wind. An adult California Gull (*Larus californicus*) was flying east 5 m above the water, 50 m from the shore, close to 150 Barn Swallows (*Hirundo rustica*) that were foraging low over the water. One swallow, heading west, passed 1 m below the gull, which dropped suddenly and caught the swallow with its bill, glided for a few meters and settled on the water. The gull proceeded to manipulate the swallow in its bill for 30 sec before swallowing the still moving bird head first. The gull sat on the water for 20 min, then continued its flight to the east.

Most reports of adult birds being taken by gulls have occurred while the prey were on land or water, e.g., Manx Shearwater (*Puffinus puffinus*) and Common Puffins (*Fratercula arctica*) in nesting colonies as they go to and from their burrows (Harris 1965), sick or injured birds up to the size of geese (Witherby 1948), Rock Doves (*Columba livia*) (Jyrkkanen 1975) and Eurasian Starlings (*Sturnus vulgaris*) (Drost 1958) at grain piles and ground-dwelling birds which associate with gulls (e.g., Witherby 1948). Gull predation of adult birds on water is much rarer but does occur (Hafft, Condor 73:253, 1971).

Attacks and capture of avian prey on the wing has rarely been reported and generally occurs over sea on migration (Drost 1958). Bannerman (1962) reports Herring Gulls (*L. argentatus*) capturing and eating Redwings (*Turdus musicus*) and Eurasian Blackbirds (*T. merula*) as they migrate over water by knocking the weary birds into the water.

The present account of gull predation on a Barn Swallow, while not a new method of capturing prey as evidenced by gulls catching flying insects, it is the first report of avian prey being captured in this manner.—STEPHEN A. LAYMON, *Dept. Forestry and Resource Management, Univ. California at Berkeley, Berkeley, California 94720.* *Accepted 15 Oct. 1982.*

Wilson Bull., 95(2), 1983, pp. 297–303

Factors affecting feeding and brooding of Brown Thrasher nestlings.—The nestling period is a particularly stressful time in the lives of birds. In altricial species, the time and energy demands upon parent birds are great and are related to the requirements of their offspring and to environmental factors affecting the adults. Recently, many studies have examined nestling growth and energetics (e.g., Ricklefs, Ibis 115:177–201, 1973; Ricklefs, Publ. Nuttall Ornithol. Club 15:152–292, 1974; O'Connor, Symp. Zool. Soc. Lond. 35:277–306, 1975; O'Connor, J. Zool. Lond. 185:147–172, 1978). Most studies of parental behavior are of cavity-nesting species, probably because of the relative ease of collecting observational data at nest boxes (e.g., Kluyver, Ardea 38:99–135, 1950; Kessel, Am. Midl. Nat. 58:257–331, 1957; Pinkowski, Wilson Bull. 90:84–98, 1978; Walsh, Wilson Bull. 90:248–260, 1978). In contrast, fewer researchers have quantified factors affecting parental care in open-nesting passerines. In our study, patterns of feeding and nest attendance during the nestling period were observed in male and female Brown Thrashers (*Toxostoma rufum*) in relation to nestling age, time of day, and weather.

Study area and methods.—The study was conducted near Ames, Story Co., Iowa during May–July 1978 on a 15-ha pasture used for grazing cattle. The vegetation was a mixture of woodland and shrub habitat (67%), interspersed with grassland (26%). A stream (7%) meandered through the hilly, lightly grazed range.

Feeding frequencies and nest attendance (time spent brooding and shading) were recorded at four nests with brood sizes of two, three, four, and five young, respectively. Before hatch a portable blind was set up about 20 m from the nest, and a small mirror (10-cm diameter) was positioned above the nest to facilitate watching its contents with 20 × 60 binoculars. Observations began as soon after hatch as possible and continued throughout the nestling period. Each brood was watched daily in alternate 3-h shifts; dawn to 09:00, 09:00–12:00, 12:00–15:00, 15:00–18:00, and 18:00 to dusk. Thus, all daylight hours were sampled every 2 days; broods were observed an average of 68 h each. One adult at each nest was captured during the incubation period by using a mist net and marked with colored leg bands and a spot of paint on the head. Sex was determined by examining the incubation patch; females had no feathers in the patch, whereas males had a few. Females also had thicker, more vascularized skin in the patch than did males. Individual nestlings were identified by painting the top of the bill with colored enamel (Best, Wilson Bull. 89:625–627, 1977a). Ages of nestlings were divided into 24-h intervals beginning at the time of hatch (0–24 h = 0 day old, 25–48 h = 1 day old, etc.).

