SHORT COMMUNICATIONS

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LOGGERHEAD SHRIKES, RED FIRE ANTS AND RED HERRINGS?[1]

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Loggerhead Shrikes (*Lanius ludovicianus*) are prominent birds of open habitats and are important bioindicators of environmental degradation because they are predatory and closely associated with many agricultural areas. Once relatively common throughout much of North America, the Loggerhead Shrike has been declining in numbers for most of the 20th century and is currently diminishing at about 5% per year (Hess 1910, Graber et al. 1973, Bystrak and Robbins 1977, Geissler and Noon 1981, Morrison 1981, Burnside and Shepherd 1985). It is one of the few species to exhibit significant declines in USFWS Breeding Bird Surveys (BBS) in all continental regions (Robbins et al. 1986, Droege and Sauer 1990, Peterjohn and Sauer 1993). Regions most affected appear to be those with breeding populations of the migratory subspecies (*L. l. migrans*; Bystrak 1983). The Loggerhead Shrike has been included in the National Audubon Society's Blue List since 1972 (Tate 1986):

Several factors implicated in this shrike's decline are: (1) poor reproductive success (Strong 1972, Porter et al. 1975, Luukkonen 1987, Gawlik 1988), (2) removal of fencerows and fencelines, a modern agricultural practice that deprives birds of suitable habitat such as hunting substrate, observation perches, and nest sites (Kridelbaugh 1982, 1983; Luukkonen 1987; Novak 1989; Yosef 1994), (3) reduced survival on the winter range in migratory subspecies (Haas and Sloane 1989, Brooks and Temple 1990a), (4) dietary uptake of agricultural pesticides and herbicides by females, resulting in thinning of eggshells (Busbee 1977, Anderson and Duzan 1978, Morrison 1979), (5) inclement weather that reduces reproductive success by destroying nests or reducing the food supplies of parents feeding young (Porter et al. 1975, Craig 1978), (6) disease (Legrand 1986), (7) interspecific competition (Cadman, unpubl. report), and (8) collisions with cars (Robertson 1930, Clark 1970, Bystrak 1983).

Scott and Morrison (1990) recently demonstrated that factors other than prey abundance may have prevented shrikes from nesting outside their present range. Brooks and Temple (1990b) found that shrike densities in the upper Midwest do not seem to be limited by availability of suitable breeding habitat, and that habitat changes are not correlated with declines in shrike density. In addition, on the winter range of Loggerhead Shrike, recently Lymn and Temple (1991) found a significant positive correlation between abundance and habitat condition, and a significant negative correlation between shrike numbers and the presence of red imported fire ants (*Solenopsis invicta*). They suggested that the occurrence of these ants rendered many of the remaining patches of habitat unsuitable because they competed for the same prey. The effects of fire ants on wildlife populations is controversial (Brennan 1991, 1993; Porter et al. 1988; Lymn and Temple 1991; Porter and Savignano 1990; Allen et al. 1993)

We hypothesized that if Lymn and Temple's (1991) suggestion is true and these ants have altered the ecosystem to the extent that it is no longer able to support shrike populations, then the effect should be evident on shrikes whose territories were occupied by fire ant colonies. We predicted that shrikes whose breeding territories were heavily infested would have to forage for longer periods of time to catch the minimum sustainable number of prey and their reproductive success might be lower. We tested the hypothesis by surveying 10 shrike breeding territories in our Florida study area containing varying densities of ant colonies, and assumed that all ant colonies are evenly distributed.

STUDY AREA AND METHODS

To assess the effects of fire ant colony densities on shrike territory size, number of nesting attempts per season, total number of eggs laid per pair, number of young fledged per pair, prey capture rates of adult shrikes, and percent of total time spent in flight either changing perches or in chase after prey, we studied 10 breeding pairs during 1993 (mid February–mid June) at the MacArthur Agro-ecology Research Center

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TABLE 1. The relationship between the density of IFA colonies and six breeding season (1993) parameters of Loggerhead Shrikes in Florida. We chose $P = 0.05$ as the minimum acceptable level of significance. Asterisk denotes statistical significance.

