1. INTRODUCTION

1.1 Background

Poultry is the trend of rearing domestic birds like chicken, duck, pigeon, turkey and ostrich for dual purpose i.e. meat and eggs. There is a tremendous growth of poultry farming in the last six decades, it has created income generation in urban and rural areas (Bhattarai, 2008). The chickens are however the most predominant in terms of economic importance (Nnadi and George, 2010). Concurrently, there has been a major structural change in the poultry industry throughout the world, especially, the commercial poultry industry in the developed country and developing countries has moved towards large-scale (Narrod, 1997; Narrod and Pray, 2001; Delgado *et al*., 2008). The poultry sector has undergone major structural changes during the past two decades due to the introduction of modern intensive production methods, genetic improvements, improved preventive disease control and biosecurity measures, increasing income and human population, urbanization and due to the demand of poultry meat in tourism and changing food (Sharma, 2010). Approximately 20 billion poultry exist worldwide FAO (2007) and of this about 75% are in developing countries. Duck farming play a vital role for income generation, nutritional fulfilment and employment generation (Islam *et al*., 2012). Ducks are the indicators of the richness and diversity of wetland ecosystem and they are the object of urgent attention (Baral and Inskipp, 2005). According to Department of Livestock Services, Livestock and Poultry Inventory, (2009/10), Poultry production is moving towards self sufficiency and the growth rate of Nepal's commercial sector is satisfactory at around 17-18 percent annually and its contribution to overall GDP is also encouraging and increasing. According to information grabed from Statistical information on Nepalese Agriculture 2014/15, Nepal's total duck population is 3,90,287 and duck meat production decreased from 287 metric tonnes in 2000/01 to 232 metric tonnes in 2014/15, moreover duck egg production also decreased from 15,757 in 2000/01 to 13,554 in 2014/15 due to urbanization, limited availability of water resources and change in farmers priorities. Geographically, 73.0 percent are located in the Terai followed by 23.9 percent in the Hills and 2.9 percent in the mountains while in terms of administrative division, the distribution of ducks was highest (36.5%) in the Eastern followed by the Central (31%), Western (21.9%), Mid-western (6.9%) and (3.5%) in Far-Western Development Region. Factors that hinder development of poultry to its fullest capacity include poor management systems and disease (Permin *et al*., 1997). Intestinal parasitism is a major problem in poultry, especially those reared under the extensive and semi extensive systems (Ajayi, 1983).

1.2 Ducks in Nepal

Duck belongs to order Anseriformes and family Anatidae. Anatidae includes the duck and most duck-like waterfowl, such as geese and swans. The ducks of the world are of two types, the muscovy duck (*Cairina moschata,* Linnaeus, 1758) and the mallard duck (*Anas platyrhynchos,* Linnaeus, 1758) which are the ancestor of domestic ducks in its many different breeds (Harrison and Greensmith, 1993). The mallard duck has been "hybridized" with about 50 species of ducks and geese. These birds are adapted to an aquatic existence with webbed feet, flattened bills, and feathers that are excellent at shedding water due to an oily coating secreated by uropygial gland. Ducks are of great use for research and educational purpose. In Nepal, domestic duck mallard (*Anas platyrhynchos,* Linnaeus, 1758*)* and the muscovy duck (*Cairina moschata,* Linnaeus, 1758) play major role in rural economy in the form of meat and egg. There are several breeds of ducks in Nepal as reported by FAO 2014 such as white Peking duck which was introduced in Nepal from Hungary, Ng Chow duck, a cross between Peking and local Hong Kong ducks from Hong Kong, Indian runner and Khaki campbell from India.

