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Distribution and 16S rDNA sequences of *Argas monachus* (Acari: Argasidae), a soft tick parasite of *Myiopsitta monachus* (Aves: Psittacidae)

Mariano Mastropaolo · Paola Turienzo · Osvaldo Di Iorio · Santiago Nava · José M. Venzal · Alberto A. Guglielmone · Atilio J. Mangold

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Abstract Specimens of *Argas monachus* Keirans et al. were collected from *Myiopsitta monachus* nests in 42 localities in Argentina and Paraguay from 2006 to 2010. A list of localities where this tick has been found is presented. 16S rDNA sequences of specimens of *A. monachus* from different localities were compared to confirm whether they belong to the same specific taxon. *Argas monachus* is present in the phytogeographic provinces of Chaco, Espinal, and Monte, but not in the Pampa (all from de Chaco Domain) where the host is well distributed. No differences were found among 16S rDNA sequences of geographically distant specimens.

Keywords Ticks · *Argas monachus* · *Myiopsitta monachus* · Argentina · Distribution · DNA sequences

Introduction

The genus Argas is represented by 12 species in the Neotropical Region (Guglielmone et al. 2003; Estrada Peña et al. 2003), and nine of them are exclusive of this Region. However, the knowledge for most Neotropical species of this genus is restricted to the

M. Mastropaolo (✉) · S. Nava · A. A. Guglielmone · A. J. Mangold
INTA, EEA Rafaela, CC 22, CP 2300 Rafaela, Santa Fe, Argentina
e-mail: mmastropaolo@rafaela.inta.gov.ar

M. Mastropaolo
Cátedra de Parasitología y Enfermedades Parasitarias, Facultad de Ciencias Veterinarias, Universidad Nacional del Litoral, Kreder 2805, CP 3080 Esperanza, Santa Fe, Argentina

P. Turienzo · O. Di Iorio
Entomología, Departamento de Biodiversidad, FCEyN, UBA, Buenos Aires, Argentina

J. M. Venzal
Departamento de Parasitología Veterinaria, Facultad de Veterinaria, Universidad de la República, Regional Norte, Sede Salto, Rivera 1350, CP 50000 Salto, Uruguay

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original description or to punctual data on distributional records, with few works focusing on ecological aspects.

Argas monachus (Acari: Argasidae) is a Neotropical tick only described for Argentina, where all records were made in the Chaco phytogeographic province (Keirans et al. 1973; Ivancovich and Luciani 1992; Guglielmone et al. 2007). This tick had been associated exclusively with the monk parakeet *Myiopsitta monachus* (Aves: Psittaciformes) (Keirans et al. 1973; Ivancovich and Luciani 1992; Guglielmone et al. 2007), a bird species with a native distributional range that includes Argentina, Bolivia, Brazil, Paraguay and Uruguay (Collar 1997). *Myiopsitta monachus* is the only psittacid that built permanent communal nests of thorny twigs rather than nesting in holes or cavities (Navarro et al. 1992), and all stages of *A. monachus* are found dwelling in the nests of this bird (Keirans et al. 1973).

In a broad sense, the distribution of parasites with a host association characterized by a high specificity is determined by the distribution of its principal host, with environmental