Brooding and shading behaviors were distinguished because they evidently serve opposite functions. Brooding occurred when the adult settled down on the nestlings and presumably provided them with heat. During shading, the adult perched on the nest rim with wings slightly spread over the young, protecting them from direct sunlight and possible overheating. (Occasionally adults shaded when no sunlight struck the nest directly.) The percentage of the nest bowl naturally exposed to direct sunlight during 30-min periods was estimated as 0, 1–25, 26–50, or 51–75%. Temperature was monitored hourly. Rainfall was categorized on the basis of its intensity and duration during 30-min intervals: none, light rain <50% of the time, heavy <50%, light ≥50% and heavy <50%, heavy ≥50% and light <50%, and heavy 100%.

Results and discussion.—Both male and female adult Brown Thrashers incubate the eggs (males about 29% and females 71% of the time) (Erwin, J. Tenn. Acad. Sci. 10:179–204, 1935; Partin, Breeding Biology and Behavior of the Brown Thrasher (*Toxostoma rufum*), Ph.D. diss., Ohio State Univ., Columbus, Ohio, 1977) and care for their young. The relative contribution by each sex in feeding the nestlings varied among broods. In three of the four pairs observed, males fed the young significantly more frequently than females over the nestling period (63% vs 37%, respectively; $\chi^2 = 101.8$, df = 1, N = 1404 feeding trips, $P < 0.01$). At the fourth nest, the male fed significantly less than the female (44% vs 56%, respectively; $\chi^2 = 6.6$, df = 1, N = 397, $P < 0.05$). According to previous studies, female Brown Thrashers generally feed the young more often than males (Gabrielson, Wilson Bull. 24:65–94, 1912; Erwin 1935; Partin 1977). Three males also aided females in brooding the young. The male that did not brood was also the male that fed less than his mate, indicating some variability among individual thrashers and pairs in these behaviors.

Brooding, shading, and feeding of nestlings were related to nestling age, time of day, and certain weather factors. The sample size was inadequate to test for brood-size effects, although they have been documented in other species (e.g., Royama, Ibis 108:313–347, 1966; Mertens, Ibis 111:11–16, 1969; Walsh 1978; Johnson and Best, Auk 99:148–156, 1982).

During the first 2 days after hatch, the adults spent a relatively large percentage of their time brooding the young, but nest attendance had declined to a low and constant level once the nestlings were 5 days old (Fig. 1; see also Partin 1977). Frequency of feedings by both parents increased with nestling age up to 6 days, then leveled off. The increased energy requirement and reduced need for protection against inclement weather as nestlings grew older resulted in an inverse relationship between feeding frequency and nest attendance, but the relationship was significant only for female parents (females: r [Pearson product-moment] = −0.26, N = 581, $P < 0.01$; males: $r = -0.08$, $P < 0.10$). Several passerines exhibit a similar pattern of adult feeding and attendance behavior during nestling development (for reviews, see Kendeigh, Ill. Biol. Monogr. 22, 1952; Skutch, Parent Birds and Their Young, Univ. Texas Press, Austin, Texas, 1976).

Brooding comprised most of the time spent in nest attendance (Fig. 1). The pattern of change in brooding time with nestling age was the same for all three males that brooded.

