Artículo
Article

www.biotaxaorg/RSEA. ISSN 1851-7471 (online) Revista de la Sociedad Entomológica Argentina 81 (2): 29- 38, 2022

Diversity of the Heteroptera (Insecta: Hemiptera) aquatic and semi-aquatic assemblage of the Río Grande basin (Jujuy-Argentina) in an altitudinal and temporal gradient

GOMEZ Graciela C.[1,2]*, CONTRERAS, Eugenia F.[1] & TORREJON Silvia E.[2]

[1] Instituto de Biología de la Altura, Universidad Nacional de Jujuy. Jujuy, Argentina.

[2] Consejo Nacional de Investigaciones Científicas y Técnicas. Jujuy, Argentina.

* E-mail: gracielagomez@inbial.unju.edu.ar

Received *08 - III - 2022* | Accepted *24 - VI - 2022* | Published *30 - VI - 2022*

https://doi.org/10.25085/rsea.810203

Diversidad del ensamble de Heteroptera (Insecta: Hemiptera) acuáticos y semiacuáticos de la cuenca del Río Grande (Jujuy-Argentina) en un gradiente altitudinal y temporal

RESUMEN. El objetivo de este trabajo fue realizar un estudio preliminar de la diversidad, composición y estructura del ensamble de heterópteros acuáticos y semiacuáticos de la cuenca del Río Grande (Jujuy-Argentina) a lo largo de un gradiente espacial y temporal. Se presenta por primera vez una lista de los taxones presentes en el área que incluye 11 géneros pertenecientes a ocho familias. Los sitios estudiados correspondientes a la baja cuenca presentaron la mayor diversidad, el género *Rhagovelia* fue el más abundante en ambos períodos hidrológicos. En contraste, la alta cuenca presentó una baja diversidad, este ensamble estuvo dominado por *Ectemnostega*, tanto en el periodo lluvioso como en el seco. A nivel temporal no se registraron diferencias significativas de la diversidad de chinches acuáticas y semiacuáticas en la cuenca.

PALABRAS CLAVE. Chinches acuáticas. Cuenca alta. Cuenca baja. Jujuy. Río Grande.

ABSTRACT. The objective of this work was to realize a preliminary stydy the diversity, composition and structure of the aquatic and semiaquatic Heteroptera assemblage of Río Grande basin (Jujuy, Argentina) along a temporal and spatial gradient. For the first time, a list of the taxa inhabiting the area is presented, which includes 11 genera belonging to eight families. The sites corresponding to the lower basin exhibited higher diversity, and the genus *Rhagovelia* was the most abundant in both hydrological seasons. In contrast, the upper basin exhibited a low diversity, and its assemblage was dominated by *Ectemnostega*, both in the wet and dry season. Significant differences in the diversity of aquatic and semiaquatic bugs at the temporal level were not found in this basin.

KEYWORDS. Aquatic true bugs. Jujuy. Río Grande. upper basin. lower basin.

INTRODUCTION

Aquatic heteroptera, commonly known as water true bugs, belong to the Order Hemiptera. Three of the seven infraorders are related to aquatic environments: Nepomorpha includes species that live underwater or in flooded margins; Gerromorha composed by species living on the surface water film, and Leptodomorpha that includes species inhabiting humid soils of marshes and swamps, as well as river and lake banks (Bachmann, 1998; Melo, 2009).

The highest richness of water true bugs is found in the Neotropical region. Particularly in South America where six families, 43 genera, and approximately 380 species of Gerromorpha; and 10 families, 39 genera, and around 510 species of Nepomorpha are represented (Mazzucconi et al., 2009).

Heteroptera inhabit a wide range of aquatic ecosystems (freshwater, sea water, interstitial water, and high altitude aquatic environments), from 0 to 4700 m.a.s.l. Regarding their food habits, they are predators, scavengers and detritivores (Mazzucconi et al., 2009; Melo, 2009).

From an ecological point of view these insects are very vulnerable to alterations in their environment, therefore are considered a good group to evaluate certain water quality parameters. Thus, they are commonly used to monitor this natural resource (Bachmann, 1998). On the other hand, these insects are beneficial to humans, since many species feed on mosquito larvae. Furthermore, they are excellent models in evolutionary biology, biogeography, ecology and conservation studies due to their diverse lifestyles, and because they are easy to observe in their environment (Mazzucconi et al., 2009).

In Argentina, there are many studies on aquatic and semiaquatic Heteroptera, such as research carried out in the Pampa (Kanopko et al., 2009), Patagonia (Melo, 2009), Cuyo (Scheibler et al., 2016), Northeast (López Ruf et al., 2003; Torres et al., 2007; Mazzucconi et al., 2008) and Northwest (Torres et al., 2008). Currently, records of aquatic and semiaquatic Heteroptera species for Jujuy province include 53 species (Melo & Dellapé, 2021). However, knowledge about their diversity is only limited to records of Calilegua National Park (Torres et al., 2008).

The Río Grande basin in Quebrada de Humahuaca (UNESCO World Heritage 2003) begins in a high altitude desert (Puna) and crosses xerophilous shrublands (Monte de Sierras y Bolsones), mist grasslands, mountain rainforests (Yungas) and dry forests (Chaco) (Gomez & Molineri, 2022). Due to this wide environmental variability, it can be divided in two sectors: lower and upper basins (Chayle & Agüero, 1987), which differ widely in terms of soil, climate and biological communities.

