ORNITOLOGIA NEOTROPICAL 24: 257–265, 2013
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ECTOPARASITIC LOAD OF BLUE-CROWNED PARAKEET (*ARATINGA A. ACUTICAUDATA*, PSITTACIDAE) NESTLINGS

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Resumen. – Carga ectoparasitaria de pichones de Calancate Común (*Aratinga a. acuticaudata,* Psittacidae). – El Calancate Común (*Aratinga a. acuticaudata*) se distribuye en Brasil, Bolivia, Paraguay, Uruguay y Argentina, donde nidifica en cavidades de árboles maduros. Nuestro objetivo fue identificar los artrópodos que parasitan sus pichones en una población de Chaco y determinar prevalencia, intensidad y abundancia de los mismos. En 2006 y 2007 obtuvimos 24 pichones de diez nidos en la Reserva Provincial Loro Hablador. Los pichones fueron expuestos a vapores de acetato de etilo y luego agitamos el plumaje para desprender los parásitos. Asimismo, prospectamos algunos huecos con nidos. En laboratorio, identificamos los piojos masticadores *Paragoniocotes anomalus* (Phthiraptera: Philopteridae), *Heteromenopon laticapitis* y *Psittacobrossus* cf. *anduzei* (Phthiraptera: Menopodidae); el ácaro *Ornithonyssus bursa,* las chinches hematófagas *Ornithocoris toledoi* y *Triatoma sordida,* y larvas de mosca del género *Philornis.* Este trabajo representa el primer registro de *T. sordida*, *O. bursa* y *P.* cf. *anduzei* parasitando Calancate Común en Argentina, y el primer registro de *Philornis* sp. como parásito de loros en el país. *Ornithonyssus bursa* fue el parásito de mayor prevalencia (90%), *H. laticapitis* el de mayor abundancia media (7 piojos/loro) y *O. toledoi* el de mayor intensidad (32.5 chinches/loro). Los hematófagos aparecieron en edades más tempranas (25 días) que los pennífagos (35 días). Son necesarios más estudios a futuro para evaluar el impacto de estas especies sobre el desarrollo de pichones y éxito reproductivo en el Calancate Común.

Abstract. – The Blue-crowned Parakeet (*Aratinga a. acuticaudata*) ranges through Brazil, Bolivia, Paraguay, Uruguay, and Argentina, where it nests in cavities of mature trees. Our objective was identify the arthropods parasitizing the nestlings in a population of Chaco and determine their prevalence, intensity and abundance. In 2006 and 2007, we studied 24 nestlings from ten nests in the Reserva Provincial Loro Hablador. We exposed nestlings to ethyl acetate vapors and then removed parasites by agitating feathers. Also, some tree holes with nests were visually prospected. In the laboratory, we identified the chewing lice *Paragoniocotes anomalus* (Phthiraptera: Philopteridae), *Heteromenopon laticapitis,* and *Psittacobrossus* cf. *anduzei* (Phthiraptera: Menopodidae), the mite *Ornithonyssus bursa*, the hematophagous bugs *Triatoma sordida* and *Ornithocoris toledoi,* and botfly *Philornis* sp. This is the first record of *T. sordida*, *O. bursa,* and *P.* cf. *anduzei* parasitizing Blue-crowned Parakeet in Argentina, and the first record of *Philornis* sp. parasitizing parrots in Argentina. *Ornithonyssus bursa* was the most prevalent

(90%), *H. laticapitis* had the highest mean abundance (7 lice/parrot), and *O. toledoi* the highest intensity parasite (32.5 bugs/parrot). Haematophagous species appeared at younger host ages (25 days) than penniphagous (35 days). Further studies are needed to evaluate the impact of these species on the nestling development and breeding success in the Blue-crowned Parakeet. *Accepted 15 October 2013.*

Key words: Blue-crowned Parakeet, botflies, chewing lice, ectoparasites, haematopagous bug, *Heteromenopon laticapitis,* mites, nestlings, *Ornithocoris toledoi, Ornithonyssus bursa, Paragoniocotes anomalus, Philornis* sp. *Psittacobrosus* cf. *anduzei, Triatoma sordida.*

