

# SAMBA'S EIGHTH INTEGRATIVE THINK TANK

## Bath, 11-15 June 2018

The research challenges in the vector control  
of triatomines in Paraguay.



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# CHAGAS DISEASE



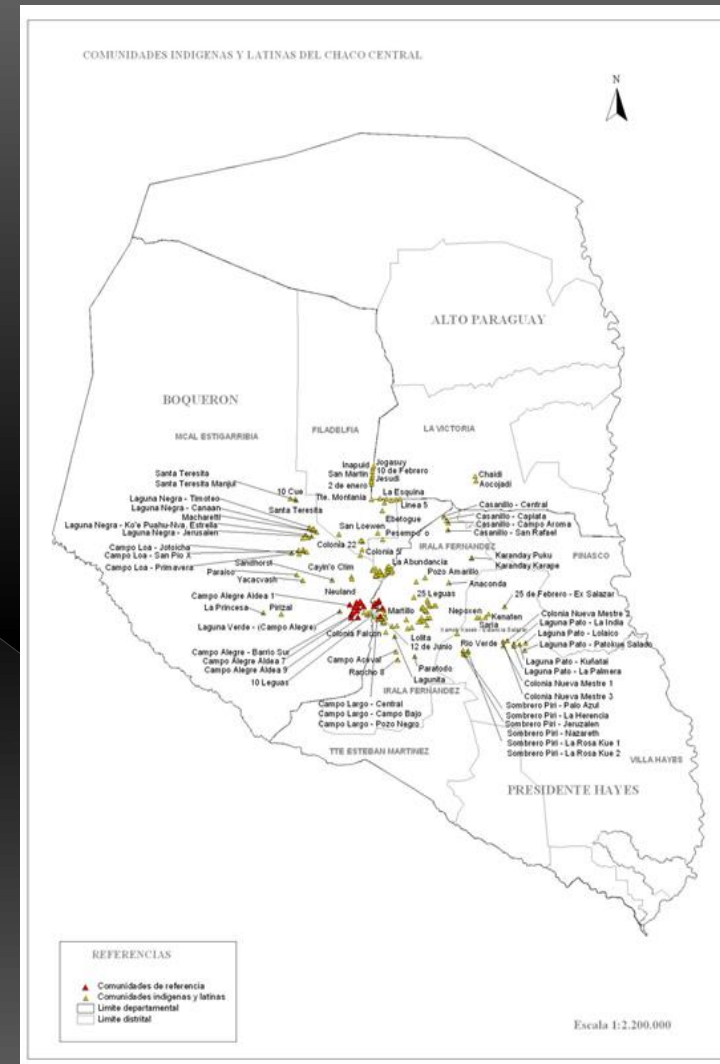
- ✓ It is an enzooty (it is not eradicable)
- ✓ Multiple reservoirs (domestic and wild)
- ✓ Domestic cycles / wild cycles
- ✓ It is established mainly in contexts of poverty: precarious housing



