FEEDING BEHAVIOR OF DOWNY WOODPECKERS
I. PREFERENCE FOR PAPER BIRCHES AND SEXUAL DIFFERENCES

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THIS report describes how Downy Woodpeckers (*Dendrocopos pubescens*) feed on paper birches (*Betula papyrifera*) more than on any other tree in central New Hampshire, where present observations were made in the vicinity of Lyme throughout the year, but particularly in fall and winter when trees were bare of foliage. The woodpeckers appeared to have been attracted by a coccid, *Xylococculus betulae*, which they extract by a series of pecks that often leave a characteristic trapdoor mark in the bark.

Sexual differences in feeding, noted particularly under winter conditions, appeared to depend on male dominance. I have found no published accounts of these various findings by others, but A. E. Brower of the Maine State Forest Service (pers. comm.) has noted the trapdoor marks, and I am indebted to Alex L. Shigo of the Northeastern Forest Experiment Station of Durham, New Hampshire for contributing further information on the coccid in the course of several field trips. For general accounts of Downy Woodpeckers see Lawrence (1967) and Bent (1939).

Feeding observations were of two types: In Type A I watched individuals for about 5 minutes (see preliminary survey, Table 1) being sure that they pecked or obviously fed for at least 20 seconds rather than just alighting or progressing up a bole or limb. In Type B I followed individual Downy Woodpeckers for periods of 30 to 40 minutes continuously, noting the time spent on each tree as well as on the parts of the trees which, I divided, for convenience, into base, bole, limbs, and branches. Sex and individual head markings (Kilham, 1962) were noted for all feeding Downy Woodpeckers.

FEEDING BEHAVIOR ON PAPER BIRCHES

When feeding on mature paper birches Downy Woodpeckers may alight on the bole, then hitch upward, pecking on all rough, black places in a systematic manner whether these are branch scars, junctures of living branches, cankers, enlarged lenticels, or other defects. Pecking can be as rapid as 130 to 140 pecks per minute. Many pecks are exploratory, which is difficult to determine on thickened bark, but on smooth, white bark one may find a scattering of peck marks leading to a circular cut where a woodpecker has found and extracted a coccid. Pecking is occasionally

mixed with glancing blows and tearing away loose strips of bark that may accumulate on the ground or snow below.

Picking and gleaning is a second method of feeding. It was especially noticeable on warmer days in October and November when Downy Woodpeckers of both sexes might feed on superficial prey in the crowns of paper birches in company with Chickadees (*Parus atricapillus*).

It is difficult to tell whether Downy Woodpeckers are actually feeding when their prey is minute, but with larger prey, such as adult female *Xylococculus betulae*, a woodpecker may make two types of motions that I have watched at close range in an aviary as well as in the field. One is a vibration of the head associated with extremely rapid darting of the tongue; the other is hunching the wings forward and pressing the belly against the bark to prevent bits of prey from falling to the ground.

Aside from the sound of pecking, which carries well on cold days, the fluttering of Downy Woodpeckers against the boles of paper birches often helps one find them. This fluttering, particularly noticeable among females, is due to the smoothness and hardness of the bark; the birds flutter up a bole from one rough spot to another and on arriving at a feeding place often lose their grip, fall free a few inches, and then return.

Importance of Xylococculus betulae.—Downy Woodpeckers doubtless find many species of insects on paper birches, but *Xylococculus betulae* appears to be of special importance most of the year. Hubbard and Pergande (1898) describe the various stages in a life cycle in which the adult female is a comparatively large, 3 mm, orange-red, soft-bodied coccid lying in a layer of white waxy secretions within a small cavity just under the outer bark of paper birches, from where she extrudes a wax tube 3 cm or so in length outward from her anus. The coccids secrete a saccharine "honey dew" from these tubes in warmer months. The bark of a single tree can shelter many coccids. They penetrate the vicinity of buds in higher branches as well as all varieties of rough places, such as lenticels and branch stubs, from the crown to the base. As a female coccid and her attendant larvae grow and develop within outer bark, they may cause it to heave and thus aid Downy Woodpeckers in their search.

