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DOWNY WOODPECKER PREDATION AT GOLDENROD GALLS

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In Tompkins County, New York, the Canadian goldenrod (*Solidago canadensis*) is common. Several gall-inducing insects lay eggs either exclusively or almost exclusively in this species. The larvae of two moth species induce elongated galls after eggs are laid into the tip of the growing plant (Uhler 1951). The larvae of a small fly (*Eurosta solidaginis*) induce formation of a round gall, a "ball gall." While the Downy Woodpecker (*Picoides pubescens*) eats larvae of both moths and the gall fly, the gall fly is more abundant and is the central player in the following story.

The gall fly larva grows during the summer into a maggot that weighs about .04 g by fall. Larvae pupate in late winter and adults emerge in early spring, repeating the cycle annually. Fly larvae may be parasitized by either of two wasp larvae (*Eurytoma obtusiventris* or *E. gigantea*) or preyed upon by a beetle larva (*Mordellistena unicolor*). On average these insect larvae weigh about .005 g. Downy Woodpeckers use all these larvae and pupae as a food resource. To get a larva or pupa a Downy Woodpecker will chisel a distinctive, conical hole into the side of the gall. In one survey as many as 40% of the gall insects were eaten by the woodpecker (Milne 1940). Yet, in another survey conducted in Tompkins County, New York (Uhler 1961), as few as zero to 9% were eaten from year to year. Working in the same area as Uhler, we found areas with nearly 50% of the gall insects eaten, yet other areas with virtually no insects eaten. This preliminary information suggested that gall insects could be an important food for Downy Woodpeckers and that some factors could greatly alter the accessibility of the gall insects for the woodpecker. Herein, we report on the influence of several factors on predation by the Downy Woodpecker on the goldenrod ball gall. These include: gall height and diameter, patchiness of the galls, distance from the gall to woody cover, snow depth, and the woodpecker's selection of galls dependent on the species of insect in the ball gall.

METHODS

We sampled abandoned farmland in Tompkins County, New York from Fall 1980 to Spring 1983. Goldenrod occurred in patches with densities from less than 1 to about 100 stems/m^2. Average stem densities approximated 10 to 20 stems/m^2 with about one out of 5 stems having one or more galls. The goldenrod gall fly and its insect parasites and predators were identified by means of the helpful work of Uhler (1951, 1961).

Surveys of seasonal predation rates were conducted by repeated searches for tagged stems with galls. Strips of labeling tape were numbered and stapled around the plant stem below the gall. The tags resembled leaves on the stem and were not noted to have an influence on

Downy Woodpecker predation. Tags aided relocation of the stems on later visits and reduced subjectivity in selection of galls for the repeated surveys. Some tags were lost, and in mid-winter many stems with galls were buried by snow. In one survey the percent rediscovery 4 months after tagging and after snow melt was 98% (513 out of 524). Normally 100% of the galls found on one trip could be rediscovered on the next trip if there was no intervening snowfall. Galls less than .5 mm diameter were ignored since these galls rarely had larvae in them and rarely were attacked by Downy Woodpeckers.

The effect of distance from the gall to woody cover (stems >3 m height) on the frequency of predation was measured. For all but one of the study sites the transition from woody cover to field was abrupt and formed a straight line. In the one exception, the 1980–1981 survey, patches of woody vegetation occurred irregularly throughout the site. At this site, gall diameter, height, distance to woody cover and patchiness were measured concurrently. Patchiness was estimated by the average distance to the 5 nearest galls.

We suggest that Downy Woodpeckers select directly for galls containing the larger fly in preference to galls containing the smaller wasps or beetle. This selection would involve the following insect life histories (from Uhler 1951, 1961) and Downy Woodpecker behavior.

