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Comparative study of endo-parasites in captive *mouflon sheep* (*Ovis aries*) at Lahore district, Pakistan

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Abstract

This project was designed to study the prevalence of endo-parasites in Mouflon sheep (*Ovis aries*) kept at Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park, Punjab, Pakistan. Fresh faecal samples were collected and analyzed for the identification of endo-parasites. Fecal egg count and identification of each animal was determined by Modified Mc Master Technique. It was determined that male and female Mouflon sheep (*O.aries*) of Lahore Zoo (46.40%) were most susceptible to gastro-intestinal helminthiasis followed by Jallo Wildlife Park (33.98%) and Lahore Safari Park (19.62%). The infestation of twelve different endo-parasites were determined at three different captive localities. Prevalence of *O.columbianum* (49.75%) was maximum in Mouflon sheep (*O.aries*). The intensity of eggs of different endo-parasites in various Mouflon sheep (*O.aries*) samples ranged from 90 to 1750 egg per gram in three different localities. It was concluded that high prevalence of endo-parasites was determined from the current study indicating life threats and economical loss of natural number of wild fauna in Pakistan.

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Introduction

Mouflon sheep (*O.aries*) represents a popularly hunted and food producing animal species in Central Europe. Apart from the protected population in the Jabbah valley (700 Urial), the Punjab Mouflon sheep (*O. aries*) suffers hunting pressure for their trophy value and has declined drastically in only a short period in some areas of Pakistan. It persists only in few numbers of species at low densities. Mouflon sheep is very sensitive to many parasitic diseases (*muelleriosis, trichostrongylosis, fasciolosis or dicrocoeliosis*). These diseases cause health problems, untimely death of animals and causes economic losses for breeders. Therefore anthelmintics are used frequently in the breeding of Mouflon sheep (*O.aries*), especially in game parks and farms. All species of deer have been found to host a wide range of endo-parasites. Parasites cause a multitude of problems for wildlife and although it often appears that wild life have adapted to the presence of parasites, they have not adapted to the adverse effects of parasitism (Bliss, 2009).

Parasitism is a big problem of animal stock which lowers the productivity. It is also very important in case of wild animals when kept in captivity. Parasites can also be transferred to animals themselves when they are moved from one place to another without proper sanitation and treatment of diseased animals. In wild conditions, animals have some natural resistance against parasitic diseases or live in a balanced condition but in captivity as the environmental and living condition changes which will influence the animal's behavior and ecology, the risk of having a parasitic disease might also be increases (Atanaskova, 2011).

Disease monitoring in wild animals has presently become necessary component of games management. The presence of endo-parasites in an animal's body particularly in young animals leads to health worsening declined condition, reduced body, weight gains and reproductive disorders. Game losses are difficult to determine with any degree of accuracy due

to methodological reasons (Fox, 2000; Cisek *et al.*, 2003). The parasitic burden and its relationship with the host have been successfully exploited by modern scientists in the control of wildlife pests and predators in our forests and agricultural system. Most of the parasites are reputed for their abundance and have great impact in maintaining the stability of various ecosystems. Mostly, the endo-parasitic infection was recorded to be highest in autumn months (Borkovcova *et al.*, 2013).

The prevalence of endo-parasites was recorded maximum in the captive localities and nematodes were found to be highly prevalent. However, infections with endo-parasites should not be neglected. Most of the cervids observed have not shown any type of clinical signs and symptoms of diseases but still contain a sufficient number of endo-parasites (Rana *et al.*, 2015).

Infection with helminthes is a major health issue in captive and wild deer. Competition and transmission of diseases from domestic animals are major threats. Parasitic disease constitutes one of the major management problems causing mortality and morbidity in wild animals in captivity (Rao and Acharjyo, 1984). A higher rate of nematode infection and worm burden has been observed in female hosts compared with the males). The ruminants are heavily infected by a variety of helminths of high economical significance (Farooq *et al.*, 2012).

Literature with respect to endo-parasites in captive animals shows that helminthes are most frequently occurring endo-parasites than any other parasite. Protozoans come after the nematodes according to frequency of report (Pencheva, 2013).

