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THE EPIDEMIOLOGY OF PHYSOCEPHALOSIS IN CAMEL IN THE UNITED ARAB EMIRATES

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ABSTRACT

During a 4 year observation period (2013-2016), a total of 622 stomach of adult and young camels were examined for the presence of the stomach worm, *Physocephalus dromedarii*. The highest percentage of positive cases (26.7%) with burdens between 1 and more than 3,000 nematodes were found in dromedaries of a Dubai camel dairy farm that previously had imported camels from Sudan, Pakistan and Saudi Arabia. The overall prevalence of the parasite in camels from other farms in Dubai and Abu Dhabi added up to only 4.6% and 2.0%, respectively. Only one of the camels examined from other emirates were found infected. It is believed that *P. dromedarii* was introduced to the UAE with dromedaries from abroad. However, all positive animals were long term residents on the dairy farm or were born there. Scarab beetles serve as intermediate hosts and small vertebrates can be included in the life cycle as paratenic hosts.

Key words: Dromedary camel, *Physocephalus dromedarii*, United Arab Emirates

Nematodes of the genus *Physocephalus* in dromedaries were described for the 1st time by Seurat (1912) in Algeria and Baskakov (1924) in Turkmenistan. Badanin (1939) in his thesis, drew attention to the fact that *Physocephalus* specimens found in the abomasi of dromedaries in Turkmenistan differ from *Physocephalus sexalatus* in pigs in larger lengths and marked swelling in the mid-body of females. These features in connection with different intermediate hosts and larger measured 3rd stage larvae found in scarab beetles motivated Mushkambarova (1967) to divide *P. sexalatus* into two subspecies, *P. sexalatus sexalatus* found in pigs and *P. sexalatus dromedarii* occurring in dromedaries. Detailed microscopical and ultrastructural examination of these nematodes from dromedaries revealed morphological differences that allowed clear distinction from *P. sexalatus* from pigs and to upgrade the former subspecies to species level under the name of *P. dromedarii* (Schuster *et al*, 2013). Since eggs of the parasite cannot be found with routine coproscopic procedures, examination of the abomasum for adult nematodes at necropsy is the only diagnostic procedure at present. Despite findings of other abomasal nematodes in camels in previous years (*Haemonchus longistipes, H. contortus, Camelostrongylus mentulatus* and *Parabronema skrjabini*) 1st incidence of *Physocephalus* infection of dromedaries in Dubai were diagnosed only in July 2011 and October 2012. Repeated further findings of *P. dromedarii* in dromedaries gave point to an epidemiological study of this situation.

Materials and Methods

Between January 2013 and December 2016 a total of 165 young (>100 kg b.w.)[1] and 457 adult camels (>400 kg b.w.) sent for necropsy were specifically examined for the presence of abomasal nematodes. Of these animals, 412 were sent by veterinarians of EICMP farm and 152 originated from breeding farms in Dubai. Further camels were submitted from farms in Abu Dhabi (n=49) and the northern Emirates (n=9) (Table 1). The majority of these animals were adult females. Only EICMP farm sent also carcasses of sub-adult camels. Newborn and suckling calves were not enrolled in this study.

The diagnostic procedure included the opening of the abomasum by scissors, scratching the abomasal folds and washing the content in body-warm (40°C) normal saline in a bucket. After a sedimentation time of 20 min the supernatant was discharged and the sediment was re-suspended with warm normal saline. The process was repeated until the supernatant remained clear. The sediment of

1. Our experience showed that calves with a body weight below 100 kg were not infected with *P. dromedarii* and for this reason they were not considered.

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the abdominal content was then transferred into petri dishes and examined under a stereoscopic microscope. All nematodes in the sediment were taken out by forceps and transferred into a petri dish containing cold normal saline. Species determination and sexing was performed under a stereoscopic microscope. *P. dromedarii* could be easily recognised by the mid-body swelling in female (Fig 1) and the corkscrew twisted posterior end of the male specimens (Fig 2). In case of *Haemonchus* spp. the lengths of spicules were measured microscopically in lactic acid brightened males and taken as criterion for species differentiation.

