KLEIN GRASS AND WEEPING LOVEGRASS TUSSOCKS AS OVERWINTERING MICROHABITAT FOR *HIPPODAMIA CONVERGENS* (GUERIN-MENEVILLE)

By

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CHAPTER I

INTRODUCTION

The aggregation phenomenon, i.e. massing of groups of individuals, is well documented among dormant coccinellids. Hagen 1962, and Hodek 1973 discuss aggregation behavior of lady beetles in reference to dormancy, both diapause and aestivation. Coccinellids may aggregate during diapause and/or aestivation depending on the locality and environmental conditions. Evidence of the assemblage behavior of coccinellids is noted by Douglass (1930) in New Mexico, Gillette (1923) in Colorado, Hagen (1962) in various United States locations, Sherman (1938) in the Carolinas, Stewart et al. (1967) in Arkansas, Thomas (1932) in North Carolina, and Throne (1935) in Michigan. In nearly all cases, aggregations were noted in association with mountains, or at least relatively high elevations.

Among coccinellid aggregation sites, the microhabitat varies considerably among different species. Microhabitat may consist of space under a stone, rock crevices, grass clumps or tussocks, leaf litter and a variety of other objects.

Other workers have made observations on the microhabitat preferences of coccinellids. Pulliainen (1966) noted that *Myrrha octodecimguttata* strongly preferred pine bark at a height of 1-10 cm above the ground. *Coccinella novemnotata* was found to prefer 4 weed spp. aggregations (McMullen 1967). When assemblages were found in alfalfa, no height or density preferences were discovered.

Aggregations of H. convergens have been found to overwinter on top of Mt. Scott (elevation=751 m) in the Wichita Mountains of southwestern Oklahoma (Wood).[1] A number of small assemblages of H. convergens were discovered in various grass tussocks on the Oklahoma Agricultural Experiment Station Agronomy Farm, west of Stillwater, Oklahoma. This area is devoid of mountains. Prompting this attempt to characterize the overwintering habitat, it was noted that within the same species of grass tussocks, certain ones were preferred for hibernational aggregation over others. The objective of this study was to examine morphological characteristics among preferred and non-preferred tussocks.

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[1]Wood, E. A., Jr., Personal Communication, Department of Entomology, Oklahoma State University, Stillwater, Oklahoma, 1977.

CHAPTER II

METHODS AND MATERIALS

Description of the Study Site

The study area chosen is an agronomic research plot located on the Oklahoma Agricultural Experiment Station west of Stillwater, Payne County, Oklahoma. The study area for samples 1 and 2 consisted of 39 rows of klein grass tussocks, each row approximately 45 m long. The study area for sample 4 was composed of 25 rows of the same species of tussocks, each row approximately 45 m long. Klein grass, *Panicum coloratum* (L.), was imported from Africa for its pasture potential. Used extensively in Texas for pasture improvement, the good qualities of this range grass include drought resistance, high nutritional value, ability to fare well under only moderate fertilization and ability to support wildlife very well (Taliaferro).[2] Grass seed was germinated in a greenhouse and seedlings were transplanted individually in rows with ca. 0.5 m spacings.

The study area for sample 3 consisted of 32 rows of weeping lovegrass tussocks, each row approximately 30 m long. Weeping lovegrass, *Eragrostis curvula* (Schrad.), possesses similar characteristics to those just mentioned for klein grass (Rommann 1974). Seedlings were produced

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[2]Taliaferro, C. M. Personal Communication, Department of Agronomy, Oklahoma State University, Stillwater, Oklahoma, 1978.

similarly and were transplanted individually in rows with ca. 0.3 m spacings.

