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Received 8 February 1983, accepted 6 July 1983.

Broodedness in Bobolinks

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Extensive quantitative information on the number of broods raised per female bird per season is scarce (Cody 1971). This knowledge is necessary for an accurate analysis (or modelling) of population dynamics or reproductive "strategies" of individuals. In particular, a comparison of the reproductive fitness of monogamous males with that of polygynous males depends on knowing the reproductive success of paired females, which is pertinent also to questions dealing with sexual selection, female choice, and polygyny threshold models. To obtain complete data on reproduction, it is necessary that individual females be marked and monitored throughout the breeding season.

Replacement of lost clutches of eggs is common in birds (Lack 1968), but Lack (1968: 302) generalized that "most species of birds raise only one brood in a year, because the time required for courtship, nest-building, incubation and raising the young to independence is so long that a second brood could not normally be completed before the ecological conditions which permit breeding have ended for the year." Great Tits (*Parus major*), however, were found to raise two broods per year more frequently in habitat where food was more abundant (Perrins 1965), and older females were more likely to be double-brooded than younger females in this species (Kluijver 1951). The latitude at which a bird breeds apparently is related to broodedness in two opposing ways. Lack (1968: 196) stated that ". . . most passerine birds of high latitudes raise more than one brood each year . . . ," presumably because the longer daylength reduces the time to fledging relative to that at lower latitudes. Ecological conditions, however, may be suitable for nesting for a longer period of time at lower latitudes, and, therefore, more broods per female may be raised in a year than at higher latitudes (e.g. doves, many passerines).

The Bobolink (*Dolichonyx oryzivorus*) is a polygynous, ground-nesting icterid that winters from November to March in South America between latitudes 8°S and 32°S (Engels 1969) and breeds in North American hayfields and meadows from May to July between latitudes 40°N and 50°N. Recent studies of populations of marked birds in Wisconsin (Martin 1971), Oregon (Wittenberger 1978), and New York (R. L. Kalinoski pers. comm.) reaffirmed the earlier conclusion of Bent (1958) that Bobolinks can renest after nest failure but do not attempt a second nesting after fledging young from the first nest. An unmarked population of Bobolinks was studied annually in Michigan for 30 yr by O. S. Pettingill, Jr. (pers. comm.) and his students; this group never observed females to be double-brooded.

In the study reported here, adult Bobolinks were captured with mist nets from May to July 1982 at two sites 95 km apart in New York: (1) Bald Hill, 13.0 km southeast of Ithaca, Tompkins County, and (2) Cornell Biological Field Station located at Shackelton Point, 3.5 km northeast of Bridgeport, Madison County. Each bird was marked with a U.S. Fish and Wildlife Service band, and its tail was painted a unique combination of colors with Testors model airplane paint for recognition at a distance. All resident adults ($n = 76$) in both populations were marked by mid-June. The population at Shackelton Point nested in two fields (total 22 ha) that were not mowed regularly and were dominated by grasses (e.g. *Phleum pratense* and *Anthoxanthum odoratum*) and forbs (e.g. *Solidago, Fragaria,* and *Taraxacum*). Saplings of dogwood (*Cornus* spp.) and white ash (*Fraxinus americanus*) were common. The population at Bald Hill nested in a series of four contiguous fields (total 21 ha) that were cut annually for hay after the breeding season and were dominated also by grasses and forbs (e.g. *Phleum, Anthoxanthum, Bromus, Medicago,* and *Linaria*). There were no species of woody plants in these fields. Shackelton Point is a more hydric, lakeplain site, with dense herbaceous vegetation, whereas Bald Hill is a more xeric, hilltop site where herbaceous vegetation is sparser.

At both sites, I located nests by observation of females from elevated blinds, by observation of males feeding nestlings, and by incidentally flushing females from their nests. The location of each nest was mapped and marked in the field with plastic flagging tied at a known distance and direction from each nest. All nests that produced fledglings were found; all nests constructed in each population were probably found, with the possible exception of nests that may have been abandoned or destroyed shortly after initiation. Nests were checked daily until hatching and generally were not visited again until 7–8 days later, when nestlings were banded. Young left the nest 10–11 days after hatching. A nest was recorded as "successful" if nestlings were present on day 7–8 and absent from the undisturbed nest on day 10–11, provided the female associated with that nest was observed tending fledged young immediately after this period.

In total, 21 females at Shackelton Point and 20 females at Bald Hill were marked and monitored. At Bald Hill, 6 of 20 females (30%) built a second nest and laid a second clutch of eggs after successfully producing young from the first nest. Nests of 10 (of 14) single-brooded females were destroyed at Bald Hill; 3 of these females renested, and 1 of these females constructed a third nest after her first two nests failed. None of the females at Shackelton Point was double-brooded, but 1 of 5 females that experienced nest failure renested.