Downy Woodpeckers make a series of pecks in a nearly complete circle, then open up the birch bark with glancing blows to expose and extract female coccids. These maneuvers leave a trapdoor mark that remains permanently and becomes somewhat oval and elongate with time. A paper birch may have hundreds of such old marks showing that Downy Woodpeckers have worked on it a number of years.

Xylococculus betulae also infects other tree species including the yellow birch (*Betula lutea*) and beech (*Fagus grandifolia*) (Shigo, 1964). Downy

TABLE 1
TREES FED UPON BY DOWNY WOODPECKERS[1]

Trees	Main observations					Less regular observations	
	Sept.	Oct.	Nov.	Dec.	Jan.	Mar.	May-Aug.
Paper birches	29	28	21	28	22	19	17
Elms (dying)	1	7	7	6	—	—	—
Maple	1	—	—	—	2	16	3
Other	4	7	1	6	4	15	11
TOTAL	35	42	29	40	28	50	31
Per cent on paper birches	83	67	72	70	79	38	55

[1] 4-year survey, 1963–66.

Woodpeckers occasionally feed on these trees in much the same manner as on paper birches (see Tables 1 and 2).

Types of paper birches and local conditions.—I could walk through miles of woodlands in winter months, pass hundreds of healthy paper birches without encountering a single Downy Woodpecker, and then come to a small stand of defective trees where I would hear the pecking of one or more of these woodpeckers within a few minutes. As this experience was repeated not only on successive days, but also in successive years, details of the nature of these defective birches and of local conditions affecting their manner of growth are worth recording.

I divided paper birches for convenience into five categories in relation to their attractiveness to woodpeckers. Of these categories the first two, Grades I and II, were the healthiest, with the whitest bark and the fewest blemishes. These trees were the least attractive to *D. pubescens*. The birches of Grade III, and especially those of Grade IV, were often crooked or leaning, had broken branches in their crowns, and showed other defects such as blackened places from cankers, old wounds, broken branch stubs, healing bands of sapsucker drill-holes, and occasionally the fungus *Poria obliqua*. Grade V paper birches were dying or largely dead. They were seldom visited by Downy but were especially attractive to Hairy Woodpeckers (*D. villosus*).

Local conditions that led to defects were generally recognizable (Table 2). Chief among them were heavy exposure to winds on elevated ridges and, on steep hills and mountain slopes, exposure along with other factors resulting from logging operations described, among others, by Spaulding and MacAloney (1931) and by Hall (1933).

A feature of the paper birches that attracted the Downy Woodpeckers was the number bearing bands of blackened drill holes made by Yellow-bellied Sapsuckers (*Sphyrapicus varius*). Sapsuckers may be attracted to Grade IV paper birches for several reasons discussed elsewhere (Kilham,

1964). One is that birches weakened by various causes may have impaired defense mechanisms, such as might prevent an undue loss of sap, and another that wounded areas act as sinks in concentrating phloem exudate. *Xylococculus betulae* is, from one point of view, a miniature sapsucker—conditions that favor obtaining a maximum of nutrient from the phloem exudate of paper birches being, in all probability, much the same for both animals.

Winter studies in stands of defective paper birches

I made repeated visits to a number of stands of coccid-infested paper birches between 1964 and 1968 (Table 2), the principal phenomena noted being the ecologic conditions that appeared to underly the birches' defectiveness and the persistence with which Downy Woodpeckers fed on them. Several difficulties beset these winter studies—deep snow often made the stands inaccesible and heavy frost sometimes coated limbs and boles on mountain tops, forcing the woodpeckers to feed elsewhere for weeks at a time. Thus I was fortunate to find an area at a lower altitude in 1968 and 1969 where I made the more continuous studies described below.