Experimental Design

The first and second samples were taken in the klein grass tussocks in Nov. 1978 and March 1979, respectively. Before any beetle counts were made, each grass tussock was designated as suitable or unsuitable for beetle habitation based on the hypothesis that some tussocks are preferred over others. Criteria for such designation includes: symmetry of the tussock, i.e. whether stems arise in one centralized area (preferred) or stems arise in a radial manner (not preferred), and the number of stems per tussock (sparse stems not preferred). Each tussock was labeled with a metal stake as suitable or unsuitable and a number was assigned to each tussock. For each category, suitable or unsuitable, 25 tussocks were selected randomly to be sampled with 50 total tussocks counted. Two replications were made totaling 100 tussocks with 50 total per category.

The third sample was taken from weeping lovegrass tussocks in Jan. 1980. A uniform sample method was used in which the odd-numbered plants in the odd-numbered rows and even-numbered plants in rows with even numbers were sampled. One replication was made totaling 434 tussocks.

The fourth sample was taken from klein grass tussocks in Jan. 1981. Sampling procedure followed that used for sample 3 taken in 1980 from weeping lovegrass. One replication was made totaling 410 tussocks.

Parameters measured included number of coccinellids, average height of stems (measured in meters), number of stems per tussock and circumference of tussock at ground level (measured in cm). Transformation of beetle numbers was performed following the procedure used by Kempthorne (1952) to allow for negative binomial distribution of the convergent lady beetle. Means were calculated for each parameter and pertinent statistical tests were performed. Density (stems/cm^2) was also calculated from the parameters measured.

At the outset of this experiment, it was postulated that the beetles would likely prefer tussocks of certain degrees of compactness or density.

A measure of density was calculated by the formula:

$$\text{Density} = \frac{\text{No. of Stems in a Tussock}}{\text{Area of Tussock in Sq. cm.}}$$

The resulting ratio (stems/cm^2) was calculated for each tussock and a Duncan's Multiple Range Test was performed. Statistical tests between categories were also performed.

CHAPTER III

RESULTS AND DISCUSSION

All aggregations of beetles observed in this study were monospecific though heterospecific aggregations have been recorded in the literature. Hodek (1973) noted that *Hippodamia convergens* often joins other *Hippodamia* species in valley aggregations.

Table I shows means ± SD of all parameters for each sample and for both suitable and unsuitable categories. Samples 1 and 2 were pooled (N = 50/category) and the corresponding means were calculated. No significant differences were found in the circumference for klein grass samples 1 and 2 pooled (t=0.80, df=90) and sample 4 (t=1.69, df=408). In addition, average height was not significant for samples 1 and 2 pooled (t= 1.44, df=97) and sample 4 (t=1.27, df=408). Number of beetles were found to be significant at the .05 level for sample 1 (t=3.34, df=27.9), and samples 1 and 2 pooled (t=2.36, df=49.3), and significant at the .10 level for sample 2 (t=1.66, df=36.9). Significance at the .01 level was found for number of stems/tussock on sample 2 (t=2.76, df=37.4) and samples 1 and 2 pooled (t=3.20, df=87.5) while sample 1 was significant at the .10 level (t=1.64, df=48). The pooled statistic for the density of samples 1 and 2 was significantly different between categories at the .10 level (t=1.65, df=69.5). Results of sample 4 data analysis showed significant differences at the .01 level for number of beetles (t=8.07, df=177.8), number of stems/tussock (t=14.79, df=211.8), stem height

TABLE I

PARAMETER MEANS AND STANDARD ERRORS FOR 3 SAMPLES OF KLEIN GRASS TUSSOCKS AND 1 SAMPLE OF LOVEGRASS TUSSOCKS. STILLWATER, OKLAHOMA