Despite the importance of this basin, the most populous of Jujuy province, aquatic insect diversity has been scarcely studied (Gomez & Molineri, 2021). The objective of this work was to realize a preliminary study the diversity, composition and structure of the aquatic and semiaquatic Heteroptera of Río Grande basin (Jujuy, Argentina) throughout a spatial and temporal gradient.

MATERIAL AND METHODS

Study area: the study area corresponds to the Río Grande basin, located in Jujuy province, between 736 and 3693 m.a.s.l. Based on the vegetation, climate and topography, the basin can be divided in two sectors: “upper basin”, which comprises the area to the north of Bárcena locality (1883 m.a.s.l.) towards the north; and “lower basin”, to the south of the locality (Chayle & Agüero, 1987) (Fig. 1). The upper basin area is characterized by scarce vegetation, scarcely developed soils; dry, cold climate, low rainfall and sharp thermal amplitude. Biogeographically it corresponds to the Puna and Monte de Sierras y Bolsones ecoregions. On the other hand, the lower basin is characterized by a variety of plant formations resulting from a sharp altitudinal gradient (400 to 3000 m a.s.l). It has a warm, humid climate and soils with abundant organic matter. Summer rainfall is abundant and during the colder months, the condensation and catchment of mist water compensates rainfall scarcity (Malizia et al., 2010).

The main outlet of the basin is Río Grande, with 60 important tributaries due to their length and permanent water flow, such as Yala and Xibi-Xibi rivers (Chayle & Agüero, 1987).

Sampling of aquatic and semiaquatic Heteroptera: six surveys were carried out in Río Grande basin during two hidrological periods, between 2012 and 2014. Eight sampling sites (four in the upper basin and four in the lower basin) were selected following an altitudinal and biogeographic gradient.

Along Río Grande, the main outlet of the basin, four surveys were carried out: two in the dry period (June 2012/2013) and two in the wet period (December 2012/2013). Study sites were: Azul Pampa (22º58’18”S; 65º27’01”W; 3542 m.a.s.l.), Pinchayoc (23º16’24”S; 65º21’44”W; 2870 m.a.s.l.), Jueya (23º30’34”S; 65º22’11”W; 2560 m.a.s.l.), Tumbaya (23º50’36”S; 65º28’00”W; 2112 m.a.s.l.), Yala (24º06’57”S; 65º23’58”W; 1440 m.a.s.l.) and La Mendieta (24º19’07”S; 64º57’48”W; 733 m.a.s.l.) (Fig. 1).

Along the tributaries, two surveys were carried out: one in the dry period (June, 2014) and one in the wet period (December, 2014) in Yala river (24º07’06”S; 65º24’31”W; 1468 m.a.s.l.) and Xibi-Xibi river (24º11’48”S; 65º19’59”W; 1314 m.a.s.l) (Fig. 1).

Each sampling point was codified with two letters as follows: Azul Pampa (AP), Pinchayoc (PI), Jueya (JU), Tumbaya (TU), Yala (YA), La Mendieta (LM), Yala river (YL), Xibi- Xibi river (XX).

Sampling year identification: 1 (2012), 2 (2013) y 3 (2014).

Hydrological period identification: 1 (dry), 2 (wet).

As an example, AP11 corresponds to Azul Pampa site sampled in 2012 during the dry period.

At each site, a sample was taken with a net of 250 µm mesh width, both on the main channel and the margins. Heteroptera specimens obtained in the field were individualized and quantified under a Nikon SMZ 800 stereo binocular microscope, and preserved in jars with alcohol 70%. Specimen identification was carried out to the genus level using the keys of Domínguez & Fernández (2009) and Heckman (2011).

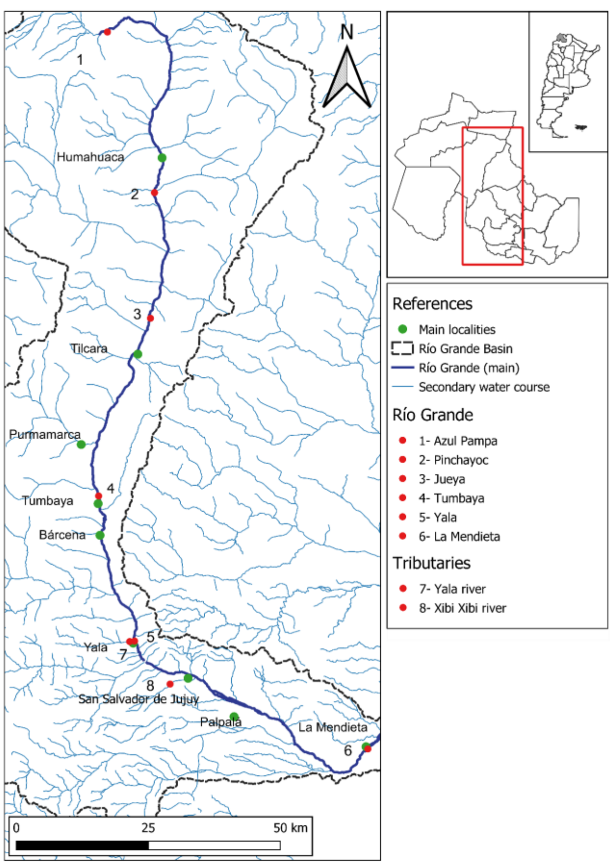

Fig 1. Río Grande basin in Jujuy province (Argentina). Location of the eight sampling sites.