The mallard duck (*Anas platyrhynchos*) (photo 3) is a dabbling duck belonging to the surface-feeding ducks tribe which is common in Europe, North America and Asia (Nowak *et al*., 2011). The mallard duck is approximately 6m (2 ft.) long with a wing span of 82-95 cm (32-37 in.) The male duck known as drake is brightly coloured from September to June during breeding season and stands out with a brilliant glossy green head and upper neck, separated from a light grey breast and a rusty coloured back by a white ring resembling a collar. Its bill is yellowish green and exhibits two distinct black feathers in the center that curve back, giving the male characteristic curly tail. The female mallard known as hen is much less colourful and smaller than the drake. The hen's back and breast is a darker brown than the drake's without distinct curly tail. The hen has an orange bill marked with black spots and orange legs and feet. Both the drake and hen have a distinguishing speculum (a bright blue rectangular spot of color) and yellow feet. After breeding season, they mould their feathers.

The muscovy duck (*Cairina moschata*) (photo 4) is a large duck native to European countries and also found in tropical countries. They are large ducks, with the males about 76 cm long and weighing up to 7 kg while females are considerably smaller, and only grow to 3 kg. The bird is predominantly black and white, with the back feathers being iridescent and glossy in males, while the females are more drab. The bill can be yellow, pink, black or mixture of these. They may have white patches or bars on the wings, which become more noticeable during flight. Both sexes have pink or red wattles around the bill and eye, males have larger and more brightly colored than female with black feet. They are mostly preferred for meat rather than egg. The ducks are often raised around water sources and are more common in

certain ethnic communities like Tharu, Newar and Rajbansi for religious and cultural significance. The duck population is scattered throughout the country and generally raised in traditional farming systems along with local chickens.

1.3 Duck farming practices in Nepal

Duck farming in Nepal is an agricultural occupation of plain region for home use to produce egg and meat. Ducks are raised together with indigenous fowls and livestock in the Terai districts. Ducks are only kept enclosed at night but during the day the ducks are free to roam outside in search of feed. Most of the duck farmers feed with broken rice, rice bran and leftover food. Ducklings are given boiled leafy vegetables and rice. They are mostly sheltered in bamboo basket (photo. 7) and wooden pen (photo. 6) in backyard. Hygiene of pen is poor and sanitation is maintained once a week. While talking about their health care, farmers are unaware about diseases in duck and deworming is practiced by some literate farmers only. Nepal's poultry production systems follow the FAO classification method relating to bio-security levels and is usually more related to farm size into the following categories (Dhaubhadel, 1992). i) Scavenging system ii) Semi-scavenging iii) Intensive system. Ducks are more prolific and more adaptable to free-range system (photo 1, 2 and 3) of rearing where they are allowed to scavenge in open paddy fields, canals, ponds, drainage and open area. Ducks are kept in a traditional scavenging system and no commercial farming of ducks exists at present FAO (2014). The pilot research carried out by Practical Action organization from April-November 2013 in Chitwan and Nawalparasi districts of Nepal with the financial support of Grand Challenges Canada proved integrated rice-duck technology is beneficial in minimizing the cost of production, increasing rice productivity, providing environmental benefits and increasing the income of farmers through sale of organic rice and duck meat even it sought to develop an integrated approach to counter malnutrition by combining duck and rice production. Hossain *et al*., (2012) reported practicing integrated rice duck farming in many countries like Japan, Korea, China, Vietnam, Philippines, Bangladesh, India, Laos, Thailand, Myanmar, Sri Lanka, Iran, Tanzania etc. In Nepal duck-fish farming is practiced in Hetauda, Pokhara and Bhairawa fisheries development centers to increase yield of fish and ducklings are sold to local people (FAO, 1979).

The risk factors associated with prevalence of parasites in duck on basis of farming practice are free range duck keeping system where they are allowed to scavenge in open paddy fields, canals, ponds, drainage and open area during which they may pick up infective larvae and eggs of different parasites along with intermediate host. Poor hygiene and sanitation of pen which causes contamination through faecal discharge. A lack of deworming might have contributed for the recycling of parasites. The hot and humid climate might also been contributing for the propagation of parasites.