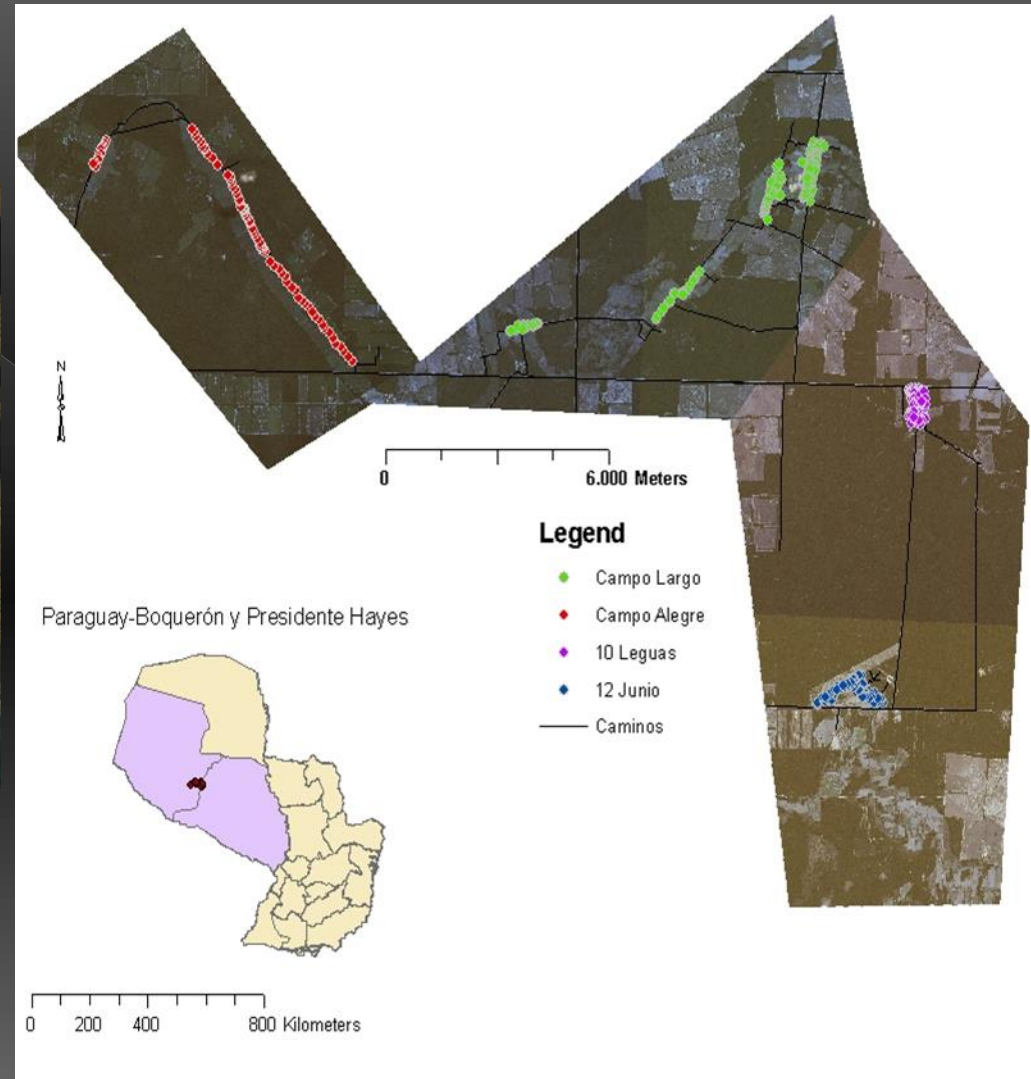
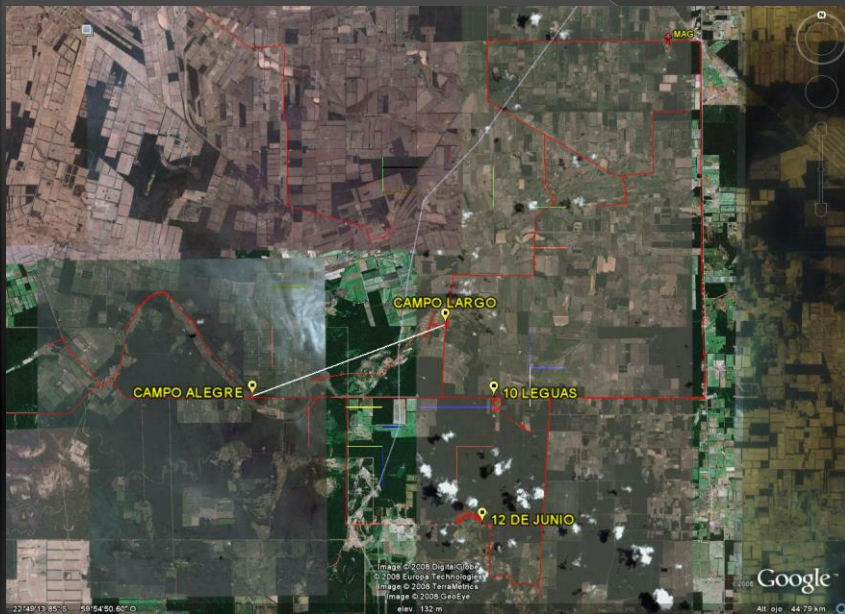
- ✓ Wide distribution
- ✓ Home transmission from the southern United States to the province of Chubuc in Argentina.
- ✓ It reaches limits beyond those established in geography
- ✓ 9 million carriers of the infection and 100 million exposed to the risk (may have decreased to 60 million)

# Premises of the Chaco

- Presidente Hayes: the only department in Paraguay that is not yet free of transmission.
- In the Chaco: the great distances, the extreme climate, the diminished residual effect of the insecticides and the conditions of extreme poverty of the indigenous ethnic groups, make control actions difficult.
- There are rapid repopulations or infestations. *T. infestans* is wild or feral, which implies high pressure on the houses.
- Other species, such as *T. sordida*, are already found in intradomiciliary colonies and positive for *T. cruzi*.
- The environmental changes and the destruction of the virgin Chaco forest force the displacement of human and animal populations and the establishment of several species of eminently jungle triatomines in domiciliary spaces (*T. sordida*, *T. platensis*).
- In these areas of great opportunities for reinfestation, intra and peridomiciliary, entomological surveillance becomes a preponderant role.



# Indigenous communities of the Paraguayan Chaco



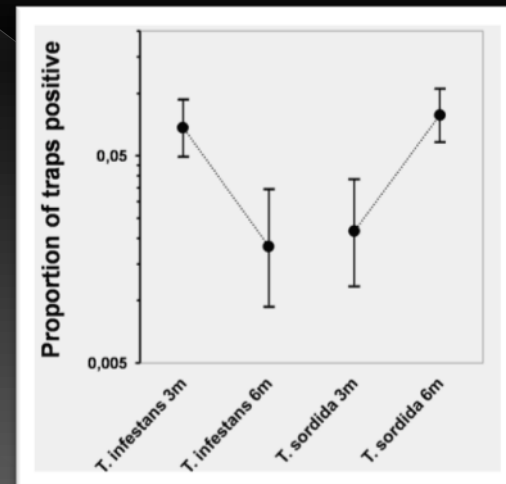
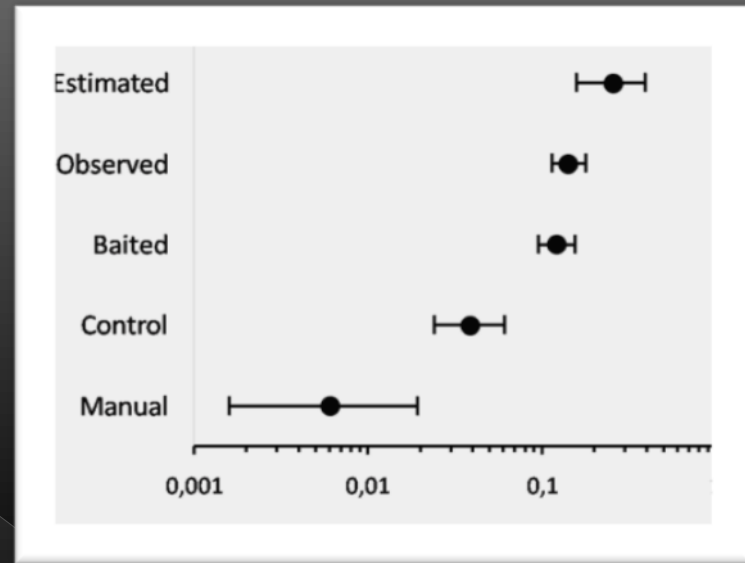
# FIELD TRIALS

