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RAPID SPREAD OF *BALCLUTHA RUBROSTRIATA* (HEMIPTERA: CICADELLIDAE) IN TEXAS AND SOUTHWESTERN LOUISIANA, USA WITH NOTES ON ITS ASSOCIATED HOST PLANTS

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Abstract

The red streaked leafhopper, *Balclutha rubrostriata* (Melichar) (Hemiptera: Cicadellidae), is an invasive insect from southeastern Asia that is known to be a vector of the phytoplasma that causes Sugarcane White Leaf Disease (SCWL). Sugarcane is a vital crop for the United States and is being considered as a biofuel source. The purpose of this survey was to determine whether *B. rubrostriata* has established populations in Texas and Louisiana, USA; and, if established, to estimate its range expansion. The gulf coast region of Texas, east Texas, and 2 southwestern parishes of Louisiana were surveyed for the red streaked leafhopper. Samples of the leafhopper were collected in all Gulf Coast regions and the majority of east Texas counties. However, it was only collected in one Louisiana parish. The leafhopper appears to be closely associated with an invasive grass, King Ranch Bluestem, *Bothriochloa ischaemum* (L.), throughout much of its present range in the United States, and it is now common along much of the Texas Gulf Coast and is moving into Louisiana.

Key Words: *Balclutha rubrostriata*, leafhopper, Texas, Louisiana, sugarcane, white leaf phytoplasma

Resumen

El saltahoja rojo rayado, *Balclutha rubrostriata* (Melichar), es un insecto invasor del sudeste de Asia, que es conocido por ser un vector de la fitoplasma que causa la Enfermedad fr Hoja Blanca de la Caña de Azúcar (EHBCA). La caña de azúcar es un cultivo importante para los Estados Unidos y está siendo considerado como una fuente de biocombustible. El propósito de este estudio fue determinar si *B. rubrostriata* ha establecido poblaciones en los estados de Texas y Louisiana en los EE.UU., y, en caso de estar establecido, para estimar su rango de expansión. Se realizó un sondeo de la región de la costa del golfo de Texas, al este de Texas, y dos parroquias del suroeste de Louisiana para evaluar por la presencia del saltahoja rojo rayado. Se recolectaron muestras del saltahoja en todas las regiones de la costa del golfo y la mayoría de los condados del este de Texas. Sin embargo, sólo fue recolectado en una parroquia de Louisiana. El saltahoja parece estar estrechamente asociado con un zacate invasor, ‹King Ranch Bluestem›, *Bothriochloa ischaemum* (L.), en gran parte de su área de distribución actual en los Estados Unidos, y ahora es común a lo largo de la Costa del Golfo de Texas y se esta moviendo dentro de Louisiana.

Palabras Clave: especies invasoras, saltahojas, Texas, Louisiana, hoja de caña de azúcar, blanco fitoplasmas

The leafhopper genus *Balclutha* contains 111 grass-feeding species and is near cosmopolitan in distribution. The red streaked leafhopper (RSLH), *Balclutha rubrostriata* (Melichar), is native to Sri Lanka and India, but has spread to Australia, Asian Islands, Southeast Asia, Japan, the eastern Mediterranean, and several African countries in the Old World. In the New World it has been found in Puerto Rico, U.S. Virgin Islands, Central America, Hawaii, and recently in Texas, USA (Knight 1987; Andrew & Hughes 2005; Hanboonsong et al. 2006; Zahniser et al. 2010).

Balclutha rubrostriata is an ecological and economic threat in several ways. In Thailand, *B. rubrosriata* is known to attack sugarcane (*Saccharum* spp.; Cyperales: Poaceae), and in a survey conducted by Hanboonsong et al. (2006), over 30% of the individuals tested carried the phytoplasma (sugarcane white leaf phytoplasm 16SrXI) that causes sugarcane white leaf disease (SCWL). This prevalence was second highest of the vectors tested, suggesting that *B. rubrostriata* is a highly competent vector. This disease can cause total leaf chlorosis and tiller prolifera-