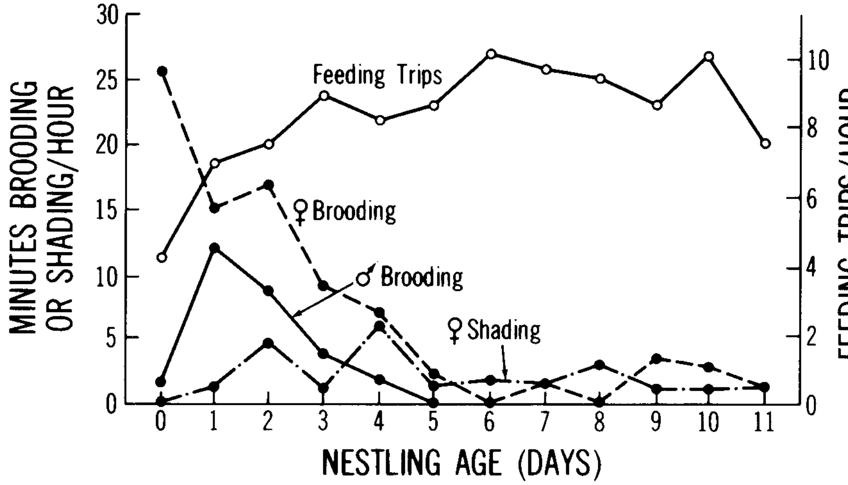

FIG. 1. Average time during the day female Brown Thrashers spent brooding or shading and attentive males spent brooding, and mean number of nestling feedings per h by both parents in relation to nestling age.

That males spent noticeably less time brooding than females on the day of hatching (0 day old) could be an extension of the difference between the sexes with respect to incubation behavior; the eggs hatch asynchronously, thus, while the first hatchlings are being brooded, the yet unhatched eggs are being incubated. The decline in time spent brooding by males after day 1 paralleled that of females and probably was linked with the development of endothermy in the nestlings (Dunn, Condor 77:288–293, 1975). Males ceased to brood by the time the young were 6 days old, and daytime brooding by females occurred only during rain and/or in the early morning and late evening when temperatures fell below 20°C. Nestlings were brooded at least part of the night until fledging (the females were almost always on the nest at dusk and at dawn).

All four males shaded their nestlings until they were about 6 days old, although time spent shading by males was negligible (less than 5% of the total time) compared with that of females. Shading behavior was apparently related to the amount of sunlight on the nest and to ambient temperature rather than to nestling age (see discussion on weather effects).

Only the first 6 days of the nestling period were included in the analysis of nest attendance relative to time of day. After that, only the female brooded and shaded the young; these behaviors accounted for very little of her time.

Females brooded most in early morning (06:00–07:00) when ambient temperature was lowest (Fig. 2). Then brooding rate by females dropped to its lowest level for the day, even though temperatures were still relatively cool. All four females showed this pattern. After fasting all night and spending a relatively large amount of time in the first few daylight hours brooding and feeding the young, females may require a relatively long feeding bout to replenish their depleted energy reserves. Brooding by males seemed unrelated to time of day or weather patterns associated with time of day.

Shading behavior peaked abruptly between 12:00 and 15:00, when ambient temperature and light intensity reached their daily highs (see also Best, Auk 94:308–319, 1977b; Fischer,

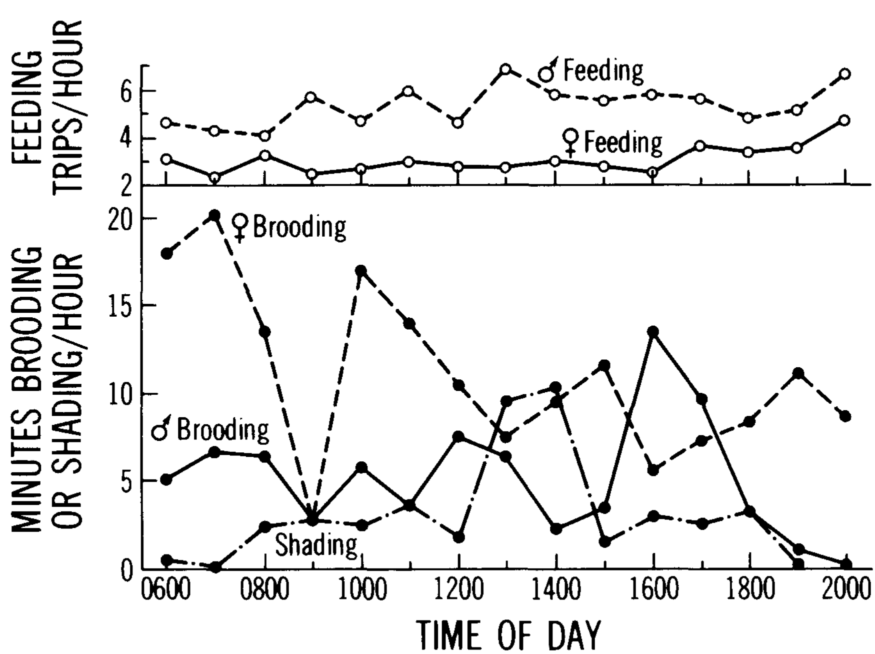

FIG. 2. Average feeding frequency and nest attendance by adult Brown Thrashers relative to time of day.