From financial perspective, Cervids have economic importance to human beings. Deer meat for which they are hunted and farmed is called venison. Deer skin is used for making of shoes, boots and gloves. Antlers are used into button and knife handles (Kanungo *et al.*, 2010).

Keeping in view all the above mentioned facts, the present research was conducted for the comparative study of endo-parasites in *Mouflon sheep (O.aries)* kept at Jallo Wildlife Park, Lahore Safari Park and Lahore Zoo respectively.

The work was carried out to know the Mean (\pm SE) of egg per gram (EPG), Prevalence (%) and diversity of the endo-parasites identified in the faecal samples of *Mouflon sheep (O.aries)* captive at Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park.

Materials and methods

Study Area

The present study was performed for a period of seven months from March, 2013 to September, 2013 in three captive areas Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park, Lahore, Punjab, Pakistan. The numbers of Mouflon sheep (*O.aries*) in three different localities in Lahore district are shown in Table 1.

Location

The study area (three captive wildlife parks) was situated in Lahore district, a capital city of Punjab province in Pakistan. Lahore is situated in central Punjab at latitude 31.32'59 N, longitude 74.20'37 E. It is divided into ten towns. Agriculture land is irrigated by electric tube well and canals.

Jallo Wildlife Park was established in 1978. It is public recreation and wildlife site spread over an area of 456 acres (185 ha). It is about 28 km east to Lahore city in Wagha Town, Lahore, near the Indian border. About 43 acres (17 ha) has been allocated as a breeding centre for wildlife.

Lahore safari park is also called Woodland Wildlife Park. It is wildlife as well as safari park located on Raiwind road about 30 km from Lahore zoo in Allama Iqbal Town, Lahore. It was established in 1982 and is spread over 242 acres (98 ha). 80 acres (32 ha) has been allocated for wildlife. This park is recently renamed as Lahore Safari Zoo.

Lahore Zoo is one of the largest zoo in South Asia. It is thought of the third or fourth oldest zoo in the world. It was established in 1872. Lahore Zoo is spread over 25(10 ha) acres and is located on Mall road of Lahore city besides the Jinnah garden in Data Gunj Buksh Town, Lahore.

Climate

The study area has four seasons with long and extremely hot summer and dry, cold winter a monsoon and dust storms. During the month of May, June and July weather is extreme when the temperature ranges from 40-48(104-118F). The monsoon season starts with heavy rainfall recorded in Lahore is 221 millimeter (8.7 in), which occurred in August 13, 2008.

Experimental Procedure

Fresh fecal samples were collected directly from the *Mouflon sheep (O.aries)* of three captive areas. There fecal samples were placed in separated clean polythene bags having tag no., sex, age of animal and date of collection of fecal matter. Each fecal sample was brought to the Research Laboratories of Wildlife and Fisheries Department GC University, Faisalabad to check the presence of eggs of endo-parasites.

The fecal samples were analyzed by applying the modified MC Master Technique thorough Whitlock chamber method, employing saturated sodium chloride solution. Precisely 2 gram fecal samples was weighed on electronic weight balance and kept into beaker of 200 ML. In order to soften the fecal matter, 2.5 ML tap water was added into the beaker containing fecal sample. Here after, 45.5 ML of saturated sodium chloride solution was added as floatation solution. After thorough mixing, solution was stained with the help of tea stainer and filled in whitlock chamber. After 2-3 minutes, helminthes eggs were float due to low specific gravity. Refined samples were examined under light microscope at 10 x. Eggs were identified with the help of available keys to diagnose eggs (Soulsby, 1982).

Egg per Gram Calculations

Prevalence of endoparasites in eggs per gram (EPG) were determined following Soulsby. The number of eggs per gram (EPG) of faeces was calculated by multiplying the number of eggs by 50 as:

$$EPG = (16 + 24) \times 50^* = 2000 / 2 = 1000.$$

The images of endo-parasites were taken by Olympus B x 40 microscope under the 400 x. The data thus obtained was analyzed by applying appropriate statistical analysis following (Thrusfield, 2005).