tion (Wongkaew et al. 1997), which can create up to 100% crop yield losses in some areas (Rishi & Chen 1989). Leafhoppers are known to transmit at least 7 other viruses to sugarcane including *Fiji disease virus* (FDV), sugarcane mosaic virus (SrMV), *sugarcane steak virus* (SCSMV), *peanut clump virus* (PCV), *sugarcane yellow leaf virus* (SCYLV), *sugarcane bacilliform virus* (SCBV), and *sugarcane mild mosaic virus* (SCMMV), all of which are economically important (Cronjé 2003). While *B. rubrostriata* has not been identified as a vector of these latter viruses, it has also not been evaluated for competency, and there is no reason to believe that this exotic leafhopper species could not introduce and vector other viruses. Knight & Webb (1993) have found that the ability to transmit viruses has evolved on 3 separate occasions within the leafhopper tribe Macrostelini, and those that can transmit viruses are likely able to transmit different viruses. In fact, Nault & Ammar (1989) found that many of these viruses survive only within the vector by transovarial transmission, and the viruses may be of insect origin and then secondarily transferred to plant hosts. This suggests that the virus could be carried by its leafhopper host and transmitted to sugarcane several generations after a leafhopper is introduced to a new area. Besides potentially vectoring SCWL and other viruses, leafhoppers cause direct damage to sugarcane by sap removal (Long & Hensley 1972) and while this damage is not usually as extensive as is caused by some other pests, it still contributes to detrimental effects on the host plant. Adding additional pests, especially exotic pests that arrive without natural enemies can cause high population densities, and significant negative effects.

Zahniser et al. (2010) first recognized that *B. rubrostriata* occurred in Texas, USA. *Balclutha rubrostriata* was collected in Bexar County, Texas where it was found to be the dominant organism in surveys, making up nearly 85% of samples. They also found a single museum specimen from the Texas A&M Kingsville Invertebrate Museum that was collected in Kingsville, Kleberg County, Texas in 1991. Additionally, they discovered re-

