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Prevalence of ectoparasites of pheasants in Dhodial Pheasantry district Mansehra, KPK, Pakistan

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Ectoparasites adversely affect the birds by lowering their economic production levels, such as by causing irritation, anemia, and morbidity ratio. The present study of ectoparasites prevalence was conducted in Dhodial Pheasantry District Mansehra. A total of 250 (Male n=125 and Female n=125) pheasants belongs to different species, ages and sexes were randomly captured for ectoparasites prevalence from 2017 to March 2018. Among them, 203 (81.2%) were found to be infested by one or more species of ectoparasites. In the male, the infestation was (.2%) while in the (79.2%). The dust-ruffling method and visual examination method were used for ectoparasites (found on skin and feathers) quantification from live pheasants. Nine species of ectoparasites were identified, with mean intensity and standard deviation (SD) of *Cuclotogaster heterographus* 78.4% (24.7±13.6), *Menacanthus stramineus* 73.2 (24.4±13.5), *Menopon gallinae* 61.2% (16.4±8.6), *Goniodes colchici* 58% (13.3±6.7), *Goniodes gigas* 52.8 (19.9±10.4)*, Goniodus pavonis* 22.8 (5.4±2.1), *Trinoton anserium* 20.4 (6.5±3.4), *Argas persicus* 54.4 (30.1±15.3), *Echadnophaga gallinacea* 22% (21.7±9.1). The maximum infestation of ectoparasites was recorded from *Catreus wallichi*, *Phasianus colchicus,* and *Crossoptilon mantchuricum*, followed by *Lophura leucomelana leucomelana*, *Lophura nycthemera*, *Pavo cristatus negripennis*, *Lophura edwardsi*, *Syrmaticus ellioti,* and *Crossoptilon auritum*, whereas the lowest infestation was recorded from *Lopura diardi*, *Chrysolophus amherstiae*, *Syrmaticus reevesi Lophura leucomelana hamiltoni*, *Pavo o* followed by *Pavo muticusChrysolophus pictus*, *Lophophorus impejanus*. The difference between the prevalence of double and mixed infestation was calculated and was found statistically significant ($p < 0.05$).

Keywords: Ectoparasites Prevalence, Pheasants, Dhodial Pheasantry, Mansehra.

INTRODUCTION

Birds are useful environmental indicators and play a very important role in the food chain; they provide in a short time the animal proteins and thus reduce the deficiency of protein supply (Pearson, 1995; Khan et al. 2003; Khan., 2021). Pheasants are potentially useful environmental icons and play a valuable role in the ecosystem and have a central position in the food web and are vulnerable due to human interruption such as habitat exploitation and overhunting (Fuller and Garson, 2000; Khan et al. 2003).

Pheasants due to their beautiful charismatic breeding sound and colorful plumages have made

themselves an important figure in traditional beliefs and conservation campaigns, as well as cultural icons which are appreciated by both local people and the mainstream public and are easy to trap and they, are a good source of protein and have great importance on economic point of view for human (Kumar et al. 1997; IUCN, 1998; Nawaz and Malik, 2000).

Almost all organisms facing the problems of competition and predation, among them one of the main biotic stresses is parasitism. Birds that have access to wild and outdoor areas have a greater diversity of endoparasites and ectoparasites (Price, 1980; Pandey et al. 1992). The birds are infested by various types of ectoparasites such as mites, ticks, fleas, and including various species of chewing lice (Abedin and Huq, 1977; Rahman et al. 1989).

The chewing lice commonly found obligatory ectoparasites of wild and domestic birds, where they live for their entire life cycle. These are more particularly found widespread among the Galliformes birds and their heavy infestations also occur in some of the other bird species such as domestic fowls (Kettle, 1990; Mullen and Durden, 2002). The infested Pheasants scratch their head and body, which is likely to remove the discomfort caused by the action of the lice infestation (Wall and Shearer, 2001).

Mites are permanent parasites of birds; they can easily collect from the body of a bird by using the visual examination. They are small in size and look like the grain of tiny sand (Brooke, 1985). Mites like *Ornithonyssus sylviarum* and *Dermanyssus gallinae* infested pheasant and most of the other birds. Mites cause inflammation such as thickened, hardens, and deformed legs which lead to the formation of scaly legs (Mullen and Durden, 2002).

Flea species and subspecies parasitize mammals and birds. A small number of flea species can parasitize the birds and making them weak and cause illness (Traubr, 1985; Durden and Traub, 1995).

Increased mortality due to ectoparasites is caused by the loss of blood, which weakens the host, by viral disease or vectors that act as mechanical or biological agents transmitting several pathogens (Mir *et al*., 1993; Pearson, 1995). Much less is known about their ectoparasites and the impact of such parasites and pathogens on population dynamics and the spreading of local birds. Despite increased attention in the role of birds in the dispersion of infectious disease vectors (Hubalek, 2004; Palomar et al. 2012; Arnal et al. 2014). Every animal including man does exist ectoparasite which affects their health in one way or the other. In the same way, birds encounter multiple health hazards brought by ectoparasites and endoparasites, some of which in turn can adversely affect other animal population's health including humans. The objectives of the present study:

i. To know the overall prevalence and type of ectoparasite infestation on pheasants.

ii. To find the infestation rate of ectoparasites among the species of pheasants.