Boulder Slope.—I found 3 males and 6 female Downy Woodpeckers feeding on paper birches within this stand of approximately one hectare in the winter of 1967–1968 and, although I seldom saw all 9 of these individuals in any one of 20 visits, I frequently encountered 5 or 6 of them on a single day (Table 2). The same individuals were often found in the same groups of birches. This suggestion of territorial behavior was marked by occasional conflicts such as the following:

On 18 January 1968 at 15:45 Female A (FA) flew 50 meters to attack Female C (FC) on their common boundary. The 2 females circled around a tree trunk toward the ground. FC did a bill-waving dance (Kilham, 1962), then flew at FA who left. I heard a "chirr" note when the two were in conflict. A more prolonged type of conflict took place between Male A (MA) and a rival in a snow flurry on 10 February 1968. Two males fought on trunks of small saplings along their common border from 7:20 to 7:35. They were often within 18 cm of each other in their bouts of bill-waving dances as well as in intermittent pauses of motionless resting.

The territory of FC was of special interest. As described above for 18 January, she defended a concentration of paper birches on a knoll that appeared to offer the best feeding conditions of the entire area, as I could often find as many as five Downy Woodpeckers working in its close vicinity. To my surprise these trees received almost no attention from the woodpeckers in the following year, and I wondered whether intensive feed-

TABLE 2
SAMPLES OF SINGLE DAY OBSERVATIONS ON DOWNY WOODPECKERS

Special area	Temp.	Number and sex feeding on: Paper birches M	F	Other trees	Date	Hours	Conditions weakening paper birches
Moose Mountain	20°F	4	3	None	5 Jan. 1966	13:30–16:15	Steep slope; lumbered and exposed to wind
Winslow	40°F	1	3	None	24 Oct. 1968	16:35–16:55	Steep slope; lumbered and exposed to wind
Holt's Ledge	0°F	3	3	None	30 Dec. 1967	08:00–10:00	Hill top exposed to wind
Holt's Ledge	45°F	4[1]	3[1]	None	3 Nov. 1968	07:30–11:00	Hill top exposed to wind
Boulder Slope	28°F	2	2	1 male, yellow birch	19 Mar. 1967	11:00–11:20	Excessive rocks and boulders
Boulder Slope	20°F	3	4	1 male, yellow birch; beech	6 Jan. 1968	15:00–16:00	Excessive rocks and boulders
Boulder Slope	32°F	3	3	None	27 Jan. 1968	15:00–16:00	Excessive rocks and boulders
Boulder Slope	2°F	2	3	None	11 Feb. 1968	07:30–09:00	Excessive rocks and boulders
Boulder Slope	0°	1	2	None	4 Jan. 1969	07:20–08:00	Excessive rocks and boulders

[1] Feeding in crowns of paper birches mostly by picking and gleaning.

ing by Downy Woodpeckers could largely eliminate a nonbreeding winter insect population such as these coccids from certain groups of trees.

I encountered fewer Downy Woodpeckers in the Boulder Slope area in the winter of 1968–69, when there appeared to be fewer coccids, but I did see nearly all of the same nine individual woodpeckers noted the year before and of these the two almost always present were the members of Pair A, whose activities are described in detail below.

Sexual Differences in Feeding Behavior of Pair A

I followed the activities of individual Downy Woodpeckers for periods of 30 to 40 minutes on various days in January, February, and March 1969, noting the relations of the birds with each other and with the parts of trees on which they fed, as shown in Tables 2 and 3. Among favorable circumstances were: (1) the woodpeckers did little else throughout the day except feed on paper birches; (2) after leaving one paper birch they usually flew to an adjacent one; and (3) the members of one pair, FA and MA, which remained together through two successive winters, fed much of the time when no more than 20 m apart and I could thus follow the activities of both simultaneously. In 7 years of winter observations these were the only Downy Woodpeckers that I found traveling consistently as a pair. Two factors appeared to contribute to their close association: (1) their winter territory was also their spring-summer breeding territory in 1968, and (2) it contained many coccid-infected paper birches. They were thus not forced to wander as single individuals in order to find sufficient food in winter, which, so far as I have observed, is the more usual situation among Downy Woodpeckers in central New Hampshire.