		N	No. Beetles	No. Stems/tussock	Stem Height(m)	Density (Stems/cm^2)
Klein grass	Sample 1 (Nov. 1978)					
	Suitable	25	4.3±8.9b	98.1±30.4c	0.7±0.1	0.4±0.3
	Unsuitable	25	0.2±0.4	83.2±33.3	0.7±0.1	0.4±0.2
	Sample 2 (Mar. 1979)					
	Suitable	25	0.3±0.6c	111.4±59.9a	0.7±0.1	0.4±0.3
	Unsuitable	25	0.1±0.3	73.5±32.6	0.7±0.1	0.3±0.1
	Pooled					
	Suitable	50	2.3±6.6b	104.8±47.5a	0.7±0.1	0.4±0.3c
	Unsuitable	50	0.1±0.3	78.5±33.0	0.7±0.1	0.3±0.2
Weeping Lovegrass	Sample 3 (Jan. 1980)					
	Suitable	188	2.8±6.6a	375.1±169.8a	0.8±0.1a	1.9±1.1a
	Unsuitable	246	0.004±0.1	177.8±61.0	0.8±0.2	1.0±0.6
Klein grass	Sample 4 (Jan. 1981)					
	Suitable	134	0.6±1.8a	220.8±65.6a	0.7±0.1a	0.7±0.4
	Unsuitable	276	0.01±0.1	138.3±51.8	0.7±0.1	0.5±0.4

a Means between suitable and unsuitable significantly different at the .01 level.

b .05 level of significance

c .10 level of significance

(t=3.30, df=394.6), and density (t=9.38, df=241.9).

Analysis of sample 4 data showed significant differences at the .01 level for number of beetles (t=3.71, df=133.8), number of stems/tussock (t=12.76, df=216.3), and stem height (t=5.06, df=330.3) between categories. No significant differences was found in density between suitable and unsuitable tussocks (t=1.36, df=239.9).

Since the circumference was not significant for klein grass in samples 1, 2, and 4, only stem number and not density ratio was used for category comparisons. Table II represents the distribution of H. convergens recovered with respect to stem number of klein grass in which beetles were found in samples 1 and 2 pooled. Stem numbers were divided into 30 intervals as shown in Fig. 1, and a Duncan's Multiple Range Test was performed. Interval 11 was significantly different from all intervals. Beetles preferred a range of 110-130 stems/clump. This range was contained in intervals 10 and 11 where 56% of the total beetles were collected. The distribution of H. convergens collected with respect to the stem number/tussock in klein grass, sample 4, is illustrated in Table IV. Stem numbers were divided into 6 intervals and analyzed in the same manner as sample 1 and 2 pooled. A preference for 140-340 stems/tussock was seen in sample 4. This range was included in intervals 2, 3, 4, and 5 where 96.1% of the total beetles were collected (Figure 3).

Lovegrass circumference was significant at the .001 level, thus density ratios were calculated and were significantly different at the .001 level. The ratios were divided into five intervals as shown in Figure 2 and analyzed using a Duncan's Multiple Range Test. Interval 3 and interval 2 were significantly different from themselves and all of

TABLE II

DISTRIBUTION OF DORMANT *HIPPODAMIS CONVERGENS* (GUERIN-MENEVILLE) WITH RESPECT TO THE STEM *NUMBER/TUSSOCK* IN KLEIN GRASS TUSSOCKS. STILLWATER, OKLAHOMA, 1978 AND 1979.

Stem Number	Sample 1 and 2 Klein Grass Tussocks			
	No. Tussocks in Interval		No. Beetles in Interval	% of Total Beetles
	Suitable	Unsuitable		
less than 60	5	15	3	2.6
61- 70	5	11	22	18.9
71- 80	8	5	5	4.3
81- 90	2	3	1	0.9
91-100	6	4	9	7.8
101-110	4	4	2	1.7
111-120	9	2	32	27.6
121-130	0	3	33	28.4
131-140	2	0	0	0
141-150	3	1	6	5.2
151-160	1	0	0	0
greater than 160	4	1	3	2.6

Figure 1. Number of Tussocks Found With Respect to Stem Number/Tussocks and Number of Beetles/Tussock in Klein Grass Tussocks. Stillwater, Oklahoma, 1978 and 1979. (Intervals used for Duncan's Multiple Range Test)

