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Research Article

The First Assessment of Heteroptera (Hemiptera) Ectoparasite Records on Psittaciformes (Aves) Species

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ABSTRACT: Some insect species of the Heteroptera (Hemiptera) (true bugs) suborder from Arthropoda class, are present as ectoparasites in some reptile, bird and mammal species. These species are fed by blood- sucking and are considered economically harmful. Parrot species belonging to the order Psittaciformes (Aves) show a native distribution in tropical and subtropical regions, but some species have started to be invasive or alien species in other countries except the native range. There is no current list of ectoparasites carried by parrots that are important in the world animal trade. This research was designed on two orders of animals, host and ectoparasites of economic importance. The aim of this study is to present the Heteroptera species that are infected to Psittaciformes species worldwide. Studies on this subject all over the world. Five Psittaciformes species were found to be infected with 11 Heteroptera species. Heteroptera species usually infect insectivorous and predatory birds. Infection of economically important Psittaciformes species by Heteroptera species should be monitored.

KEYWORDS: Insect, True bug, Parrot, Economic importance, infection

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INTRODUCTION

The suborder Heteroptera (Hemiptera) (true bugs) are composed of arthropod species that are widely distributed and can live in different habitat types. The species belonging to this suborder have adapted to terrestrial, aquatic and semi-aquatic environments. Terrestrial species generally feed on plants and damage the plant by absorbing the seeds, which are the nutrient reserves of the plants. Some terrestrial heteropters live in soil, caves or ant nests as saprophyte. Some species live as predators of small arthropods. Some species blood-sucking on vertebrates. Cimicidae (true bugs) and Polyctenidae (bat bugs) families of suborder Heteroptera live as ectoparasites on birds and mammals. Bedbugs and *Triatoma* species (kissing bugs) of the Reduviidae family transmit the fatal *Trypanosoma cruzi* disease (Aydın, 2016).

The species belonging to the order Psittaciformes (Aves) are distributed in tropical and subtropical regions. This order consists of three families: Psittacidae (real parrots) (79 genera, 375 species) Cacatuidae (cockatoo) (7 Breed, 21 species) and Strigopidae (New Zealand parrots) (2 genera and 3 species) (Rowley, 2019). 54 of these species were introduced to areas outside their native range and 38 species were established in the non-native range across the World (Avery et al., 2018). Invasions caused by exotic species are accepted as a major threat to global biodi-

versity (Carrete & Tella, 2008). Wildlife trade is an important pathway for the introduction of invasive alien species across the world. The European Union has banned the importation of wild-caught birds. With this ban there was a strong decline, especially in the western Palearctic region. Although regional bans can reduce the risk of invasion globally, bans must be global to be fully effective and to prevent trade flows from being reoriented (Reino et al., 2017). The global trade in wildlife not only causes outbreaks of human disease but also provides disease transfer mechanisms that threaten the livestock, international trade, rural livelihoods, local wildlife populations and ecosystems. Outbreaks from wildlife trade have caused hundreds of billions of dollars of economic damage worldwide (Karesh et al., 2005).

There is no current list of ectoparasites carried by parrots, which are important in the world animal trade. This research was designed on two sets of orders host and ectoparasite animals of economic importance. The aim of this study is to present the Heteroptera species that are infected to Psittaciformes species in the world.

MATERIALS AND METHODS

The literature search was made on google scholar, web of science, scopus about parrots and Heteroptera species. Queries on the internet were performed, using the following criteria: “bird”, “Psittaciformes”, “parrot”, “parakeet”, “ecto-parasite”, “Heteroptera”, and “true bug”. The database was established about this subject. Numerical assessments and comparisons have been made about the species in this database.

RESULTS

Five species belonging to the Psittaciformes family were found to be infected with 11 Heteroptera species in four countries in South America; Argentina, Bolivia, Mexico and Papraguay (Table 1). In other parts of the world, no research has been found on bug ectoparasites of parrots (Figure 1).

