Global Veterinaria 16 (1): 111-118, 2016
ISSN 1992-6197

DOI: 10.5829/idosi.gv.2016.16.01.10282

Cestodes and Nematodes Recorded in Stray Cats in Kuwait

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Abstract: In spite of increasing numbers of stray cats in the streets of Kuwait, little is known about their parasites and the extent of risk they may pose to public health. A survey was conducted to study the parasites of stray cats trapped from different localities of Kuwait. Out of 240 cats examined, 207 (86.25%) were found to be infected with at least one parasite. Parasites identified included 4 cestodes: *Diplopylidium nolleri* (54.6%), *Diplopylidium acanthotetra* (45.4%), *Joyeuxiella pasquali* (38.3%) *and Taenia taeniaeformis* (0.8%); and 7 nematodes: *Ollulanus tricuspis* (26.3%), *Physaloptera gemina* (4.2%), *Gnathostoma sp.* (0.4%), *Pterygodermatites cahirensis* (34.6%), *Ancylostoma tubaeforme* (1.3%), *Toxocara cati* (1.3%) and *Toxascaris leonina* (15%).The effect of demographic factors (age, sex, site and season) on parasitism is discussed.

Key words: Cat · Cestodes · Nematodes · Kuwait

INTRODUCTION

Stray cats are a huge part of the growing pet over-population problem everywhere. There are 600 million cats worldwide, 75% of them are unowned (Margaret Mcluskey, World Society for Protection of Animals, personal communication). In Kuwait, it is common to see stray cats roaming streets and lurking around garbage containers, but there are no statistical data available on their numbers. Many appear to live throughout the country in multiple colonies in urban neighbour hoods, on farms and near abattoirs and fish markets feeding on garbage, insects, small animals and meat and fish offal. This style of life facilitates the spread of disease agents and poses a threat to public health, livestock and domesticated pets.

In spite of increasing numbers of stray cats in Kuwait, little is known about their diseases and parasites and the extent of risk they may pose to public health. The only study of intestinal helminths of stray cats was conducted in a limited geographical area, around Kuwait city [1]. In many parts of the world parasitism of stray cats has been studied e.g. in Spain, Australia, USA, Brazil, Egypt and India [2-7]; as well as in the Gulf region e.g. in Iran,United Arab Emirates, Qatar and Iraq [8-11]. Most of these studies point to the risk of stray cats passing diseases to man and other animals.

The present study was carried out to identify the parasites of stray cats in Kuwait, determine the prevalence of parasitism and the effect of age, sex, habitat and type of diet on the fequency and intensity of parasitic infection. The main objective of this study is to evaluate the extent of the risk of stray cats may pose to public health, livestock and domestic pets. Because of the size of data obtained, the present paper covers cestodes and nematodes. Data on protozoa and trematodes were published separately [12, 13].

MATERIALS AND METHODS

Country Description: Kuwait is a small country located in the desert geographical region. Because of the type of the climate and soil, vegetation is extremely sparse. The climate is continental characterized by its dry hot season (April-November) and mild cold wet season (December-March). Dust storms often occur during hot season and

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temperature sometimes reaches 50ºC. Because of this harsh climate and limited vegetation, mammalian life, including cats, tend to search for suitable habitats close to human dwellings, with the associated risk of disease or parasite transmission.

Field and Laboratory Work: Procedures of cat sampling, study sites, laboratory investigations and statistical analysis were mentioned in the previous paper [13]. Brefiely, stray cats were trapped from various districts of six administrative Governorates; the investigated districts were grouped into 2 main localities, Locality 1 and Locality 2, on the basis of the following criteria e.g. the standard of living of inhabitants, density of population, level of municipal services and accumulation of garbage. The captured cats were transferred to the laboratory where date of examination, site of trapping, gender, age and pregnancy and lactation status were recorded. According to age, the cats were grouped into adults (more than 6 months) and juveniles (≤ 6 months). For necropsy, cats were anesthetized using Rompun 2% intramuscular (1.5 ml/ 10 kg) and humanely killed by intracardial injection with T61 (1-4 ml according to age).