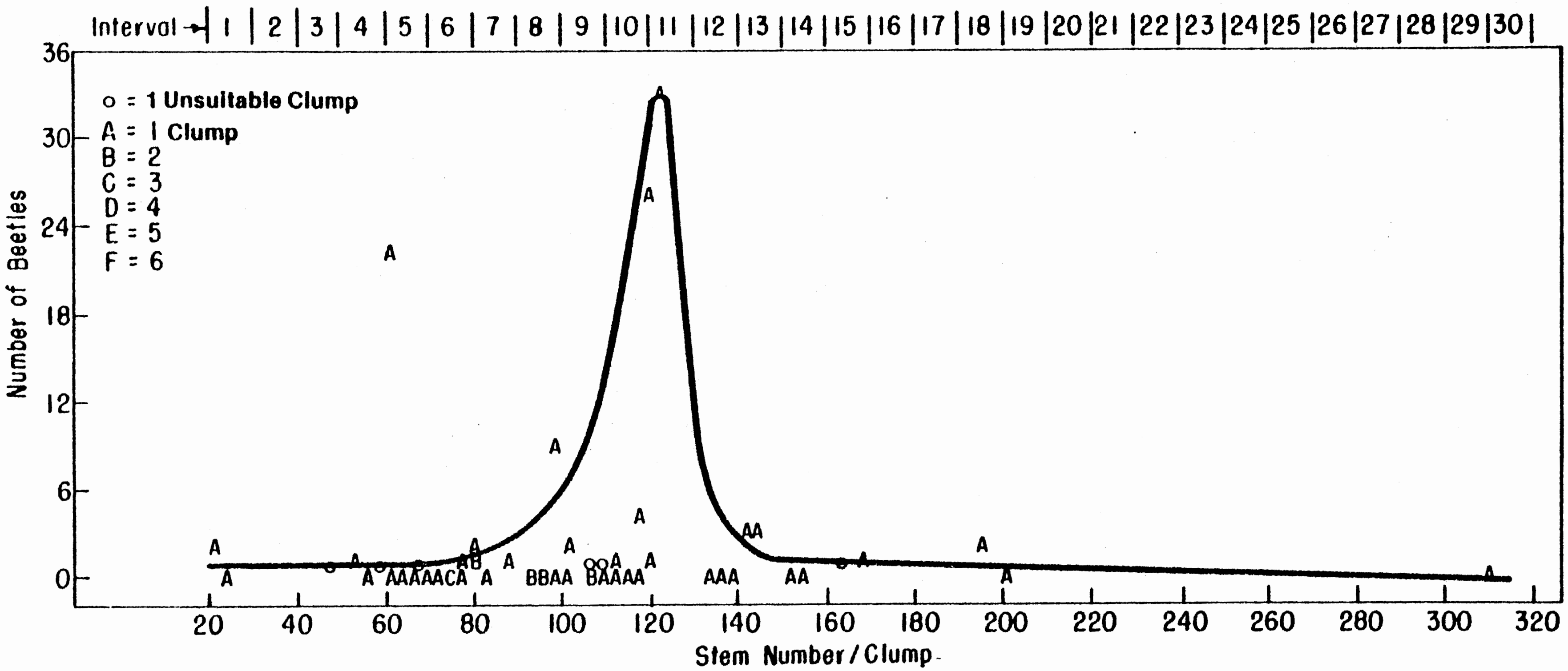

Interval
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
o = 1 Unsuitable Clump
A = 1 Clump
B = 2
C = 3
D = 4
E = 5
F = 6
Number of Beetles
0
6
12
18
24
30
36
Stem Number/Clump
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320

TABLE III

DISTRIBUTION OF DORMANT *HIPPODAMIA CONVERGENS* (GUERIN-MENEVILLE) WITH RESPECT TO THE DENSITY OF LOVEGRASS TUSSOCKS. STILLWATER, OKLAHOMA, 1980.

