

Population fluctuation of *Culicoides insignis* Lutz (Diptera: Ceratopogonidae) in Posadas, Misiones, Argentina

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Fluctuación poblacional de *Culicoides insignis* (Diptera: Ceratopogonidae) en Posadas, Misiones, Argentina

RESUMEN. En Argentina, la distribución de la enfermedad del Virus de la Lengua Azul se encuentra restringida al noreste del país. En la región Neotropical el principal vector sería *Culicoides insignis* Lutz. El objetivo de este trabajo fue determinar la fluctuación poblacional de *C. insignis* en la ciudad de Posadas y también la influencia de las variables climáticas como determinantes en la abundancia de esta especie. Los ejemplares fueron capturados mediante trampas de luz en el período comprendido entre enero y diciembre de 2013. La relación entre el número de *C. insignis* capturados y las variables ambientales fue analizada por regresión lineal multivariada. Se recolectaron 2.952 ejemplares de *C. insignis* representando el 93,4% del total de *Culicoides* capturados. Los análisis de regresión lineal multivariada muestran que la humedad relativa media mensual fue la variable que mejor explicó la dinámica de *C. insignis* en la zona de estudio. La transmisión de patógenos está probablemente influenciada por la abundancia del vector en el área. Los picos poblacionales observados indican los períodos donde debe haber mayor control para evitar la transmisión de la enfermedad. Este es el primer reporte sobre fluctuación poblacional de *C. insignis* en el noreste del país.

PALABRAS CLAVE. Posadas. Variables climáticas. Vector VLA.

ABSTRACT. The Bluetongue virus appears to be restricted in Argentina to the northeastern area of the country. In the Neotropical region the main vector could be *Culicoides insignis* Lutz. This study was aimed to determine the population fluctuation of *C. insignis* in Posadas city and test the influence of climatic variables as determinants of the abundance of this species. The specimens were collected in Posadas city using CDC light traps from January to December 2013. The abundance of *C. insignis* in relation to environmental variables was analyzed using multivariate linear regression. A total of 2,952 specimens of *C. insignis* were collected representing 93.4% of the total *Culicoides* captured. The multivariate linear regression analyses show that the monthly mean relative humidity was the variable that best explained the population dynamics of *C. insignis* in the work area. The pathogen transmission is probably influenced by the abundance of the vector in this area. The population peaks observed are indicative of periods when there should be more control to prevent transmission of the disease. This is the first report of population fluctuation of *C. insignis* in northeastern Argentina.

KEYWORDS. BTV vector. Climatic variables. Posadas.

Culicoides Latreille (Diptera: Ceratopogonidae) is a highly diverse genus of biting midges, with 1,415 species described worldwide (Borkent, 2016). Borkent & Spinelli (2007) listed 266 species in the Neotropical region, 44 of these have been reported in Argentina (Ayala & Marino, 2018). The genus is known in Misiones province by 29 species, although it is presumed that this number is underestimated (Spinelli, pers. obs.). Adult females are haematophagous and they are well known for the nuisance caused by their bites, which can produce burning and itching, and eventually immediate or delayed reactions that range from allergic dermatitis, papules, and pustules as a result of overinfection caused by scratching, to more severe reactions such as eczema, desquamation, and scars with alterations in skin pigmentation (Ronderos et al., 2003b; Borkent & Spinelli, 2007). Biting midges have sanitary importance because they are efficient vectors of protozoa, nematodes and viruses (Wirth & Blanton, 1959; Borkent & Spinelli, 2007). Species of *Culicoides* are recognized as vectors of the Bluetongue Virus (BTV) (Mellor et al., 2000; Borkent & Spinelli, 2007). This disease affects both wild and domestic ruminants causing economic losses and serious damage, even death. This virus appears to be restricted in Argentina to the northeastern area of the country (SENASA, 2004; Veggiani Aybar et al., 2011). In the Neotropical region *Culicoides insignis* Lutz is suspected to be the main vector (Tanya et al., 1992; Mellor et al., 2000; Ronderos et al., 2003b; Borkent & Spinelli, 2007). This is one of the most abundant species in Argentina, commonly associated with cattle farms (Ronderos et al., 2003b). Despite its importance as a vector of BTV, little is known about the distribution and abundance of *Culicoides* in northeastern Argentina. Thus, the aim of this work is to determine the population fluctuation of *C. insignis* in Posadas, Misiones, Argentina, and test the influence of climatic variables as determinants of the abundance of this species.

