Biological Control in the Colombian Sugarcane Industry

(Picture: L. Rivera)

ISO Zoom Series

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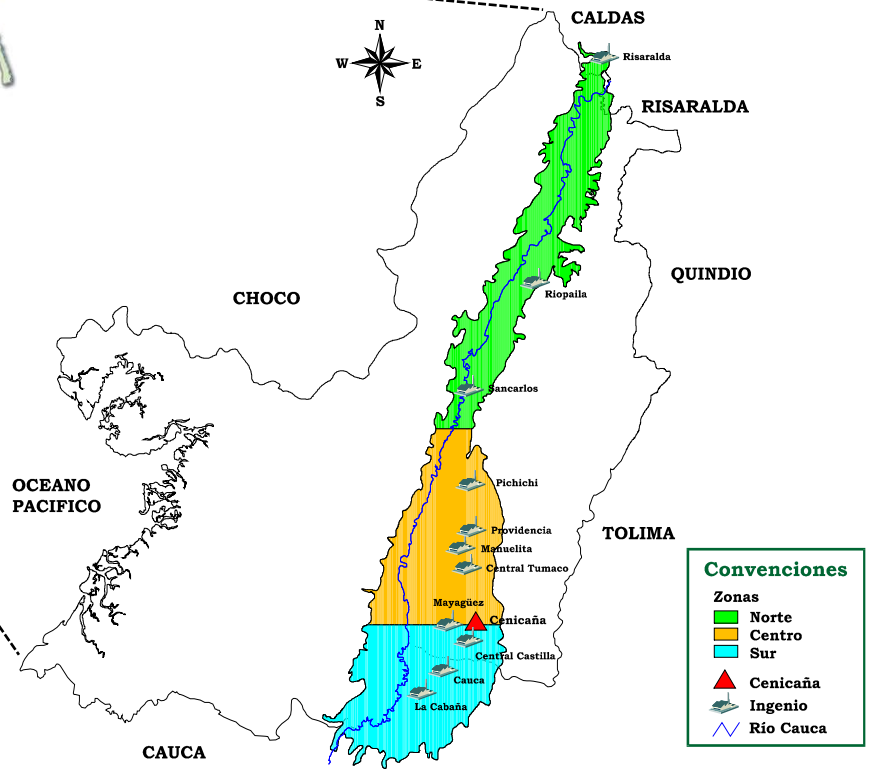


Cauca River Valley (CRV), Colombia.
Altitude: 1,000 MASL.
Area: 3,000 km^2
Annual average Temperature: 23.5°C.
Annual rainfall: 1160 mm on a bimodal pattern.
Relative humidity: 77 %.

In the Cauca River Valley (CRV):
243,000 has.
2,750 farmers, 70% < 60 has.
13 Mills, 6 ethanol distilleries.

In the mountains of Colombia:
250,000 has. for producing raw, unrefined cane sugar known as Panela
70,000 farmers aprox.
20,000 Panela Mills

Colombian Sugarcane Research Center

Integration of the knowledge from stakeholders, growers and researchers in the search for higher productivity under site-specific agriculture and a sustainable approach.

The sugarcane stem borers *Diatraea* spp.

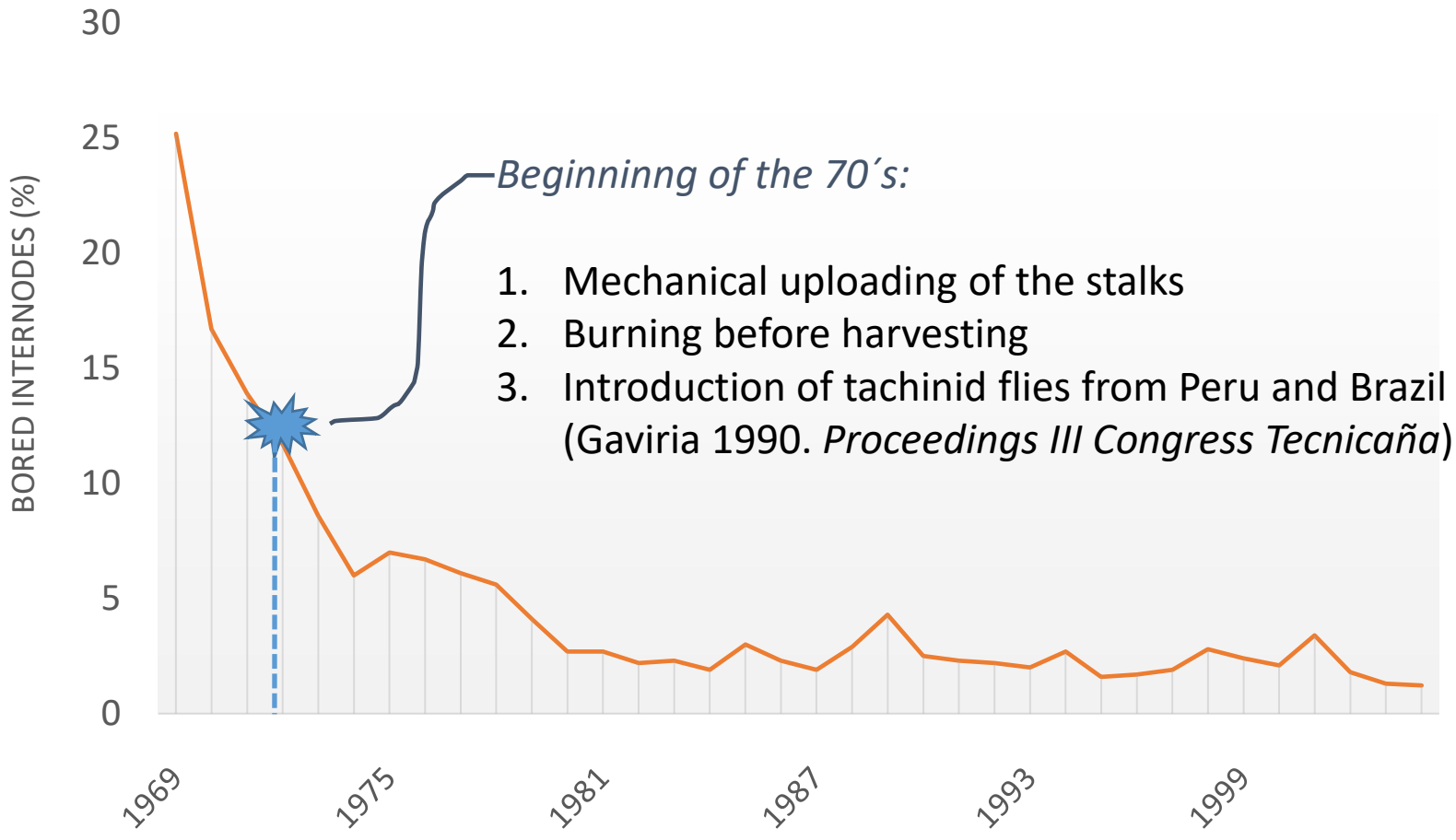
Most important sugarcane pest in Colombia
(Vargas *et al*. 2015. *Fla. Entomol*).

41 species recognized thus far in the western hemisphere, but at least seven species in Colombia
(Barrera *et al*. 2017. *PlosOne*; Solis and Metz 2016. *Zookeys*).

