each sex, growth curve shape should not vary between groups from different breeding locations. Under these conditions, however, differences in asymptotic size could still be expressed between the sexes and could be evaluated in a straightforward manner.

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Effect of snow cover on starling activity and foraging patterns.—Winter is often a time of high mortality for temperate bird populations (Dunnett 1956, Gibb 1960). Low food availability may be worsened by periods of prolonged snow cover (Hamilton 1949). Moreover, a bird must be able to acquire more food during the short winter day than at any other time to maintain its body weight; lighter birds suffer significantly higher mortality than their heavier conspecifics (Kendeigh 1934).

TABLE 1

ACTIVITIES AND FOOD SOURCES USED BY FLOCKS OF STARLINGS ON 10 SNOWLESS DAYS
AND 10 DAYS OF COMPLETE SNOW COVER

Ground condition	Activity				Food source			
	Foraging	Flying	Loafing	Total	Grasses and lawns	Agri-cultural fields	Human-generated	Fruit trees
Snow-covered	114 (21)[a]	171 (31)	265 (48)	550	16 (14)[b]	4 (4)	88 (77)	5 (4)
Snowless	214 (36)	107 (18)	281 (46)	602	94 (43)	24 (11)	88 (42)	6 (3)

[a] Percent of all flocks.
[b] Percent of foraging flocks.

Many temperate European Starlings (*Sturnus vulgaris*) are able to maintain normal body weight in winter (Dunnett 1956), and populations apparently suffer little mortality even during severe winters (Coulson 1960). Starlings are especially capable of exploiting human-generated foods (e.g., feedlots, handouts) during winter. For example, Hamilton (1949) reported an increased reliance on these food sources by starlings after a single snowfall. Such opportunism might account for the starling's success in winter. Here I describe changes in the activity patterns and food sources used by starlings after a series of snowfalls.

Methods. — I established two circular 300-km² study areas in central New Jersey. Franklin, in Middlesex County, was mainly urban-suburban with little agriculture. Adelphia, about 40 km SSE of Franklin in Monmouth County, was predominantly rural-agricultural with large wooded tracts. Roadside censuses were conducted along 50-km established routes in each area. Censuses began within 30 min after sunrise and lasted approximately 3 h. At the start of each census, I recorded temperature, snow depth, and wind velocity. I drove at an average speed of 30 km/h and recorded all starling flocks (one or more birds), using three categories of activity: foraging, flying, and "loafing." The latter category included sitting, preening, and displaying. Censuses were taken both the day before and the day after a snowfall that completely covered the ground (mean snow depth: 10 ± 4 cm; range = 6–20 cm). Snowfalls in central New Jersey are generally widespread. Ten of these paired observations were made between December and April, with not more than one pair per week.

I measured invertebrate density in grasses and grain density in harvested corn and soybean fields (Maccarone 1985). These habitats are used extensively by starlings in central New Jersey (Fischl 1983). In each area, three lawns and three of both types of crop field were sampled every two weeks before the first snow cover in late December. I determined land cover types by physical inspection of 500 random points in each area.

Results. — A total of 550 starling flocks was observed during 10 days of complete snow cover, and 602 flocks were observed on 10 snowless days (square root transformation, $t = 0.69$, df = 18, $P > 0.10$). There was, however, a significant effect of ground cover condition on activity ($\chi^2 = 41.32$, df = 2, $P < 0.001$) (Table 1). A greater proportion of flocks foraged during censuses taken on snowless days than did flocks censused on days of snow cover (Wilcoxon, T = 8, df = 10, $P < 0.05$). There was no difference between ground cover conditions in the proportions of flock flying or loafing.

Food sources used by starlings also differed between days of snow cover and snowless days ($\chi^2 = 43.23$, df = 3, $P < 0.001$) (Table 1). The same number of flocks (88) used human-generated food sources during both ground conditions; however, that number comprised

77% of all foraging flocks (71% of all birds) on snow days but only 42% of all foraging flocks (19% of all birds) on snowless days (Wilcoxin, T = 0, df = 10, $P < 0.001$). The size of flocks using human-generated foods did not differ between snow (7.0 ± 7.0 [SD]) and snowless (6.5 ± 7.3) days.

Flocks foraging on grasses on snowless (17.1 ± 25.6) and snow (5.8 ± 5.3) days did not differ. Those few flocks using grasses during snow days were observed on the leeward side of buildings and windrows. Flocks using fruit-bearing trees were larger on snowless (17.1 ± 13.1) than on snow (3.4 ± 0.9) days ($t = 2.31$, df = 11, $P < 0.05$), while those in crop fields were similar on snow (31.2 ± 11.8) and snowless (31.9 ± 40.2) days.

