NEW PERSPECTIVES FOR MANAGING GRASSLAND SPITTLEBUGS

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INTRODUCTION

Spittlebugs (Homoptera: Cercopidae) are the most widespread and damaging pest of the most extensive agricultural activity in the Neotropics, pastures for milk and beef production. Despite a long history and increasing pest status in forage grasses and sugar cane, an effective and coordinated IPM program does not yet exist One limitation is a rudimentary understanding of the variation in spittlebug-forage-habitat interactions, crucial to tailoring management to the diverse geographic and production systems where grassland spittlebugs occur

There is no effective **IPM** for grassland spittlebugs:

- Tendency to overgeneralize among the diversity of species, genera and habitat associations
- Natural history of the family is poorly understood
- Biological information for the majority of economically important species is lacking
- Detailed site-specific ecological studies are scarce
- IPM tools are rudimentary or absent

Spittlebug nymphs and adult on *Brachiaria decumbens*

OBJECTIVES

- Describe the seasonal population fluctuations of spittlebugs in contrasting regions of Colombia
- Identify variation and patterns at the level of farm, region, season and year in certain components of population ecology including:
  - species composition
  - abundance
  - phenology
  - population synchrony
  - voltinism
  - incidence of natural enemies
- Based on this information, develop new guidelines for advancing the integrated management of spittlebugs in pastures and rangelands

Spittlebug damage on *Bothriochloa pertusa* (A), *Pennisetum clandestinum* (B) and *Brachiaria decumbens* (C).

METHODOLOGY

Four contrasting regions were developed as model sites for studying the field ecology of grassland spittlebugs These sites varied from 15-1000 m elevation and 1000-3600 mm mean annual precipitation under markedly different seasonal patterns highly seasonal with unimodal rainfall (Caribbean Coast Savannas, *Bothriochloa pertusa*), highly seasonal with bimodal rainfall (Interandean Region, *Brachiaria dictyoneura*), intermediate seasonal (Eastern Savannas, *Brachiaria decumbens*), and continuously humid (Amazonian Piedmont, *B. decumbens*) (**Fig. 1**)

Comparative population studies were performed over two years in four sites representing three of these regions At each site, three study plots were established on a representative farm. Each plot was in a separate paddock and maintained under the normal grazing and pasture management regime Spittle mass and sweep net surveys were performed twice weekly (**Fig. 2**). All nymphs were determined to instar, adults to sex and species, and natural enemies were censused

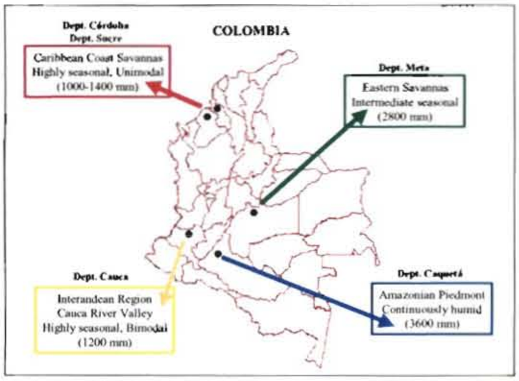

Fig. 1. Contrasting regions for comparative population studies.

Fifth instar (A) and teneral adult (B) in spittle mass.

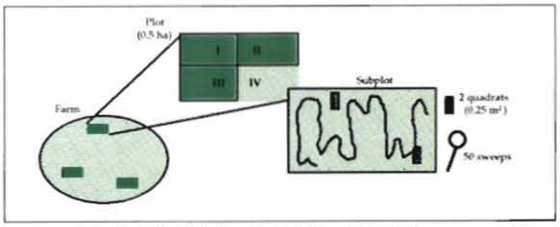

Fig. 2. Survey methodology for spittlebug nymphs and adults.