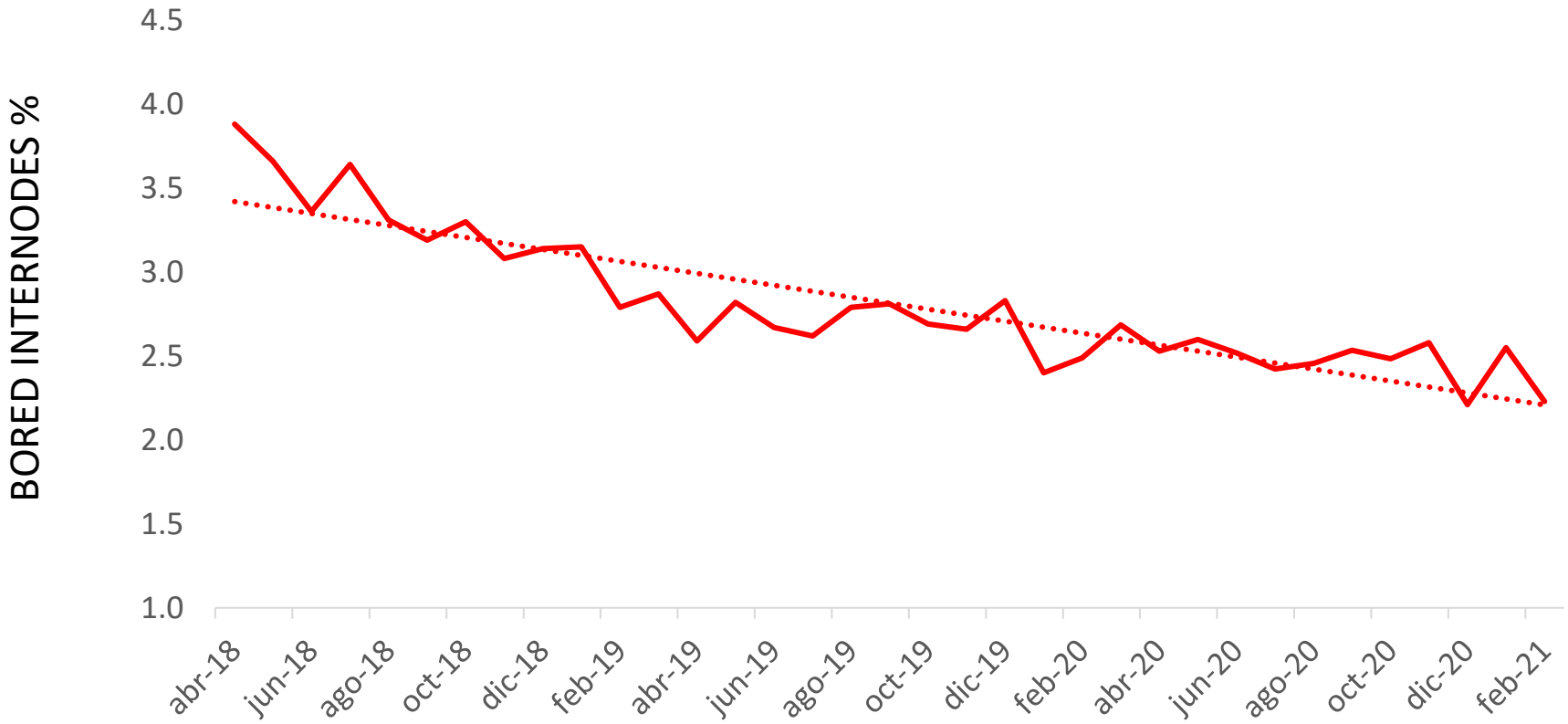
Diatraea saccharalis, *D. indigenella*, *D. tabernella* and *D. busckella* are the most abundant in the Cauca River Valley of Colombia
(Vargas *et al*. 2018. *Neo. Entomol.*).

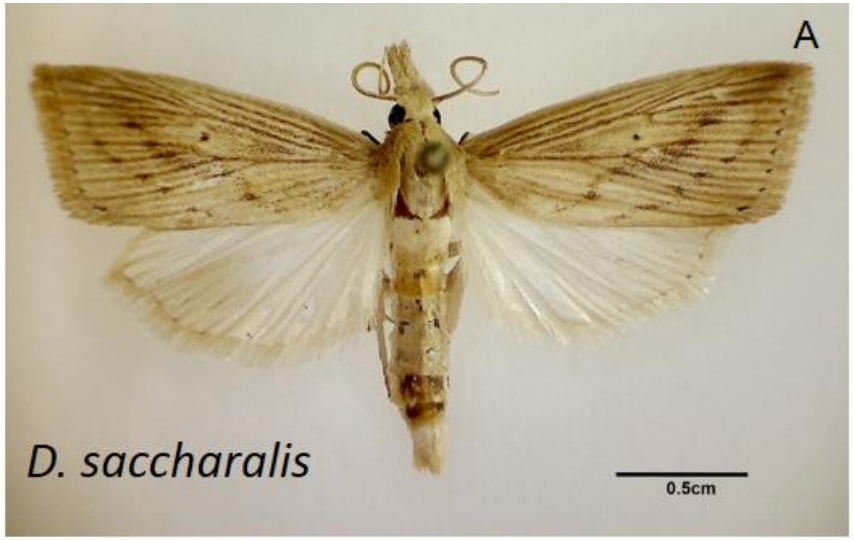
In the CRV, economic losses caused by the sugarcane borers, *Diatraea* spp., are estimated at 143 kg of sucrose per each percent of bored internodes (Gómez *et al*. 2009. *Proceedings VIII Congress Tecnicaña*)

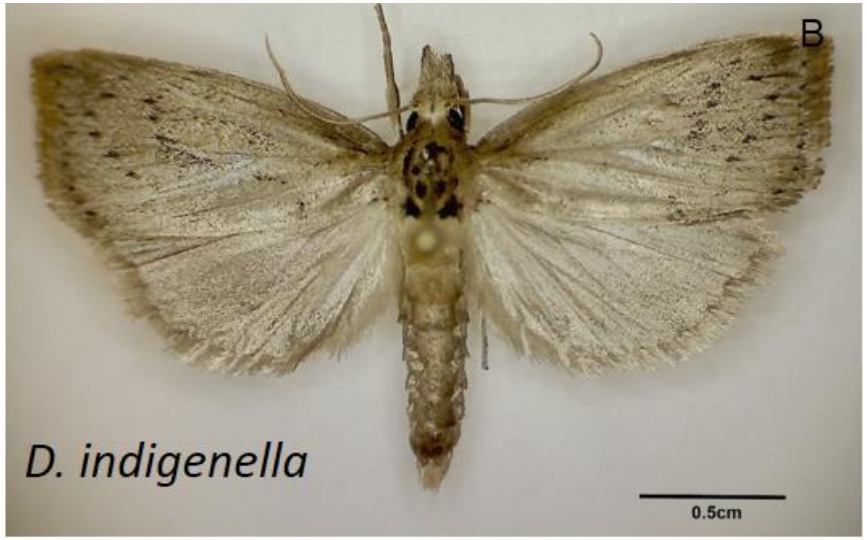
Background

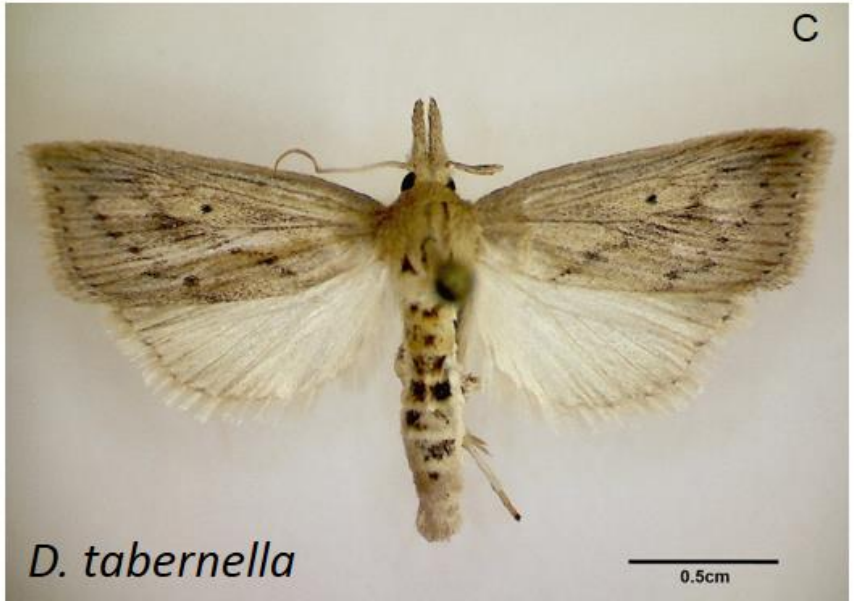

30
25
20
15
10
5
0
BORED INTERNODES (%)
1969
1975
1981
1987
1993
1999
Beginninng of the 70´s:
1. Mechanical uploading of the stalks
2. Burning before harvesting
3. Introduction of tachinid flies from Peru and Brazil (Gaviria 1990. *Proceedings III Congress Tecnicaña*)

… most recently









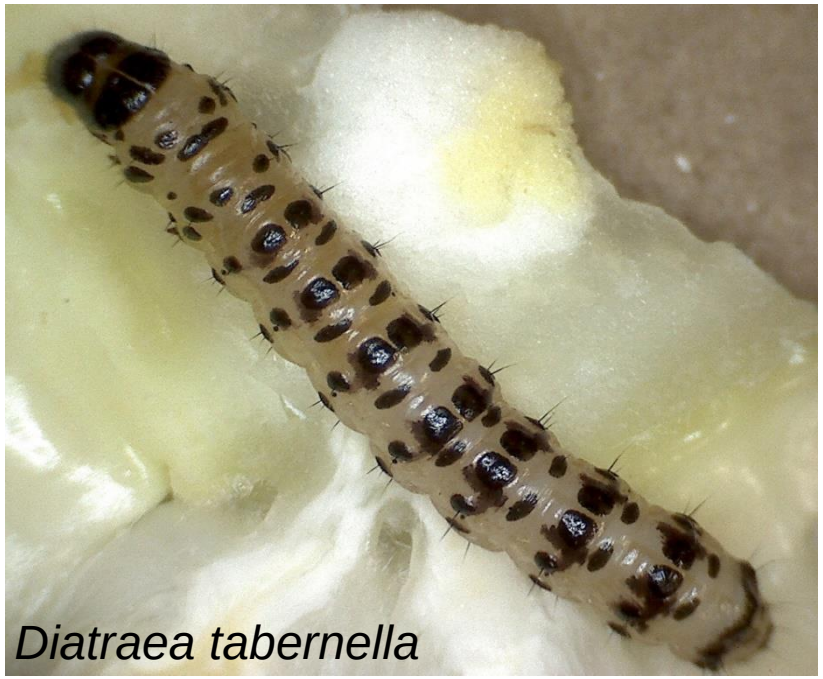
(Pictures: L.A. Lastra)