Data analysis: to perform the analyses, an abundance matrix of the genera of Río Grande basin was built. The abundances were expressed as total number of individuals present (absolute abundance). To estimate and compare the diversity of Heteroptera present throughout the basin in the two hydrological periods, Hill (qD) numbers were used. These consider *q* values from 0 to 2, with a 95% confidence interval. qD values can be interpreted as effective numbers of genera, where *q=0* represents genera richness; *q=1* represents the exponential of Shannon entropy, and *q=2* is the equivalent of the inverse Simpson index. Results were illustrated as a continuous function of the *q* parameter (Chao et al., 2014; Chao & Jost, 2015).

To describe the spatial (upper and lower basin) and temporal (i.e., seasonal- wet, dry) distribution, a non-metric multidimensional ordination (NMDS) was carried out using the Bray-Curtis distance matrix (similarity index for continuous data). Likewise, to identify differences among sampling seasons in the upper and lower basin, two permutational multivariate analyses of variance (PERMANOVA) (Anderson, 2001) were performed. These were based on the Bray-Curtis similarity matrices built from the abundance of each genus.

All the analyses were carried out using R software (versión 3.3.0; R Foundation for Statistical Computing, Viena, Austria). In addition, rank-abundance curves were built to evaluate taxonomic composition changes throughout the spatial gradient and among seasons (dry and wet). These curves are a graphical method that sorts species from higher to lower abundance, and thus brings information about dominance and presence of rare species within the community (Armada, 2007).

RESULTS

Structure and diversity of aquatic and semiaquatic Heteroptera at a temporal and spatial scale: 309 individuals corresponding to eight families and 11 genera were collected (Table I). The relative abundances of aquatic bugs found throughout the basin were: 56,3% Veliidae; 20.7% Naucoridae; 8,1% Hebridae; 3,2% Corixidae; 1,3% Belostomatidae; 1,0% Saldidae; 0,3% Gelastocoridae and 0,3% Gerridae.

Family	Genus	AP12	AP21	AP22	PI12	PI22	JU22	TU21	YA12	LM12	LM21	LM22	YL31	YL32	XX31	XX32
Corixidae	*Sigara*	0	0	0	2	0	0	0	0	0	0	0	0	8	0	0
	Tenagobia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Ectemnostega	0	6	3	4	2	1	0	0	0	0	0	0	10	0	0
Saldidae	*Pseudosaldula*	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Veliidae	*Microvelia*	0	0	0	0	0	0	0	0	0	0	31	0	0	4	4
	Rhagovelia	0	0	0	0	0	0	0	29	46	17	5	0	0	38	0
Gelastocoridae	*Nerthra*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Belostomatidae	*Belostoma*	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Hebridae	*Hebrus*	0	0	0	0	0	0	0	0	0	0	0	1	0	21	3
Naucoridae	*Ambrysus*	0	0	0	0	0	0	0	0	0	0	0	3	0	37	24
Gerridae	*Trepobates*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Table I. Absolute abundance (total number of individuals present) of aquatic and semiaquatic Heteroptera of Río Grande basin (Jujuy, Argentina) collected from 2012 to 2014 during the dry and wet seasons. Sampled sites with no collected Heteroptera specimens were excluded. Locality: Azul Pampa (AP), Pinchayoc (PI), Jueya (JU), Tumbaya (TU), Yala (YA), La Mendieta (LM), Yala river (YL), Xibi- Xibi river (XX); sampling year: 2012 (1), 2013 (2), 2014 (3); hydrological period: dry (1), wet (2).

Based on the diversity profile (Fig. 2A) a clear difference at the richness level (*q=0*) was observed. The lower basin (nine genera) exhibited more richness compared to the upper basin (four genera). Regarding order 1 (*q=1*), the lower basin was found to behave as a virtual community with 4.4 effective genera, while in the upper basin diversity reaches 2.4 effective genera. Thus, the lower basin was 1.8 times more diverse than the upper basin. In the case of order 2 diversity (*q*=2), it behaved similarly than order 1: the lower basin reached 3.3 effective genera and the upper basin reached 1.8 effective genera. At the temporal level, the order 0, 1 and 2 diversity weresimilar in both periods (Fig. 2B).