Results

Table 1. Number of Mouflon Sheep (*Ovis aries*) in three different localities.

Sr. No.	Locality	Adult Male	Immature Male	Total Male	Adult Female	Immature Female	Total Female	Grand Total
1	Jallo Wildlife Park	4	2	6	4	2	6	12
2	Lahore Zoo	7	2	9	8	2	10	19
3	Lahore Safari Park	3	0	3	5	0	5	8
Total		14	4	18	17	4	21	39

Fig. 1, shows the prevalence %age of total number of twelve species of endo-parasites namely *F. hepatica*, *T. giardi*, *M. expansa*, *N. spathiger*, *G. pachyscelis*, *Trichostrongylus spp.*, *H. contortus*, *B. trigonocephalum*, *O. columbianum*, *C. cotylophorum*, *F. magna*, *O. circumcincta* were identified in the fecal samples of Mouflon sheep (*O. aries*), captive at three different localities.

Fig. 2, shows the prevalence %age in the fecal samples of Mouflon sheep (*O. aries*), captive at three different localities. Maximum infection of endo-parasites was

The present study was performed for a period of seven months from March, 2013 through September, 2013 in three captive localities. Jallo Wildlife Park, Lahore Safari Park and Lahore Zoo, Lahore, Punjab. The three captive localities were selected due to the availability of Mouflon sheep (*O. aries*) existing in Pakistan. Fecal samples of about 39 Mouflon sheep (*O. aries*) including adult male and female, immature male and female were collected and examined for the comparative study of endo-parasites. The number of Mouflon sheep (*O. aries*) in three different captive localities in Lahore district is shown in Table 1.

recorded in Mouflon sheep (*O. aries*), at Lahore Zoo (47%) Jallo Wildlife Park (34%), and Lahore Safari Park (19%) respectively.

Fig. 3, shows the sex wise prevalence of endo-parasites in Mouflon sheep (*O. aries*), at three keptive localities. Highest infection of endo-parasites was calculated in females as compared to males which might be due to stress and unhealthy environmental conditions in Lahore Zoo and Jallow Wildlife Park. The infection in immature male and females is due to the licking of contaminated soil in captivity.

Table 2. (a). Analysis of variance showing comparison locality and endo-parasites in Mouflon sheep (*Ovis aries*)

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F-value
Locality	2	54.167	27.083	5.02*
Endo-parasites	11	208.083	18.917	3.51**
Error	22	118.500	5.386	
Total	35	380.750		

* = Significant (P<0.05); ** = Highly significant (P<0.01).

Endo-parasite variations

Table 2, shows the comparison between localities and endo-parasites identified in the faecal samples of Mouflon sheep (*O. aries*). All the three localities

namely Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park showed statistically significant variations in the presence of endo-parasites in the fecal sample of Mouflon sheep (*O. aries*) (P>0.01).

Similarly the number of endo-parasites identified in the above mentioned localities, Where Mouflon sheep (*O.aries*) captive was statistically significantly different ($P < 0.05$). Highest number of endo-parasites

were recorded from the Mouflon sheep (*O.aries*) captive at Lahore Zoo (5.92 ± 1.26) followed by Jallo Wildlife park (3.83 ± 0.63) and Lahore Safari Park (3.00 ± 0.70).

Table 2. (b). DMR-test showing localitywise and endo-parasites wise Mean±SE of Mouflon sheep (*Ovis aries*).

Locality	Mean±SE	Endo-parasites	Mean±SE
Jallo Wildlife Park	3.83 ± 0.63 B	<i>F.hepatica</i>	0.00 ± 0.00 C
Lahore Zoo	5.92 ± 1.26 A	<i>T.giardi</i>	0.67 ± 0.67 BC
Safari Park	3.00 ± 0.70 B	<i>M.expansa</i>	0.67 ± 0.67 BC
		<i>N.spathiger</i>	3.67 ± 1.20 ABC
		<i>G.pachyscelis</i>	5.67 ± 0.88 A
		<i>Trichostrongylus spp.</i>	4.67 ± 1.45 AB
		<i>H.contortus</i>	6.33 ± 2.40 A
		<i>B.trigonocephalum</i>	4.67 ± 1.86 AB
		<i>O.columbianum</i>	7.33 ± 1.86 A
		<i>C.cotylophorum</i>	6.67 ± 1.76 A
		<i>F.mangna</i>	4.67 ± 0.88 AB
		<i>O.circumcincta</i>	6.00 ± 2.65 A

Means sharing similar letter in a column are statistically non-significant ($P > 0.05$).