Vargas *et al*. 2015. *Fla. Entomol.*

Diatraea indigenella

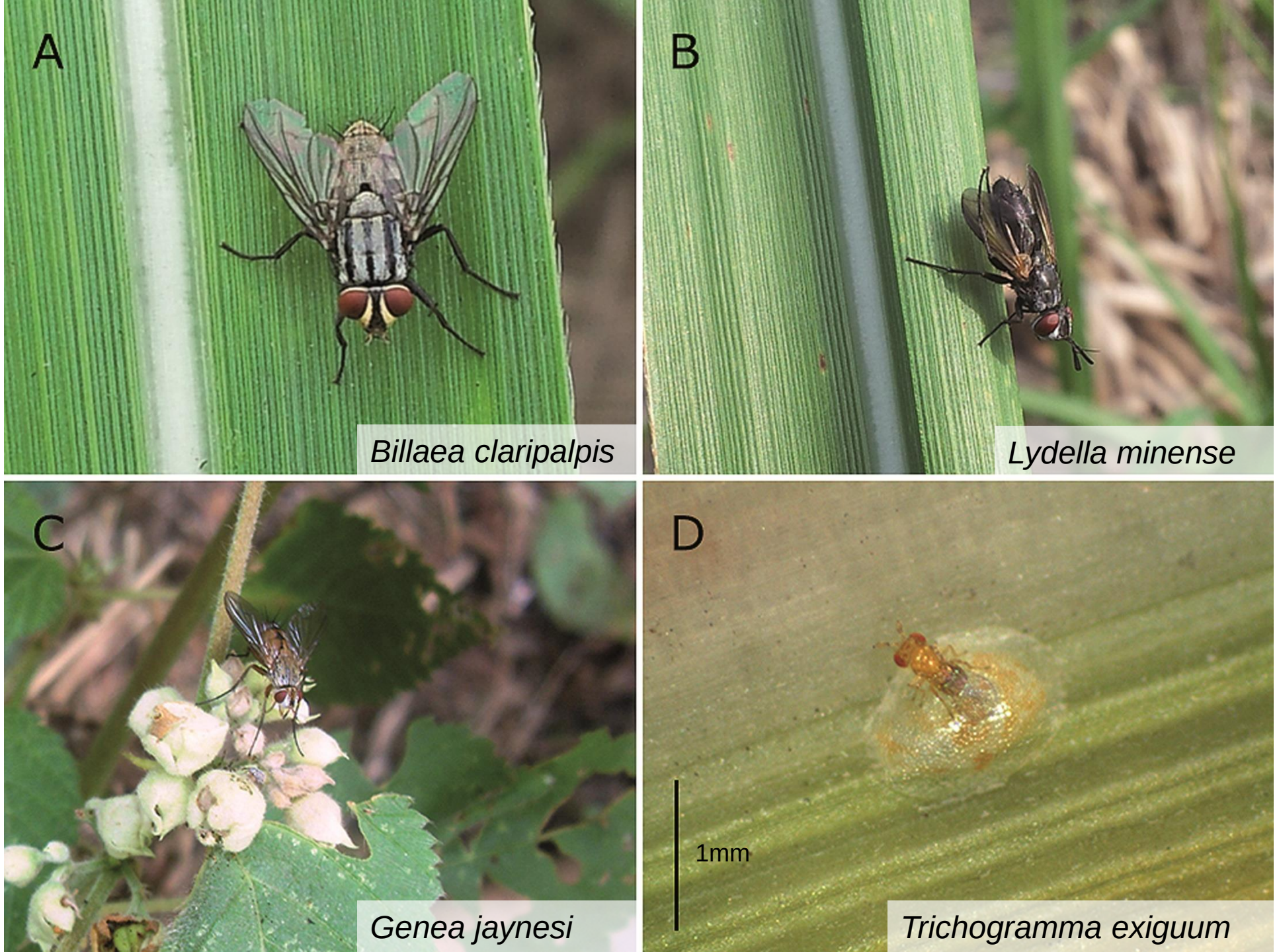
Diatraea busckella

Diatraea saccharalis



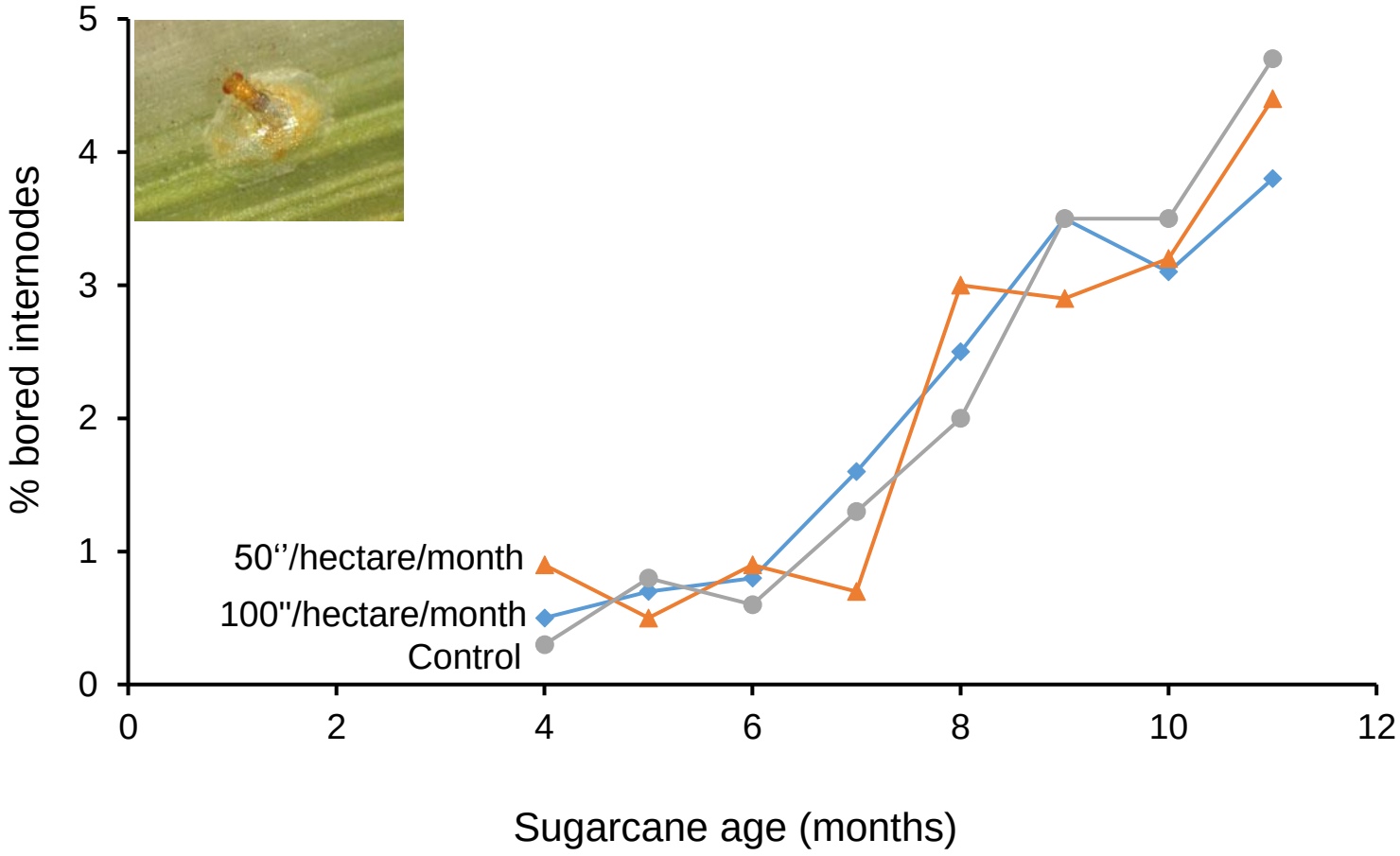
Diatraea tabernella

(Pictures: L.A. Lastra)



(Pictures: X. Granobles, C; L.A. Lastra, D)

Changes in percent bored internodes under releases of *Trichogramma* sp.