INTRODUCTION

The Blue-crowned Parakeet *Aratinga a. acuticaudata* ranges from south-western Mato Grosso (Brazil), and the lowlands of eastern Bolivia to Paraguay, western Uruguay, and northern Argentina, south to La Pampa and western Buenos Aires province (Forshaw 1989, Collar 1997). They nest in cavities of mature trees, about 7 m from the ground, and usually lay two eggs per clutch (Hartert & Venturi 1909). No further details of nestling habits have been recorded at wildlife, despite this parrot species is relatively easy to observe and wide distribution (Aramburú in press). Two chewing lice, *Heteromenopon* (*H.*) *militaris,* and *Heteromenopon* (*H.*) *laticapitis* (Phthiraptera: Amblycera: Menopodidae) has been cited as permanent parasites of Blue-crowned Parakeet (Cicchino & Castro 1997). Recently, a cimicid bug, *Ornithocoris toledoi* was found at these parrot nests (Carpintero *et al.* 2011). Ectoparasites are an important cause of mortality, morbidity, and/or reduced fecundity in birds (Feare 1976, Duffy 1983). The negative effects on clutch size (Møller 1991, 1993), growth and survival of nestlings (Merino & Potti 1995, Hurtrez-Boussés *et al.* 1997), parental behavior (Hurtrez-Boussés *et al.* 1997, Hurtrez-Boussés & Renaud 2000), natal dispersal (Brown & Brown 1992) and future breeding success and host's survival (Brown *et al.* 1995, Richner & Tripet 1999) are known. Negative effects of parasites are increased in birds that breed in domed or cavity nests reused for several breeding seasons (Bucher 1988), like the Blue-crowned Parakeet.

Ectoparasite parameters have important consequences for the dynamics of the parrot-parasite system: few individuals in the population heavily infected, and the majority of lightly infected individuals (aggregated distribution) allow host population increase and escape regulation (Anderson & May 1978). Parasites are good indicators of the condition, both of an area as a population of hosts (Gardner & Campbell 1992) and allow clarify the evolutionary and demographic history hosts, when this information is missing or is difficult to assess directly (Whiteman & Parker 2005). The objective of this work was to describe the ectoparasitic fauna present in a nestling population of this parrot species, and to determine the prevalence, abundance, intensity and degree of dispersion of such parasitic species.

METHODS

Field studies of the breeding biology of Blue-crowned Parakeet were carried out during December and January 2006 and 2007 at Loro Hablador Natural Reserve, Chaco Province (25º28'S–61º54'W, Argentina). A total of ten Blue-crowned Parakeet nests were prospected by climbing trees (six during 2006 and four during 2007). To have access to the chamber of the cavity and nestlings we opened a small window on the trunk. Nestlings (n= 24) were sampled once to remove ectoparasites. Because lice need feathered nestlings to colonize them, we only used for analysis a host age range from 22 to 56 days, in order to establish the age at the first infestation. Each bird was fumigated in a plastic bag containing cotton soaked in ethyl acetate during five minutes to kill ectoparasites. The sampling method was feather agitation or brushing (Clayton *et al.* 1992). Average values of ectoparasitic load were used when more that one nestling was sampled at the same nest. Additionally, four of total nest chambers were inspected after the nestlings left it, to find haematophagous arthropods inhabiting inside nests. Data of the bug *O. toledoi* published recently due to importance in itself (see Carpintero *et al.* 2011), are mentioned here again because it is the same colony and same time period.

For each parasite species obtained by brushing, the following parameters were determined: prevalence (proportion of parasitized nestlings with a particular parasite species), abundance (mean number of parasites on examined hosts), mean intensity (mean number of parasite per infested hosts in a sample) (Margolis *et al.* 1982, Bush *et al.* 1997) and degree of dispersion of parasites evaluated with the variance/mean ratio and the aggregation index K (Southwood 1978, Elliot 1983). The age of nestling at the first infestation was determined for each parasite species. Nymph/adult and female/male ratios of parasites were assessed.

RESULTS

Three lice species were found by brushing method: *Paragoniocotes anomalus* (Phthiraptera: Ischnocera: Philopteridae), *Heteromenopon laticapitis* and *Psittacobrossus* cf. *anduzei* (Phthiraptera: Amblycera: Menopodidae). Additionally, a mite *Ornithonyssus bursa* (Acarina: Macronyssidae), a cimicid bug *Ornithocoris toledoi* (Hemiptera: Heteroptera: Cimicidae), and a fly larvae *Philornis* sp. (Diptera: Muscidae) were also recorded. *Triatoma sordida* (Hemiptera: Reduviidae: Triatominae) and *Ornithocoris toledoi* were found by nest prospection. The parasitological parameters are shown in Table 1.