During October the fly larva, using its mouth hooks, prepares an exit tunnel up to but not including the epidermis. In May the adults, which lack mouth hooks, push open the epidermal layer and emerge. Downy Woodpeckers frequently enlarge this exit tunnel when extracting the larva (Moeller and Thogerson 1978). However, if the fly larva is preyed upon or parasitized by a larva of other insects, this happens in the summer before the fly larva prepares an exit tunnel. The other insect larvae do not make a tunnel because adults of the other species get out on their own effort. Sometimes a Downy Woodpecker will make a few scattered peck marks on a gall and then abandon it. We hypothesized that the woodpecker would be more likely to abandon a gall, leaving peck marks but no chiseled hole, if it could not find an exit tunnel.

To test this hypothesis nearly 3000 galls were collected in March from 3 locations in 2 years without any examination for Downy Woodpecker peck marks or chiseled holes. Since the 3 samples yielded the same trend, they were pooled. These samples were examined meticulously in the laboratory under good light conditions. A total of 1077 galls were found with the hard-to-see peck marks or large, chiseled holes. Although some peck marks may have been missed, this possible error would occur with equal probability for galls containing a fly or containing the other insects and would not bias the results. The attacked galls were opened to determine the insect occupant. The proportion of galls with peck marks but no chiseled hole was calculated for galls with a fly larva or with a carnivorous larva.

The total predation by Downy Woodpeckers over a large area was estimated. A field next to a suet station was surveyed to determine the

number of galls opened by woodpeckers. Sixty-four 1 m^2 sample plots were positioned along a grid that covered a 1 ha field. The survey was conducted in April 1981 when the seasonal predation was finished. Similar fields within about 300 m of the suet station comprised a total area with goldenrod galls of about 5 ha. Woody shrubs were distributed throughout the surveyed and adjacent areas and Downy Woodpecker predation occurred throughout.

The assessment of predation by Downy Woodpeckers is complicated by Black-capped Chickadees (*Parus atricapillus*) which also peck holes into these galls. Downy Woodpeckers tend to make a tidy, narrow, conical hole by pecking, while Black-capped Chickadees tend to make a messy, large, irregular hole by grabbing bits of the gall with their bill and tugging them free. Schlicter (1978) found up to 50% of the galls attacked by the chickadee in southern Ontario. In the Ithaca area Black-capped Chickadee predation is rare. Uhler (1961) never noticed this out of 17,000 galls. J. Glase and D. Gray, who collectively spent about 200 weeks in field studies of chickadees, saw this predation about 5 times (pers. comm.), while we observed a chickadee attacking a gall once. Out of thousands of galls we have examined, probably fewer than 30 were attacked by the Black-capped Chickadee and few of these occurred in our quantified surveys. In our analyses we have made the slightly erroneous assumption that all holes were made by the Downy Woodpecker.

RESULTS

The Downy Woodpecker fed on galls from early November until late April in a highly sporadic manner (Table 1). Galls tagged for the 1980–1981 survey were buried by snow from January to mid-February. A thaw then exposed the galls and was followed by a burst of predation detected on the mid-February survey. Two other surveys during 1980–1981 from widely separated areas were less intensive, but still indicated a pulse of predation following this thaw. During subsequent weeks of 1980–1981 the predation rate varied greatly and was not related to any environmental condition that we noted.

The 1981–1982a survey involved a random set of galls with about ⅔ of the galls 15–30 m out from a forest edge. Characteristics of these galls were similar to the preceding set of galls, and snow cover was similar for these 2 years. For both of the above surveys, almost all of the predation occurred in early spring.

Galls in the 1981–1982b survey were unique in that they were selected to be on tall stems (>1 m) and close to trees (<2 m). Unlike galls of other surveys none of these galls was buried by snow. Almost all the predation on this latter set of galls occurred in fall, with virtually no galls eaten in spring. A Downy Woodpecker was twice seen in this area during late spring, so the absence of predation was not likely due to the absence of a bird. Casual observations of other patches of galls suggest that heavy predation on large galls on tall stems near trees before January is a common event.

TABLE 1. Seasonal incidence of Downy Woodpecker attack on goldenrod galls. The number attacked equals the sum of galls with a few scattered peck marks plus galls with completely chiseled holes. The 1980–1982a surveys involved a random selection of galls at distances up to 30 m from woody vegetation, most of which were snow covered during midwinter. The 1982–1983 surveys used galls similar to those of the first two surveys, but few were snow covered during this milder winter. The 1981–1982b survey used only tall galls near woody vegetation.