(Gómez 1990. *Carta Trimestral, Cenicaña*)

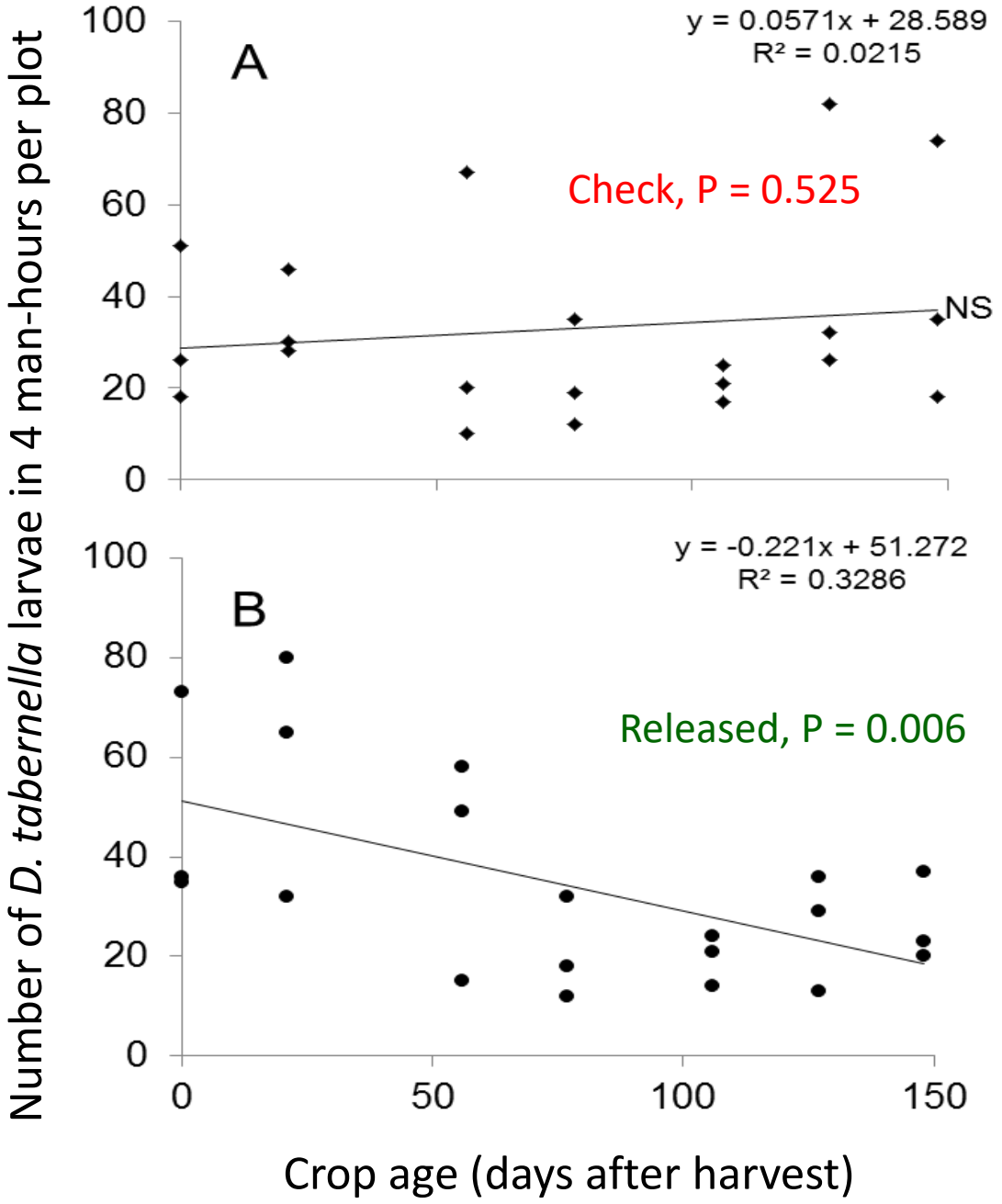
Trichogramma species found in *Diatraea* spp. eggs in Colombia

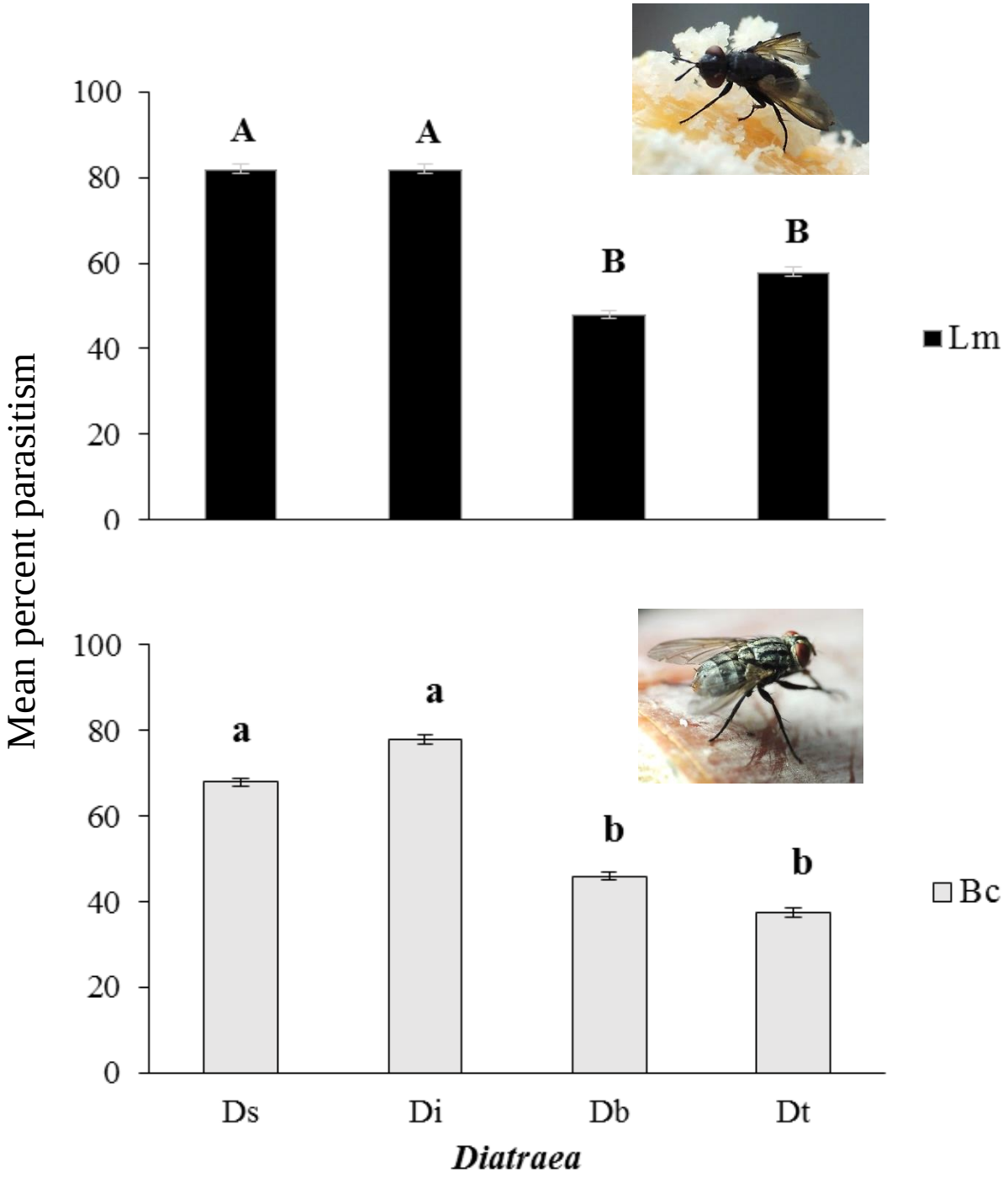
Source	Host	Species
Commercial insectaries	*Sitotroga cerealella*	*T. pretiosum*
Departments in Colombia		
Magdalena	*D. busckella*	*T. exiguum*
Cesar	*D. busckella, D. saccharalis*	*T. exiguum*
Cauca	*D. indigenella*	*T. exiguum*
Valle	*D. indigenella*	*T. exiguum*
Risaralda	*D. saccharalis*	*T. exiguum*
Nariño	*D. saccharalis, D. indigenella*	*T. exiguum*
Tolima	*D. saccharalis*	*T. exiguum*

(Gómez *et al.* 1996. *Proceedings XXII Congress ISSCT*)

Decrease over time in number of *D. tabernella* larvae in plots released with *T. exiguum* (A) in comparison with check plots with no releases (B).

(Vargas *et al*. 2015. *Proceedings X Congress Tecnicaña*)





Host resistance to parasitism

Reduced parasitism on *D. tabernella* and *D. busckella*.