Parasitology Procedures: Isolation of helminths**:** The stomach and intestine were removed from each necropsied cat and placed in separate containers; the mucous membrane of each organ was scraped between the blades of a forceps. After that, their contents were washed out over a 500 um sieve with tap water. The residues were systematically searched by eye for helminths, which were transferred to 70% ethanol for preservation until identification. The residues were then thoroughly inspected under the stereomicroscope to remove the minute nematodes and scoleces of cestodes.

The worms were counted; the number of cestodes was based on the number of scoleces. For identification, nematodes were cleared and counted in polyvinyl lactophenol and cestodes were stained with a simple and rapid technique using lactophenol cotton blue (LPCB) according to the method of Henedi and El-Azazy [14]. Some specimens were stained with alum carmine, cleared in xylene and clove oil and mounted in Canada balsam.

Parasite identification: The recovered parasites were identified according to the following keys and textbooks: Witenberg [15], Soulsby [16], Schmidt [17] and Anderson *et al*. [18]. In addition, helminth specimens were sent to John M. Kinsella, Helm-West Laboratory, Missoula, Montana, USA for confirmation and voucher specimens were deposited in the US National Parasite Collection.

Table 1: Number of stray cats examined by age and reproductive status

	Age group		
Gender/Reproductive status	Juvenile	Adult	Total
Male	41	65	106
Barren Females	39	45	84
Pregnant	-	36	36
Lactating	-	14	14
Total	80	160	240

RESULTS

Demographic Data: Cat samples comprised 134 (55.8 %) females and 106 (44.2 %) males, of which 95 and 65 were adults, respectively. The overall number of young cats (≤ 6 months) was 80. Adult females were classified according to their reproductive status as pregnant (n= 36, 37.9 %), lactating (n= 14, 14.7 %) and barren (n= 45, 47.4 %) (Table 1).

Prevalence and Intensity of Helminth Species: Out of 240 stray cats examined, 207 (86.25 %) were found to be infected with at least one parasite. The majority of cats (85.8 %) had mixed infections with different parasites.Tape worms were the most frequently recovered parasites with overall prevalence 70.4 %. Mainly cestodes occurred in mixed infections with a mean burden 134±19. Four species of cestodes were recorded representing 2 families, Dipylidiidae and Taeniidae. Among cestodes and even among all helminths, *Diplopylidium nolleri* was the most common (prevalence of 54.6 % and mean burden 126±20), followed by *D. acanthotetra* (prevalence of 45.4 % and mean burden 39±8). *Joyeuxiella pasqualei* was less in prevalence and abundance when compared with the two species of *Diplopylidium*. *Taenia taeniaeformis* was the least in frequency among all cestodes and was only encountered in 2 cats (0.8 %) with very low intensity (mean burden 1±0) (Table 2).

The prevalence of nematodes ranked the second (60.4 %) among helminth higher taxa. Seven species of nematodes were recorded in this study with *Pterygodermatites cahirensis* was the most prevalent (34.6 %), while the stomach worm, *Ollulanus tricuspis* was the most abundant (mean burden 116±17). Nine immature worms of *Gnathostoma* sp. were found in the stomach of a male adult cat. Two ascaridid species, *Toxascaris leonina* and *Toxocara cati*, were recorded, but with differences of infection rate and abundance. The former worm was found in 15 % of cats with a mean burden 17±5 (range 1-83), while the latter was recorded in 1.3 % of cats with a mean burden 2±1. *Physaloptera*

Table 2: Prevalence and mean intensity of different parasites recorded in stray cats from Kuwait relative to gender and age