Density (stems/cm^2)	Sample 3 Lovegrass Tussocks			
	No. Tussocks in Interval		No. Beetles In Interval	% of Total Beetles
	Suitable	Unsuitable		
less than 1.00	42	153	8	2.7
1.01 - 2.0	92	81	208	69.3
2.01 - 3.0	39	12	50	16.7
3.01 - 4.0	9	0	34	11.3
greater than 4.0	6	0	0	0

Figure 2. Number of Tussocks Found With Respect to Stem Number/cm^2 and Number of Beetles/Tussocks in Lovegrass Tussocks. Stillwater, Oklahoma, 1980. (Intervals Used for Duncan's Multiple Range Test)

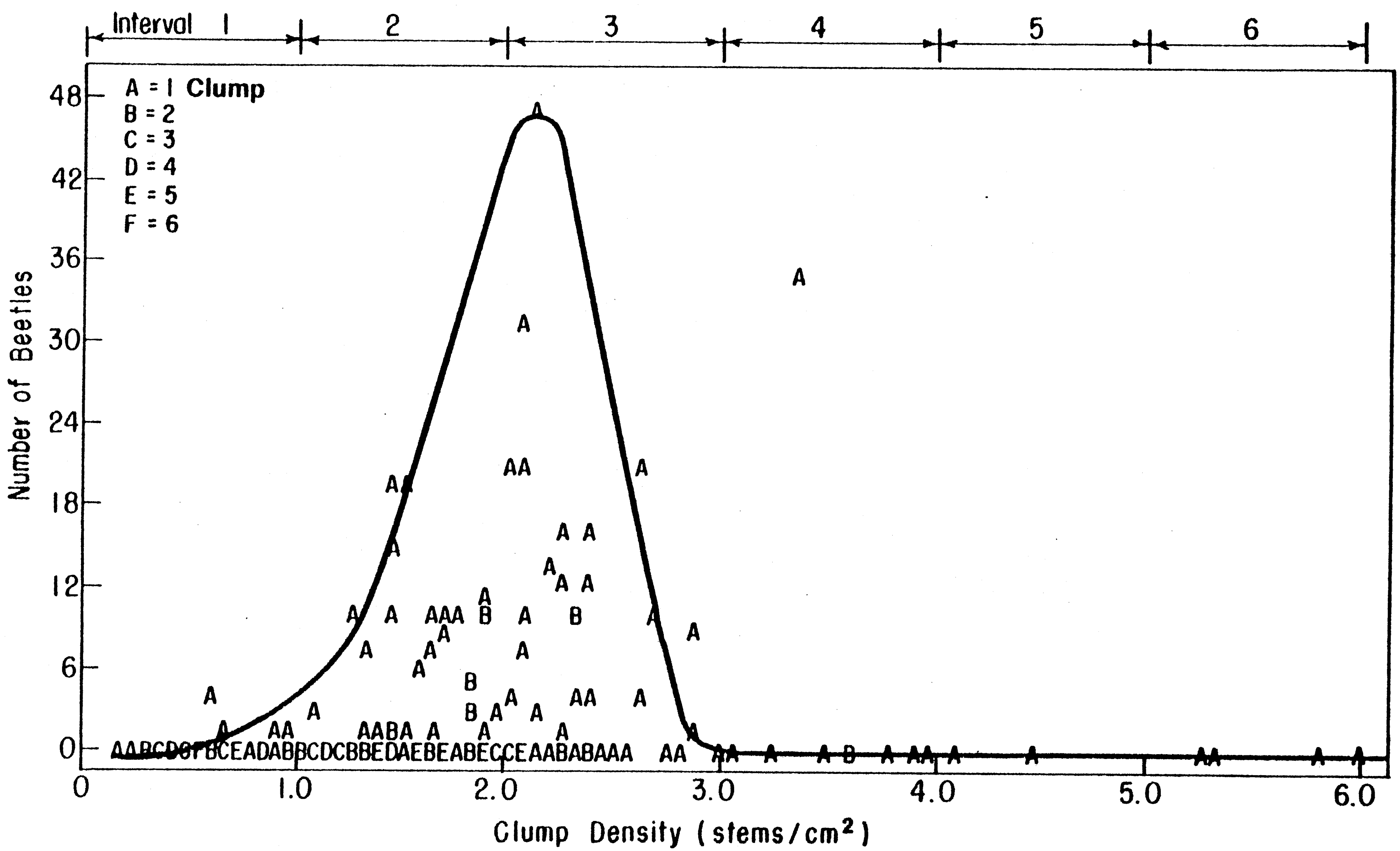
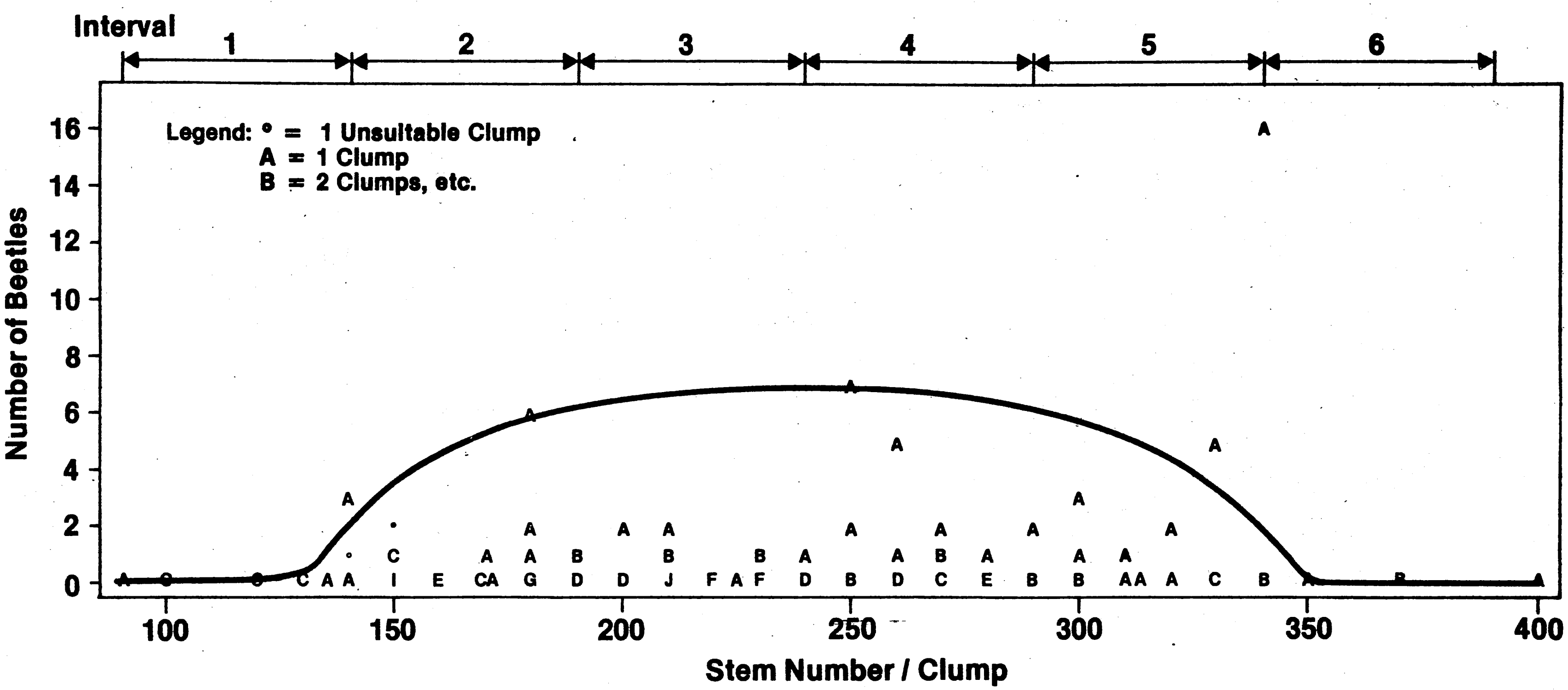