For data analysis, the proportion of infected animals was related to the group with the respective host characteristic like age, place of origin, length of stay and examination year; the 95% confidence interval was calculated using the software package Quantitative Parasitology 3.0 (QP WEB) (Rozsa *et al,* 2000).

Results and Discussion

Overall, the examination of 622 camels revealed the presence of *P. dromedarii* in 118 (=18.9%) animals. In positive samples there was always a surplus of female nematodes. Juvenile specimens (4^{th} larval stages) in a mixture with adults were present in 17% of the samples. Two stomachs contained in addition, a small number of *Haemonchus longistipes* as mixed infection.

Out of 412 dromedaries originating from EICMP farm, *P. dromedarii* was detected in 110 (=26.7%) carcasses with an average intensity of 108.5 (range: 1 – 3688). Adult camels were significantly more often infected than sub-adult animals (Table 2). Only 7 (4.6%) out of 152 camels from other farms in Dubai were positive for *P. dromedarii* with an intensity ranging from 1 to 30 specimens. The only positive camel that was sent for necropsy from a breeding farm in Abu Dhabi originated originally from Dubai and participated in camel races on a racecourse that is situated at a distance of only 8 km from EICMP farm. None of the 9 camels from northern Emirates were infected with *P. dromedarii*.

Documentation at the EICMP farm allowed a deeper analysis of positive cases, not only to trace back the origin of *P. dromedarii* infected camels but also to count the exact duration of stay at the farm. During the first 3 years of observation (2013–2015), the proportion of positive cases in adult and young camels varied insignificantly between 24.1 and 47.5% and 2.9 and 14.3%, respectively whereas, in 2016 there was a distinct increase in both age groups to 53.4 and 38.9%, respectively (Table 2).

Infected camels were long-term residents on the farm. The shortest stay of an infected camel was 110 days but the average sojourn time ranged from 1787 to 2265 days (149–189 months) (Table 3). For

Table 1. Origin of adult and young dromedaries examined for *Physocephalus dromedarii* at the Central Veterinary Research Laboratory in Dubai 2013-2016.

Year	EICMD farm	Other farms in Dubai	Farms from Abu Dhabi	Farms from northern Emirates	Total
2013	66	34	13	6	**119**
2014	139	53	20	1	**213**
2015	131	48	10	2	**191**
2016	76	17	6	0	**99**
Total	**412**	**152**	**49**	**9**	**622**

Table 2. Occurrence of *Physocephalus dromedarii* in adult and young camels from EICMP farm, Dubai, UAE.

Year	Adult camels			Young camels		
	Examined (N)	Positive (n)	in % (95% Confidence Interval)	examined (N)	positive (n)	in % (95% Confidence Interval)
2013	40	19	47.5 (31.5;63.9)	34	1	2.9 (0.1;15.3)
2014	72	18	25.0 (15.5;36.6)	42	6	14.3 (5.4;28.5)
2015	83	20	24.1 (15.4;34.7)	65	8	12.3 (5.5;22.8)
2016	58	31	53.4 (39.9;66.7)	18	7	38.9 (17.3;64.3)
Total:	**253**	**88**	**34.8 (28.9;41.0)**	**159**	**22**	**13.8 (8.9;20.2)**

Fig 1. *Physocephalus dromedarii* males; posterior end is corkscrew- like twisted.