- Experimental field study with pre and post intervention to measure the presence or absence of triatomines in houses with traps baited, placing traps with and without pheromones. In the first stage 95 homes were evaluated and in the second 192.
- The post-intervention measures were carried out at 1, 3 and 6 months in the negative dwellings where the sensors were placed.
- Pheromones: Hexanal and nonanal. With a slow release system with polypropylene bags and 200  $\mu$ L of pheromone.



# Sticky and baited traps with semiochemicals can help improve the surveillance of *T. infestans* and other vectors.

- The increase of the sensitivity to the traps (approximately 500%) allowed to estimate the house infestation with rates of 20-26%; in contrast, only 0-1.4% of households were identified as infested by manual searches.



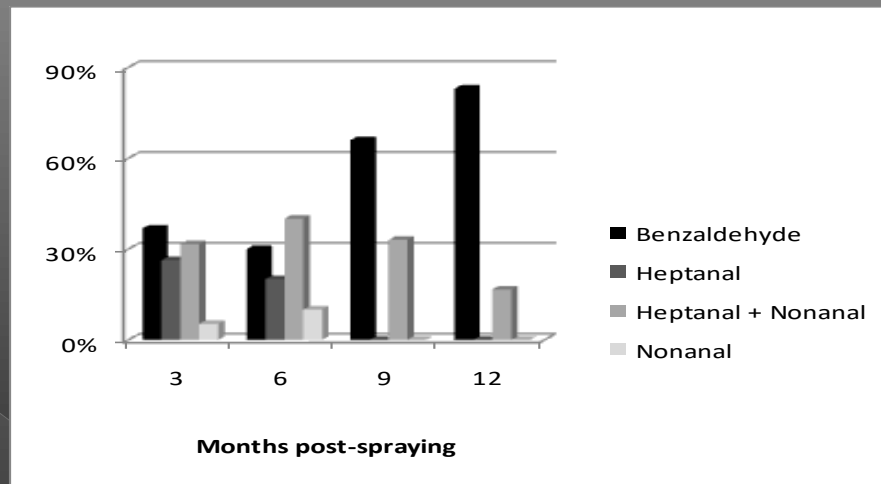
**Communities as ethnicity, number of households and persons per household**

Communities	Ethnic Group	No. Inhabitans per house	No. Houses
12 de Junio	Angaité	6.7	61
10 Leguas	Angaité	6.4	56
Campo	Enlhet Norte	4.6	132
Campo Alegre	Nivaclé	4.3	84
<b>Total</b>			<b>333</b>

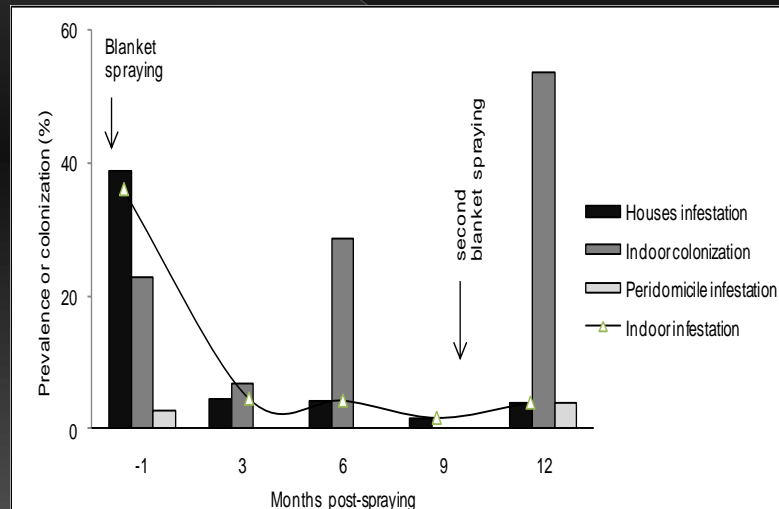
**Infestation by manual capture and natural infection rate in the baseline**

Community	No. Inspected houses	No. Intradomicile infested houses(%)	No. Peridomestic infested houses (%)	Intradomiciliar colonization (%)	No. Collected triatomine	Number of <i>T. infestans</i> infected with <i>T. cruzi</i> (%)
12 de Junio	60	42 (70)	0 (0)	30 (71.4)	519	46 (11.4)
10 Leguas	56	17 (30)	1 (1.8)	10 (58.8)	125	2 (2.1)
Campo	129	39 (30.2)	3 (2.3)	23 (58.9)	236	8 (5.4)
Campo Alegre	80	20 (25)	5 (6.3)	11 (55)	106	5 (23.8)
<b>Total</b>	<b>325</b>	<b>118 (36.0)</b>	<b>9 (2.8)</b>	<b>74 (62.7)</b>	<b>986</b>	<b>61 (9.1)</b>

