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Effects of PCBs on Mourning Dove Courtship Behavior

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PCBs influence several reproductive parameters in birds such as behavior (DAHLGREN and LINDER 1971, PEAKALL and PEAKALL 1973) and fertility and hatchability (PLATONOW and REINHART 1973). Most studies of PCBs have focused on the negative effects at the end of the reproductive cycle, namely egg production, fertility, parental behavior, and survival of young. The effects of PCBs early in the reproductive cycle have not been investigated. In this study, we examined PCB effects on mourning dove *(Zenaida macroura carolinensis)* courtship behavior and subsequent reproductive effort.

MATERIALS AND METHODS

Mourning doves (N = 24 pairs) that had previously laid at least 1 fertile clutch in breeding cages (1.8 x 0.7 x 0.5 m) were fed either 0, 10, or 40 ppm of the PCB Aroclor 1254 for 42 days. Two weeks after the 42-day treatment period, doves were paired and observed each morning for 30 days. The 30-day trial period allowed ample time for mourning doves to court, nest, and lay eggs. The trial was divided into 2 phases, courtship and nesting, which were determined by the pair's behavior. The courtship phase was subdivided into the pair bond formation period (PBFB) and the courting period (CP) for pairs that completed the courtship phase. This was done to determine whether lengthening of the courtship phase and reduction in behavior intensity was due to failure of pairs to progress from courtship to nesting and to determine treatment effects during the 2 periods on pairs that did nest. The courtship phase was defined as the first day of pairing through the day prior to nest building. The pair bond formation period was defined as the first day of pairing to the day of pair bond formation, i.e., the day that the male and female interacted in some form of courtship behavior, usually billing. The courting period was defined as the time between pair bond formation the the first day of nest building. The nesting phase was defined as the first day of nest building to the end of the 30-day trial, and therefore included egg laying and incubation.

Behavior recorded included perch coos, billing (heteropreening), nest site selection, nest coos, nest building, and incubation. All behaviors have been previously described by CRAIG 1911, NICE 1922, and JACKSON and BASKETT 1964. Behaviors were scored to obtain a measure of total behavioral intensity and to reduce variability among pair performances (KEITH 1978, TORI 1982).

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Behavior scores were compiled for each phase and period for each treatment group. Length (in days) of each phase and period was recorded. Analysis of variance (ANOVA; SNEDECOR and COCHRAN 1967) was used to test for differences in behavior scores and lengths of each phase and period for each treatment group.

RESULTS

Courtship phase. Normally, males began courting within 1 to 3 days, exhibiting charges at the female, perch cooing, and nest site selection. Soon after, pair bonds were formed as females began billing with males and participating in nest site selection. Both 10 and 40 ppm PCBs significantly ($P<0.01$) increased the mean number of days doves spent in the courtship phase (Table 1). Doves fed 10 ppm PCBs spent twice as much time in the courtship phase as did control doves. Only 4 of 8 pairs fed 10 ppm PCBs completed the courtship phase and progressed into the nesting phase. Doves fed 40 ppm PCBs spent the entire 30-day trial in the courtship phase. Only 2 of 8 pairs formed pair bonds, with no pairs progressing into the nesting phase. Behavior scores during the courtship phase were reduced in birds fed 10 and 40 ppm PCBs (Table 1). Ten ppm PCBs decreased mean behavior scores 45% when compared to controls, although this difference was not significant ($P>0.05$). Behavior scores were significantly reduced by 72% in doves fed 40 ppm PCBs ($P<0.01$).

TABLE 1

PCB (0, 10, or 40 ppm) effects on mourning dove courtship phase length and courtship behavior scores[a].

PCBs(ppm)	N(pairs)	LENGTH(days)	BEHAVIOR SCORES (per pair/day)
0	8	11.3±2.1 A	11.3±2.0 A
10	8	22.1±3.4 B	6.2±1.8 AB
40	8	30.0±0.0 C	3.2±0.8 B

[a]Data are $\bar{X}$ + SE. Means with different letters are significantly different at $P<0.01$.

Pair bond formation period (PBFP). There were no significant ($P>0.05$) differences in length of time or behavior scores between control doves and doves fed 10 ppm PCBs during the PBFP (Table 2). However, doves fed 10 ppm PCBs formed pair bonds approximately 4 days sooner than did control doves.

Courting period (CP). Ten ppm PCBs caused a significant ($P<0.05$) increase in the amount of time doves spent in the CP (Table 2). Doves fed 10 ppm PCBs spent approximately 8.5 more days in the CP than did controls. Behavior scores were not significantly ($P>0.05$) affected by 10 ppm PCBs, but behavior scores averaged 32% lower than controls.

TABLE 2

Pair bond formation period and courting period lengths and courtship behavior scores of doves fed 0 or 10 ppm PCBS. Includes only pairs that completed the courtship phase and progressed to nesting[a].

PCBs (ppm)	N (pairs)	PBFP Length (days)	PBFP Behavior Score[b]	CP Length (days)	CP Behavior Score[b]
0	8	7.4±2.2 A	6.3±2.9 A	4.0±1.4 A	17.3±2.6 A
10	4	2.8±1.8 A	6.1±2.7 A	12.5±2.9 B	11.7±2.1 A

[a]Data are $\bar{X}$ ± SE. Means with different letters are significantly different at $P<0.05$.