MATERIALS AND METHODS

Study area

The present study was conducted in Dhodial Pheasantry, District Mansehra, Khyber Pakhtunkhwa, Pakistan (fig. 1) which lies at 34° 14 and 35° 11' N and 72° 49' and 74° 08' E, with a total area of 8.5 ha (Waseem et al. 2020, Ullah et al. 2020).

The village Dhodial is famous for its conservation project on pheasants and is Asia`s largest pheasantry Ali (2005). Worldwide 49 species of pheasants are present; among them, 32 are present in Dhodial pheasantry therefore it is considered Asia`s largest pheasantry. Some of the famous pheasant species found in pheasantry are Lady Amherst pheasant, Reeves pheasant, Golden pheasant (exotic species), Monal, Kalij, Koklass, and cheer pheasants. It provides a safe breeding environment for the Pakistan endemic pheasants (White-crested Kalij, Koklass, Monal, Cheer pheasant, and Western Horned Tragopan) and also kept breeding of exotic pheasants for the general people raise in-home and local farmer NWFP Wildlife Department (2004) (Ullah et al. 2020; Rahat et al. 2020; Ahmad et al. 2021; Khan et al. 2021; Ullah et al. 2021).

Preliminary survey

The present study was conducted in Dhodial Pheasantry district Mansehra, from October-2017 to March 2018. A total number of 250 pheasants (n-125 male and female n-125) was examined for the prevalence of ectoparasites. The laboratory work and identification of the ectoparasites were carried out in the Parasitology and Entomology laboratory of VRS (Veterinary and Research Station) Balogram, Swat.

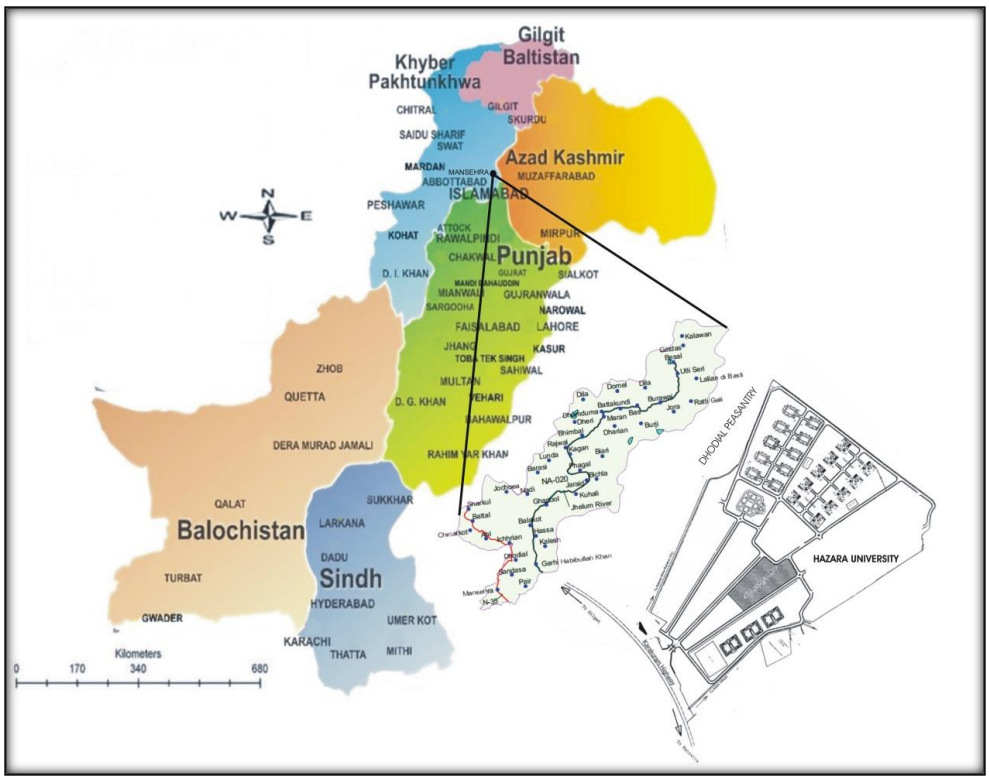

Figure 1: Hypothetical Sketch of Dhodial Peasantry in District Mansehra

Visiting the cages

During this study, each cage was visited internally and pheasants were randomly selected and captured with help of a pheasant capturing instrument (catcher) for ectoparasites prevalence load and mean abundance.

Sampling technique

Pheasants were trapped from the cage with help of a catcher. Visual examination and dust-ruffling methods were used for collective quantification of ectoparasite load from live birds Clayton and Walther (1997).

Visual examination

In this method, birds were immobilized with the help of surgical tape. The feathers of the head, the neck, under the wings, body, and legs were raised and thoroughly examined for ectoparasites. The magnifying glass was used to observe ectoparasites having less than 1mm body size. The ectoparasites were counted and transferred to the labeled bottles containing 70% ethanol and later on identified by using taxonomic keys Shanta *et al.* (2006).

Dust ruffling method

In this method, live birds were held in one hand over the colored, smooth collecting surface and were dusted with an insecticidal powder (1.0% Permethrin) followed by feather-ruffling Khattak *et al.* (2012). The eyes of the birds were covered to prevent irritation. After each bout of ruffle ectoparasites were collected, counted, transferred to 70% ethanol containing viols, and identified by using taxonomic keys.

