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Comparative study of endo-parasites from fecal samples of sambar (*Rusa unicolor*) and goral (*Naemorhedus goral*) in captivity

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Abstract

This project was designed to study the prevalence of endo-parasites in Sambar (*Rusa unicolor*) and Goral (*Naemorhedus goral*) kept at Jallo Wildlife Park and Lahore Zoo, Punjab, Pakistan. Fresh faecal samples were collected and analyzed for the identification of endoparasites. Faecal eggs count and identification of each animal were determined by Modified Mc Master Technique. It was determined that male and female Sambar (*R. unicolor*) of Jallo Wildlife Park (81.81%) were mostly susceptible to gastro-intestinal helminthiasis compared with Lahore Zoo (75.0%). It was also investigated in Goral (*N. goral*) of Jallo Wildlife Park (88.0%) were mostly susceptible to gastro-intestinal helminthiasis compared with Lahore Zoo (63.63%). Over all prevalence (%age) in Sambar (*R.unicolor*) and Goral (*N.goral*) was 77.5% in two different captive localities. The infestation of twelve different endo-parasites was determined at two different captive localities. Prevalence of *Trichostrongylus spp. and Gaigeria pachyscelis* were present in large numbers in Sambar (*R.unicolor*). *G. pachyscelis*, *H. contortus* and *B. trigonocephalum* were recorded in Goral (*N.goral).* The intensity of eggs of different endo-parasites in various Sambar (*R.unicolor*) and Goral (*N. goral*) samples ranged from 90 to 1750 egg per gram in two 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

An endangered species is a population of living being that is at the danger of becoming extinct because of several reasons; predation of wild animals and destroy their habitat by cutting the trees for urban areas. They are few in number and are threatened by the varying environmental conditions or negative activity of human impact. It has been well documented that the captive conditions like zoos and parks provide shelter and breeding sanctuaries for animals that are endangered. Wild animals are the part of our natural ecosystem and their unhealthy conductions and extinction can cause destructive effects in the food chain and environment. 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).

Sambar deer (*Rusa unicolor*) the largest species of deer native to south East Asia, is a member of the rusine deer group. It is closely related to the red deer (*Cervus elaphus elaphus*) of Asia and Europe, the rusa deer (*Cervus timonensis*) of Asia and the Rocky Mountain elk (*Cervus elephanus nelsoni*) of North America (Whitehead, 1972).

Himalayan goral (*Naemorhedus goral*) is a goat like creature so rare that it is listed as a nearly threatened species by the International union for the Conservation of Nature. Native people in the Himalayas find it difficult to grow crops and so exist on a meatbased diet. Gorals are hunted for meat, for their fur, for sport and to harvest parts for folk medicine that can be sold as far away as South Korea. Parasitism in sheep and goat is a substantial problem plaguing farmers across the nation. Sheep are more susceptible to internal parasites than most other types of farm livestock for several reasons. As gastrointestinal parasite infection is the most important limiting factor of sheep productivity, parasitism has a highly detrimental effect on the sheep industry (Jones, 2001).

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 transfered 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 ai*., 2003). The parasitic burdoren 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 autmn 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. Protozones 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 Sambar *(R. unicolor)* and Goral (*N. goral*) kept at Jallo Wildlife Park and Lahore Zoo respectively.

Aims

The research work was aimed to know the

Mean (±SE) of egg per gram (EPG), Prevalence (%) and diversity of endo-parasites identified in the fecal samples of Sambar (*Rusa unicolor)* and Goral (*Naemorhedus goral)* captive at Jallo Wildlife Park and Lahore Zoo.

Materials and methods

Study Area

The present study was performed for a period of seven months from March, 2013 to September, 2013 in two captive areas Jallo Wildlife Park and Lahore Zoo, Lahore, Punjab, Pakistan. Lahore is the capital city of Punjab province in Pakistan. It is situated in central Punjab at latitude 31.32'59 N, longitude 74.20'37 E. and is divided into ten towns. Agriculture land is irrigated by electric tube well and canals.

JalloWildlife 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 WaghaTown, Lahore , near the Indian border. About 43 acres (17 ha) has been allocated as a breading centre for wildlife.

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 acres (10 ha) and is located on Mall road besides the Jinnah garden in Data Gunj BukshTown of Lahore city.

