Analysis of Roach (Blattodea:Blattellidae) populations in colonies of *Solenopsis invicta* (Buren) (Hymenoptera:Formicidae)

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Abstract: Fire ant colonies infested with cockroaches were examined with attention to prevalence of roaches. Colonies were grouped by age, presence or absence of covered areas, and placement in an incubator or lack thereof. Examination of population density over a four-day period showed a higher prevalence of roaches in covered areas. Cockroaches who hid in narrow spaces thus preferred hiding in covered areas for comfort, or else faced improved conditions for survival in narrow spaces. The furthered understanding of roach habitats could be used to more effectively control or eliminate roach populations..

Keywords: *Solenopsis invicta*, Formicidae, Blattellidae, invasion, population density

Solenopsis invicta (Buren), known as the red imported fire ant, is an invasive species of ant which has displaced local ant species following its introduction in the 1930s (Vinson, Sorenson 1988). They have a painful venomous sting which is particularly dangerous to allergic individuals. The ants are even known to come indoors such that the very young and very old are considered at risk for fire ant attacks (Tankersley 2008). Past studies have examined the viability of controlling fire ant behavior or killing them via neuropeptide manipulation and other chemical means (Bajracharya et al 2014).

Colonies of fire ants reared in laboratories are occasionally infested by cockroaches of the family Blattellidae (Blattodea), such as the brown-banded cockroach, Supella longipalpa (Fabricius). Cockroaches are known to infest cooking and eating facilities, particularly ones frequented by humans or other creatures (Quandt et al 2013). Roach allergies are common in humans as well, and they've been the subject of immunotherapy in medical studies as they present an unsanitary health hazard (Bassirpour 2014). In the case of fire ant colonies, roaches feed on the provisions set out for ants as well as their refuse and corpses, and they can agitate ants and disrupt feeding. Roaches tend to appear in disorganized swarms and seek narrow, concealed spaces to eat, sleep, and hide from danger (Zajdel & Filipowicz 2014).

An experiment was designed to examine the presence and proliferation of invasive roach nymphs in fire ant colonies. The infested environment was manipulated to examine roach behavior and further understanding through observation. The experiment was particularly focused on the local fire ant colonies relevant to the experimenter.

Materials and Methods

The fire ant colonies originally belonged to Dr. Patricia Pietrantonio before their disposal. Colonies were normally prepared by placing the ants in plastic bins laid with absorbent paper and painted with a 30% concentration of Insect-a-Slip (BioQuip, Rancho Dominguez, California). The ants

were then offered test tubes (BioQuip, Rancho Dominguez, California) filled with water and stoppered with cotton swabs, plastic brood chambers laid with clay (BioQuip, Rancho Dominguez, California), plastic cups (BioQuip, Rancho Dominguez, California) laid with dead crickets for food, and cotton swabs set with cotton squares soaked in a ~10% dilution of clover honey (Harmony Farms, La Crescenta, California) in water which was regularly replenished (BioQuip, Rancho Dominguez, California). All colonies relevant to the test were kept at 80°F in an incubator (Percival Scientific 66 series, Perry, Iowa). All relevant colonies had fire ant numbers ranging from the dozens to hundreds each. Roaches would infest the colonies from the surrounding areas of the room and lay eggs, and nymphs would swarm about the colonies and under the petri dishes in particular. The petri dishes were replaced with small plastic trays bearing the soaked cotton, and new bins were prepared for the colonies to be moved. New colonies were laid with paper towels instead of absorbent paper. Ants were taken into the new colonies via test tubes filled with water and plugged with cotton.

During this transition period, from 4 May 2014 to 7 May 2014, prevalence of live roach nymphs was noted daily. Particular attention was given to the presence of roach nymphs in tight, isolated areas such as under the plastic trays, absorbent paper, and petri dishes. Thirteen different colonies were examined. Colonies 1, 2, and 3 were kept outside the incubator in room temperature air, and they were not changed or cleaned in the month before the experiment. Colonies 4, 5, 6, 7, and 8 were kept within the active incubator and were not changed or cleaned in the month before the experiment. Colonies 9, 10, 11, 12, and 13 were new colonies prepared in the aforementioned method. Colony 9 was changed on 29 April, colony 10 on 27 April, colony 11 on 29 April, colony 12 on 2 May, and colony 13 on 2 May.

Results

Most colonies showed distinct differences in roach proliferation between exposed and covered areas. Estimates were taken in lieu of counting individual live roach nymphs, which sometimes numbered in the hundreds. Several colonies, notably the new colonies 9 through 13, showed either no roach nymphs or a gradual increase in the number of nymphs present. Covered area was considered to be under absorbent paper, paper towels, and petri dishes.

Table 1. Approximate number of roaches per 2.54 square centimeters.