Parts of trees fed upon.—Table 3 shows MA fed on the upper bole, limbs, and branches of paper birches, and FA fed on main and lower parts. A typical pattern was for MA to progress up the bole into the crown of a birch, move out along a branch, often while clinging upside down, until he neared the end, then to drop to another branch. He was apt to choose the largest and tallest paper birches or, if he worked on the bole, those most blackened by defects. FA, on the other hand, fed primarily on the mid-third of the boles of paper birches. Here smoother bark made clinging difficult so that she often fluttered in progressing from one rough, blackened spot to another. She occasionally failed to establish a grip and fell free. This led to more fluttering, which I came to regard as a characteristic feature of her behavior. MA rarely fluttered apparently because he fed on paper birches with rougher bark as well as on smaller branches where he could cling more securely. I was not sure what factors led MA to occupy the upper portions of the birches. Both MA and FA pecked steadily and

TABLE 3

RECORDS OF INDIVIDUAL DOWNY WOODPECKERS FEEDING ON THE BOULDER SLOPE

Individuals and dates observed	Paper birches		Parts of birches fed upon							Duration of observation (min)
	No. visited	Max. time on any one	Base	Mid ⅓ of bole	Top ⅓ of bole	Limbs	Branches, twigs, crown	Other tree species	Supplanting attacks by male	
MA 27 Jan.	6	10 min	0	0	0	+[1]	+	None		40
FA 28 Jan.	17	12 min	++	++	0	0	0	None	One at start of period	35
FA 6 Feb.	4	14 min	0	++++	0	0	0	None	One at end of period	33
[2] MA 8 Feb.	7	8 min	0	0	+	+	++	None	One	20
[2] FA 8 Feb.	6	15 min	0	++++	0	0	0	None		40
MA 9 Feb.	9	15 min	0	0	+	+	++	None	4 in 7 min on first arrival of MA	33
FA 9 Feb.	8	20 min	0	+++	+	0	0	3 yellow birches (a min each)		40
MA 11 Feb.	4	15 min	0	0	+	+	++	None	None	30
FA 11 Feb.	4	12 min	0	+++	+	0	0	None		30
MA 16 Feb.	5	20 min	0	0	++	+	+	None	One at start of period	30
FA 16 Feb.	8	5 min	0	++++	0	0	0	3 yellow birches (total 12 min)		30
MB 8 Mar.	12	8 min	++++	0	0	0	0	None	Intruder in territory A	30

[1] + to ++++ represent relative amounts of time spent on part of tree indicated.
[2] Brackets indicate simultaneous observations made on MA and FA.

appeared to find food at an equal rate. If he preferred the upper parts and smaller branches for feeding, as he apparently did for he was the dominant partner, it could have been for other reasons. He may, for example, have found the clinging better, or felt a greater sense of dominance when higher up.

Relation of height of feeding on paper birches to male dominance.—Supplanting attacks by males on females are more frequent among Downy Woodpeckers at whatever time of year members of a pair travel together than among other species of woodpeckers I have observed. MA, for example, flew at FA at least once an hour, and frequently at lesser intervals in January and February. FA's usual reaction to one of MA's attacks was to drop away from her feeding place and fly to an adjacent tree. MA, on alighting where she had been, usually pecked briefly and then moved on to feed at a higher level on the same or another paper birch. Thus on most occasions little indicated that his motive was simply to displace his mate from an especially favorable feeding place; rather he appeared to be keeping his mate down to a lower level on feeding trees as a way of asserting dominance. On 9 February 1969, for example, I followed FA as she worked unusually high in several paper birches early in the day before MA arrived. MA flew toward her at 7:42, alighted on a tree close to hers, then made four supplanting attacks in the next 7 minutes. After these attacks FA worked within 1 to 3 m above the snow on three yellow birches, trees on which MA almost never fed, then returned to her usual habit of feeding on the middle or lower thirds of successive paper birches. Her behavior following attacks was even more striking on 28 February. On this occasion she fed at the bases of seven paper birches in succession after being supplanted by MA, even going below the snow surface in wells formed around the trunks by the action of wind and sun.