The study was conducted in an urban reserve of Posadas called "Área de Recursos Ambientales El Zaimán (ARA)" (27° 25' 59.70" S; 55° 53' 35.67" W), located in the southwest of Misiones province. This reserve belongs to the Paranaense ecoregion (Martínez Crovetto, 1963; Cabrera, 1971). The entomological survey was carried out in the forest of the reserve from January to December, 2013. The specimens of *Culicoides* were collected by CDC light traps, with collecting jars containing 70% ethanol. A total of two traps were used, every 15 days. These traps were placed on the branches of trees at 1.50 m from the floor and they were on from 18:00 h to 7:00 h.

Collected specimens were separated and placed in properly labelled tubes containing 70% ethanol for preservation. In the laboratory, identification of adults was performed following the taxonomic keys of Wirth & Blanton (1959) and Spinelli et al. (2005). Some specimens were mounted for microscopic examination on Canada balsam following the technique proposed by Borkent & Spinelli (2007). All specimens were deposited in the scientific collection of Centro de Investigaciones Entomológicas - Parque Tecnológico Misiones (CIE-PTMi), Posadas city, Misiones province, Argentina. The climatic variables considered for the study were: mean monthly temperature, mean minimum monthly temperature, mean maximum monthly temperature, monthly accumulated rainfall, and monthly mean relative humidity. They were recorded by the meteorological station of Posadas city, located at 10 km from the sampling site.

The abundance of *C. insignis* was considered as the dependent variable and the monthly climatic variables as independent variables. For this analysis, the general equation of the models developed was $y = a_0 + a_1x_1 + a_2x_2 + \dots + a_nx_n$, where y corresponds to the abundance of *C. insignis*, a_0 is a constant and $a_1 \dots a_n$ are the coefficients of the different climatic variables (X_1 to X_n). The climatic variables were designated as follows: X_1 —mean monthly temperature, X_2 —mean minimum monthly temperature, X_3 —mean maximum monthly temperature, X_4 —monthly accumulated rainfall, and X_5 —monthly mean relative humidity. Multivariate linear regressions analyses were carried out using the R free Software, version 3.2.1 (R Core Team, 2014). The statistical significance of each variable was tested in a Stepwise Selection procedure using variable retention.

A total of 3,162 adult of *Culicoides* specimens were collected. *Culicoides insignis*, with 2,952 specimens, represented the 93.4% of total captured. From 2,952 specimens, 66.2% were females (1,954 specimens) and 33.8% were males (998 specimens). The percentages of the other species captured were as follows: *C. venezuelensis* Ortiz & Mirsa (2.72%), *C. limai* Barretto (1.11%), *C. debilipalpis* Lutz (0.92%), *C. flinti* Wirth (0.47%), *C. fernandoi* Tavares & Sousa (0.47%), *C. leopoldoi* Ortiz (0.41%), *C. plaumanni* Spinelli (0.32%), *C. guttatus* (Coquillett) (0.09%), *C. bambusicola* Lutz (0.06%) and *C. pusillus* Lutz (0.06%). The species *C. insignis* was present during the whole year, and its abundance peaks in June and July (Fig. 1).

The multivariate linear regressions analyses were carried out with five regressive variables. Only one of them, the monthly mean relative humidity, was retained

after the stepwise selection procedure. With a p-value lower than 0.05, this term was statistically significant with a confidence interval of 95%. These results indicate that the most influent variable over the abundance of *C. insignis* was the monthly mean relative humidity ($y: -1769.03 + 28.61 x_5$; R^2 adjusted= 0.32; $P < 0.03$) (Fig. 2). None of the other climatic variables were significantly correlated with the abundance of *C. insignis* throughout the sampling period.