	All cats (240)			Female (134)			Male (106)			Adult (160)			Juvenile (80)		
Parasite Species	Prevalence (%)	Intensity ±SEM	Range	Prevalence (%)	Intensity ±SEM	Range	Prevalence (%)	Intensity ±SEM	Range	Prevalence (%)	Intensity ±SEM	Range	Prevalence (%)	Intensity ±SEM	Range
D. nolleri	54.6	126±20	1-4383	59.7	98±12	1-857	48.1	170±25	1-4383	63.1	141±21	1-4383	37.5	77±13	1-962
D. acanthotetra	45.4	39±8	1-327	50	41±7	1-303	39.6	36±7	1-327	57.5	43±8	1-327	21.3	22±5	1-84
J. pasqualei	38.3	21±6	1-191	39.5	23±6	1-191	36.8	17±5	1-120	46.9	24±6	1-191	21.3	6±2	1-116
T. taeniaeformis	0.8	1±0	1	0.7	1±0	1	0.9	1±0	1	1.3	1±0	1	-	-	-
O. tricuspis	26.3	116±17	1-1838	26.9	105±18	1-1838	25.5	132±15	1-1068	27.5	65±13	1-1068	23.8	235±21	1-1838
P. gemina	4.2	7±3	1-27	5.9	7±3	1-27	1.9	10±3	1-18	5.6	8±3	1-27	1.3	1±0	1
Gnathostoma sp	0.4	9±0	9	-	-	-	0.9	9±0	9	-	-	-	1.3	9±0	9
P. cahirensis	34.6	7±3	1-77	34.3	9±4	1-77	34.9	6±3	1-25	33.8	8±4	1-77	36.3	7±3	1-33
A. tubaeforme	1.3	4±2	2-7	1.5	5±2	2-7	0.9	2±-	2	1.9	4±2	2-7	-	-	-
T. cati	1.3	2±1	1-3	0.7	3±-	3	1.9	2±1	1-2	1.3	3±1	2-3	1.3	1±-	1
T. leonina	15	17±5	1-83	11.9	19±8	2-71	11.9	15±5	1-83	19.3	18±5	1-83	6.3	6±3	1-22

Table 3: Prevalence and 95% confidence intervals (C.I.) of parasites in 240 cats of different age groups, sexes and seasons

		Nematodes			Cestodes		
			95% CI			95% CI	
		Prev.	Low	High	Prev.	Low	High
Sex	Male	57.7	47.56	67.1	64.2	54.2	73.2
	Female	62.7	53.91	70.89	75.4	67.18	82.4
Age	Adult	63.7	55.78	71.2	81.9*	75.01	87.52
	Young	53.8	42.24	64.92	47.5	36.21	62.29
Season	Wet	70.5*	61.9	78.2	73.6	65.2	81.0
	Dry	48.6	39.0	58.3	66.6	57.1	75.3
Locality	1	52.9	43.5	62.3	76.1	67.3	83.5
	2	67.5*	58.4	75.6	65.0	55.9	73.4
Total	60.4	53.9	66.6	70.4	64.2	76.1	

* P-value < 0.05 statistically significant

gemina and *Ancylostoma tubaeforme* were recorded in low prevalence rates 4.2 % and 1.3 %, respectively (Table 2).

Effect of Demographic Factors on Parasitism: The overall infection rate with parasites was slightly higher ($p > 0.05$) in females (94.3 %) than in males (86.5 %). However, the overall prevalence was significantly higher ($p = 0.01$) in adults (91.8 %) than in juveniles (73.7 %). The infection rate was also significantly higher ($p= 0.02$) in the wet season than in the dry season. However, no significant difference was observed between the prevalence rate of parasites in cats trapped in Locality 1 and 2, respectively (Table 3).

Adults had significant higher intensity and infection rate with cestodes ($p=0.00$) than juveniles. No significant ($p > 0.05$) effect of cat age on infection with nematodes was observed; however, their intensity and prevalence were significantly higher ($p = 0.00$) in the wet season than in the dry season. On the other hand, the prevalence of cestode infections was not influenced by season. The gender of cats had no effect on the prevalence of each group of helminths. The infection rates with cestodes and nematodes were higher in females than males, but this was not significant. On the other hand, the prevalence of helminths was affected by the reproductive status of females. Pregnant and lactating females had significantly higher ($p = 0.02$) infection rate (96 %) than barren females (82.1 %). Nematodes showed significantly higher ($p= 0.00$) infection rates in cats captured in Locality 2 than Locality 1. While, the prevalence of cestodes was not affected by the origin of cats (Table 3).