(Aya *et al*. 2018. *Biol. Control*).

Consistent with low levels of parasitism on field and pest outbreaks

(Vargas *et al*. 2013. *Fla. Entomol*.; Vargas *et al*. 2018. *Neo. Entomol*.).

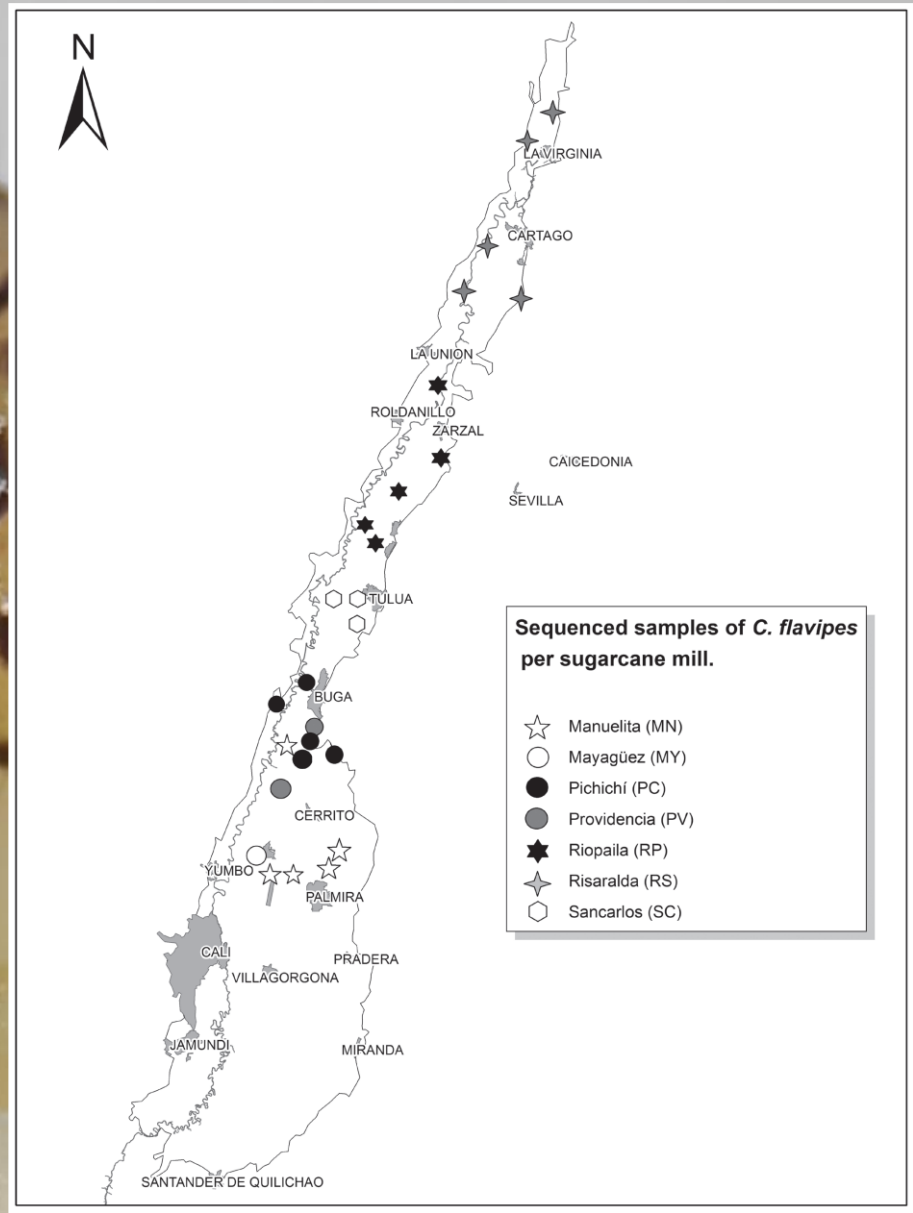
Diatraea: F = 10,07; g.l = 3,28; P = 0,001
Tachinid: F = 3,75; g.l = 1,28; P = 0,06
D x T: F = 0,80; g.l = 3,28; P = 0,50

Search for additional alternatives such as the use of *Cotesia flavipes*

(Picture: L. Salamanca)

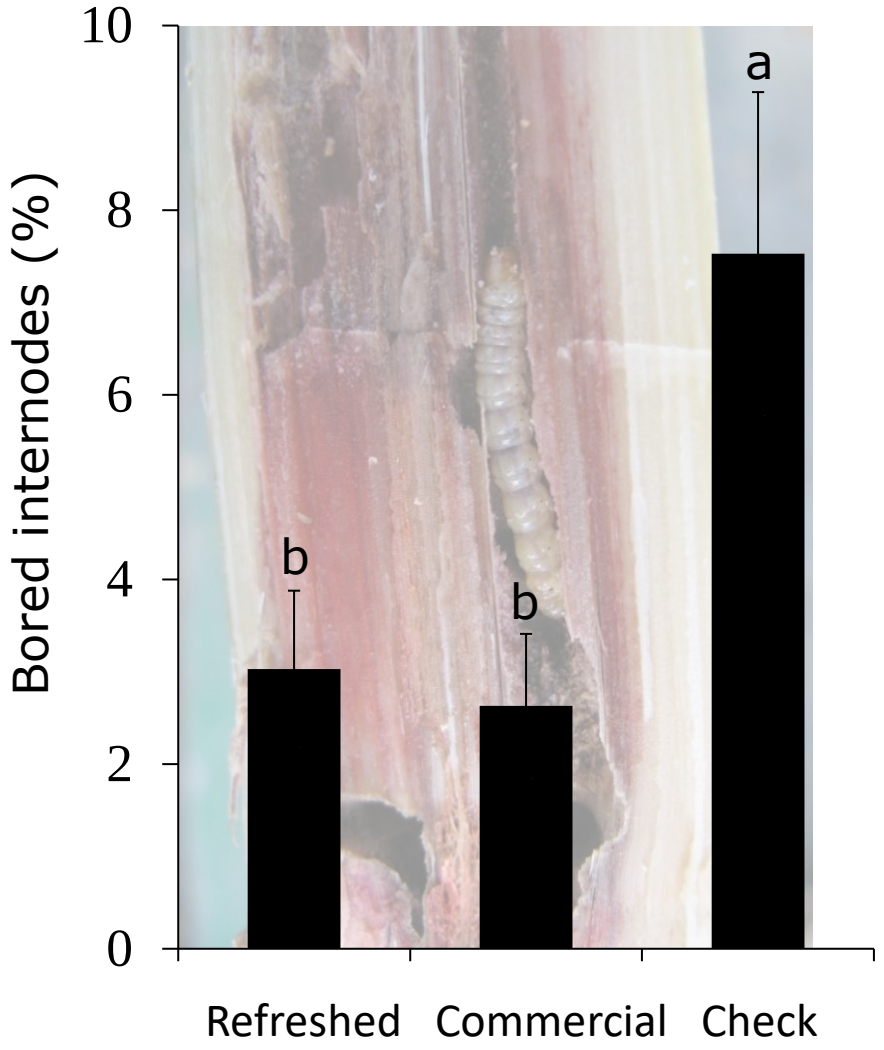
Search for additional alternatives such as the use of *Cotesia flavipes*

Results confirmed that the genetic identity of the specimens sequenced corresponded to *C. flavipes*, with a genetic divergence of 0.00 to 0.03 as compared with GenBank registers.
(Aya *et al*. 2017. *Fla. Entomol*).



Mean percentage of bored internodes (± SE) evaluated in 6-mo-old sugarcane plots after 3 releases of 4 g of cocoons per ha each, from 2 sources of *C. flavipes* (field refreshed and commercial), compared to a check with no releases.

