Bull. Environm. Contam. Toxicol. 27, 678–682 (1981)

Effects of Polychlorinated Biphenyls on the Metabolic Rates of Mourning Doves Exposed to Low Ambient Temperatures

Gildo M. Tori[1] and Larry P. Mayer[2]

[1]Ohio Cooperative Wildlife Research Unit and [2]Department of Zoology, The Ohio State University, Columbus OH 43210

Organochlorine compounds have been reported to decrease the ability of some birds to cope with cold stress (LUSTICK et al. 1972, VANGILDER and PETERLE 1980). In some studies, organochlorines increased metabolic rates (PRESTT et al. 1970, PETERLE et al. 1974), and in other studies, metabolic rates were reduced (JEFFERIES et al. 1971, JEFFERIES and PARSLOW 1977). JEFFERIES et al. (1971) found that metabolism in pigeons increased until a critical dose level was reached, above which the metabolic rate decreased with increasing dosage. They concluded that low levels of organochlorines increased metabolic rate and that high levels decreased metabolic rate.

To our knowledge no investigators have examined the effects of PCBs on mourning doves (Zenaida macroura carolinensis). For this reason, we examined the effects of PCBs (at 40 ppm) on the metabolic rate of mourning doves exposed to low environmental temperatures.

MATERIALS AND METHODS

Twenty adult male mourning doves were trapped with baited walk-in traps in Columbus, OH, during the spring of 1981. Doves were held in 0.5 x 0.5 m cages housed in an environmental room. All birds were maintained on a 14L:10D photoperiod at temperatures ranging from 20 to 22°C throughout the test period. Birds were randomly divided into 2 groups: 10 birds were fed the control diet of untreated Purina pigeon checkers and 10 birds were fed the treated diet of Purina pigeon checkers dosed with 40 ppm of the PCB Aroclor 1254 for 42 days, then returned to the untreated diet. Food and water were available ad libitum.

Nocturnal metabolic trials began after the 42-day treatment

0007-4861/81/0027-0678 $01.00

period and ran for 2 consecutive weeks. Oxygen consumption was measured at 25, 15, 5, 0, and -5° C with a Beckman F-3 Paramagnetic Oxygen Analyzer connected to an Esterline Angus Miniservo Strip-Chart recorded according to the methods described by LUSTICK and LUSTICK (1972). Flow rates were maintained constant at 1000 cm^3/min for all temperatures except -5° C, where the rate was increased to 1250 cm/min. Metabolic rates were measured on alternate days for 4 control and 4 treatment doves, randomly chosen from each group of 10, for each temperature trial. All birds were fasted for 3 h prior to metabolic measurements, and weighed before and after each metabolic trail on a Ohaus Model 700 Triple Beam Balance. Body temperatures were recorded with a Bailey instrument Model Bat-4 potentiometer connected to a copper-constantan thermocouple inserted approximately 3 cm into the cloaca.

Metabolic rate and body temperature were analyzed over the range of ambient temperatures with a 2 x 5 factorial analysis of variance (ANOVA). Fisher's Least Significant Difference (LSD) (SNEDECOR and COCHRAN 1967) was used to test the difference of body temperature means and metabolic rate means between control and treatment groups at each ambient temperature.

RESULTS

Mean weights (± SE) of control (129.15 ± 4.60 g) and PCB-fed doves (130.30 ± 5.29 g) did not vary significantly.

Decreasing ambient temperatures below the lower critical temperature significantly ($P < 0.01$) decreased metabolic rate when compared to controls over the entire range of ambient temperatures tested (ANOVA). The mean metabolic rate of PCB-fed doves was consistently lower at each ambient temperature, except at 25° C (Fig. 1). Differences in metabolic rates between control and PCB-fed doves tended to become larger as ambient temperatures decreased. However, Fisher's LSD test showed no significant differences in metabolism between experimental and control groups at any single ambient temperature tested. One PCB-fed dove died during a -5° C trial. Its body temperature, taken immediately after death, was 17° C. This dove was excluded from statistical analysis.

PCBs had a significant ($P < 0.02$) effect on body temperatures of PCB-fed doves. However, a significant ($P < 0.007$) interaction existed between PCBs and ambient temperature on body temperature. Therefore, the effects of PCBs on body temperature is not consistently the same at each ambient temperature tested. There were significant ($P < 0.01$, LSD) decreases in body temperature of PCB-fed doves at 0 and -5°C (Table 1). There were no significant differences in body temperatures between control and PCB-fed doves at 5, 15, or 25°C.