Comparative Ecology of the Thrashers, *Toxostoma,* of South Texas, M.S. thesis, Texas A & M Univ., College Station, Texas, 1979; Johnson and Best 1982).

Several investigators have related diurnal changes in nest attendance to ambient temperature rather than to time of day as such (e.g., Fautin, Wilson Bull. 53:107–122, 1941; Cox, Wilson Bull. 72:5–28, 1960; Weeden, Auk 83:368–388, 1966; Skutch 1976). In several species, in which only females brood, time spent brooding declines steadily as temperature increases, reaches a low point in the afternoon, then sometimes rises in the evening (e.g., Kendeigh 1952:74; Cox 1960; Nolan, Ornithol. Monogr. 26, 1978; Johnson and Best 1982). When data from the entire nestling period were included in the analysis, Brown Thrashers also seemed to loosely follow this pattern. During the last half of the nestling period brooding by females was confined almost entirely to early morning and early evening.

Time of day evidently had little effect on how frequently nestlings were fed by either adult (Fig. 2), even though brooding and shading by both adults fluctuated widely so that they did not have the same amount of time available each hour for feeding trips. In contrast, other authors have found that overall feeding rates vary with time of day (Kluyver 1950, Kessel 1957, Cox 1960, Best 1977b, Pinkowski 1978). These diurnal changes have been related to the amount of time the female spends brooding and to the increased begging intensity of young immediately before and after their overnight fast.

Rainfall also influenced behavior of both adults. Mean time spent brooding by females increased steadily as rainfall intensity and duration increased; however, sample sizes for the individual rainfall classes were small. Females brooded an average of 4 of 30 min with no

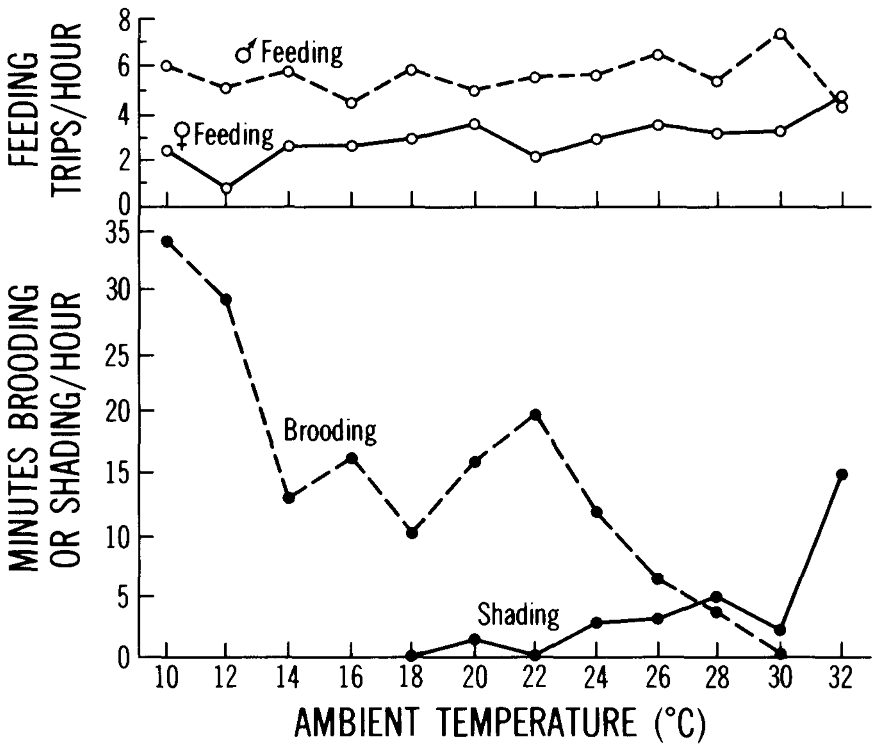

FIG. 3. Feeding trips by male and female Brown Thrashers and average time spent brooding and shading by both adults in relation to ambient temperature. (Hourly periods with rain were excluded from this analysis.)

rain and increased brooding to 28 of 30 min during continuous heavy rain. Brooding by males during a rainstorm was rare; if the male was at the nest when rain began, he usually brooded the young but almost always was relieved immediately by the female (see also Partin 1977).