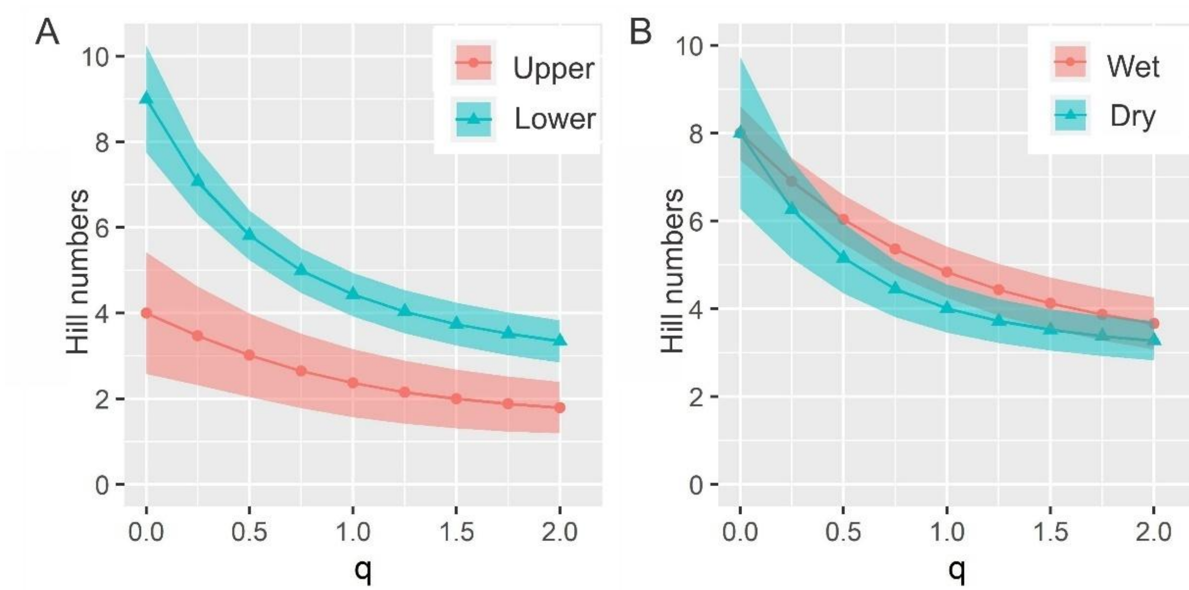

Fig. 2. Diversity profiles of Heteroptera genera of Río Grande basin, based on Hill numbers (the shaded line corresponds to the 95% confidence interval). A) spatial scale; B) temporal scale.

The non-metric multidimensional scaling (Fig. 3) showed two groupings at the spatial scale: the lower basin sites were found towards the right of the ordination plot (YL31, XX31, XX32, LM12, LM21, LM22, YA12). Towards the left, the upper basin sites were grouped (AP12, AP21, AP22,PI12,PI22, JU22). The genera represented in the lower basin *Trepobates* Uhler, which characterized the Yala river (YL31), and *Hebrus* Curtis and *Ambrysus* Stål, related to the Xibi-Xibi river (XX31 and XX32). On the other hand, during the dry season *Tenagobia* Bergroth was associated to Río Grande in a section corresponding to La Mendieta locality (LM21), and *Microvelia* Westwood and *Belostoma* Latreille were associated to that same section during the wet season (LM22). Likewise, *Rhagovelia* Mayr was present in Río Grande in Yala (YA12) and La Mendieta (LM12) localities in the wet season. In contrast, the upper basin assemblage was comprised by the genus *Pseudosaldula* Cobben in Río Grande, which was present in Azul Pampa (AP12, AP22) and Pinchayoc (PI22) sites during the wetseason. On the other hand, *Ectemnostega* Enderlein and *Sigara* Fabricius were associated to Río Grande in a section between Azul Pampa and Jueya localities during the wet season (AP22, PI12, JU22). These were also found in Yala river, which belongs to the lower basin (YL12).

In addition, a section of Río Grande that corresponds to the upper basin (Tumbaya, TU21) was distanced from the two mentioned groupings in the ordination space. In this, the genus *Nerthra* Say was the most collected.