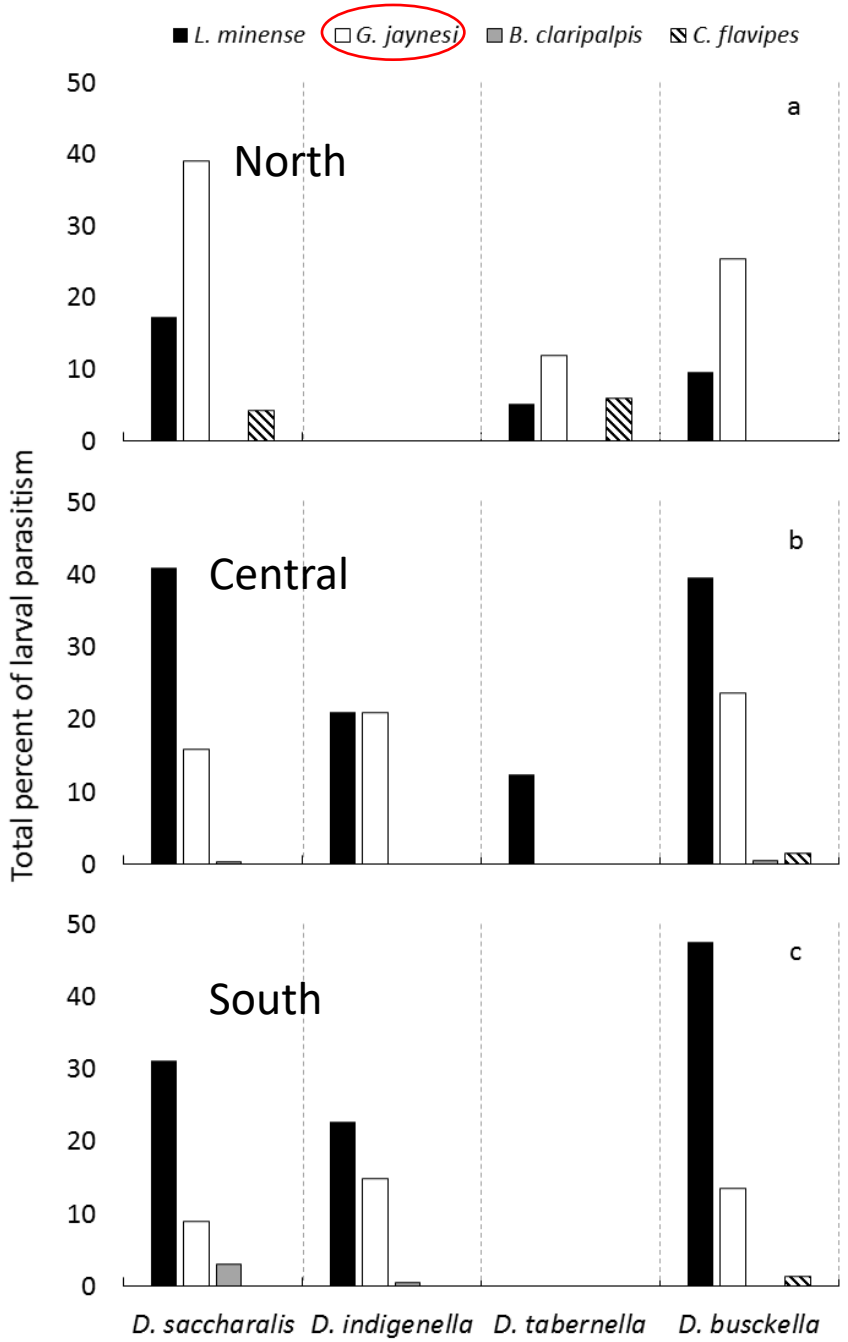
(Arboleda & Vargas 2019. *Fla. Entomol.*)



G. jaynesi

Genea jaynesi is distributed across the CRV attacking different species of *Diatraea* (Vargas *et al.* 2018. *Neotr. Entomol.*)

Efforts to mass rear have been futile, suggesting the need of an alternative approach; i.e., Conservation Biological Control.



Percent representation of larval parasitois in Riopaila-Castilla Mill in southern CRV

Billaea claripalpis (Wulp, 1895)

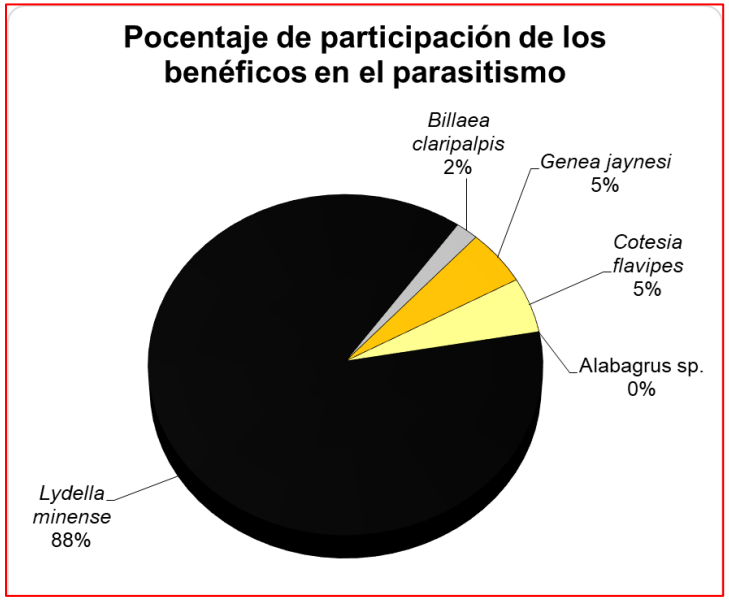
Cotesia flavipes (Cameron, 1981)

***Alabagrus* sp.**

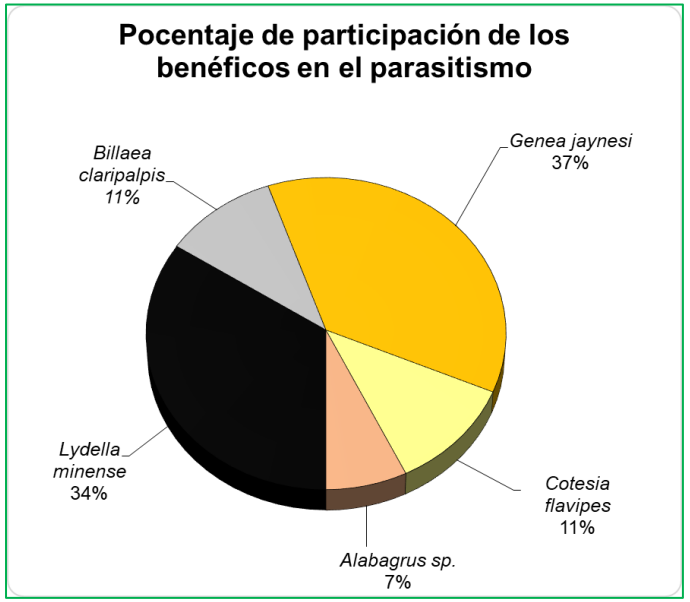
Genea jaynesi (Aldrich, 1932)

Lydella minense (Townsend, 1927)

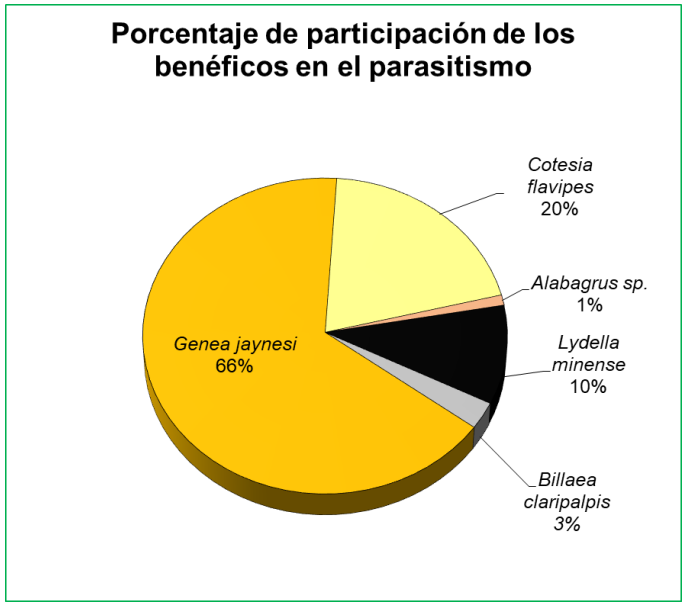
2017



2018



2019



Preliminary information on plants that serve as shelter and food for these natural enemies in hedgerows and non-cultivated areas (e.g., field borders)

Need of more information on bioecology of this insect.

What is the effect of maintaining broadleaf weeds (nectar source) in sugarcane field borders in relation to taquinid’s population and pest regulation?