Exposed area						Covered area				
Colony	4-May	5-May	6-May	7-May		Colony	4-May	5-May	6-May	7-May
1	2.000	1.500	1.000	2.000		1	5.000	6.000	4.000	6.000
2	0.250	0.000	0.125	0.125		2	8.000	4.000	2.000	2.000
3	0.125	0.000	0.000	0.000		3	2.000	4.000	0.000	0.000
4	0.500	0.250	1.000	1.000		4	12.000	12.000	10.000	8.000
5	0.125	0.000	0.500	0.000		5	6.000	12.000	4.000	4.000
6	0.000	0.125	0.250	0.125		6	8.000	12.000	12.000	16.000
7	0.000	0.000	0.000	0.000		7	8.000	12.000	12.000	10.000
8	0.125	0.125	0.250	0.250		8	6.000	6.000	6.000	8.000
9	0.000	0.000	0.000	0.000		9	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000		10	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000		11	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000		12	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000		13	0.000	0.000	0.000	0.000

Discussion

Over the four-day examination period, the number of roaches appeared consistent overall, with drops in prevalence in a few colonies mitigated by increases in other colonies. There was no significant observed trend toward an increase or decrease in roach population density per square inch. However, the disappearance of roach nymphs in colony three suggested the extinction of invaded roaches, either by failure to reproduce or attack and consumption by the fire ants.

However, there were differences in roach populations depending on the categorization of each colony. The colonies kept within the incubator, 4, 5, 6, 7, and 8, showed a greater overall prevalence of roach nymphs than the colonies kept at room temperature, 1, 2, and 3. This suggested that the warmer conditions of the incubator are not just supportive of fire ants, as was intended, but also the invasive cockroaches. The newly changed colonies, 9, 10, 11, 12, and 13, showed no cockroach nymph prevalence at all throughout the survey period (Table 1). These colonies were prepared without petri dishes so as to limit covered spaces and provide conditions unfavorable to the cockroaches. The success in that effort suggested that lack of hiding places can be outright dangerous to the roach nymphs in terms of survival.

The key difference was found between roach prevalence in exposed versus covered areas. In every single colony and on every observation day, the number of roaches in covered areas was equal to or greater than the number of roaches in exposed areas. In the case of colonies 2, 3, 5, and 7, the presence of roaches suggested that all of the box's roaches had placed themselves in covered areas (Table 1). Therefore, roach nymphs showed an overwhelming preference for closed areas over open ones. No instances were observed where ants actually ate roach eggs, nymphs, or adults. However, the aforementioned covered areas were often isolated from the ants, which could not fit into the narrow spaces under petri dishes and

beneath the absorbent paper. Throughout each colony that showed live roach nymphs, many more roach nymph bodies were found laid around the absorbent paper. The results suggest that covered areas might afford a degree of safety for the roach nymphs which they might not otherwise have. Other risk factors that might cause nymphs to seek safety are the threat of desiccation or exposure to light. Attractive qualities for narrow areas may include warmth, aggregation, or personal shelter. Whatever the cause, the roach nymphs overwhelmingly preferred covered areas over exposed ones.

A furthering of this avenue of study might involve an examination of the colonies' prevalence of ants compared to that of the invasive cockroaches to look for any relation in population levels. The number of colonies and length of examination might also be increased to grant a wider range of data and find more factors to compare. As the experiment was aimed at furthering understanding of roaches, other organisms might be substituted for ants, either in laboratory colonies or more natural or domestic settings. In this way, the usefulness of the experiment may be expanded beyond applicability in fire ant colonies. Through the conclusions gathered, measures could be taken to lessen the roaches' ability to establish invasive populations in fire ant colonies or otherwise by removing closed, covered areas. This would allow better care and maintenance of colonies for scientific study, and it might also provide improved sanitary conditions in human and animal environments.

References Cited

Bajracharya, P.; Lu, H.L.; Pietrantonio, P.V. (2014). The Red Imported Fire Ant (Solenopsis invicta Buren) Kept Y not F: Predicted sNPY Endogenous Ligands Deorphanize the Short NPF (sNPF) Receptor. PLOS ONE, 9(10).

Bassirpour, G.; Zoratti, E. (2014). Cockroach allergy and allergen-specific immunotherapy in asthma: potential and pitfalls. Current Opinion in Allergy and Clinical Immunology, 14(6):535-541.

Quandt, S.A.; Summers, P.; Bischoff, W.E.; Chen, H.; Wiggins, M.F.; Spears, C.R.; Arcury, T.A. (2013). Cooking and Eating Facilities in Migrant Farmworker Housing in North Carolina. American Journal of Public Health, 103(3):E78-E84.

Tankersley, M.S. (2008). The stinging impact of the imported fire ant. Current Opinion in Allergy and Clinical Immunology, 8(4):354-359.

Vinson, S.B.; Sorenson, A.A. (1988). Imported Fire Ants: Life History and Impact. Texas Department of Agriculture, Austin, Texas. 28 pp.

Zajdel, M.; Filipowicz, B. (2014). Exit selection process during crowd evacuation, modelled on the cockroach emergent behaviour. Bulletin of the Polish Academy of Sciences-Technical Sciences, 62(3):557-563.