18 studies and 30 bug records on Heteroptera ectoparasites of parrots in South America continent have been determined (Table 1). Of these records, 62% were found in the monk parakeet (*Myiopsitta monachus*) (MP) nest and stomach content, 21% were found in blue-crowned parrot (*Aratinga acuticaudata*) nests, 7% were found in the thick-billed Parrot (*Rhynchopsitta pachyrhyncha*) nests, 7% were found in the burrowing parrots (*Cyanoliseus patagonus*) nests and 2% were found in the blue-fronted Parrot (*Amazona aestiva*) nests (Figure 2). The highest percentage of true bugs were found in the Monk Parrot nests,

Two species (*Lyctocoris campestris* and *Cardiastethus aequinoctialis*) of the determined Heteroptera species are in family Anthocoridae, three species (*Ornithocoris toledoi, Psitticimex uritui* and *Cyanolicimex patagonicus*) in family Cimicidae, two species (*Chinavia musiva* and *Nezara viridula*) are in family Pentatomidae, four species (*Triatoma delpontei, Triatoma infestans*, *Triatoma platensis* ve *Triatoma sordida*) are in family Reduviidae. Frequency graph shows that *Psitticimex uritui* is the most common species and reported on 38% of records. Following species after that all respectively; *Triatoma infestans* and *Triatoma sordida* (Figure 3). 50% of the records belong to the Cimicidae family (Figure 4).

73% of the research based on parrots infected by bug species has been conducted in Argentina. The other countries respectively; Bolivia (20%), Mexico (4%) and Paraguay (%3) (Figure 5).

CONCLUSION AND DISCUSSION

Parrots spread naturally over five continents in the world (Rowley, 2019). More than 16% of the world's parrot species (Aves: Psittaciformes) currently established at least one breeding population outside their natural distribution areas (Menchetti & Mori, 2014). MP and rose-ringed parakeet (*Psittacula krameri*) (RRP)

are the most successful species that have established breeding populations outside their natural distribution areas across the world (Strubbe & Matthysen, 2007; Conroy & Senar 2009; Gaudioso et al. 2012).

Research has also been carried out on ectoparasites in countries where parrots have spread as invasive - alien species in the Western Palearctic region. In Italy, ectoparasites have been investigated on MP and RRP, but no true bugs have been recorded (Mori et al., 2015). Ectoparasites have been investigated on MP in Barcelona - Spain, but no true bugs have been recorded (Mori et al., 2019). No records of true bug ectoparasites have been identified in the world in IAS status parrots. In ectoparasitic studies conducted in countries where parrots have native distribution, the maximum number of true bugs were found in MP nests.

Among the hemipters known to be harmful due to their bite and blood-sucking functions as well as their damages to agricultural plants, there are many species belonging to the families of Cimicidae, Reduviidae and Anthocoridae (Aydın, 2016). 14 species in Cimicidae family, 11 species in Reduviidae family and two species in Anthocoridae family were evaluated in this research.

Cimicid bugs (Hemiptera, Heteroptera: Cimicidae) are blood-sucking arthropods and found on some birds; parrots, swallows, swifts, sparrow, and domestic fowl (Carpintero & Aramburú 2007). Cimicid species lay eggs in the place where their hosts live. Both adults and nymphal stages suck blood. In particular, a species regularly attacks the raptors. The Mexican chicken bug (*Haemato-siphon inodorus*) has contributed to the death of one or both of the nestling Bald Eagles (*Haliaeetus leucocephalus*) through the depletion of blood and irritation in Arizona (Grubb et al. 1986). Mexican chicken bugs contributed to the deaths of four nestlings from in Prairie Falcon (*Falco mexicams*) nests in southwestern Idaho, US. (Mcfadzen & Marzluff. 1996). Heteroptera species usually infect insectivorous and predatory birds. Infection of economically important Psittaciformes species by Heteroptera species should be monitored.

Cimicid true bug *Psitticimex uritui* (Lent & Abalos, 1946) is one of the most abundant ectoparasites detected in Monk Parakeet nests (Aramburú et al., 2003, Aramburú et al., 2008). The interaction between these two bird populations is related to MP's nest adoption behavior. This may explain the existence of the same true bug species in both nests. The low population of true bugs in the brown cacholote (*Pseudoseisura lophotes*) nests indicates that MP is the main host for *Psitticimex uritui* (Aramburú et al., 2009). The most common species of bugs in parrot nests in South America; *Psitticimex uritui* of the Cimicidae family.

The southern green stink bug (*Nezara viridula*) has a global distribution and is regarded as cosmopolitan. This is a pest (CABI, 2019) and the highly polyphagous species on many crops, able to feed on plants from over 30 families (Todd, 1989). The southern green stink bug is believed to have originated in Ethiopia (Squitier, 2010). It has been recorded in most zoogeographical regions of the world including Africa, Americas, Asia, and Europe (Todd, 1989). Following the spread of agriculture, *N. viridula* spread in many parts of the world, including expansion in the Neotropic and Aphrotropic regions. Nearctic and Palearctic regions are probably affected by global climate change (Panizzi & Lucini, 2016). This species is the phytopage, and it may have been detected in the MP nest due to a temporary visit. In fact, this species is not a direct parrot ectoparasites.