RESULTS

Species Composition. Seven spittlebug species from four genera were detected at these sites The genus *Prosapia* was reported for the first time in South America because *Prosapia simulans* was detected at economically damaging levels in the Cauca River Valley (Fig. 3) This species is a potential threat to sugarcane production An undescribed species of the genus *Mahanarva* was detected Diversity was lowest in the highly seasonal sites where one species dominated. Three species occurred in the intermediate seasonal site, one in high abundance. Diversity was highest in the continuously humid site where four species occurred, two in high abundance (**Table 1**).

Table 1. Species composition (% adult abundance) of spittlebugs in four contrasting regions of Colombia

Species	Caribbean Coast Savannas	Interandean Region	Eastern Savannas	Amazonian Piedmont
	Highly seasonal (unimodal)	Highly seasonal (bimodal)	Intermediate seasonal	Continuously humid
Aeneolamia lepidior	< 1	--	--	--
Aeneolamia reducta	100	--	5	--
Aeneolamia varia	--	--	94	74
Mahanarva sp. nov	--	--	--	1
Prosapia simulans	--	< 1	--	--
Zulia carbonaria	--	100	--	*
Zulia pubescens	--	*	1	25

* Species found in the area but not detected at survey site

Natural Enemies. Five classes of natural enemies were encountered in the four regions predaceous flies, parasitic flies, parasitic nematodes, parasitic mites and fungal entomopathogens Syrphid fly larvae (*Salpingogaster nigra*) are the most well-known and widespread spittlebug natural enemies Pipunculid flies were reported for the first time parasitizing New World cercopids (adults). A total of 75 isolates of fungal entomopathogens from at least 10 genera (*Aspergillus, Beauveria, Curvularia, Dactylella, Fusarium, Metarhizium, Paecilomyces, Penicillium, Sporothrix, Trichoderma*) have been obtained from nymphs or adults of six spittlebug species

In the comparative population surveys, the three sites highly seasonal for rainfall experienced the lowest overall incidence of natural enemies. The continuously wet site experienced the greatest (**Table 2**)

Table 2. Incidence of spittlebug natural enemies (months of year detected) in four contrasting regions of Colombia

Species	Caribbean Coast Savannas	Interandean Region	Eastern Savannas	Amazonian Piedmont
	Highly seasonal (unimodal)	Highly seasonal (bimodal)	Intermediate seasonal	Continuously humid
Fungal entomopathogens	--	5	1	5
Parasitic flies (Pipunculidae)	--	*	--	--
Parasitic mites (Erythraeidae)	8	6	7	11
Parasitic nematodes (Mermithidae)	2	--	7	2
Predaceous flies (Asilidae)	--	*	--	--
Predaceous flies (Syrphidae)	--	3	2	7

* Enemies found in the area but not detected during population surveys

Population Fluctuation. Spittlebug nymphs and adults occurred during the wet season and disappeared during the driest periods. The insect survived the dry season as dormant or diapausing eggs.

The greatest population fluctuations occurred in the most seasonally dry sites based on (1) complete disappearance of the insect during the dry season months and (2) extreme population peaks during the wet season beginning with the return of the rains (**Fig. 4**). Population fluctuations were less pronounced in the intermediate seasonal site, corresponding to the shorter and less severe dry season. Nymphs and adults were not detected in at least one of the driest months of each year. In the continuously humid site, nymphs and adults were detected every month of the year corresponding to the lack of a distinct dry season

Population synchrony was greatest in the seasonal sites where abrupt nymph population peaks were paired with consecutive adult population peaks. Such synchronous population peaks were not detectable in the continuously humid site

...*sapia simulans*, Central ...pecies newly reported from ...nd South America. Male (left)

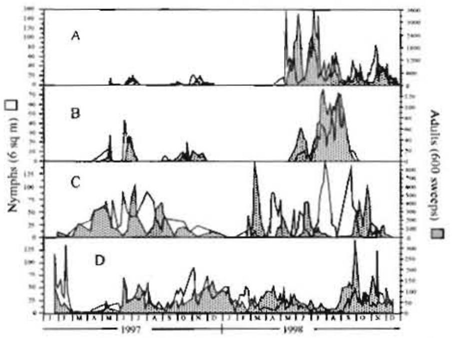

Fig. 4. Population fluctuation of nymph and adult spittlebugs during two years of study in three contrasting regions of Colombia. **A)** Highly seasonal unimodal (Caribbean Coast, Dept. Córdoba), **B)** Highly seasonal unimodal (Caribbean Coast, Dept. Sucre), C) Intermediate seasonal (Eastern Savannas, Dept. Meta), D) Continuously humid (Amazonian Piedmont, Dept. Caquetá).