The infestation and colonization were high. *T. cruzi* triatomine infection was 9%

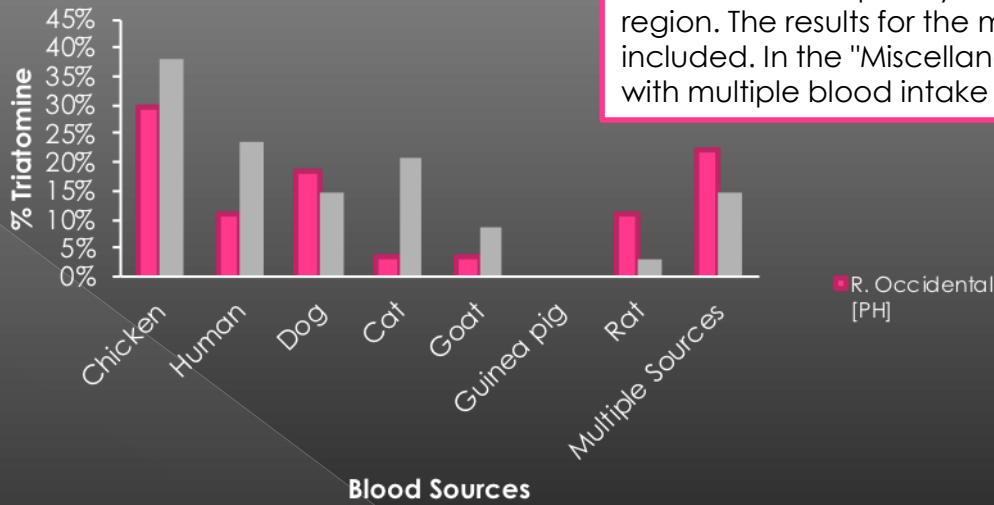


The sensors with pheromones captured 3 times more than the search by hour / man

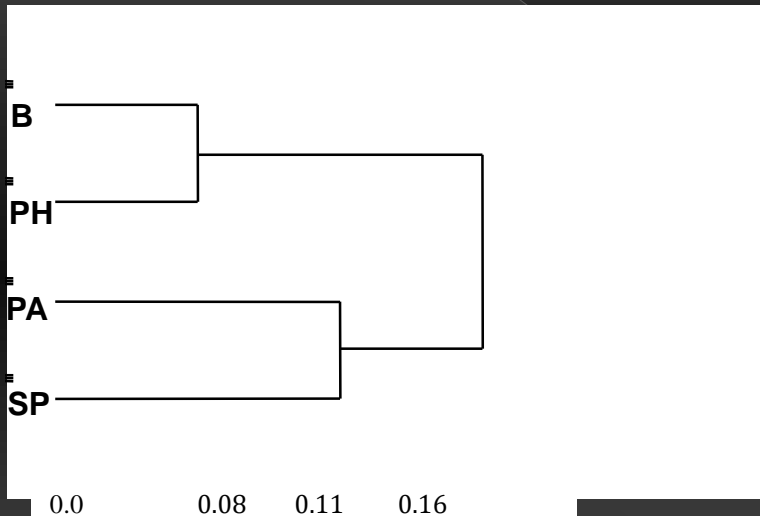


Process of infestation and colonization





Blood intake frequency for *T. sordida* in the Eastern and Western region. The results for the most common vertebrates are included. In the "Miscellaneous" category, the individuals found with multiple blood intake are included.



Heads: Dendrogram of grouping of four populations of *T. sordida* by genetic distance based on the genetic distance of Nei. BO: Boquerón, PH: Pte. Hayes, PA: Paraguarí, SP: San Pedro.

Panzeria et al 2015. Our chromosomal studies suggest that *T. sordida* populations in Paraguay have at least three taxa.

