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ORIGINAL

Distribution of ectoparasites of *Canis lupus familiaris* L. (*Carnivora: Canidae*) from Panama

Distribución de los ectoparásitos de *Canis lupus familiaris* L. (*Carnivora: Canidae*) de Panamá

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ABSTRACT

Objetive. To determine the distribution of ectoparasites in dogs in Panama. **Materials and methods**. There were surveyed 720 canines belonging to 57 communities. **Results.** The results showed that 84% of the dogs were infested with at least one species of ectoparasite. Dogs from lowlands showed a higher percentage of parasitism and a greater biodiversity of parasites than dogs from highlands. There were found seven species of ticks, four species of fleas, two species of lice, and one specie of botfly. The ticks *Rhipicephalus sanguineus*, *Amblyomma cajennense*, *A. ovale* and the flea *Ctenocephalides felis* were widespread; however *Ixodes boliviensis* and *Pulex simulans* showed a much narrower geographic distribution and they were found only in dogs from highlands. The flea species *Rhopalopsyllus cacicus* and the tick *Haemaphysalis juxtakochi* were found for the first time in panamanian dogs. **Conclusions.** The environmental situation in Panama, can encourage that wildlife ectoparasites parasitized dogs in absence of their native hosts. This condition may increase transmission risk of some diseases where the ticks and fleas are vectors.

Key words: Dogs, ectoparasites, Panama. (Source: DeCS, ICYT, AIMS)

RESUMEN

Objetivo. Determinar la distribución de ectoparásitos de perros en Panamá. **Materiales y métodos**. Se examinaron 720 individuos en 57 comunidades. **Resultados.** Los resultados demostraron que el 84% de los perros presentaron al menos una especie de ectoparásito. Los perros de tierras bajas mostraron un mayor porcentaje de parasitismo y mayor biodiversidad de parásitos que los animales de tierras altas. Se encontraron siete especies de garrapatas, cuatro de pulgas, dos de piojos y una de mosca. Las garrapatas *Rhipicephalus sanguineus*, *Amblyomma cajennense*, *A. ovale* y la pulga *Ctenocephalides felis* mantuvieron una distribución más amplia; mientras que *Ixodes boliviensis* y *Pulex simulans* sólo se reportaron en tierras altas. La pulga *Rhopalopsyllus cacicus* y la garrapata Haemaphysalis juxtakochi se reportaron por primera vez en perros de Panamá. **Conclusiones.** La situación medioambiental en Panamá puede propiciar que la fauna de ectoparásitos parasiten perros ante la ausencia de hospederos nativos, esta condición puede aumentar el riesgo de transmisión de algunas enfermedades en las que las garrapatas y pulgas son vectores.

Palabras clave: Perros, ectoparásitos, Panamá. (Fuente: DeCS, ICYT, AIMS)

INTRODUCTION

Dogs were the first animal species to be domesticated by humans and have been used extensively as hunters, protection purposes and as food (1, 2). The domestication process took place in several isolated geographic localities over a period of many centuries, producing the diversity of breeds that we know today (3). Presently, dogs are considered pets instead of wild animals, and live in close association with humans.

The domestication of the dog also created new ecological interactions between the ectoparasites of these canines and humans, exposing people to new pathogenic agents. There are many ectoparasites of dogs that serve as reservoirs, vectors, or intermediate hosts for pathogenic bacteria, fungi and metazoan parasites (e.g., tapeworms and roundworms). Bacteria such as *Rickettsia rickettsii*, *Rickettsia felis*, *Ehrlichia chaffeensis* and parasitic helminths like *Dipylidium caninum* and *Hymelonepis nana*, are examples of microorganisms that are associated with ectoparasites of dogs and that also can affect humans (4).

Studies of ectoparasites of panamanian dogs are scarce. The only complete checklist was published in 1966 in the "Ectoparasites of Panama", by Fairchild et al (5) and there have been no other published studies on this subject. The objective of this paper is to present new data regarding the distribution of the ectoparasites infesting Panamanian dogs and to describe their ecological relationships.

MATERIALS AND METHODS

From June 2007-April 2009, we collected ectoparasites from dogs representing 57 communities in Panama (Figura 1) as part of a larger effort from several different research projects (see acknowledgement). The selection of dogs depended on the owners consent. The ectoparasites were preserved in 95% alcohol. Engorged ticks nymphs were collected and kept alive in plastic bottles plugged with cotton, and then placed in an incubator (average temperature of 29ºC and 80% of humity) until molt.