Mean number of endo-parasites in the fecal samples of Mouflon sheep (*O.aries*) captive at Lahore Zoo and Lahore Safari Park were statistically less difference. A total number of twelve species of endo-parasites namely *Faseiola hepatica*, *T. giardi*, *M. expansa*, *N. spathiger*, *G. pachyscelis*, *Trichostrongylus spp.*, *H. contortus*, *B. trigonocephalum*, *Oesophagostomum columbianum*, *C. cotylophorum*, *F. magna*, *O.*

circumcincta were identified from the faecal samples of Mouflon sheep (*O. aries*) captive at Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park. The most dominant endo-parasitic species statistically was *O. columbianum* (7.33 ± 1.86), *C. cotylophorum* (6.67 ± 1.76), *H. contortus* (6.33 ± 2.4) and *G. pachyscelis* (5.67 ± 0.88) followed by Mouflon sheep (*O.aries*).

Table 3. (a). DMR-test showing the interaction of Sex and Locality wise Mean±SE of Mouflon sheep (*Ovis aries*).

Locality	Sex		Mean
	Male	Female	
Jallo wild life park	2.00 ± 0.41	1.83 ± 0.30	1.92 ± 0.25 B
Lahore Zoo	2.83 ± 0.67	2.83 ± 0.68	2.83 ± 0.47 A
Safari park	1.25 ± 0.37	1.58 ± 0.42	1.42 ± 0.28 C
Mean	2.03 ± 0.30 A	2.08 ± 0.29 A	

Means sharing similar letter in a row or in a column are statistically non-significant ($P > 0.05$).

Table 3, shows the analysis of variance comparing the number of endo-parasites found in the faecal samples of Mouflon sheep (*O.aries*) localities wise, sex wise and endo-parasitic wise. Mean endo-parasites varied statistically significantly localities wise and endo-

parasitic wise.

The interaction between localities and sex wise and sex and endo-parasitic wise shows the mean number of endo-parasites in fecal samples of Mouflon sheep

(*O.aries*) also varied statistically significantly. Mean number of endo-parasites was statistically higher in (2.83± 0.47) Mouflon sheep (*O. aries*) captive at Lahore Zoo when compared with Jallo Wildlife Park (1.92 ± 0.25) and Lahore Safari Park (1.42±0.28).

The fecal samples of male (2.03± 0.30) Mouflon sheep (*O.aries*) had same number of mean endo-parasites as compared to female (2.08±0.29). Mouflon sheep (*O.aries*) faecal samples had statistically similar mean number of endo-parasites. A total number of twelve species of endo-parasites namely *F. hepatica*, *T. giardi*, *M. expansa*, *N. spathiger*, *G. pachyscelis*, *Trichostrongylus spp.*, *H. contortus*, *B. trigonocephalum*, *O. columbianum*, *C. cotylophorum*, *F. magna*, *O. circumcincta* were

identified in the fecal samples of Mouflon sheep (*O. aries*), captive at three different localities.

In Mouflon Sheep (*O.aries*) *O. columbianum* (3.67 ± 0.67) and *C. cotylophorum* (3.33 ± 0.61) were found in maximum number when compared with *H. contortus* (3.17 ± 0.79) *O. circumcincta* (3.00 ± 0.86) and *G. pachyscelis* (2.83 ± 0.31).

The interaction between endo-parasites and locality wise shows the mean number of endo-parasites in fecal samples of Mouflon sheep (*O.aries*) statistically highly significant. Mean number of endo-parasites was statistically higher in Lahore Zoo (2.83±0.47) as compared to Jallo Wildlife Park (1.92±0.25) and Lahore Safari Park (1.42±0.28) in Mouflon sheep (*O.aries*).