Analysis of *Diplopylidium* sp. and *Joyeuxiella* sp. infection generated comparable results which is likely due to similar biology. The prevalence of these cestode species was higher in adult cats than in juveniles; but no effect was observed relative to sex, season and site. The frequency of *O. tricuspis* was affected by season and site where it was highly significant ($p = 0.01$) in the wet season and Locality 2, but no significant difference in prevalence was reported relative to gender and age. *T. leonina* had the same trend as *O. tricuspis* as its prevalence was significantly higher ($p= 0.00$) in the wet season and Locality 2; in addition it was also affected by age; *T. leonina* was significantly higher ($p= 0.00$) in adults than in juveniles. With respect to the prevalence of

P. cahirensis, no significant differences were observed between males and females, adults and juveniles, wet season and dry season and Locality 1 and Locality 2. However, analysis of data regarding the frequency of *P. cahirensis* and dipylidiid cestodes which ranked the first most common among nematodes and cestodes respectively revealed that there was a positive highly significant (p= 0.00) correlation between them in terms of occurrence. The prevalences of helminth species of less than 5 % were too low to merit detailed analysis.

DISCUSSION

In the only study on feline parasitism in Kuwait, Abdul-Salam and Baker [1] examined 103 stray cats collected from districts around Kuwait city and found 76 (73.8 %) of them were infected with five helminths (2 cestodes and 2 nematodes). The higher infection rate (86.25 %) with 25 helminth species (4 cestodes and 7 nematodes) recorded in this study is attributed to the higher number of cats examined in different localities of Kuwait state.

The results of this study are comparable to other reports from the Gulf region in that the prevalence rates of parasitism in stray cats were high, 90 % in Iran [8], 87 %in United Arab Emirates (U.A.E.) [9], 83.2% in Qater [10] and 90.9% in Iraq [11]. Similar results were obtained in studies conducted in the other parts of the world e.g. Spain [2], Brazil [5], Egypt [6] and Nigeria [19], where the overall prevalence of feline parasitic infection was 90 %, 90 %, 91 % and 85.5 % respectively. This high infection rate of parasitic infections in stray cats was expected as they are scavengers feeding on garbage, insects, small animals and fish and meat offal.

The present study also agreed with most of these studies in the Gulf region that the vast majority of worms were cestodes, but they differed in which species of tapeworms was common in each country. *D.nolleri* was the most prevalent cestode in this study and in that of [8] in Iran. However, *Joyeuxiella* spp and *T. taeniaeformis* were the most frequent tapeworms recorded in UAE [9] and in Qatar [10] respectively.

Probably, these differences in the prevalence rates of cestode species among the Gulf countries were attributed to variations in the infection rates of metacestodes in intermediate hosts as well as to the abundance and availability of these intermediate hosts to stray cats in each country. Delahay *et al*. [20] stated that differences in parasite species or their prevalence and abundance might vary among host populations as a result of variations in some factors including diet.

Very little had been described relative to the biology of *Diplopylidium* and *Joyeuxiella.* The cysticercoids of these cestodes have been found in lizards, snakes, toads and small mammals [15]. It had been believed 2 intermediate hosts were required for Diplylidiinae of which the primary ones were coprophagous insects and the secondary ones, reptiles or occasionally amphibian or small mammals; but this had never actually been proved for any member of dipterous insects. Witenberg [15] failed to infect the maggots of common fly, meal-worms and cockroaches with the gravid segments of these cestodes. Similarly, Ortlepp [21] was unable to infect dung beetles fed the gravid proglottids of *J. fuhrmanni*.

The method by which the reptiles became infected was obscure, although the cysticercoids of these dipylidiid cestodes had been recorded from lizards in many countries including Turkey [22], Russia (former USSR) [23], India [24], Tanzania [25], South Africa [26] and Iraq [27].