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 occure in August 13,2008.

Animals

The total number of Sambar (*R. unicolor*) and Goral (*N. goral*) in captivity are shown in table 1-2 respectively. Number and percentage (%) of infected Sambar (*R. unicolor*) and Goral (*N. goral*) in two different captive localities are shown in table 3-4 respectively and the prevalence percentage of endo-parasites is shown in table 5.

Experimental Procedure

Fresh fecal samples were collected directly from Sambar (*Rusa unicolor*) and Goral (*Naemorhedus goral*) in two different captive localities. 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 Zoology,

Wildlife and Fisheries Department GC University, Faisalabad to check the presence of eggs of endo-parasites.

All the Sambar (*R.unicolor*) and Goral (*N.goral*) breed kept at Jallo Wildlife Park and Lahore Zoo belonging to different age and sex were be scrutinized for the presence of gastro-intestinal infections and prevalent species of helminthes. About Sambar 15 and Goral 20 samples were selected from Jallo Wildlife Park and Lahore Zoo for the presence 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 beacker containing fecalsample. Here after, 45.5 ML of saturated sodium chloride solution was added as floatation solution. After through 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) x 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

Endoparasite variations

Fecal samples of about 35 captive wild animals including adult male and female, immature male and female were collected and examined for the comparative study of endo-parasites After examined the faecal samples, twelve species of endoparasites namely, *F. hepatica*, *Thysaniezia spp.*, *M. expansa*, *N. spathiger*, *G. pachyscelis*, *Trichostrongylus spp.*, *H. contortus*, *B. trigonocephalum*, *O. columbianum*, *C. cotylophorum*, *F. magna*, *O. circumcincta* were identified in the faecal samples of Sambar (*R. unicolor*) and Goral (*N. goral*) captive at two different localities. *Trichostrongylus spp. and G. pachyscelis* were dominant in Sambar (*R. unicolor*). *Gaigeria pachyscelis*, *H. contortus* and *B. trigonocephalum* were calculated in large numbers in Goral (*N. goral*)

Table 6, shows the Mean endo-parasites varied statistically significantly localities wise and endo-parasitic wise.Mean number of endo-parasites was statistically higher in Sambar (*R.unicolor*) captive at Jallo Wildlife Park (62.28±12.69) when compared with Lahore Zoo (25.00±09.73).

Table 7, shows the Mean number of endo-parasites was statistically higher in Sambar (*R. unicolor*) captive at Jallo Wildlife Park (61.46±17.05) when compared with Lahore Zoo (6.25±2.83). In Sambar (*R. unicolor*) *G. pachyscelis* (112.50±66.65), *Trichostrongylus spp.* (87.50±54.08), *M. expansa* (56.25±33.32), *and B. trigonocephalum* (6.25±33.32) were found in maximum number when compare with others endo-parasites.

Table 8, shows the Mean number of endo-parasites was statistically higher in Goral (*N. goral*)) captive at Jallo Wildlife Park (41.67±16.38) when compared with Lahore Zoo (27.27±10.37). In Goral *O. columbianum* (56.80±3.65) and *C. cotylophorum* (53.65±12.04), were found in maximum number when compared with *H. contortus* (48.46±11.81), *G. pachyscelis* (45.61±4.39 *F. magna,* (42.11±16.45), *O. circumcincta* (41.52±9.49) and others endo-parasites.

Table 9, shows the Mean number of endo-parasites was statistically higher in Goral (*N. goral*) captive at Jallo Wildlife Park (16.67±7.19) when compared with

Lahore Zoo (6.25±2.83). *H. contortus* (43.75±31.19), *G. pachyscelis* (25.00±18.90) and *C. cotylophorum* (25.00±18.90) were found in maximum number when compared with *B. trigonocephalum* (18.75±13.75) and *O. circumcincta* (12.50±8.18).