For the identification we using published descriptions for ticks (5, 6), lice (7), fleas (8). In addition, we revised the reference material from the Colección Zoológica "Dr. Eustorgio Méndez" of the Gorgas Memorial Institute for Health Research (CoZEM-

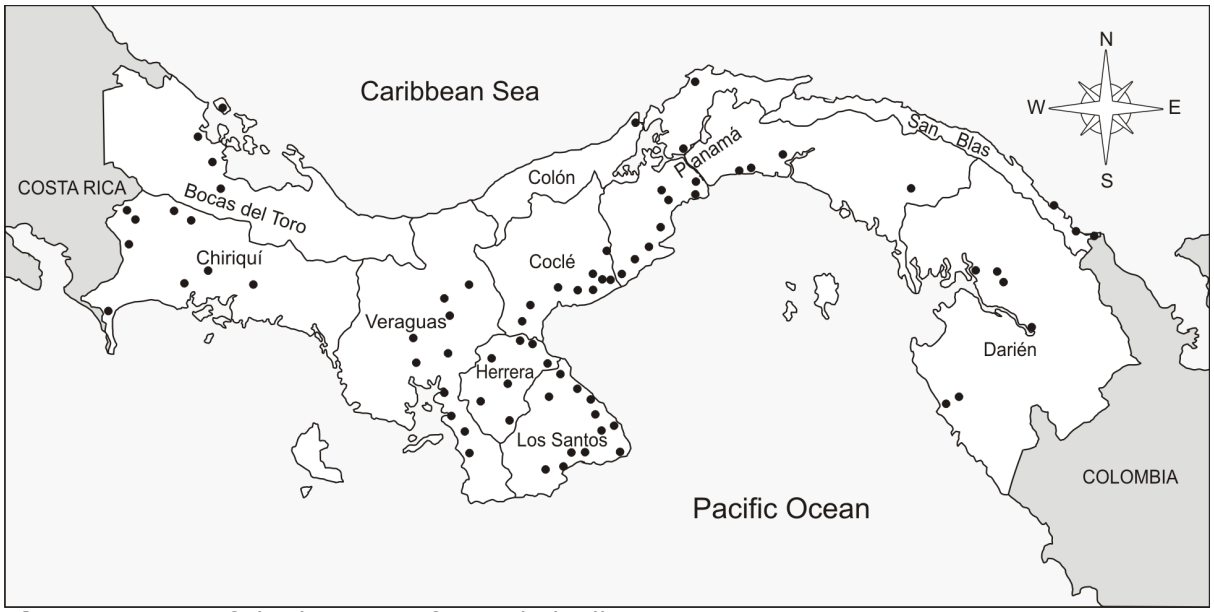

Figure 1. Map of the location of sampled villages.

ICGES for Spanish acronomy) in Panama City. The ectoparasites were placed in CoZEM-ICGES collection.

RESULTS

There were examined 720 dogs from 57 towns and found that 84% of the animals were infested by at least one ectoparasite (Table 1). The highest prevalence of parasitism was observed in dogs from suburban and rural localities in lowlands (altitude: 0-1000 meters). Dogs from highland towns presented a much lower prevalence. Dogs from lowland towns exhibited a greater richness of ectoparasites than conspecifics from the highlands (Table 2).

Seven species of ticks, four species of fleas, two species of lice and one botfly were observed (Table 2). The only species that it could raise was *Amblyomma cajennense*. The species with greatest distributions were the flea *Ctenocephalides felis* and the ticks *Rhipicephalus sanguineus* s.l., *A. cajennense* and *Amblyomma ovale*. The tick, *Ixodes boliviensis* and the fleas *Pulex simulans* and *Rhopalopsyllus cacicus*, were restricted to high-lands.

DISCUSSION

Rhipicephalus sanguineus s.l. was found in all towns from rural and urban lowlands. This species was introduced to the New World from Old World dogs and infest multiple species of Carnivores with domestic cats and dogs being the preferred hosts (9). According to Guglielmone et al (9), the development of this tick, including an extra-parasite cycle after feeding, enables it to spread to new localities and infest new host, including humans.

This close proximity to humans makes *R. sanguineus* the most implicated pathogens in diseases dispersions, such as spotted fever on America (*R. rickettsii*) (10,11), mediterranean spotted fever (*Rickettsia conorii*) (12) and canine ehrlichiosis (*Ehrlichia canis*) (13). In Panama, genetic material of *R. amblyommii* has been found in *R. sanguineus* (14), species implicated to cause a mild fever, even when its impact to humans is unknown in many counties.