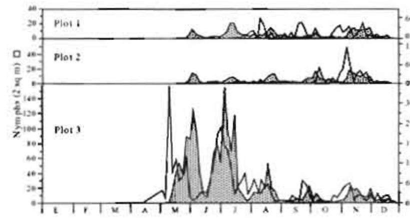

Fig. 5. Population fluctuation of total nymphs and adults in three paddocks. *Aeneolamia reducta*, highly seasonal site (Caribbean Coast, Dept. Sucre).

Aeneolamia lepidior

Aeneolamia reducta

Aeneolamia varia

Mahanarva sp. nov.

Zulia carbonaria

Zulia pubescens

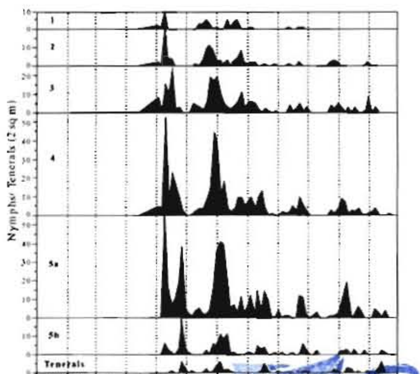

Fig. 6. Population fluctuation of nymphal life stages. *Aeneolamia reducta*, highly seasonal site (Caribbean Coast, Dept. Sucre, Plot 3).

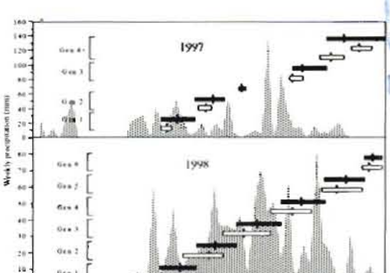

Fig. 7. Weekly precipitation and phenograms of spittlebug nymphs and adults. Horizontal bars indicate period of occurrence of the life stage while vertical lines indicate accumulation of 50% insect-days. *Aeneolamia reducta*, highly seasonal site (Caribbean Coast, Dept. Sucre).

Phenology. Resolution of population dynamics was greatly enhanced by considering all study paddocks separately. As an example, population curves of Sucre 1998 (Caribbean Coast savanna, highly seasonal) were assessed to gauge on-farm variation in abundance and phenology. In terms of abundance, paddock P3 experienced 5-6 times more nymphs and adults than P1 and P2. In terms of phenology, the first nymph population peak in P3 was not detected in P1 and P2 (Fig. 5)

These phenological differences offered strong evidence for rapid colonization of previously uninfested areas of a farm through adult movement. Initial adult population peaks in P1 and P2 coincided with the second adult peak in P3, but were not accompanied by a preceding nymph peak. Adults in P1 and P2 were therefore immigrants. Fires that swept through P1 and P2 (but not P3) late in the dry season probably killed the soil-borne eggs; colonizing adults from surrounding unaffected areas, such as P3, re-established the local population.

Resolution of population dynamics was further enhanced though an assessment of all spittlebug life stages, not just total nymphs and total adults. This permitted an interpretation based on progression of the generation rather than overall population peaks.

For instance, in Sucre 1998, P3, there was a clear recruitment of nymphs from one life stage to the next up through teneral adults still found in the spittle mass. This was evidence for two large and synchronous initial generations in this paddock These contributed to four more distinct, but less synchronous, generations. Generation size also appeared to decrease with the progression of the wet season These six generations matured approximately every 1.5 months end May, start July, mid August, end September, mid November and mid December (Fig. 6)

This detailed analysis led to phenograms that graphically depict population and generation development in the survey sites. Based on calculations of 50% accumulated insect-days for each generation, *Aeneolamia reducta* on the Caribbean Coast completed its life cycle every 43.1 d (n=16) This corresponded very well with results obtained from greenhouse studies (45 3 d). *A. reducta* is therefore the most prolific grassland spittlebug known, achieving six generations in a highly seasonal environment characterized by 2-3 dry months per year (**Fig. 7**).