Table 3. (b). DMR-test showing the interaction of Endo-parasites and Locality wise Mean±SE of Mouflon sheep (*Ovis aries*).

Endo-parasites	Locality		
	Jallo Wildlife park	Lahore Zoo	Lahore Safari park
<i>F.hepatica</i>	0.00 ± 0.00 f	0.00 ± 0.00 f	0.00 ± 0.00 f
<i>T.giardi</i>	1.00 ± 0.00 def	0.00 ± 0.00 f	0.00 ± 0.00 f
<i>M.expansa</i>	1.00 ± 1.00 def	0.00 ± 0.00 f	0.00 ± 0.00 f
<i>N.spathiger</i>	3.00 ± 0.00 bc	0.00 ± 0.00 f	0.00 ± 0.00 f
<i>G.pachyscelis</i>	3.00 ± 0.00 bc	3.50 ± 0.50 b	2.00 ± 0.00 b-e
<i>Trichostrongylusspp.</i>	1.00 ± 0.00 def	3.50 ± 0.50 b	2.50 ± 1.50 bcd
<i>H.contortus</i>	1.50 ± 0.50 c-f	5.50 ± 0.50 a	2.50 ± 0.50 bcd
<i>B.trigonocephalum</i>	3.50 ± 0.50 b	3.00 ± 0.00 bc	0.50 ± 0.50 ef
<i>O.columbianum</i>	3.00 ± 1.00 bc	5.50 ± 0.50 a	2.50 ± 0.50 bcd
<i>C.cotylophorum</i>	2.00 ± 1.00 b-e	5.00 ± 0.00 a	3.00 ± 0.00 bc
<i>F.mangna</i>	1.50 ± 0.50 c-f	2.50 ± 0.50 bcd	3.00 ± 0.00 bc
<i>O.circumcincta</i>	2.50 ± 0.50 bcd	5.50 ± 0.50 a	1.00 ± 0.00 def

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Table 4, shows the interaction between age, sex and locality wise and age, endo-parasitic and locality wise shows the mean number of endo-parasites in fecal samples of Mouflon sheep also varied statistically significantly. Mean number of endo-parasites was statistically higher in adult male (1.86± 0.28) and female (1.83±0.25) Mouflon sheep captive at three

different localities when compared with immature male (0.22 ±0.07) and female (0.36±0.09).

The fecal samples of the male and female Mouflon sheep (1.48± 0.26) had maximum number of mean endo-parasites at Lahore Zoo as compared to the fecal samples of Mouflon sheep (0.98±0.14) at Jallo

Wildlife Park and (0.75±0.17) at Lahore Safari Park respectively.

The fecal samples of male (1.04± 0.17) Mouflon sheep (*O.aries*) had same number of mean endo-parasites as compared to female (1.10 ± 0.16). Mouflon sheep (*O.aries*) fecal samples had statistically similar mean number of endo-parasites.

The interaction between endo-parasites and locality wise shows the mean number of endo-parasites in faecal samples of Mouflon sheep (*O.aries*) statistically highly significant. Mean number of endo-parasites was statistically higher in Lahore Zoo (1.48±0.26) as compared to Jallo Wildlife Park (0.98±0.14) and Lahore Safari Park (0.75±0.17) in Mouflon sheep (*O.aries*).

Table 4. DMR-test showing the interaction of Age, Sex and Locality wise Mean±SE of Mouflon sheep (*Ovis aries*).

Age	Sex	Locality			Age x Sex Mean
		Jallo Wildlife park	Lahore Zoo	Lahore Safari park	
Adult	Male	1.67 ± 0.38 b	2.67 ± 0.61 a	1.25 ± 0.35 c	1.86 ± 0.28
	Female	1.17 ± 0.24 c	2.67 ± 0.51 a	1.67 ± 0.43 b	1.83 ± 0.25
Immature	Male	0.33 ± 0.14 e	0.33 ± 0.14 e	0.00 ± 0.00 e	0.22 ± 0.07
	Female	0.75 ± 0.18 d	0.25 ± 0.13 e	0.08 ± 0.08 e	0.36 ± 0.09
Mean		0.98 ± 0.14 B	1.48 ± 0.26 A	0.75 ± 0.17 C	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Diversity of endo-parasites