Microscopic study

The microscopic study was carried with help of a Stereo-microscope. The magnification power of objective lenses used was 10x, 40x and 100x oil emersion.

Slides preparation

The collected specimens were poured in transparent patri dish from labeled vials and are visualized with the help of a stereo-microscope for initial identification. The specimens are fixed in 95% ethanol and separated in different orders in separate Petri dishes. Permanent slides were prepared by following the technique of Palma (1978). Slides were prepared for photography and identification of the ectoparasites.

Photography from slides

Stereomicroscope and 12-megapixel digital cameras (Nokia mobile N8-00) were used for photography of ectoparasites.

Identification

For identification purposes, the ectoparasites were placed on a slide with the help of fine forceps and camel hair brush and were identified with the help of a stereo-microscope. Identification of the collected ectoparasites was carried out with help of different standard published texts and keys such as Soulsby (1982), Wall and Shearer (2001), Taxonomy, and checklist of Price *et al.* (2003) and book of Veterinary Parasitology Taylor *et al*. (2007).

Statistical analysis

The record of collected data was statistically analyzed to find mean intensity and standard deviation (±SD) by following Margolis *et al*. (1982). The chi-square test was done for calculation of p-value among the difference of single and mixed infestations and p-value were considered to be statistically significant ($p < 0.05$).

RESULTS

The present study was conducted from October 2017 to March 2018 on a random sampling of 18 species of Pheasants from Dhodial pheasantry Mansehra. A total of 250 pheasants were examined out of which, n=9 Himalayan Monal (*Lophophorus impejanus*), n=4 Temmink tragopan *(Tragopan temminiki*), n=23 Nepal Kalij ***(****Lophura leucomelana leucomelana*), n=19 White-crested Kalij (*Lophura leucomelana hamiltoni*), n=18 Silver pheasant (*Lophura nycthemera*), n=14 Siamese fireback *(Lopura diardi*), n=25 Cheer ***(****Catreus wallichi*), n=21 Ring-necked *(Phasianus colchicus*), n=20 Golden (*Chrysolophus pictus*), n=16 Lady Amherst's ***(****Chrysolophus amherstiae*), n=12 Green peafowl (*Pavo muticus*), n=15 White Peafowl *(Pavo cristatus albino)*, n=11 Black shoulder Peafowl *(Pavo cristatus negripennis*), n=7 Brown eared ***(****Crossoptilon mantchuricum*), n=6 Blue-eared *(Crossoptilon auritum*), n=9 Edward ***(****Lophura edwardsi*), n=7 Elliot's ***(****Syrmaticus ellioti*) and n=14 Reeves *(Syrmaticus reevesi*).

Overall ectoparasites infestation

In the present study, the gender-wise ectoparasites prevalence was n=250 (Male n=125 and Female n=125). The pheasants, representing different species, age groups, and Sexes were indiscriminately captured and examined, of which 203 (81.2%) pheasants were found to be infested with one or more species of ectoparasites (fig. 2). Additionally, the males have infested 83.2% and females 79.2% (Table 1).

Table1: Overall Prevalence of ectoparasites infestations in pheasants

Gender	Total birds	Infested Birds	Percentage (%)
Male	125	104	83.2
Female	125	99	79.2
Total	250	203	81.2

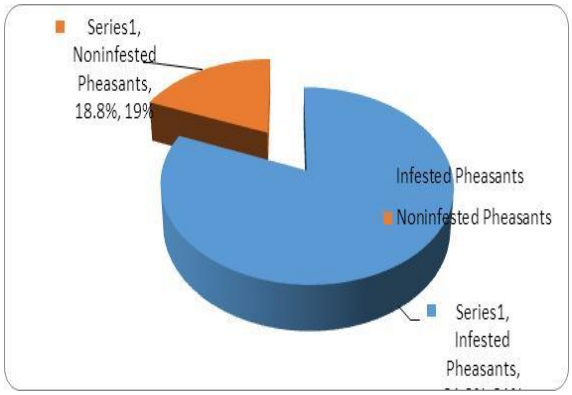

Figure 2: Showing overall prevalence of ectoparasites infestation in Pheasants

Ectoparasites prevalence and their body locations

The prevalence and mean intensity ± SD of nine species of ectoparasites found in Pheasants along with their body locations were recorded. Seven species of Mallophaga (chewing lice), among them the most prevalent was *Cuclotogaster heterographus* 78.4% (24.7±13.6), *Menacanthus stramineus* 73.2% (24.4±13.5), *Menopon gallinae* 52.8% (16.4±8.6), *Goniodes colchici* 58% (13.3±6.7), *Goniodes gigas* 52.8% (19.9±10.4), *Goniodus pavonis* 22.8% (5.4±2.1), *Trinoton anserium* 20.4% (6.5±3.4), while one species of soft ticks *Argas persicus* 54.4% (30.1±15.3) and *Echadnophaga gallinacea* 22% (21.7±9.1) was recorded with prevalence and mean intensity ± SD respectively (Table 2).

Ectoparasites species and their host distribution

6th infestation:

Three species of pheasants were infested by six ectoparasites species.