Regions with low precipitation that is highly seasonal may be characterized by:

- lower incidence of natural enemies
- low local diversity of spittlebugs
- pronounced population fluctuations
- high population synchrony

Regions with high precipitation that are continuously humid may be characterized by:

- higher incidence of natural enemies
- high local diversity of spittlebugs
- less pronounced population fluctuations
- low or no population synchrony

Dual-purpose production in forest margins of Amazonian Piedmont

NEW MANAGEMENT PERSPECTIVES

In sites more seasonal for rainfall, spatial and temporal determination of early season outbreaks is vital. Scouting strategies must focus on nymphs, before the first generation of mobile adults. Control tactics should target these foci to suppress nymph populations and thereby decrease colonization of other non-infested areas and reduce the size of subsequent generations. Given the extensive nature of pasture and rangelands, identification of foci is critical before control tactics such as intensive grazing, mowing, burning and pesticides become practical

In sites less seasonal for rainfall, the insect occurs all year round and presents little population synchrony Control strategies should be based on cultural tactics to reduce habitat quality for reproduction and development. Habitat management such as grazing management, host plant selection, resistance and diversification should be investigated With enhanced rainfall and continual presence of the insect, deployment of fungal entomopathogens and other natural enemies as agents of biological control will be more feasible

CONCLUSIONS

- New spittlebug enemies remain to be discovered In particular, there is a very high diversity of fungal entomopathogens that should be exploited. Few spittlebug natural enemies have been seriously evaluated as agents of biological control.
- High resolution and accurate interpretation of local population dynamics depend on detailed site-specific studies that (1) gauge on-farm variability and (2) discriminate among all life stages. Very few regions have this information available for guiding the selection and targeting of management tactics
- The wide geographic range where spittlebugs occur as pests of graminoid crops is accompanied by wide variation in spittlebug-forage-habitat interactions that is relevant to pest status, pest ecology and consequently the development of pest management strategies. Information from more regions must be gathered to determine how seasonal rainfall patterns may broadly drive local species diversity, population dynamics, phenology and the incidence and impact of natural enemies

ABSTRACT Comparative field population studies of grassland spittlebugs were performed over two years in four contrasting regions of Colombia. The methodology was designed to describe on-farm, regional and seasonal variation in certain components of population ecology including species composition, abundance, synchrony, phenology and natural enemies. Spittle mass and sweep net surveys were performed twice weekly in plots established on representative farms. Nymphs were determined to instar, adults to sex and species, and natural enemies were censused. Six classes of enemies and seven spittlebug species were identified from these sites. In the two sites highly seasonal for rainfall, one species occurred, and population fluctuation and synchrony were the greatest. Strong evidence was gathered for rapid colonization of previously uninfested areas of a farm through adult movement, suggesting that suppression of initial population foci is important for management. At the site of intermediate seasonality, one species dominated while two others were present, and population fluctuations and synchrony were reduced. In the site that never experienced a dry season, three species were sympatric, population fluctuations were further reduced and species-specific, and there was a continuous presence of nymphs and adults, or no population synchrony. Local phenology was most precisely determined through analysis of nymphal life stages permitting a detailed evaluation of population development and number of generations. For instance, six generations of *Aeneolamia reducta* were completed in the highly seasonal site despite 2-3 months of drought. There was excellent correspondence in generation time as estimated from population fluctuations (43.1d) and biology studies (45.2d). In sites seasonal for rainfall, spatial and temporal determination of early season outbreaks is vital for directing control tactics to suppress local populations before they spread to other areas and contribute to future generations. Less seasonal sites with continual pest presence and little population synchrony are more appropriate for application of cultural control and deployment of natural enemies such as fungal entomopathogens.