However, since this true bug has a global distribution and extends its range, it can be detected as temporary visitors in the nests of other bird and parrot species in the future. Some species of parrots, such as RRP and MP, whose native distribution areas are tropical and subtropical regions, were introduced to the Nearctic and Palearctic region by parrot trade and established invasive or alien breeding

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populations in these regions. Further studies are needed to detect parasite-host interaction of these species. However, two study has been conducted on ectoparasites.

Two parrot species in Turkey; RRP and Alexandrine parakeet (*Psittacula eupatria*) have established populations as alien species (Kirwan et al., 2008). However, no research has been found about Heteroptera ectoparasites of these species. There is no current list of ectoparasites carried by parrots that are important in the world animal trade. This research was designed on two orders of animals, host and ectoparasites of economic importance.

Research on Heteroptera ectoparasites of Psittaciformes species spreading in five continents in the world has been conducted only in South America continent. It is interesting that no research has been conducted in other continents of the world. True bugs may not have been recorded in other studies since they prefer nests instead of birds' feathers as habitats. Five Psittaciformes species were found to be infected with 11 Heteroptera species. This is the preliminary list of bug ectoparasites in parrot nests. In this study, an assessment has been made about ectoparasitic bugs of some parrot species which are spreading all over the world. According to this research; the most dominant parrot species is the MP The most common species of bugs that causes the most infestation is *Psitticimex uritui* from the Cimicidae family. In the coming years, with the studies on different parrot species on different continents, the host and bug diversity will increase.

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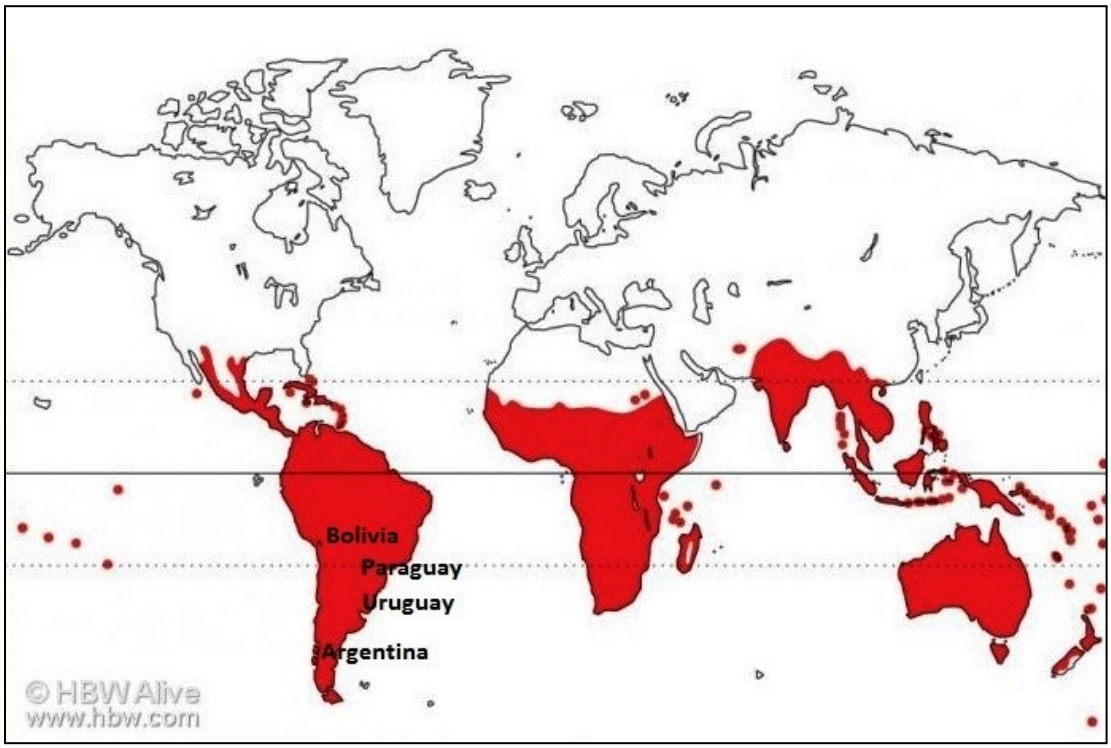

Figure 1.Native distribution range of Psittaciformes species worldwide (Rowley, 2019) and countries where bug & parrot research has been conducted.