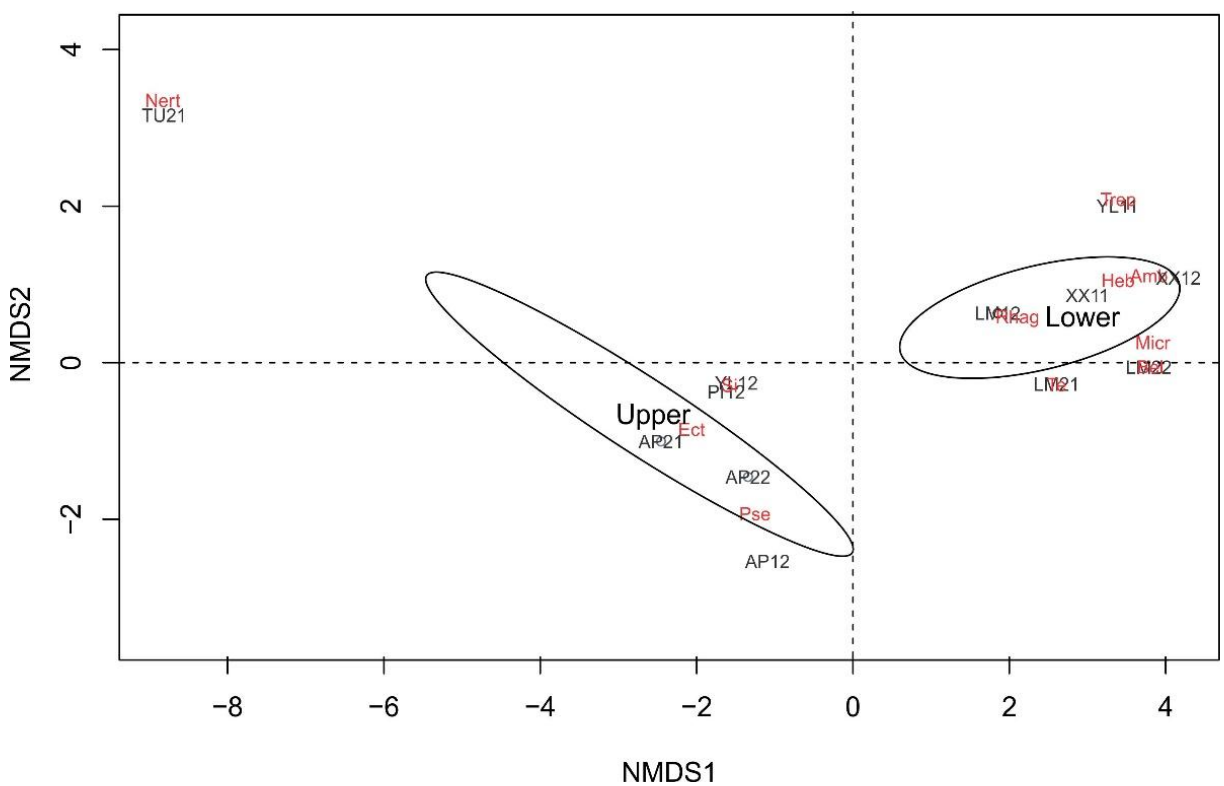

Fig. 3. NMDS analysis of the Río Grande basin sites based on the total abundance of Heteroptera, during the wet and dry season (stress= 8,38 x 10 -5). Codes of the genera are found in Table I.

The rank abundance curves (Fig. 4) indicated that the semiaquatic and aquatic Heteroptera assemblage of the lower basin was more equitable than that of the upper basin: the slope of the curve of the former was gentler, while at a higher altitude it was steeper, with only one dominant genus: in the upper basin the assemblage was dominated by *Ectemnostega* both in the dry (86%) and wet season (67%), while *Rhagovelia* was the most abundant genus in both seasons (dry: 45%, and wet: 49%).

Common genera throughout the entire basin were *Ectemnostega* and *Sigara*. The abundances of the former diminished from higher altitude (67-86%) towards downstream (6%). On the other hand, the genus *Sigara* was less abundant both in the upper basin (13%) and the lower basin (5%), and in both sectors it was found only in the wet season.

The upper basin presented two exclusive genera: *Nerthra* and *Pseudosaldula*. In contrast, the lower basin presented seven exclusive genera: *Rhagovelia*, *Ambrysus*, *Microvelia*, *Hebrus*, *Belostoma*, *Tenagobia* and *Trepobates*.

The Permutational multivariate analyses of variance (PERMANOVA) confirmed altitudinal variations in the composition of the aquatic and semiaquatic Heteroptera assemblage (F=4,1; p=0,002). They did not show any significant differences among seasons (F=0,7; p= 0,622) (Table II and III).

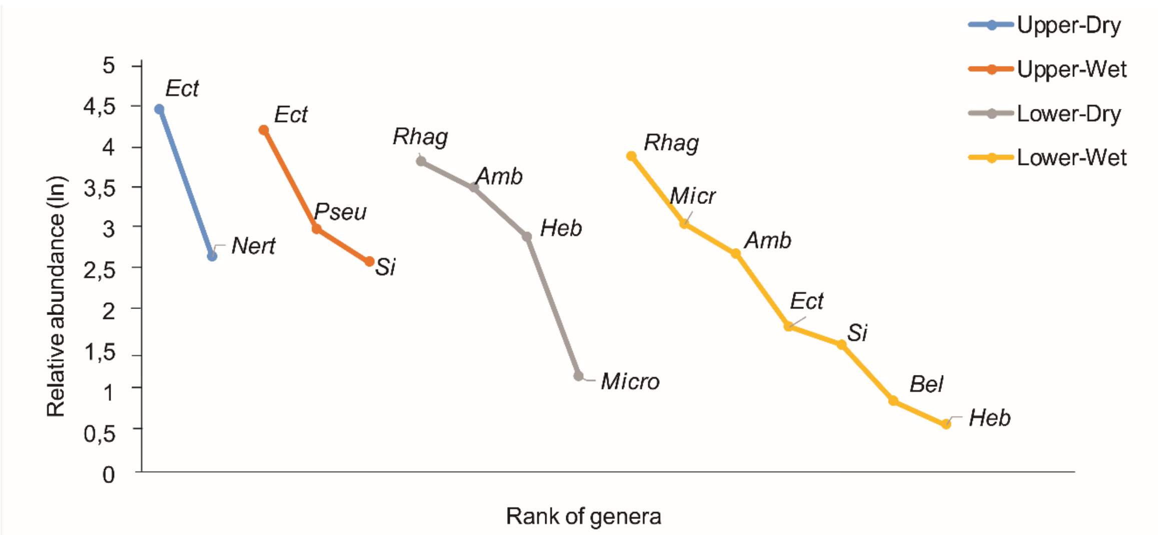

Fig. 4. Rank abundance curves of Heteroptera genera present in the lower and upper Río Grande basin (Jujuy, Argentina).

Source of variation	DF	Sum of Squares	Mean Squares	F	R2	p (>F)
Basin	1	1.41	1.411	4.199	0.244	0.002
Error	13	4.367	0.336		0.756	
Total	14	5.777			1	

Table II. PERMANOVA based on Bray-Curtis differences of the total abundances of aquatic and semiaquatic Heteroptera of Río Grande basin (Jujuy, Argentina) to evaluate spatial differences (upper and lower basin) (p < 0,05, n=14).

