

INFLUENCE OF COLLECTION METHOD AND COLLECTION TIME ON SURVIVAL, SEXUAL PROPORTION AND NUMBER OF SPITTLEBUG ADULTS CAPTURED¹

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ABSTRACT - Adults of *Zulia entreriana* (Berg.) and *Deois flavopicta* (Stal) collected in ten sweep samples of a sweep-net and transferred to cages using an aspirator tended to live shorter than those transferred using a container lined with cotton. Sweeping itself did not affect the adult survival. Adults collected in 10, 30 or 50 sweep samples lived the same period as those captured by pulling an open end of a cage 20 cm above the pasture at 30° angle. Spittlebugs collected at 8 a.m. - 9 a.m. lived longer than those collected at midday - 1 p.m. or 5 p.m. - 6 p.m. More adults were captured by sweeping at 5 p.m. - 6 p.m. than at 8 a.m. - 9 a.m. or midday - 1 p.m. A comparison of sexual proportions of adults captured by sweeping with those based on all the adults in 1 m² pasture areas showed that the sweep-net method tended to underestimate the proportion of females.

Index terms: *Zulia entreriana*, *Deois flavopicta*, *Brachiaria decumbens*, Cercopidae.

INFLUÊNCIA DO MÉTODO E TEMPO DE COLETA SOBRE A SOBREVIVÊNCIA, PROPORÇÃO SEXUAL E NÚMERO DE ADULTOS CAPTURADOS DE CIGARRINHAS-DAS-PASTAGENS

RESUMO - Adultos de *Zulia entreriana* (Berg.) e *Deois flavopicta* (Stal) coletados em amostras de dez batidas de rede entomológica e transferidos às gaiolas através de um aspirador sobreviveram menos tempo do que os transferidos através de um receptáculo revestido internamente com algodão. A amostragem propriamente dita pela rede não afetou a sobrevivência dos adultos. Adultos coletados nas amostras de 10, 30 ou 50 batidas sobreviveram o mesmo tempo quanto os capturados arrastando-se o lado aberto de uma gaiola 20 cm acima do pasto em ângulo de 30°. As cigarrinhas coletadas às 8 h - 9 h, sobreviveram mais tempo do que as coletadas às 12 h - 13 h ou 17 h - 18 h. Foi obtido maior número de adultos utilizando-se a rede entomológica às 17 h - 18 h do que às 8 h - 9 h ou às 12 h - 13 h. A comparação das proporções sexuais de adultos capturados pelo uso da rede entomológica com os baseados na captura de todos adultos em áreas de 1 m² de pasto mostrou que o método da rede entomológica tendeu a tornar menor a proporção de fêmeas.

Termos para indexação: *Zulia entreriana*, *Deois flavopicta*, *Brachiaria decumbens*, Cercopidae.

INTRODUCTION

Spittlebugs are one of the important limiting factors in attaining full potential of meat production in Brazil. By one estimate, these insects reduced green matter content of Brazilian

pastures by about 15% (Empresa Brasileira de Pesquisa Agropecuária 1984). Apart from pastures, they damage rice (Ferreira & Guazzelli 1982, Barbosa et al. 1983, Nilakhe 1985) and corn (Santos et al. 1982).

Knowledge about biology, behavior and ecology of spittlebugs is needed in order to develop sound control strategies. These types of studies require a fairly large number of insects. Normally, adults are collected by means of a sweep-net and then transferred with use of an aspirator to cages with grass plants serving as food. It is not unusual to find 40% - 50% mortality of adults caged over *Brachiaria decumbens* Stapf plants the day following collection. Mortality of adults caged over rice plants in field ranged from 31% - 67% the day following collection (Souza & Nilakhe 1985). Such high mortalities probably occur partly

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because of the collection and holding methods used. It was believed that sweeping injures the adults thus reducing their survival. Therefore, any information that would help increase survival would be useful. Tests were conducted to compare survival of adults captured in samples of different numbers of sweeps of a sweep-net with those captured using a cage method. Influence of an aspirator on survival was also studied. In addition data on survival of adults collected at different times of a day are reported. Influence of collection method and collection time on number of adults captured and their sexual proportion was also studied. Such information should be useful in deciding the ideal collection method and the best time to capture a maximum number of insects.

