

Morphology and Prevalence of Some Helminth Parasites in *Gallus domesticus* from Gurez Valley of Jammu and Kashmir, India

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Abstract

The present study was aimed to study the distribution, diversity, and prevalence of helminth parasites in domestic fowl from this valley of Gurez. A total of 137 domestic fowl were examined for helminth parasites from May 2013 to April 2015. A high rate of helminth infection (40.14%) was observed. One cestode *Raillitina tetragona* and two nematodes, *Ascaridia galli* and *Heterakis gallinarum* were encountered during the present study. The collected parasites were identified according to the keys and description given by Soulsby (1982) and Yamaguti (1958). High prevalence of infection was observed during summer (41.86%) followed by autumn (34.21%), spring (33.33%) and winter (30.76%). Males (36.96%) were more infected than females (34.37%). The young ones were more infected than adults. Thus, seasonal dynamics and sex of the hosts significantly influenced the prevalence of GIH infection in domestic fowl. Nematodes were more prevalent than cestodes.

Keywords: Gurez; *Gallus domesticus*; *Raillitina tetragona*; *Ascaridia galli*; *Heterakis gallinarum*; Prevalence

Introduction

Gurez is a valley located in the high Himalayas on banks of river Kishenganga, about 86 km from District Bandipora and 123 km of Srinagar in northern Jammu and Kashmir, India. In northeast of Srinagar, the main valley of Gurez extends between (34° 30' to 34°41' N latitudes) and (74°37' to E 74°46'E longitudes) at an average altitude of about 2370 m.a.s.l (about 8,000 feet). It is surrounded on its north by Ladakh, by Bandipora on the south, by Ganderbal on its southeast and on the west by Kupwara with its peripheries touching Line of Control (LoC) that divides the states of India and Pakistan. The valley is nestled among high towering peaks and lofty and glaciated snowcapped mountains which are not just an unvarying landmass but show great differences in elevation aspect, rock type, ruggedness and glacial work which coalesce to make contrasting land surfaces. One has to cross the coldest and dangerous peak Razdan (Razdan pass) located above 4000 m.a.s.l. to reach the valley. The pass not only connects the region with the rest of Kashmir but also divides the two on geographical, socio-cultural and linguistic lines. The valley is drained by mighty Kishenganga (Neelam) River between Kaobal Gali in east and Kanzalwan in west while other aquamarine and crystal streams also run through it.

Birds are important for their commercial, recreational, ethical, spiritual values and form a rich protein source for humans. There is a rich diversity of birds in this area. Among birds, Poultry is of great importance in rural production system in this area. Chicken was the only poultry bird being reared for meat and egg production. Unlike rest of Bandipora district, which has a good population of duck and geese, no non-chicken poultry species was reported from the area. The average number of chicken per household varied from 5-10. During summer months, hens laid as many as 20 eggs/month whereas no egg production was reported during winter months; which may be attributed to the short day length coupled with very little scavenging feed resources. The domestic fowl and eggs provide an important source of protein for human consumption. The increased mortality and decreased productivity in chickens is mainly due to mismanagement, lack of nutritional feeding, diseases and predation.

Among the problems facing extensive types of production of chickens in Gurez are parasitic diseases. There are numerous species of helminthes that cause significant damage to the organs in which they live. Cestodes are more commonly found in warm weather

when intermediate hosts are abundant. Helminthiasis was considered to be important problems in chickens [1,2]. Helminth parasites were incriminated as major causes of unsoundness and lowering performance of poultry in Egypt [3]. Avian helminthiasis constitutes one of the most common endoparasitism causing serious troubles in chicken production. Chicken cestodiasis not only cause loss of body weight of the raised chickens but also may cause several problems in affected flocks such as enteritis, loss of blood, loss of production, nervous manifestations and death [4]. The prevalence and intensity of helminth infections in birds may be influenced by several factors as distribution of intermediate hosts such as beetles, ants, crustaceans, houseflies *etc.* and their infection rate and the number of infective parasite eggs or larvae. The free ranging management system and climatic conditions, such as temperature and humidity alter the population dynamics of parasites resulting in dramatic change in prevalence and intensity of helminth infections.