1.4 Diseases in duck

The Nepalese Veterinary authorities (2013) have reported 85 new outbreaks of highly pathogenic avian influenza at various farms across Bagmati, Narayani and Bheri affecting broilers, layers, parents stock birds and backyard birds. Jha *et al.,* (1996) reported high death in poultry due to infectious bursal disease, infectious bronchitis, coccidiosis, ascariasis, Newcastle disease and fowl cholera. Dhakal (2000) reported Marek's disease apart from coccidiosis and chronic respiratory disease. Maximum mortality occurred in birds older than 20 weeks due to Gumboro disease (Singh and Bhurtel 1998/1999). Collibacillosis was a major disease affecting birds younger than 8 weeks followed by coccidiosis and aspergillosis (AHRD, 1999/2000). Avian parasites commonly seen include protozoa (one-celled animals), helminths (worms) and arthropods (insects and mites) and the effects vary from benign to acute death (Ritchie *et al.* 1997). Parasitic diseases come first among other disease that cause reduction in productivity of rural poultry (Adejinmi and Oke, 2011). However parasitic diseases are often neglected because they are insidious and rearly result into epidemics like the viral and bacterial diseases (Eshetu *et al.*, 2001). According to NARC (2072/73) intestinal parasites like round worm, cecal worm and tape worm causes diseases in duck whereas mycotoxixcosis, fowl cholera, duck plague, duck viral hepatitis and botulism have been also reported in duck. Permin and Hanson (1998) have reported diseases like coccidiosis ascariasis, capillariasis and amidostomiasis in duck.

There are more than 2,00,000 named species of protozoa of which nearly 10,000 are parasitic in invertebrates and in almost every species of vertebrate (Collier *et al.*, 1998). Three main genera of haemosporidians that infect birds are Plasmodium causal agent of true avian malaria, and Haemoproteus and Leucocytozoon cause other related haemosporidioses and is transmitted by blood-sucking dipteran insects (Krizanauskiene *et al.,* 2006), these parasites occur worldwide, irrespective of climatic barriers (Wiersch *et al.,* 2007). In the infected birds, the clinical disease is associated with fever, depression, anorexia, loss of body weight, dyspnea, hepatomegaly, splenomegaly, ocular haemorrhage, haemolytic anaemia, (Aiello, 1998 and William, 2005). Mortality in bird due to the disease may be up to 90 % (Jordan and Pattison, 1998). Coccidiosis in duck is mainly caused by protozoans from three genera i.e. *Eimeria, Tyzzeria* and *Wenyonella* (Permin and Hansen, 1998). Local chicken, ducks and pigeon are reared in semi-scavenging or scavenging system so such birds are in constant contact with soil (Pandey and Jiang, 1992), which serves as an important reservoir and transmission site for external larval stages of helminthes and insects (Muhairwa *et al*., 2007).

The major gastrointestinal parasites reported in duck are of genus *Amidostomum* sp. (Kavetsk a *et.al.* 2004). *Ascaridia* sp. (Hoque *et al.,* 2014 and Adejinmi and Oke, 2011). *Heterakis* sp. (Muhairwa *et al*., 2007). *Capillaria* sp. (Hoque *et al.,* 2014 and Muhairwa, *et al.,* 2007), *Echinuris* sp. (Farias and Canaris, 1986), *Syngamus trachea* (Adejinmi and Oke, 2011). *Subulura brumpti* (Muhairwa *et al*., 2007). *Tetramere* sp. (Farias and Canaris, 1986; Paul *et*

*al.,*2014). *Echinostoma* sp. (Musa *et al.,* 2012). *Notocotylus attenuates* and *Prosthogonimus cuneatus* (Youssefi *et al.,* 2014). *Zygocotyle lunata* (Farias and Canaris, 1986). *Echinoparyph ium sp.* (Saijuntha *et al*., 2013 and Aboulaima *et al.,* 2011).*Railietina sp.* (Muhairwa *et al.,* 2007 and Paul *et al*., 2014). *Diorchis* sp. (Youssefi *et al.,* 2014). *Hymenolepis* sp. (Soliman, 2 009). Duck and other water fowl acts as reservoirs for all most all serovars of influenza (H1 to H17) and they may act as constant source for frequent outbreaks in human and chicken flu (Mondal, 2015).

