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New Parasitic records of Aves: Phasianidae (*Alectoris chukar*) in Malakand division northern, Pakistan

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Summary

More than 24,000 species of helminth parasitize wild birds worldwide, and this number is expanding as interest in wildlife parasitology increases. The objective of the current study was to update the baseline of helminthological surveys conducted on chukar partridges (*Alectoris chukar*) in northern Pakistan. After reviewing the available literature, a parasite-host association checklist was developed. Nematodes (53.8 %) were the most commonly reported parasite, followed by cestodes (15.3 %) and trematodes (15.3 %) respectively.

Seventy (70) chukar partridge (*Alectoris chukar*) distributed across the Malakand division of northern Pakistan were screened for parasitosis during the period from October 2020 to the end of December 2021. Blood samples of all the specimens were screened for haemoprotozoa, the digestive tract was examined for protozoans and helminths. The examined birds were infected with nine different helminth parasite species identified as cestodes (4 species), trematodes (2 species) and 3 species of nematodes. 29 out of 70 birds were infected, with the male and female infection rates being 36 % and 52.1 %, respectively, with a total prevalence of 41.3 %. Among the infected birds 10 (34.4 %) contained cestodes, 2 (6.8 %) contained trematodes and 17 (58.6 %) contained nematodes. Of which *Ascaridia galli* and *Capillaria phasianina* recorded the highest prevalence (10 %). While *Amoebotaenia cuneate, Choanotaenia infundibulum, Hypoderaeum conoideum, Lyperosomum longicauda* recorded the least (1.4 %) respectively. Reporting of *Raillietina echinobothrida, Amoebotaenia cuneate* and *Lyperosomum longicauda* constitute new host records. *A. cuneate is a new record in the parasitological list in the country.* In terms of host's sexuality, the overall figures show no significant changes in infection indices.

Keywords: Chukar partridge; helminth parasites; northern Pakistan

Introduction

Chukar partridge (*Alectoris chukar*) is a famous game bird belonging to the family Phasianidae. Chukar is a common bird in mountainous areas of the Middle East, Western Europe and Asia (Cramp & Simmons, 1980). They are most prevalent in Asia and have been introduced in areas of North America and New Zealand. Chukar in Pakistan is found in arid, hilly and rocky environments with higher elevation valleys in the inner Himalayan range. In Pakistan it is found in Sindh's Khirthar range and Punjab's Chinji Reserved Forest and Margalla Peaks (Ullah & Khan, 2021). The IUCN has classified the chukar Partridge as Least Concern, im-

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plying that the species' population is stable (Bird Life International, 2016). However, population reductions have been reported in some parts of the world; for instance, a small population in Europe is predicted to decline by about 30 % in 11.7 years (three generations) (Bird Life International, 2015). Wild bird populations have declined by an estimated 50 to 60 % on average during the last 40 years (Ullah *et al.,* 2021).

Birds, like other animals, suffer from various diseases. Birds, in the semi-scavenging system are subjected to various forms of parasites, which include various protozoan, helminths, lice, termites, ticks, and fleas. (Rahman *et al.,* 1989). Birds with access to open spaces have a greater variety of parasites (Pandey *et al.,* 1992). Several *Alectoris* species and subspecies have been the subject of parasitological studies in various regions of the world. Many endoparasite species were obtained and identified from them. Gastro-intestinal protozoans and helminths make up the majority of the first category, with average infection rates broadly clustered around 50 %.

Numerous studies, including those by Ruff and Wilkins (Ruff, 1990) on *A. chukar* from the United States; Vasilev (Vasilev, 1992) on *A. chukar kleini* from Bulgaria; and Perrucci *et al.* (1997) on *A. graeca* from the United States, Turkey, and Italy, revealed important information. Generally, parasites cause higher mortality due to blood loss, which weakens the host, by diseases caused by toxic endo-parasites, by which arthropods act as mechanical or biological vectors transmitting a variety of pathogens. (Pearson, 1994). Pakistan, like other Asian countries, is still lagging behind. That is to say, most *Alectoris* species knowledge is narrative and zoogeographical.

The present study, therefore, aims to establish the identity of the helminth parasitic communities of the chukar partridge from northern Pakistan as well as reporting on their prevalence. The sample size employed was much larger than the preliminary ones referred to above, as well as being more representative by obtaining it from several localities and comprising both sexes.

