THE EXCLUSION OF THE RED IMPORTED FIRE ANT (FORMICIDAE: *SOLENOPSIS INVICTA* BUREN) TO PREVENT PREDATION ON THE EASTERN BLUEBIRD *SIALIA SIALIS*

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INTRODUCTION

The Red Imported Fire Ant (RIFA), *Solenopsis invicata* Buren (Hymenoptera: Formicidae) was first introduced into North America in the 1930" (Buren 1972, Buren et al. 1974). Since that introduction they have spread to cover more than 290 million acres in the Southeastern United States, Puerto Rico, and Southern California. In 2001 (McCubbin and Weiner 2002) infestations were discovered in Australia. In 2004 infestations of this pest were confirmed in Taiwan, Hong Kong, and Mainland China. Infestations of individual mounds have been discovered and destroyed in New Zealand. These newer infestations on the Pacific Rim have given this pest global status.

The impacts on human health of this invasive pest are well documented and understood even by the general public within infested zones. About 15% of the human population can have a localized allergic reaction to the proteins found in the fire ant's venom. About 1 – 2% of the population can have a severe systemic reaction that results anaphylaxis (Caldwell et al. 1999).

Fire ants have been known to damage electrical equipment such as switches, well pumps, air conditioners, and even runway approach lights. Their mounds damage equipment such as mowers, combines, and vehicles. Significant amounts of money is spent each year to manage fire ant populations (Miller et al. 2000). The impacts of RIFA on vertebrates and invertebrate species have also been a focus of much research (Allen et al. 2004).

RIFA are opportunistic and omnivorous predators. Their primary targets are other invertebrate species. As invasive competitors they are often capable of displacing and excluding other ant species (Porter and Savignano 1990, Vinson and Scarborough 1991, Morris and Steigman 1993) This role as dominate predators can place RIFA in the position of direct competitors with vertebrate insectivores such as northern bob white quail and the Eastern bluebird.

The eastern bluebird was once very common, but began to decline during the mid-1800's (Janetatos 2007). Changes in land use patterns and competition of exotic vertebrate species such as European starlings and the house sparrow contributed to a reduction in suitable nesting sites for the birds. The establishment of Bluebird Nestboxes is widely attributed with the recovery of the species from near extinction.

This study evaluated the predation of RIFA on eastern bluebird nestlings in nest boxes located Northeastern Richland County, and the efficacy of a baffle device to exclude the RIFA from the boxes. Tests were conducted both in the field and in a controlled laboratory experiment testing uncoated baffles, baffles coated with Fluon AD-1™ (Northern Products Inc153 Hamlet Avenue P.O.Box 1175 Woonsocket RI, 02895), and baffles coated with Tanglefoot™ (The Tanglefoot Company, 314 Straight Avenue, S.W.Grand Rapids, MI 49504-6485 USA).

In 2000, bluebird nest boxes were established in the Midlands area of South Carolina by the Department of Natural Resources as an educational community outreach program. The number of boxes has ranged from 72 during the first year to a total of 246 boxes in 2006. Boxes were monitored by volunteers for a number of factors including predation.

MATERIALS AND METHODS

Field Study

In 2000, bluebird nest boxes were established in the Midlands area of South Carolina by the Department of Natural Resources as an educational community outreach program. The number of boxes has ranged from 72 during the first year to a total of 246 boxes in 2006. Boxes were monitored by volunteers for a number of factors including predation.

Volunteers collecting data on the bluebird nestlings often complained about the impacts of RIFA predation on the nestlings. RIFA predation is particularly noticeable and upsetting to the volunteers because the RIFA are usually still in the box and predating the nestlings when the volunteers check the box.

Baffles have been widely used in the past to exclude predators such as raccoons, squirrels and snakes. They have been largely ineffective for protecting nestlings from RIFA. Due to the small size of RIFA and their ability to crawl on inverted surfaces they have are able to go around the baffle or take advantage of small openings between the baffle and the pole

Fluon AD-1™ is often used to contain laboratory colonies of RIFA in plastic trays. It was hypothesized that if a baffle was treated with Fluon AD-1™ and was tightly sealed it might prevent RIFA from predating the nestlings.