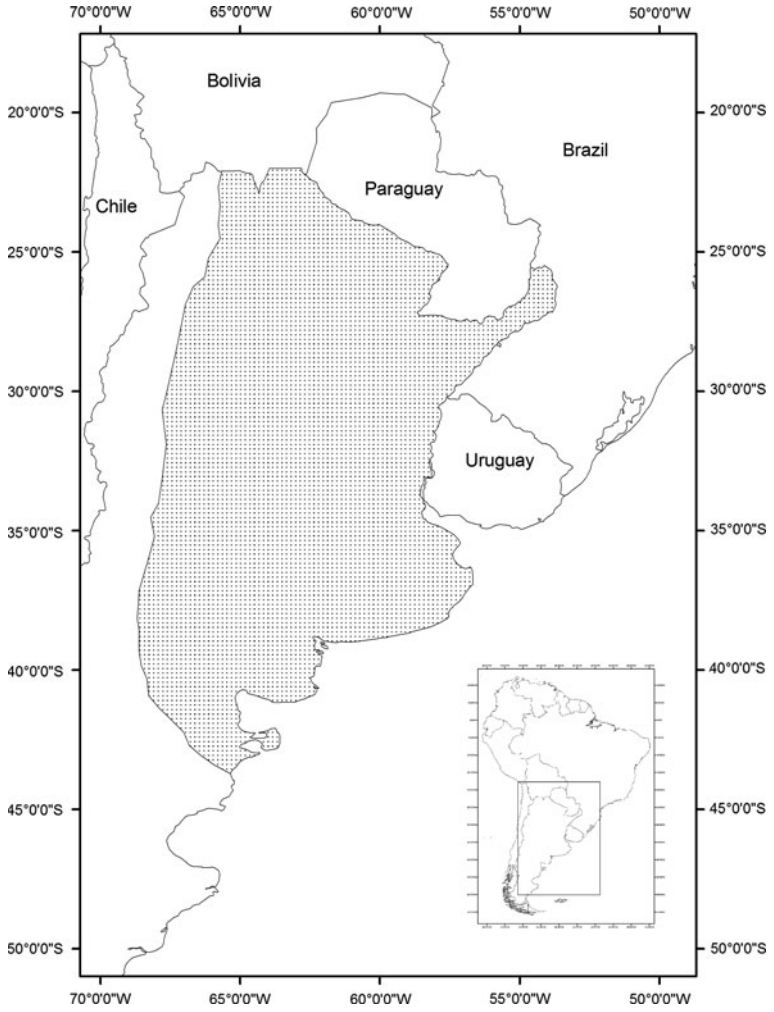

Fig. 1 Distribution of *Myiopsitta monachus* in Argentina

variables (vegetation, temperature, humidity, hydric deficit, among others) acting (or not) as limiting factors. In Argentina, *M. monachus* is present in a wide area that comprises the Chaco, Monte, Espinal and Pampa phytogeographic provinces of the Chaco Domain (Narosky and Yzurieta 2003) (Fig. 1). In order to infer, in a first approach, whether host or environmental variables are the limiting factors for the distribution of *A. monachus*, we carry out an extensive sample of this tick along a region that represents the distribution of it host in Argentina. Additionally, 16S rDNA sequences of specimens of *A. monachus* from different localities are compared to confirm if they belong to the same specific taxon.

Materials and methods

Between 2006 and 2010, *M. monachus* nests were examined for ticks in 58 localities, which represent the current distribution of this bird in Argentina. One finding made by the authors in Paraguay is also included in the analysis. The samples were carried out shaking the nests with an extensible rod (Fig. 2a) and collecting the dropped material over a white flannel (Fig. 2b). In each locality, at least five nests were sampled before considering it negative. One locality was considered positive when one nest was found with ticks, independently of the number of ticks or the stages that were found. Localities sampled by Keirans et al. (1973); Ivancovich and Luciani (1992); Guglielmone et al. (2007) and Aramburú et al. (2009) were also considered for this study. All localities (positive and negative) were plotted and analyzed according to the phytogeographic provinces modified from Cabrera (1994).

Identification of ticks was performed according to the description of Keirans et al. (1973). DNA was extracted from specimens from Córdoba Province (Quilino, 30°12′S 64°31′W), Santa Fe Province (La Brava, 30°26′S 60°08′W), San Juan Province (Caucete, 31°51′S 68°11′W) and Salta Province (Palma Horqueta, 24°12′S 63°09′W). DNA

Fig. 2 **a** Shaking *Myiopsitta monachus* nest with an extensible rod over a *white flannel* **b** Collecting the ticks dropped from the nest

extraction and polymerase chain reaction (PCR) amplification were made as described by Mangold et al. (1998). The amplified DNA was purified using Wizard SV Gel and PCR Clean-Up (Promega®) according to the manufacturer's protocol, and the purified PCR products were employed to carry out the sequences of circa 420 bp fragment of the mitochondrial 16S rDNA gene. The sequences were edited and aligned using the BioEdit Sequence Alignment Editor (Hall 1999) with the CLUSTAL W program (Thompson et al. 1994), and they were compared with Mega 4.0 (Tamura et al. 2007). Specimens from all positive localities were deposited at the tick collection of Instituto Nacional de Tecnología Agropecuaria, Estación Experimental Agropecuaria Rafaela, Santa Fe (INTA) and Facultad de Ciencias Veterinarias, Universidad Nacional del Litoral, Santa Fe (FAVE).