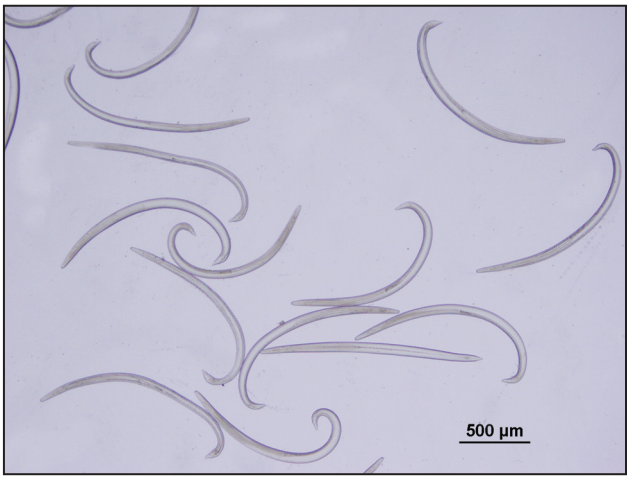

Fig 4. *Physocephalus dromedarii* 3rd stage larvae released from body cavity of *Scarabaeus cristatus*.

Fig 2. *Physocephalus dromedarii* females; there is a swelling in the mid-body caused by loops of the uterus.

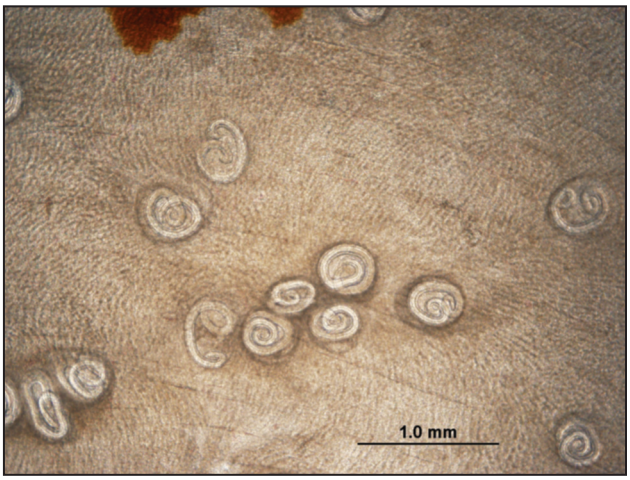

Fig 5. Stomach wall of a lizard with *Physocephalus dromedarii* 3rd stage larvae in a compressorium.

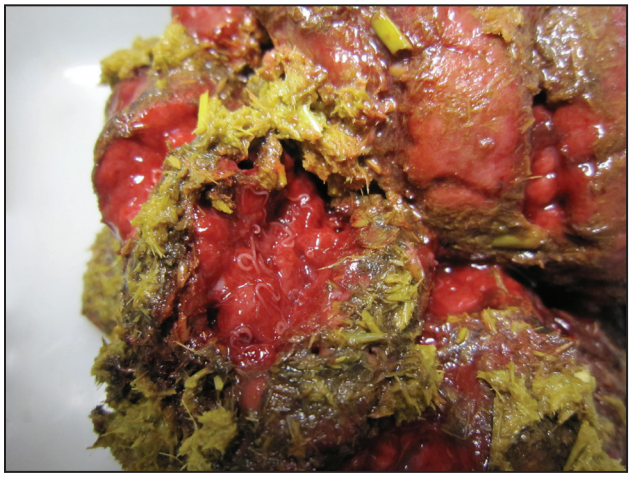

Fig 3. *Physocephalus dromedarii* in its habitat, i.e. between abomasal folds.

Fig 6. Histological section of the stomach wall of a lizard infected with *Physocephalus dromedarii* 3rd stage larvae surrounded by a wall of connective tissue.

this reason, the analysis of the origin of animals gave inconclusive results. The highest percentage (40.7%) of *Physocephalus* infected adult camels originally were purchased from farms within the UAE but this percentage does not significantly differ from camels bought from abroad when comparing the confidence intervals (Table 4). The fact that *Physocephalus* positive animals were found among camels that were born on the farm indicates that the parasite is well established and reproduces there.

Table 3. Dwelling time of camels infected with *Physocephalus dromedarii* on the EICMP farm.