Starting with the 2004 season 49 bluebird nestboxes at Sandhill REC were protected using baffles constructed from the top half of a 1 liter Pepsi bottle. Half of the baffles were coated with Fluon AD-1™ the other half were coated with Tanglefoot™.

During this initial season none of the nestboxes that were protected with baffles were predated by RIFA.

At the Sandhill Research and Education Center, the forty-nine bluebird nest boxes were equipped with baffles constructed by cutting a 1 liter plastic Pepsi bottle in half. Approximately half of the resulting cones were coated with Fluon AD-1™ and the other half with Tanglefoot™. The baffles were attached to the poles supporting the nest boxes using electrical tape. Electrical tape was used because we were able to get a complete seal and the material is very weather proof.

Throughout the nesting season RIFA predation was noted and compared between baffle protected nest boxes and unprotected nest boxes. Results are reported in this study for 2004 – 2006.

Figure 5.1: Photograph of baffle deployed in the field.

<u>Lab Study</u>

The initiation of the field experiment was not designed as a scientific experiment, and was implemented based upon the educated guess that such a device might have potential. After noting the high level efficacy of the baffles in the field it was determined that a more comprehensive and rigorous experiment was needed to test the efficacy of the baffle.

An experiment was designed using 5 replications of a completely randomized block design using three common pole types: metal, pvc, and wood. Three types of baffles were used: uncoated, Tanglefoot™ coated, and Fluon AD-1™ coated. A pole of each type without a baffle was used as the untreated control (UTC).

Peanut butter is a well known attractant for RIFA and was used at the top of each pole to simulate the nestlings. A matrix with all of the combinations was constructed and place in a laboratory reared colony.

Data were recorded as an hit (1) if fire ants were found feeding feeding on peanut butter bait at intervals of one hour, two hours, four hours, and six hours, or miss (0) if fire ants were not found feeding on the peanutbutter at the specified intervals. Initial tests extended to data points as far out as 72 hours, but showed that if RIFA were going to breach the barrier this would happen within the six hour time frame. Using SAS software Fisher's Exact Test was used to determine if the protection provided by the baffle was significantly different.

RESULTS

<u>Field study results</u>

The total number of nest boxes has ranged from a low of 72 boxes in 2001 to a high of 246 in 2004. The mean RIFA predation of the nestboxes was 15.4 ± 3.0 during the study. The mean total predation (predation by RIFA and other predators) recorded was 38.3 ± 6.2 (See Table 5.1). RIFA predation accounted for 40.3% of the total predation throughout the duration of this study.

Nestboxes protected by the baffles deployed during the 2004 – 2006 seasons provided 100% protection from RIFA predation. This protection was consistent without regard to the type of coating i.e. Tanglefoot™ or Fluon AD-1™. Due to the results obtained in the laboratory tests below with uncoated baffles we deployed some uncoated baffles in the spring of 2006. This uncoated baffle provided equal protection during the season as baffles with either Tanglefoot™ or Fluon AD-1™ coating. See table 4.1.