1-Cheer pheasant ***(****Catreus wallichi*) were infested by a maximum number of ectoparasites species, *Goniodes colchici* 88%, *Menopon gallinae* 76%*, Cuclotogaster heterographus* 64%*, Menacanthus stramineus* 56%*, Argas persicus* 28% and *Echadnophaga gallinacea* 20%.
2-Ring necked *(Phasianus colchicus*) were infested by *Goniodes gigas* 85.8%, *Goniodes colchici* 76.1%, *Cuclotogaster heterographus* 61.9%*, Argas persicus* 57.1%, *Menacanthus stramineus* 42.8%, and *Echadnophaga gallinacea* 19%.
3-Brown-eared pheasant ***(****Crossoptilon mantchuricum*) were infested by *Goniodes colchici* 71.4%, *Menacanthus stramineus* 57.1%, *Cuclotogaster heterographus* 42.2%, *Argas persicus* 42.8%, *Menopon gallinae* 28.5%, and *Echadnophaga gallinacea* 28.5%.

5th infestation:

The six species of pheasants were infested by five ectoparasites species:
1-Nepal Kalij ***(****Lophura leucomelana leucomelana*) were infested by *Menopon gallinae* 86.9%, *Menacanthus stramineus* 73.9%, *Cuclotogaster heterographus* 56.5%, *Argas persicus* 26% and *Echadnophaga gallinacea* 13%.
2-Silver pheasant *(Lophura nycthemera*) were infested by *Goniodes colchici* 77.7%, *Cuclotogaster heterographus* 61.1%, *Goniodes gigas* 50%*, Argas persicus* 33.3%, and *Echadnophaga gallinacea* 16.6%.
3-Black shoulder peafowl *(Pavo cristatus negripennis*) were infested by *Goniodus pavonis* 90.9%, *Goniodes gigas* 72.7%, *Trinoton anserium* 63.6%, *Argas persicus* 54.5%, and *Echadnophaga gallinacea* 27.2%.
4-Blue eared pheasant (*Crossoptilon auritum*) were infested by *Cuclotogaster heterographus* 66.6%, *Menacanthus stramineus* 50%*, Goniodes gigas* 33.3%, *Argas persicus* 33.3%, and *Echadnophaga gallinacea* 16.7%.
5-Edward pheasant ***(****Lophura edwardsi*) were infested by *Goniodes colchici* 77.7%, *Menacanthus stramineus* 55.5%, *Menopon gallinae* 44.4%, *Argas persicus* 33.3%, and *Echadnophaga gallinacea* 11.1%.
6-Elliot's pheasants ***(****Syrmaticus ellioti***)** were infested by *Cuclotogaster heterographus* 71.4%, *Goniodes gigas* 57.1%, *Menopon gallinae* 42.8%, *Argas persicus* 28.5%, and *Echadnophaga gallinacea* 14.2%.

4th infestation:

The five species of pheasants were infested by four ectoparasites species:
1-White crested Kalij *(Lophura leucomelana hamiltoni*) were infested by *Goniodes colchici* 84.2%, *Menacanthus stramineus* 73.6%, *Cuclotogaster heterographus* 57.8%, and *Menopon gallinae* 47.3%.
2-Siamese fireback (*Lopura diardi*) were infested by *Cuclotogaster heterographus* 71.4%, *Menacanthus stramineus* 57.1%, *Goniodes gigas* 42.8%, and *Argas persicus* 28.5%.
3-Lady Amherst's ***(****Chrysolophus amherstiae*) were infested by *Menopon gallinae* 81.2% *Cuclotogaster heterographus* 56.2%, *Menacanthus stramineus* 47.7%**,** and *Argas persicus* 31.2%.

Table 2: Prevalence ectoparasites of pheasants along with body locations

Name of Ectoparasites	Site of Recovery	No. of Ectoparasites	*(%)	Mean intensity±SD
Phthiraptera (Mallophaga) *Cuclotogaster heterographus*	Head, neck, wing feathers	196	78.4	(24.7±13.6)
Menacanthus stramineus	Neck, wing, tail feather	183	73.2	(24.4±13.5)
Menopon gallinae	Head, neck, and body	153	52.8	(16.4±8.6)
Goniodes colchici	Wing, neck, tail feathers	145	58.0	(13.3±6.7)
Goniodes gigas	Body, wing, neck feather	132	52.8	(19.9±10.4)
Goniodus pavonis	Body, the base of feathers	57	22.8	(5.4±2.1)
Trinoton anserium	Head, wing, tail, breast, feather	51	20.4	(6.5±3.4)
Acari (Argasidae) *Argas persicus*	Thigh, underwings, tail, legs, nest	136	54.4	(30.1±15.3)
Siphonaptera *Echadnophaga gallinacea*	Head, face, bird sitting areas	55	22.0	(21.7±9.1)

*Total population of pheasants was 250.