Interval 1
2
3
4
5
6
A = 1 Clump
B = 2
C = 3
D = 4
E = 5
F = 6
Number of Beetles
Clump Density (stems / cm²)

TABLE IV

DISTRIBUTION OF DORMANT *HIPPODAMIA CONVERGENS* (GUERIN-MENEVILLE)
WITH RESPECT TO STEM NUMBER/TUSSOCK IN KLEIN GRASS TUSSOCKS.
STILLWATER, OKLAHOMA 1981.

Stem Number	Sample 4 Klein Grass Tussocks			
	No. Tussocks in Interval		No. Beetles in Interval	% of Total Beetles
	Suitable	Unsuitable		
less than 140	13	159	3	3.9
141-190	38	78	15	19.4
191-240	38	35	9	11.7
241-290	25	4	22	28.6
291-340	16	1	28	36.4
greater than 341	3	0	0	0

Figure 3. Number of Tussocks Found With Respect to Stem Number/Tussocks and Number of Beetles/Tussocks in Klein Grass Tussocks. Stillwater, Oklahoma, 1981. (Intervals Used for Duncan's Multiple Range Test)



Interval
1
2
3
4
5
6
Legend: ° = 1 Unsuitable Clump
A = 1 Clump
B = 2 Clumps, etc.
Number of Beetles
0
2
4
6
8
10
12
14
16
Stem Number / Clump
100
150
200
250
300
350
400

the other intervals. These intervals contained a density range of 1.0-3.0 stems/cm^2 and seemed to be preferred by beetles in the lovegrass tussocks. A total of 86% of the total number of beetles collected fell into this range (Table III, Figure 2).

Designation of tussocks to one of two categories is somewhat subjective, therefore comparisons between categories should be made with some caution. Nevertheless, in samples 1 and 2 combined, single beetles were found in only 6 of the 50 tussocks designated as unsuitable (Figure 1). In sample 3, only one beetle was found in one of 246 tussocks designated as unsuitable (Figure 2). A total of 3 beetles were found in 2 of the 276 unsuitable tussocks for sample 4 (Figure 3).

The results of comparison of density becomes fairly apparent: the beetles prefer the medium density tussocks over both the less dense tussocks and the highly dense tussocks. This preference may serve in the prevention of moisture loss during the winter. Dessication from exposure is often a primary mortality factor for overwintering beetles (McMullen, 1967). Further, Hodson (1937) found that both _H. convergens_ and _Coleomegilla maculata_ (DeGeer) showed a marked preference for certain moisture situations. Hodson believed moisture level of the hibernacula is significant in reducing the effect of sudden cooling by means of latent heat properties of water. Moisture content of the klein grass tussocks may be confounded in the beetle preferences for the more dense tussocks. Thus, the "shelter effect" in the more dense tussocks, i.e. dense protective cover and moist microenvironment, serves to both buffer temperature extremes and to maintain proper humidity, since Oklahoma winter months are often very dry.

Dense grass tussocks may maintain a snow layer longer than a less dense tussock. This may aid in survival since Latta (1928) found that a temperature drop from -2°C to -12°C without snow cover resulted in 100% mortality of *H. convergens*.

Luff (1965) found that height and density of grass tussocks combine to reduce temperature fluctuations within the tussocks and he further mentioned that absorption of solar radiation is greater as density of plant growth increases. Preferences of tussock selection by *H. convergens* may be influenced by the warmer temperatures of the more dense tussocks. However, in extremely high density tussocks, aggregations may be physically limited by the space available. This physical limitation might account for a decreased percentage of beetles found in the most dense tussocks.

