PCBs, Organochlorine Pesticides, and Reproduction in River Otters from Louisiana

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Abstract: Reproductive tracts from 89 3-year-old female river otters *(Lutra canadensis),* from Louisiana were examined. Eighteen of these were in a reproductive phase out of synchrony with the expected population norms. Eight of 32 otters had fewer embryos than corpora lutea, indicating intrauterine mortality in 25% of the sample. Chemical analyses of liver tissue from 57 otters revealed a low prevalence of polychlorinated biphenyls (PCB) and organochlorine pesticide contamination. These low levels of organochlorine compounds were not associated with atypical reproductive synchrony or intrauterine mortality.

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Reproduction of at least 1 mustelid species is adversely affected by low concentrations of environmental contaminants. Mink *(Mustela vison)* fed diets containing as little as 0.64 ppm PCBs experienced both reproductive failure and mortality (Platonow and Karstad 1973). Reproductive failure was due to embryo mortality and poor kit survival (Platonow and Karstad 1973, Aulerich and Ringer 1977, Jensen et al. 1977). The reproductive difficulty seemed to be associated with the female as males produced apparently healthy sperm (Platonow and Karstad 1973).

The effects of PCBs on other mustelids have received little attention. Laboratory studies have shown that ferrets *(Mustela putoris furo)* (Bleavins et al. 1980) are less sensitive to PCBs than are mink. Other mustelids have not been examined under controlled, experimental conditions.

Henny et al. (1981) examined PCB concentrations in river otters from 3 study areas in Oregon and reported that concentrations were highest in an area where otter populations were declining. Hill and Lauhachinda (1980) reported intrauterine mortality, embryo resorption, and the absence of pregnancy in sexually mature river otters from Alabama and Georgia; however, no attempt was made to relate these reproductive problems to contaminants.

The authors' primary objective was to examine the reproductive status of river otters from Louisiana in relation to PCB and organochlorine pesticide concentrations. Secondarily, the influence of age and collection location on contaminant burdens in river otters was examined.

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Methods

Otter carcasses were obtained from trappers from the 1978–79 through the 1980–81 trapping seasons. Age was determined by tooth annuli cementum (Tabor and Wight 1977) and by X-ray of the epiphyseal closure of the long bones. A total of 89 female otters ≥3 years old were available for study. The uterus of each otter was opened and examined for embryos. Ovaries were sliced into thin sections and examined macroscopically for developing follicles and corpora lutea.

Intrauterine mortality was determined by comparing the number of corpora lutea with the number of embryos. To ensure that an early stage embyro was not overlooked, only otters with embryos ≥10 days old were included in calculating intrauterine mortality. Embryo ages were estimated from the crown-rump length measurements presented by Hill and Lauhachinda (1980).

Reproductive histories that were observed in river otters from Louisiana (Table 1) were combined with the data of Hill and Lauhachinda (1980) to construct an estimate of seasonal reproductive phases in river otters from the Southeast and to identify

Table 1. Reproductive status of 89 ≥3-year-old female river otters from Louisiana, 1978–81.

	December		January		February	
Reproductive Status	No.	%	No.	%	No.	%
With fetuses	1	3.2	18	50	19	86.4
With corpora lutea only	20	64.5	13	36.1	3	13.6
With follicles only	7	22.6	4	11.1	0	0
With no signs of reproductive activity	3	9.7	1	2.8	0	0

otters with "atypical" reproductive histories. The term "atypical" is used with some reservation because otters exhibit delayed implantation making the exact timing of reproductive events difficult to determine. Histories that were termed atypical were: 1) adult otters (≥3 years old) trapped in February with no implanted embryos, although the presence of corpora lutea indicated ovulation had occurred (very late implantation or aborted pregnancies); 2) adult otters trapped December-February with follicles present, but no corpora lutea or embryos present (skipped previous reproductive season); and 3) adult otters trapped December-February with no follicles, corpora lutea, or embryos present (skipped previous reproductive season, no follicles developing for current season). This interpretation corresponds with data on otters from New York (Hamilton and Eadie 1964), considering a delay in the reproductive season related to latitude.