Table 3: Ectoparasites species and their host distribution in different species of pheasants

Name of Pheasants	Gcol	Ches	Gpav	Mstr	Ggig	Tans	Mgal	Aper	Egal	Total No. of Ectoparasite species
Monal	+	+	-	+	-	-	-	-	-	3
T. tragopan	-	+	-	+	-	-	-	-	-	2
White C. kalij	+	+	-	+	-	-	+	-	-	4
Nepal kalij	-	+	-	+	-	-	+	+	+	5
Silver	+	+	-	-	+	-	-	+	+	5
Siamese fireback	-	+	-	+	+	-	-	+	-	4
Cheer	+	+	-	+	-	-	+	+	+	6
Ring necked	+	+	-	+	+	-	-	+	+	6
Golden	-	+	-	+	-	-	+	-	-	3
Lady Amherst's	-	+	-	+	-	-	+	+	-	4
Green peafowl	-	-	+	-	+	+	-	-	-	3
Whitepeafowl	-	-	+	-	+	+	-	-	+	4
Black S. P	-	-	+	-	+	+	-	+	+	5
Browneared	+	+	-	+	-	-	+	+	+	6
Blueeared	-	+	-	+	+	-	-	+	+	5
Edward	+	-	-	+	-	-	+	+	+	5
Elliot's	-	+	-	-	+	-	+	+	+	5
Reeves	-	+	-	+	-	-	+	+	-	4

Ches=*Cuclotogaster heterographus,* Gpav= *Goniodes pavonis,* Mstr= *Menacanthes stramineus,* Gol= *Goniodes colchici,* Ggig= *Goniodes gigas,* Tans= *Trinoton anserium,* Mgal= *Menopon gallinae,* Aref= *Argas persicus,* Egal= *Echadnophaga gallinacea,* White C. kalij= White Crested kalij, T. tragopan= Timnnik tragopan, Black S. P = Black Shoulder Peafowl.

Table 4: Showing dominance (%) of ectoparasitic infestation in different species of pheasants

Name of Pheasants	Ches	Gpav	Gcol	Mstr	Mgal	Tans	Ggig	Aper	Egal
Monal (n=9)	55.5	-	66.6	33.3	-	-	-	-	-
T. tragopan (n=4)	75.0	-	-	50.0	-	-	-	-	-
White C. kalij (n=19)	57.8	-	84.2	73.6	47.3	-	-	-	-
Nepal kalij (n=23)	56.5	-	-	73.9	86.9	-	-	26.0	13.0
Silver (n=18)	61.1	-	77.7	-	-	-	50.0	33.3	16.6
Saimese F. (n=14)	71.4	-	-	57.1	-	-	42.8	28.5	-
Cheer (n=25)	64.0	-	88.0	56.0	76.0	-	-	28.0	20.0
Ring necked (n=21)	61.9	-	76.1	42.8	-	-	85.7	57.1	19.0
Golden (n=20)	60.0	-	-	70.0	80.0	-	-	-	-
Lady Amherst (n=16)	56.2	-	-	47.7	81.2	-	-	31.2	-
Green peafowl (n=12)	-	83.3	-	-	-	58.3	41.6	-	-
White peafowl (n=15)	-	86.6	-	-	-	66.6	53.3	-	20.0
Black S. P. (n=11)	-	90.9	-	-	-	63.6	72.7	54.5	27.2
Brown eard (n=7)	42.5	-	71.4	57.1	28.5	-	-	42.8	28.5
Blue eard (n=6)	66.6	-	-	50.0	-	-	33.3	33.3	16.7
Edward (n=9)	-	-	77.7	55.5	44.4	-	-	33.3	11.1
Elliot's (n=7)	71.4	-	-	-	42.8	-	57.1	28.5	14.2
Reeves (n=14)	50.0	-	-	64.2	78.5	-	-	28.5	-

Ches=*Cuclotogaster heterographus,* Gpav= *Goniodes pavonis,* Mstr= *Menacanthes stramineus,* Gol= *Goniodes colchici,* Ggig= *Goniodes gigas,* Tans= *Trinoton anserium,* Mgal= *Menopon gallinae,* Aref= *Argas persicus,* Egal= *Echadnophaga gallinacea,* White C. kalij= White Crested kalij, T. tragopan= Timnnik tragopan, Black S. P. = Black Shoulder Peafowl

Table 5: Showing prevalence of double, triples and mixed infestation on pheasants

Type of infestation	Parasites	Frequency of occurrence	
		Total	%
Double infestation	Ches+Mstr	03	1.2
Triple infestation	Ches+Gcol+Mstr Ches+Mstr+Mgal Gpav+Tans+Ggig	06 16 10	
		32	12.8
4th infestation	Ches+Gcol+Mstr+Mgal Ches+Mstr+Ggig+Aper Ches+Mstr+Mgal+Aper Gpav+Tans+Ggig+Egal Ches+Mstr+Mgal+Aper	16 10 13 13 11	
		63	25.2
5th infestation	Ches+Mstr+Mgal+Aper+Egal Gcol+Ches+Ggig+Aper+Egal Gpav+Tans+Ggig+Aper+Egal Ggig+Ches+Mstr+Aper+Egal Gcol+Mstr+Mgal+Aper+Egal Mgal+Ches+Ggig+Aper+Egal	20 14 10 04 07 05	
		60	24
6th infestation	Mstr+Ches+Gcol+Mgal+Aper+Egal Ches+Gcol+Mstr+Ggig+Aper+Egal *Gcol*+Ches+Mstr+Mgal+Aper+Egal	22 18 05	
		45	18

Ches=*Cuclotogaster heterographus,* Gpav= *Goniodes pavonis,* Mstr= *Menacanthes stramineus* Gol= *Goniodes colchici,* Ggig= *Goniodes gigas,* Tans= *Trinoton anserium,* Mgal= *Menopon gallinae,* Aref= *Argas persicus,* Egal= *Echadnophaga gallinacean.*

