

MOLE CRICKET PHEROMONES

1990 ANNUAL RESEARCH REPORT

prepared for:

United States Golf Association

October 26, 1990

Submitted by:

**A. LEON STACEY, Ph. D.
111 Palmetto Court
St. Simons Island, Georgia 31522**

(912) 638-7471

EXECUTIVE SUMMARY

This report represents the annual status report for the first year of intense research activity devoted to isolating and utilizing pheromones to affect mole cricket population dynamics on golf courses. Biologically active materials were found and, with further refinements, may be produced for commercial marketing. No previous research has been done with mole cricket pheromones. The current research could potentially develop into a new and environmentally sound approach to managing turf insect pests.

Various glands and body parts were dissected from both male and female crickets. During the cricket flight season, acetone homogenates of the spermatheca (♀ crickets) and an unknown gland (♂ crickets) were biologically active and appeared to act as attractants (sex or aggregating pheromones). An alarm substance from the rectum (♀ + ♂) significantly reduced "fly-in" crickets. Additional tests are needed to improve on the pheromone dispensing system and to further refine optimum rates needed for activity.

Late season tests with the alarm substance formulated in spray mixes had no apparent influence on crickets.

Results of the first years' study are extremely encouraging. The attractants and the alarm substance may eventually fit well into a pest management system by influencing the population dynamics of crickets i.e. concentrating crickets into one area while repelling them from others. Such uses could reduce our total dependence on insecticides.

Although no previous work has been done with mole cricket pheromones, the concept has been used successfully in eradication programs for several insect pests of agronomic importance and millions of dollars have been saved.

BACKGROUND INFORMATION

Preliminary research conducted in 1989 indicated that pheromones (sex attractants, aggregating chemicals and repellents or alarm substances) may be involved in the behavior and population dynamics of the tawny mole cricket, Scapteriscus vicinus. Body parts tested included oocytes (immature eggs), spermatheca (sperm storage structure from female crickets), testes, aedeagus (penis), the last two abdominal segments from both male and female crickets, rectum and an unknown gland dissected from male crickets. The unknown gland from male crickets apparently contained a very strong aggregating pheromone or sex attractant and the rectums had a repelling affect. Moribound crickets (both male and female) discharge a foul smelling liquid just before death which serves as an alarm substance to repel other members of the population. Other researchers have observed this but no previous research has been done to determine if the alarm substance can be used to affect cricket populations. Quantitative data were not taken in 1989.

RESEARCH EFFORTS - 1990

Type specimens of the tawny mole cricket have been saved for the last three years and additional specimens have been collected this season. Specimens have been pooled by date collected e.g. MAR 01-15, MAR 15-30, APR 01-15, etc. Based on data collected in 1989, APR 01-15 crickets possess the highest concentration of pheromones. Therefore, specimens collected during that time frame were used for test purposes.

Beginning MAR 01, 1990 pheromone release traps containing potential attractants and repellents were put in place at St. Simons Island Club. Early research efforts were to quantify the amounts of homogenates necessary to influence cricket behavior. Amounts are expressed in "Cricket Equivalents" (CE's) i.e. 50 CE's of testes indicates that homogenates contained testes dissected from 50 mole crickets (Table 1). Ten mls of each material tested were placed on cotton balls in standard boll weevil pheromone traps. Because of trap vandalism, the large green cup portion of each trap was removed to reduce chances of people seeing them. Later, it was decided to make signs explaining to golfers and others, the importance of leaving traps in place. Traps were re-charged once per week for four weeks. Turf damage was assessed by randomly tossing a 9 ft² grid and counting cricket damage. Based on early test results presented in Table 1, three materials were chosen for further work (APR to JUL): (1) An Alarm Substance obtained by washing moribund or dead crickets with acetone. The amount of acetone used was ten mls/50 crickets to provide alarm substance at a concentration of 50 CE's and ten mls/100 crickets to provide alarm substance at 100 CE's. (2) Spermatheca dissected from adult female crickets. These structures were placed in a glass homogenizer with ten mls acetone to provide two concentrations (10 CE's and 50 CE's). (3) An Unknown Gland dissected from adult male crickets. This gland is positioned in the penultimate abdominal segment and was described previously by Dr. James Reinhardt as an unknown gland. These glands were similarly homogenized in acetone to provide two concentrations (50 and 100 CE's).