Results and discussion

Argas monachus was detected in 42 of the 59 sampled localities (Table 1). The distribution of the sampled localities in relation with phytogeographic provinces is shown in Fig. 3. All positive nests were found in localities of Chaco, Monte, and Espinal provinces, but not in the Pampa province. The southern limit distribution was found at Toay (36°43′S, 64°41′W), La Pampa Province, in the Espinal phytogeographic province.

No differences were found among 16S rDNA sequences of ticks from Quilino (GenBank EU283344), La Brava (GenBank JF443859) and Caucete (GenBank JF443860), and the only difference between those three sequences with the sequence of the specimen from Palma Horqueta (GenBank JF443858) was one transition GxA in the position 286.

The results reached in this study show that *A. monachus* is widely distributed in the Chaco, Monte and Espinal phytogeograpic provinces, but not in the Pampa, in spite of its hosts is well established in this area. This fact suggests that climatic conditions and abiotic factors rather than host distribution must drive the distribution of the tick. Also, because the development of the non-parasitic phase of the life cycle of *A. monachus* is in the nest of its host (M. Mastropaolo, S. Nava, A. J. Mangold, pers. com.), the influence of the vegetation should be not significant. Nevertheless, it is important to take into account that the presence of *M. monachus* in the Pampa region, is a relatively late event that has been favored by the introduction of eucalyptus trees and human-built structures as electricity towers (see Forshaw 1978). Therefore, this is a factor that should be considered before reach definitive conclusions.

Although the distribution of *A. monachus* has been determined for Argentina, additional studies should be carrying out in the other South American countries where *M. monachus* is also distributed. Furthermore, the nests of other species of the family Psittacidae present in South America, especially *Myiopsitta luchsi* which was formerly considered conspecific with *M. monachus* (Collar 1997), should be examined for *A. monachus* ticks. Taking into account that Argas ticks have been demonstrated as vectors of pathogens (Hoogstraal 1985; Reeves 2008) and involved in paralysis (Capriles and Gaud 1977), additional work on the vector competence of *A. monachus* would be of interest. Finally, *M. monachus* has been introduced in many disparate regions of the world, as for example United Kingdom, Kenya, Japan, Spain, Czech Republic and the United States, among others (Russello et al. 2008). Consequently, *A. monachus* could be introduced in these countries, being its impact on endemic birds unpredictable.

Table 1 Localities where *Myipsitta monachus* nests were sampled for *Argas monachus*

Country/Province	Locality	Coordinates	Phytogeographic province	Status	References	Collection ID[a]
Argentina						
Buenos Aires	Cañuelas	35°02′S 58°44′W	Pampa	Negative	Aramburú et al. (2009)	
	El Pino	35°01′S 57°41′W	Pampa	Negative	*Ibid.*	
	Gándara	35°26′S 58°06′W	Pampa	Negative	*Ibid.*	
	Gobernador Udaondo	35°18′S 58°36′W	Pampa	Negative	*Ibid.*	
	INTA Delta	34°10′S 58°52′W	Pampa	Negative	This study	
	Punta Blanca	34°56′S 57°41′W	Pampa	Negative	Aramburú et al. (2009)	
	San Vicente	35°03′S 58°26′W	Pampa	Negative	*Ibid.*	
	Villanueva	35°41′S 58°26′W	Pampa	Negative	*Ibid.*	
Chaco	Avia Terai	26°41′S 60°45′W	Chaco	Positive	This study	FAVE CH00007
	Pampa del Infierno	26°30′S 61°11′W	Chaco	Positive	*Ibid.*	INTA 1971
Cordoba	Cruz del Eje	30°43′S 64°49′W	Chaco	Positive	*Ibid.*	FAVE CB00011
	La Esperanza	30°12′S 64°31′W	Chaco	Positive	Guglielmone et al. (2007)	
	La Luisiana	30°21′S 64°23′W	Chaco	Positive	*Ibid.*	
	Los Leones	30°19′S 65°07′W	Chaco	Positive	Keirans et al. (1973); This study	INTA 1968
	Los Socavones	30°13′S 64°34′W	Chaco	Positive	Guglielmone et al. (2007)	
	Quilino	30°13′S 64°30′W	Chaco	Positive	This study	INTA 1908
Corrientes	Mercedes	29°08′S 58°09′W	Espinal	Positive	This study	FAVE CR00003
Entre Rios	Ceibas	33°26′S 58°48′W	Pampa	Negative	*Ibid.*	
	Viale	31°50′S 60°10′W	Espinal	Negative	*Ibid.*	
	Villaguay	31°50′S 59°20′W	Espinal	Negative	*Ibid.*	
	Los Conquistadores	30°33′S 58°27′W	Espinal	Positive	*Ibid.*	FAVE ER00012
Formosa	Bartolome de las Casas	25°24′S 59°34′W	Chaco	Positive	Ivancovich and Luciani (1992)	
	Chiriguanos	24°06′S 61°28′W	Chaco	Positive	This study	INTA 2164