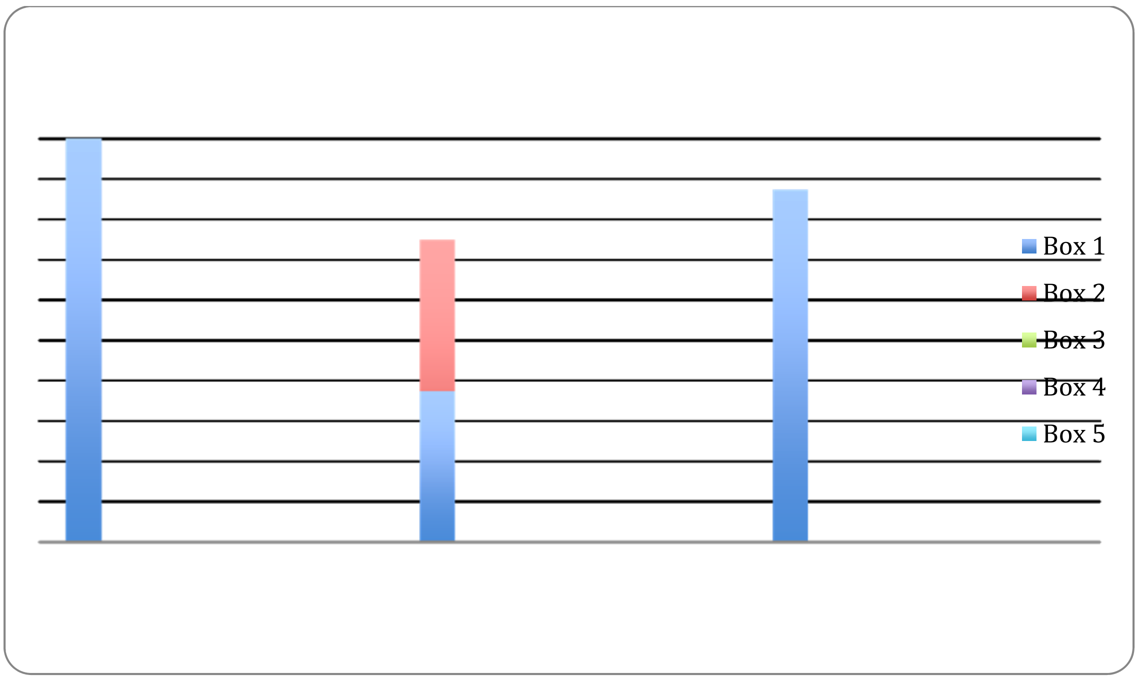
Table 5.1: Field Study Summary Table: Baffles were initiated in the field in 2004. RIFA accounted for 40.3% of the total bluebird predation. Nestboxes protected by the baffle were 100% effective at eliminating RIFA predation regardless of baffle coating.

Year	Total number of boxes	Number of protected boxes	Number of unprotected boxes	Number of nestboxes with RIFA predations	Total number of nestboxes with predation (RIFA and other predators)	Number of RIFA predations on protected boxes
2000	139	0	139	5	21	-
2001	72	0	72	12	16	-
2002	170	0	170	9	33	-
2003	214	0	214	13	40	-
2004	249	48	201	23	61	0
2005	233	48	185	27	53	0
2006	248	48	200	19	44	0
Total				108	268	0
Mean				15.4±3.0	38.3±6.2	0±0

<u>Lab results</u>

The results obtained the laboratory experiment are shown in Figure 5.1. The UTC in all replications and pole types found RIFA attacking the baits within one hour after the experiment was initiated. The baits that were protected with the baffles on the other had showed zero RIFA attacking the baits at the conclusion of the experiments. These results were held without regard to the baffle coating. Thus the uncoated baffle provided equal protection to the baffles that were coated with Fluon AD-1™ and Tanglefoot™. The estimated number of ants found on the baits were converted to hit or miss (1 or 0) since the estimated number of ants was the same for all of the treatment categories. These results found the baffle treatments were statistically different from the UTC $p = 4.13 \times 10^{-12}$ Fisher's Exact Test.

Figure 5.2: The average estimated number of ants (0 – 100+) reaching bait at 1, 2, 4, and 6 hour intervals in each attack box and for each baffle coating and pole type.



CONCLUSIONS/DISCUSSION

This study demonstrates that RIFA can be and probably are a significant portion of the predation of nestlings in field populations. In spite of this, the bluebird population continues to thrive thanks to the nest box programs throughout the range of this bird.