Parameter	F-test	Adjusted r^2	P	Power
Territory size	3.900	0.244	0.08	0.2018
Number of clutches	0.275	−0.088	0.62	0.0517
Number eggs/pair	0.132	−0.107	0.73	0.0593
Number young fledged/pair	4.799	0.297	0.06	0.0617
Fledging success (%)*	6.288	0.370	0.04	0.0542
Prey captured/hour	0.051	−0.118	0.83	0.2610
Percent time in flight	0.285	−0.086	0.61	0.0635

(MAERC) of the Archbold Biological Station, Highlands County, Florida. MAERC is a 4,200-ha cattle ranch that has extensive Bahia-grass (*Paspalum notatum*) pastures. Barbed wire fences encircle and divide the pastures and cabbage palm (*Sabal palmetto*), live oak (*Quercus virginianus*), wax myrtle (*Myrcus cerifera*), and a few other less common species of trees and bushes have colonized these fencelines.

During the 1990–1993 breeding seasons we trapped shrikes and banded them for individual recognition with U.S. Fish and Wildlife Service aluminum bands and color bands (Yosef and Lohrer 1992). For consistancy of habitat of the territories included in our sample, we surveyed only territories smaller than four hectares in area, and containing a decreasing gradient of density (0–13 mounds per square meter) by fire ants. In June 1993 we surveyed each shrike territory for ant colonies by choosing a random point at a fenceline in the territory, and stepped off 25 steps at right angles away from the fence. We surveyed a square meter at the end of each set of 25 steps and took 10 samples per territory. Since Lymn and Temple (1991) do not mention as to whether ant colonies were single- or multiple-queen colonies, and we are unaware of any survey of the status of the southcentral Florida colonies, we did not attempt to identify the type of colonies included in shrike territories included in our study.

Unless otherwise stated, data are presented as means ± SD. We employed simple regression to check for the effects of fire ants on shrike reproductive success, area defended, and foraging behavior. We chose $P = 0.05$ as the minimum acceptable level of significance. We calculated the power (probability of getting a significant result) using the statistical package JMP (SAS Inst., 1989; Table 1).

RESULTS

We measured an average density of 5.1 ± 3.7 (range 0–13) fire ant mounds per m^2 in the 10 Loggerhead Shrike territories sampled. The average area defended by the shrikes was 2.43 ± 0.86 ha (range 1.3–4.0). The 10 shrike pairs had an average of 2.1 ± 0.316 clutches per season (range 2–3), clutches averaged 7.2 ± 1.62 eggs (range 6–11) per pair per season, and fledged an average 1.9 ± 2.18 young (range 0–6) per pair, i.e., an average fledging success of 25.2% ± 26.6 (range 0–71.4). Adult shrikes captured on average 10.2 ± 1.99 prey (range 8–14) per hour, and spent 7.05 ± 0.81% (range 5.9–8.3) of their diurnal activity time in flight. We found no statistically significant relationship between the density of ant colonies in six of the seven parameters tested (Table 1). Fledging success was positively corelated with the density of IFA mounds.

DISCUSSION

Several studies have shown that fire ants are aggressive predators that feed mainly on arthropods (Lymn and Temple 1991). It is claimed that the invasion of these ants into an area can reduce arthropod diversity in the habitat (Porter and Savignano 1990). However, the extent to which these invaders adversely affect the natural food chain is unclear. Mann (1994) reported that when fire ants invaded an area in Texas the number of indigenous ant species fell by 70%, and that number of arthropod species (insects, spiders, ticks, etc.) dropped by 40%. In addition, Mann (1994) reported that the spraying of powerful ant-killer destroyed all native ants, which were the chief barriers to the spread of the fire ants. He did not report, however, the effect on arthropod populations following the fire ant eradication project in the 1960s. It is also uncertain if this reported reduction in arthropod diversity, or human efforts to contain the invasion by spraying of pesticides, affects the predators most. Thus, it is important to first study not only the effects of fire ants on the biodiversity of a given habitat or region, but also how it may have been affected by humans trying to control the pests. It is possible that the spraying of mirex eliminated the prey base of wintering shrikes and, consequently, adversely affected their populations.