Source of variation	DF	Sum of Squares	Mean Squares	F	R2	p (>F)
Basin	1	0.325	0.325	0.774	0.056	0.622
Error	13	5.452	0.419		0.943	
Total	14	5.777			1	

Table III. PERMANOVA based on Bray-Curtis differences of the total abundances of aquatic and semiaquatic Heteroptera of Río Grande basin (Jujuy, Argentina) to evaluate seasonal differences (p <0,05, n=14).

DISCUSSION

Out of eight families, the most abundant families of semiaquatic and aquatic bugs registered in the Río Grande basin were Veliidae and Naucoridae. The first comprised more than 50% of the total abundance, due to its capacity to adapt to a wide range of habitats (both permanent or temporal, and natural or artificial) (Schuh & Weirauch, 2020; Mazzucconi et al., 2009). Although Naucoridae exhibited a relatively low abundance, it occupied the second place. López Ruf (2008) points out that the family Naucoridae exhibits a low density of individuals. The remaining families (Hebridae, Corixidae, Belostomatidae, Saldidae, Gelastocoridae and Gerridae) were cited by Torres et al. (2008) in lentic and lotic environments of Calilegua National Park, but no studies that could explain the low population density found in this work were carried out. For this reason, it would be necessary to carry out complementary sampling aimed at deepening the study of these poorly represented families.

Based on the diversity profile, the aquatic and semiaquatic Heteroptera assemblage of the lower basin was more diverse than that of the upper basin. To date, no study had compared aquatic insect (and particularly bug) diversity in both areas. Knowledge on the aquatic biota inhabiting Río Grande basin was only limited to one study about water ecological quality (Gomez & Molineri, 2022); however, this higher diversity is expected considering that the lower basin is located in the Yungas, with a much more habitats and food resources. In contrast, the upper basin is located in the Puna and Monte de Sierras y Bolsones ecoregions, whose climatic and topographic characteristics are less favorable for the development of biological communities.

The NMDS analysis showed two groups of sampling sites with largely different Heteroptera assemblages at the spatial scale: one group corresponding to the upper basin, and the other to the lower basin. These results agree with that observed in the rank abundance curves, which showed that the genus *Ectemnostega* dominated the upper basin assemblage in both studied seasons. Rivers that belong to this sector are characterized by their high altitudes, wide thermal amplitude, fine sediments, and scarce vegetation. In that regard, Melo (2014) points out that species of this genus have a Neotropical distribution, restricted to Andean and extra Andean areas of South America. For its part, Scheibler et al. (2016) registered *Ectemnostega* (*E.*) *quadrata* as the most abundant, and endemic to the Andean region.

In contrast, *Rhagovelia* was the most abundant genus in the lower basin in the two seasons. The sampled rivers in this sector of the basin are located at altitudes lower than 1500 m.a.s.l. and are characterized by coarse sediments, stormy waters and lush riparian vegetation. The genus *Rhagovelia* is distributed in South America, from Colombia to the Argentine Patagonia. Its species inhabit forest streams, moving through moderate to rapid flows propelled with their middle legs (through the feathery tarsal fans) as paddles (Bachmann, 1998; Mazzucconi et al., 2009).

On the other hand, the most collected genera in the lower and upper basin were *Ectemnostega* and *Sigara* (Corixidae), which exhibit a wide tolerance to altitudinal changes. Both were found in Río Grande, in a sector located between Jueya and Azul Pampa localities (2560 – 3542 m.a.s.l.), and also in Yala river (1468 m.a.s.l.). Although there is a wide altitudinal difference among these sectors, upper basin rivers are subjected to very low night temperatures due to the wide thermal amplitude. In addition, because the Yala river is a mountain river, it has stormy, cold waters. In that sense, Cummins et al. (2008) point out that the family Corixidae is adapted to the cold: some of its representatives, such as *Ectemnostega* (*Ectemnostega*) *quadrata* Signoret 1885 and *Sigara* (*Tropocorixa*) *jensenhaarupi* Jaczewski 1927 (endemic to the Andes region) are cold stenothermal species, which are very abundant at higher altitudes in mountain wetlands of Mendoza province (Scheibler et al., 2016). Melo (2014) cites *Ectemnostega* (*Ectemnostegella*) *quechua* (Bachmann 1961) in high altitude freshwater bodies of northwest Argentina, with scarce vegetation and variable, but generally low temperatures; and *Sigara* (*Tropocorixa*) *yala* Bachmann 1979 in freshwater bodies of Jujuy province located at altitudes higher than 1450 m.a.s.l.

Regarding the genera that were only collected at the upper basin, *Nerthra* was found in a sector of Río Grande corresponding to Tumbaya locality, with fine sediments and whose margins have sandbanks were water accumulates. In that regard, Bachmann (2006) indicates that species of this genus are found in muddy or loamy, flooded beaches of lentic and lotic environments. On the other hand, *Pseudosaldula* was registered in a sector of Río Grande corresponding to two localities (Azul Pampa and Pinchayoc) at altitudes higher than 2800 m.a.s.l. According to Melo & Carpintero (2014), Andean Saldidae inhabit waterbodies located at higher altitudes, associated to wet margins of ponds and stream rocks.