Table 1 continued

Country/Province	Locality	Coordinates	Phytogeographic province	Status	References	Collection ID[a]
La Pampa	Toay	36°43′S 64°31′W	Espinal	Positive	*Ibid.*	INTA 2165
La Rioja	Castro Barros	30°35′S 65°41′W	Chaco	Positive	*Ibid.*	INTA 2167
	Chamical	29°29′S 65°43′W	Chaco	Positive	*Ibid.*	INTA 2169
	Chepes	31°21′S 66°39′W	Chaco	Positive	*Ibid.*	INTA 2168
	Paraje Santa Cruz	31°18′S 66°27′W	Chaco	Positive	*Ibid.*	INTA 2166
Salta	Dragones	23°14′S 63°25′W	Chaco	Positive	*Ibid.*	FAVE SA00010
	El Ocultar	24°09′S 62°38′W	Chaco	Positive	*Ibid.*	FAVE SA00011
	Palma Horqueta	24°12′S 63°10′W	Chaco	Positive	*Ibid.*	INTA 2177
	Rivadavia	24°14′S 62°42′W	Chaco	Positive	*Ibid.*	FAVE SA00009
	Tolloche	25°30′S 63°38′W	Chaco	Positive	*Ibid.*	FAVE SA00012
San Juan	Caucete	31°52′S 68°12′W	Monte	Positive	*Ibid.*	INTA 2171
	Bermejo	31°35′S 67°34′W	Monte	Positiva	*Ibid.*	INTA 2167
	Punta del Medano	32°14′S 67°26′W	Monte	Positive	*Ibid.*	INTA 2174
San Luis	El Calden	31°56′S 65°49′W	Chaco	Positive	*Ibid.*	INTA 2173
	La Tranca	32°22′S 67°12′W	Monte	Positive	*Ibid.*	INTA 2172
Santa Fe	Iriondo	31°19′S 60°45′W	Espinal	Negative	*Ibid.*	
	Isla Berduc	31°40′S 60°43′W	Espinal	Negative	*Ibid.*	
	Monte Vera	31°31′S 60°40′W	Espinal	Negative	*Ibid.*	
	Pilar	31°24′S 61°15′W	Espinal	Negative	*Ibid.*	
	Rafaela	31°12′S 61°30′W	Espinal	Negative	*Ibid.*	
	San Agustin	31°41′S 60°56′W	Espinal	Negative	*Ibid.*	
	Ambrosetti	29°57′S 61°34′W	Espinal	Positive	*Ibid.*	FAVE SF00041
	Capivara	30°31′S 61°17′W	Espinal	Positive	*Ibid.*	FAVE SF00038