Materials and Methods

During the present study from May 2013 to April 2015, the domestic fowl were purchased from the local people at different study sites. The hosts were then taken alive to the temporary laboratory maintained at Dawar - the capital of Gurez or were brought alive to Department of Zoology, University of Kashmir for parasitic examination. For the collection of endoparasites the body of the hosts was dissected open midventrally and different organs including alimentary canal were removed and kept in separate desired size petridishes where these organs were teased and cut open to search for parasites if any. Therefore, the gastrointestinal tract was subjected to routine examination to collect the gastrointestinal parasites, according to the procedure as described by Fowler [5]. Cestodes were collected by the help of dropper and preserved in 10% formalin or cornoy's fluid for

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the identification. Morphology of cestodes was studied by preparing permanent slide according to the methods as described by Cable [6]. After washing, nematodes were collected by the help of curved needle and kept in glycerin alcohol. Nematodes were best killed in steaming hot 70% alcohol, and stored in the same solution. Later, a few drops of glycerin were added. Thorough morphological study of nematodes was performed by the preparation of sub-permanent slide by adding one drop of lactophenol. The other steps in this were fixation, staining, dehydration, de-alcoholisation and clearing, mounting and labeling. Parasites were identified according to the keys and description given by Soulsby [7] and Yamaguti [8]. On comparing the recovered parasites were identified as *Raillietina tetragona*, *Ascaridia galli* and *Heterakis gallinarum*.

Light microscopy was conducted under Olympus Research microscope with lens combination of 7X, 10X, and 15X eye pieces and 4X, 10X, 20X, 40X and 100X objectives. The drawings for identification purposes were made to scale with the help of prism type camera-Lucida. The Photographs were taken with the help of Sony Digital SLR Camera Model Number (DSLR – A200). Photomicrography was conducted with DP – 12 Digital Camera attached to Olympus Research Microscope in the department of Zoology.

The prevalence of Helminthiasis was recorded as per formulae described as

$$\text{Prevalence} = \frac{\text{No. of individual having a disease at a particular point in time}}{\text{No. of individual in the population at risk at that point in time}} \times 100$$

Definitions

The ecological terms used in this study are

$$\text{Prevalence} = \frac{\text{Total number of hosts infected}}{\text{Total number of hosts examined}} \times 100$$

$$\text{Mean Intensity} = \frac{\text{Total number of Parasites}}{\text{Total number of hosts infection}}$$

$$\text{Relative Density or Abundance} = \frac{\text{Total number of Parasites}}{\text{Total number of hosts examined}}$$

The above nomenclature is followed by that given by Morgolis et al. [9]

Data analysis

The most common measurements of parasite population levels in hosts are prevalence, mean intensity and mean abundance [10]. Prevalence refers to the percentages of organisms infected by a particular species of parasite. Mean intensity is the number of parasites of a given species per infected host. Mean abundance refers to the number of parasites of a given species per host examined, infected and uninfected. The nomenclature used to define ecological parameters is in consistency with that of Margolis et al. [9].

Results

As mentioned above three different helminth parasites belonging to two classes; cestoda and nematode were observed during the present study. The description of these recovered parasites is as follows:

Cestoda

Raillietina tetragona

Generic diagnosis: Numerous proglottids. Rostellum with hammer shaped hooks, suckers armed with minute deciduous or persistent hooks. Testes numerous. Cirrus pouch small. Genital pores unilateral or bilateral. Ovary bilobed. Vitelline gland compact. Egg capsule with one to several eggs. Parasites of birds and mammals.

Species diagnosis: Rostellar hooks in circular row. Genital pores unilateral and the egg capsules with several onchospheres. Testes numerous; ovary median.

Description: *Raillietina tetragona* found in small intestines of domestic fowls and in case of heavy infection its location to large intestine also. Its size varies from 6-17 cm. The scolex is smaller that measures 0.17 mm in width. The rosetellum is armed with one or two rows of hooks and suckers, which are oval and armed. Eggs are found in egg capsule, each containing one or more eggs (Figures 1 and 2).

Remarks: While comparing the present form under study with the different species described under the sub genus *Raillietina* Stiles and it closely relates to *Raillietina (R.) tetragona* reported from various avian hosts such as *Gallus gallus domesticus*, *Meleagris gallopavo*, *Lagopus lagopus*, *L. mutus*, *Pavo cristatus*, *P. muticus* etc. The present form shows its resemblance to *Raillietina (R.) tetragona* Molin in number and size of rostellar hooks, numbers of testes, position of genital pore, etc., (Table 1) besides some minor variations which are of intra specific nature and have no such taxonomic significance. Thus the present form is assigned to species *Raillietina (R.) tetragona* and forms the first record of its nature from the Gurez valley.

Nematoda

Ascaridia galli [11]

Generic diagnosis: Mouth with three well-developed lips, one dorsal and two sub-ventral, long oesophagus, club shaped without posterior bulb. Lateral alae often present.

Male: Caudal alae poorly developed or absent. Spicules almost equal in size. Caudal papillae relatively large. Gubernaculum absent.

