

# INTESTINAL COCCIDIANS IN DROMEDARY CALVES - AN ANALYSIS OF NECROPSY AND PARASITOLOGICAL RESULTS

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## ABSTRACT

A total of 1,593 camel calves were sent for necropsy and subsequent parasitological examination to the Central Veterinary Research Laboratory between January 2017 and June 2024. This article reports findings of intestinal coccidians in neonatal and young calves up to an age of 12 months. The content of rectum or small colon was examined for the presence of *Cystoisospora orlovi* and *Eimeria* spp. using the floatation method. Samples of diarrhoeic calves were examined for *Cryptosporidium* oocysts. Out of 1,437 samples examined with the floatation method, 94 were positive for *C. orlovi* and 55 samples contained *Eimeria* spp. oocysts. *Cryptosporidium* oocysts were detected in 72 out of 972 examined samples. The majority of *C. orlovi* oocysts were detected in camel calves in an age group up to 4 weeks of age, while *Cryptosporidium* oocysts were diagnosed mainly in 3 to 8 weeks old animals. The youngest calf with an *Eimeria* infection was 30 days old but the majority of *Eimeria* positive camels had a body weight between 100 and 220 kg. Out of 886 samples from necropsied adult dromedaries in the same time period, 74 were positive for *Eimeria* oocysts and *C. orlovi* was found in one sample only. Examination of 42 diarrhoeic samples for *Cryptosporidium* oocysts gave negative results.

**Key words:** *Camelus dromedarius*, *Cryptosporidium*, *Cystoisospora orlovi*, *Eimeria*, necropsy

Among the *Eimeria* species in Old World camelids, five were named in the literature (*E. cameli*, *E. rajasthanii*, *E. dromedarii*, *E. bactriani* and *E. pellerdyi*) but the validity of the latter two species remained obscure (Schuster, 2018; Dubey and Schuster, 2018). Little is known about *Cystoisospora orlovi*. Oocysts of this species were described for the first time from camels in Kazakhstan by Cygankov (1950) and were later found also in dromedaries in India (Raisinghani *et al*, 1987), the UAE (Kinne *et al*, 2001, 2002), Kenya (Younan *et al*, 2002) and recently also in Iraq (Al-Yasari *et al*, 2024). *Cryptosporidium* spp. is another group of intestinal coccidians that are found in camels. Contrary to the above mentioned species, the genus *Cryptosporidium* with more than 40 described species has a broad host spectrum and some of the species are zoonotic (Ryan *et al*, 2022). *Cryptosporidium* spp. findings in dromedaries from Iran, Iraq, Kuwait, Saudi Arabia, Algeria, Egypt, Ethiopia and Australia and in Bactrian camels from Azerbaijan and China were recently reviewed by Elmahallawy *et al* (2023). Noaman *et al* (2022) recently published a review paper on enteric protozoa, however, none of these published articles specifically dealt with camel calf coccidians in their first months of life.

The aim of this study was to analyse parasitological findings of intestinal coccidians in dromedary calves of up to 12 months of age necropsied at the Central Veterinary Research Laboratory in Dubai, United Arab Emirates between 2017 and 2024.

## Materials and Methods

During an eight and a half years (90 month) period between January 2017 and June 2024, total of 1,593 dromedary calves were necropsied at the Central Veterinary Research Laboratory in Dubai. The majority of samples were sent from a large camel dairy farm. Of these calves, 1,437 samples (faecal samples or colon content) were submitted to the department of parasitology. Samples from stillborn calves or calves less than 4 days of age were excluded.

All samples were examined with the simple floatation method using saturated NaCl/ZnCl<sub>2</sub> solution in tubes for the detection of *Eimeria* spp. and *Cystoisospora orlovi* oocysts. Specimens of liquid or pasty content (n=972) were stained in addition with the carbol-fuchsin method after Heine (1982) known as the negative staining (Potters and van Esbroeck, 2010). With samples positive for *Cryptosporidium*

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oocysts, acid fast staining or modified Ziehl-Neelsen staining (Rekha *et al*, 2016) was performed to confirm the correctness of the result. It has to be mentioned that the carbol-fuchsin staining will also detect *Cystoisospora* oocysts when their concentration in the faecal smear is high enough.

Unfortunately, the age was not indicated on the submission forms for all of the calves. Body weight and sex was taken from necropsy protocols.

In the same time span, 886 faecal samples from necropsied adult dromedaries were also examined with the floatation method.