All 10 nests were infested, and only one of the 24 nestlings was not parasitized. A single species (*Ornithonyssus bursa* or *Heteromenopon laticapitis*), two species (*H. laticapitis* + *O. bursa, O. toledoi* + *O. bursa*), or three species of parasite (*Paragoniocotes anomalus* + *Psittacobrossus* cf. *anduzei* + *O. bursa*, *H. laticapitis* + *P. anomalus* + *O. bursa*, *Philornis* sp + *H. laticapitis* + *O. bursa*) were found on 20, 50, and 30 % of parasitized nests, respectively (mean 2.1 ± 0.7, n = 10).

Chewing lice

Heteromenopon laticapitis was the most prevalent and abundant chewing lice, followed by *P. anomalus* with a minor prevalence and abundance. *Psittacobrossus* cf. *anduzei* was the rarest species. We found only a female at a 40-days old nestling and together with *P. anomalus.* All distributions were aggregated ($p < 0.05$), and the lice appears when the nestlings were feathered (+ 35 days).

Haematophagous or semihaematophagous arthropods

Acari. Ornithonyssus bursa was the most prevalent and abundant ectoparasite, and the distribution was aggregated ($\chi^2 = 205.7$; df = 9; $p < 0.05$).

Insecta. a) Seven *Philornis* sp. larvae (botflies) were found in only one nestling. The distribution was at random ($\chi^2 = 16.0$; df = 9; $p > 0.05$). Moreover, three siblings who were not used in the method of brushing also were parasitized by fly larvae. Position of larvae in the body was, nestling 1: neck, left periorbital area, and upper head; nestling 2: left cheek; and nestling 3: left wing back and neck.

b) Bugs *Ornithocoris toledoi* were found in one of the nests and in both years, nymphs (333) and adults (52): 19 were males, and 33 females (sex ratio female/male = 1.7). On two nestlings (28- and 29-days old) during the year 2006, only nymphs were found by brushing

TABLE 1. Parasitological parameters of chewing lice and haematophagous or semihaematophagous arthropods for Blue-crowned Parakeet. First infestation age was expressed as a percent of nestling period's duration. Ref: * Significant ID value indicates an aggregated distribution ($p < 0.05$).

	Heteromenopon laticapitis		*Paragoniocotes anomalus*		*Psittacobrossus* cf. *anduzei*	*Ornithonyssus bursa*		*Philornis* sp.	*Ornithocoris toledoi*	*Triatoma sordida*
	Nymphs	Adults	Nymphs	Adults	Nymphs	Larvae	Adults	Nymphs		Total
Prevalence	40%	60%	20%	20%	60%	10%	70%	10%		10%
Abundance	3.1 ± 4.9	3.8 ± 6.5	0.4 ± 1.3	0.6 ± 1.3	1.9 ± 2.1	0.7 ± 2.2	4.3 ± 11.4	3.3 ± 10.3		
Intensity	7.8	6.4	2.2	3.1	3.1	7.0	6.1	32.5		
ID (var/mean)	7.8*	11.0*	3.6*	2.8*	2.4*	7.0	30.5*	32.5*		
K aggregation index	0.46	0.38	0.16	0.34	1.34	0.12	0.14	0.10		
Maximun number/nestling	20	25	8	7	8	7	58	36		1
Minimun Infestation Age	35	35	40	40	28	52	25	28	55	40
Nesting period	58%	58%	67%	67%	47%	87%	42%	47%	92%	67%

TABLE 2. Lice parasitological parameters for four Neotropical parrots. In order to standardize first infestation age, it was expressed as a percent of nestling period's duration. A = only adults; AN = adults and nymphs. References: Burrowing Parrot (Mey *et al.* 2002), Monk Parakeet (Aramburú *et al.* 2003), Blue-fronted Amazon (Berkunsky *et al.* 2005), and Blue-crowned Parakeet (this paper). [1] Parameters calculated or recalculated from published data. * Significant ID values ($p < 0.05$).

Parrot species	Burrowing Parrot		Monk Parakeet	Blue-fronted Amazon		Blue-crowned Parakeet	
Lice species	*Paragoniocotes meridionalis*	*Heteromenopon macrurum*	*Paragoniocotes fulvofasciatus*	*Paragoniocotes heterogenitalis*	*Paragoniocotes semicingulatus*	*Heteromenopon laticapitis*	*Paragoniocotes anomalus*
Prevalence	71 %	100 %	10 %	65 %	9 %	70 %	20 %
Abundance	1.67 ± 1.53 (n = 3)	6.67 ± 3.51 (n = 3)	0.73 ± 3.11 (n = 52)	14.95 ± 16.11 (n = 23)	0.13 ± 0.46 (n = 23)	7.0 ± 10.9 (n= 10)	1.1 ± 2.5 (n = 10)
Intensity	3.2 ± 0.7	6.7 ± 3.5	7.6 ± 7.6 [(1)]	17.8 ± 14.4	1.5 ± 0.7	9.9 ± 12.0 (n = 7)	5.3 ± 3.2 (n = 2)
ID (Var/Mean)	1.40	1.85	13.26*	17.36*	1.61*	17.0*	5.7*
K aggregation index	1.40	23.65	0.03[(1)]	0.25	0.13	0.43	0.22
Distribution	Random	Random	Aggregated	Aggregated	Aggregated	Aggregated	Aggregated
First infestation	35 % AN	34 % AN	63 % A	55 % AN	72 % A	58% AN	67% AN
Nymph/Adult Ratio	0.06	0.67	2	0.34	0.5	0.81	0.70
Female/male ratio	2	0.62	2	1.68	-	1.47	1.64