MATERIALS AND METHODS

Collection method and adult survival

Of the five treatments evaluated, four involved use of a sweep-net and for the fifth a cage was used. With use of a sweep-net, adults were collected in samples of 10, 30 and 50 sweeps from pastures of *B. decumbens*. The sweep-net used had a 40 cm diameter ring, a cone-shaped bag made of strong muslin 70 cm deep, and a handle about 130 cm long. For each sweep, the pasture in a semicircle of 1.3 m radius (distance between the person and the outermost part of the ring) was swept and the person walked a distance of 1.5 m (two small steps). Captured spittlebugs were transferred to saran covered cages of 35 cm x 35 cm x 60 cm tall, one for each of the three types of sweep samples. Grass plants were placed inside cages to serve as food and shelter. Sweeping was continued until about 100 adults were collected per cage. For the fourth treatment, adults were collected in ten sweep samples and held in the saran cage. Then the insects were transferred to permanent-holding cages using an aspirator with a suction tube 60 cm long and inside diameter of 1 cm. The cage method consisted of capturing adults by pulling an open end of 1 m³ saran covered cage 20 cm above the pasture at 30° angle. After moving 10 m - 15 m, insects appearing on the screen were collected using a glass jar (6 cm diameter x 12 cm tall) whose inside was lined with about 1 cm cotton. Adults were transferred to permanent-holding cages in the same manner. The permanent-holding cage consisted of *B. decumbens* plants grown in 2 kg capacity pots and enclosed in a cage made of a metal frame covered with a 15 mesh nylon cloth. Plants provided enough food for the ten caged adults. Cages were held in a greenhouse and mortality was recorded daily. Temperatures inside greenhouse fluctuated between 18°C - 36°C. Six pots were used per treatment and the whole test comprising of the five treatments was repeated

over three different collection periods designated as Tests 1, 2 and 3 with each species of spittlebug, *Deois flavopicta* (Stal), and, *Zulia entrerriana* (Berg.). In all tests the insects were collected at 8 a.m. - 9 a.m. and were transferred to the permanent-holding cages within two hours.

Analysis of variance was performed on the mean adult survival per pot. For each spittlebug species, the data were analyzed as a two factor experiment, where the two factors were collection method and test. To stabilize variance, observations were transformed as $\sqrt{x + 0.5}$, where x is equal to the observed count. However, in tables, data are presented on original scale.

Collection time and adult survival

Spittlebug adults were collected in ten sweep samples at 8 a.m. - 9 a.m., midday - 1 p.m., and 5 p.m. - 6 p.m. and were transferred to potted grass plants by means of a test tube. Fifteen adults were placed in each pot and there were six pots per collection time. The whole test was repeated twice with *D. flavopicta* and *S. entrerriana*. Other details were the same as in the preceding section.

Effect of collection method and collection time on numbers captured and sexual proportion

Five continuous plots of 25 m x 25 m in twelve *B. decumbens* pastures were used. In each plot, two samples, one of 1 m³ of cage and another of ten sweeps of a sweep-net were taken in the immediate vicinity during 8 a.m. - 9 a.m., midday - 1 p.m. - and 5 p.m. - 6 p.m. Methodology for the sweep-net sample was the same as given in the first section. For each cage sample, a cage of 1 m³ made with wooden frame and saran was used. The cage was hooked in the center of a 3 m - long, 3 cm - diameter light weight metal pipe, and was carried by two people in arms upright position in such a manner that the cage remained about 1 m above the soil level until it was lowered to the area being sampled. Carrying the cage in this manner did not alert the spittlebug adults present directly below the cage; thus no adult entered through the open end of the cage facing the pasture. Adults inside the cage were collected by using an aspirator. To obtain all adults, plants inside the cage were shaken vigorously clipped at ground level, and the clipped plants and stubs were examined carefully for any remaining adults. Details about the cage method were given by Nilakhe et al. (1984), and Nilakhe (1986). Adults collected were brought to laboratory, separated by species and sexed.