In contrast, in the lower basin seven genera were only collected there: *Trepobates*, *Hebrus*, *Ambrysus*, *Tenagobia, Microvelia*, *Belostoma* and *Rhagovelia.* The first was present in Yala river, in agreement with that reported by Mazzucconi et al. (2009), who state that species of this genus are distributed from Colombia to northwest Argentina. Bachmann (1998) points out that *Trepobates* inhabits small foothill streams. In Jujuy province, Torres et al. (2018) registered *Trepobates taylori* (Kirkaldy) in a lentic waterbody of Calilegua National Park, located in the lowest altitudinal level of the Yungas. Unlike that exposed by the mentioned authors, in this study the genus *Trepobates* was registered in a stormy mountain river (Yala river).

Hebrus and *Ambrysus* were found in the margins of the Xibi-Xibi river. *Hebrus* species inhabit stagnant sectors of lotic environments, over floating plants or emerging rocks; and on the surface of lentic environments; while *Ambrysus* is typical of lotic environments, mountain streams and rivers with stony bottoms; and clear, calmer waters. Both genera are distributed from Colombia to the center of Argentina (Bachmann, 1998; López Ruf, 2008; Mazzucconi et al., 2009). In Jujuy province, records of these genera correspond to Calilegua National Park: *Hebrus* sp., *Ambrysus gemignanii* De Carlo 1950, *Ambrysus kolla* López Ruf 2004 (Torres et al., 2008).

On the other hand, *Tenagobia, Microvelia* and *Belostoma* were found in Río Grande in a sector corresponding to La Mendieta locality. Species of these genera are found on the surface of lentic environments with vegetated margins, and sometimes in slow water flow streams over emerging plants, in the bottom surface of rocks, and over sandy margins of rivers (Bachmann, 1998; Mazzucconi et al., 2009).

Rhagovelia was also present in Río Grande, specifically in Yala and La Mendieta localities. In these sites, the water flow is turbulent and margins are vegetated. According to Bachmann (1998), *Rhagovelia* species are found in the surface of streams with moderate to rapid flow and in forest areas.

On the other hand, the PERMANOVA analysis confirmed the previously described results, which corroborates the variations in the composition of the aquatic and semiaquatic Heteroptera assemblage throughout an altitudinal gradient (upper and lower basin). However, no significant differences among seasons (dry and wet) were found. Seasonality is an important factor that can affect the composition and density of aquatic invertebrate communities, as it has been shown for chironomids (Diptera, Chironomidae) (Tejerina & Molineri, 2007), EPT (Ephemeroptera, Plecoptera and Trichoptera) (Moya et al., 2009), and benthos in general (Mesa, 2010). The fact that no seasonal differences in the diversity of Heteroptera were found in this study could have been because sampling was carried out at the beginning of the wet season, when flows had not reached their maximum level. For this reason, it would be necessary to increase the frequency and number of samples in a longer period of time than the one carried out.

This study constitutes the first contribution to the knowledge about aquatic and semiaquatic bug diversity in Río Grande basin; and thus represents a great advance in the study about Heteroptera of Jujuy province, whose records were limited only to Calilegua National Park (Torres et al. 2008).

ACKNOWLEDGMENTS

This manuscript was supported by a fellowship of CONICET (National Council of Scientific Research, Argentina) and the following grant: SECTER-UNJu (F/009).

LITERATURE CITED

Anderson, M.J. (2001). A new method for non-parametric multivariate analysis of variance. *Austral Ecology*, **26**, 32–46.

Armada, N. R. 2007. Diferencias entre composición y estructura forestal en dos sitios de selva de montaña en Salta, Argentina. Disponible en: http://aulavirtual.agro.unlp.edu.ar/pluginfile.php/7927/mod_folder/content/0/Tesina_Neli_Romano_Armada.pdf?forcedownload=1

Bachmann, A.O. (1998). Heteroptera acuáticos. Biodiversidad de artrópodos argentinos. *Una perspectiva biotaxonómica* (ed. Morrone, J.J. & Coscarón, S.), pp. 163-180. Edic. Sur. La Plata, Argentina.

Chayle, W., & Agüero, P.N. (1987). Características de remoción en masa en la cuenca del Río Grande (Quebrada de Humahuaca-Jujuy). *Revista del Instituto de Geología y Minería*, **7**, 107-121.

Chao, A., Gotelli, N.J., Hsieh, T.C., Sander, E.L., Ma, K.H., Colwell, R.K., & Ellison, A.M. (2014). Rarefaction and extrapolation with Hill numbers: A framework for sampling and estimation in species diversity studies. *Ecological Monographs*, **84(1)**, 45-67. DOI: 10.1890/13-0133.1

Chao, A., & Jost, L. (2015). Estimating diversity and entropy profiles via discovery rates of new species. *Methods in Ecology and Evolution*, **6(8)**, 873-882.

Cummins, K.W., Merritt, R.W. & Berg, M.B. (2008). Ecology and distribution of aquatic insects. *An introduction to the aquatic insects of North America* (ed. Cummins, K.W., Merritt, R.W. & Berg, M.B.), pp. 105-122. Kendall/Hunt Publishing Co., Dubuque.