Table 1. Number of Sambar (*Rusa unicolor*) in two different captive localities

Sr No.	Localities	Adult Male	Immature Male	Total Male	Adult Female	Immature Female	Total Female	Grand Total (Male & Female)
1	Jallo Wildlife Park	4	1	5	4	2	6	11
2	Lahore Zoo	1	0	1	2	1	3	4
Total		5	1	6	6	3	9	15

Table 2. Number of Goral (*Naemorhedus goral*) in two different captive localities

Sr No.	Localities	Adult Male	Immature Male	Total Male	Adult Female	Immature Female	Total Female	Grand Total (Male & Female)
1	Jallo Wildlife Park	2	2	4	3	2	5	9
2	Lahore Zoo	3	1	4	5	2	7	11
Total		3	0	3	0	0	0	20

Diversity of endoparasires

Table 10, shows that in Jallo Wildlife Park and Lahore Zoo, number of endo-parasites species recorded in the fecal sample of Sambar were 9, and 5. Where as total number of endo-parasites in these experimental localities were 36 and 5. Maximum number of endo-parasites was identified in the faecal sample of Sambar captive at Jallo Wildlife Park and Lahore Zoo.

Table 11, shows Jallo Wildlife Park and Lahore Zoo number of endo-parasites species recorded in the faecal sample of Goral were 6 and 5. Where as total number of endo-parasites in these experimental localities were 9 and 5. Maximum number of endo-parasites was identified in the faecal sample of Goral captive at Jallo Wildlife Park and Lahore Zoo.

Table 3. Number and percentage (%) of infected Sambar (*Rusa unicolor*) in two different captive localities.

Sr No.	Location	Animals examined (Male)	Animals infected (Male)	Animals examined (female)	Animals infected (female)	Total animals Examined (Male&Female)	Total animals infected Male & Female (Infected %)
1	Jallo wildlife park	5	4	6	5	11	9(81.81%)
2	Lahore zoo	1	1	3	2	4	3(75.0%)
Total		6	5	9	7	15	12(80.0 %)

Table 4. Number and percentage (%) of infected Goral (*Naemorhedus goral*) in two different captive localities

Sr No.	Location	Animals examined (Male)	Animals infected (Male)	Animals examined (female)	Animals infected (female)	Total animals Examined (Male&Female)	Total infected Male & Female (Infected%)
1	Jallo wildlife park	4	4	5	4	9	8(88.0 %)
2	Lahore zoo	4	3	7	4	11	7(63.63 %)
Total		8	7	12	8	20	15(75.0%)

Discussion

Prevalence of endoparasites

Of the total 35 number of Sambar (*R.unicolor*) and Goral (*N. goral*) 77.5% 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), Borkovoka *et al.* (2013) and Rana *et al.* (2015). It is evident from these results that all captive Sambar (*R. unicolor*) and Goral (*N. goral*) 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).

It was observed from these results that majority of captive Sambar (*R.unicolor*) and Goral (*N.goral*) were highly susceptible to endo-parasites. These findings supports the earlier reports of Cisek *et al.*(2003), Santin-Duran *et al.* (2004), Farooq *et al.* (2012), Borkovoka *et al.* (2013) and Pencheva (2013) and Rana *et al.* (2015).

Table 5. Prevalence (%) of Endo-parasites identified in fecal samples of samber and goral captive at two different localities.

Sr. No.	Endo-parasite eggs identified	Total animals examined	Infected animals	Prevalence (%) of endoparasites
1	*Faseiola hepatica*	35	9	25.71%
2	*Thysaniezia spp.*	35	11	31.42
3	*Moniezia expansa*	35	4	11.42
4	*Nematodirus spathiger*	35	5	14.28
5	*Gaigeria pachyscelis*	35	28	80.0
6	*Trichostrongylus spp.*	35	30	85.71
7	*Haemonchus contortus*	35	23	65.71
8	*Bunostomum trigonocephalum*	35	24	68.57
9	*Oesophagostomum columbianum*	35	11	31.42
10	*Cotylophoron cotylophorum*	35	12	34.28
11	*Fascioloides magna*	35	6	17.14
12	*Ostertagia circumcincta*	35	8	22.85

Table 6. DMR-test showing the interaction of Endo-parasites and Locality Mean ±SE of Sambar (*Rusa unicolor*).