Pheromone traps were installed APR 07. Holes of golf used for the test were as follows:

Alarm Substance - 50 CE's - Retreat 1, Plantation 3, Island Club 7 and Sea Palms West 8.

Alarm Substance - 100 CE's - Retreat 3, Retreat 5, Plantation 4 and Plantation 5.

Spermatheca - 10 CE's - Island Club 6, 8, 13 and Seaside 5 (behind green).

Spermatheca - 50 CE's - Island Club 6, 9 and a common grounds area near the clubhouse.

Unknown Gland - 50 CE's - Island Club 7, 14, 12 (tee area) and Seaside 5 (tee area).

Unknown Gland - 100 CE's - Island Club 13, 14 and 15.

The fairway used as a check for comparisons was Island Club 1. Turf damage ratings were made APR 07 (pre-treatments), APR 21, MAY 05 and 19, JUN 02 and 16. Traps were re-charged once per week. Data are presented in Table 2.

The most dramatic development resulted from placement of one trap near the tee of Island Club 12. This trap contained the unknown gland at 50 CE's. Damage was so severe that re-sodding was done between MAY 05 and MAY 19. The new sod quickly became re-infested. The JUN 16 turf damage assessment was 9.0 and a ground mole had moved in to feed on crickets. Differences were not observed between the 50 and 100 CE rates of the unknown gland. Tests involving spermatheca indicated it is somewhat less attractive.

The alarm substance appears to offer more potential for cricket management. At both the 50 and 100 CE rates, it appeared to significantly reduce the fly-in crickets that can be overwhelming during APR and MAY. Additional tests with this material will be done to refine rate responses and to determine potential for use through sprayers.

The pheromone release system is inadequate as it is. Improved results should be expected after a slow release system is developed. Products such as Supersorb[®] are incompatible with the acetone carrier.

ADDITIONAL RELEVANT STUDY

Jekyll Island - On APR 08, a pheromone release trap containing homogenates of the unknown gland (200 CE's) was placed on the northernmost hole (5) of the southernmost course (Oceanside). The alarm substance (100 CE's) was strategically positioned on the more northern holes of Pine Lakes and Indian Mounds. By APR 15, the entire 9 holes of Oceanside needed blanket treatment.

Table 1. Turf Damage Assessments Following Installation of Pheromone Traps

<u>Homogenates (No. CE's)</u>	<u>Turf Damage Ratings By Date</u>		
	March 03	March 17	March 31
Check	1.1	1.2	1.6
Testes (10)	1.3	1.4	1.2
(50)	1.7	1.5	1.3
(100)	1.4	0.9	1.2
Unknown Gland (10)	1.1	2.0	3.1
(50)	0.8	6.1	9.0
(100)	0.9	6.0	9.0
Oocytes (10)	0.8	1.2	1.3
(50)	1.1	1.3	1.1
(100)	1.3	1.3	1.2
Rectum (10)	1.4	1.3	0.9
(50)	1.2	1.2	0.6
(100)	1.6	1.6	0.8
Spermatheca (10)	0.9	6.3	7.1
(50)	1.1	6.0	6.8
(100)	1.3	7.2	7.4
Adeagus (10)	1.3	1.3	1.3
(50)	0.9	1.2	1.2
(100)	1.0	1.0	1.2
Alarm Substance (10)	0.8	1.1	1.2
(50)	1.0	0.6	0.4
(100)	1.1	0.4	0.4

Table 2. Turf Damage Assessments Following Installation of Pheromone Traps

<u>Homogenate (CE's)²</u>	<u>Turf Damage Ratings¹</u>					
	<u>April 07</u>	<u>April 21</u>	<u>May 05</u>	<u>May 19</u>	<u>June 02</u>	<u>June 16</u>
AS ³ - (50)	0.8	0.3	0	0	0	0.2
AS - (100)	0.7	0.2	0.3	0	0	0.25
SP ⁴ - (10)	1.2	1.4	1.9	2.9	2.0	1.35
SP - (50)	0.6	1.8	2.6	2.9	1.4	1.5
UKG ⁵ - (50)	0.85	3.1	4.75	3.6	2.4	3.7
UKG - (100)	0.4	2.8	2.4	2.9	1.2	1.6
Check	0.2	0.4	0.7	1.3	1.1	0.9