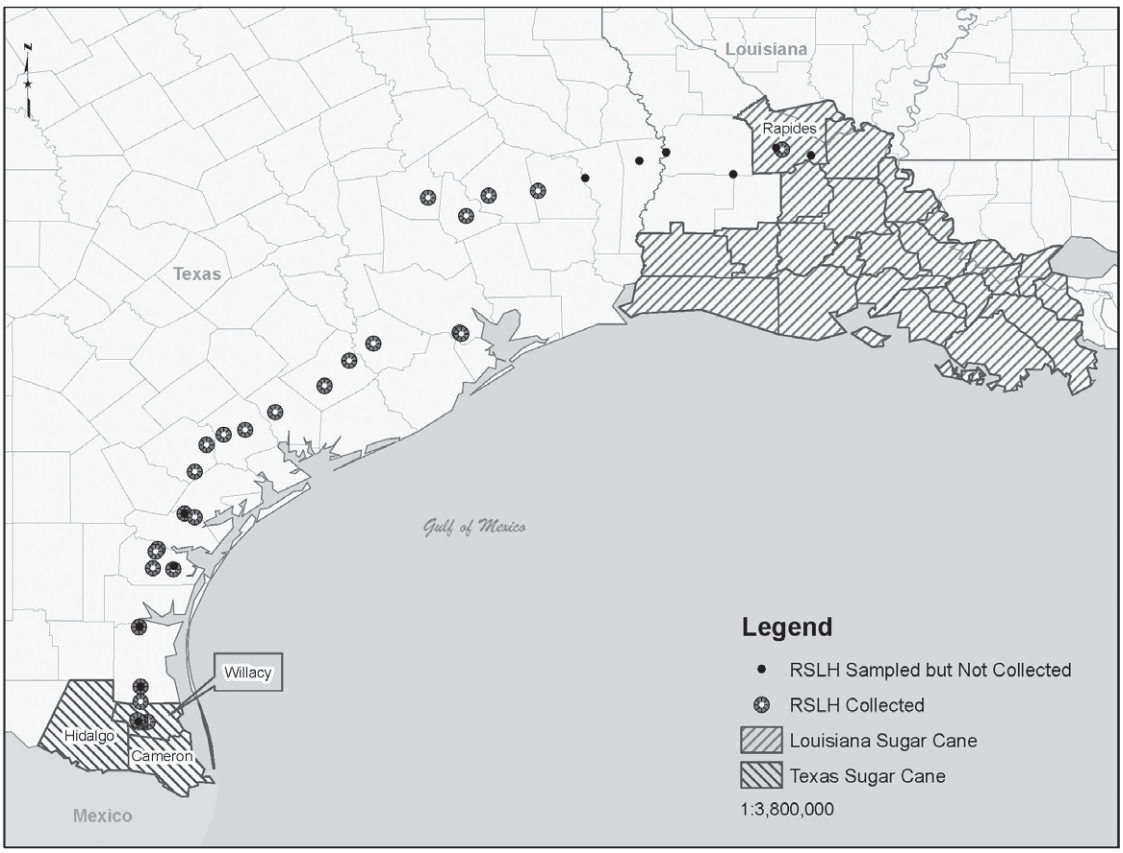

Fig. 1. Collection sites for survey of *Balclutha rubrostriata*. Large circles are survey sites where *B. rubrostriata* was collected. Black dots represent sample sites where samples were collected but *B. rubrostriata* was not found. A few sites appear to be a combination of the 2 but these represent independent samples on different grass types as reported in Table 1. Counties where sugarcane crops occur are shaded.

ports from Kerr County and Travis County, Texas of specimens collected in 2006 and 2008 respectively.

It was thought that SCWL would stay contained within Southeast Asia because of the specific insect vector system (Marcone 2002). However, the newly documented introductions show that this assumption may not be true, and that *B. rubrostriata* could introduce SCWL to the sugar-producing regions of the United States gulf coast. Our project goals were to determine whether *B. rubrostriata* was established in Texas and Louisiana and, if so, to document its range expansion toward sugarcane crops.

Materials and Methods

Insects were collected from grass fields, near highways by sweep netting. Sites for collections were along a transect from the sugar-producing regions of south Texas to those of southwestern Louisiana (Fig. 1). Species of grasses at these collection sites were recorded. In Willacy County, Texas and Rapides Parish, Louisiana, grasses within three feet of sugarcane crop were swept, along with additional collections on actual sugarcane, and these samples were maintained as separate collections. All collection site coordinates were recorded using a Garmin eTrex20 GPS along with a location name. Collection samples were stored in separate plastic containers and subsequently placed in freezers. Insects were later separated in to three vials: Miscellaneous Insects, RSLH, and other leafhoppers. Specimens were point-mounted or pinned, and deposited Sam Houston State University Invertebrate Collection (accession numbers SHSUE 006,106 - SHSUE 006,572). No effort was made for equivalent sampling at each site, but where *B. rubrostriata* was found, total insects collected were counted to determine a percentage of the sample represented by that species (reported as prevalence). Morphological confirmation of the red streaked leafhopper followed taxonomic traits listed by Zahniser et al. (2010) and Webb & Vilbaste (1994).

Results

The samples of all 16 Texas counties and two Louisiana parishes yielded over 2,200 invertebrates in which *Balclutha rubrostriata* averaged about 40.2% of each sample. Thus, in many of these samples it was the most abundant insect species associated with these grasses. While the RSLH accounts for 40.2% overall, when sampling on KR Bluestem (*Bothriochloa ischaemum*; Cyperales: Poaceae), *B. rubrostriata* was always present. Zahniser et al. (2010) confirmed the presence of *B. rubrostriata* in Bexar and Hays Counties in Texas. They also found, through internet sources, that *B. rubrostriata* had been observed in Kerr and Travis Counties in Texas. This survey adds 16 additional Texas counties, and 1 Louisiana parish to the distribution of *B. rubrostriata*. New Texas county records include: Willacy, Kenedy, Nueces, Refugio, Goliad, Victoria, Jackson, Wharton, Fort Bend, Harris, and Walker. Rapides Parish is a new state record for Louisiana. Figure 1 displays the physical locations of the 26 collection sites, and Table 1 lists the GPS coordinates of each site, the percentage of the sample represented by *B. rubrostriata*, and the type of grass(es) from which samples were collected. These results appear to demonstrate a positive correlation between King Ranch Bluestem over other grasses for RSLH. King Ranch Bluestem was prevalent in all counties, and it was found to be within 3 feet (91.5 cm) of sugarcane crops in Willacy County. One sample was taken from sugarcane. RSLH was not collected from sugarcane in Willacy County but was found in King Ranch bluestem less than 3 feet (91.5 cm) away.