In this study, we found the co-existence of *R. sanguineus* with *A. cajennense*, *A. oblongoguttatum*, *A. ovale*, *Haemaphysalis juxtakochi* and *Ixodes affinis* on the same host or localities. The frequency of co-existence of *R. sanguineus* and

Table 1. Conditions of the towns and numbers of dogs samples.

Province	Town	Type of town				Altitude (meters)	Dogs sampling		
		A[1]	B[2]	C[3]	D[4]		(N)[5]	(n)[6]	(%)[7]
Bocas del Toro	Almirante			■		5	4	4	100
	Bocas del Toro			■		25	7	7	100
	Changuinola			■		10	7	7	100
	Srilico Creek				■	50	19	17	89
Coclé	Aguadulce-El Roble		■			40	21	15	71
	Antón		■			50	4	4	100
	El Valle		■			600-800	51	34	66
	Las Guías			■		50-120	2	2	100
	Natá			■		30-50	11	11	100
	Penonomé		■			75	9	5	55
Colón	Gamboa			■		80	7	6	85
	Colón-Margarita	■				20	9	5	55
	Donoso-Guayabalito				■	40	5	5	100
	San Lorenzo				■	20	2	2	100
Chiriquí	Alanje		■			30	18	15	83
	Alto Boquete		■			1100-1500	5	4	80
	Boquerón		■			120	3	3	100
	Cerro Punta		■			2100-2200	17	4	23
	David	■	■			30	21	18	85
	Puerto Armuelles		■			0-20	13	8	61
	Río Sereno			■		750	5	5	100
	Volcán-Renacimiento		■			1500	7	2	28
Darién	Jaque-Biroquerá				■	0-15	21	21	100
	Metetí-Río Iglesias			■		50	34	27	79
	Santa Fe			■		45	16	16	100
	Yaviza			■		34	47	38	100
Herrera	Chitré		■			20	5	2	4
	El Toro				■	30-70	16	16	100
	Monagrilo			■		80-120	9	5	55
	Ocú			■		110	11	11	100
	Pesé			■		90	8	8	100
	Potuga			■		100	5	5	100
Los Santos	Agua Buena			■		80	11	11	100
	La Villa			■		70	7	7	100
	Paritilla			■		40-100	3	3	100
	Pedasi			■		0-20	13	13	100
	Tonosí			■		300	7	7	100
Panamá	Arraiján-Bique			■		0-30	2	2	100
	Chame-Bejuco		■			0-80	6	6	100
	Chepo		■			50-80	17	17	100
	Ciudad de Panamá	■				0-80	27	17	62
	La Chorrera	■				50-120	62	45	72
	Lídice			■		80	8	8	100
	Tortí			■		50	52	52	100
Veraguas	Cañazas				■	200	5	5	100
	La Mesa			■		80	4	4	100
	Las Palmas				■	100	3	3	100
	Montijo				■	10	1	1	100
	San Bartolo			■		70	6	6	100
	Santa Fe			■		400-600	6	6	100
	Soná			■		110	6	6	100
Comarca Nöbe Bugle	Cerro Banco				■	580	4	4	100
	Soloy				■	120	5	5	100
Comarca Kuna Yala	Armila				■	0-5	15	15	100
	La Miel				■	0-10	6	6	100
	Mulatupo				■	0-20	5	3	100
	Puerto Obaldía			■		0-50	20	20	100
	TOTAL						**720**	**604**	**84**

[1] Urbans towns with a population between 50,100-100,000 habitants.
[2] Urbans towns with a population between 10,000-50,000 habitants.
[3] Urbans towns with a population between 5,000-10,000 habitants.
[4] Rural towns.
[5] Total dogs sampled, 6 Number of dogs with ectoparasites, 7 Percentage of parasitized dogs.

A. cajennense on the same dogs was associated with horses and cattle in areas of pecuariam activities. In contrast to *R. sanguineus*, the immature and adults of *A. cajennense* infests a wide variety of host and is one of the most commons ticks species found on domesticated animals in Panama (5). This species show a preference for disturbed areas, especially sites where deforestation creates habitats that are more adequate for their establishment (15).

In Latin American, *A. cajennense* affects mostly humans and transmits *R. ricketsii* in many countries (16). In Panama, *A. cajennense* has been found as vector of *R. rickettsii* (17) and *R. amblyommii* was detected from the genetic material of horses and dogs (14). In this study, nymphs and adults of *A. cajennense* were collected in dogs.