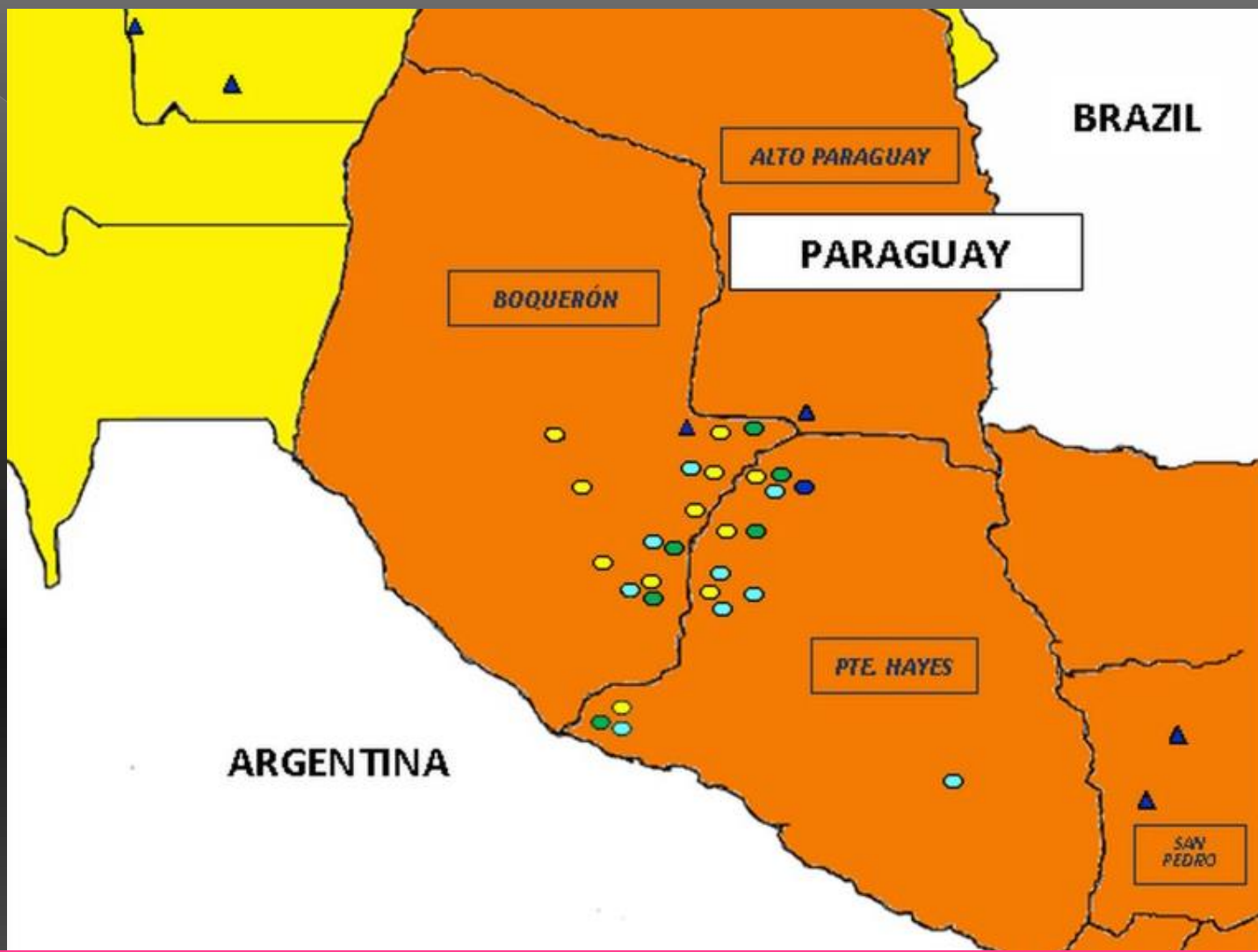
In the Chaco region we only find *T. garciabesi*, while in the eastern region it appears that *T. sordida* Argentina and *T. sordida* sensu lato, which coexist in sympathy.

The ecological differentiation and different feeding patterns described by González Britz et al 2014, supports our results.

We suspect that in addition to *T. garciabesi* and *T. guasayana*, there are also other cryptic species in Paraguay.

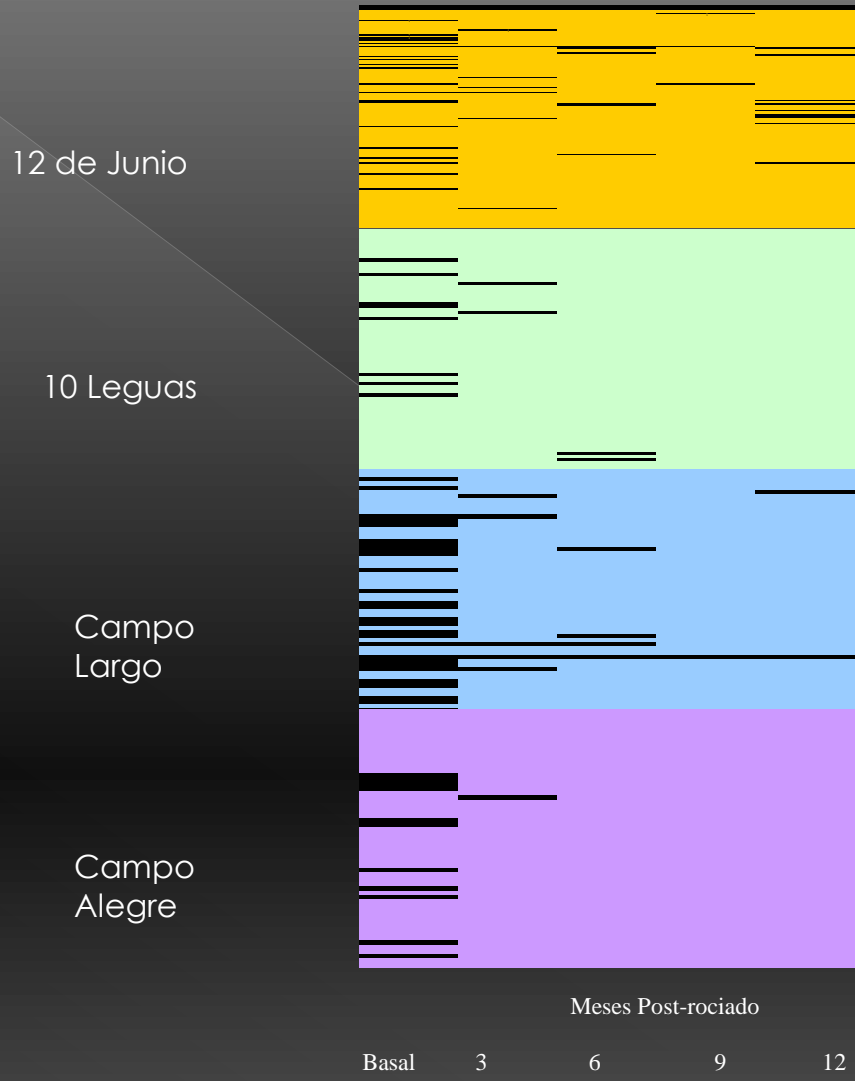
Acosta et al 2017. Hosts and vectors of *Trypanosoma cruzi* discrete typing units in the Chagas disease endemic region of the Paraguayan Chaco

DISTRIBUTION OF *TRYPANOSOMA CRUZI* DTU IN THE PARAGUAYAN CHACO.