Discussion

Even though Hanboonsong et al. (2006) identified *B. rubrostriata* as an important vector of SCWL, little is known about this leafhopper species. In general, the genus *Balclutha* is documented to use grasses and sedges as host plants, but ecological and biological data are "infrequent" for this group (Blocker 1967), which is the case for *B. rubrostiata*. It has been found on sugarcane by Hanboonsong et al. (2006) in Thailand, on rice (*Oryza sativa* L.; Poales: Poaceae) in the Philippines (Knight 1987) and on King Ranch Bluestem in Texas (Zahniser et al. 2010), but other grass associations are unknown.

This study confirmed the presence of *B. rubrostriata* in 15 Texas counties and 1 Louisiana parish. The majority of the RSLH were collected from King Ranch Bluestem suggesting that this may be an attractive host plant for the leafhopper. King Ranch Bluestem is itself an invasive species and has expanded across the state of Texas possibly making it easier for *B. rubrostriata* to expand its distribution. We observed a gradient for which KR Bluestem has established along the Texas gulf coast regions, east Texas, and Southwestern Louisiana. That is, south Texas (and the associated Gulf Coast regions) appears to have the highest rate of KR Bluestem encroachment. However, this gradient diminishes eastward through the eastern regions of Texas and western Louisiana; and the red streaked leaf hopper mirrors this gradient (Fig. 1, Table 1), suggesting some relationship. Fig. 1 and Table 1 also suggest that as KR Bluestem establishes populations across the eastern regions of Texas and the southwestern parishes of Louisiana, where sugarcane crops are

TABLE 1. PREVALENCE OF THE INVASIVE RED STREAKED LEAFHOPPER *BALCLUTHA RUBROSTRIATA* FROM GRASSES COLLECTED IN AND BETWEEN TEXAS AND LOUISIANA COUNTIES/PARISHES DURING NOV 2012.

State	County/Parish	Coordinates	Grass type sampled§	On or near Sugarcane	Prevalence
Texas	Fort Bend	N29.51468 W95.88710	King Ranch Bluestem∞	No	64%
Texas	Goliad	N28.47640 W97.33118	King Ranch Bluestem	No	78%
Texas	Goliad	N28.69752 W97.23778	King Ranch Bluestem	No	71%
Texas	Harris	N29.60671 W95.18835	King Ranch Bluestem	No	87%
Texas	Harris	N29.59479 W95.17507	King Ranch Bluestem	No	68%
Texas	Jackson	N28.96059 W96.068	King Ranch Bluestem	No	54%
Texas	Jasper	N30.85539 W94.17183	Other	No	0%
Texas	Kenedy	N26.73726 W97.76912	Other	No	0%
Texas	Kenedy	N26.73727 W97.76913	King Ranch Bluestem	No	60%
Texas	Kenedy	N27.22174 W97.78156	Other	No	0%
Texas	Newton	N30.99520 W93.73548	Other	No	0%
Texas	Nueces	N27.85401 W97.62993	King Ranch Bluestem	No	62%
Texas	Nueces	N27.83209 W97.64880	King Ranch Bluestem	No	79%
Texas	Nueces	N27.69515 W97.66837	King Ranch Bluestem	No	42%
Texas	Nueces	N27.68790 W97.50481	King Ranch Bluestem	No	60%
Texas	Nueces	N27.71153 W97.50188	Other	No	0%
Texas	Polk	N30.71204 W94.95106	King Ranch Bluestem	No	85%
Louisiana	Rapides*	N31.03723 W92.34353	Sugarcane	Yes	0%
Louisiana	Rapides	N31.08610 W92.57912	Little Bluestem mix	No	1%
Louisiana	Rapides	N31.09822 W92.62677	Other	No	0%
Louisiana	Rapides	N31.06461 W93.51728	Other	No	0%
Texas	Refugio	N28.13858 W97.41550	King Ranch Bluestem	No	62%
Texas	Refugio	N28.13859 W97.41551	Other	No	0%
Texas	San Jacinto	N 30.54963 W95.13313	King Ranch Bluestem	No	80%
Texas	San Patricio	N28.11025 W97.33248	King Ranch Bluestem	No	27%
Texas	Tyler	N30.75299 W94.55467	Little Bluestem mix	No	69%
Louisiana	Vernon	N30.88665 W92.97527	Other	No	0%
Texas	Victoria	N28.77738 W97.09771	King Ranch Bluestem	No	73%
Texas	Victoria	N28.81588 W96.92510	King Ranch Bluestem	No	20%
Texas	Walker	N30.69611 W95.44169	King Ranch Bluestem	No	ca. 37%
Texas	Wharton	N29.17435 W96.27995	King Ranch Bluestem	No	49%
Texas	Wharton	N29.37792 W96.08134	King Ranch Bluestem	No	50%
Texas	Willacy*	N26.45327 W97.71160	King Ranch Bluestem	Yes	71%
Texas	Willacy	N26.45212 W97.77171	King Ranch Bluestem	Yes	77%
Texas	Willacy	N26.45250 W97.78802	King Ranch Bluestem	Yes	25%
Texas	Willacy	N26.45250 W97.78802	Other	Yes	0%
Texas	Willacy	N26.46687 W97.79696	King Ranch Bluestem	Yes	74%
Texas	Willacy	N26.61512 W97.77155	Sugarcane	Yes	0%