The high prevalence and abundance of *Diplopylidium* and *Joyeuxiella* in stray cats from different localities of Kuwait indicate that reptiles constitute the main part of their diet. It is strongly suggested that the source of infection to cats is *Hemidactylus* geckos, which are widespread in the residential areas of Kuwait and also distributed in other Gulf countries[28]. Mimioglu and Sayin [22] observed that *Hemidactylus turcicus* was the preferred prey of cats. It would be worth while to study the complete life cycles of *Diplopylidium* and *Joyeuxiella* in the Gulf region. *T. taeniaeformis*, the rodent borne cestode, was found rarely (0.8%), in contrast with much higher prevalence rates in Qatar (73.6%) [10], U.A.E. (16.7 %) [9] and Egypt (30.3 %) [29]. The low prevalence could indicate that rodents do not play a substantial role in the diet of stray cats in Kuwait, perhaps because of low densities of these preys in localities where stray cats occur. Abdul-Salam and Baker [1] justified the absence of this tapeworm in their survey that rodents were scarce due to the active rodent control campaign conducted by Ministry of Health in Kuwait. On the other hand, the low prevalence of *Strobilocercus* (*Cysticercus*) *fasciolaris*, the larval stage of *T. taeniaeformis*, among rodents could be another reason for the low prevalence of this cestode in cats. Al-Mahi [30] reported a low infection rate (4.23%) of *T. taeniaeformis* in wild cats in Egypt as a reflection of the scarcity of *S. fasciolaris* in rodents; only *Rattus norvigacus*, among other rodents examined, was found to be infected with low prevalence (5.77 %) and a mean abundance (0.06).

P. cahirensis is the most prevalent nematode with prevalence rate 34.6%, but of low intensity (mean burden=7). The same finding was recorded by Schuster *et al*. [9] in UAE with comparable infection rate (35.6%) and Intensity (mean burden=6). Higher infection rate (52.2%) was recorded in Iran [31]. In Iraq, this nematode was found in stray cats by Daoud *et al*. [32], but in a recent survey in Mosul city Al-Obaidi [12] did not report it; similarly, *P. cahirensis* was absent in the study of Abu-Madi *et al*. [10] in Qatar.

The larvae of *P. cahirensis* were found in beetles [33] and in geckoes [34]. The common utilization of intermediate and paratenic hosts between this spirurid nematode and dipylidiid cestodes and the significant positive association in terms of frequency of occurrence between them may explain their high prevalence among the parasites in this study and that of [9] in UAE. However, the infection rate and intensity of *P. cahirensis* were considerably lower than that of dipylidiid cestodes; perhaps, because of differences in the prevalence and abundance of their larval stages in insects and reptiles.

O. tricuspis ranked the second after *P. cahirensis*, but was the most abundant among nematodes. This seems in contradiction with other reports from the Gulf region; apart from Schuster *et al*. [9], it has not been reported. This nematode is easily missed during examination of stomach ingesta because of its small size. The high intensity (one cat harbored 1836 worms) is not uncommon and may be due to the cat-to-cat transmission by consumption of infected vomitus or even through autoinfection [35, 36].

Although *T. cati* is a common parasite of felidae, in this study only 1.3 % of the examined cats were infected with low intensity (mean burden≤2), similar to other studies in the region [9, 10]; this may be low tolerance of its e ggs to high temperatures and desiccation. In contrast, it seems that *T. leonina* has a greater tolerance to high temperatures and low humidity [37]; therefore, it was reported at higher prevalence (15%) and a mean burden (7).

P. gemina is recorded for the first time in cats in Kuwait and even in the Gulf region. *Physaloptera praeputialis* is the more common species of Physalopteridae, reported from the Gulf region [8-11]. The spicules of *A. gemina* as measured in the present study are longer than that reported for *P. praeputialis* [38, 39]. Our specimens differ from that of *A. kuwaitensis*, which was recovered from the stomach of rodents in Kuwait [40], in the length of the body of the female and male as well as in the length and shape of the spicules.

A. tubaeforme was found only in 2 cats (1.3 %) with mean intensity of 4, which seems low when compared to other studies. Again this variation may be attributed to differences in environmental conditions. The life cycle of this hookworm is direct and therefore the larvae are affected by ambient temperatures and humidity [41]. The hookworm of carnivores recorded previously from Kuwait was *A. caninum*, found in dogs [42] and cats [1] with a low prevalence rate of 2.9 % and 0.48 %, respectively. Although low-level *A. caninum* infections may occur in cats, they are easily confused with *A. tubaeforme*.