I never saw MA feed at the base of paper birches in the manner of FA. I was therefore surprised on 8 March to follow a second male, MB, as he fed for 30 minutes entirely at the bases of 12 paper birches in succession. All of these trees were within Territory A. My interpretation was that intruder MB was occupying a subordinate position. A sense that he was vulnerable to attack may have led him to stay low on the birches, where he might escape the notice of the owner, MA. MA and his mate were at the opposite side of their territory from MB at the time and seemingly unaware of the intrusion. The behavior of a single female F2 on 21 March was the opposite extreme. I found her feeding almost entirely on the topmost branches on paper birches as she moved from one to another, well outside the territory of Pair A. I thus came to feel that dominance, whether sexual or territorial, had much to do with the feeding behavior of the birds in-

volved, and that if one were to study Downy Woodpeckers casually and on miscellaneous trees, one might miss the fact that sexual differences in feeding habits can occur among them.

COMPARISONS WITH OTHER *DENDROCOPOS* SPECIES

Hairy and Downy Woodpeckers differ in the time of onset as well as in the pattern of their courtship, and these differences may be related to types of prey sought and to the number of daylight hours needed to secure it in winter. Incidents leading to this concept were as follows:

A pair of Hairy Woodpeckers that roosted, spent two winters, and nested on the Boulder Slope began courtship behavior in late December in the shortest days of the year and reached a crescendo of duets of drumming, exchanges of intimate notes, search for potential nest sites, and pseudo-copulations in February, as described elsewhere for other pairs (Kilham, 1966). Their behavior settled into a quiet phase in late March when they became difficult to locate because of a near absence of drumming. It is of interest that White-breasted Nuthatches (*Sitta carolinensis*) carry on lively courtship in winter months and go through a similar quiet phase later on; possibly one explanation may hold for both species. Winter courtship activities doubtless consume physical and emotional energy, but by March the members of pairs of both Hairy Woodpeckers and nuthatches alike have largely adjusted to their mates and to their breeding territories. The quiet phase may thus be one of building up reserves for the period of actual nesting beginning in late April.

As Table 4 shows, the early breeding behavior of Downy Woodpeckers begins more or less abruptly with the first warm days in March, 3 months later than that of Hairy Woodpeckers. This divergence in timing of the two sympatric species of *Dendrocopos* may be explained by the differences in their feeding habits. Downy Woodpeckers feed on paper birches and other trees in winter in what, to a human observer, is a monotonous fashion, as though finding and extracting minute prey left them little time for extraneous activities. Hairy Woodpeckers and White-breasted Nuthatches, on the other hand, have winter food supplies of such a nature that feeding takes only a portion of their time, leaving them several hours a day for courtship activities. With White-breasted Nuthatches the main food supply consists of acorns and other stores gathered in the preceding fall while both male and female Hairy Woodpeckers (Kilham, 1965) subsist primarily on larvae of wood-boring beetles (*Scolytidae, Buprestidae,* etc.) which, requiring a year or more to develop, are relatively large and rewarding in a nutritive sense compared to the time spent in finding and extracting them from dead or drying wood.

TABLE 4

RELATIONS OF WINTER FEEDING TO EARLY BREEDING BEHAVIOR IN HAIRY AND DOWNY WOODPECKERS[1]

Features of behavior compared	*D. pubescens*	*D. villosus*
Sexual differences in feeding behavior:		
Nature of	Facultative (both sexes may feed same manner when alone)	Operative at essentially all times
Dependent on	Male dominance	Differences in bill length plus innate behavior
Effects on pair bond	Divisive: M and F mutually repellent much of time	Prolonged courtship; close pair bond
Winter economy:		
Methods of feeding	Pecking	M, excavates deep in wood; F, more superficial, scaling bark, etc.
Type and location of prey	Minute: within bark of living trees	Comparatively large wood-boring larvae. Dead and dying trees
Per cent of daytime needed to seek prey	$\bar{c}$ 95 per cent	$\bar{c}$ 75 per cent
Effect on onset of breeding behavior	Precludes all time needed to find sufficient prey	Promotes margin of leisure for courtship, etc.
Change with spring:		
Breeding behavior	Abrupt onset with warm days	Quiet phase; main prenesting problems of territory, nest site, pair formation settled
Food economy	Picking and gleaning of newly emerging insect populations	Methods of foraging as in winter, new sources of prey as logs, etc. uncovered as snow melts

[1] For details, see text.