Female: Valva near middle of the body. Uterine branches divergent, oviparous, eggs thick shelled. Adults as intestinal parasites of birds (Table 2).

Species diagnosis: First pair of ventral caudal papillae anterior to

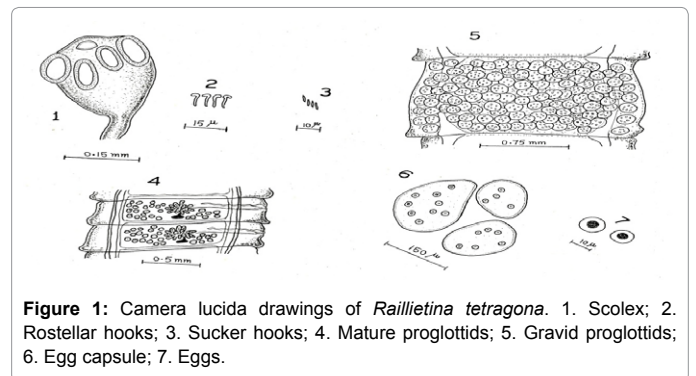


Figure 1: Camera lucida drawings of *Raillietina tetragona*. 1. Scolex; 2. Rostellar hooks; 3. Sucker hooks; 4. Mature proglottids; 5. Gravid proglottids; 6. Egg capsule; 7. Eggs.

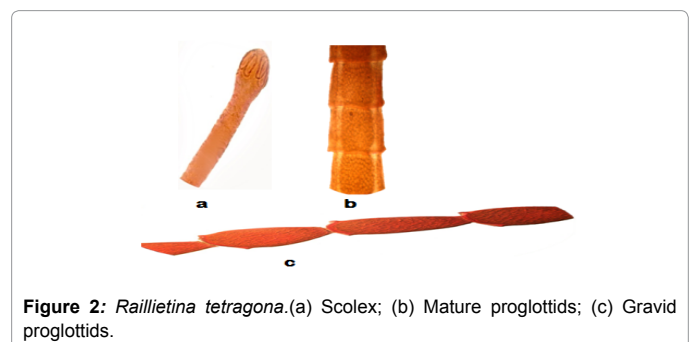


Figure 2: *Raillietina tetragona*. (a) Scolex; (b) Mature proglottids; (c) Gravid proglottids.

Particulars	Tanveer (1989)	Aziz (1992)	Present study
Strobila size	-----	155-240 x 2.85-3.0	122-220 x 2.70-2.95
Scolex	0.234-0.242 x 0.266-0.284	0.125-0.168 x 0.16-0.21	0.145-0.170 x 0.16-0.17
Rostellum	-----	0.33-.36 x 0.24-0.26	-----
Rostellar hooks:			
Number	94-110	90-110	90-100
Size	5-6	4-7	4-6
No. of testes	30-36	26-38	24-32
Egg capsule number	-----	70-130	-----
Host	Fowl	Fowl	Fowl

Table 1: Comparative characteristics (measurements in mm) of *Raillietina tetragona*.

Particulars	Kates and Colglazier (1970)	Tanveer (1989)	Aziz Mir (1992)	Ramadan and Znada (1992)	Ayesha (2007)	Present Study
Body length	60-65 (M); 80-100 (F)	10-12 (M); 15-17 (F)	45.3-68.4 (M); 80-109 (F)	42-76 (M); 72-108 (F)	22-38 (M); 270 -75.3 (F)	45-80 (M); 60-90 (F)
Max. Width	-----	0.4-0.7 (M); 0.7-0.9 (F)	0.79-1.18 (M); 1.38-1.50 (F)	0.56-0.91 (M); 0.90-1.80 (F)	0.41-1.03 (M); 0.6-0.89 (F)	0.60-1.07 (M); 1.25-1.45 (F)
Esophagus length	-----	1.5-2.4	3.89-4.34 (F)	2.48-5.32 (M); 2.88-4.24 (F)	1.77-3.25 (M); 2.49-3.0 (F)	3.40-4.2 (M);
Esophagus width	-----	-----	0.45-0.55 (F)	0.28-0.59 (M); 0.38-0.49 (F)	0.31-0.41 (M); 0.31-0.41 (F)	0.30-0.42 (M); 0.35-0.44 (F)
Tail length	-----	0.32-0.53 (M); 1.5 (F)	0.68-0.86 (M); 1.35-1.4 (F)	0.57-0.78 (M)	0.51-0.60 (M); 0.91-1.05 (F)	0.6-0.7 (M); 0.82-1.00 (F)
Spicule length	1.5-2.4	1-2.7 and above	2.20-2.52	-----	2.88, 2.02, 1.94, 2.13 (M); 2.88, 2.02, 1.94, 2.13 (F)	2.3-2.55
Egg size	-----	0.04-0.08	0.056-0.076 x 0.044-0.052	-----	0.06 x 0.04	0.55-0.65 x 0.04-0.47

Table 2: Comparative characteristics (measurements in mm) of *Ascaridia galli*.