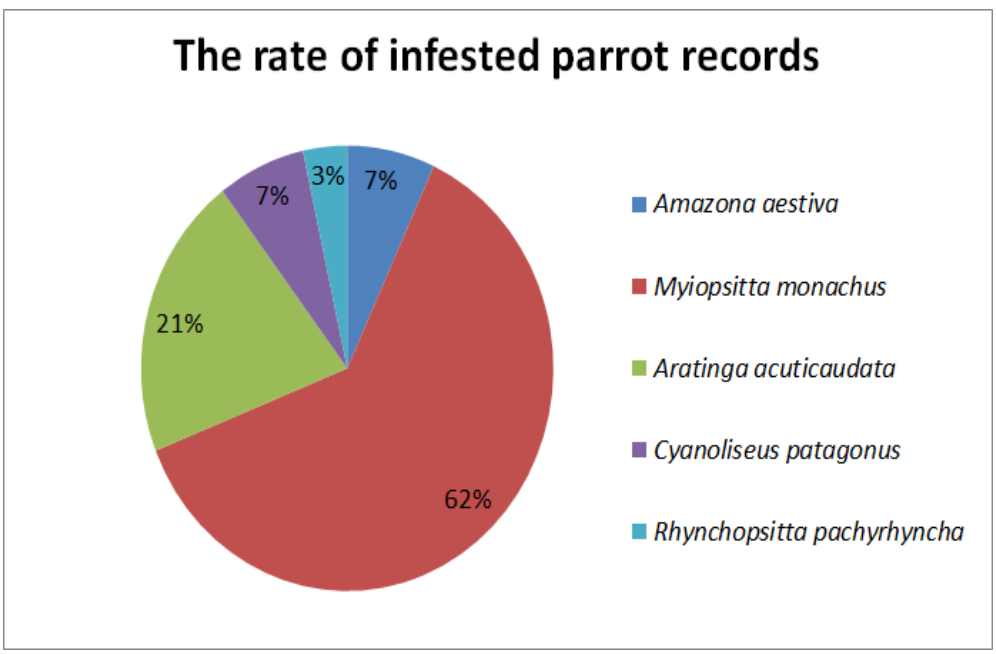

Figure 2. The rate (%) of parrot species infested with bugs

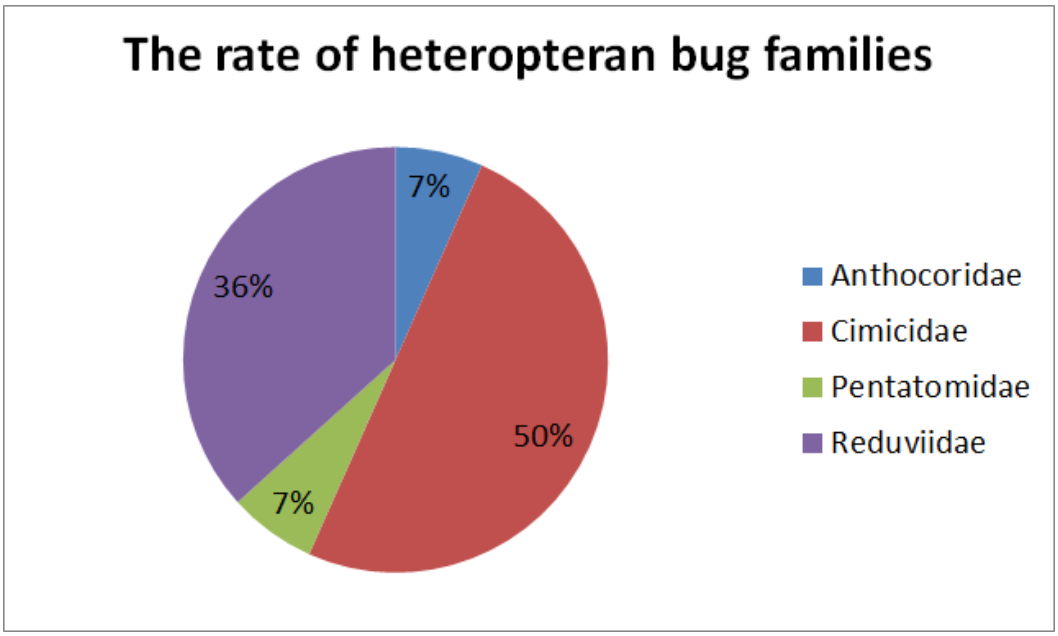

Figure 4. The rate of (%) families