Ligon (1968) describes a type of sexual difference in Red-cockaded Woodpeckers (*D. borealis*) feeding on pines in Florida that is surprisingly similar to what I have noted for Downy Woodpeckers feeding on paper birches in New Hampshire. According to Ligon males of *D. borealis* feed primarily on the upper branches of the pines, whereas the females feed on the main trunks lower down. Females of *D. borealis* may fall free from the trunks and then regain their footholds, a behavior pattern similar to what I have termed fluttering in *D. pubescens* females. The two species are also alike in a number of other attributes. Both feed on superficial prey on living trees and have bills and bodies of approximately the same dimensions in both sexes. In contrast to the Downy, the Red-cockaded Woodpecker is a stenotopic species, living in a relatively uniform environment of coastal plain pines and traveling about in small social groups throughout the year. Downy Woodpeckers are eurytopic and usually travel alone. Sexual differences appear among them only in special situations such as I have described for paper birches in winter or in other months when the members of a pair are feeding together on the same types of prey. The sexual feeding differences in both these *Dendrocopos* species may depend on male dominance. In the case of *D. pubescens* this is asserted by the male's relatively frequent supplanting attacks on the female. As I have no evidence that feeding is better at higher levels than lower down, I believe that males prefer to feed at higher levels than females partly as a manifestation of their dominance.

Selander (1966) stresses that the survival value of sexual differences in feeding behavior may well be in a more effective utilization of niches. Other factors may be operative as well, and I have wondered whether the feeding habits of woodpeckers are not closely related to their entire ways of life. I suggest that the development of a prolonged courtship and an intimate pair bond in some species such as *D. villosus*, while others like *D. pubescens* have a short courtship and a looser pair bond, may result from their basically different methods of feeding.

The subject of the food economy of a species in relation to the totality of its behavior is obviously complex. One approach to the problem is to concentrate on special situations, as I have done in the cases of Yellow-bellied Sapsuckers feeding on wounded paper birches and other trees (Kilham, 1964), of Hairy Woodpeckers feeding on elms dying of the Dutch Elm disease (Kilham, 1965), and of present studies of Downy Woodpeckers feeding on trees infected with *Xylococculus betulae*.

CONCLUSIONS AND SUMMARY

A survey of the year around feeding habits of Downy Woodpeckers between 1963 and 1966 revealed that these woodpeckers are attracted to

paper birches more than to other trees in central New Hampshire, apparently by a coccid *Xylococculus betulae,* which they remove by pecking a circular opening in the bark.

The territorial, breeding, and other behavior of Downy Woodpeckers coming to localized stands of coccid-infected paper birches in cold weather months can be summarized as follows:

1. The Downy Woodpeckers worked steadily, pecking on paper birches throughout the day, spending less than 5 per cent of their time on other tree species, and doing little else in the way of preening or other activities from December until late in March.

2. The members of one pair (Pair A) were unusual in being together through two successive winters and in defending a territory that included many coccid-infected birches. Most individuals observed in winter months were single birds that sometimes defended smaller groups of trees.

3. When the two members of Pair A were followed with timed observation over a total of 22 hours in January, February, and early March, 1969, they were found to exhibit constant and well-marked sexual differences in which the female (FA) fed on the bark of the middle and lower portions of the bole down to the snowline while her mate (MA) nearly always fed on the top third of paper birches on both bole and smaller branches. These differences appeared to result from a dominance of the male and were maintained by supplanting attacks on the female.

4. The fact that a neighboring male fed at the bases of paper birches when trespassing in Territory A, suggested that dominance is territorial as well as sexual.

5. Concomitant and other observations made on Hairy Woodpeckers has led to any hypothesis that the patterns of breeding behavior and their times of onset, whether at the beginning of winter as for *D. villosus* or at the end of it as for *D. pubescens* may be closely related to and have even evolved from feeding behavior patterns.

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