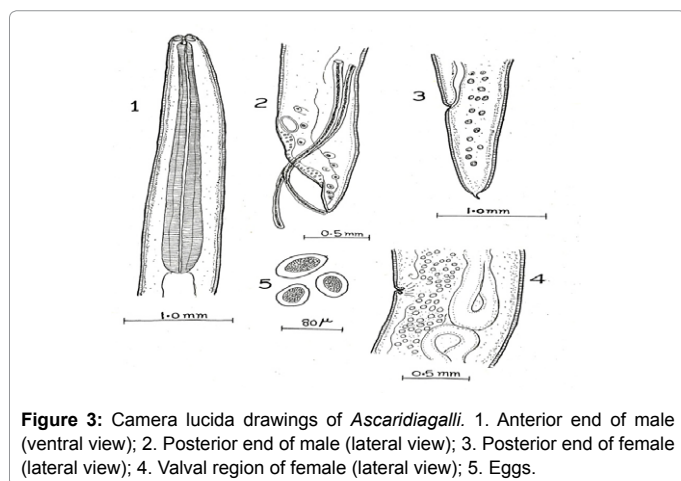


Figure 3: Camera lucida drawings of *Ascaridiagalli*. 1. Anterior end of male (ventral view); 2. Posterior end of male (lateral view); 3. Posterior end of female (lateral view); 4. Valval region of female (lateral view); 5. Eggs.

precloacal sucker; fourth pair of ventral papillae widely separated just posterior to second pair of lateral papillae. Spicules about equal; average length 1.9 mm, with marked membranous structure over about the distal half; distal ends typically blunt with slight indentation, 24-28 μ wide.

Description: The parasites are elongated, rounded, semitransparent, and creamy white. Mouth is surrounded by three lips. Esophagus has no posterior bulb. It occurs in small intestines of domestic fowl (Figures 3 and 4).

Remarks: The various characteristics of the present form under study like oesophagus, genital suckers, body size, length of tail, length of spicules, egg size etc, are in agreement with that of *Ascaridia galli* Schrank [11] Freeborn [12]. Hence the present form is assigned to *Ascaridia galli* Schrank [11] Freeborn [12]. This also makes the first record from the study area (Gurez).

Heterakis gallinarum [11,13]

Generic diagnosis: Lips without cordons, body usually with

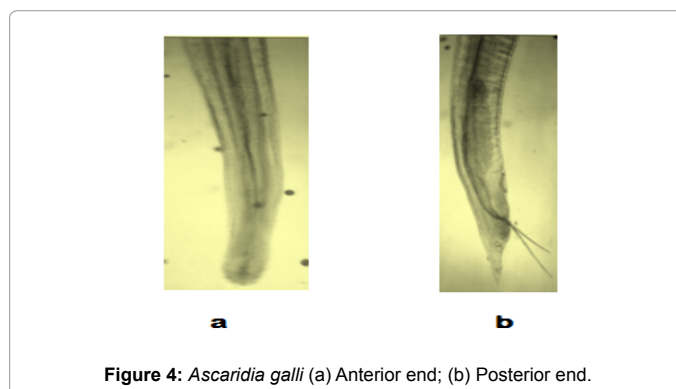


Figure 4: *Ascaridia galli* (a) Anterior end; (b) Posterior end.

well developed lateral alae. Anterior end usually curved dorsally, oesophagus with a short pharynx and a posterior bulb containing a vulvular apparatus. Male caudal end with a round preanal sucker. Spicules two equal, sub equal or markedly unequal in length. Vulva near middle of the body or anterior to it. Branches of uterus opposite. Eggs with thick shells. Adult worms parasitic in the intestine of birds and mammals.

Description: These parasites are commonly called as ceecal worms. They are small, round and white. The anterior extremity is slightly bent (Table 3). The esophagus is provided with posterior bulb. The body length of male ranges from 5-7 mm. The length of esophagus ranges from 0.90-1.05 mm. The spicule length ranges from 1.25-2.05 mm. The tail measures 0.33-0.50 mm. Females are larger than male worms. Their body length measures from 7-10 mm and their maximum width is 0.36 mm. The tail is straight, long; narrow and pointed (Figures 5 and 6).