Materials and Methods

A total of 70 chukar partridge *A. chukar* (23 male and 47 female) were caught by hunters from 18 different localities during the shooting seasons in northern Pakistan from October 2020 to the end of December 2021 (Fig 1). Birds were collected instantly after being shot by hunters, packed in individual plastic bags, and brought to the Department of Parasitology Abdul Wali Khan University Mardan, Pakistan for parasitological analysis. Each bird was given a thorough examination with the results showing that almost all of them were healthy. None of them showed injuries, skin lesions (such as hyperdermatosis, epidermitis and acanthosis) or excessive feather loss or damage. All of the specimens were adult and older than one year, as judged from the observation of the plumage pattern and weight. Sex differentiation was always confirmed by gonadal checking. After decapitation, the abdominal and thoracic cavities were opened, followed by systemic autopsy examination which include, the esophagus through to the gizzard,

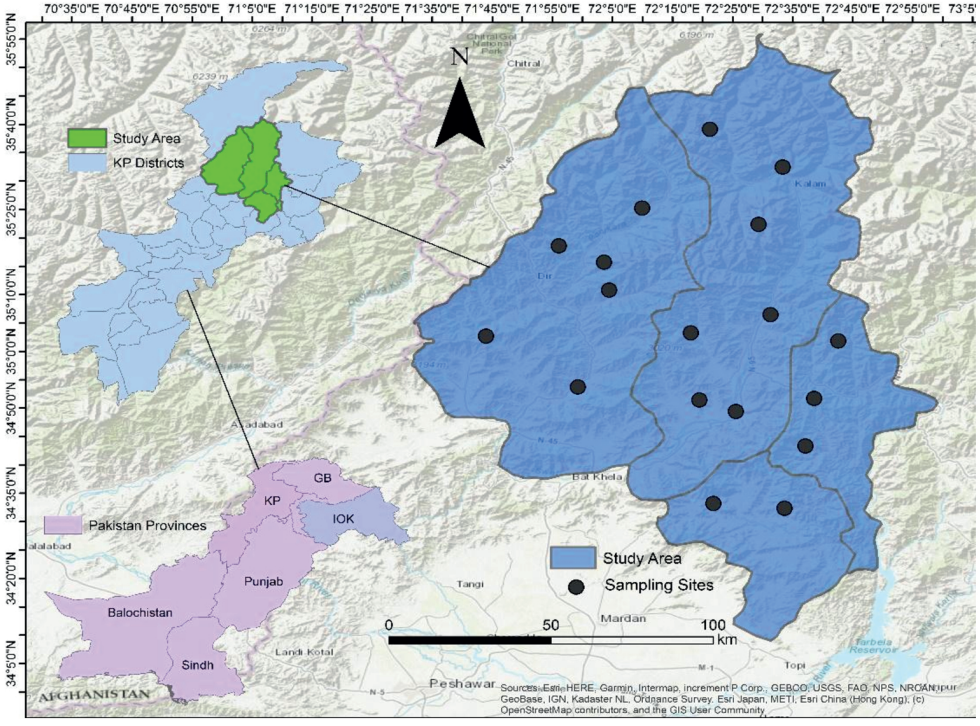

Fig. 1. Map of northern Pakistan showing administrative details and site of the study area.

the small intestine, duodenum, (jejunum and ileum), the caeca, and the ileocecal junction to the cloaca. Each section was opened longitudinally. The intestinal scrapping and floatation methods were used to collect the parasites (Calvete *et al.,* 2003). After being cleaned with 1 % normal saline, the recovered helminths were then preserved in 70 % alcohol. Trematodes and cestodes were all dyed in the lab with acetocarmine and then cleaned with xylene, while nematodes were cleared with lactophenol. Each specimens were morphologically identified using morpho-taxonomic signs and standard identification keys under stereo zoom microscope (SZM405, HT Company Ltd, ILF, UK) (Soulsby, 1982).

Ethical Approval and/or Informed Consent

All applicable national and institutional guidelines for the care and use of animals were followed.