Statistical procedures were similar as given in the first section. The variation due to pastures, and plots within pasture, were included in the analysis also. To analyse the data about sexual proportions of captured adults, the number of males and females obtained in five plots for each combination of collection method and collection time for each pasture were added and a percentage of females was obtained. For an analysis of variance, these

percentages were subjected to angular transformation (LeClerg et al. 1962), however, in Table, the data are presented on original scale.

Studies reported here were conducted during February 1984 to January 1985. At least one of the tests dealing with adult survival as influenced by collection method and collection time was performed during each of the two rainy seasons. The pastures used were located in the Dourados region and near Campo Grande, MS, Brazil.

RESULTS

Collection method and adult survival

Adults of *Z. entreriana* collected in samples of ten sweeps of a sweep-net and transferred from one cage to another by means of an aspirator lived shorter than those collected in 30 and 10 sweep samples and cage method and transferred by means of a glass jar lined with cotton (Table 1). However, sweeping itself did not reduce survival of adults collected in samples of 50, 30 or 10 sweeps. In the case of *D. flavopicta*, interaction of collection method x test was significant. In Test 1, no significant differences were found

TABLE 1. Effect of collection method on survival of spittlebug adults.

Collection method	Survival in days of spittlebugs ¹	
	<i>Zulia entreriana</i>	<i>Deois flavopicta</i>
Samples of 10 sweeps + aspirator	5.62 a	6.02
Samples of 50 sweeps	6.70 ab	6.59
Samples of 10 sweeps	6.83 b	7.94
Samples of 30 sweeps	7.30 b	7.38
Cage	7.42 b	7.64

¹ In a column, means not followed by the same letters differ significantly at 5% level of probability according to Duncan's multiple range test. In the case of *D. flavopicta*, interaction of collection method x test (collection period) was significant.

among treatments ($P > 0.05$). In Test 2, use of an aspirator reduced adult survival in comparison with the other four treatments in which spittlebugs were transferred using a glass jar lined with cotton. In Test 3, adults transferred with an aspirator lived shorter than those in the 10 and 30 sweep

samples and the ones collected using a cage, but not in comparison with those collected in 50 sweep samples. Adults collected in 50 sweep samples lived shorter than those collected in ten sweep samples ($P < 0.05$).

Collection time and adult survival

Spittlebug adults of both species collected at 8 a.m. - 9 a.m. lived longer than those collected at midday - 1 p.m. and 5 p.m. - 6 p.m. ($P < 0.05$) (Table 2). Significant differences between tests for each species were obtained, however, interactions, collection time x test were not significant for either of the species.

Effect of collection method and collection time on numbers captured and sexual proportion

The mean grass plant height among the twelve *B. decumbens* pastures varied from 10 cm to 32.3 cm (Table 3). Predominant spittlebug, species in eight of twelve fields was *Z. entreriana*. Table 3 also shows that a wide range of spittlebug adult densities were found in this study.

TABLE 2. Effect of collection time on survival of spittlebug adults.

Collection time	Survival in days of spittlebugs ¹	
	<i>Zulia entreriana</i>	<i>Deois flavopicta</i>
8 a.m. - 9 a.m.	3.33 a	3.12 a
midday - 1 p.m.	2.10 b	2.31 b
5 p.m. - 6 p.m.	2.38 b	2.33 b

¹ In a column, means not followed by the same letter differ significantly at 5% level of probability according to Duncan's multiple range test.

An analysis of variance on the number of adults captured showed significant differences for plots within pasture, and among pastures also. No significant differences were found among collections made by the cage method during 8 a.m. - 9 a.m., midday - 1 p.m., and 5 p.m. - 6 p.m. ($P > 0.05$) (Table 4). In the case of sweep-net method, more adults were captured during 5 p.m. - 6 p.m. than during 8 a.m. - 9 a.m. or midday - 1 p.m. ($P < 0.05$). An analysis of variance on the percentages of females captured showed no

significant interaction of collection method x collection time. The cage method yielded significantly higher percentage of females (64.2) than the sweep-net method (48.0) ($P < 0.05$). A greater percentage of females were obtained during 5 p.m. - 6 p.m. (62.2) than at 8 a.m. - 9 a.m. (51.0) or midday - 1 p.m. (55.2).