When examining the field data the actual level of RIFA predation presented is lower than would be predicted from the complaints of the volunteers. It doesn't take long when speaking with participants to realize the enthusiasm and attachment they have for the nestlings. A quotation from a listserve sums up the feelings of responsibility shared by the many volunteers, "*I will guarantee that there is not a bluebirder . . . that has not shed a tear or two either for the joy these birds bring or the heart ache we occasionally feel depending on what we find or learn about these birds over the course of our lives! It hurts just as much to lose that first nest as it will the last next only you feel more guilty the longer you put up nestboxes because we "believe" we have learned enough to be able to prevent ALL losses!" – (Kridler 2005)*

Predation is a natural part of the life cycle, and most of the participants recognize this fact. Most of the natural predators of the bluebird nestlings, however, do not present the negative visual and visceral impact of RIFA preying upon the nestlings. Predation is a necessary and important part of the natural process. It is possible that ants in general may have always been one of the predators of Eastern Bluebird nestlings. RIFA, however, are a non-native and invasive species with reduced competition and are not a part of the natural predator-prey ecology.

The annual variation of the RIFA predation is likely due to normal variations in the RIFA population and/or activity. Factors such as temperature and moisture play a role in the level of RIFA activity.

It is probable, though not tested in this study, that RIFA impacts the bluebird population in other ways. Both species primary food sources are small arthropods and competition for this food source could be impacting the bluebird populations or behavior in ways that have not yet been measured or tested.

A number of solutions to fire ant predation have been suggested, most of these recommendations have had very little replicated testing to prove their efficacy (Sialis http://sialis.org/predatorid.htm). Most commonly coating the poles with grease, petroleum jelly, or Tanglefoot™ is recommended. Personal experiences with these suggest that they may give some temporary protection for fire ant predation, but over time, debris such as dirt, leaves, and even dead ants can allow the fire ants to bridge the barrier. Another disadvantage, at least for the use of grease or petroleum jelly is the potential for polluting the environment as these coatings are washed off and into the soil.

A number of studies have looked at the use of chemical barriers to serve as a barrier to RIFA. Reports of the efficacy of chemical barriers are mixed Pranschke (Pranschke et al. 2003) found a barrier of bifenthrin was effective. Hooper-Bui (Hooper-Bui 2005) however concluded that barriers of fipronil or bifenthrin did not significantly reduce fire ant foraging activity. With any insecticide treatment for fire ants there are a lot of variables that can impact the ultimate results. This likely leads to the varied results reported in the literature. If researchers are obtaining such mixed results it is unlikely that the untrained general population can hope to get consistent results

The baffle is inexpensive compared to chemical treatment and more effective. These treatments do not reach the high levels of efficacy found with this baffle device. They are also more expensive and must be repeated on a regular basis to maintain a reduction in the RIFA population.

Originally we thought that the use of coatings such as Tanglefoot™ or Fluon AD-1™ be necessary for the baffles to be effective, since baffles used to prevent squirrel or snake predation had proved ineffective against RIFA. These coatings carried with them some disadvantages. Tanglefoot™ is unpleasant and difficult to work with and debris can stick to the coating rendering it ineffective. Fluon AD-1™ is expensive and difficult to obtain. Further, under humid conditions it becomes ineffective at containing RIFA. The thin layer is easily damaged again rendering it ineffective.

In our laboratory experiments we decided to try the baffle without these coatings for the sake of comparison. We were surprised to learn that this was as effective as either coating preventing 100% of RIFA in the test boxes from reaching the attractant. While uncoated a baffles have only been tested for a single season in the field our data suggest once again they performed as well as their coated counterparts.

Data for preliminary tests are not included, but a number of brands of bottles were tested. We found that bottles with a smooth surface and a vertical slope were effective. Bottles with any type of texturing were not effective (data not included in this report). Another important property in the success was that all gaps between the tape and the pole substrate must be closed. The RIFA were able to exploit any small opening.

We have not tested this method against other species of ants besides RIFA. We would hypothesize that it may not be effective against all ant species. Species such as

Technomyrmex albipes are notoriously difficult to contain in laboratory situations thus we would surmise this device would also not be effective against *T. albipes* or other species that are similarly difficult to contain.

These data do suggest that the baffles are as effective in the field as they are in the laboratory test thus we feel that the baffle is a very effective means of protecting bluebird nestlings from RIFA predation. It is simple, inexpensive and effective. It carries the added benefit of reusing a product that has a very long decay half life.

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