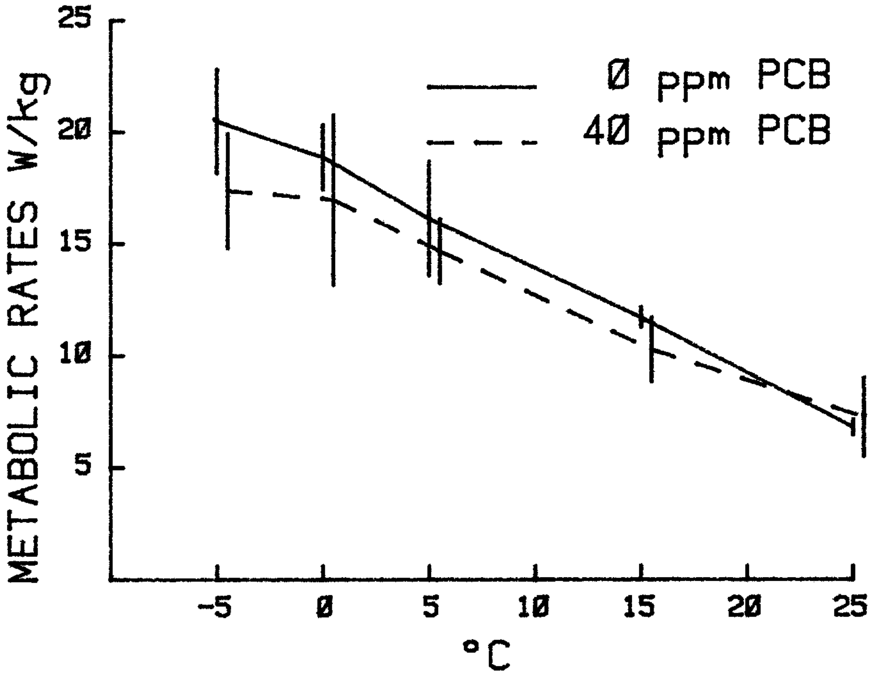

Fig. 1. Mean (± 2 SE) metabolic rates of doves plotted against ambient temperatures.

TABLE 1

Body temperatures ($\bar{X}$ ± SE) of male mourning doves fed 0 or 40 ppm PCBs at ambient temperatures of -5, 0, 5, 15, and 25° C (N = 4).

	PCBs			
	0 ppm		40 ppm	
Temperature (° C)	$\bar{X}$	SE	$\bar{X}$	SE
-5	39.8	0.47	36.7*	0.33[a]
0	40.1	0.09	38.4*	0.12
5	40.0	1.39	41.4	0.20
15	41.0	0.29	40.7	0.40
25	41.5	0.50	41.0	0.22

[a]N = 3 due to death.
*Significantly different (P < 0.01) from control; LSD test).

DISCUSSION

Controls. Metabolic rates of control doves increased with decreasing ambient temperatures below the lower critical temperature as would be predicted (FARNER and KING 1974). Our results are in agreement with other reported metabolic rates of mourning doves (HUDSON and BRUSH 1964).

Body temperatures of control doves varied with ambient temperatures, exhibiting a downward trend with decreasing ambient temperatures. IVACIC and LABISKY (1973) showed that mourning doves exhibited a lower body temperature when exposed to decreasing ambient temperatures.

PCB Treatment. Metabolic rates of PCB-fed doves increased with decreasing ambient temperature, but rates were reduced compared to controls. These differences tended to become larger at the lower ambient temperatures. The largest difference occurred at -5°C, where PCB-fed doves had a metabolic expenditure 15% lower than control doves. Also, accompanying the reduction in metabolic rate, we observed a significant reduction in body temperatures at 0 and -5°C.

Our data support the observation of JEFFERIES et al. (1971) that high doses of organochlorines reduce the metabolic rate in Columbidae. Reduced metabolic rates were also found in gulls (*Larus fuscus*) fed high doses of DDT (JEFFERIES and PARSLOW 1972).

PCB-induced reductions in metabolic rate and body temperature might be indicative of a breakdown in thermoregulatory ability, and thus might significantly affect survival of PCB-exposed doves during periods of inclement winter weather. Death of the PCB-fed dove during the -5°C trial possibly lends credence to the observation that PCB contamination could reduce survival of cold stressed birds. LUSTICK et al. (1972) found that DDT significantly decreased survival of cold-stressed quail (*Colinus virginianus*). Survival and thermoregulatory ability of mallard (*Anas platyrhynchos*) ducklings hatched from DDE-treated hens was also significantly reduced during cold stress (VANGILDER and PETERLE 1980).

Because doves normally experience winter temperatures below -5°C, PCBs could reduce adult winter survival. Juvenile doves are even more susceptible to cold stress, and consequently have a higher winter mortality rate than adults (CHAMBERS et al. 1962, IVACIC and LABISKY 1973). The effects of PCBs on juveniles during winter could significantly increase their mortality.

ACKNOWLEDGEMENTS

We are grateful to D. Wilson and L. Vangilder for their assistance on the project. Drs. Lustick, Bookhout, Peterle, and Vangilder reviewed the manuscript. This work was partially supported by Patuxent Wildlife Research Center (USDI 14-16-0009-78-976).

REFERENCES

CHAMBERS, G. D., H. M. WIGHT, and T. S. BASKETT: J. Wildl. Manage. 26, 155 (1962).
FARNER, D. S. and J. R. KING: Avian Biology, V. IV. New York: Avenue Press (1974).
HUDSON, J. W. and A. H. BRUSH: Comp. Biochem. Physiol. 12, 157 (1964).
IVACIC, D. L. and R. F. LABISKY: Wilson Bull. 85, 182 (1973).
JEFFERIES, D. J. and J. F. PARSLOW: Bull. Environ. Contam. Toxicol. 8, 306 (1972).
JEFFERIES, D. J., M. C. FRENCH, and B. E. OSBORNE: Brit. Poult. Sci. 12, 387 (1971).
LUSTICK, S. and D. LUSTICK: Comp. Biochem. Physiol. 43, 643 (1972).
LUSTICK, S., T. VOSS, and T. J. PETERLE: Proc. Natl. Bobwhite Quail Symp. 1, 213 (1972).
PETERLE, T. J., S. I. LUSTICK, L. E. NAUMAN, and R. E. CHAMBERS: Trans. Int. Cong. Game Biol. 11, 457 (1974).
PRESTT, I., D. J. JEFFERIES, and N. W. MOORE: Environ. Pollut. 1, 3 (1970).
SNEDECOR, G. W. and W. G. COCHRAN: Statistical Methods, Ames: Iowa State Univ. Press (1967).
VANGILDER, L. D. and T. J. PETERLE: Bull. Environ. Contam. Toxicol. 25, 23 (1980).

Accepted September 14, 1981