To determine if organochlorine compunds were influencing reproduction, 57 of the 89 otters were selected for study. Concentrations of organochlorine compounds in liver were compared for otters with atypical reproductive histories versus those from otters with normal reproductive histories and from those with signs of intrauterine mortality versus those without intrauterine mortality.

To determine if organochlorine burdens increased with age, livers from 5 1-year-old and 5 2-year-old females from St. Bernard Parish were collected for chemical analysis. Animals from St. Bernard Parish that were analyzed as part of the reproductive study provided the data for the ≥3-year-old age class.

A sufficient number of otters were available to allow comparison of contaminant burdens at 4 localities in Louisiana: St. Bernard Parish, Terrbonne Parish, Atchafalya Basin (St. Martin, Iberville, and Iberia parishes), and the southwest coastal parishes (Cameron and Vermilion parishes). Only livers from 1-year-old otters were used for this part of the study.

Livers were dissected from carcasses, wrapped in aluminum foil, and frozen. Samples were later thawed and analyzed for p,p'-DDT, p,p'-DDD, p,p'-DDE, dieldrin, endrin, toxaphene, oxychlordane, *cis*-chlordane, heptachlor epoxide, *cis*-nonachlor, *trans*-nonachlor, and polychlorinated biphenyls (PCBs). Samples were homogenized, a subsample mixed with anhydrous sodium sulfate, and extracted with hexane in a soxhlet apparatus. Extracts were cleaned up by Florisil column chromatography, and pesticides separated from PCBs by silica gel chromatography. Residues were quantified by electron-capture gas-liquid chromatography (EC-GLC) using a 1.5/1.95% SP-2250/SP-2401 column. Residues in 2 samples were confirmed by gas chromatography/mass spectrometry (GC-MS). For details of these procedures see Cromartie et al. (1975) and Kaiser et al. (1980). The lower limit of reportable residues was 0.1 ppm for pesticides and 0.5 ppm for PCBs. Trial recoveries of pesticides and PCBs from fortified mallard tissue using these methods ranged from 93% to 103% ($\bar{x}$ = 98.5%). Residues were not corrected for percent recovery but were corrected for moisture loss; a uniform 74% sample moisture content was used because this was the highest moisture level observed.

Statistical comparisons were made by Chi-square tests at the $\alpha = 0.05$ level.

Results

Based on our criteria, the reproductive status of 18 of the 89 otters was termed atypical. Intrauterine mortality was indicated in 8 of 32 otters. The reproductive status of the 57 otters that we selected for chemical assessment was 41 with typical histories and 16 with atypical histories; of those with embryos ≥10 days old, intrauterine mortality was indicated in 8 and no intrauterine mortality was indicated in 24.

PCBs occurred in only 10 (18%) of the 57 otters in the ≥3-year-old age class. Among those otters with PCB residues, concentrations of PCBs were uniformly low (0.37-0.83 ppm, Table 2). The prevalence and concentration of PCBs were not different between otters with typical versus atypical reproductive histories. Likewise, the prevalence of PCBs in otters with evidence of embryo mortality (1 of 8, 12%) was not different from otters without signs of embryo mortality (3 of 24, 12%).

Similarly, DDE occurred infrequently and at low levels (Table 3). The prevalence and concentrations of DDE in otters exhibiting typical versus atypical reproductive histories were not significantly different. The prevalence of DDE was not higher in otters with evidence of embryo mortality (1 of 8, 12%) than in otters without signs of embryo mortality (1 of 24, 4%).

In the ≥3-year-old age class, 8 of 41 (20%) otters from St. Bernard Parish and 2/12 (17%) from Atchafalaya Basin had PCB concentrations above our detection sensitivity, a difference that was not significant. Insufficient sample sizes prevented

Table 2. PCB prevalence and concentrations[a] in livers from ≥3-year-old female river otters from Louisiana, 1978–81. Broken line separates "typical" (above) from "atypical"[b] reproductive histories.

