Texas Imported Fire Ant Research and Management Project
Final Progress Report - October 2001

Physiology Program: Understanding basic physiological and behavioral process involved in fire ant colony integration that may potentially be exploited in their management.

Principal Investigator
S. Bradleigh Vinson
Department of Entomology
2475-TAMU, Texas A&MUniversity
College station, TX 77843-2475
Phone: 979/8456-9754; Fax: 979/847-8668
e-mail: bvinson@acs.tamu.edu

Relevance/Implication of Project:
The physiology program is focused on four research areas. Each one of these areas has the potential to provide information that can be used to develop improved approaches to IFA management. These four areas are based on earlier research and are designed to provide the necessary physiology expertise in support of research being conducted in several other programs. For example, the development of techniques to rear parasites and pathogens has great potential for the mass production and release of biological control agents. Having methods to rear also provides us with a way to determine how these agents function and develop, how they evade the hosts defenses, and provides an opportunity to consider the genetic and molecular improvement of the organisms being reared. All of which could provide new tools for management.

Summary of Work Proposed to be Done:
This project was focused on five research areas.
A. The first was concerned with the control of reproduction. It is known that queens in polygyne colonies lay fewer eggs than the single queen that occurs in a monogyne colony and that the queens in polygyne colonies vary greatly in their reproductive effort. However, we discovered that one of the queens in a polygyne colony tends to be preferred by workers and it is this female that lays most of the eggs. While this dominance is generally consistent, it is influenced by nutrition. Further, the dominate queen is treated differently than the subordinate queens by workers. These data suggest that there are factors other than hormones that influence reproduction.

Some of the questions we are examining include:
Determine if the dominate queen only attracts and is only tended by her own progeny.

Results
We have set up the experiments and collected the samples needed to answer this question. However, these samples are presently stored and waiting in line to be processed.

Determine if oophagy, the consumption of eggs by workers or queens, is involved in maintaining a queens dominate position, and if so, can we influence oophagy and or dominance.

Background
We had discovered that queens in polygyne colonies differ in the amount of brood associated with them when separated. All eggs and brood is moved to the nest with the dominate queen. However, we did not know if all the eggs were from the dominate queen or if some were from the subordinate queens. Secondly, do all the eggs develop into adults or are some neglected and, if so, are neglected eggs and larvae from subordinate queens.

Results
We initiated these studies but had difficulty in getting enough labeled eggs and larvae to determine their fate under different experimental designs. We thus put this question aside until we can develop a better method of egg and larval marking.

Determine if certain queens are preferentially fed and the effect of queens being aggregated or dispersed on their nutritional health.

Background
We had discovered that queen in polygyne colonies differ in the number of workers they attract when separated. We also had shown that the most attractive queen was fed more and produced more eggs than the remaining or subordinate queens. However, we did not know if the subordinate queens benefited or not.

Results
We have shown that subordinate queen benefit from their association with the dominant queen in that they receive more food when associated and are also less likely to be killed. The food intake also translates into egg production in that the subordinate queens lay more eggs when associated with the dominant queen. The dominant queen also shows some benefit in being associated with other queens, as she also receives more food and lays more eggs. Although more eggs are produced when queens are associated, each polygyne queen including the dominate queen produce fewer eggs than a single monogyne queen. However, as a group the polygyne queens produce more eggs for a colony than a momogyne queen and therefore polygyne colonies may be better adapted to changeable environments.

Determine whether certain queens are moved to safety when in danger and the effect of queen dominance on queen survival.
Results
We have demonstrated that the dominant queen is moved first when a nest is confronted with unfavorable conditions, but when queens are separated the subordinate queen moves first, but not always to a safer location. Thus, when queens are together the workers prevent the movement of the queens. Once workers locate a safe route, they move the dominant queens first to the safer location. The subordinate queens are then allowed to move to the safer location.

B. We proposed to develop a bioassay to determine the function of the antennal glands in the IFA and to determine the relationship of this material to queen pheromones regulating reproduction, dealation, and queen execution. We also proposed to initiate research to isolate and identify the glandular material.

Background:
Working with Dr. Renthal in San Antonio and colleagues in Perugia, Italy we discovered that glands exist in the antennae of female fire ants (Isidoro et al., 2000), but their function is unknown.

Results
We developed a bioassay and we have examined the effects of gland removal on the behavior of IFA colonies. We have found that queens lacking this gland are executed. Workers with out the glands were also killed. However, removal of the glands from queens or workers did not cause any other changes in the behavior of the colony. Although these data do not provide any cue as to the role of the gland, its presence appears to be very important. When antennae with glands that were removed from queens were place into the colony, workers tended them for a day or two, but no unusual behaviors were noted. Further we investigated the chemical nature of the material and found that there was no response of workers to the lipid soluble fractions and no significant differences in the composition of compounds were seen in the segments of the antennae with and without glands. However, Renthal has seen differences in the protein content of gland segments.

C. We proposed to isolate and identify certain venoms from competing ants.

Background
During studies of the competitive interactions of several native ants with the IFA, we observed that several of the native species sprayed the fire ants with a venom that stopped the fire ants attack. The venom was subsequently found to be repellent. We plan to evaluate the venom of several other ant species as a repellent and to conduct structure activity studies to determine the active functional group(s) important to the repellent properties of the venom.

Results
We have isolated and identified several components of the venom of *Monomorium* that is repellent to worker fire ants. We have made a number of analogues and these are being tested to determine the active repellent region of the molecule. Once this region is identified we can use this to develop second generation repellents.

D. Fire ants produce sound and sound is thought to be a good way to communicate in tunnel systems that comprise a mound. We proposed to examine the role of sound produced by IFA in communication.

Results
We have characterized the organs responsible for the sound and the differences based on size. We have also determined that the sound produced is very variable but the variation does not appear to be associated to specific tasks or behavior. Stridulation is commonly employed when the ant is restrained. Stridulation under conditions of restraint is common in many ground dwelling insects and has been suggested as a means to frighten predators that grasp them and aids in the insects escape. We have also evaluated the general role of stridulation in overall colony activities. These studies have revealed that stridulation is common during certain colony activities and not so common during other activities. These data are being developed for publication.

E. We have been developing techniques to rear parasites and pathogens in an artificial medium. We plan to continue to make improvements and to use our media to understand the development of IFA parasites and pathogens so improvements in their use can be made.

Results

We characterized the hemolymph of the fire ant as a first step in the development of diets to rear parasites and diseases of the IFA. Using our data we developed an artificial hemolymph. We used the artifical hemolymph to examine the development of the Phorid fly in the fire ant. We were able to remove the various developmental stages of the fly and maintain these in the artificial media enabling us to characterize the developmental stages of the fly. The development of the Phorid fly was recently published and the data regarding the composition of the hemolymph is “in press”.