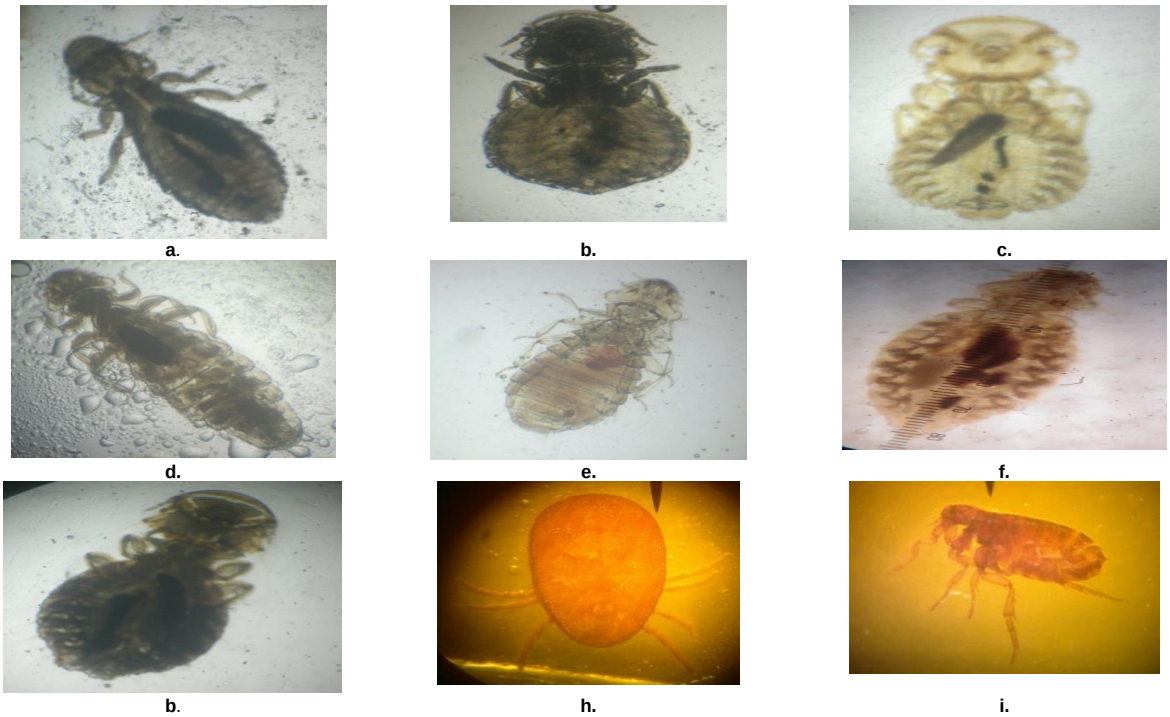

Figure 3: shows a. *Cuclotogaster heterographus* b. *Goniodes gigas* c. *Goniodes colchici* d. *Trinoton anserium* e. *Menacanthus stramineus* f. *Menopon gallinae* g. *Goniodus pavonis* h. *Argas persicus* i. *Echadnophaga gallinacean* ectoparasites were recorded from Pheasants in the Dhodial Pheasantry Mansehra, from October 2017 to March 2018.

Table 6: Month wise number of infested Pheasants and prevalence of ectoparasites found on them (Phasianus spp) in the Dhodial Pheasantry Mansehra, from October 2017 to March 2018 (n=250)

Month	*Cuclotogaster heterographus*	*Menacanthus stramineus*	*Menopon gallinae*	*Goniodes colchci*	*Goniodes gigas*	*Goniodus pavonis*	*Trinoton anserium*	*Argas persicus*	*Echadnophaga gallinacea*
	No. of birds infested (%)	No. of birds infested (%)	No. of birds infested (%)	No. of birds infested (%)	No. of birds infested (%)	No. of birds infested (%)	No. of birds infested (%)	No. of birds infested (%)	No. of birds infested (%)
0ct n=44	21 (47.1)	16 (36.3)	18 (40.9)	13 (29.5)	-	-	-	19 (43.1)	-
Nov n=38	28 (73.6)	22 (57.8)	23 (60.5)	18 (47.3)	17 (44.7)	12 (31.5)	8 (21.0)	11 (28.9)	5 (13.1)
Dec n=42	25 (59.5)	27 (64.2)	19 (45.2)	21 (50)	24 (57.1)	10 (23.8)	11 (26.1)	7 (16.6)	14 (33.3)
Jan n=46	20 (43.4)	17 (36.9)	16 (34.7)	15 (32.6)	8 (17.3)	6 (13.0)	5 (10.8)	4 (8.6)	7 (16.6)
Feb n=44	17 (38.6)	15 (34.0)	12 (27.2)	11 (25)	6 (13.6)	5 (11.3)	-	9 (20.4)	-
Mar n=36	11 (30.5)	12 (33.3)	9 (25)	8 (22.2)	5 (13.8)	-	-	10 (27.7)	-
Total n=250	122 (48.8)	109 (43.6)	97 (38.8)	86 (34.4)	60 (24)	33 (13.2)	24 (9.6)	60 (24)	26 (10.4)

Oct- October, Nov-November, Dec-December, Jan-January, Feb-February, Mar-March, n-Number, %-Prevalence