Results and Discussion

The findings revealed nine helminth species, including four species of Cestode (*R. echinobothrida*), (*R. tetragona*) (*A. cuneate*) and (*C. infundibulum*), two Trematode (*H. conoideum*) and (*L. longicauda*) and three Nematode which include (*H. gallinarum*), (*A. galli*) and (*C. phasianina*). 54.3 % of the specimens examined contained at least one species of helminth parasites. The scientific names of the parasites encountered in both sexes of the host, along with their infection sites and infection rates, are included in Table 1. Only the caecum, small intestine and bile duct were infected internally. No flagellate protozoans, such as Haemoproteus or Plasmodium were found in the upper digestive tracts of any of the chukars studied, and no trematode species were found in the livers or gallbladders of any of the chukar. The mouth, oesophagus and crop of all of the sampled chukars revealed no infection with Capillaria nematodes. In addition, helminth such as the gapeworm *Syngamus trachea* were not detected in any of the specimens. The host site preference for either of the above species is the small intestine. Their prevalence was moderately higher in male than female hosts.

Both davaineid (*Raillietina echinobothrid* and*, Raillietina tetragona*) and dilepidida (*Amoebotaenia cuneate* and *Choanotaenia infundibulum*) tapeworms were present. The majority of the parasites found were connected to the mucosa by scolices, while some samples were present loosely in the lumen of small intestines. The present study cited *R. echinobothrida* and *Amoebotaenia cuneate* and *Lyperosomum longicauda* for the first time in this host. *R. echinobothrida* and *Lyperosomum longicauda* have been found parasitizing house crow (*Corvus splendens*) in Pakistan (Suleman & Khan, 2016), domestic birds and pigeons in the Nigeria (Edosomwan & Igetei, 2018). *Amoebotaenia cuneate* was detected in a single specimen in the present study, normally they are responsible for morbidity and mortality in most avian species, but they are of particular importance in poultry (Demis, 2015). *R. echinobothrida* was first detected in the house sparrow (*Passer domesticus*) in Iraq with the infection rate of 44.6 %. (Mohammad, 2013). From both domestic and wild birds, a wide variety of Cestodes species have been identified. Chickens (*Gallus gallus domesticus*), turkeys (*Meleagris gallopavo*), ducks (Anatidae species), geese (*Anser cygnoides*), swans (Cygnus), guinea fowl (Numididae), pigeons (Columbidae), pea fowl (*Pavo cristatus*), ostriches (*Struthio camelus*), pheasants (*Phasianus colchicus*), quails (*Coturnix coturnix*), and other birds are all affected by the diseases they cause (Samour, 2004).

The cestodes *R. tetragona* is the most common parasites in the present study. Mohammad (1990) found the same results in the black partridge, *F. francolinus arabistanicus*. This could be because the cestodes' intermediate hosts, which include a diversity of insects and other invertebrates, are numerous in the animal diet consumed by the hosts. Sawada (1955) mentions 5 species

Table 1. Prevalence of Helminthes parasite species in chukar partridges.

Endoparasites spp.	No of parasites	No of infected birds	Prevalence of infected birds	Infection rate (%)		Infection sites
				♂	♀	
Raillietina echinobothrida	7	3	4.3	8.7	2.1	Small intestine
Raillietina tetragona	9	5	7.1	13	4.2	Small intestine
Amoebotaenia cuneate	3	1	1.4	0	2.1	Small intestine
Choanotaenia infundibulum	1	1	1.4		2.1	Small intestine
Hypoderaeum conoideum	3	1	1.4	0	2.1	Small intestine
Lyperosomum longicauda	2	1	1.4		2.1	Bile duct
Heterakis gallinarum	5	3	4.3	8.7	2.1	Intestinal caecum
Ascaridia galli	13	7	10	8.7	10.6	Small intestine
Capillaria phasianina	10	7	10	13	8.5	Small intestine
Total parasites	53	29	41.3	52.1	36	

of ants as an intermediate hosts within 26 different invertebrates' species while Yamaguti (1959) reported 5 species of ants that can be used as intermediate hosts.

Male chukars proved to be more susceptible to parasitization by either of these tapeworms than their female counterparts, although it is unknown if this is because of prevalence or intensity.

One of the two trematode species *Hypoderaeum conoideum* was encountered in the small intestine while *Lyperosomum longicauda* was found in the bile duct. When compared to specimens usually seen in Pakistani house crow, the posterior extremities of an adult male of the latter species showed some slight morphological differences (chicken, turkey and duck). The female chukar demonstrated a higher propensity for infection for both of these trematode parasites. Different digenetic trematodes like *Dicrocoelium petrovi, Brachylaemus fuscatus* and *Dicrocoelium sp*. are also isolated in adults of other *Alectoris* species (Vasilev, 1992). The lack of Trichomonas invasion in partridges may be linked to the fact that they do not consume "crop milk" after hatching, without completely ruling out the potential of certain inherent resistance to infection. The helminths of *A. chukar* in the Malakand division of northern Pakistan suggest that *Alectoris* spp. are common in their geographical range. All the helminth species have a worldwide distribution and can be found in other *Alectoris* species (Tables 2).