method (29 and 36, respectively). The distribution was aggregated ($\chi^2 = 292.5$; df = 9; $p < 0.05$).

c) *Triatoma sordida*, a blood-sucking bug was found in one of prospected nests. Nymphs and adults were found at the last breeding period (nestlings 55–56 days old), but not were counted (only a sample was taken of the total, because the difficulties in access at nest).

DISCUSSION

Chewing lice. Our study presents the first record of *Psittacobrossus* cf. *anduzei* parasitizing the Blue-crowned Parakeet. Lice parasitological parameters are compared with obtained for others parrot species in Table 2. Prevalence of *P. anomalus* (20%) was closer to the prevalence of *P. fulvofasciatus* (parasitizing Monk Parakeet *Myiopsitta monachus*, 10%) and *P. semicingulatus* (parasitizing Blue-fronted Parrot *Amazona aestiva* 9%). In many cases, low prevalence is related to effective preening (Clayton *et al.* 1992). *Heteromenopon laticapitis* had a high prevalence, but was less than *H. macrurum* parasitizing the Burrowing Parakeet (*Cyanoliseus patagonus*) (Mey *et al.* 2002).

Lice are permanent ectoparasites transferred between parent birds and their offspring (Clayton *et al.* 1992, Clayton & Moore 1997). In this study, vertical transmission of lice take place when the feather sheaths are open (35-, 40-days old), corresponding to more than 50% of the stay of the nestlings in the nest. Lice found in Monk Parakeets and Blue-fronted Amazon had a similar pattern, but louse parasitizing Burrowing Parakeet showed an earlier acquisition (35%).

Adult lice were more abundant than nymphs. This result is similar to *P. meridionalis* and *H. macrurum* (Mey *et al.* 2002) and overall proportion reported in Canadian passerines (Wheeler & Threlfall 1986) and Neotropical birds (Clayton *et al.* 1992). This tendency toward an adult bias suggests that vertical transmission usually involves adult lice.

Females were slightly more abundant than males, but the difference was not significant. Similar results were found on compared *Paragoniocotes* species (Mey *et al.* 2002, Aramburú *et al.* 2003, Berkunsky *et al.* 2005), but not in *H. macrurum* parasitizing Burrowing Parakeet (Mey *et al.* 2002). A female-biased ratio is common in suborder Ischnocera, because relatively few males are required to fertilize all of the females in isolated populations (Nadler & Hafner 1990, Clayton *et al.* 1992).

Haematophagous or semihaematophagous arthropods. This study presents the first record of *O. bursa* parasitizing the Blue-crowned Parakeet. Mite parasitological parameters are compared in Table 3; *O. bursa* was more prevalent in Blue-crowned Parakeet than in other parrots, but shows less intensity and aggregation. *Ornithonyssus bursa* had received attention mainly because of their effects on *Hirundo rustica* life history (timing of reproduction, clutch and offspring sizes) (Møller 1990, 1991, 1993), and more recently as vector of some pathogens, like Western equine encephalitis virus and *Coxiella burnetti* (Valiente Moro *et al.* 2005, Jofré *et al.* 2009).

Botflies produce myiasis affecting the development, growth, survival, and blood hemoglobin levels of the host (Quiroga 2008) and their effects could increase as a result of climate change (Beldomenico 2009). Larvae live subcutaneously in furuncles, with their caudal spiracles visible through the dermal openings of their hosts. Infesting larvae are semi-haematophagous, because they feed upon their hosts' erythrocytes, mononuclear cells, necrotic cellular debris, and body fluids (Arendt 2000). The genus *Philornis* is associated with a wide range of Neotropical birds (Couri *et al.* 2009), especially Passeriformes and Columbiformes (Dudaniec & Kleindorfer 2006). In Argentina, this genus is represented

TABLE 3. *Ornithonyssus bursa* parasitological parameters for Neotropical parrot species. In order to standardize first infestation age, it was expressed as a percent of nestling period's duration. [1]Parameters calculated or recalculated from published data. References: Monk Parakeet (Aramburú *et al.* 2003), Blue-fronted Amazon (Berkunsky *et al.* 2005), and Blue-crowned Parakeet (this paper).