The co-existence of *R. sanguineus* with *A. oblongoguttatum*, *A. ovale*, *H. juxtakochi* and *I. affinis* occurred in rural populations, indigenous towns and in sub-urban areas near forests. Dogs in communities close to forest were often used for hunting wild animals and this function may explain the infestations of dogs by these ticks. Immature stages from these species parasitize mostly small mammals and birds while adults infest medium to large-sized mammals, including dogs (5, 9). The tick parasitism on domestic animals could allow alternate conditions for the establishment of new pathogens in humans populations increasing the associated risks for pathogen transmission. This is the first record of *H. juxtakochi* parasitized panamanian dogs. Former records of this species include host as *Nasua nasua*, tapirs, deer and the porcupine *Coendou rothschildi* (5, 9).

Ixodes boliviensis was only found in rural communities within an elevation of 1100-1500 meters. Fairchild et al (5) stated that this species was most common in dogs from altitudes close to 850 meters (2500 feet); however, during this study, we found did not find any *I. boliviensis* in localities under this altitude. Instead, we observed R. sanguineus and A. ovale in towns with similar altitudes to those cited, as habits for I. boliviensis, by Fairchild et al (5). Differences between these studies can be explained by the increases in human populations in those communities that have created conditions favorable for the establishment of *R. sanguineus*.

In contrast to highlands communities as Boquete, Volcan and Cerro Punta (Table 2), which have also experienced a significant increase in human populations, only *I. boliviensis* has become established, suggesting that towns in altitudes greater than 1000 meters limit the distribution of *R. sanguineus* in Panama. Even though the possibility of infested dogs with *R. sanguineus* from lowlands can occur in these populations, the establishment of population of these ticks needs further verification.

The Costa Rican localities from the Province of Cartago (Puricil and Tapanti) have altitudes between 1300 and 1400 meters. In these areas, *I. boliviensis* is present but not *R. sanguineus*, a result that has also been observed in Panama (Carlos Víquez, personal communication). In urban areas from the Costa Rican cities like Heredia and San José, which has an average altitude of 1200 meters, *R. sanguineus* is commonly found, while *I. boliviensis* only is observed in rural zones (Grace Alpízar, personal communication).

These differences in the distribution between *R. sanguineus* and *I. boliviensis* in Costa Rica and Panama at similar altitudes, but different human population densities, can be explained by the extension of urban development. A city with wide urban zones provides more opportunities for *R. sanguineus* to colonize and develop populations. Similarly, these conditions minimize opportunities for the establishment of *I. boliviensis*, due this species needs different hosts for immature stages as well as adequate oviposition sites. Additionally, high levels of urbanization increase the local temperature and influences general weather patterns; conditions that also favor the establishment of *R. sanguineus*.

Ctenocephalides felis maintain a wide

Table2. Species of ectoparasites for town.

Province	Town	Ectoparasites collected													
		Amblyomma cajennense	*Amblyomma oblongogutta tum*	*Amblyomma ovale*	*Haemaphysal is juxtakochi*	*Ixodes affinis*	*Ixodes boliviensis*	*Rhipicephalu s sanguineus*	*Ctenocephali des canis*	*Ctenocephali des felis*	*Pulex similans*	*Rhopalopsyll us cacicus*	*Heterodoxus spiniger*	*Trichodectes canis*	*Dermatobia hominis*
Bocas del Toro	Almirante			■				■							■
	Bocas del Toro			■											
	Changuinola							■		■					
	Srilico Creek		■	■										■	■
Coclé	Aguadulce-El Roble			■				■		■					
	Antón	■		■				■		■					
	El Valle			■				■		■			■	■	■
	Las Guías	■		■				■		■					
	Natá			■				■		■					
	Penonomé			■				■		■					
Colón	Gamboa		■	■				■		■					■
	Colón-Margarita		■					■		■					
	Donoso-Guayabalito				■			■		■					
	San Lorenzo	■	■	■				■		■					
Chiriquí	Alanje	■				■		■		■					
	Alto Boquete						■			■	■	■			
	Boquerón							■		■					
	Cerro Punta						■				■				
	David	■						■		■					
	Puerto Armuelles							■		■					
	Río Sereno					■				■					
	Volcán-Renacimiento						■			■	■				
Darién	Jaque-Biroquerá								■	■					
	Metetí-Río Iglesias	■		■		■		■	■	■		■	■	■	
	Santa Fe	■		■				■	■	■		■	■	■	
	Yaviza			■						■					■
Herrera	Chitré							■		■					
	El Toro							■		■					
	Monagrillo	■						■		■					■
	Ocú	■						■		■					
	Pesé	■						■		■					
	Potuga	■						■		■					
Los Santos	Agua Buena									■					
	La Villa	■		■				■		■					■
	Paritilla			■				■		■					
	Pedasí							■		■					
	Tonosí	■								■					
Panamá	Arraiján-Bique	■						■		■		■	■		■
	Chame-Bejuco							■		■					■
	Chepo	■		■				■		■					
	Ciudad de Panamá	■	■	■				■		■					
	La Chorrera	■						■		■					
	Lídice	■		■				■		■				■	
	Tortí	■		■				■		■					■
Veraguas	Cañazas	■						■		■					
	La Mesa							■		■					
	Las Palmas							■		■		■	■		
	Montijo	■						■		■					
	San Bartolo	■						■		■					
	Santa Fe			■				■		■					
	Soná	■								■					
Comarca Nöbe Bugle	Cerro Banco		■	■						■					
	Soloy		■	■						■					
Comarca Kuna Yala	Armila		■	■				■		■					
	La Miel			■				■							
	Mulatupo		■	■						■					
	Puerto Obaldía			■				■	■	■					