*Counties containing sugarcane fields

§King Ranch Bluestem (*Bothriochloa ischaemum*); Little Bluestem (Schizachyrium scoparium (Michx.) Nash);other (native grasses); Sugarcane (*Saccharum* sp.); Little Bluestem mix (Little bluestem mixed with native grasses).

∞Other acceptable synonyms for King Ranch bluestem: Yellow bluestem, KR bluestem

maintained, *B. rubrostriata* has the potential to spread with it.

Even though leafhoppers have been documented to disperse over great distances (Ghauri 1983), little is known about the mechanisms of this dispersal and establishment. It is interesting that the invasive *B. rubrostriata* appears to prefer another invasive species, *B. ischaemum*, as a host plant in Texas. However, we observed no deleterious effects on the invasive grass even when the leafhopper made up 85% of the insects collected from that grass. King Ranch Bluestem is native to the north Asian steppes and Mediterranean Europe (Harlan 1951; Correll & Johnson 1970) but it is unknown whether *B. rubrostriata* is associated with the grass in its native range. This invasive grass was intentionally introduced in Texas as a livestock grass. Through Texas A&M experiments, it was found that King Ranch Bluestem was ideal for these areas because it is a

drought tolerant, nutritional and a palatable grass for livestock (Dwyer et al. 1964). By the 1950s, fields throughout the Edwards Plateau of Texas were intentionally planted with King Ranch Bluestem (Riskind & Diamond 1988) and it was also introduced into Oklahoma (White & Dewald 1996). If the association we observed is important for maintaining *B. rubrostriata* in the United States, the absence of this invasive grass may be a reason that the RSLH has not readily dispersed into Louisiana but is very well established in Texas.

In Thailand *B. rubrostriata* had the second highest prevalence of SCWL, making it potentially a serious threat to sugarcane in the United States. Sugarcane is not only an important food crop in the United States; it is also being considered a strong candidate for a biofuel plant. The overwhelming presence of *B. rubrostriata* in many of our samples suggests it has the ability to take over grassland communities (Crowl et al. 2008). Since *B. rubrostriata* is a vector for a deadly phytoplasma (Hanboonsong et al. 2006) of an economically important crop, *B. rubrostriata* is an imminent threat that needs to be managed before it has a chance to start transmitting the SCWL to Texas and Louisiana sugarcane crops. It is uncertain whether the SCWL virus is currently being carried by the leafhopper but, as suggested by Nault & Ammar (1989), leafhoppers can maintain the virus for numerous generations even without an association with sugarcane.

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