The current study found that the Pakistani chukar population can be parasitized by at least two species of eimeriid coccidians (*A. galli* and *C. phasianina*). A similar finding was reported in Poland, *C. phasianina* was reported for the first time in partridges (Rząd, 2021). Comparatively, the partridge parasites population is more diversified but less dominated by a single parasite species than that of the pheasant parasite community. The literature findings about the higher frequency of *Capillaria* nematodes in partridges, which are reported below, are supported by our study. The earliest reports of partridge helminths in Poland were found in the 1950s and 1960s. *Heterakis gallinarum, Ascaridia compar* (Schrank, 1790), *A. galli* (Schrank, 1788), and four species of *Capillaria*, including *C. caudinflata*, have all been found to parasitize the intestines of these birds. Nematodes from the *Capillaria* genus and the *H. gallinarum* species are the most prevalent (Kozakiewicz, 1983). The species *Heterakis gallinarum* (Schrank, 1788) is widely distributed. Pheasant (*P. colchicus*) is the typical host of this nematode, where it is particularly prevalent in birds i.e., it has been observed in hosts belonging to the Anseriformes and Passeriformes as well as Galliformes. (Fagasi, 1964).

Male hosts had higher rates of parasitism than female hosts, except *A. galli*. This could be explained by females' behavioural differences from males, particularly during the egg-laying stage,

Table 2. Helminthes parasite species reported in chukar and *Alectoris* species worldwide.

	Alectoris species				
	barbara	**graeca**	**rufa**	**chukar**	**References**
Cestoda					
Choanotaenia infundibulum	It	Fr	Sp	Bu, Ir	Vasilev, 1992; Al-Barwari & Saeed, 2012; Tarazona *et al*., 1978; Masala *et al*., 1986; Belleau & Léonard, 1991
Raillietina tetragona	It	Tu	Sp	Ir	Al-Barwari & Saeed, 2012; Masala *et al*., 1986; Koroglu & Tasan, 1996; Reina *et al*., 1992
Nematodes					
Ascaridia galli			It,	US	Tibbits & Babero, 1969; Macchioni & Marconcini, 1982
Capillaria phasianina				Gr	Githkopoulos, 1984
Capillaria contorta			Sp	Gr	Githkopoulos, 1984; Reina *et al*., 1992
Ganguleterakis altaica		Ka		Bu	Vasilev, 1992; Gvozdev, 1956
Ganguleterakis macroura				Bu	Vasilev, 1992
Ganguleterakis tenuicaudata		Fr	Sp	Bu	Vasilev, 1992; Tarazona *et al*., 1978; Belleau & Léonard, 1991
Heterakis gallinarum		Ka, Fr, Tu	Sp	Ir	Al-Barwari & Saeed, 2012; Gvozdev, 1956; Belleau & Léonard, 1991; Reina *et al*., 1992; Tarazona *et al*., 1978
Trematodes					
Dicrocoelium petroni				Bu	Vasilev, 1992
Hypoderaeum conoideum				Bu	Vasilev, 1992
Conoidasida					
Eimeria kofodi				Ir	Al-Barwari & Saeed, 2012
Eimeria caucasica				Ir	Al-Barwari & Saeed, 2012

It= Italy, Fr= France, Sp= Spain, Bu= Bulgaria, Ir= Iran, Tu= Turkey, US= United States, Ka= Kazakhstan, Gr= Greece

Table 3. Weight comparison between infected and uninfected male and female partridge.

Host	Total no	Infected	Mean weight	Non infected	Mean weight
Male	23	12	545.3 g	11	557.6 g
Female	47	17	463.5 g	30	478.7 g

when females took more insects as food. There are no significant differences in the weights of infected and non-infected male and female hosts. (Table 3).

The study reveals that partridges are afflicted with a variety of helminth parasites that may negatively impact their health. Signs and pathology have undoubtedly gained the most interest, but the method of transmission from an affected to a non-infected bird is perhaps the most relevant aspect in terms of possible control methods. To further understand the association between parasites and related diseases in the partridge population, more field research is needed. Strict hygiene measures are also needed to prevent the spread of undesirable pathogens via parasites.

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Conflict of Interest

Authors state no conflict of interest.

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