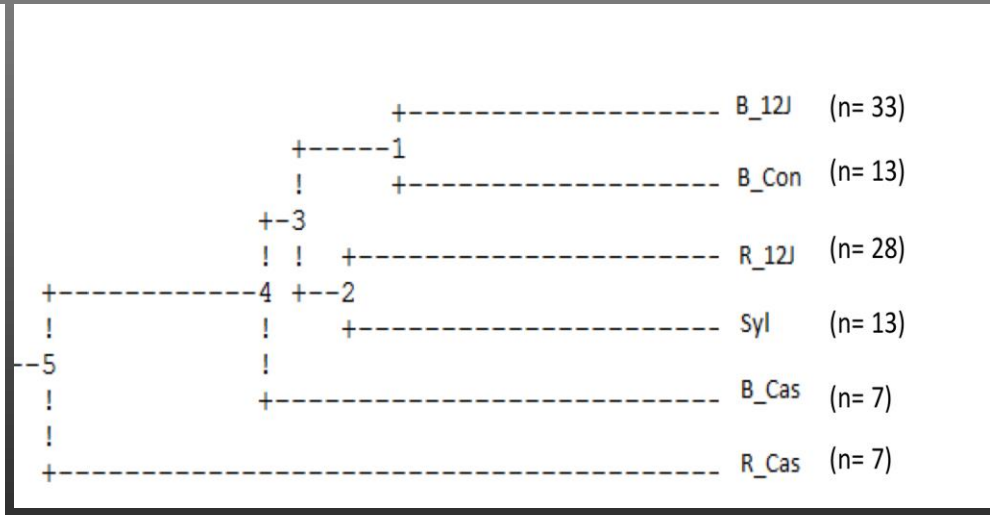
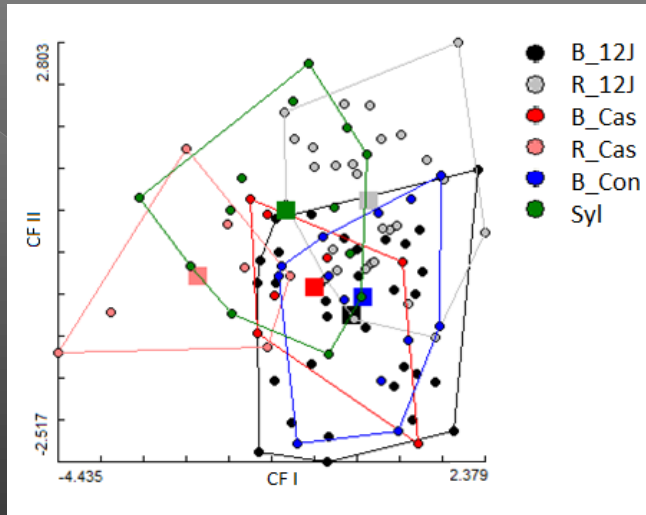
Paraguay (orange) and Bolivia (yellow) and the distribution of characterized trypanosomes. The circles and triangles represent isolations of domestic and wild cycles, respectively. The colors indicate different DTUs of *Trypanosoma cruzi*. Green, TcII; blue, TcIII; yellow, TcV and light blue, TcVI.

FINFESTATION FREQUENCY OF T. INFESTANS IN THE FOURTH INDIGENOUS COMMUNITIES OVER 12 MONTHS OF OBSERVATION



There is persistence of triatomine infestation despite massive spray

# MORPHOMETRY OF WINGS OF INFESTING AND RE-INFESTING TRIATOMINES



The wing shapes of the *T. infestans* females of basal control (B) and post-intervention (R) in the studied populations, as well as those captured in wild environments (Syl), showed some significant differences in the discriminant analysis.

Locality	% of assigned insects	No. of insects analyzed
12 de Junio	25	7
Casuarina	11	3
Concepción	11	3
Sylvatic	53	15
<b>Total</b>	<b>100</b>	<b>28</b>

The wing shapes of the *T. infestans* females of basal control (B) and post-intervention (R) in the studied populations, as well as those captured in wild environments (Syl), showed some significant differences in the discriminant analysis.

# Nero el vinchuquero: Insect catcher

- A German shepherd trained to look for kissing bugs in the forest. Thanks to this trained dog we were able to locate complete colonies of *T. infestans* and other vectors in forest areas of the Chaco.
- We achieve an important contribution to the knowledge about the characteristics of this insect in the wild habitat.
- The strategies in the entomological surveillance have been adjusted, they were no longer restricted to possible failures in the spraying at home and peridomicile and it was taken into account the potential reinfestation from the wild area.