Heteroptera detected on parrot species

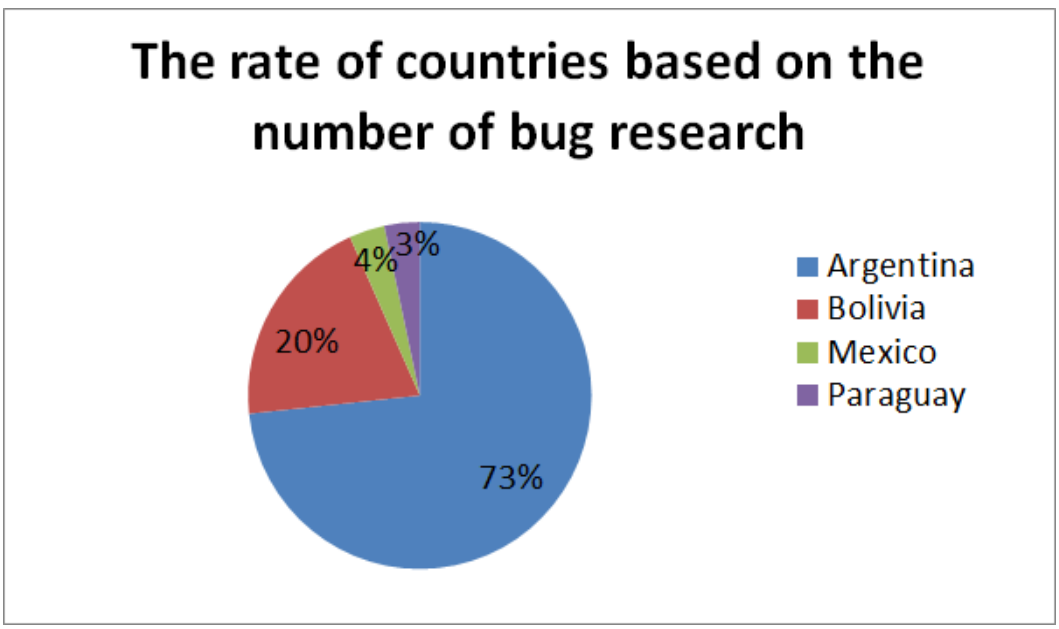

Figure 5. The rate of countries based on the number of Heteroptera ectoparasites and parrot research

