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Occurrence of anthropogenic litter in nestling Tree Swallows (*Tachycineta bicolor*)

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Abstract

While undertaking a study of the effects of strontium-90 on Tree Swallow (*Tachycineta bicolor*) near Chalk River, Ontario, we noticed the presence of anthropogenic litter (pieces of metal, glass, and plastic, and paper, plastic, and foil wrappers, >1 mm in size) in the nestlings. Although combustible litter (pieces of plastic and wrappers) were not quantified before the nestlings were incinerated in 2014 and 2015, gizzards were dissected in 2016. Litter (>1 mm diameter) was found in 30% of the 74 nestlings examined. This material is most likely provided to nestlings, along with food (insects) and natural grit (sand, stones, and mollusc shells), which we also found, by parent birds; however, it could lead to internal injuries and/or harmful substances being absorbed by the young birds.

Key words: Tree Swallow; *Tachycineta bicolor*; nestling; grit; environmental impact; anthropogenic litter; metal; glass; plastic; paper

Introduction

Insoluble and soluble natural grit (sand, stones, and mollusc shells) is an important component of many avian diets, as it improves the process of grinding foods, such as seeds, plant material, and insects, in the gizzard (Barrentine 1980; Best and Gionfriddo 1991; Gionfriddo and Best 1995). In atricial species, grit is provided by parents. The amount and size of grit consumed by a species is believed to depend on the specific diet of the bird (Gionfriddo and Best 1995). Tree Swallow (*Tachycineta bicolor*), an insectivorous species, requires grit for efficient digestion (Mayoh and Zach 1986), and adults have been found to feed grit to nestlings as young as three days of age (Mayoh and Zach 1986).

If anthropogenic litter (e.g., pieces of metal, glass, and plastic as well as paper, plastic, and foil wrappers) is present near nesting locations, it too could be fed to nestlings. However, ingested anthropogenic litter could lead to internal injury, and/or harmful substances from the materials could be absorbed by the nestlings (Bellrose 1975; Trost 1981; Azzarellow and Van Vleet 1987; Fry *et al.* 1987; Laist 1987; Colabuono *et al.* 2010). Herein, we report on the ingestion of anthropogenic litter by Tree Swallow nestlings near Chalk River, Ontario, Canada.

Methods

In preparation for a strontium-90 (Sr-90) study described in Lee *et al.* (2019), nest boxes were installed on the 4000-ha property of the Canadian Nuclear Laboratories' Chalk River Laboratories (46.052578°N, 77.360890°W; Figure 1) in suitable Tree Swallow nesting habitats (wetland and shoreline; De Steven 1980; Robertson and Rendell 1990). Tree Swallows will readily inhabit nest boxes and tolerate human disturbances, making them an ideal bird for biomonitoring and research (De Steven 1980; Mayoh and Zach 1986; Robertson and Rendell 1990).

Monitoring of the nest boxes began in late April or early May of each year, and observations of nesting, egg laying, clutch size, hatchings, nestling growth, and fledging were documented. When nestlings were 12 days old (as determined from known hatch dates), one nestling from each nest box with at least four young was collected (on average a nest box would contain six nestlings). In all, 74 12-day-old nestlings