Remarks: *Heterakis gallinarum* has been recorded from a variety of gallinaceous birds from Jammu and Kashmir. The present observations are in conformity with those of Tanveer [14], Aziz Mir [15] except for minor deviations with regard to the length of the body and tail. Hence assigned to the species *Heterakis gallinarum*. Moreover the same makes it as the first record of its nature from Gurez valley.

Particulars	Gram (1921)	Qadri (1982)	Tanveer (1989)	Aziz Mir (1992)	Ayesha (2007)	Present Study
Body length	8.3-10.9	5.25-10.91	5-7 (M); 6-8 (F)	7.65-8.4 (M); 8.6-12.5 (F)	5.85-8.6 (M); 8.21-10.00 (F)	5-7 (M); 7-10 (F)
Width	0.32-0.39	0.216-0.407	0.21-0.32	0.26-0.32 (M); 0.32-0.38 (F)	0.24-0.33 (M); 0.16-0.25 (F)	0.20-0.36
Oesophagus	1.06-1.12	0.742-1.072	0.90-1.10	0.89-0.97 x 0.16-0.23 (M); 0.97-1.02 x 0.18-0.23 (F)	0.94-1.05 x 0.31-0.52 (M)	0.90-1.05
Spicule length	2-2.17; 0.7-1.1	1.206-20.412-0.566.296;	1.0-1.3	1.75-2.64 (M)	1.37-1.99	1.25-2.05
Tail length	0.45, 1-1.14	0.309-0.481;0.711-0.1.01	0.30-0.40 (M); 0.4 (F)	0.41-0.65 (M); 0.52-0.68 (F)	0.30-0.33	0.33-0.50
Egg size	-----	-----	-----	0.069-0.076 x 0.038-0.046	0.05-0.06 x 0.03-0.04	-----

Table 3: Comparative characteristics (measurements in mm) of *Heterakis gallinarum*.

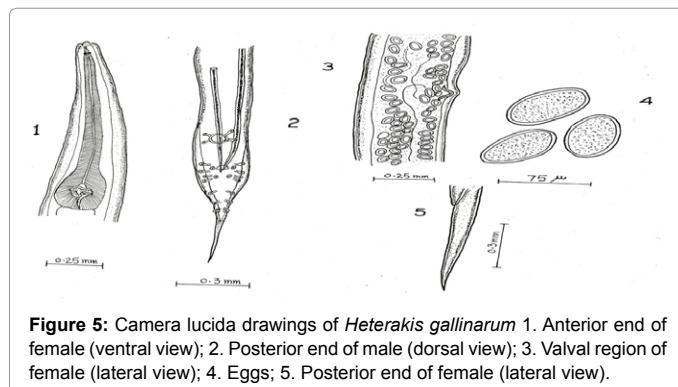


Figure 5: Camera lucida drawings of *Heterakis gallinarum* 1. Anterior end of female (ventral view); 2. Posterior end of male (dorsal view); 3. Valval region of female (lateral view); 4. Eggs; 5. Posterior end of female (lateral view).

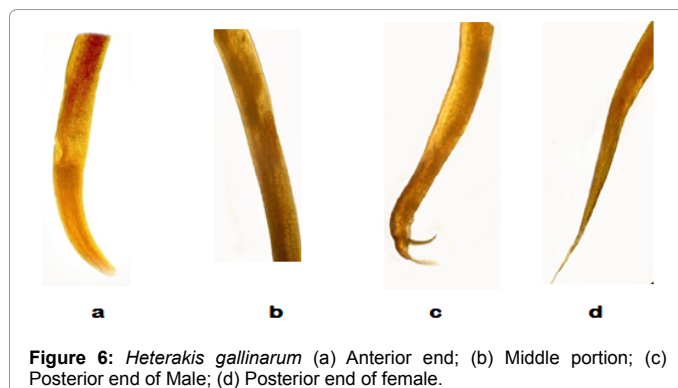


Figure 6: *Heterakis gallinarum* (a) Anterior end; (b) Middle portion; (c) Posterior end of Male; (d) Posterior end of female.

Helminth parasite dynamism in avian host (Fowl)

Prevalence: A total of 137 specimens of fowl were examined during the present study which revealed 40.14% (55/137) of infection by helminthes in this beautiful valley. Three different types of helminth parasites recovered during the study include two nematodes (*Heterakis gallinarum* and *Ascaridia galli*) and one cestode i.e., *Raillietina tetragona*. *Heterakis gallinarum* showed a highest prevalence of 35.76% followed by *Ascaridia galli* (32.11%) and *Raillietina tetragona* (27.00%) (Tables 4 and 5).

