Risk areas for Chagas disease in the Mexican state of Veracruz, based on ecological niche modelling and socioeconomic factors

César A. Sandoval-Ruiz[1] & Sergio Ibáñez-Bernal [2].

[1]Escuela de Biología, Benemérita Universidad Autónoma de Puebla. Blvd. Valsequillo y Av. San Claudio Edificio 112-A, Ciudad Universitaria Col. Jardines de San Manuel, C. P. 72570, Puebla, Mexico [2]Red de Ambiente y Sustentabilidad, Instituto de Ecología, A. C. Carretera antigua a Coatepec 351, Congregación El Haya, Xalapa, CP. 91070, Veracruz, México.

E-mail: cesarsandovalruiz@gmail.com

Introduction

Chagas disease is an endemic zoonosis in Latin-America, where it is naturally transmitted to humans by the faeces of hematophagous triatomine bugs (Hemiptera: Reduviidae). It is one of the most important public health problems in Latin-American countries, affecting about 8-10 million people. However, ca. 110 million people live in areas with vector infestation and are therefore at risk of infection. Chagas disease is an important but neglected zoonosis in Mexico. Approximately 1.1 million people are estimated to be infected with *Trypanosoma cruzi* in Mexico but ca. 30 million Mexicans are considered at risk for Chagas disease. Over the past decade 27% of the total number of cases in Mexico has been reported from Veracruz State.

The potential geographical risk areas for Chagas disease transmission in the state of Veracruz, predicted by ecological niche modelling of *Triatoma dimidiata* distribution and socio-economic factors is here presented. as a guide for planning a surveillance and intervention programs targeted at Chagas disease in Veracruz

Methods

We assembled a database containing 190 locality records for *Triatoma dimidiata* along the state of Veracruz

We used 22 digital grid layers summarizing the environmental conditions of Veracruz State. Three of these represented topographic features (slope, elevation and compound topographic index), and the remaining 19 variables comprised annual, seasonal and extremes of temperature and precipitation drawn from the WorldClim project.

Ecological niche models were generated with the desktop implementation of Genetic Algorithm for Rule-set Production (GARP)
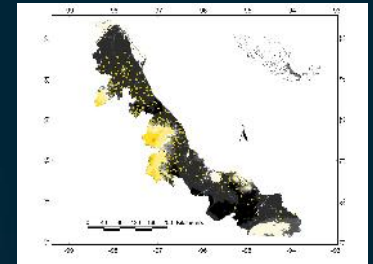

Results

According to the ecological niche model, *T. dimidiata* is likely distributed through areas of Veracruz State with warm annual mean temperatures (20-26.5°C) and annual precipitation ranging from 800 to 3800 mm. *T. dimidiata* is more frequently found between 400-800 m asl but was not recorded above 1300 m asl.

Potential risk areas
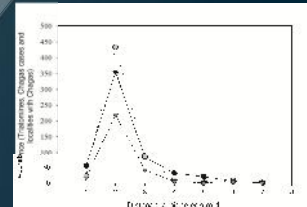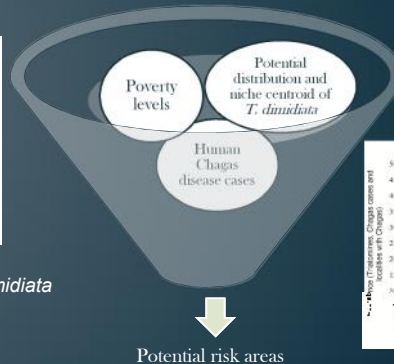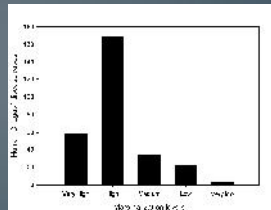
Significant relationship between the distance to the centroid and all *Triatoma*/disease incidence variables as indicated by Spearman correlation values: human Chagas disease (r= -0.8, *P*< 0.01), positive localities with Chagas disease in humans (r= -0.8, *P*< 0.01) and localities positive for vector infestation (r= -0.9, *P*< 0.01
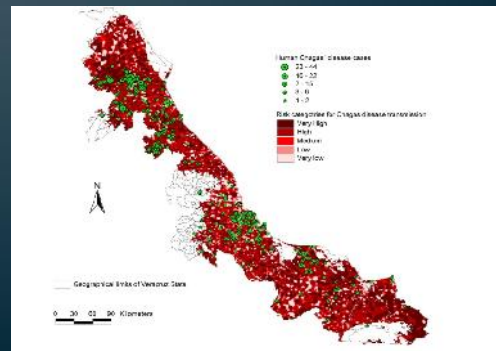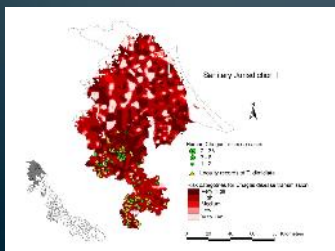
Risk map for Chagas disease transmission in the state of Veracruz, based on ecological niche centroid distance, deprivation level of localities and human cases reported. Color intensity represents higher risk, and relative size of circles the number of human Chagas disease cases accumulated from 2000-2008
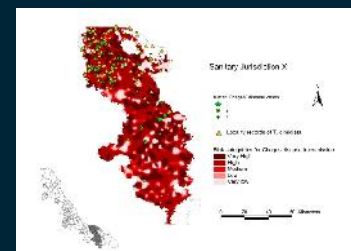
Predicted that the northern and central localities of the state are the most important transmission areas. However, southern Veracruz was predicted as epidemiologically important despite fewer records, perhaps due to a limited surveillance of this particular area. We consider this analysis useful to organize an effective surveillance and control program in Veracruz State

Chagas disease was more prevalent in socially-deprived localities: 20.4% (59) of cases were found at very high, 58.5% (169) at high, and only 21.1% (61) human cases corresponded to localities with middle-very low social marginalization levels

Few human cases reported outside the predicted distribution of *T. dimidiata* could be explained by human migration from endemic areas to large cities

The predictions, using the ecological niche centroid theory to recognize the geographic zones of high, middle, low and negligible risk of disease transmission are expected to be useful for the cost-effective organization and activation of the State's Chagas disease prevention and control program

Referencias
❖Salazar-Schettino, P. M., *et al.* 2005. Epidemiología de la enfermedad de Chagas en el estado de Veracruz. *Salud Pública Mex.* 47 (3): 201-208
❖Vidal-Acosta. V., S. Ibáñez-Bernal & C. Martínez-Campos. 2000. Infección natural de chinches Triatominae con *Trypanosoma cruzi* asociadas a la vivienda humana en México. *Salud Pública Mex.* 42 (6): 496-503.
❖Sandoval-Ruiz, C. A., Cervantes-Peredo, L., Mendoza-Palmero, F. S. & Ibáñez-Bernal, S. 2012. The Triatominae (Hemiptera: Heteroptera: Reduviidae) of Veracruz, Mexico: geographic distribution, taxonomic redescriptions, and a key. *ZOOTAXA* 3487: 1–23