Mean ambient temperature at the start of censuses taken on snow days was −2.2 ± 2.6°C, and −3.2 ± 2.3°C on snowless days. In neither ground cover condition was ambient temperature correlated with the proportion of all flocks observed foraging, or the proportion of foraging flocks using commensal foods. Mean wind velocity did not differ between snow (16 ± 8 km/h) and snowless (16 ± 10 km/h) days, and it was not correlated with activity or use of food sources in either ground cover condition.

Invertebrates in grasses and grain in harvested crop fields were still abundant by early winter. In December, shortly before the first snowfall, the density of lawn invertebrates (> 5 mm long) was 15 ± 31 individuals/m². This included mainly beetle larvae and other arthropods. Soybean density was 80 ± 30 soybeans/m², and kernel density was 42 ± 48 kernels/m². Grasses, soybean fields, and corn fields together accounted for 35% of the combined Franklin and Adelphia surface area and were used by 55% of foraging flocks when the ground was clear. After complete snow cover, only 17% of all foraging flocks used these same substrates.

Discussion.—The sharp decrease in the number of foraging flocks suggests that starlings had a more difficult time finding food after a snowfall. Feeding activity appeared to be somewhat less affected by wind velocity and ambient temperature, neither of which differed with ground cover conditions.

The most apparent change was the twofold increase in the proportion of foraging flocks using human-generated foods. A similar proportionate increase was found by Hamilton (1949). Compared to that study, however, reliance on human-generated foods in the present study was substantially higher on both snowless and snow-covered ground. It is possible that increased urbanization may provide additional opportunities for starlings.

The aggression often observed among foraging birds at human-generated food sources may explain why the number of flocks using these sources did not change after a snowfall, despite an increase in proportionate use. Garbage pails and food scraps are more readily defended than more homogeneously distributed foods, and aggression may limit access (Stokes 1962). Proportionate use of human-generated foods by starlings is highest in winter (Maccarone 1985), and these sources may be defended during this season even when the ground is clear. Many birds that did not compete successfully at dumpsters and feedlots may have loafed (conserving energy while waiting for a better opportunity) or moved elsewhere to forage.

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Agonistic communication among wintering Purple Finches.—Agonistic displays traditionally have been viewed as exchanging information on the motivations and intentions of the signaler (Dawkins and Krebs 1978, but see Hinde 1981). Dawkins and Krebs (1978) argue there is no apparent advantage to an individual involved in a conflict to reveal its intentions or motivations. An individual may benefit most by lying about its intentions in order to deceive its opponent. This has led to the hypothesis that no true information should be communicated by agonistic signals. Other workers have retained a traditional view and argue that agonistic displays do communicate information and that individuals should have the ability to detect lying (Rhijin 1980, Hinde 1981).

Studies of agonistic communication have not provided complete support for either viewpoint. In reanalyzing data from 3 earlier studies, Caryl (1979) concluded there was no evidence that signalers revealed their intentions during agonistic displays. Other recent studies have reached the conclusion that agonistic displays *do* communicate the intentions (Bossema and Burgler 1980, Nelson 1984) or relative fighting abilities (Clutton-Brock and Albon 1979, Evans 1985) of the signaler. This study reports on information transfer during agonistic communication among Purple Finches (*Carpodacus purpureus*) in winter flocks. I describe the agonistic displays of the Purple Finch and the general course of agonistic encounters, and ask the following questions: (1) Do responses to signals vary with the type of display given? (2) Do displays predict the signalers' next acts? (3) Do winners and losers differ in their use of displays?

Methods.—Aggressive encounters were videotaped at a feeder at Elkhart Lake, Sheboygan County, Wisconsin, in January 1985. The Purple Finch is an irregular winter resident at the study site, and the finches came to the feeder in flocks of approximately 10–20 birds. A Panasonic video camera (Model WV-3400) was concealed in an enclosure 3 m from the feeder. All videotaping was done between 07:00 and 11:00 CST. The feeder, stocked with a mixture of thistle and small black sunflower seeds, was 1.5 m off the ground and had a 7 × 25 cm platform from which the finches could feed. The American Goldfinch (*Carduelis tristis*) was the only other species that visited the feeder regularly.

Finches fed on the platform, and aggressive encounters occurred over access to the seeds.