TABLE 3. Mean number of spittlebug adults obtained using two collection methods, classification of the insects according to species, and grass height of *Brachiaria decumbens* pastures sampled, Mato Grosso do Sul, 1984-85.

Pasture	\bar{x} grass height ¹	\bar{x} no. of spittlebug adults ²		% spittlebugs belonging to species	
		sweep sample	cage sample	<i>Zulia</i> <i>entreriana</i>	<i>Deois</i> <i>flavopicta</i>
1	32.3	15.73	5.80	100	0
2	16.5	17.93	4.33	39	61
3	14.2	23.07	7.73	15	85
4	12.0	23.67	7.60	39	61
5	14.1	25.93	11.07	40	60
6	16.1	30.67	6.60	76	24
7	30.4	41.47	15.27	78	22
8	28.5	42.80	10.13	79	21
9	30.0	49.20	17.60	82	18
10	24.3	55.20	16.13	82	18
11	10.0	56.07	27.40	97	3
12	23.5	59.47	15.33	96	4

¹ Each datum is mean of 25 observations.

² A sweep sample consisted of ten sweeps of a sweep-net. A cage sample consisted of all adults in 1 m² of the pasture. Each datum is based on 15 observations.

DISCUSSION

In a study about influence of collection method on adult survival, the cage method was included only for comparative purposes. Dragging cage on pasture for routine collection of spittlebug adults would be impractical. Although the results for the two spittlebug species studied were somewhat different, it can be stated that generally the adult survival was same irrespective of whether the insects were collected in samples of 10 or 50 sweeps of a sweep-net. This is good because collecting spittlebugs in 50 sweep samples would reduce the collection time in comparison to ten sweep samples. An aspirator helps in a quick transference of adults from one cage to other, however, its use tended to reduce adult survival. Perhaps the suction process injures the insects. A glass jar lined with cotton used in transferring insects from one cage to another, generally helped improve the survival. It is possible that cotton

acts as a cushion against the jumping insects thus reducing impact against a hard surface such as glass. However, at times adults get tangled in cotton and there is a possibility of adults jumping out of the jar. Therefore, only a few insects (5 - 6) can be transferred at a time, whereas, an aspirator permits the transfer of a large number of adults. In studies needing a greater precision, a jar lined with some smooth surface such as cotton could be used, whereas for other purposes an aspirator should be adequate.

The reasons so as to why spittlebugs collected in the morning lived longer than those collected in the afternoon and evening are not clear. Adults in these tests survived about half the period as those in tests to study influence of collection method on survival. A possible explanation for such a difference is that although the two studies were conducted about the same period, adults were obtained from different localities. It is likely

TABLE 4. Mean number of spittlebug adults obtained using two collection methods three times a day in *Brachiaria decumbens* pastures, Mato Grosso do Sul, Brazil, 1984-85¹.

Collection method	Collection time	Mean no. of adults ²	Percent females ³
Cage	8 a.m. - 9 a.m.	12.22 a	59.37
	midday - 1 p.m.	12.00 a	64.27
	5 p.m. - 6 p.m.	11.78 a	68.96
Sweep-net	8 a.m. - 9 a.m.	36.40 b	42.58
	midday - 1 p.m.	32.75 b	46.19
	5 p.m. - 6 p.m.	43.55 c	55.40

¹ A sweep-net sample consisted of ten sweeps and a cage sample consisted of adults in 1 m² of pasture.

² Mean not followed by the same letter differ significantly at 5% level of probability by Duncan's multiple range test.