Collins et al. (1974) studied the after-effects of spraying mirex to eradicate fire ants. They found that in vertebrates Loggerhead Shrikes accumulated the highest concentrations of pesticides from amongst two dozen avian species sampled. Although mirex was detected in 89% of samples analyzed, most levels were less than 1 ppm. In shrikes, levels of 8 ppm were found three months after a single treatment.

We concur with Lymn and Temple (1991) that the vast amounts of insecticides used to control fire ants probably posed greater threats to migrant populations of Loggerhead Shrikes than to fire ants themselves. The actual effects on the foraging ability of these birds has never been evaluated. Busbee (1977) found that two parts per million of dieldrin killed shrikes, and lower doses affected their hunting ability. This suggests that pesticides are contributing to the decline in an indirect manner, possibly through sub-lethal impairment of motor skills. Busbee (1977) found that the development of mouse-killing behavior in young shrikes was significantly prolonged when treated with a low dose of organochloride insecticide.

Lymn and Temple (1991) contend that large areas of grasslands in the Gulf Coast region are of reduced value to wintering bird species because of infestation by fire ants. Our results do not substantiate these claims. The relationship between fledging success and ant mound density may be explained as a spurious correlation because all clutches or broods lost were due to predation by mammalian (e.g., raccoon, *Procyon lotor*) or reptilian (e.g., yellow rat snake, *Elaphe obsoleta*) predators, inclement weather, or to spraying of fertilizers. In no case have we observed fire ants attack or kill eggs, nestlings, fledglings, or adult shrikes. The varying fire ant densities did not influence reproductive success of the birds.

Loggerhead Shrikes on the ranch capture an average of 7.4 prey per hour (Yosef and Grubb 1992) and 8.4 prey per hour (Yosef 1993). The foraging rate of shrikes included in our study was 10.2 prey per hour, which is higher than capture rates observed previously (Yosef and Grubb 1992). It is possible that although prey captures per hour was not related to territory size, our results were attained because we included only the smallest territories in our sample, which are also assumed to be in the best nutritional condition (Yosef and Grubb 1992).

The ability of fire ants to kill hatchlings of ground-nesting birds is controversial (Brennan 1991, 1993; Allen et al. 1993). Brennan (1993) contends that the observations of fire ants feeding on "chicks that are not normal and healthy" is a case of scavenging and not predation. His conclusions are based also on the experiments by Rosene (1969) who placed pipping Coturnix Quail (*Coturnix coturnix*) eggs at various distances from fire ant mounds and found that all chicks hatched successfully.

In our study, the absence of significant relationships between the density of ant mounds and shrike territory size, prey capture rate and percent of total time in flight, suggests that Lymn and Temple (1991) may have found an exceptional correlation. We also attained a similar correlation, but one that can be explained as owing to completely different causes. The problem is complex. Monocultural agriculture, modern silvicultural practices, removal of fencelines and hedgerows, pesticide/herbicide/fertilizer spraying, predation, are potential problems that must be resolved in relation to each other prior to singling out any single cause that may have contributed to the decline in populations of the migratory subspecies of the Loggerhead Shrikes of the Midwest. However, the idea of indirect relationships between fire ants and terrestrial vertebrates that eat arthropods is highly interesting and should not be treated lightly. Arthropods generally comprise a large proportion of the Loggerhead Shrike's diet (e.g., 72%, Bent 1950) but other than circumstantial evidence (Lymn and Temple 1991), no trophic relationship has been demonstrated. Therefore, we suggest that the relationship between shrikes and fire ants be carefully reevaluated and experimental evidence collected before action is taken such as spraying of additional, stronger, or newer pesticides (Drees and Vinson 1989, 1990) that can may well worsen the situation for native animals.

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