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NAPHTHALENE SHOWS NO REPELLENCY FOR STARLINGS

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Birds nesting or roosting in urban areas can cause a variety of health, nuisance, aesthetic, and structural problems. This is particularly true for starlings (*Sturnus vulgaris*), which perch or nest on ledges or support beams, and in various nooks and crannies in urban structures (Davis 1959, Thompson and Coutlee 1963, Miller 1975, Weber 1979, Martin and Martin 1982).

One chemical registered by the U.S. Environmental Protection Agency (EPA) for repelling birds from structures is naphthalene (Eschen and Schafer 1986), a crystalline aromatic hydrocarbon used widely in homes as a fumigant for moths and other insects. Our office occasionally is contacted by persons wanting information on the use and effectiveness of this chemical for resolving bird problems; however, we can find no experimental results and only 2 anecdotal reports (Wright 1963) on naphthalene as a bird repellent. Therefore, we conducted an experiment to evaluate the effectiveness of naphthalene as a repellent for starlings.

METHODS

In 1984, 51 wooden nest boxes (28 × 13 × 17 cm) were placed 2.5–3.0 m from the ground on utility poles throughout the 2,400-ha NASA Plum Brook Station in Erie County, Ohio. Boxes were at least 120 m apart. Each box had a 5.1-cm-diameter entrance hole; most boxes had slight (<5 mm) openings where the detachable roof met the box sides.

Between 30 April and 2 May 1985 all nesting material was removed from the boxes, and on 3 May 1 of 3 treatments (0, 0.6, or 8.0 g of naphthalene) was assigned randomly to each box with the restriction that 17 boxes received each treatment. The proper weight of naphthalene was placed in a clear plastic vial (7 cm long, 3-cm diameter) containing 9 6-mm-diameter ventilation holes, and the vial was secured with wire to the inside back wall of the nest box. Vials with pebbles similar in size and color to the naphthalene crystals were placed in the control nest boxes. Each box was examined for nesting activity 3–4 times weekly, from 6 May to 15 July, by removing the roof and noting contents of the box (i.e., nesting material, number of eggs and nestlings, and evidence of predation). In addition, a survey of starling activity at nest boxes was

Table 1. Nesting activity by starlings in naphthalene-treated and untreated nest boxes, Erie County, Ohio, April–July, 1985–1986.

Starling nesting activity	Treatment level Weight (g) of naphthalene per box		
	0	0.6	8.0
No. of boxes			
Available[a]	37	37	37
With nests[b]	34	33	36
With eggs[b]	34	30	33
With nestlings[b]	24	19	23
With fledglings[b]	10	9	12
With predation[b]	27	23	24
With second clutch[b]	13	12	11
With second fledglings[b]	2	2	1
No. observations with adult starling in or on box[c]	194	153	175
Clutch size ($\bar{x}$[SD])[d]	4.3 (1.4)	4.0 (1.2)	3.9 (1.4)
No. of fledglings ($\bar{x}$[SD])[d]	4.2 (1.3)	3.6 (0.9)	3.2 (1.1)

[a] Each treatment level was assigned randomly to 17 and 20 nest boxes in 1985 and 1986, respectively.
[b] Chi-square tests, 2 df, $P > 0.10$.
[c] $\chi^2 = 5.43$, 2 df, $P = 0.07$ ($n = 1{,}590$ total observations/treatment).
[d] $F = 0.77$; 2, 130 df; $P > 0.10$ (clutch size); $F = 2.91$; 2,33 df; $P = 0.08$ (no. of fledglings).

made from an automobile 3 times weekly. Each box was observed at a distance of 5–15 m for 1–2 min for the presence or absence of an adult starling either inside of, or perched on, the box. Naphthalene was replaced every 3–4 weeks, an interval during which the material usually volatilized to about 50% of its original weight.

The same experiment was conducted again in 1986. Sixty nest boxes were used and each of the 3 treatments was randomly assigned to 20 boxes. Vials were placed in cleaned nest boxes on 24 April, and nest box monitoring was conducted from 25 April to 18 July.

The experiment was conducted identically in the 2 years, and the decision was made a priori to combine data for the 2 years in the analysis. Chi-square analysis was used to test for differences among the 3 treatments in the number of boxes with various nesting activities. One-way analysis of variance was used to test for differences among the 3 treatments in mean clutch size and young fledged per box.

RESULTS

Starling use of boxes was high; they built nests in 43 of 51 boxes in 1985 and in all 60 boxes in 1986. There was no significant difference among the 3 treatment levels in the 6 measures of starling nesting activity (number of boxes with nests, eggs, nestlings, fledglings, renesting, and adult starling occupation) or in the level of predation (chiefly raccoon [*Procyon lotor*]) (Table 1). Overall, 12, 11, and 13 broods fledged from boxes treated with 0, 0.6, and 8.0 g of naphthalene, respectively. Mean clutch and brood sizes also were not significantly different among the 3 treatments (Table 1).

Three species other than starlings laid eggs in the nest boxes: house wrens (*Troglodytes aedon*), 7 nests; bluebirds (*Sialia sialis*), 2 nests; and tree swallows (*Tachycineta bicolor*), 1 nest. Overall, 3, 7, and 0 non-starling nests were found in boxes treated with 0, 0.6, and 8.0 g of naphthalene, respectively.

DISCUSSION

The question of whether birds possess olfactory capabilities was controversial for many years. Anatomical, physiological, and behavioral studies in the past few decades established that birds possess olfactory systems whose complexity and functional significance vary widely among species (Wenzel 1973). Passeriform birds, which include starlings, are generally considered to have more poorly developed olfactory ability than other orders. However, recent studies indicate that starlings have olfac-

tory ability and that volatile cues may guide the selection of green plant material used in nest building (Clark and Mason 1986).

In mammals, the trigeminal system, a chemoreceptive system separate from the olfactory and gustatory systems, mediates avoidance of irritating chemicals such as capsaicin and formaldehyde (Silver 1987) and also is likely to be responsible for naphthalene perception (J. R. Mason, Monell Chem. Senses Cent., Philadelphia, Pa., pers. commun.) Birds also appear to use trigeminally-mediated information, but apparently are less sensitive than mammals to such irritants as capsaicin (Mason and Maruniak 1983). In fact, naphthalene may not act as an irritant for birds. A common grackle (*Quiscalus quiscula*) was observed in the wild to pick up a naphthalene crystal (mothball) in its bill and rub it vigorously against its body feathers (Dubois 1969).

Thus, although starlings have olfactory and trigeminal abilities, the levels of naphthalene tested in this experiment had no apparent repellent effect. Treatment levels of 0.6 and 8.0 g equaled 0.1 and 1.3 g of naphthalene, respectively, per liter of space inside the nest boxes. This is 2.5 and 32.5 times the treatment level of 0.04 g/L (5 lbs/2,000 ft^3) recommended on the EPA registration label (Courtsal 1983). For both treatment levels, the naphthalene odor was readily apparent to humans when nest boxes were opened. Therefore, we conclude that naphthalene, at commercially feasible levels, has no value as a repellent for starlings.

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