Female feeding frequencies decreased as rainfall increased. When rain lasted less than 50% of the time during the 30-min intervals, feeding trips per 30 min averaged 1.6, but when rain occurred more than 50% of the time, only 0.3 feeding trip per 30 min was made. No feeding occurred during continuous heavy rain. Male feeding rates varied widely among the rainfall classes, possibly because of small sample sizes. Rainfall has a strong depressing effect on feeding rates in other species (Kluyver 1950; Gibb, Ibis 92:507–539, 1955; Johnson and Best 1982).

Parental behavior also was related to ambient temperature (Fig. 3). Time spent brooding by males and females decreased as temperature increased from 10–30°C (females: Y [linear regression] = 35.49 − 1.12×, F[1,224] = 42.05, $P < 0.001$, r^2 [coefficient of determination] = 0.16; males: Y = 7.99 − 0.23×, F = 7.38, $P < 0.01$, $r^2 = 0.03$). An inverse relationship between brooding time and ambient temperature also has been reported by others (Best 1977b, Johnson and Best 1982).

TABLE 1
TIME MALE AND FEMALE BROWN THRASHERS SPENT SHADING NESTLINGS RELATIVE TO NEST EXPOSURE TO DIRECT SUNLIGHT[a]

Percent of nest in direct sunlight	Number of 30-min observation intervals	Min shading per 30 min ($\bar{x} \pm$ SD)	
		female	male
0	346	0.8 ± 3.1	0.0 ± 0.1
1–25	79	2.3 ± 4.2	0.1 ± 0.3
26–50	22	4.9 ± 7.6	0.3 ± 1.3
51–75	4	10.3 ± 8.2	2.5 ± 5.0

[a] Observations were made at three nests with brood-sizes of three, four, and five young.

Shading young occupied only a small portion of the adults' time when temperatures were below 30°C but increased sharply in occurrence at higher temperatures. The relationship between time spent shading by females and ambient temperature is exponential in Gray Catbirds (*Dumetella carolinensis*) (Johnson and Best 1982).

Adults began shading when the temperature reached 20°C and sun shone on the nest (shading occurred only rarely when sunlight was not on the nest; see Table 1). This suggests that overheating of the young is not likely at temperatures below 20°C, even if sunlight is striking the nest; thus, the adults did not shade. Lower ambient temperatures, however, usually occur in the early morning and evening when light intensity also is lower (r [ambient temperature vs light intensity] = 0.37, N = 237, $P < 0.01$).

The number of feeding trips per h for males and females was relatively constant over the range of temperatures sampled, with males feeding consistently more than females (Fig. 3). Males spent considerably less time in nest attendance than females, so they potentially had more time for feeding.

Although adults spent relatively little time shading the young, it was important when the sun shone directly on the nest (Table 1). In three nests (broods of three, four, and five young), time spent shading by females increased logarithmically with the amount of sunlight striking the nest (log female shading time [per 30 min] = 0.014 + 0.017·[% of nest in sunlight], $F[1,2] = 35.44$, $P < 0.05$, $r^2 = 0.99$). (In the analyses above, the mean shading time per 30 min [average for all three broods] for each of the four nest exposure classes [see methods] was regressed against the mid-points of the exposure classes.) Females spent much more time shading than males at all levels of nest exposure to sunlight; there was not enough data on shading by males to test statistically.

Nestlings usually moved away from direct sunlight and occupied a shaded part of the nest whenever possible. When the young could not escape the sun, they depended upon shading by the adults. Female Gray Catbirds increased time spent shading until sun shone directly on about 50% of the nest (Johnson and Best 1982); at higher exposures, shading time leveled off. When compared with female Brown Thrashers, time spent shading by female Gray Catbirds increased much more rapidly with greater exposure of the nest to sunlight.