distribution across Panama, it was found on every dog from urban, suburban and rural localities within 0-1400 meters. A previous study showed that *C. felis* is the fleas with a major dispersion in Panama (8). In contrast, *C. canis* has a narrower range, being only found in rural localities from Darién and Kuna Yala (Table 2). This flea is considered to be rare species and was included in the Tipton and Méndez (8) based upon only one reference point by Dunn (op. cit).

Pulex similans were captured exclusively on dogs from Boquete and co-exists with *I. boliviensis*, *C. felis* and *R. cacicus saeus*. Tipton and Méndez (8) discussed the difference between *P. irritans* and *P. simulans*, and characterized *P. simulans* as a lowland species and *P. irritans* as highland species (over 5000 feet). To distinguish these species, we used the aedeagus, the main morphological character proposed by Smit (18). We reviewed this character in specimens of *P. irritans* from United States and Colombia (CoZEM), compared them with the specimens from Volcan and Boquete, and found that they exhibited the aedeagus morphology of *P. simulans*.

Rhopalopsyllus cacicus was only found in dogs from Boquete. Tipton and Méndez (8), affirm that *R. cacicus* is a parasite of several species of mammals, such as opossums (*Metachirus nudicaudatus* and *Philander opossum*), armadillos (*Dasypus novencinctus*), rodents (*Proechimys semispinosus*, *Agouti paca* and *Dasyprocta punctata*) and carnivores (*Nasua nasua*). Our observation represents the first geographical record of this ectoparasite for Panamanian dogs. Previously, these authors registered *R. australis tupinus* in dogs of a non-specified locality.

On the other hand, *Trichodectes canis* and *Heterodoxus spiniger* were collected from dogs from Central Provinces and Darien. These records provide new data regarding the distribution of these ectoparasites in Panama. The only previously reported site was Panama City. *Trichodectes canis* is a primary ectoparasite of *Canidae*, and maintains a close relationship with its host (4). This species infests dogs, coyotes, foxes and wolves in different regions from America (7), whereas in Europe (Check Republic), it has been found on *Nyctereutes procyonoides* (19), demonstrating its adaptability to parasites wild canids.

Unlike *T. canis*, *H. spiniger* has also been found on cats and dogs, which are alternative hosts (20, 21). These lice are primarily parasites of marsupials (e.g. kangaroos, wallabies), establishing associations with dogs only in modern times (22, 23). This species is Pantropical, nevertheless, its distribution in many Neotropicals countries is poorly documented (21).

During this study, *Dermatobia hominis* was the only species found to be causing myiasis in dogs. According to Bermúdez et al (24), the myiasis produced by this species in dogs corresponded to 64% of reported cases in Panama during the 2002-2005. These same authors indicated the other flies as *Cochliomyia macellaria* and an unidentified species of Lucilia (=Phaenicia sp.) can cause myiasis in dogs. The parasitism is commonly associated with towns near forests of other wooded sites.

In conclusion, the environmental situation in Panama, can encourage that wildlife ectoparasites parasitized dogs in absence of their native hosts. This condition may increase transmission risk of some diseases where the ticks and fleas are vectors (as ehrlichiosis and rickettsiosis).

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