In summarizing, *H. convergens* shows a preference for grass tussocks that have a moderately high density. This preference probably has an adaptive advantage that improves winter survival of the species in lowland areas. Application of this research may imply that an effort could be made to preserve choice overwintering habitat in order to support higher populations of the beetles through the winter.

CHAPTER IV

SUMMARY

This investigation was designed to determine the preference in the choice of hibernacula of the convergent lady beetle, *Hippodamia convergens* (Guerin-Meneville), with regard to morphological aspects of two introduced range grasses, *Panicum coloratum* (L.), and *Eragrostis curvula* (Schrad.). A total of four samples were made on diapausing coccinellids from 1978-1981.

Studies of the density preference of *Hippodamia convergens* (Guerin-Meneville) showed the species to prefer tussock densities in the range of 1.0-3.0 stems per cm^2 for weeping lovegrass. Preferences for klein grass tussocks ranging from 110-130 stems per tussock and 140-340 stems per tussock were found. No preference was shown for a particular tussock circumference or height.

From 1978-1981, a total of 944 tussocks were sampled. A total of 572 tussocks were categorized as unsuitable for beetle overwintering habitation. Of the 572 tussocks, only 9 tussocks containing 10 total beetles were found. It was demonstrated that tussocks could successfully be designated as suitable or unsuitable for beetle aggregation.

The information collected in this study indicates that *H. convergens* prefers tussocks of a certain density range and stem number. More information such as internal tussock temperature and humidity is needed before "shelter effect" assumptions may be verified.

REFERENCES CITED

Douglass, J. R. 1930. Hibernation of the convergent lady-beetle, Hippodamia convergens on a mountain peak in New Mexico. J. Econ. Entomol. 23: 288.

Gillette, C. P. 1923. Ladybeetle, Hippodamia convergens hibernation notes. Colorado State Entomol. Rep. 14: 20.

Hagen, K. S. 1962. Biology and ecology of predaceous Coccinellidae. Ann. Rev. Ent. 7: 289-326.

Hodek, I. 1973. Biology of Coccinellidae. Dr. W. Junk. The Hague. 260 pp.

Hodson, A. C. 1937. Some aspects of the role of water in insect hibernation. Ecol. Monographs 7: 271-315.

Kempthorne, O. 1952. Design and Analysis of Experiments. Wiley. Table 8.4. 156 pp.

Latta, R. 1928. The effect of the extreme temperature on Dec. 7, 8, and 9, 1927 on hibernating Crioceris asparagi and Hippodamia convergens at Ames, Iowa. Psyche 39: 229-31.

Luff, M. L. 1965. The morphology and microclimate of Dactylis glomerata tussocks. J. Ecol. 53: 771-817.

McMullen, R. D. 1967. A field study of diapause in Coccinella novemnotata. Can. Ent. 99: 42-50.

Pulliainen, E. 1966. On the hibernation sites of Myrrha octodecimguttata on the butts of the pine. Ann. Ent. Fenn. 32(1): 99-104.

Rommann, L. M. 1974. Weeping Lovegrass. OSU Extention Facts No. 2556; 2556-2556.1.

Sherman, F. 1938. Massing of convergent ladybeetle at summits of mountains in southeastern United States. J. Econ. Entomol. 31(2): 320-22.

Stewart, J. W., W. H. Whitcomb, and K. O. Bell. 1967. Aestivation studies of the convergent lady beetle in Arkansas. J. Econ. Entomol. 60(6): 1730-5.

Thomas, W. A. 1932. Hibernation of the 13-spotted lady beetle. J. Econ. Entomol. 24: 136.

Throne, A. H. 1935. An unusual occurrence of the convergent lady beetle. Ecology 16: 125.

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