Mean clutch sizes for double-brooded females were 5.33 (SD = 0.52) for first and 3.82 (SD = 0.98) for second clutches ($P \leq 0.05$, Wilcoxon signed ranks test). Of 32 eggs, 30 hatched from first clutches (93.7%), and 27 young fledged from first broods, based on criteria described above. Fledglings from five of these first broods were captured in mist nets later in the summer. No young survived to fledging in second broods of double-brooded females, because all nests failed by the fourth day after hatching. Only 11 nestlings hatched from a total of 23 eggs in second clutches (47.8%) of double-brooded females, but the eggs in 3 of 6 nests disappeared from the nest before hatching. Of the three nests that hatched young, each failed due to predation on the female or the nestlings.

The date of initiation of first clutches of double-brooded females ranged from 21 to 24 May 1982, and the date of initiation of second clutches ranged from 24 June to 1 July 1982. The interval between the date of initiation of each clutch ranged from 31 to 38 days for three females whose nesting chronology could be back-dated accurately. Double-brooded females were the earliest females to initiate nesting at Bald Hill, and they remained with their respective males for both clutches. One of these males was mated bigamously, and five were mated monogamously to double-brooded females.

Although the Bobolink population at Bald Hill is the only one in which the existence of double-brooded females has been documented, it is possible that previous investigators simply did not detect the fact that some second broods were attempted. I am inclined to dismiss this explanation, however, even though all females were not marked in the Michigan (O. S. Pettingill pers. comm.), Wisconsin (Martin 1971), and Oregon (Wittenberger 1978) populations, because females were not double-brooded at Shackelton Point.

Factors associated with latitude, such as daylength, cannot be responsible for differences in broodedness now described for this species. Five of the six sites where Bobolinks have been studied occur within 1° of latitude of one another, but females in only one of these populations exhibited double-broodedness (Table 1). There was no apparent relationship between multiple-broodedness and elevation in this species, and the ages of females at Bald Hill probably were not significantly different from those of females at the other sites.

A more likely explanation for double-broodedness in the Bald Hill population is that the food supply was very abundant in June and July when nestlings were being fed. I do not have quantitative data on this, but larvae of the imported cabbage butterfly (*Pieris rapae*) and its host plant at Bald Hill, winter cress (*Barbarea vulgaris*), were quite common in 1982.

TABLE 1. Latitude and elevation of sites where field studies of Bobolinks have been conducted.

Location	Latitude (°N)	Elevation (m)	Source
Douglas Lake, Cheboygan County, Michigan	45°33′	219	O. S. Pettingill, Jr. (pers. comm.)
Sauk City, Dane County, Wisconsin	43°16′	231	Martin (1971)
Lakeport, Madison County, New York	43°10′	113	R. L. Kalinoski (pers. comm.)
Bridgeport, Madison County, New York (Shackelton Point)	43°10′	114	This study
P-Ranch, Harney County, Oregon	42°49′	1,400	Wittenberger (1978)
Brooktondale, Tompkins County, New York (Bald Hill)	42°21′	490	This study

Adult Bobolinks routinely left their territories to forage in patches of winter cress and were observed to carry 1-3 cabbage butterfly larvae to nests known to contain nestlings. Lepidopteran larvae were an important food for Bobolink nestlings in Oregon (Wittenberger 1980). It may be that the density and dispersion of the host plant, in combination with spring weather favorable to first generation cabbage butterflies, produced a unique situation locally, allowing double-broodedness in Bobolinks.

I greatly appreciate the assistance of G. H. Farley, S. C. Moore, T. J. Rawinski, and D. A. Takacs in the field. Temporal continuity of the project could not have been maintained without the cooperation of J. L. Forney, Director of the Cornell Biological Field Station, and F. Liddington, owner of the Bald Hill hayfields. D. K. Dawson, B. G. Murray, Jr., V. Nolan Jr., R. T. Reynolds, P. W. Sherman, C. R. Smith, and J. F. Wittenberger provided pertinent comments on the manuscript. This research was supported by the Cornell University Agricultural Experiment Station, New York State College of Agriculture and Life Sciences.

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Received 14 February 1983, accepted 8 July 1983.

Plumage Wettability of Aquatic Birds

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Rijke (1970) investigated the feather structure and wettability of breast feathers of 32 aquatic and terrestrial bird families. He found that the breast feathers of terrestrial families tended to be more water repellant on the surface, whereas the feathers of fully aquatic families tended to have greater resistance to water penetration through the feather layer. Body feathers and flight feathers would be expected to have different characteristics, however, as a result of differences in structure, feather density, and packing; furthermore, maintenance activities, such as preening, also affect wettability.