	Monk Parakeet	Blue-fronted Amazon	Blue-crowned Parakeet
Prevalence	48 %	21 %	90 %
Abundance	12.3 ± 26.0 (n = 52)	6.3 ± 28.7 (n = 28)	6.1 ± 11.8 (n = 10)
Intensity	25.7 ± 32.81	23.9 ± 55.9	6.8 ± 12.3
ID (Variance/Mean)	54.7	131.8	22.9
K aggregation index	0.15[1]	0.05	0.28
First infestation nestling period's	30%[1]	55%	43%

by three species: *P. torquans*, *P. blanchardi*, and *P. seguyi* (Couri *et al.* 2009). *Philornis seguyi* has lethal and sublethal effects on House Wren (*Troglodytes aedon*) nestlings, with a prevalence of 25% and 12.8 larvae/nestling intensity (Quiroga & Reboreda 2012), both values higher than those obtained in this work. Unfortunately, in our case we could not complete the development to know the species. It is the first record of *Philornis* sp. parasitizing parrots in Argentina. The flies may look bare areas to lay eggs, at least at first, then can be covered by feathers, and the larvae appear to affect the nestling parrot survival (IB pers. observ.). Botfly ectoparasitism is responsible for 56% of nestling losses in Pearly-eyed Thrasher (*Margarops fuscatus*) and Puerto Rican Parrots (*Amazona vittata*) (Arendt 2000). In the Scarlet Macaw (*Ara macao*), botfly prevalence at Peru was higher (29%), while mean intensity was minor, 5.0 larvae/nestling (Olah *et al.* 2013). Some techniques have been developed to remove the botfly larvae and improve quality of life and survival in the Scarlet Macaw, a threatened parrot (Olah *et al.* 2013). However, removal of infesting larvae, carries with it a high risk of injury, infection, impairment, and even death to the parrot host because of the species' thick integument and often sensitive locations of the infesting larvae, and alternative control measures must be sought (Arendt 2000).

The Blue-crowned Parakeet is recently presented as the primary natural host of *Ornithocoris toledoi*; its presence in the Chaco province is also a new distributional record of this bug in Argentina (Carpintero *et al.* 2011). It is the first record of the primary natural host of this cimicid, which was unknown; *O. toledoi* had been found only on chickens (*Gallus gallus*) from Brazil, Bolivia, and Argentina (Santiago del Estero and Córdoba) (Usinger 1966). Possible infestation ways include bats (Chiroptera), which use both bird nests or hollow trees for shelter (Carpintero *et al.* 2011).

We present the first record of this *Triatoma* species parasitizing the Blue-crowned Parakeet in Argentina. In Bolivia, *T. sordida* was found in four Blue-crowned Parakeet's nest, together with *T. platensis* (Noireau *et al.* 1997), a species not found in the present study.

Most of the parasite species in this study showed aggregated distributions. This pattern has important consequences for the dynamics of the parrot-parasite system, because will tend to stabilize parasite-host interactions (Anderson & May 1978). In highly aggregated distributions, parasites will be unable to regulate the host population. K values less than 1.0, like our results, tend to promote stability within the system (Hudson & Dobson 1997).

Behavioral mechanisms which prevent or reduce parasites include grooming, fresh plant material as a repellent and periodic cleaning (Aramburú in press). Grooming and nest sanitation is more intense in the host species with highest infestation levels (Cantarero *et al.* 2013). Grooming, including scratching and preening, is a common mechanism in parrots because their social system is complex. Blue-crowned Parakeet carries wooden pieces inside the nest, but no fresh plant. Nest sanitation behavior is infrequent, accumulating debris, carcasses and eggshells or nonviable eggs (IB pers. observ.). Further studies are needed to evaluate the impact of parasitism on nestling development and breeding success, transmission ways and behavior anti-parasites of Blue-crowned Parakeet.

ACKNOWLEDGMENTS

We wish to thank Román Ruggera, Bérénice Charpin, Chantal de la Fournière, and Joaquín Carrera for their help in fieldwork. We also thank Marcela Lareschi and Diego Carpintero for their collaboration in the identification of mites and bugs, respectively.

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