Gnathostoma spp. are mainly encountered in Southeast Asia and South America, where raw fish are consumed frequently. these spirurid parasites use small copepod crustaceans as first intermediate hosts, while freshwater fish and other animals e.g. frogs, snakes and small mammals act as second intermediate/paratenic hosts. Final hosts, including Cats, become infected by eating one of second intermediate/ paratenic hosts containing the infective stage (third larval stage). In Iraq, the adjecent country, where fresh water bodies present Al-Obaidi [11] reported higher infection rate (24%) with *Gnathostoma* sp than that reported in our study ; only one cat trapped around the Kuwait fish market was found to be infected. Althoug it is evident that the cat was infected by eating raw fish, it is not possible to know the source on infection i.e. via local or imported fish. Kuwait imports fish from many countries where *Gnathostoma* has been reported e.g. Egypt [43], India [44] and Southeast Asia [45]. The advanced third larval stages of *Gnathostoma* in fish tissues are killed in 48 hours by freezing and by refrigeration after 30 days [46].

This study showed that variations in demographic factors play a significant role in determining the prevalence and intensity of different parasite higher taxa and species. No significant differences between the sexes were observed. However, pregnant and lactating cats had significantly higher prevalence rates of helminths than barren females. These differences may be related to relaxation of immunity [16] or to behavioral changes and increased food intake [47, 48].

Significant higher prevalence of overall helminths was detected in the adults than juvenile group. But no significant difference was noted between cats which were captured in Locality 1 and those were trapped from Locality 2. This trend was also demonstrated when the results of cestode infection was analyzed. No regional as well as seasonal differences in the prevalence of cestodes were found. This observation is likely to be related to the comparable levels of regional and seasonal abundance of

intermediate and paratenic hosts. On the other hand, nematodes showed higher infection rates in Locality 2 than Locality 1. In Locality 2, comparatively higher densities of stray cats were observed; the situation which facilitates the transmition of nematodes, thus they are less likely to be exposed to harsh environmental conditions prevailing in Kuwait. It has been known that overstocking of farm animals may enhance the transmission of parasites. El-Azazy [49] found that in Saudi Arabia, higher prevalence of abomasal nematodes in small ruminants was unexpectedly recorded in summer because animals are overstocked on limited pasture areas during a period of drought. Likewise for ecological factors, higher prevalence of nematodes, particularly *O. tricuspis* and *T. leonina*, was recorded in wet season when climatic conditions are favorable for the thriving of preparasitic stages.

This study reveals in general that stray cats – as scavengers in a given area- can act as indicators of pathogens prevailing in the environment. Cats were found to be infected with soil-borne- (e.g. *Toxocara*), insect-borne- (e.g. *Physaloptera*), reptile-borne- (e.g. *Diplopylidium*; *Joxeuiella*; *Pterygodermatites*), fish-borne- (e.g. *Gnathostoma*), rodent-borne parasites (e.g. *Toxascaris*; *Taenia taeniaeformis*). However, the importance of stray cats as reservoir hosts for some zoonotic parasites e.g.*T. cati* and *A. tubaeforme*, the causative agents of visceral larva migrans (human toxocariasis) and cutaneous larva migrans (creeping eruption), respectively, is not clear as these parasites were recorded at low infection rates. Gnathostoma larval migrans has been reported in a guest worker in Kuwait [50]. This study provides data on the biodiversity of the feline parasitic fauna found in Kuwait. High prevalence of cestodes in stray cats, which use geckos as paratenic hosts, could pose risk to pets as these reptiles can access to houses and gardens to be available to household cats.

ACKNOWLEDGEMENT

The authors are grateful to the Kuwait Foundation for Advancement of Sciences for financial support and to John M. Kinsella, Helm-West Laboratory, Missoula, Montana, USA, for his help in verifying the identification of parasites.

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