enrichment of HpCDD and OCDD in the yolk lipids (Braune and Norstrom, 1989).

Toxicity

Since crude PCB concentrations are often insufficient for assessing the ecotoxicological significance of the occurrence of PCBs in biota samples (Kubiak et al., 1989; Giesy et al., 1994), the use of I-TEQ has been suggested. In these sense, no relation was found between PCB levels in Herring Gull’s eggs and breeding success in Canada. However, when I-TEQ levels were used, a strong correlation with their reproductive success was found (Kubiak et al., 1989; Tillitt et al., 1992).

Values determined in this paper, when expressed as I-TEQ, show higher potential toxicity risks for Audouin’s Gull eggs. An increase of toxic equivalents with the food chain was also determined in piscivorous birds from Great Lakes in comparison with planktivorous birds or fishes, the latter having similar food habits and showing
similar I-TEQ levels (Jones et al., 1993). Interestingly, 99.3 % and 97.7% of Total I-TEF found in Audouin’s and Yellow-legged Gull eggs are due to PCB, as has also been reported for other birds: Forster Terns (Smith et al., 1990; Jones et al., 1993), Guillemots (Jarman et al., 1993), Caspian Terns and Cormorants (Tillitt et al., 1991). These results indicate the relevance of analysing these compounds in future monitoring programs.

Since for levels greater than 10 pg/g of TEQ, several toxic effects have been assessed in gulls from Great Lakes (Giesy et al., 1994). the I-TEQ levels registred for Audouin’s and Yellow-legged Gull eggs in this study indicate a potential source of embryonic diseases in both species, especially in the former one.

CONCLUDING REMARKS
Dioxin-like PCBs, dioxins and furans, the most toxic of the contaminants known, are present in eggs of Audouin’s and Yellow-legged Gull from the Western Mediterranean. The fact that Audouin’s Gull, a rare species in the world, exhibits 95% of the I-TEF analysed related to AAH-inducing PCB congeners, points out the importance of their analysis in endangered species.

The results show that accumulation through the trophic web increases the importance of contamination from industrial or urban residues. It is difficult to ascertain the origin of such contaminants in animals since they are dependent on the source of dioxins and coplanar PCBs as well as on their uptake and metabolization. However, the fact reflects their wide distribution in the environment.

A possible relation between Total I-TEQ determined and clutch size, period of incubation, hatching success and flegling success, has been determined in Fostern Terns (Harris et al., 1993) and Cormorant (Van der Berg et al., 1994). Therefore, future monitoring programs concerning to Audouin’s Gull, should include the analysis of AHH-active compounds to establish the relation between these compounds and Audouin’s Gull breeding success.

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