¹Turf Damage Ratings (0-9) Scale

²CE's = Cricket Equivalents

³AS = Alarm Substance

⁴SP = Spermatheca

⁵UKG = Unknown Gland

LATE SEASON TESTS WITH ALARM SUBSTANCE IN SPRAY MIX

To further evaluate the activity of alarm substances, efficacy evaluations were performed in September with water-diluted extracts applied as sprays to cricket infested turf. Rates of 100, 1,000 and 100,000 CE's/acre were used in spray volumes of 10, 20 and 30 gallons per acre. Cricket activity was monitored for two weeks. No apparent changes resulted from any of the treatments made (Table 3). The lack of response indicates that the alarm substance may affect cricket behavior in a gaseous state and that water diluted extracts interferes with volality and subsequent activity.

Table 1. Mole Cricket Damage to Turf Following Installation of Pheromone Traps.

		Turf Damage Ratings ¹ by Date								
		MAR 09	MAR 23	APR 06	APR 20	MAY 04	MAY 18	JUN 02	JUN 15	JUN 29
<u>Treatment/Location</u>										
AS ² 50 CE's ³										
IC ⁴	-1	0.90	1.00	1.40	1.60	1.80	0.50	0.70	0.70	1.00
IC	-2	0.80	1.10	1.30	1.50	1.90	0.40	0.70	0.80	1.20
IC	-3	0.80	1.00	1.20	1.40	1.80	0.80	1.00	1.10	1.20
	\bar{X}	0.83	1.00	1.30	1.50	1.83	0.56	0.80	0.86	1.13
AS 100 CE's										
IC	-4	1.10	1.00	1.40	1.70	1.80	0.70	0.90	1.00	1.40
IC	-5	1.00	1.00	1.60	1.80	1.60	0.50	1.00	1.00	1.30
IC	-6	0.80	1.00	1.30	1.80	1.70	0.90	1.00	1.00	1.20
	\bar{X}	1.00	1.00	1.43	1.76	1.70	0.70	0.96	1.00	1.30
AS 200 CE's										
IC	-7	-	-	1.30	1.30	1.70	0.70	0.80	1.00	1.40
IC	-8	-	-	1.20	1.60	1.90	0.60	0.60	0.80	1.00
IC	-9	-	-	1.10	1.70	1.80	0.60	0.60	0.80	1.20
	\bar{X}	-	-	1.20	1.53	1.80	0.63	0.66	0.86	1.20
AS 500 CE's										
IC	-10	-	-	-	1.20	2.00	0.50	0.70	1.00	1.20
IC	-11	-	-	-	1.40	1.60	0.70	0.70	1.00	1.40
IC	-12	-	-	-	1.10	1.40	0.90	1.20	1.40	1.40
	\bar{X}	-	-	-	1.23	1.66	0.56	0.86	1.13	1.33
Untreated Check										
IC	-13	0.80	1.00	1.40	1.50	1.60	0.60	0.60	0.80	1.00
IC	-14	1.00	1.10	1.30	1.70	1.90	0.50	0.60	1.40	1.40
IC	-15	1.30	1.50	1.60	1.80	2.30	0.70	0.60	1.00	1.00
	\bar{X}	1.03	1.20	1.43	1.66	2.30	0.60	0.60	1.06	1.13

- 1 Turf Damage Ratings (0-9) Scale
- 2 AS = Alarm Substance
- 3 CE's Cricket Equivalentents
- 4 IC = Island Club

Table 2. Percentage of Fairways Needing Treatment for Mole Crickets Following Installation of Pheromone Traps.

<u>TREATMENT</u>	<u>% OF AREA TREATED</u>	
	<u>MAY 05</u>	<u>JUL 01</u>
AS ¹ 50 CE's ²		
IC ³ -1	30	80
IC -2	33	100
IC -3	30	100
\bar{X}	31	93.3
AS 100 CE's		
IC -4	25	75
IC -5	35	70
IC -6	30	80
\bar{X}	30	75
AS 200 CE's		
IC -7	20	60
IC -8	25	50
IC -9	33	75
\bar{X}	29.3	61.6
AS 500 CE's		
IC-10	33	40
IC-11	50	40
IC-12	33	33
\bar{X}	38.6	37.6
UNTREATED CHECK		
IC-13	25	70
IC-14	60	100
IC-15	30	80
\bar{X}	38.3	83.3