## Results and Discussion

During the 90 month observation period, *C. orlovi* oocysts (Figs 1, 2) were detected in 94 samples and 72 samples were positive for *Cryptosporidium* oocysts (Figs 3, 4). In three calves, a mixed infection between *C. orlovi* and *Cryptosporidium* oocysts was diagnosed. During the same time period, *Eimeria* oocysts were detected in 55 samples. A species determination revealed the presence of 3 species, *E. cameli* (Fig 5), *E. rajasthani* (Fig 6) and *E. dromedarii* (Fig 6). The distribution of the detected coccidians throughout the observation period is shown in Tables

**Table 1.** Detection of *Cystoisospora orlovi* oocysts in necropsied dromedary calves (n=1437) in Dubai between 2017 and 2024.

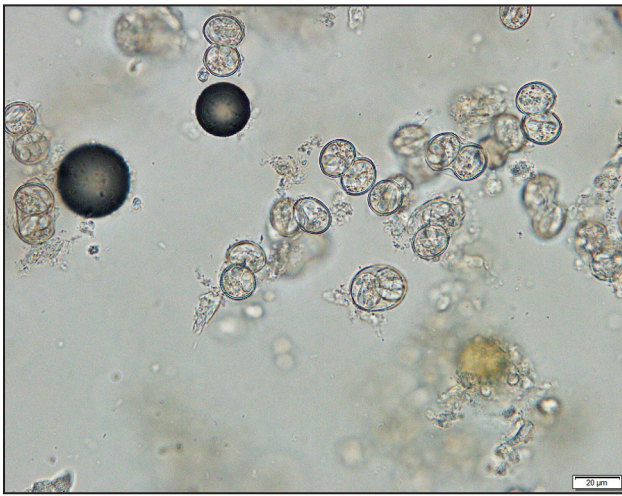
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2017	2		1		3					1	1		8
2018	1	2											3
2019	3	1	7	1									12
2020	3	5	2	1			1			1			13
2021		4	5	1								2	12
2022	2	3	4	5	2					1		1	18
2023	1	7	6									1	14
2024	2	2	2	5	2								13
<b>2017-2024</b>	<b>14</b>	<b>24</b>	<b>27</b>	<b>13</b>	<b>7</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>1</b>	<b>4</b>	<b>94</b>

**Table 2.** Detection of *Cryptosporidium* oocysts in necropsied dromedary calves (n=972) in Dubai between 2017 and 2024.

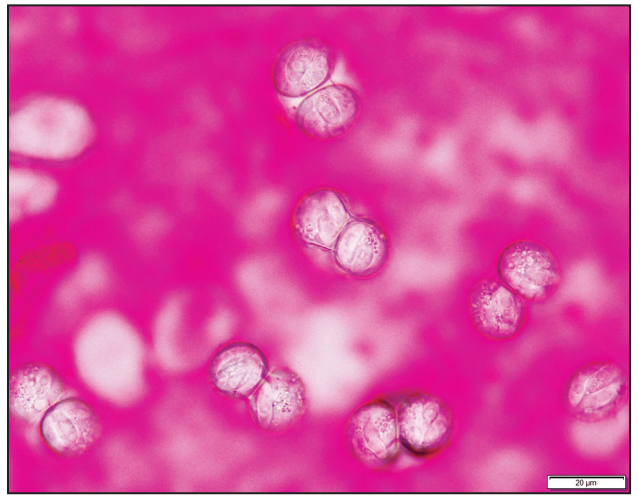
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2017			3		1	1							5
2018	1	1	1				1						4
2019	1	6	2	8	4	2							23
2020	1	3	3										7
2021			1	1								1	3
2022			1		1	1	1					1	5
2023		2	2	4	4				1				13
2024			1	3	6	2							12
<b>2017-2024</b>	<b>3</b>	<b>12</b>	<b>14</b>	<b>16</b>	<b>16</b>	<b>6</b>	<b>2</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>72</b>

**Table 3.** Detection of *Eimeria* oocysts in necropsied dromedary calves (n=1437) in Dubai between 2017 and 2024.

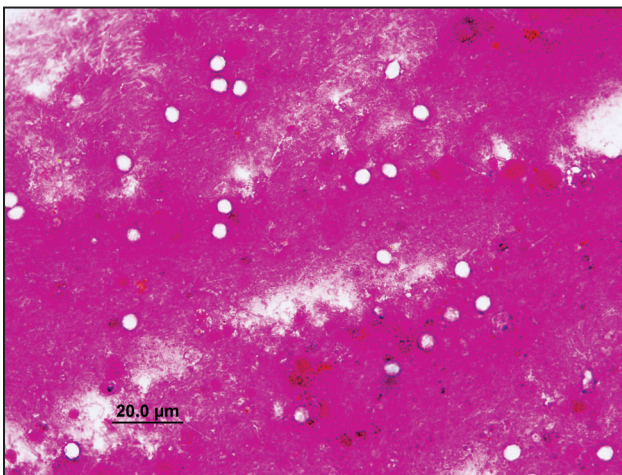
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2017								1					1
2018	2		1		1								4
2019	1		3	1		1				1			7
2020						2							2
2021	1								1				2
2022	1		2	2		1	1					2	9
2023	5							1				1	7
2024	1			4	10	8							23
<b>2017-2024</b>	<b>11</b>	<b>0</b>	<b>6</b>	<b>7</b>	<b>11</b>	<b>12</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>3</b>	<b>55</b>