First Report of Colonies of Sylvatic  
*Triatoma infestans* (Hemiptera:  
Reduviidae) in the Paraguayan  
Chaco, Using a Trained Dog



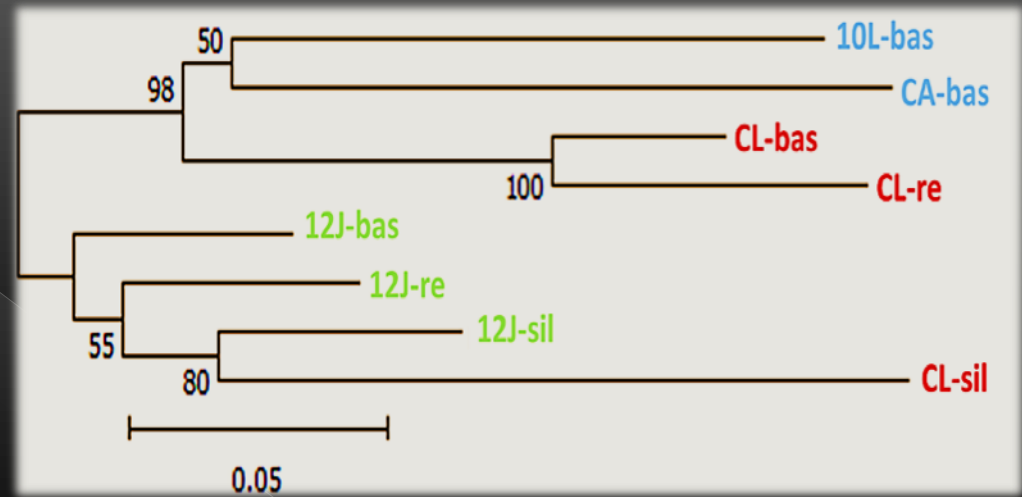
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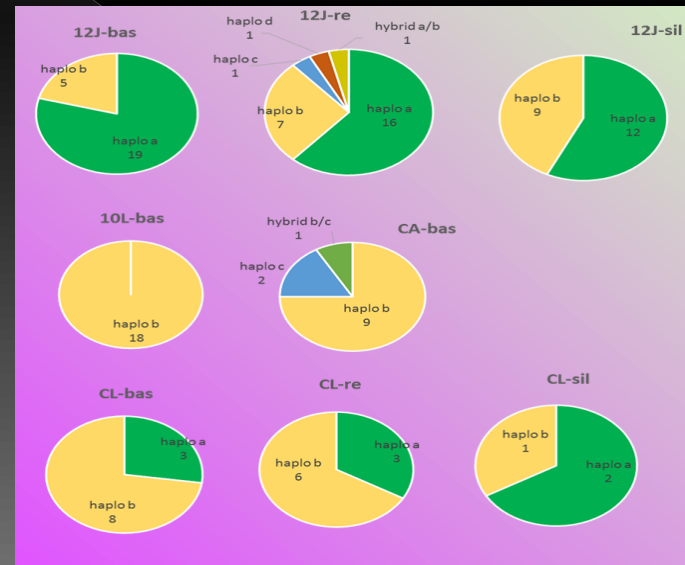
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# GENETIC FLOW BETWEEN DOMESTIC AND SYLVATIC POPULATIONS? OF *T. INFESTANS* OF THE PARAGUAYAN CHACO

✓ A clear genetic difference was detected between the basal populations of June 12 (12J), Campo Alegre (CA) and 10 Leguas (10L). However, the reinfestation populations were not genetically differentiated from the basal ones of the same community => The post-spraying reinfestation would be produced by remaining foci of each community.



✓ The sylvatic triatomines captured around 12J, did not differ from the domestic individuals of that community => there is significant genetic flow between the wild and the domestic populations in 12J



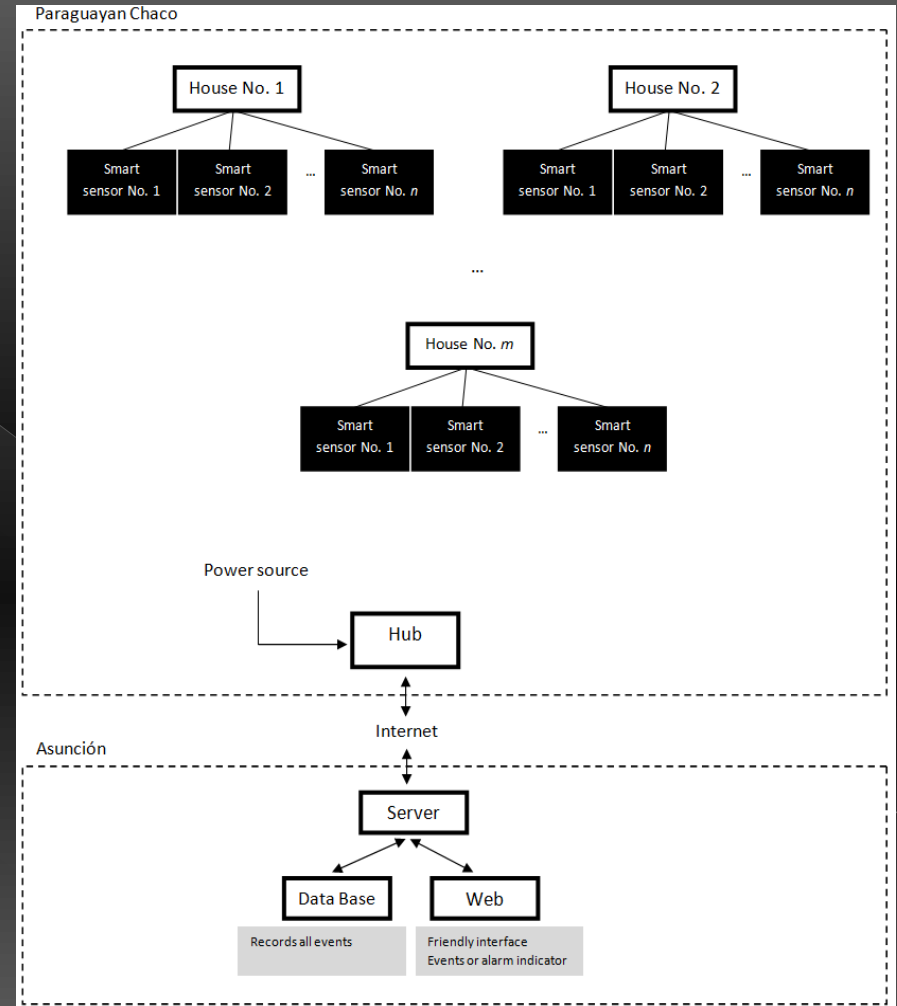
# What we knew ... What did we need ?