This is the first report dealing with population fluctuation of *C. insignis* in the northeast of Argentina. The high abundance of *C. insignis* is coincident with the results obtained by Ronderos et al. (2003a) in a studied carried out in the area affected by the Yacyretá dam lake in the period 1993-1998.

With respect to the effects of the climatic variables on the abundance of *C. insignis*, it was observed that the monthly mean relative humidity was the only variable that explained the dynamics of the species population at the study site during the period considered.

Although *C. insignis* was present during the whole year, the highest number of specimens was collected in June and July, when the temperature values were the lowest, and the humidity values were the highest. In these months the recorded minimum and maximum temperature were 16.8 °C and 22.8 °C respectively, while the humidity percentage showed values ranging from 74.6 to 81.7%. This is in agreement with the results obtained by Perruolo (2001) in Venezuela, who observed an inversely proportional relationship between the abundance of *C. insignis* and high temperatures, and a greater abundance during periods of abundant rainfall and low temperature.

On the other hand, Veggiani Aybar et al. (2011) in northwestern Argentina, found that the mean minimum and maximum temperatures and levels of accumulated rainfall were the variables most strongly related to the abundance of *Culicoides* species, showing that *C. insignis* is more abundant in the summer, when temperatures are high. However, in La Florida (Tucumán province) this species is more abundant in autumn and winter, with an abundance of specimens significantly lower than those of the others sampling sites. Lager et al. (2004) also observed “low activity” (presumably low density) of *C. insignis* at low temperatures in the north of Corrientes province.

The great differences between the amount of *C. insignis* and other species of *Culicoides* observed in this study are in agreement with data presented by Silva et al. (2010) for Brazilian Amazonia, where *C. insignis* was also the most abundant species, with 93% of the total *Culicoides* captured in their sampling using CDC traps. All these data suggest a strong attraction of this species by light traps.

Culicoides insignis is presumed to be the main vector of the BTV in the Neotropical region (Borkent & Spinelli, 2007). However, the available information is insufficient to exclude the possibility that other *Culicoides* species could also transmit the BTV, since the virus has not yet been isolated from potential vectors in the region (Ronderos et al., 2003b). It is also necessary to determine which species of *Culicoides* involved in BTV transmission and to reconfirm the serotypes present in Argentina. Since the rate of transmission of BTV is potentially determined by the level of abundance of the vectors, the population peaks observed during the winter indicate that this period could be the most important respect to the risk of virus transmission and vector control.

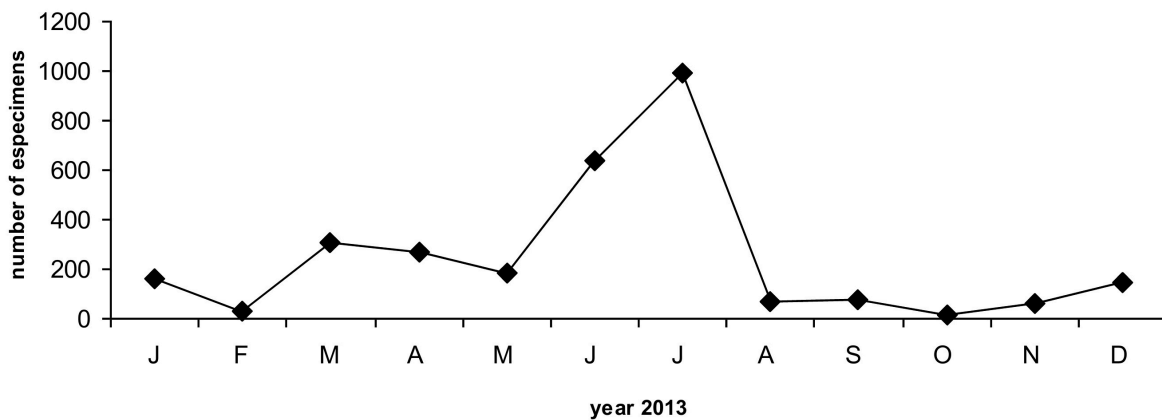


Fig. 1. Population fluctuation of *Culicoides insignis* Lutz in Posadas city, Misiones province Argentina, from January to December, 2013. Y axis: Abundance; X axis: Months.