A quick survey on field borders

Broadleaf weeds in sugarcane field borders (16)
*Alternantera albotomentosa**
Acharis pintoi
Amaranthus hibridus
*Bidens pilosa**
Commelina diffusa
Croton hirtus
*Emilia fosbergii**
*Emilia sonchifolia**
Euphorbia hirta
Galinsoga caracasana
Mimosa pudica
Oxalis stricta
Portulaca oleraceae
Rumex crispus
Tridax sp.
Trifolium repens

(Pictures: L. Rivera)

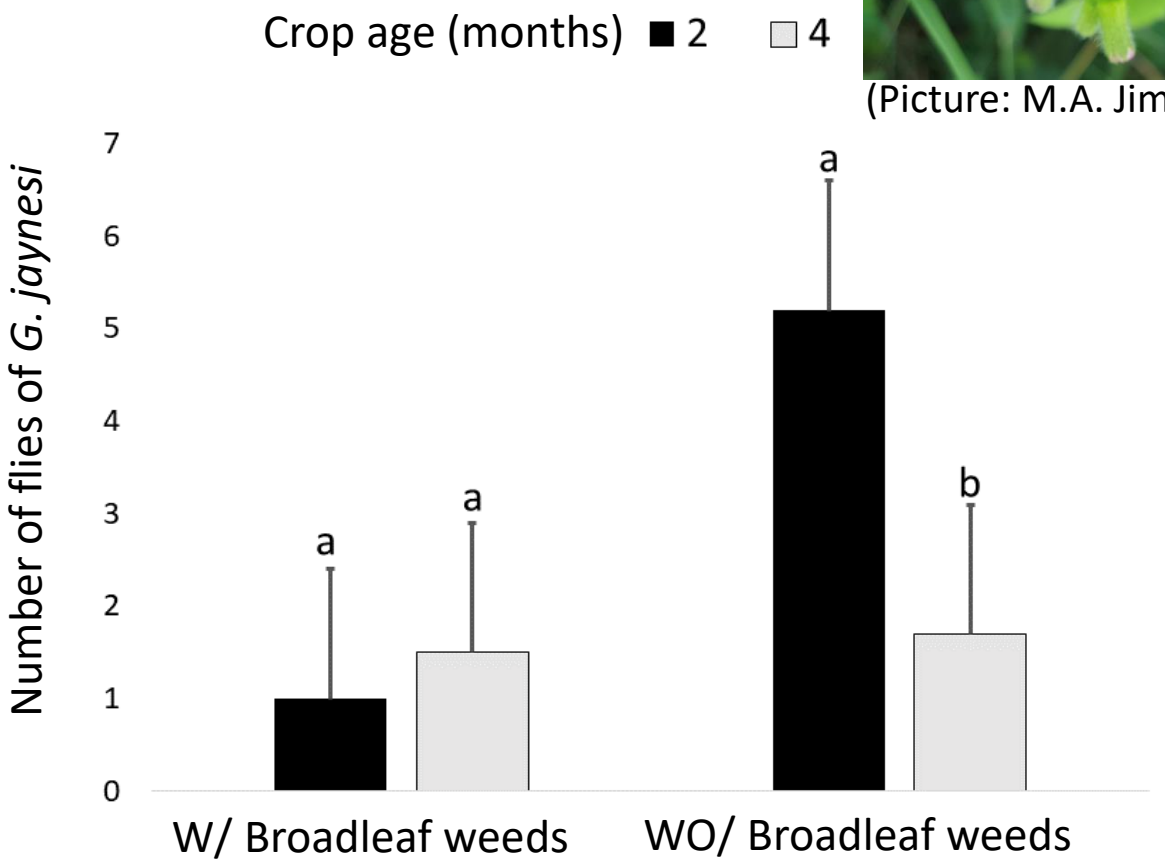
* Flies directly observed on flowers

(Picture: M.A. Jimenez)

Number of *G. jaynesi* individuals

Interaction between treatment and crop age. In the second evaluation the number of flies decreased where BLW were eliminated.

(Jiménez *et al*. 2018. *Proceedings XI Congress Tecnicaña)*



Mean number of *G. jaynesi* individuals ± SE per field in ten minutes (Tukey-Kramer, p < 0,05).

Trt. (F = 1,14; g.l. = 1,6; P = 0,326)
Age (F = 2,93; g.l. = 1,6; P = 0,137)
Trt.*Age(F = 13,79; g.l. = 1,6; P = 0,009)

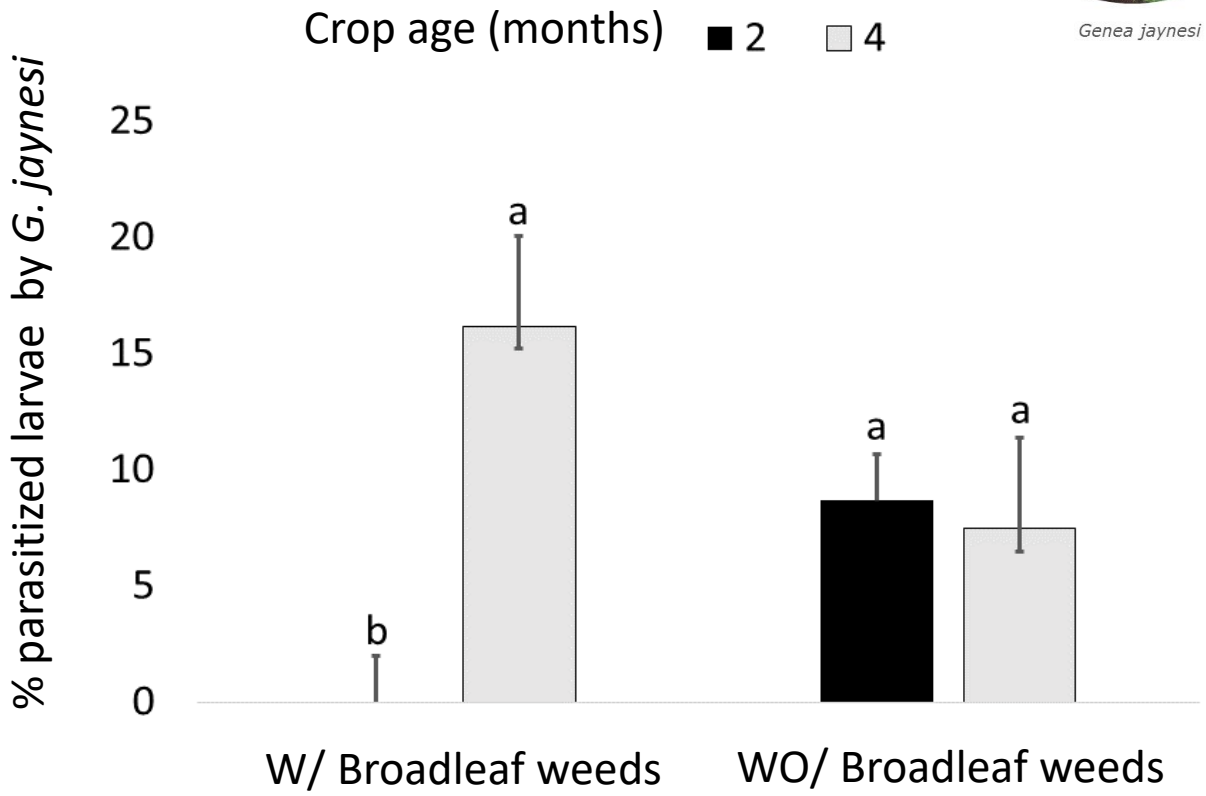
(Picture: L. Rivera)

Percent parasitism

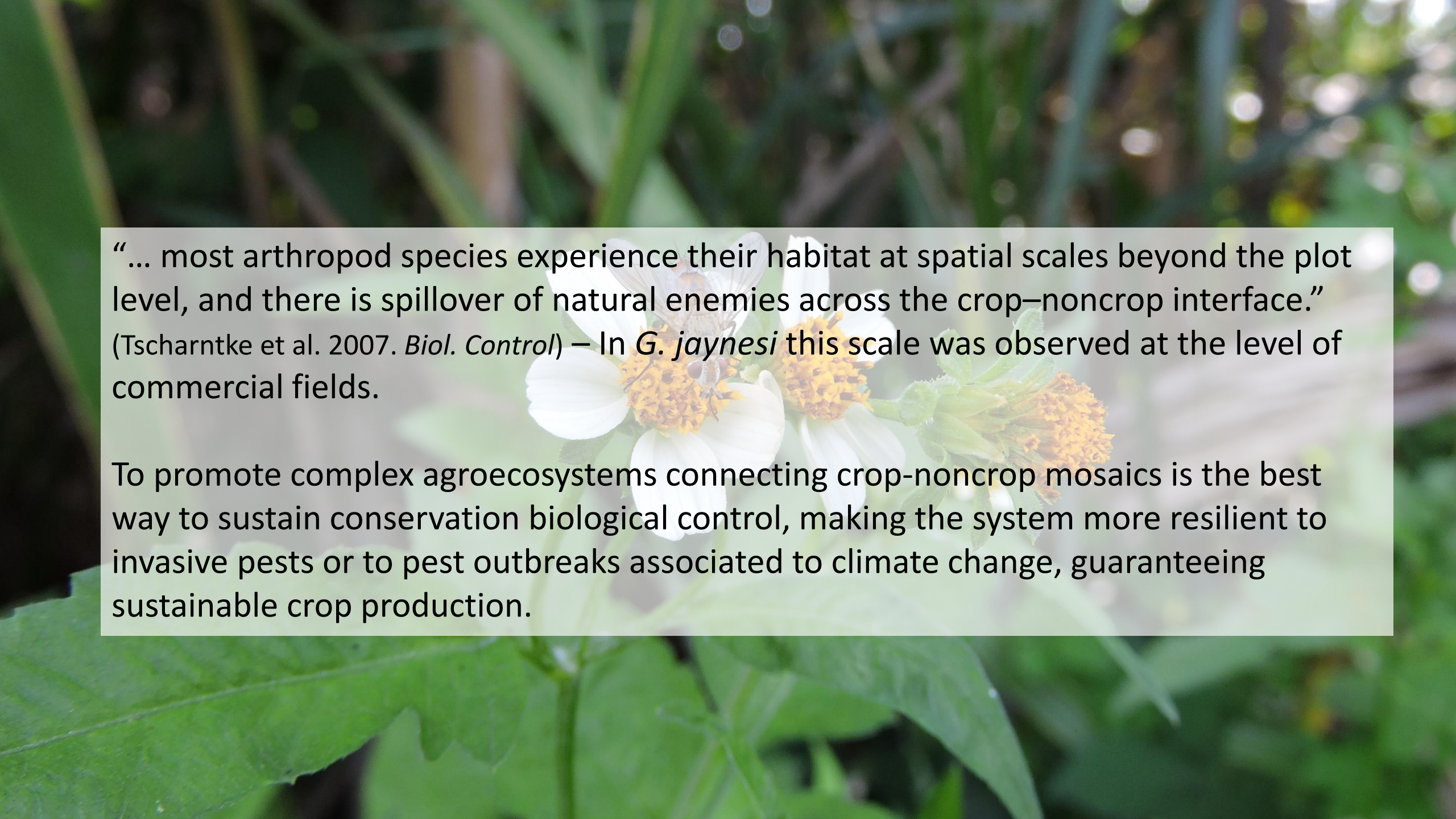
Interaction between treatment and crop age. An increase of parasitism was observed in the second evaluation where BLW were sustained.