Seasonal prevalence: The study showed that the prevalence of parasites in fowl was throughout the year but the prevalence varied from season to season. The highest prevalence was observed during summer followed by autumn and least in winter. During summer 43 fowl were examined, out of which 15 (34.88%), 17 (39.53%) and 18 (41.86%) were found infected with *Raillietina tetragona*, *Ascaridia galli* and *Heterakis gallinarum* respectively. Similarly during autumn out of 38 specimens examined, 9 (23.68%), 12 (31.57%) and 13 (34.21%) were infected with *Raillietina tetragona*, *Ascaridia galli* and *Heterakis gallinarum* respectively. However a lowest prevalence of these helminth parasites was observed during winter. Out of 26 specimens examined

5 (19.23%); 6 (23.07%) and 8 (30.76%) were infected with *Raillietina tetragona*, *Ascaridia galli* and *Heterakis gallinarum* respectively (Table 6). Thus a decreasing order of prevalence was summer > autumn > spring > winter.

Age-wise prevalence: Fowl specimens of different age groups were examined. Out of 49 examined fowl specimens of 0-6 months age, 14 (28.57%), 17 (34.69%) and 18 (36.73%) were infected with *Raillietina tetragona*, *Ascaridia galli* and *Heterakis gallinarum* respectively. Similarly out of 54 fowl specimens of 6 months - 2 years age group, 15 (27.77%), 18 (33.33%) and 19 (35.18%) were infected with *Raillietina tetragona*, *Ascaridia galli* and *Heterakis gallinarum* respectively. However out of 34 hosts from 2 years and above age group only 8 (23.52%), 9 (26.47%) and 12 (35.29%) were infected with *Raillietina tetragona*, *Ascaridia galli* and *Heterakis gallinarum* respectively. The results indicate that the hosts have maintained a moderate resistance against cestodes with advancement of age. However there is no significant age resistance shown by the hosts against nematode infection. Thus the hosts of any age group may be exposed to helminth infections with a slight resistance developing during the advancement of age (Table 7).

Sex-wise prevalence: Out of 137 specimens of *Gallus domesticus* examined during the present study, 73 were males and 64 were females. A prevalence of 28.76% (21/73), 32.87% (24/73) and 36.96% (27/73) in males, and 25% (16/64), 31.25% (20/64) and 34.37% (22/64) in females of *Raillietina tetragona*, *Ascaridia galli* and *Heterakis gallinarum* respectively was observed during the present study. The results show that there is no marked but a slight resistance shown by females as compared to males (Tables 8 and 9).

Discussion

After extensive study of the bird host, *Gallus domesticus* for helminth parasitism in Gurez valley during the present study, different species of helminth parasites were recovered with a moderately high prevalence (40.14%). These results when compared with those of other researchers around the globe indicate that this small, however isolated, valley does not figure out of the helminth infestation; but is an endemic area for helminth parasites in fowl. Permin and Nansen [16] after studying Danish organic poultry farming reported increased infestation of internal parasites including *Heterakis gallinarum*. The author further stated that species of nematodes like *Heterakis* and *Ascaridia* are widely distributed, causing non-specific clinical signs of infection, such as loss of appetite and growth, a general in condition and on occasions death. Permin et al. [17] in their survey in Denmark concluded that there was a high risk of helminth infection in free range/ organic poultry systems and that prevalence may also be high in deep litter systems. Permin et al. [18] reported that prevalence of GIH are high whether in tropical or temperate climate. Oyeka [19] found 54.5% of chickens to be infected with helminth parasites in Anambra state in Nigeria. Yadav

Host	NE	Un-infected	Infected	Percentage	Trematode	Cestode	Nematode
Fowl	137	82	55	40.14%	-----	37 (27.00%)	49 (35.76%)

Table 4: Overall prevalence of helminthes collected from fowl.

Host infected with	No. examined	No. infected	Percentage
<i>Raillietina tetragona</i>	137	37	27.00%
<i>Ascaridia galli</i>		44	32.11%
<i>Heterakis gallinarum</i>		49	35.76%
T-Value = 26.91 P-Value = 0.001			

Table 5: Prevalence of helminthes.

Host	Season	NE	Infected		
			<i>Raillietina tetragona</i>	<i>Ascaridia galli</i>	<i>Heterakis gallinarum</i>
Fowl	Spring	30	8 (26.66%)	9 (30.00%)	10 (33.33%)
	Summer	43	15 (34.88%)	17 (39.53%)	18 (41.86%)
	Autumn	38	9 (23.68%)	12 (31.57%)	13 (34.21%)
	Winter	26	5 (19.23%)	6 (23.07%)	8 (30.76%)
Total	-----	137	37 (26.11%)	44 (31.08%)	49 (35.04%)
			T-Value = 12.25 P-Value = 0.001	T-Value = 14.52 P-Value = 0.001	T-Value = 12.36 P-Value = 0.001

Table 6: Seasonal prevalence of helminthes.