[b]Per pair/day.

Nesting phase (NP). Normally, just prior to nest building, the pair had selected a nest site in one of the nest bowls provided. Both sexes participated in nest building, which was usually accomplished in 5-7 days. After nest building was complete, 2 eggs were laid, usually 1 day apart. PCBs had a significant ($P<0.05$) effect on the number of pairs nesting (Table 3). All 8 pairs in the control group nested, whereas only 4 of 8 and 0 of 8 nested in the 10 and 40 ppm groups, respectively. When only pairs that nested were compared, 10 ppm PCBs had no significant ($P>0.05$) effect on length of time or behavior scores during the NP (Table 3). PCBs, however, significantly ($P<0.05$) delayed the onset of nest initiation. Doves fed 10 ppm PCBs took approximately 7 days longer to initiate nest building than did control pairs. Egg laying was consequently delayed by the 10 ppm PCB dose. Doves fed 10 ppm PCBs took approximately 8 days longer to lay their clutches than did controls (10.0 ± 1.6 vs. 17.8 ± 3.3). Neither clutch size nor eggshell thickness was significantly ($P>0.05$) different from controls.

TABLE 3

PCB (0, 10, or 40 ppm) effects on mourning dove nesting phase length, behavior scores, and onset of nest initiation[a].

PCBs (ppm)	Pairs Nesting	Length (days)	Behavior Scores[b]	Nest Initiation[c]
0	8A	13.3±1.5 A	11.9±1.1 A	5.9±1.3 A
10	4B	15.8±3.6 A	10.5±0.9 A	13.3±2.9 B
40	0C	—	—	—

[a]Data are $\bar{X} \pm SE$. Means with different letters are significantly different at $P < 0.05$.

[b]Per pair/day.

[c]Days after pair bond formation.

DISCUSSION

Many authors have reported that aberrant reproductive behavior reduces fecundity in birds contaminated with DDE. DDE residues caused low reproductive success in common terns *(Sterna hirundo;* SWITZER et al. 1971). KEITH (1978) reported that dietary DDE reduced courtship and nesting behavior in ring doves *(Streptopelia risoria)*, which resulted in reduced reproductive performance.

PCBs fed at 10 and 40 ppm significantly increased the amount of time doves spent in the courtship phase, and at the same time reduced courtship behavior scores. The prolongation of the courtship phase could be due in part to reduction in the intensity of courtship behavior; HAEGELE and HUDSON (1977) suggested that reduction of courtship behavior by DDE in male ring doves was responsible for delays in renesting. TORI (1982) found that all courtship behavior intensities (excluding perch coos) were lower in doves fed PCBs than in doves fed the control diet. The reduction of courtship behavior might have impeded the progression into nesting for 4 pairs in the 10 ppm group that did not nest and for all 8 pairs in the 40 ppm group.

In the 10 ppm group, pairs displayed a differential ability to persist in reproduction under the influence of PCBs. This differential ability was observed previously in ring doves (KEITH 1978). The detailed analysis of the courtship phase (PBFP and CP) revealed that the 4 pairs that went on to nest still were significantly affected by PCB treatment. Behavior intensity was reduced 32% and significantly more time was spent in the courting period. Therefore 10 ppm PCBs not only produced aberrant courtship behavior in some pairs, which caused them to discontinue reproduction, but also reduced courtship behavior intensity that significantly

prolonged courting in pairs that went on to nest. This then resulted in delays of nest initiation and egg laying in doves fed 10 ppm PCBs.

In the 40 ppm PCB group, most doves did not respond normally to the presence of a mate. Females were especially affected by the PCB treatment, performing only a small number of courtship behaviors (TORI 1982). Another indication that females were affected more than males was male behavior. Males fed 40 ppm PCBs performed more perch coos than either controls or males fed 10 ppm PCBs. Continued perch cooing in the presence of females is an indication of a lack of pair bonding FRANKEL and BASKETT 1961). Only 2 of 8 pairs formed pair bonds. All 8 pairs had previously (before PCB treatment) completed a successful nesting cycle, so a dietary dose of 40 ppm PCBs clearly had a severe negative effect on subsequent reproductive effort during the 30-day test period.

Reproductive behavior in doves is dependent on gonadotrophic hormones such as estrogen and testosterone (LEHRMAN 1965, WHITE 1975a, b). PCBs have been shown to degrade estrogen and androgens by increasing the activity of hepatic microsomal enzymes (LINCER and PEAKALL 1970, NOWICKI and NORMAN 1972, CHEN and DUBOIS 1973). PCBs might have severely decreased levels of hormones in doves fed 40 ppm PCBs and in the 4 pairs that did not nest in the 10 ppm PCB group. The 4 pairs that did nest in the 10 ppm group might not have been as severely affected; instead they might have experienced a slower buildup of estrogens or androgens than controls. RICHIE and PETERLE (1979) found that circulating LH levels in ring doves fed DDE did not peak like in control doves, but instead a more gradual increase was observed. However, hormone levels must have eventually reached normal levels because these pairs went on to nest and lay eggs normally, although they were delayed in doing so. Why doves respond differently to similar treatments requires further investigation.

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