Survey	2-Week Intervals													Number attacked / Number in survey
	Oct.		Nov.		Dec.	Jan.		Feb.		Mar.		Apr.		
1980–1981	— NS —		0	8	— NS —	— NS —		0	15	1	18	3	14	59/513
1981–1982a	— NS —		— NS —		— NS —	— NS —		7	13	4	1	7	0	33/431
1981–1982b	2	9	52	17	35 NS	1	0	0	2	0	1	— NS —		117/260
1982–1983a	— NS —		— NS —		— NS —	NS	39	2	2	0	1	2	NS	46/263
1982–1983b	— NS —		— NS —		— NS —	NS	12	0	0	0	0	0	NS	12/229
1982–1983c	— NS —		— NS —		— NS —	NS	29	4	2	1	3	5	NS	44/359

NS = Not surveyed during the indicated time span; numbers adjacent to NS indicate all galls eaten in the survey area by the first survey date.

TABLE 2. Predation by the Downy Woodpecker on goldenrod ball galls as influenced by the distance from woody vegetation.

Survey date	Distance[a] (m)	Number		χ^2
		Eaten (%)	Not eaten	
Spring 1982				
	0–5	23 (14)	128	
	15–20	6 (4)	130	9.21
	25–30	4 (3)	140	
Fall 1982				
	0–3	19 (16)	103	
	3–10	4 (5)	85	22.27
	6–10	0 (0)	109	
Spring 1983				
	0–3	27 (24)	85	
	3–6	8 (5)	158	24.03
	6–10	8 (10)	73	
Spring 1984				
	0–2	8 (9)	78	
	10–12	5 (2.5)	194	11.98
	20–22	3 (3)	105	

[a] Distance intervals varied from survey to survey depending on habitat availability.

Three surveys were conducted during 1982–1983 in widely separated areas and involved different birds. For all 3 of these surveys most of the predation occurred early in winter, which differs from the 1980–1981 and 1981–1982a surveys. During 1982–1983, reduced snowfall and warmer temperatures reduced the accumulation of snow. Consequently, most of the galls were available to Downy Woodpeckers all winter. Under these conditions almost all galls that were eaten were eaten during early winter. A 4th survey during 1982–1983, more casually conducted as part of a class project, gave similar results. Thus, during a winter of low snowfall, predation began early and ended early.

A Downy Woodpecker was more likely to prey on galls close to a forest edge than on galls farther into a field (Table 2) as noted by Schlicter (1978). Not noted before is the abrupt decrease in predation as little as 3–6 m from woody cover. Four surveys and many unquantified observations support the generality that in the Ithaca, New York area predation decreased abruptly and approached zero more than 20 m into a field. The height of the gall above ground and diameter of the gall also were positively related to predation by the woodpecker (Table 3).

In the 1980–1981 survey, gall height, diameter, distance to woody cover, and patchiness were measured concurrently in fall, and related to Downy Woodpecker predation by spring. Unlike all the preceding surveys, this one was done in the field with patches of woody cover throughout the sample area. A standardized, discriminant coefficient

TABLE 3. Predation by the Downy Woodpecker on goldenrod ball galls as influenced by: (A) the height of the gall above ground, and (B) the diameter of the gall. Surveys were conducted at 2 sites in late spring of 1983 when further predation was unlikely.