Domínguez, E., & Fernández, H.R.. (2009). *Macroinvertebrados Bentónicos Sudamericanos. Sistemática y Biología*. Fundación Miguel Lillo, Tucumán, Argentina.

Gomez, G.C. & Molineri, C. (2022). Water quality assessment along a heterogeneous basin (Río Grande, Jujuy, Argentina). *Ecología austral,* **32**, 1-8.

Heckman, C. (2011). *Encyclopedia of South American aquatic insects: Hemiptera - Heteroptera, Illustrated keys to known families, genera, and species in South America*. Springer, Washington, EEUU.

Kanopko, S., Mazzucconi, S., López Ruf, M., & Bachmann, A. (2009). Los heterópteros acuáticos y semiacuáticos del Parque Provincial Ernesto Tornquist (Provincia de Buenos Aires, República Argentina). *Revista de la Sociedad Entomológica Argentina,* **68(3-4)**, 271-282.

López Ruf, M.L., Mazzucconi, S.A. & Bachmann, A. O. (2003). Heteroptera acuáticos y semiacuáticos del Parque Nacional Mburucuyá (Provincia de Corrientes, Argentina). *Revista de la Sociedad Entomológica Argentina,* **62(1-2)**, 65-71.

López Ruf, M.L. (2008). Naucoridae. *Biodiversidad de artrópodos argentinos* (ed. Claps, L., Debandi, G. & Roig-Juñet, S.), pp. 201-207. Sociedad Entomológica Argentina. Mendoza, Argentina.

Mazzucconi, S., López Ruf, M., & Bachmann, A. (2008). Gerromorpha y Nepomorpha (Insecta: Heteroptera) del Parque Provincial Salto Encantado del Valle del Cuñá Pirú, Provincia de Misiones, Argentina. *Lundiana,***9(1)**, 57-66.

Mazzucconi, S., López Ruf, M., & Bachmann, A. (2009). Hemiptera-Heteroptera: Gerromorpha y Nepomorpha. *Macroinvertebrados bentónicos sudamericanos* (ed. Domínguez, E. & Fernández, H.), pp. 167-231. Fundación Miguel Lillo. Tucumán, Argentina.

Malizia, L., Reid Rata, Y., & Molina Navarro, C. (2010). *Guía de áreas protegidas provincia de Jujuy*. Fundación ProYungas. Ediciones del Subtrópico, Tucumán, Argentina.

Melo, M. C. (2009). Biodiversidad de Heteroptera (Hemiptera) acuáticas y semiacuáticas de la Patagonia argentina. *Revista de la Sociedad Entomológica Argentina,* **68***,* 177-185.

Melo, M.C. & Dellapé, P.M. Gerromorpha, Nepomorpha & Leptopodomorpha (Hemiptera: Heteroptera) species from Argentina and Uruguay. [fecha de acceso]. < https://biodar.unlp.edu.ar/gerro-nepo-lepto/ >

Melo, M.C. (2014). Corixidae. *Biodiversidad de artrópodos argentinos* (ed.Roig-Juñet S., Claps, L. & Morrone, J.J.), pp. 347-356. Sociedad Entomológica Argentina. Tucumán, Argentina.

Melo, M.C & Carpintero, D.L. (2014). Saldidae. *Biodiversidad de artrópodos argentinos* (ed. Roig-Juñet S., Claps, L. & Morrone, J.J), pp. 357-363. Sociedad Entomológica Argentina. Tucumán, Argentina.

Mesa, L.M. (2010). Effect of spates and land use on macroinvertebrate community in Neotropical Andean streams. *Hydrobiologia*, **641(1)**, 85-95

Moya, N., Gibon, F.M., Obendorff, T., Rosales, C. & Domínguez E. (2009). Comparación de las comunidades de macroinvertebrados acuáticos en ríos intermitentes y permanentes del altiplano boliviano: implicancias para el futuro cambio climático. *Ecología Aplicada*, **8**(2), 105-114.

Scheibler, E.E., Melo, M.C., Montemayor, S.I., & Scollo, A.M. (2016). Abundance, richness, seasonal and altitudinal dynamics of aquatic true bugs (Heteroptera) in mountain wetlands of Argentina. *Wetlands*, **36**, 265-274.

Schuh, R.T. & Weirauch, C. (2020). *True bugs of the world* (*Hemiptera: Heteroptera*)*: Classification and natural history* (Second Edition).Siri Scientific Press.

Tejerina, E.G. & Molineri, C. (2007). Comunidades de Chironomidae (Diptera) en arroyos de montaña del NOA: comparación entre Yungas y Monte.

Revista de la Sociedad Entomológica Argentina, **66(3-4)**, 169-177.

Torres, P.L.M., Mazzucconi, S.A. & Michat, M.C. (2007). Los coleópteros y heterópteros acuáticos del Parque Nacional El Palmar (Provincia de Entre Ríos, Argentina): lista faunística, diversidad y distribución. *Revista de la Sociedad Entomológica Argentina,* **66(3-4)**, 127-153.

Torres, P.L.M., Mazzucconi, S.A., Michat, M.C. & Bachmann, A.O. (2008). Los coleópteros y heterópteros acuáticos del Parque Nacional Calilegua (Provincia de Jujuy, Argentina). *Revista de la Sociedad Entomológica Argentina*, **67(1-2)**, 127-144.