Table 5, shows that in Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park, number of endo-parasites species recorded in the fecal sample of Mouflon sheep (*O.aries*) were 11, 9, and 9 respectively. Where as total number of endo-parasites in these experimental localities were 46, 71 and 36 respectively. Maximum number of endo-parasites identified in the fecal

sample of Mouflon sheep was 7, 11 and 6 respectively captive at Jallo Wildlife Park Lahore Zoo and Lahore Safari Park. According to Burger Parker diversity index, the faecal sample of Mouflon sheep captive at Jallo Wildlife Park had most diverse endo-parasites species (6.66) followed by faecal sample of Mouflon sheep at Lahore zoo (6.41) and the fecal sample of Mouflon sheep at Lahore Safari park (6.25).

Table 5. Endo-parasitic diversity in Mouflon sheep (*Ovis aries*) captive at Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park.

Diversity	Jallo Wildlife park	Lahore zoo	Lahore Safari park	Total
Number of endo-parasites (S)	11.00	9.00	9.00	11.00
Total no. of endo-parasites (N)	46.00	71.00	36.00	153.00
Maximum abundant endo-parasites (N max)	7	11	6	24
D= (N max / N)	0.15	0.16	0.16	0.15
1/D	6.66	6.41	6.25	6.66

Discussion

Prevalence of endo-parasites

Of the total 39 Mouflon sheep (*O.aries*) 76.27% were determined to be affected with endo-parasites and

reflects conformity with the earlier report by Cisek *et al.* (2003), Santin-Duran *et al.* (2004), Farooq *et al.* (2012) and Borkovoka *et al.* (2013). It is evident from these results that all captive Mouflon sheep (*O.aries*)

were highly susceptible to gastro-intestinal nematodiasis. These findings supports the earlier reports of Cisek *et al.* (2003), Santin-Duran *et al.* (2004), Farooq *et al.* (2012), Borkovoka *et al.* (2013), Pencheva (2013) and Rana *et al.* (2015).

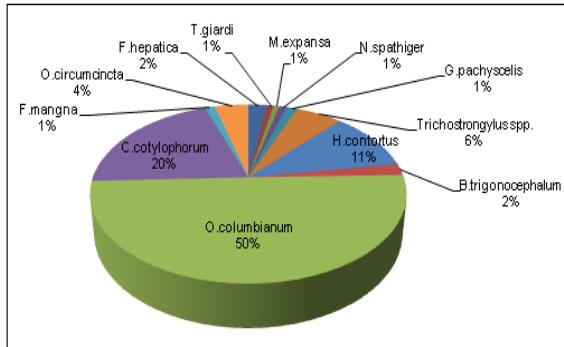


Fig. 1. Prevalence (%age) of endo-parasites at three different wildlife parks.

Mixed infection of endo-parasites was noted in majority of the Mouflon sheep at three different localities. The prevalence of twelve different endo-parasites namely *F. hepatica*, *T. giardi*, *M. expansa*, *N. spathiger*, *G. pachyscelis*, *Trichostrongylus spp.*, *H. contortus*, *B. trigenocephalum*, *O. columbianum*, *C. cotylophorum*, *F. magna*, and *O. circumcincta* were recorded in the Mouflon sheep (*O. aries*) at three different parks. The endo-parasites namely *F. hepatica*, *T. giardi*, *M. expansa*, *N. spathiger* were recorded only in Mouflon sheep (*O. aries*) of Jallow Wildlife Park. The endo-parasites, *O. circumcincta* was common in Mouflon sheep (*O. aries*), at three different captive localities. But *O. columbianum* was present in large numbers (49.75%) in Mouflon sheep (*O. aries*). The intensity of eggs of different endo-parasites in various Mouflon sheep (*O. aries*), samples ranged from 90 to 1750 eggs per gram (EPG) in three different localities.