(Jiménez *et al*. 2018. *Proceedings XI Congress Tecnicaña)*

Trt. (F = 0,00; g.l. = 1,6; P = 0,997)
Age(F = 4,98; g.l. = 1,6; P = 0,067)
Trt.*Age (F = 6,66; g.l. = 1,6; P = 0,041)



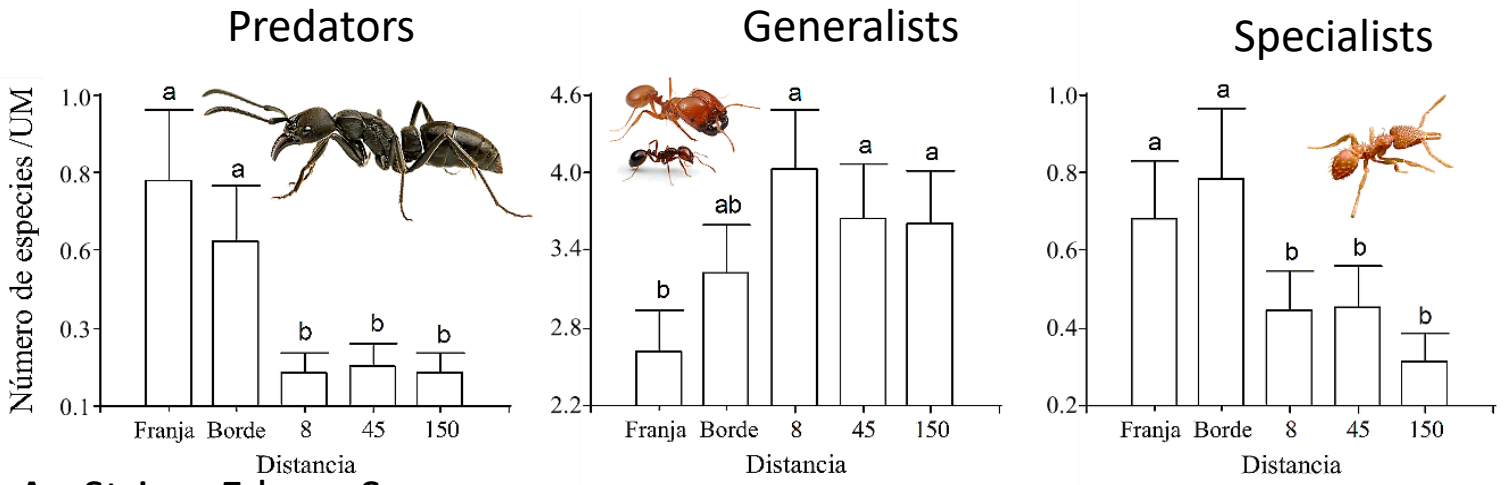
Mean percent of parasitized larvae of *Diatraea* spp. ± SE by *G. jaynesi* (Tukey-Kramer, p < 0,05).



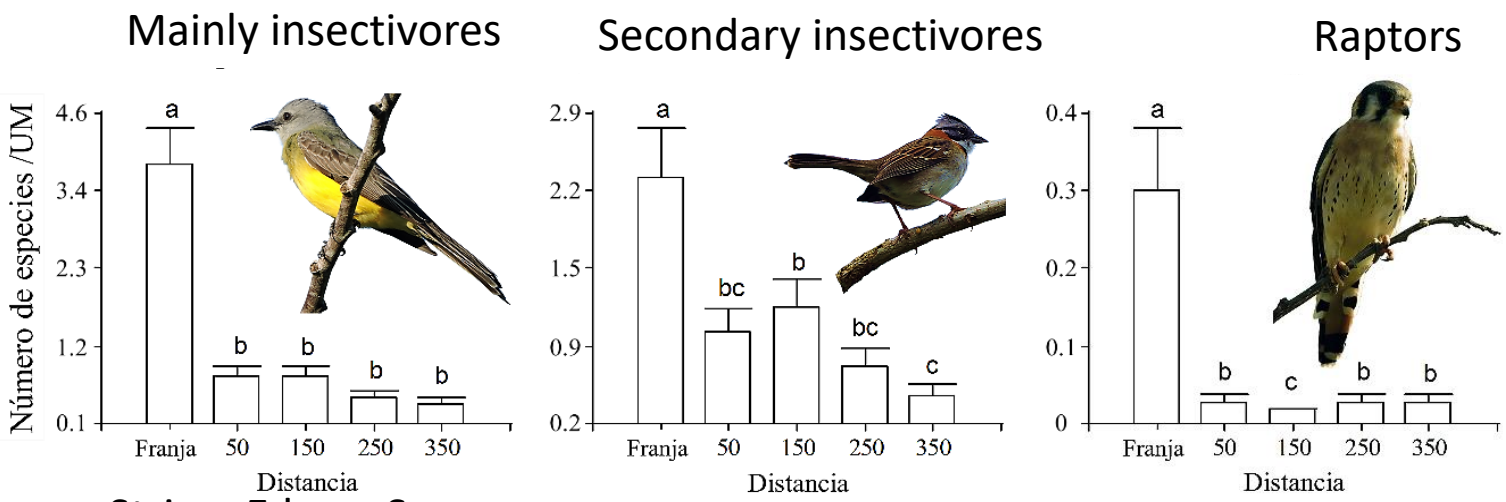
"… most arthropod species experience their habitat at spatial scales beyond the plot level, and there is spillover of natural enemies across the crop–noncrop interface." (Tscharntke et al. 2007. *Biol. Control*) – In *G. jaynesi* this scale was observed at the level of commercial fields.

To promote complex agroecosystems connecting crop-noncrop mosaics is the best way to sustain conservation biological control, making the system more resilient to invasive pests or to pest outbreaks associated to climate change, guaranteeing sustainable crop production.

The role of natural vegetation strips in sugarcane monocultures: ant and bird functional diversity responses



A Strip – Edge – Sugarcane



B Strip – Edge – Sugarcane

Change in the richness of functional groups according to food preference with increasing distance to the natural vegetation strip.

(Rivera-Pedroza *et al.* 2019. *Agric. Ecosyst. Environ.*)

(Pictures ants: A. Wild; Birds: L. Rivera)

Summary

The IPM program of sugarcane borers in the CRV of Colombia relies solely on biological control via augmentation of egg and larval parasitoids.

Pest populations evolve in response to changes in the cultivars grown, changes in the composition of the pest complex itself and changes in the climatic offer.

Plant diversity in sugarcane field borders enhance *Genea jaynesi* population as it sustains resources nearby cultivated plots.

Summary

Conservation biological control is often an approach requiring a landscape management perspective – in this case, the habitat *of G. jaynesi* (food, shelter & reproduction) occurred at a commercial field scale making easier to promote among farmers.

To promote conservation biological control via complex agroecosystems constitute an additional alternative to biological control programs already in place in the Cauca River Valley of Colombia.

‘Spillover’

Caña

- Biodiversidad
- Comunidad
- Agroindustria

Biodiversa

Thanks!

(Picture: L. Rivera)