Locality	Mean±SE	Endo-parasites	Mean±SE
Jallo Wildlife Park	62.28 ± 12.69 A	*F.hepatica*	37.50 ± 37.50 BC
Lahore Zoo	25.00 ± 09.73 B	*Thysaniezia spp.*	71.40 ± 21.40 AB
		M.expansa	39.25 ± 39.25 BC
		N .spathiger	58.30 ± 8.30 BC
		G.pachyscelis	121.40 ± 21.40 A
		Trichostronggylus spp.	0.00 ± 0.00 C
		H.contortus	37.50 ± 37.50 BC
		B. trigonocephalum	58.30 ± 8.30C
		O. columbianum	0.00 ± 0.00 C
		C. cotylophorum	50.00 ± 0.00 BC
		F. mangna	0.00 ± 0.00 C
		O. circumcincta	50.00 ± 50.00 BC

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

It was also investigated in Goral (*N.goral*) of Jallo Wildlife Park (80.0%) were mostly susceptible to gastro-intestinal helminthiasis compared with Lahore Zoo (63.63%). Mixed infection of endo-parasites was noted in majority of the wild animals at two different localities. The prevalence of twelve different endo-parasites namely *F. hepatica, Trichostrongylus spp., M. expansa, N. spathiger, G. pachyscelis, Trichostrongylus spp., H. contrtus, B. trigonocephalum, O. columbianum, C.*

cotylophorum, F. magna and O. circumcincta were recorded at two different parks found in the Sambar (*R. unicolor*) and Goral (*N. goral*). The endo-parasites namely *Trichostrongylus spp. and G. pachyscelis* were present in large numbers in Sambar (*R. unicolor*) while *G. pachyscelis*, *H. contortus* and *B. trigonocephalum* were present in large numbers in Goral (*N. goral*). The intensity of eggs of different endo-parasites in various Sambar (*R. unicolor*) and Goral (*N. goral*) samples ranged from 90 to 1750 eggs per gram (EPG) in two different localities.

Table 7. DMR-test showing the interaction of Endo-parasites and Locality Mean±SE of Sambar (*Rusa unicolor*).

Endo-parasties	Locality		Mean
	Jallo wild life park	Lahore Zoo	
F.hepatica	37.50 ± 23.94 e	0.00 ± 0.00 e	18.75 ± 13.15 CD
Thysaniezia spp.	162.50 ± 98.69 ab	12.50 ± 12.50 e	87.50 ± 54.08 AB
M.expansa	112.50 ± 65.75 bc	0.00 ± 0.00 e	56.25 ± 37.13 BC
N .spathiger	50.00 ± 50.00 de	12.50 ± 12.50 e	31.25 ± 24.89 CD
G.pachyscelis	200.00 ± 122.47 a	25.00 ± 25.00 e	112.50 ± 66.65 A
Trichostronggylus spp.	0.00 ± 0.00 e	0.00 ± 0.00 e	0.00 ± 0.00 D
H.contortus	37.50 ± 37.50 e	0.00 ± 0.00 e	18.75 ± 18.75 CD
B.trigonocephalum	100.00 ± 61.24 cd	12.50 ± 12.50 e	56.25 ± 33.32 BC
O.columbianum	0.00 ± 0.00 e	0.00 ± 0.00 e	0.00 ± 0.00 D
C.cotylophorum	12.50 ± 12.50 e	12.50 ± 12.50 e	12.50 ± 8.18 CD
F.mangna	0.00 ± 0.00 e	0.00 ± 0.00 e	0.00 ± 0.00 D
O.circumcincta	25.00 ± 25.00 e	0.00 ± 0.00 e	12.50 ± 12.50 CD

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.

It appears from the results that *Haemonchus spp.* (65.71%) was found most frequently in two species of deer but highly prevalent in Sambar (*R.unicolor*) (45.45%). 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).

Table 8. DMR-test showing the interaction of Endo-parasites and Localities Mean±SE of Goral (*Naemorhedus goral*).