It appears from the results that *Haemonchus spp.* (10.8%) was found most frequently in four species of deer but highly prevalent in barking deer. More or less similar prevalence rates of *Haemonchus spp.* have been reported earlier by Mason (1994), Cisek *et al.* (2004) Farooq *et al.* (2012), Borkovoka *et al.* (2013), Pencheva (2013) and Rana *et al.* (2015).

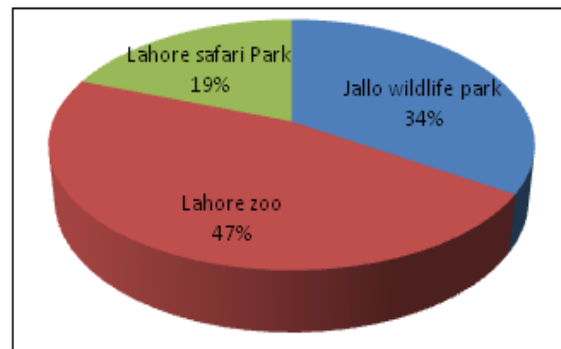


Fig. 2. Prevalence % age in mouflon sheep at three different wildlife parks.

O. columbianum (49.75%) was presents in large numbers in Mouflon sheep (*O. aries*) was highly prevalent as observed in this study is supported by the previous reports of Islam *et al.* (2003), Farooq *et al.* (2012), Borkovoka *et al.* (2013). The study recorded an overall prevalence of *B. trigenocephalum* 2.1% and *F. hepatica* 2.3% and *Trichostrongylus spp.* was 5.62%. More or less, similar prevalence rate of gastro-intestinal nematodiasis have been reported earlier by Maia (2001), Islam *et al.* (2003), Cisek *et al.* (2004), Farooq *et al.* (2012), Borkovoka *et al.* (2013), Pencheva (2013) and Rana *et al.* (2015). In the present study, *Hemoncus contortus* were also reported (10.80%) at three different localities. Same species have also been reported earlier in sheep and goat flocks in village Aqil peer at district Faisalabad (Saddiqi *et al.*, 2012).

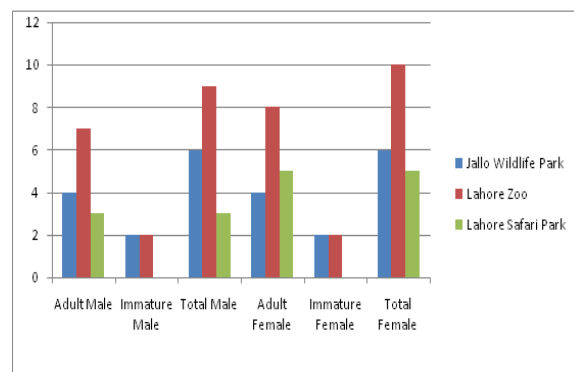


Fig. 3. Sex wise variation of prevalence in mouflon sheep at three different wildlife parks.

In Mouflon sheep (*O. aries*), *T. giardi* and *G. pachyscelis* was present in least numbers. The incidence of helminth parasites were recorded as

O.columbianum (49.75%) *C.cotylophorum* (20.35%), *Haemonchus spp.* (10.80%), *O.circumcincta* (4.13%), *Trichostrongylus spp.* (5.62%) and *G.pachyscelis* (1.35%). These findings corroborates with the observations of Kafil Hussain *et al.* (2002) Farooq *et al.* (2012), Borkovoka *et al.* (2013) and Rana *et al.* (2015) who encountered similar helminth species.

Seasonal Variations

It was noted that the incidence of helminth parasites in Mouflon sheep touched its peak during winter followed by rainy season. In rainy season, higher temperature and humidity provides favourable condition for propagation of parasites resulting higher parasitic burden among deer population. These findings corroborates well with the observations made by Farooq *et al.* (2012), Borkovoka *et al.* (2013) and Rana *et al.* (2015) who recorded higher incidence of helminthic infection in winter and rainy season in Axis deer.

Conclusion

Infection of endo-parasites were recorded. The present investigation emphasizes the necessity of future research to ensure the good management of wild threatened cervid's population in Pakistan and to find out possible ways of reducing pressures for their protection and better growth.

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