	Number		
	Eaten (%)	Not eaten	χ^2
(A) Height (cm)			
Site 1			
<56	7 (7)	93	
56–90	19 (7)	261	39.30
>90	32 (29)	80	
Site 2			
<50	2 (8)	23	
50–100	10 (5)	182	21.70
>100	31 (22)	111	
(B) Diameter (cm)			
Site 1			
0.9–1.6	1 (1)	103	
1.6–2.0	15 (7)	192	38.53
2.0–2.9	42 (23)	139	

was determined for all these variables as related to the frequency of Downy Woodpecker predation. The relative importances for height, diameter, and distance to trees were .70 to .43 to −.29, respectively. Thus, gall height was more important to the Downy Woodpecker than diameter by a ratio of .70 to .43. This analysis also predicts which galls would be eaten. Although a randomly selected gall would have about 10% probability of being eaten, the analysis could predict which gall would be eaten with 68% accuracy using information about gall height, diameter, and tree distance. The accuracy of this model suggests that these three factors had a major influence on selection. Gall height was measured in fall when all measured stems were upright. Almost all the predation occurred after snow melt when, at this site and after a year of heavy snowfall, the stems were virtually all nearly horizontal. Gall height in fall must be related to some other attribute, perhaps position in a pile of fallen stems, which influenced predation in spring. Gall patchiness was not related to Downy Woodpecker predation.

Moeller and Thogerson (1978) suggested that Downy Woodpeckers select for galls with fly larvae by selecting for larger galls. The following suggests that the woodpecker can also select directly for galls with a fly larva by responding to the presence or absence of the fly's exit tunnel. Three samples of galls were collected from several locations and the results pooled. Out of almost 3000 collected galls, 1077 showed either just peck marks or peck marks plus the large, conical hole. Examination of the gall contents showed that a Downy Woodpecker had extracted a fly larva from 551 galls. The exit tunnel was used for this extraction with 292 (53%) of the fly galls. Since the epidermal layer over the exit

tunnel comprises only about 2% of the surface of the upper hemisphere, this suggests selective use of the exit tunnel as also noted by Moeller and Thogerson (1978).

Some of the galls were attacked but abandoned, as indicated by peck marks but no chiseled hole. The woodpeckers attacked (peck marks or chiseled hole) 623 galls containing a fly larva, and, therefore, having an exit tunnel. Of these 12% were abandoned without any chiseled hole or extraction of larvae. They also attacked 454 galls containing the smaller, predaceous insects. Of these 34% were abandoned. A chi-square 2 × 2 contingency test ($\chi^2 = 80.52$, $P < 1\%$) showed that the Downy Woodpecker was more likely to peck at and then abandon a gall lacking an exit tunnel than a gall with an exit tunnel.

Predation by Downy Woodpeckers on galls becomes more meaningful to the woodpeckers if they get a large portion of their winter food from the galls. The grid survey of 64 1 m^2 plots in a 1 ha field showed that 27 of 122 galls were opened by April 1981. Since the sample plots comprised .64% of the entire field, about 4200 galls were eaten/ha. Combined with similar fields within 300 m of the suet station, about 5 times as many galls may have been eaten within this distance. Almost all of these galls were attacked between 1 January and 18 April, about 200 galls/day. The fly larvae and the sum of the predaceous larvae are about equally abundant and have an average weight of .023 g. Consequently, the average total weight of larvae eaten was about 5 g/day. However, this was the year with the abrupt February thaw and the subsequent pulse of predation. For a few weeks the predation rate might have provided 15 to 20 g/day. The number of Downy Woodpeckers responsible for this predation is not known. Nonetheless, considering that a Downy Woodpecker weighs 28 g (mean of Cornell Vertebrate Collection), and that just 5 ha of goldenrod field accounted for the estimated gall insect consumption, it seems likely that gall insects are a major winter source of food for the woodpecker during some weeks. This same area was surveyed in late April 1983. After a mild winter, 49% of all galls were attacked (173 out of 353), compared to 22% previously. For the mild winter of 1982–1983 the galls were even more important than in 1980–1981.

DISCUSSION

The variation in predation rate observed at bi-weekly intervals can be explained in part as a consequence of changes in snow cover. Yet in the absence of snow cover, predation rates were observed to vary greatly for no known reason. One possible explanation is that the Downy Woodpecker may feed intensively in one area for one period of time and then move on to another area. In that case, our survey areas could be too small to show the true average rate of predation over a large area. Arguing for the validity of the surveys is the similarity of pattern for the three 1982–1983 surveys, and that the two casual surveys and one intensive survey of 1980–1981 detected a pulse of predation following

a major snow thaw. We assume, then, that our surveys are approximately valid.