Table 1: Worldwide research on Heteroptera ectoparasites and parrot species

Family	Species	Host	Common name of host	Type of ectoparasite	Country	Location	Reference
Anthocoridae	*Lyctocoris campestris* (Fabricius, 1794)	*Myiopsitta monachus*	Monk parakeet	Nest	Argentina	Buenos Aires	Aramburú et al., 2009
Anthocoridae	*Cardiastethus aequinoctialis* Poppius, 1909	*Myiopsitta monachus*	Monk parakeet	Nest	Argentina	Buenos Aires	Aramburú et al., 2009
Cimicidae	*Ornithocoris toledoi* Pinto 1927	*Aratinga a. acuticaudata*	Blue-Crowned Parrot	Nest	Argentina	Chaco	Carpintero et al., 2011
Cimicidae	*Psitticimex uritui* (Lent & Abalos, 1946)	*Myiopsitta monachus*	Monk parakeet	Nest	Argentina	Buenos Aires	Aramburú et al., 2003
Cimicidae	*Psitticimex uritui* (Lent & Abalos, 1946)	*Myiopsitta monachus*	Monk parakeet	Food	Argentina	Buenos Aires	Aramburú et al., 2000
Cimicidae	*Psitticimex uritui* (Lent & Abalos, 1946)	*Myiopsitta monachus*	Monk parakeet	Nest	Argentina	Buenos Aires	Aramburú et al., 2009
Cimicidae	*Psitticimex uritui* (Lent & Abalos, 1946)	*Cyanoliseus patagonus*	burrowing parrots	Nest	Argentina	Rio negro	Masello & Quillfeldt, 2004
Cimicidae	*Cyanolicimex patagonicus* Carpintero, Di Iorio, Masello & Turienzo, 2007	*Cyanoliseus patagonus*	The Burrowing Parrot	Nest	Argentina	Rio negro	Di Iorio et al., 2010
Cimicidae	*Ornithocoris* sp	*Rhynchopsitta pachyrhyncha*	Thick-billed Parrot	Nest	Mexico	Chihuahua	Stone et al., 2005
Cimicidae	*Psitticimex uritui* (Lent & Abalos, 1946)	*Myiopsitta monachus*	Monk parakeet	Nest	Argentina	Tucuman	Lent & Abalos, 1946
Cimicidae	*Psitticimex uritui* (Lent & Abalos, 1946)	*Myiopsitta monachus*	Monk parakeet	Nest	Argentina	-	Wygodzinsky, 1951
Cimicidae	*Psitticimex uritui* (Lent & Abalos, 1946)	*Myiopsitta monachus*	Monk parakeet	Nest	Argentina	Tucuman	Usinger, 1966
Cimicidae	*Psitticimex uritui* (Lent & Abalos, 1946)	*Myiopsitta monachus catita*	Monk parakeet	Nest	Argentina	Córdoba	Poggio et al., 2009
Cimicidae	*Psitticimex uritui* (Lent & Abalos, 1946)	*Myiopsitta monachus catita*	Monk parakeet	Nest	Argentina	La pamba	Poggio et al., 2009
Cimicidae	*Psitticimex uritui* (Lent & Abalos, 1946)	*Myiopsitta monachus monachus*	Monk parakeet	Nest	Argentina	Buenos Aires	Poggio et al., 2009
Cimicidae	*Psitticimex uritui* (Lent & Abalos, 1946)	*Myiopsitta monachus*	Monk parakeet	Nest	Argentina	Buenos Aires	Aramburú, 1991
Pentatomidae	*Nezara viridula* (L.)	*Myiopsitta monachus*	Monk parakeet	Nest	Argentina	Buenos Aires	Aramburú et al., 2009
Pentatomidae	*Chinavia musiva* (Berg, 1878)	*Myiopsitta monachus*	Monk parakeet	Nest	Argentina	Buenos Aires	Aramburú et al., 2009
Reduviidae	*Triatoma infestans* (Klug, 1834)	*Amazona aestiva*	Blue-fronted Parrot	Nest	Argentina	Chaco	Berkunsky et al., 2005
Reduviidae	*Triatoma sordida* (Stål, 1859)	*Aratinga a. acuticaudata*	Blue-Crowned Parrot	Nest	Argentina	Chaco	Aramburú et al., 2013
Reduviidae	*Ornithocoris toledoi* Pinto 1927	*Aratinga a. acuticaudata*	Blue-Crowned Parrot	Nest	Argentina	Chaco	Aramburú et al., 2013
Reduviidae	*Triatoma platensis* Neiva, 1913	*Aratinga a. acuticaudata*	Blue-Crowned Parrot	Nest	Bolivia	Chaco	Noireau et al., 1997
Reduviidae	*Triatoma sordida* (Stål, 1859)	*Aratinga a. acuticaudata*	Blue-Crowned Parrot	Nest	Bolivia	Chaco	Noireau et al., 1997
Reduviidae	*Triatoma infestans* (Klug, 1834)	*Myiopsitta monachus*	Monk parakeet	Nest	Bolivia	Chaco	Noireau et al., 2000
Reduviidae	*Triatoma sordida* (Stål, 1859)	*Myiopsitta monachus*	Monk parakeet	Nest	Bolivia	Chaco	Noireau et al., 2000
Reduviidae	*Triatoma infestans* (Klug, 1834)	*Myiopsitta monachus*	Monk parakeet	Nest	Bolivia	Chaco	Noireau et al., 2000
Reduviidae	*Triatoma delpontei* Romaña & Abalos, 1947	*Myiopsitta monachus*	Monk parakeet	Nest	Bolivia	Chaco	Noireau et al., 2000
Reduviidae	*Triatoma infestans* (Klug, 1834)	*Aratinga acuticaudata*	Blue-Crowned Parrot	Nest	Argentina	Chaco	Ceballos et al., 2009
Reduviidae	*Triatoma infestans* (Klug, 1834)	*Amazona aestiva*	Turquoise-fronted Amazon	Nest	Argentina	Chaco	Ceballos et al., 2009
Reduviidae	*Triatoma sordida* (Stål, 1859)	Fallen parrot nest	-	Nest	Paraguay	Chaco	Rolón et al., 2011