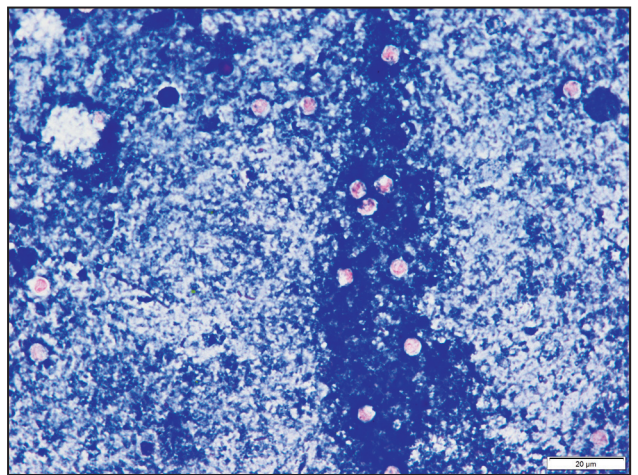
**Fig 1.** *Cystoisospora orlovi* concentrated by floatation. The majority of oocysts are already sporulated when excreted with the faeces.



**Fig 2.** *Cystoisospora orlovi* in a faecal smear stained with carbol-fuchsin. In the dried smear, the very thin oocyst wall embeds the slightly ellipsoid sporocysts tight and produces an image of a digit eight.



**Fig 3.** *Cryptosporidium* oocyst in a faecal smear stained with carbol-fuchsin (negative staining). In a freshly prepared and dried smear the round oocysts appear as colourless spots on a red background.



**Fig 4.** *Cryptosporidium* oocyst in a faecal smear (Ziehl-Neelsen staining). In this staining, oocysts are pink to red on a blue background.



**Fig 5.** *Eimeria cameli*. The large brown oocyst from dromedary camelids resemble *Eimeria macusaniensis* of South American camelids.



**Fig 6.** *Eimeria rajasthanii* (larger sized oocyst with a pole cap) and smaller sized oocysts of *E. dromedarii*

1 to 3. Most of the positive cases were diagnosed in the first half of each calendar year.

According to the statement on age on the requisition form, *C. orlovi* was detected in calves that died in an age between 10 to 50 days (Table 4). The age of 24 calves was not stated on the requisition form but according to the body weight of the carcasses at necropsy (23-47 kg), these were less than two months old (Table 5). *Cystoisospora* oocysts were found in 40 female and 53 male dromedary calves. Cystoisosporosis as primary cause or in combination with white muscle disease, pneumonia or meningitis was responsible for the death of 80 calves.

**Table 4.** Detection of *Cryptosporidium* and *Cystoisospora* oocysts in necropsied dromedary calves of different age in Dubai between 2017 and 2024 (not all the requisition forms indicated the age of the carcass).

Age (days)	<i>Cryptosporidium</i>	<i>Cystoisospora</i>
up to 20	4	12
21-30	18	51
31-40	3	3
41-50	6	2
50-60	8	0
older 60	7	0
not indicated	26	26
Total	72	94

**Table 5.** Detection of *Cystoisospora*, *Cryptosporidium* and *Eimeria* oocysts in necropsied dromedary calves of different body weight in Dubai between 2017 and 2024.

Body weight (kg)	<i>Cystoisospora</i>	<i>Cryptosporidium</i>	<i>Eimeria</i>
up to 30	15	10	0
31-40	48	22	0
41-60	31	31	5
61-80	0	6	5
81-100	0	0	7
100-120	0	3	9
120-140	0	0	29
Total	94	72	55

The age of calves with a patent *Cryptosporidium* infection ranges from 18 to 210 days (Table 4). For 26 carcasses age was not reported but the body weight range of these animals are given in table 5. Thirty-one calves were males and 24 were females. For 47 of the 72 infected calves, cryptosporidiosis was concluded as the cause of death.

The *Eimeria* oocysts were found mainly in older camel calves with a body weight ranging from 49 to 230 kg (Table 5). In 15 out of the 55 cases, the *Eimeria*

infection was fatal. Eight of these fatal cases occurred in April, May and June 2024.

In the same time period, 886 samples from necropsied adult dromedaries were examined. Of these, 74 were positive for *Eimeria* oocysts and *C. orlovi* was found in one sample only. Examination of 42 diarrhoeic samples for *Cryptosporidium* oocysts gave negative results.