Table 7: Comparative prevalence between Dust-ruffling method and Visual examination method of ectoparasites quantification from live pheasants

Name of Ectoparasites	Visual examination Method		Dust-ruffling method		Total (%)
	No. infested Pheasants	Prevalence (%)	No. infested Pheasants	Prevalence (%)	
Lice	63	25.2	140	56.0	203 (81.2)
Ticks	23	9.2	37	14.8	60 (24.0)
Flea	8	3.2	18	7.2	26 (10.4)

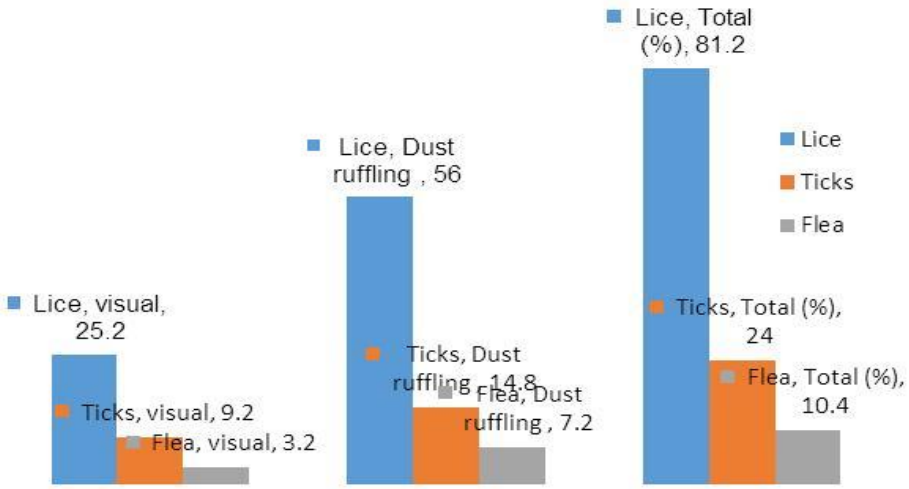

Figure 4: Showing comparative prevalence of Dust-ruffling and Visual examination method of ectoparasites.

4- Reeves' pheasants *(Syrmaticus reevesi*) were infested by Menopon gallinae 78.5%, Menacanthus stramineus 64.2%, Cuclotogaster heterographus 50% and Argas persicus 28.5%.

5-White peafowl *(Pavo cristatus albino*) were infested by *Goniodus pavonis* 86.6%, *Trinoton anserium* 66.6%, *Goniodes gigas* 53.3%, and *Echadnophaga gallinacea* 20%.

Triple infestation:

The three species of pheasants were infested by three ectoparasites species:

1-Himalayan Monal (*Lophophorus impejanus*) are infested by *Goniodes colchici* 66.6%, *Cuclotogaster heterographus* 55.5%, and *Menacanthus stramineus* 33.3%.

2-Golden pheasant *(Chrysolophus pictus*) were infested by *Menopon gallinae* 80%**,** *Menacanthus stramineus* 70% and *Cuclotogaster heterographus* 60%.

3-Green peafowl (*Pavo muticus*) were infested by *Trinoton anserium* 58.3%, *Goniodus pavonis* 83.3%, and *Goniodes gigas* 41.6%.

Double infestation:

One of the pheasant species were infested by two ectoparasites species:

Temmink tragopan *(Tragopan temminiki*) infested by *Cuclotogaster heterographus* 75% and *Menacanthus stramineus* 50% (Table 3, 4 and 5).

Monthly wise infestation change

The ectoparasites of pheasants were collected from, October 2017 to March 2018 with the highest prevalence recorded in December and November respectively. The overall prevalence of *Cuclotogaster heterographus* was 48.8%, with highest prevalence in November about 73.6% and lowest prevalence was recorded in March about 30.5%, *Menacanthus stramineus* 43.6%, with highest prevalence in December about 64.2% and lowest prevalence was recorded in March about 33.3%, *Menopon gallinae* 38.8%, with highest prevalence in November about 60.5% and lowest prevalence was recorded in March about 25%, *Goniodes colchici* 34.4%, with highest prevalence in December about 50% and lowest prevalence was recorded in March about 22.2%, *Goniodes gigas* was 24%, with highest prevalence in December about 57.1% and lowest prevalence was recorded in March about 13.8%, *Goniodus pavonis* 13.2%, with highest prevalence in December about 23.8% and lowest prevalence was recorded in February about 11.3%, *Trinoton anserium* was 9.6%, with highest prevalence in December about 26.1% and Lowest prevalence was recorded in January about 10.8%, *Argas persicus* 24%, with highest prevalence in October about 43.1% and lowest prevalence was recorded in January about 8.6% and *Echadnophaga gallinacea* 10.4%, with highest prevalence in December about 33.3% and lowest prevalence was recorded in November about 13.1%. The *Cuclotogaster heterographus, Menacanthus*

stramineus, Menopon gallinae, Goniodes colchici, and *Argas persicus* were the most prevalent ectoparasites found throughout the study periods while the least prevalence of ectoparasites (*Goniodes gigas, Goniodus pavonis, Trinoton anserium* and *Echadnophaga gallinacea*) were observed (Table 6).