This and previous studies have reported quite variable predation intensities by the Downy Woodpecker on the Canadian goldenrod ball gall. Uhler's observations of low predation rates surely result from his sampling in the middle of large fields (pers. comm.). Uhler's observation of 0 to 9% predation and our occasional observation of up to 49% predation all in the Ithaca, New York area, are real and largely due to the woodpecker's reduced predation away from the forest edge. However, Schlicter (1978) reported predation rates that differ from ours for unexplained reasons. She observed 50% of the ball galls attacked by the Black-capped Chickadee in southern Ontario, while we observed less than 1% from many surveys. Schlicter observed Downy Woodpecker predation as much as 100 m away from the forest edge to be about 40% as great as it was close to the forest edge. We never quantified samples 100 m into a field because inspection established that predation rates at this distance were nearly zero. Thus, at two sites in southern Ontario predation by both bird species for one year seems much greater than in the Ithaca area over several years.

Both Moeller and Thogerson (1978) and Schlicter (1978) reported some means of selection of galls by the Downy Woodpecker. We agree with Moeller and Thogerson that selection of large, tall galls would increase the chance of selecting a gall with a fly larva. However, we find Schlicter's speculation that the Downy Woodpecker may tap a gall and then listen for larva movement to be unlikely. We have observed that all larva in the ball galls are very sluggish even at room temperature. The larvae observed in galls opened in the field barely move at all. Our data support another explanation which may be the most significant. Apparently, the Downy Woodpecker selectively avoids galls on which it cannot find an exit tunnel. This greatly increases the probability of abandoning galls that lack the fly and have the smaller parasitic or predaceous insect larvae.

Two aspects of the woodpecker's foraging are likely to improve the rate of food capture. First, larvae are extracted through the exit tunnel with minimal enlargement of the tunnel. Experiments in progress have suggested that this use of the exit tunnel is much faster than pecking a new hole. Second, abandonment of galls when the woodpecker fails to find an exit tunnel decreases the probability that the Downy Woodpecker will spend the time to chisel a new hole only to obtain the smaller insects. Although the Downy Woodpecker does not always find the exit of a fly gall and sometimes chisels new holes in galls with the smaller insects, the Downy Woodpecker tends to improve its foraging rate by the two above strategies.

SUMMARY

Predation by the Downy Woodpecker on insects in galls of Canadian goldenrod at Tompkins County, New York, was intensive for large galls

on tall stems near woody vegetation. The rate of predation and abundance of abandoned fields with goldenrod galls suggest that these gall insects may be a major source of winter food for this woodpecker. The seasonal incidence of predation varies and is partially determined by the presence or absence of snow cover. The Downy Woodpecker selectively uses the exit tunnel prepared by the large fly larva to extract this prey. If the woodpecker fails to find an exit tunnel, the probability of the gall containing one of the smaller parasitic or predaceous insects is increased, and the woodpecker is more likely to abandon such galls without completing a chiseled hole.

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LITERATURE CITED

MILNE, L. J. 1940. Autecology of the goldenrod gall fly. Ecology 21:101–105.

MOELLER, R. K., AND M. K. THOGERSON. 1978. Predation by the Downy Woodpecker on the goldenrod gall fly larva. Iowa Bird Life 48:131–136.

SCHLICTER, L. 1978. Winter predation by Black-capped Chickadees and Downy Woodpeckers on inhabitants of the goldenrod ball gall. Can. Field-Nat. 92:71–74.

UHLER, L. D. 1951. Biology and ecology of the goldenrod gall fly *Eurosta solidaginis* (Fitch). Memoir Cornell University Agricultural Experiment Station, Ithaca, New York 300:1–51.

———. 1961. Mortality of the goldenrod gall fly *Eurosta solidaginis,* in the vicinity of Ithaca, New York. Ecology 42:215–216.

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