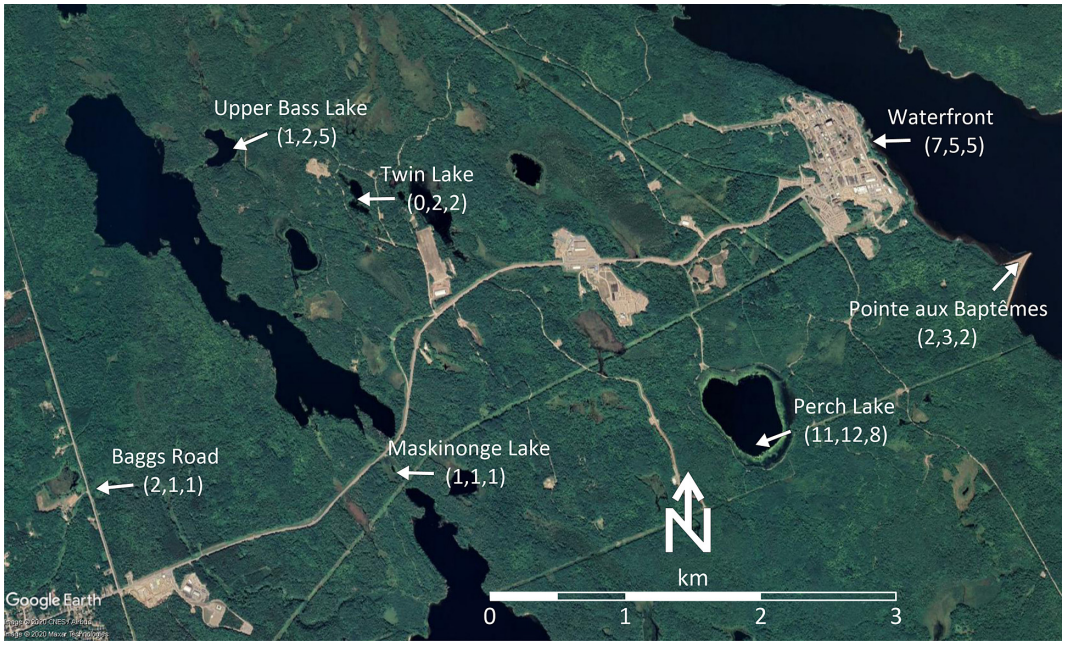

Figure 1. Number of Tree Swallow (*Tachycineta bicolor*) nestlings (2014, 2015, 2016) collected at each location on the Canadian Nuclear Laboratories' Chalk River property. Source: Chalk River Laboratories, Chalk River, Ontario, Canada. 46°03′00.2″N, 77°21′51.7″W. Google Earth Imagery date: 20 August 2019. Data providers: DigitalGlobe 2019. Accessed: November 2019.

were taken, euthanized, their external surfaces verified clean, and frozen.

In 2013, carcasses were incinerated for the determination of Sr-90 (Lee *et al.* 2019). Frozen carcasses were thawed overnight in a refrigerator, then dehydrated overnight in an oven, at 105°C. After cooling to room temperature, carcasses were heated to 250°C for 2 h and to 450°C for 16 h, with the 16 h incineration performed a second time to ensure complete ashing. After incineration, samples were cooled to room temperature. The ash was gently milled using a spatula, and any material (i.e., stone, glass, and metal fragments) larger than about 1 mm in diameter was removed. Beginning in 2014, natural grit materials and anthropogenic litter larger than about 1 mm in diameter observed in the ashes were noted and photographed.

In 2016, on thawing of the carcasses, the gizzard contents of each bird were examined visually for materials (e.g., insects, shells, plastic items) that would be incinerated during the ashing process. Observations were noted and the material was returned to the carcass before each carcass was dried and incinerated as above; non-combustible materials larger than about 1 mm in diameter were removed and photographed after the ashing process. Although the general type of litter was noted, pieces were not measured.

Results

In addition to small stones, metal, and/or glass fragments were found in five of 24 nestlings in 2014 and in 10 of 26 nestlings in 2015 (Table 1). Because the gizzards of nestlings collected in 2014 and 2015 were not examined before the nestlings were incinerated, results for combustible materials, such as plastic, are not available. In 2016, the gizzards were examined prior to incineration and we observed flying insects mixed with small stones, sand, grass, and mollusc shells, as well as anthropogenic materials, including pieces of metal and glass, sections of wrappers (most often pieces of shiny cigarette and chewing gum wrappers up to ~1 cm wide) in seven of 24 birds (Table 1). Figures 2 and 3 provide examples of litter collected from nestlings sampled in 2014–2016.

The presence of anthropogenic material in the nestlings occurred most often along the Ottawa River shoreline and around Perch Lake, where human activities are more prominent (Figure 1; Tables 2 and 3). Such material was seldom found in nestlings collected from more remote areas.

In 2016, no significant differences (*t*-test, $t_9 = 1.146$, $P = 0.281$) were found between the weights of 12-day-old nestlings with (average 21.0 g, range 19.5–22.2 g) and without (21.8 g, 20.5–22.8 g) anthropogenic litter in their gizzards.

TABLE 1. Types of litter (>1 mm diameter) found in nestling Tree Swallows (*Tachycineta bicolor*), 2014–2016.

Year	No. nestlings	% nestlings containing fragments			
		Metal	Glass	Wrapper	Plastic
2014	24	12.5	4.2	n/a*	n/a
2015	26	30.8	11.5	n/a	n/a
2016	24	12.5	20.8	4.2	4.2

*n/a = not available because these materials would have been incinerated.