Prevalence of Dust-ruffling and Visual examination method

Dust-ruffling method (Lice 56, ticks 14.8% and flea 7.2%) have significantly high infestation prevalence was observed as compared to visual examination method (lice 25.2%, ticks 9.2% and flea 3.2%) of ectoparasites quantification from the live bird (Table 7).

DISCUSSION

In the present study, a total of 250 pheasants belonging to 18 species of various age groups and sexes were randomly captured and examined for the prevalence of ectoparasites. Out of the 250 pheasants, 203 were found to be infested with ectoparasites. The overall prevalence of ectoparasites on pheasants (81.2%) is more or less similar to the previous studies of Mushi *et al*. (2000) 73.8%, Adang et al. (2008) 30% and Pertryszak et al. (2000) 72.0% on domestic pigeons, Gedion, (1991) 100% and Hagos, (2000) 93.7% on local chicken, Saxena et al. (2004) 60.9% on domestic hens, Sychra, (2005) 61% on chukar (*Alectoris chukar*), Shanta et al. (2006) 86.67% on poultry, Adang et al. (2008) 23% on laughing dove (*Streptopelia senegalensis*), Belihu et al. (2009) 91.5% on backyard local chickens, Khattak et al. (2012) 80% prevalence of ectoparasites on wild and domesticated *Francolinus pondicerianus* and *Francolinus francolinus*.

The ectoparasites recorded during the current study include: *Cuclotogaster heterographus* 78.4%, *Menacanthus stramineus* 73.2%, *Menopon gallinae* 61.2%, *Goniodes colchici* 58%, *Goniodes gigas* 52.8%, *Goniodus pavonis* 22.8%, *Trinoton anserium* 20.4%, *Argas persicus* 54.4% and *Echadnophaga gallinacea* 22%. The present study is supported by Shanta et al. (2006) who recovered a significantly higher prevalence of *Menacanthus stramineus* (74%), while *Menopon gallinae* (63%), *Lipeurus caponis* (48%), *Cuclotogaster heterographus* (25%), *Goniodes gigas* (18%), and *Goniocotes gallinae* (14%) one species of fly, *Simulium sp.* (3.7%) and two species of mites *Dermanyssus gallinae* (57%) and *Knemidocoptes mutans,* (43%) from backyard poultry. Our result is also in agreement with Khattak et al. (2012) who reported sixteen species of ectoparasites from *Francolinus francolinus* and *Francolinus pondicerianus*. The *Francolinus pondicerianus* were infested by *Menopan gallinae* 63.3%, *Menacanthes stramineus* 39.3, *Coculogaster hetrographus* 45%, and from Black partridges chewing lice *Gonides gigas* 54.2%, *Menopan gallinae* 57.1%, *Menacanthes stramineus* 60%, *Coculogaster hetrographus* 42.8% and *argas persicus* 54.5% are recovered, Showing similarity with our present result.

Additionally, the male was infested 83.2% and female 79.2% similarly reported by Okursoy and Yilmaz, (2002) from chickens male 80.6% and female 59.4% similarly Belihu *et al.* (2009) on local chicken found significantly higher infestation in male (94.3%) while in female (88.7%) and Adang et al. (2008) found laughing dove males 23.8% as compared to female 21.9%.

In the current study pheasants with higher prevalence 25.2% of 4th infestation (four parasite species) with 24%, 5th infestation (five parasite species), 18% 6th infestation (six parasitic species) 12.8% triple infestation (three parasites species) and 1.2% lowest double infestation (two parasite species). Also the difference between the prevalence of double and mixed infestation was calculated which were found to be statistically significant ($p < 0.05$). This is supported by Kennedy (1975) reported that single, double and mixed infestation determines a kind of competition among the ectoparasites for common resources. Our result also supported by the study of Adang *et al*. (2008) recorded different prevalence rate from laughing dove, higher single infestations (15.4%), double infestation (7.1%) and triple infestation (0.52%) and also find the difference of prevalence between single and mixed which were not significant ($p > 0.05$). Contrasting from our result in which the single infestation was not recovered, while the other was found higher. The difference of infestation in our result was also found to be significant.

CONCLUSION

The study concludes that all the 18 species of pheasants are infested by about total of nine ectoparasite species, which were identified in the current study from Dhodial pheasantry. These are *Cuclotogaster heterographus, Goniodus pavonis, Menacanthus stramineus Goniodes dissimilis, Goniodes gigas, Trinoton anserium, Menopon gallinae, Argas persicus* and *Echadnophaga gallinacean.* These parasites weaken these birds

and adversely affect their health, such as lowering feeding rate, reproduction, and egg-laying. More field studies are needed to better understand the correlations between ectoparasites and various diseases associated with them in partridge populations. Also, more strict sanitary controls are necessary for rearing facilities to avoid the release of undesirable pathogens through ectoparasites. Close monitoring of partridge populations, through periodical surveys and analyses of dead-found partridges, is necessary to maintain healthy populations.

CONFLICT OF INTEREST

The authors declared that the present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

NK designed and performed the experiments, ZU, SM, NA, and RAK wrote the manuscript. MSK helped NK during the conduction of the research. SM and MSK supervised the student during the entire study period. MFK and NA, helped during manuscript writing and initial review. SK, R, NA, MA, SY, S and MS were responsible for grammatical and other technical mistakes during the review process. All authors read and approved the final version.

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