- 1 AS = Alarm Substance
- 2 CE's = Cricket Equivalentents
- 3 IC = Island Club

TABLE 3

TURF DAMAGE RATINGS FOLLOWING APPLICATIONS OF INSECTICIDES AND INSECTICIDE-PHEROMONE MIXTURES FOR CONTROL OF ADULT CRICKETS

		<u>TURF DAMAGE RATINGS</u> ¹			
TREATMENT	RATE	APR 05	APR 12	APR 19	APR 26
ORTHENE ALONE	5 LBS a.i. ²	1.7	0.6	0.8	1.8
ORTHENE + AS ³	5 LBS a.i.+1,000 CE's ⁴	1.4	0.4	0.6	1.6
ORTHENE + AS	5 LBS a.i.+1,000 CE's	1.6	0.8	0.9	2.2
ORTHENE + AS	5 LBS a.i.+5,000 CE's	1.8	0.7	1.0	1.6
ORTHENE + AS	3 LBS a.i.+5,000 CE's	1.4	0.9	1.0	1.4
TRIUMPH ALONE	2 LBS a.i.	1.6	0.2	0.6	0.8
TRIUMPH + AS	2 LBS a.i.+1,000 CE's	1.7	0.4	0.4	0.6
TRIUMPH + AS	1 LB a.i.+1,000 CE's	1.8	1.0	1.2	1.6
TRIUMPH + AS	2 LBS a.i.+5,000 CE's	2.0	0.5	0.7	0.8
TRIUMPH + AS	1 LB a.i.+5,000 CE's	1.4	0.8	1.0	1.8
SEVIMOL ALONE	6LBS a.i.	1.6	1.0	1.4	1.8
SEVIMOL + AS	6 LBS a.i.+1,000 CE's	1.2	0.7	1.2	2.1
SEVIMOL + AS	3 LBS a.i.+1,000 CE's	1.7	0.9	1.4	1.8
SEVIMOL + AS	6 LBS a.i.+5,000 CE's	1.4	1.2	1.6	2.0
SEVIMOL + AS	3 LBS a.i.+5,000 CE's	1.8	1.4	1.8	2.1
SEVIMOL + UKG ⁵	6 LBS a.i.+500 CE's	1.7	0.3	0.4	0.2
SEVIMOL + UKG	3 LBS a.i.+500 CE's	1.6	0.4	0.4	0.4
UNTREATED CHECK		1.2	0.6	2.4	2.6

- 1 Turf Damage Ratings 0-9 Scale
- 2 a.i. = Active Ingredient
- 3 AS = Alarm Substance
- 4 CE's = Cricket Equivalentents
- 5 UKG = Unknown Gland

Mole crickets seem to come up to the surface w/ the attractant pheromone.

10 gal H₂O/A

TABLE 3. Influence of Water-Diluted Sprays of Alarm Substance on Cricket Activity.

Treatment	Rate	Spray Volume	Turf Damage Days Post-Treatment				
			0	1	7	10	14
Alarm Substance	100 CE's/Acre	10	3.7	3.5	3.7	3.7	3.8
		20	3.9	3.7	4.0	3.6	3.7
		30	3.5	3.2	3.5	3.3	3.3
	1,000 CE's/Acre	10	3.3	3.4	3.5	3.1	3.5
		20	3.4	3.6	3.6	3.5	3.5
		30	3.6	3.5	3.5	3.1	3.7
	10,000 CE's Acre	10	4.0	3.8	3.9	3.8	4.0
		20	3.4	3.6	3.5	3.7	3.8
		30	3.7	4.0	4.1	3.9	4.2
Untreated Check	---	--	4.1	4.4	4.2	4.3	4.6

TABLE 4

TURF DAMAGE RATINGS FOLLOWING APPLICATIONS OF INSECTICIDES & INSECTICIDE-PHEROMONE MIXTURES TIMED FOR CONTROL OF HATCHING NYMPHS