Reproductive Status	Dec	Jan	Feb
Fetuses present			
No. analyzed		15	17
No. with residues		3	1
Residues conc.		0.38[c], 0.56, 0.61	0.37
Corpora lutea only			
No. analyzed	9		3
No. with residues	2		0
Residues conc.	0.62, 0.65		
Follicles only			
No. analyzed	7	3	
No. with residues	3	0	
Residues conc.	0.67, 0.82, 0.83		
No signs reproductive activity			
No. analyzed	2	1	
No. with residues	0	1	
Residues conc.		0.61	

[a]Minimum level of detection was 0.5 ppm; all concentrations are presented as ppm adjusted to a uniform 74% sample moisture content.
[b]See text for explanation.
[c]Number of fetus < number of corpora lutea in this otter.

Table 3. DDE prevalence and concentrations[a] in livers from ≥3-year-old female river otters from Louisiana, 1978–81. Broken line separates "typical" (above) from "atypical"[b] reproductive histories.

Reproductive Status	Dec	Jan	Feb
Fetuses present			
No. analyzed		15	17
No. with residues		3	0
Residues conc.		0.16, 0.20[c], 0.33	
Corpora lutea only			
No. analyzed	9		3
No. with residues	2		1
Residues conc.	0.52, 0.81		0.11
Follicles only			
No. analyzed	7	3	
No. with residues	2	0	
Residues conc.	0.08, 0.83		
No signs reproductive activity			
No. analyzed	2	1	
No. with residues	0	0	
Residues conc.			

[a]Minimum level of detection was 0.5 ppm; all concentrations are presented as ppm adjusted to a uniform 74% sample moisture content.
[b]See text for explanation.
[c]Number of fetus < number of corpora lutea in this otter.

comparison of adults from other parishes. PCB residues were not detected in 1 year olds from St. Bernard, Terrebone, or the southwest coastal parishes; 1 of 5 from Atchafalaya Basin had PCBs.

DDE occurred at a higher prevalence in the ≥3-year-old group from Atchafalaya Basin (7 of 12, 58%) than in a similar age group from St. Bernard Parish (1 of 41, 2%). Two of 5 (40%) 1-year-old otters from the Atchafalaya Basin had DDE; none of this age group from St. Bernard, southwest coastal, or Terrebone parishes had DDE. A 1-year-old otter from Atchafalaya Basin had both the highest PCB (2.1 ppm) and DDE (2.0 ppm) residues in this study. Other organochlorine pesticides were detected in only 1 sample; a 1-year-old otter from Atchafalaya Basin had small amounts (≤0.2 ppm) of chlordane isomers.

No differences were detected in the prevalence of PCB residues among 1 year olds (0 of 5), 2 year olds (1 of 5, 20%), or ≥3 year olds (3 of 19, 16%) in St. Bernard Parish. No DDE residues were detected in these samples.

Discussion

The prevalence and concentrations of PCBs in otters from Louisiana were much lower than those reported for otters in areas of Oregon where populations were decreasing (1.7-23 ppm in the liver, 1.1-8.3 ppm in muscle) and were also lower than in areas where populations were stable or increasing (<0.05-8.4 ppm in

liver, <0.05-1.6 ppm in muscle; Henny et al. 1981). PCB concentrations in an apparently large and healthy otter population in Alabama ranged from <0.05 to 2.5 ppm in leg muscle (Hill and Lovett 1975).

A substantial percent of the sampled river otters in this study exhibited atypical reproductive synchrony and intrauterine mortality. These otters were from parishes where otter populations appeared healthy. Low levels of PCB and DDE contamination were found in these otters but there was no significant relationship between these contaminants and reproductive histories. Therefore, it appears that PCBs and DDE residues in the range of 0.65 ppm or less in liver were not a problem to otter reproduction. The observed reproductive histories may simply represent normal variability in wild river otter populations.

The higher prevalence of DDE in otters from the Atchafalaya Basin was probably related to the more agricultural nature of the watershed compared to the other areas sampled. No parent DDT compound was found, suggesting the DDE was residual from former use in the area.

The otters sampled came from parishes where otter numbers were the highest in the state. The low prevalence and concentrations of PCBs and organochlorine pesticides suggest that these contaminants pose no imminent threat to the otter population in these Louisiana parishes unless habitats become more heavily contaminated in the future.

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