At a fourth thrasher nest (brood of two young), the parents shaded infrequently when sunlight struck the nest (17 of 1110 min). During nine 30-min intervals, sunlight fell on more than 50% of the nest, but the pair almost never shaded. This nest was completed early in the season before vegetation had entirely leafed out, so it received more direct sunlight than the other three nests, but ambient temperatures were lower. Also, nestlings of the larger broods had reduced exposed surface area through which they could dissipate heat, which may have increased the need for shading.

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Journal Paper No. J–10218 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa. Project No. 2168.—PATRICIA A. HEAGY AND LOUIS B. BEST, *Dept. Animal Ecology, Iowa State Univ., Ames, Iowa 50011.* *Accepted 1 Aug. 1982.*

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Nesting ecology of the Loggerhead Shrike in central Missouri.—Loggerhead Shrike (*Lanius ludovicianus*) populations have declined in North America (Bystrak, Stud. Avian Biol. 6:34–41, 1981; Morrison, Am. Birds 35:754–757, 1981) especially in the midwest (Geissler and Noon, Stud. Avian Biol. 6:42–51, 1981) including Missouri (Kridelbaugh, Missouri Acad. Sci. Trans., 15:111–119, 1981). Lowered reproductive success may be responsible for this decline (Anderson and Duzan, Wilson Bull. 90:215–220, 1978). Studies on the nesting ecology of this widespread species are limited to the older works of Miller (Univ. Calif. Publ. Zool. 38:11–242, 1931) and Bent (U.S. Natl. Mus. Bull. 197, 1950), and the more recent papers by Graber et al. (Ill. Nat. Hist. Surv. Biol. Notes 83, 1973) and Porter et al. (Southwestern Nat. 19:429–436, 1975). Except for the work of Graber et al. in Illinois (which relied heavily on museum records for nesting data), there have been no studies of shrike nesting ecology conducted in the midwest. The present study was initated to aid in understanding the breeding biology of the Loggerhead Shrike in the region, and to compare it with previous studies done in other states to determine whether reduced reproductive success was responsible for the decline of shrikes in Missouri.

Study area and methods.—This study was conducted during the 1980 and 1981 breeding seasons (March–July) within a 24-km radius of Columbia, Boone Co., central Missouri. The 1980 nesting season (April–June) was hot and dry with a total of 15.6 cm (6.13 in) of precipitation, 17.7 cm (6.97 in) below normal (U.S. Dept. Commerce, Climatological Data 84 [4, 5, 6], 1980). The 1981 breeding season was cold and wet with a total of 53.8 cm (21.2 in) of precipitation, 20 cm (8.1 in) above normal (U.S. Dept. Commerce, Climatological Data 85 [4, 5, 6], 1981).

Most breeding pairs were located south and east of Columbia in rolling agricultural areas consisting of a mixture of rowcrops (primarily soybeans), wheat, hayfields, pasturelands, woodlots, and hedgerows. Breeding birds were trapped, using a modified wire-mesh chickadee trap baited with a mouse (Kridelbaugh, N. Am. Bird Bander, 7:50–51, 1982), and banded with a U.S. Fish and Wildlife Service aluminum band on one leg and one or two colored plastic bands on the other. Sixty adults and 120 fledglings were marked during this study. Nests of all breeding pairs were located, and were visited once every 4 days to record data on the nest-site, nesting behavior, nesting habitat, and success. In this paper three terms are used as measures of reproductive success: (1) hatching success—percentage of eggs laid that hatched; (2) fledging success—percent of young hatched that fledged; and (3) nest success—percent of nests from which one or more young fledged.

Arrival and abundance.—Twenty-eight breeding pairs were located in 1980 and 23 in 1981. The average relative abundance of nesting shrikes observed along a 15.5-km route was 0.42 pairs/km. The breeding population in central Missouri is relatively large when compared with other parts of the state (Kridelbaugh 1981). Male Loggerhead Shrikes began arriving in mid-February and established breeding territories. All nine of the wintering birds on the