- The reinfestation process of vinchucas was fast in the Chaco.
  - The visits to review the houses were made every 6 months because of the distances and the displacement costs are high.
  - The manual detection of the insect per hour / man was very low and the sticky and baited trap was very sensitive in relation to the manual search
  - The system of slow liberation did not work in the Chaco.
  - That sylvatic *T. infestans* enters the dwellings after spraying.
- A system of slow release that would allow to maintain the operation of the trap for a period of at least 3 months.
  - An early detection in real time that will decrease the costs of the Control Program.
  - Facilitate the location of where the event was occurring to direct the actions.

# We proposed.....

- Provide a system, baited:
- with slow release,
- of real-time automatic detection of a potential infestation by triatomines,
- based on an intelligent and wireless network of remote sensors.

The traps form an intelligent mesh network, connected to a Concentrator, powered by the local electrical network and responsible for re-transmitting the detection information of the traps to the remote server on the Internet.





- A total of 20 sensor traps were installed in 20 houses and chicken coops of the Tiberia indigenous community.



- In 300 days the detections of potential kissing spots were at an average of 10 intrusions per day.



- The entries decreased with the months probably associated with the loss of pheromone release.

Tramp (interior), tramp (exterior) y concentrator

The days of rain decrease to the minimum (to zero in some cases) the number of detections in the day.

The highest number of detections occur when the percentage of relative humidity is less than 30% and the temperature less than 30 °C.

# Slow release system

Hydroxyapatite (HA-T3) and kaolin (Kaolin-T3) are the processed materials that gave the best results in terms of duration of pheromone release.

With the tablet made from kaolin (Kaolin-T3), greater efficiency was obtained in the capture of vinchucas, indistinctly for females or males.

Parámetro			Tipo de material	
			Hidroxiapatita	Caolín
Ensayo de liberación de feromona	Temperatura media de 29° C	Cantidad de feromona adsorbida (mg/g de material)	0,161	0,181
		Tiempo de liberación de feromona teórica (días)	259	292
Ensayo de liberación de feromona	Temperatura media de 39° C	Cantidad de feromona adsorbida (mg/g de material)	0,148	0,181
		Tiempo de liberación de feromona teórica (días)	175	194
Eficacia en los ensayos biológicos (%)	A los 19 días de haber iniciado el proceso de liberación	Machos	0,22	33,33
		Hembras	0,083	41,67
	A los 95 días de haber iniciado el proceso de liberación	Machos	-	41,67
		Hembras	-	33,33
Materia prima para la elaboración de pastilla			Necesita procesamiento con un costo determinado	No necesita procesamiento

Comparison between the results obtained by the tablets made from hydroxyapatite and kaolin



# CONCLUSIONS

- Infestation with *T. infestans* persists despite intensive residual spraying.
- The reinfestation process is rapid and the *T. cruzi* infection levels are higher than those observed in previous studies. (9.1% to 22%). Diversity of clones in domestic environment.
- The persistence of *T. infestans* is maintained by the precariousness of the houses and the high infestation of the household goods that they possess, which are not reached by the spraying.
- The sensors with pheromones have allowed the early detection of the presence of triatomines inside the dwellings, detecting the presence of other vectors that put pressure on homes such as *T. sordida* and *T. guasayana*.
- The morphometric studies of wings and molecular haplotypes show that the intradomiciliary invasion is mixed.
- 34% of the food preferences observed are multiple, which confirms the intense mobilization of the triatomines in domiciliary and peridomiciliary areas.

# KEY POINTS AND QUESTION

- Houses may be sprayed every ~6 months to control *T. infestans* infestation, and hence reduce the risk of *Trypanosoma cruzi* transmission to/between household members.
- However, some of the *T. infestans* population may survive in refuges within the house, most notably cracks in walls.
- In addition, houses with depleted *T. infestans* populations may be colonised from nearby sylvatic populations. Consequently, *T. infestans* populations recover fairly quickly and regular spraying is required for effective *T. cruzi* control.

What is the risk of dwelling reinfestation by wild and domiciliary populations in houses sprayed previously? What is the risk of human infection by triatomines infected by the parasite (*Trypanosoma cruzi*) that causes Chagas disease inside of these dwellings?

Thank you!!

Muchas gracias !!