³ Interaction, collection method x collection time was not significant ($P > 0.05$). Cage method yielded significantly higher percentage of females than sweep-net. A greater percentage of females were obtained at 5 p.m. - 6 p.m. than at 8 a.m. - 9 a.m. or midday - 1 p.m.

that adults collected to study influence of collection time on survival were nearer the end of their adult life span. Also adults were transferred using a test tube and this might have injured bugs upon jumping in the tube. It is suggested in order to reduce stress, transfer adults in a cage with good air circulation, hold cage in shade, supply the insects with large quantities of grass plants for shelter and food, and transfer the insects to permanent holding cages as soon as possible.

In the study about effect of collection method and collection time on sexual proportion of the adults captured, the cage method was included to obtain absolute estimate of population, and principally to compare the sex ratio with that obtained by the sweep-net method. Since the number of adults captured using the cage method was the same in sampling done during 8 a.m. - 9 a.m., midday - 1 p.m., and 5 p.m. - 6 p.m., it can be concluded that very little, if any, immigration and/or emigration occurred on the days of sampling. On the other hand, the number of adults obtained using the sweep-net were consistently higher during the 5 p.m. - 6 p.m. collection. The

behavior of spittlebug adults is not known, but it is likely that during 8 a.m. - 9 a.m. and midday - 1 p.m., the female spittlebugs tend to remain closer to soil level than at 5 p.m. - 6 p.m.; also the temperature changes within a day may influence the behavior.

In the present study, the percentage of females among adults captured by sweeping in the twelve pastures ranged between 39.2% to 60.7%. In a population fluctuation study performed in the state of Mato Grosso do Sul in *B. decumbens* pastures, the percent females of *Z. entreriana* obtained in the sweeping varied from 20% to 75% (Koller & Valério 1984). However, in a four-year study conducted in the state of Minas Gerais, also in *B. decumbens* pastures, the percentages of *D. flavopicta* females obtained ranged between 18.7 to 27.6 in the collections made by a sweep-net (Melo & Silveira Neto 1983). The reason for such consistently low proportion of females are difficult to explain. It is clear that a sweep-net permits collection of a portion of adults in the area swept, and those very close to the soil are very seldom included. Thus a question arises so as to whether the sexual proportion obtained using a sweep-net is representative for the area sampled or not. The cage method permits collection of all adults present in a given area. Therefore, the sexual proportion obtained using the cage method was considered more accurate than when the sweep-net was used. In the present study, the percent of females obtained using a sweep-net was 48.0 and it was 64.2 for the cage method. The cage method may be used in studies needing greater accuracy about sexual ratios and absolute population counts. The estimates about sexual ratios could be improved by increasing the number of cage samples. When the objective is to obtain a greater number of spittlebug adults, then sweeping should be done in the evening; this probably may give a higher proportion of females also.

Ramiro et al. (1984) made hourly collections of spittlebug adults mostly in pastures of *B. decumbens*. While sweeping during 6 a.m. to 7 p.m., they tended to capture more spittlebugs during 6 a.m. to 11 a.m. and 5 p.m. to 7 p.m., however, these differences were not statistically significant ($P > 0.05$). In the present study, a greater number

of spittlebugs were captured during 5 p.m. - 6 p.m. than during 8 a.m. - 9 a.m. and midday - 1 p.m. This should be considered when studying population fluctuations. One may sample at the same time each day for all samplings, however, the time sampled should be made clear to the reader. It is suggested to avoid sampling before 8 a.m. - this may give sufficient time for dew on the grass plants to evaporate and thus the sweep-net bag would not become wet. If possible, sampling for such studies should be terminated before 5 p.m. For developing a regression model to convert sweep-net counts to absolute counts (cage method), Nilakhe et al. (1984) sampled during 8 a.m. - 11 a.m. and 1 p.m. - 4 p.m. If one intends to use this model, then it would be appropriate to sample during the mentioned periods.

CONCLUSIONS

1. Spittlebug survival was not reduced even when the insects were collected in samples of 50 sweeps of a sweep-net instead of 10.
2. Sweeping in the evenings should yield a maximum number of adults with a higher proportion of females.
3. Sweep-net method tended to underestimate the proportion of females in the area sampled. Therefore, for studies requiring accurate determination of sexual proportions, the use of a method that gives absolute counts of the insects (cage method) should be considered.

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