FIGURE 2. Examples of metal turnings found in the whole body ashes of a Tree Swallow (*Tachycineta bicolor*) nestling. Photo: Jennifer Haughton.

FIGURE 3. Examples of glass fragments found in the whole body ashes of a Tree Swallow (*Tachycineta bicolor*) nestling. Photo: Jennifer Haughton.

TABLE 2. Locations of nestling Tree Swallows (*Tachycineta bicolor*) with anthropogenic litter (>1 mm diameter) in their gizzards, 2016.

Location	No. nestlings	No. nestlings containing anthropogenic fragments			
		Metal	Glass	Wrapper	Plastic
Baggs Road	1	0	0	0	0
Maskinonge Lake	1	1	0	0	0
Upper Bass Lake	5	0	1	0	0
Twin Lake	2	0	0	0	0
Perch Lake	8	0	2	0	0
Pointe aux Baptemes	2	1	0	0	1
Waterfront	5	1*	1	1*	0

*Both fragment types were in the same nestling.

TABLE 3. Locations of nestling Tree Swallows (*Tachycineta bicolor*) containing glass and metal pieces (>1 mm diameter) in 2014 and 2015.

Location	No. nestlings	No. nestlings containing anthropogenic fragments	
		Metal	Glass
Baggs Road	3	0	0
Maskinonge Lake	2	0	0
Upper Bass Lake	3	0	0
Twin Lake	2	0	0
Perch Lake	23	4	2
Pointe aux Baptemes	5	3	1
Waterfront	12	4*	1*

*Both fragment types were found in one nestling.

Discussion

Anthropogenic litter was found in 30% of 74 nestling Tree Swallows collected in 2014–2016 near Chalk River, Ontario. We consider this to be an underestimate, because it does not include litter fragments <1 mm in diameter or combustible litter for two of the three years of the study.

Barrentine (1980) reported grit in 80% of Barn Swallow (*Hirundo rustica*) nestlings sampled, providing evidence that grit is an important dietary factor during the growth of swallow nestlings and a cause for concern for birds that nest in areas where grit-like anthropogenic material may be present.

Mayoh and Zach (1986) found that Tree Swallows had a greater percentage of anthropogenic litter in their "stomachs" than did House Wrens (*Troglodytes*

aedon) at the same age. This may be because swallows forage along shorelines and nearby roads (in a ~400 m feeding radius during the nestling period), where greater amounts of anthropogenic litter are generally found. Barrentine (1980) showed that while swallows consumed grit of various colours, sizes, and compositions, they have a clear preference for light-coloured objects between 1 and 3 mm in size. Considering metals are generally light in colour, and glass, plastic, and wrapper materials can also be a light colour, swallows could be intentionally choosing human-made materials over natural grit.

Anthropogenic litter can be domestic or industrial. The presence of metal turnings in Tree Swallow nestlings was a unique finding that is particularly relevant to industrial areas.

The potential detrimental effects of anthropogenic materials on birds are well known. For example, the ingestion of metal pieces by waterfowl can result in lead poisoning (Bellrose 1975; Trost 1981), and the occurrence and impacts of plastic ingestion by bird species, especially marine birds, are prevalent (see for example Provencher *et al.* 2014). Reported adverse health effects include: proventricular impactions, ulcerative lesions (Azzarellow and Van Vleet 1987; Fry *et al.* 1987); digestive tract blockages, stomach lining damage, appetite suppression (Azzarellow and Van Vleet 1987; Laist 1987); exposure to polychlorinated biphenyls and organochlorine pesticides (Colabuono *et al.* 2010); and lowered steroid hormone levels, delayed ovulation, and reproductive failure (Azzarellow and Van Vleet 1987).

We have documented the presence of anthropogenic litter in young Tree Swallows, in an environment previously considered to be relatively litter free. While we observed that the ingestion of litter did not significantly impact the weights of the nestlings, potential risks of ingestion of anthropogenic litter on Tree Swallow nestlings remain to be investigated.

Author Contributions

Writing – Original Draft Preparation: S.W.; Writing – Review & Editing: L.B., A.F., I.G., J.H., D.L., M.S., and S.W.; Methodology: D.L. and M.S.; Investigation: L.B., A.F., I.G., and J.H.; Resources: L.B.; Data analysis: A.F. and I.G.; Visualization: L.B.; Project Administration: M.S.; Supervision: D.L. and M.S.

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