Year	Number of positive cases	Duration of stay on the farm (in days)	
		Average	Range
2013	20	1787	110-2713
2014	24	1783	120-3242
2015	28	1933	480-3050
2016	38	2265	135-3492

Nematodes of the genus *Physocephalus* have been reported from dromedaries in few countries only. These were Algeria (Seurat, 1912; Chauve *et al,* 1990), Turkmenistan (Baskakov, 1924; Badanin, 1939; Mushkambarova, 1967; Mushkambarova and Dobrynin, 1972; Mushkambarova *et al,* 1989), Kuwait (Abdul-Salam and Farah, 1988) and Iran (Mirzayans and Halim, 1980; Anvari-Tafti *et al,* 2013; Majidi-Rad *et al,* 2015). There is no information on findings of these nematodes in East Africa, Saudi Arabia and Pakistan. In the UAE, first cases of *P. dromedarii* were detected in 2011 and 2012 only in camels of the EICMP farm. Although, *P. dromedarii* reaches a size comparable to *H. contortus* and *H. longistipes*, however, in the case of low burdens this parasite can be missed during adspection of the abomasal mucosa because of its pale pink colour and its location deep in the abomasal folds (Fig 3). For this reason, washing of the abomasal mucosa and several steps of sedimentation are necessary to increase the diagnostic sensitivity.

The relatively high number of positive cases on the EICMP farm compared to other farms in Dubai, only one infected camel from Abu Dhabi[2] and negative results in camels from the northern Emirates makes the EICMP farm a hotspot for *P. dromedarii* and suggests that this parasite might have been introduced with imported camels from abroad in an early stage of development of this farm. Unfortunately, the origin of the parasite could not be traced back since all infected animals stayed longer on the farm than the prepatent period of *P. dromedarii* lasted. Experimental infection trials showed that it takes up to 10 weeks for the parasite to reach sexual maturity. Only at 12 weeks after infection, the terminal part of the uterus is filled which eggs what makes this time span equivalent to the prepatent period (Schuster *et al,* 2016b).

Like other spirocercid nematodes *P. dromedarii* is a biohelminth and dung eating beetles serve as intermediate hosts. Both larval stages and imagines of beetles can become infected and harbor 3rd stage larvae of the parasite (Fig 4) in their body cavity.

Large concentrations of camels produce large amount of camel dung that attracts dung eating insects. *Scarabaeus cristatus* is a large dung rolling scarab beetle that has been found frequently in early morning hours and in late afternoons on the territory of the EICMP farm. The examination of 366 *S. cristatus* showed an extensity of infection with *Physocephalus* 3rd stage larvae of 93.3 % with an average burden of 1,538 reaching from one to more than 17,000 larvae (Schuster *et al,* 2016a). A part of the beetle population left the farm and was also found in a camel free equestrian area 15 km distant to the EICMP farm. These beetles showed a comparable *Physocephalus* prevalence of more than

2. The only positive camel from a farm in Abu Dhabi most probably got infected in Dubai.

Table 4. Occurrence of *Physocephalus dromedarii* in adult and young camels from EICMP farm according to country of origin.

Age group		Origin					
		Sudan	KSA	Pakistan	UAE	borne on farm	total
Adults	examined	24	70	62	86	11	253
	positives	9	26	14	35	4	88
	in % (95% Confidence Interval)	37.5 (18.8;59.4)	37.1 (25.9;49.5)	22.6 (12.9;35)	40.7 (30.2;51.8)	36.4 (10.9;69.2)	34.8 (28.9;41.0)
Young	examined	1	25	23	17	93	159
	positives	0	5	4	1	12	22
	in % (95% Confidence Interval)	0.0	20.0 (6.8;40.7)	17.4 (14.4;50.0)	5.9 (0.1;28.7)	12.9 (6.8;21.8)	13.8 (8.9;20.2)

90% but due to the absence of infected final hosts had a strikingly lower average larval burden of 605.

Apart from large dung rolling beetles there is a number of smaller scarabeids known as tunnelers and dwellers of the family Aphodiidae. These smaller insects can be eaten by reptiles, birds and rodents then functioning as paratenic hosts. In these hosts, the parasite larvae settle in the submucosa and muscular layer of stomach and intestines causing inflammation and encapsulation (Figs 5, 6) and leading to an interruption of the motoric function of the digestive tract. Heavily infected hosts eventually die and can be ingested by camels.