Host	Age group	NE	Trematode	Cestode			Nematode		
				<i>Raillietina tetragona</i>	<i>Ascaridia galli</i>	<i>Heterakis gallinarum</i>	<i>A. galli</i>	<i>H. gallinarum</i>	
Fowl	<6 month	49	-----	14 (28.57%)	17 (34.69%)	18 (36.73%)			
	6 months-2 years	54	-----	15 (27.77%)	18 (33.33%)	19 (35.18%)			
	>2 years	34	-----	8 (23.52%)	9 (26.47%)	12 (35.29%)			
Total		137	-----	37 (26.62%)	44 (31.49%)	49 (35.73%)			
				T-Value = 8.67 P-Value = 0.013	T-Value = 9.64 P-Value = 0.011	T-Value = 7.63 P-Value = 0.017			

Table 7: Age-wise prevalence of helminthes.

Host	Sex	NE	Trematode	Cestode <i>Raillietina tetragona</i>			Nematode		
				<i>A. galli</i>	<i>H. gallinarum</i>	<i>A. galli</i>	<i>H. gallinarum</i>		
Fowl	Male	73	-----	21 (28.76%)	24 (32.87%)	27 (36.96%)			
	Female	64	-----	16 (25.00%)	20 (31.25%)	22 (34.37%)			
Total	-----	137	-----	37 (27.16%)	44 (32.25%)	49 (35.76%)			
				T-Value = 47.40 P-Value = 0.013	T-Value = 57.50 P-Value = 0.011	T-Value = 45.00 P-Value = 0.014			

Table 8: Sex-wise prevalence of helminthes.

	NE	Parasite		NI	Percentage
		Single	Multiple		
Multiple type	137	<i>Raillietina tetragona</i>		21	15.32
		<i>Ascaridia galli</i>		19	13.86
		<i>Heterakis gallinarum</i>		26	18.97
		<i>Raillitina + Heterakis</i>		5	3.64
		<i>Raillitina + Ascaridia</i>		7	5.10
		<i>Ascaridia + Heterakis</i>		14	10.21
		<i>Raillitina+Heterakis+Ascaridia</i>		4	2.91

Table 9: Single and multiple species infection in domestic fowl.

and Tandon [20] revealed 90.9% of helminth infections in subtropical high rainfall area of India. Mpoame and Agbede [21] found 93.55% of domestic fowl infected with gastrointestinal helminthes. Eshetu et al. [22] found 91.01% chickens infected with gastrointestinal helminthes from Amhara region Ethiopia. Nokana et al. [23] during their survey of helminth parasites in backyard flocks in Michigan by litter examination also showed relatively high contamination rates. Edger [24] reported the presence of a wide range of helminthes in chickens including *A. galli*. Wilson et al. [25] revealed the prevalence of *A. galli* was in the range of 40% on commercial farms in the state of Arkansas. Long [26] reported that majority of broiler chickens were infected with *A. galli* at the age of 23-29 days. Konanenko and Khaizade [27] while working on helminth fauna of Charadriiformes and Anseriformes observed a prevalence of 50%, 45%, 13.3% and 16% of cestodes, nematodes,

trematodes and acanthocephalans respectively. Luka and Ndams [28] reported that 62% of domestic fowl were infected with helminth parasites in Samaru, Zaria Nigeria. Phiri et al. [29] reported 95.2% free range chickens infected with GIH in central Zambia. Wahid reported a prevalence of 30.75%, 31.25% of *Raillitina* spp. and *Heterakis* spp. in domestic ducks, and a prevalence of 50% of *Ascaridia galli* in goose from Srinagar Kashmir. Ayesha reported a prevalence of 51.42%, 31.42% and 30.71% of *Raillitina tetragona*, *Heterakis gallinarum* and *Ascaridia galli* in domestic fowl from Doda district of Jammu and Kashmir.