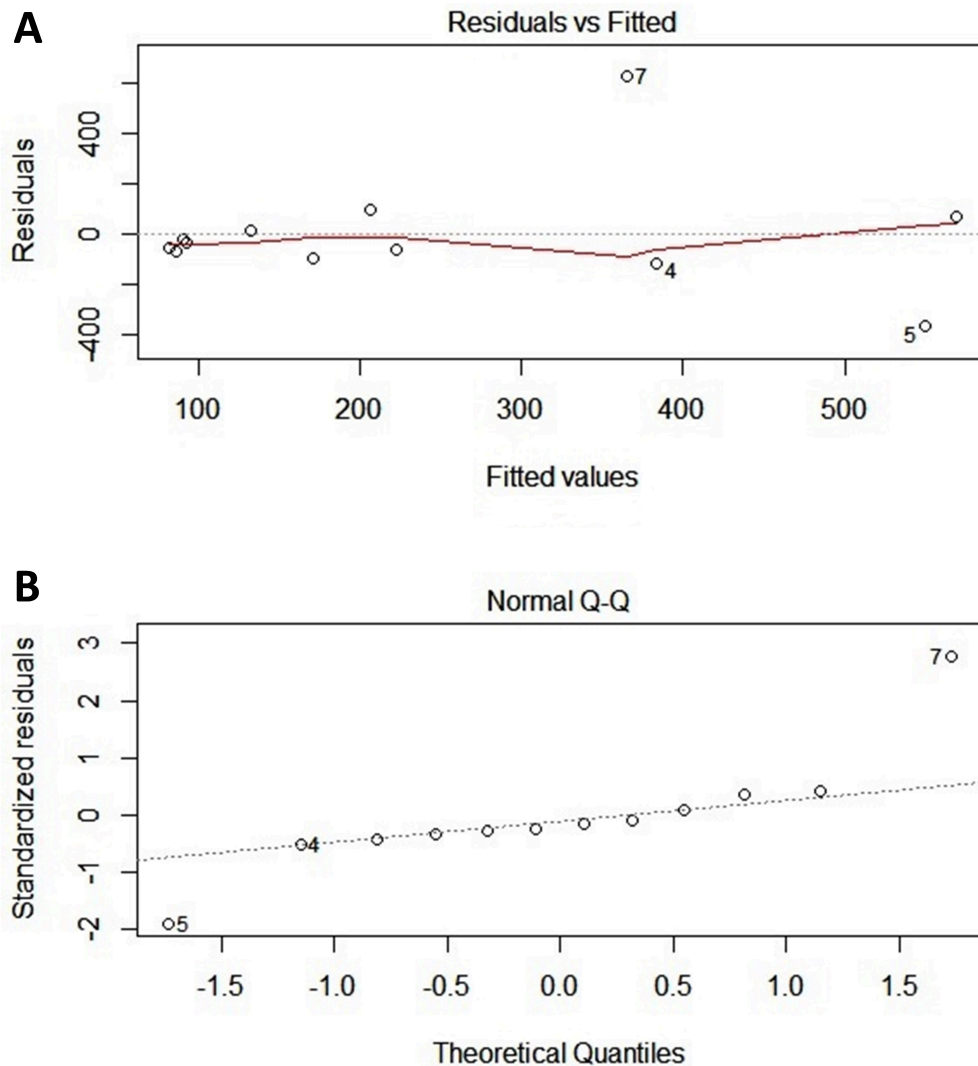


Fig. 2. Multivariate linear regression analysis between monthly mean relative humidity and number of specimens of *Culicoides insignis* Lutz in Posadas city, Misiones province, Argentina, from January to December, 2013.

Validation of regression models in: A. Residual vs Fitted Plot and B. Normal Q-Q Plot.

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