		<u>TURF DAMAGE RATINGS</u> ¹			
TREATMENT	RATE	JUN 14	JUN 21	JUN 28	JUL 5
ORTHENE ALONE	3 LBS a.i. ²	0.7	0.3	0.4	0.8
ORTHENE + A.S. ³	3 LBS a.i.+1,000 CE's ⁴	0.8	0.6	0.5	0.5
ORTHENE + A.S.	2 LBS a.i.+1,000 CE's	1.0	0.8	0.6	1.0
ORTHENE + A.S.	3 LBS a.i.+5,000 CE's	1.2	0.4	0.5	0.5
ORTHENE + A.S.	2 LBS a.i.+5,000 CE's	1.0	0.8	0.8	0.8
TRIUMPH ALONE	2 LBS a.i.	1.0	0.0	0.0	0.2
TRIUMPH + A.S.	2 LBS a.i.+1,000 CE's	0.9	0.2	0.0	0.4
TRIUMPH + A.S.	1 LB a.i.+1,000 CE's	0.8	0.5	0.5	0.5
TRIUMPH + A.S.	2 LBS a.i.+5,000 CE's	0.9	0.2	0.0	0.0
TRIUMPH + A.S.	1 LB a.i.+5,000 CE's	1.1	0.4	0.6	0.6
SEVIMOL ALONE	4 LBS a.i.	1.2	0.6	0.7	1.1
SEVIMOL + A.S.	4 LBS a.i.+1,000 CE's	1.2	0.6	0.8	1.2
SEVIMOL + A.S.	2 LBS a.i.+1,000 CE's	1.0	1.2	1.2	1.4
SEVIMOL + A.S.	4 LBS a.i.+5,000 CE's	0.8	0.5	0.9	1.2
SEVIMOL + A.S.	2 LBS a.i.+5,000 CE's	1.0	1.4	1.6	2.0
SEVIMOL + UKG ⁵	4 LBS a.i.+500 CE'S	1.3	0.7	0.8	0.8
SEVIMOL + UKG	2 LBS a.i.+500 CE's	1.0	0.6	1.4	1.6
UNTREATED CHECK		0.8	1.2	1.7	2.6

- 1 Turf Damage Ratings 0-9 Scale
- 2 a.i. = Active Ingredient
- 3 AS = Alarm Substance
- 4 CE's = Cricket Equivalents
- 5 UKG = Unknown Gland

not effective

TABLE 5

TURF DAMAGE RATINGS FOLLOWING APPLICATIONS OF INSECTICIDES &
INSECTICIDE-PHEROMONE MIXTURES TIMED FOR CONTROL OF 4TH - 5TH STAGE
MOLE CRICKET NYMPHS

TREATMENT	RATE	TURF DAMAGE RATINGS ¹		
		AUG 23	AUG 30	SEP 6
ORTHENE ALONE	4 LBS a.i. ²	1.2	0.4	1.0
ORTHENE + A.S. ³	4 LBS a.i.+1,000 CE's ⁴	1.0	0.3	0.8
ORTHENE + A.S.	2 LBS a.i.+1,000 CE's	0.9	0.6	1.9
ORTHENE + A.S.	4 LBS a.i.+5,000 CE's	1.4	0.2	0.8
ORTHENE + A.S.	2 LBS a.i.+5,000 CE's	0.8	0.5	0.8
TRIUMPH ALONE	2 LBS a.i.	0.6	0.2	0.0
TRIUMPH + A.S.	2 LBS a.i.+1,000 CE's	1.2	0.0	0.0
TRIUMPH + A.S.	1 LB a.i.+1,000 CE's	1.3	0.6	0.4
TRIUMPH + A.S.	2 LBS a.i.+5,000 CE's	1.0	0.0	0.1
TRIUMPH + A.S.	1 LB a.i.+5,000 CE's	1.2	0.4	0.2
SEVIMOL ALONE	6 LBS a.i.	1.4	0.5	1.1
SEVIMOL + A.S.	6 LBS a.i.+1,000 CE's	0.9	0.3	0.6
SEVIMOL + A.S.	3 LBS a.i.+1,000 CE's	1.3	0.8	1.2
SEVIMOL + A.S.	6 LBS a.i.+5,000 CE's	0.8	0.2	0.6
SEVIMOL + A.S.	3 LBS a.i.+5,000 CE's	1.1	1.0	1.4
SEVIMOL + UKG ⁵	6 LBS a.i.+500 CE's	1.1	0.4	0.9
SEVIMOL + UKG	3 LBS a.i.+500 CE's	1.0	0.7	1.3
UNTREATED CHECK		1.1	1.9	2.8

- 1 Turf Damage Ratings 0-9 Scale
- 2 a.i. = Active Ingredient
- 3 AS = Alarm Substance
- 4 CE's = Cricket Equivalentents
- 5 UKG = Unknown Gland

not effective