Table 1 continued

Country/Province	Locality	Coordinates	Phytogeographic province	Status	References	Collection ID[a]
	La Brava	30°27′S 60°08′W	Espinal	Positive	*Ibid.*	INTA 2175
	La Penca	30°21′S 60°31′W	Chaco	Positive	*Ibid.*	FAVE SF00037
	Monigotes	30°32′S 61°38′W	Espinal	Positive	*Ibid.*	FAVE SF00040
	Paso de las Piedras	30°20′S 60°39′W	Espinal	Positive	*Ibid.*	FAVE SF00039
	San Bernardo	28°42′S 61°32′W	Chaco	Positive	*Ibid.*	FAVE SF00036
	Tostado	29°13′S 62°14′W	Chaco	Positive	*Ibid.*	INTA 1974
Santiago del Estero	Los Pirpintos	25°52′S 61°57′W	Chaco	Positive	*Ibid.*	INTA 2169
	Lugones	28°24′S 63°16′W	Chaco	Positive	*Ibid.*	FAVE SE00010
	Pampa de los Guanacos	26°14′S 61°50′W	Chaco	Positive	*Ibid.*	INTA 1972
	Pozo Hondo	27°03′S 64°36′W	Chaco	Positive	*Ibid.*	FAVE SE00011
	Tacañitas	28°38′S 62°37′W	Chaco	Positive	*Ibid.*	INTA 1970
	Vilelas	27°58′S 62°36′W	Chaco	Positive	*Ibid.*	INTA 1973
Paraguay						
Boquerón	Fortin Toledo	22°21′S 60°20′W	Chaco	Positive	*Ibid.*	INTA 2176

Type locality

[a] Specimens under the acronym INTA are deposited in the tick collection of Instituto Nacional de Tecnología Agropecuaria, Estación Experimental Agropecuaria Rafaela, Santa Fe, and specimens under the acronym FAVE are deposited in the tick collection of Facultad de Ciencias Veterinarias, Universidad Nacional del Litoral, Santa Fe

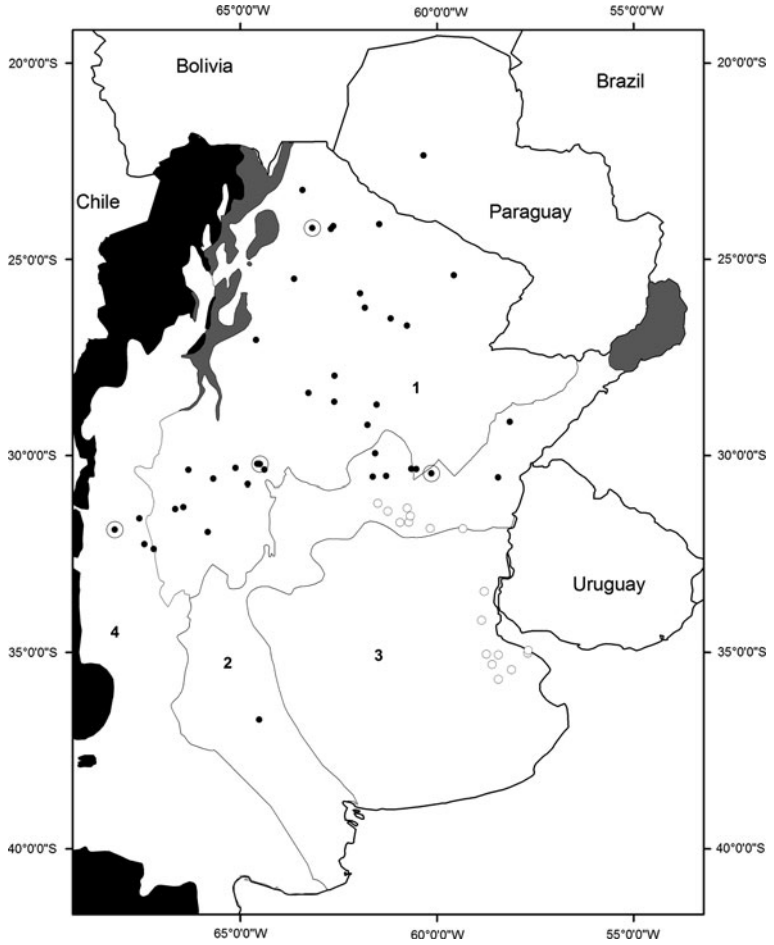

Fig. 3 Positive (*black circle*) and negative (*white circle*) localities for *Argas monachus* across phytogeographics provinces of Argentina modified from Cabrera (1994). (*1*) Chaco; (*2*) Espinal; (*3*) Pampa; (*4*) Monte. (*dark shaded box*) Andean patagonic domain; (*light shaded box*) Amazonic domain. 16S rDNA sequences were obtained from specimens collected from positive localities marked with a *bigger circle*

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