Locality	Mean±SE	Endo-parasites	Mean±SE
Jallo Wildlife Park	41.67 ± 16.38 A	*F.hepatica*	0.00 ± 0.00 C
Lahore Zoo	27.27 ± 10.37 A	*Thysaniezia spp.*	5.56 ± 5.56 BC
		M.expansa	5.56 ± 5.56 BC
		N .spathiger	30.26 ± 10.22 ABC
		G.pachyscelis	45.61 ± 4.39 A
		Trichostronggylus spp.	26.17 ± 5.85 ABC
		H.contortus	48.46 ± 11.81 A
		B.trigonocephalum	34.14 ± 13.29 AB
		O.columbianum	56.80 ± 3.65 A
		C.cotylophorum	53.65 ± 12.04 A
		F.mangna	42.11 ± 16.45 A
		O.circumcincta	41.52 ± 9.49 A

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

Trichostrongylus spp. and G. pachyscelis were present in large numbers in Sambar (*R. unicolor*) *G. pachyscelis*, *H. contortus* and *B. trigonocephalum* were present in large numbers in Goral (*N. goral*) 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) and Rana *et al.* (2015). The study recorded an overall prevalence of *Faseiola hepatica* was 25.71%, *Moniezia expansa* 11.42% and *Trichostrongylus spp.* was 85.71%. More or less similar prevalence rate of gastro-intestinal nemotodiasis have been reported earlier by Islam *et al.* (2003), Shibashi *et al.* (2003), Cisek *et al.* (2004), Farooq *et al.* (2012), Borkovoka *et al.* (2013), Pencheva (2013) and Rana *et al.* (2015). *Capillaria spp.* (0.85%) and *Moniezia spp.* (0.85%) were recorded in very less amount which was supported by previous reports like Cisek *et al.* (2003), Farooq *et al.* (2012) and Rana *et al.* (2015). In present study *Hemoncus contortus* were also reported abundantly (65.71%) at two different localities and same species have also been reported earlier in sheep and goat flocks in village Aqil peer at district Faisalabad (Saddiqi *et al.* (2012).

Table 9. DMR-test showing the interaction of Endo-parasites and Localities Mean±SE of Goral (*Naemorhedus goral*).

Endo-parasites	Locality		Mean
	Jallo wild life park	Lahore Zoo	
F. Hepatica	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Thysaniezia spp.	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
M. Expansa	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
N .Spathiger	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
G.Pachyscelis	37.50 ± 37.50	12.50 ± 12.50	25.00 ± 18.90
Trichostronggylus spp.	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
H.contortus	62.50 ± 62.50	25.00 ± 25.00	43.75 ± 31.96
B.Trigonocephalum	25.00 ± 25.00	12.50 ± 12.50	18.75 ± 13.15
O.Columbianum	25.00 ± 25.00	0.00 ± 0.00	12.50 ± 12.50
C. Cotylophorum	37.50 ± 37.50	12.50 ± 12.50	25.00 ± 18.90
F. Mangna	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
O. Circumcincta	12.50 ± 12.50	12.50 ± 12.50	12.50 ± 8.18

Seasonal variations

It was noted that the incidence of helminth parasites in Sambar touched its peak during winter followed by rainy season. In rainy season, higher temperature and humidity provides favourable condition for propagation of endoparasites resulting higher parasitic burden among deer population. These findings corroborates well with the observations made by Kafil Hussain *et al.* (2002) Farooq *et al.* (2012) and Borkovoka *et al.* (2013) who recorded higher incidence of helminthic infection in winter and rainy season in Axis deer.

Table 10. Endo-parasitic diversity in Sambar (*Rusa.*

Diversity	Jallo wildlife park	Lahore zoo	Total
Number of endo-parasites (S)	9.00	5.00	9.00
Total no. of endo-parasites (N)	36.00	5.00	41.00
Maximum abundant endo-parasites (N max)	7	7	14
D= (N max / N)	0.19	1.4	0.34
1/D	5.26	0.71	2.94

unicolor) captive at Jallo Wildlife Park and Lahore Zoo.

Table 11. Endo-parasitic diversity in Goral (*Naemorhedus goral*) captive at Jallo Wildlife Park and Lahore Zoo.

Diversity	Jallo wildlife park	Lahore zoo	Total
Number of endo-parasites (S)	6.00	5.00	6.00
Total no. of endo-parasites (N)	9.00	5.00	14.00
Maximum abundant endo-parasites (N max)	2	1	3
D= (N max / N)	0.22	0.2	0.21
1/D	4.54	5	14.28

Conclusion

In majority of the Sambar (*R. unicolor*) and Goral (*N. goral*) mixed infection of endo-parasites was recorded.The present investigation revealed that there is utmost necessity of future research for better management of wild threatened cervid's population in Pakistan and to find out possible ways of reducing threats for their protection and better growth .

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