The remarkable prevalence of infection observed in domestic fowl from Gurez valley can be attributed to a number of factors like the type of management and production system, exposure to intermediate hosts, inadequate or no use of anthelmintics, the climatic conditions which alter the population dynamics of the parasite. As the environment and climatic conditions of the study area (Gurez valley) seem to be unfavourable for such a high intensity of infection that could have as such resulted in a lowest level of infection, a major ecological factor like dispersal and emigration plays a significant role in maintaining such a high prevalence of helminth infection in this beautiful valley of Gurez. During severe winters a small fraction of human population along with their poultry birds migrate from this valley to Kashmir valley until the onset of spring. Thus a chance of transmission of infection (even if minimum) might have occurred which shows a good proliferation

while the birds are back in their native land. During pleasant summers, the shepherds, Bakerwals along with their poultry birds, visit the high altitude pastures of Gurez for grazing their sheep and goats where the possible chances of transmission of helminth infection do occur. As the summers are very favourable for helminth proliferation, a high prevalence of infection was observed during summers.

In the present study, a good number of domestic fowl were harbouring more than one type of helminth species which is in agreement with the work of many other researchers found in following references [16,17,21,22,24-35].

The most prevalent helminth parasite recorded during the present study from Gurez was *Heterakis* spp. (35.76%) followed by *Ascaridia galli* (32.11%) and *Raillitina* spp. (27.00%). The present study is in agreement with the work of many others like; Qureshi (1950) reported a high prevalence of *Ascaridia galli* (31.02%) and *Raillitina tetragona* (18.7%) in Desi adult fowls in U.P India. Wilson et al. [25], Permin et al. [16] in deep litter and backyard system, Eshetu et al. [22] from Amhara region also reported similar prevalence in their studies. However Mpoame and Agbede [19], Schou et al. [13], Luka and Ndams [28] reported a higher prevalence of *Ascaridia galli*. Since the present results are in agreement with those of many others, still the variations can be attributed to the environmental conditions in the area and inadequate availability of intermediate hosts. The environmental conditions like temperature and moisture do favour the larval development and facilitate transmission and ingestion of infested droppings.

The present studies indicate that with the advancement of age there was a decrease in the prevalence of infection which makes it in agreement to the reports made by the researchers in the references [7,21,29,32,36-38]. It is evident that it can be attributed to the increased immune status in adults than in young ones against the helminth parasites. To accommodate with the environmental conditions and thus traditionally the chicks do hatch out during late spring and as such they do enjoy the summer and autumn in their young age when these get exposed to helminth infections. These could be the possible reasons for decrease in prevalence of helminth infection with increase in age.

As is evident from the observations made during the present study that males do show a slightly higher rate of infection than females, which can be related with the physiological influence of hormones on the susceptibility of host animals to infection [32]. Similar trend was observed by Fakae and Paul-Abiade [33] in fowl where male fowls carried significantly ($p < 0.05$) more parasite burden than females. Magwish et al. [32] also observed that prevalence of *Heterakis gallinarum* was higher in males than females. Similar results were observed by Ayesha in domestic fowl from Doda district of Jammu and Kashmir.

Although helminth parasites were prevalent throughout the year, but the observations made in the present study show higher prevalence of infection during the warm summer months followed by autumn, spring and winter respectively. As the study area is far-off from University of Kashmir and along the Line of control, monthly investigations were not possible. Thus, seasonal investigations were made to study the helminth infestation throughout the year. The higher prevalence observed during summer and lower during cold winters can be due to the impact of many factors like geographical location of the area, environmental conditions prevailing in the area. Low temperature inhibits the development and survival of infective larval stages and as such decreases the access to intermediate hosts or final hosts. On the other hand, the enough availability of intermediate hosts and favourable temperature for larval development favours the

chances of helminth proliferation in summers. It can be suggested that the seasonal fluctuations in the abundance of infective stages in the environment may also play a contributing role in the differences observed. These findings are in accordance to the reports made by many workers from other parts of the world. Threlfall [37] examined herring gulls in north-wales and found seasonal diversity of helminth parasites and attributed the differences to changes in the diet of the gulls over the course of the year caused by an altered availability of the intermediate hosts. Busher [10] and McLaughlin and Burt [39], reported that the density and the magnitude of helminth infection increases to peak in late summer. Wallace and Pence [40] stated that there is no recruitment of replacement species during winters due to changes in diet and limited availability of infective stages in intermediate hosts. Fedynich and Pence [41] reported that mallards had higher mean abundance of helminth in summer than in winter. Mpoame and Agbede [21] reported that the parasitic prevalence and the worm burdens were generally higher during April to October. Magwisha et al. [32] observed that helminth infection varied in the months of rainy season.

The present study reveals that single type infections were more prevalent than multiple type infections. Multiple type infections with helminthes in domestic fowl was also observed by researchers in the references [18,20,21,29,32]. In this study, majority of the host birds harboured multiple type of infection of helminthes which suggest that the prevailing environmental conditions and free range management systems are favourable to many species of helminth parasites [42-44].

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