Our results showed the significance of the 3 coccidian pathogens in young dromedary calves in the United Arab Emirates. In general, little is known about the parasite fauna of dromedary calves in their first months of life. This is because this age group is not available when parasitological examinations are done with material taken from abattoirs (Mahmoud *et al*, 2009; Tafti *et al*, 2009; Razafi *et al*, 2009). In other studies, the youngest animals were grouped in the category less than one year (Yakhchali and Moradi, 2012; Bouragba, 2020) or less than five years (Sazmand *et al*, 2011; Maxamhud, 2023) or coccidian findings in juvenile camels were subjects of case reports (Wang *et al*, 2008; Gu *et al*, 2016; Zahedi *et al*, 2018).

All 3 reported protozoans have a faecal-oral way of transmission. Although in our material, the overall prevalence with *Eimeria*, *Cystoisospora* and *Cryptosporidium* oocysts was relatively low and amounted to 3.8, 6.6 and 7.4%, respectively. Most of the detected cases were seen in the first half of the year (Tables 1 to 3). This is because of the main calving period following in spring and climatic peculiarities. Freshly excreted *Eimeria* oocysts need to sporulate outside the host. According to Gerlach (2008) the duration of *E. cameli* sporulation at room temperature lasts 6 to 8 days. It shortens under warmer conditions. Under natural conditions in the UAE desert with air temperatures in summer reaching more than 50°C, bring the temperature at the surface of the soil up to 65°C. Under such conditions, camel faecal piles lose 60% of its weight due to evaporation of water within 6 hours and oocysts will die. *Cryptosporidium* spp. and *C. orlovi* sporulate already in the gut of the infected camel and are infectious when they are excreted but due to their thin oocyst wall, they are extremely susceptible to high temperatures and desiccation. Frequent *Eimeria* infections were detected between April and June 2024. Most probably, this was an aftermath of heavy rainfalls in March, April and May 2024.

In the study, percentage of *Eimeria* positive calves was lower than in adult dromedaries examined in the same time period. A study of *Eimeria* prevalence

in racing camels at an age up to six years in Dubai revealed a prevalence of *E. cameli* between 7.7 and 17.5%. *E. rajasthani* and *E. dromedarii* were less frequent showing a prevalence of 1.5-7.4 and 1.9-4.8%, respectively (Dubey and Schuster, 2018). Comparable *Eimeria* prevalence was reported from Iran (Sazmand *et al*, 2012), Nigeria (Mahmuda *et al*, 2014), Uganda (Jesca *et al*, 2018) and Egypt (El Khabaz *et al*, 2019).

While *Eimeria* species of camels can be distinguished by the morphology of their oocysts the exact species inventory of *Cryptosporidium* spp. can be done only with molecular tools since most of the 14 different species that have been found in farm animals have similar sizes and only *C. muris* can be distinguished by larger oocyst measurements (7.5x5.6 µm). In our study, we found *Cryptosporidium* oocysts in 74 out of 972 examined camel calves without species identification with the majority of positive samples being diagnosed between the months February and May. Other studies reported much higher prevalences of 55.0% (Jawad and Jasim 2016), 56.0% (Hussin *et al*, 2015), 58.0% (Saidi *et al*, 2022) or even 66.0% (Hasan *et al*, 2021).

Some *Cryptosporidium* species are zoonotic and in addition to camels, Hussin *et al* (2015) found *Cryptosporidium* oocysts in 56.0% of examined camel breeders or in their families. These results however, are more than dubious. A molecular study carried out in the UAE residents revealed 26 out of 134 stool samples positive for *Cryptosporidium* spp. (ElBakri *et al*, 2014).

In a large molecular study involving 476 Bactrian camels the coccidians identified were *C. andersoni*, *C. bovis*, *C. hominis*, *C. occultus*, *C. parvum* and *C. ubiquitum* (Chao *et al*, 2020). Other studies detected *C. muris* (Abdel-Wahab and Abdel-Maogod 2011, Wang *et al*, 2021; Zhang *et al*, 2021). Part of our *Cryptosporidium* samples were sequenced and the species found were *C. parvum*, *C. hominis* and *C. meleagridis* (Procter *et al*, 2024).

*C. orlovi* is the least known coccidian species in camels. The occurrence of *C. orlovi* in the UAE is known since 2001 (Kinne *et al*, 2001; 2002) and a review of annual reports of the Central Veterinary Research Laboratory in Dubai between 2005 and 2016 revealed findings of *Cystoisospora* oocysts in 72 out of 2,885 and in 12 out of 76,969 examined faecal samples from dromedary calves and adult camels, respectively (Schuster *et al*, 2017). As shown in this study, the number of cases of camel calf cystosporosis in the following years between 2017 and 2024 has increased

(94/1.437). As in the previous study, the majority of cases were found in an age group between 21 and 30 days. Subsequently, the majority of cases were detected in the main calving period between January and May. The route of infection of camel calves with this parasite is still unknown.

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