So far, findings of *P. dromedarii* are concentrated in one camel farm in Dubai only. However, the occurrence of the parasite in camels of other farms in Dubai indicate that *P. dromedarii* is spreading.

References

Abdul-Salam JM and Farah MA (1988). Seasonal fluctuations of gastrointestinal helminths of camels in Kuwait. Veterinary Parasitology 28:93-102.

Anvari-Tafti M, Sazmand A, Hekmatimoghaddam S and Moobedi I (2013). Gastrointestinal helminthes of camels (*Camelus dromedarius*) in the center of Iran. Tropical Biomedicine 30:56-61.

Badanin NV (1939). Helminths of the camel (In Russian). Thesis, Allunion Institute for Helminthology. pp 56.

Baskakov VP (1924). On the fauna of parasitic worms of camels in Turmenistan (in Russian). Trudy Gosudarstvennogo Instituta Eksperimental'noj Veterinarii 2:92-105.

Chauve M, Hamza-Cherif R and Marfoua K (1990). Parasitisme chez le dromadaire (*Camelus dromedarius*) en Algérie: enquêtes dans 4 wilayats (Adrar – Bechar – Laghouat – Ghardaia). Maghreb Vétérinaire 5, 35-36:38-39.

Majidi-Rad M, Hosseini SH, Rajabloo M, Nabian S and Gerami-Sadeghian A (2015). Parasites of one-humped camel (*Camelus dromedarius*) in Iran: an abattoir study. Journal of Camel Practice and Research 22:261-264.

Mirzayans A and Halim R (1980). Parasitic infection of *Camelus dromedarius* from Iran. Bulletin de la Societe de Pathologie Exotique et de ses Filiales 73:442–445

Mushkambarova MG (1967). Scarab beetles in the lower reach of the rivers Murgab and Tedzen as intermediate hosts for helminthes (In Russian). Thesis, Turkmenistan Agricultural Institute, Ashchabat. pp 68.

Mushkambarova MG and Dobrynin MI (1972). Materials on physocephalosis of the one humped camel in Turkmenistan (in Russian). Izv Akad Nauk Turkmenskoj SSR Ser Biologiceskaja 4:62-67.

Mushkambarova MG, Dobrynin MI and Berdyev AB (1989) Helminthoses and their prophylaxis in camels in Turkmenistan. Ylym, Ashgabat. pp 52.

Rozsa L, Reiczigel J and Majoros G (2000). Quantifying parasites in samples of hosts. Journal of Parasitology 86:228-232.

Schuster RK, Wibbelt G and Kinne J (2013). A re-description of *Physocephalus dromedarii* stat. nov. (Nematoda: Spirocercidae), an abomasal nematode of dromedaries (*Camelus dromedarius*). Journal of Helminthology 88: 499-505.

Schuster RK, Sivakumar S, Wibbelt G and Reiczigel J (2015). Light and scanning electron microscopical examination of the third stage larva of *Physocephalus dromedarii* (Nematoda: Spirocercidae) - an abomasal nematode of the one humped camel (*Camelus dromedarius*). Parasitology Research 114:1913-1920.

Schuster RK, Sivakumar S, Ismail AA and Baumann MPO (2016a). *Scarabaeus cristatus* (Coleoptera: Scarabaeidae) as intermediate host of *Physocephalus dromedarii* (Nematoda: Spirocercidae) — a contribution to the epidemiology of camel physocephalidosis. Parasitology Research 115:1161-1165

Schuster RK, Sivakumar S and Kinne J (2016b). Life cycle and development stages of *Physocephalus dromedarii* (Nematoda: Spirocercidae). Asian Pacific Journal of Tropical Biomedicine 6:930-934.

Seurat LG (1912). Sur la présence an Algérie du Spiroptera sexalata Molin chez ledDromadaire et chez l'ane. Comptes Rendus des Seances de la Societe de Biologie et de ses Filiales 64:174–176.