The main challenges in duck poultry in rural area are lack of finance, knowledge of disease and treatment, space and scientific knowledge etc.

1.5 Objectives of the Study

1.5.1 General objective

- To determine the general prevalence of gastrointestinal parasites of duck in four different wards of Harpur VDC i.e. ward no.6 (Ektanga), ward no.7 (Teliya), ward no.8 (Baderwa) and ward no.9 (Ramauli) of Parsa district.

1.5.2 Specific objectives

- To compare the diversity of GI parasites of duck in four wards of Harpur VDC.
- To determine the diversity of GI parasites of duck in four wards of Harpur VDC.
- To identify the GI parasites of ducks by morphology and micrometry.

1.6 Rationale of the Study

Ducks are tough animals and good scavengers. They are easier and cheaper to keep than chickens. Since our country is agricultural country and more than half population of Nepal are engaged in farming and husbandry. Backyard poultry can fulfill the nutrition in their diet and add some income in livelihood. Our country is rich in natural resources like natural vegetation and water bodies which is favourable condition for duck farming. Duck farming is yet not in highlight and has been paid less attentation in comparision to chicken poultry though it has significant contribution in meat and egg production and carry religious value. Globally lots of work have been done on duck infection, disease and parasites regarding its importance but limited work was found to be done on the parasites of duck. Every year in rural area farmers have to bear heavy loss due to high mortality of duck due to different kinds of infection, diseases and parasites. Due to lack of identification of diseases and treatment and lack of veterinary hospitals at local assess, people are less interested in duck farming commercially. Thus, there is a need for studying and documenting the prevalence of parasites to understand the mode of infection and the potential transmission of parasites between

species, both native and introduced (Begon *et al.* 1999). In order to assess and manage the effect of parasites on population dynamics, it is also essential to evaluate the parasitic distribution and their extent of pathogenesity (Morner 2002). The present findings will provide some baseline information on the parasitic burden in duck and help to formulate appropriate strategies to mitigate the endoparasitic problem of duck in different wards of Harpur VDC.

2. LITERATURE REVIEW

Besides food poisoning, bacterial, fungal and viral infections, the ducks are also susceptible to various parasitic diseases caused by different protozoans, trematodes, cestodes and nematodes parasites. Different ecological factors like geographical location, subtropical climatic condition, water lodged and low areas of the country are suitable for duck habitat but these factors also favour in growth, multiplication, development, survival and spread of parasites. As a result, almost all of the ducks suffer from parasitic diseases (Farjana *et al*., 2004) which affect the growth and production performance of ducks (Anisuzzaman *et al.*, 2005). Other factors like the system of management, the nutritional status, the ecology of the parasites and their host-parasite relationship exert significant effect on the occurrence of the helminth infection in ducks (Ahmed, 1969; Qadir, 1979 and Islam *et al*., 1988). Parasitic infestation cause diseases in ducks and affect their productivity and growth due to malnutrition, weight loss, lowered egg production and death of young birds (Mondal *et al*., 2008). Since ducks are scavenger and dabbling creature, they spend most of their time swimming and dabbling in water bodies and act as definite host for some parasites. Cyclops, daphnia and beetles act as intermediate host of helminthes parasites (Soulsby, 1982). Viral, bacterial and protozoan are more economically important because they cause death of host however, helminthiasis are economically very important to the poultry industry because it results in poor egg production, poor weight gain, poor immune responses to disease pathogens and vaccines (Pandey and Jiang, 1992). Village poultry generally scavenge for food and hence are at a higher risk of picking up infective forms of helminths from the environment (Ahmed, 1969). In this section some important published work related to present work has been reviewed.

2.1 In global context

2.1.1 Parasites in duck

Parasites are those organisms living outside the body and within their hosts in the eye, lacrimal duct, trachea, lungs, oesophagus, crop, proventriculus, entire intestinal tract, small intestine, oviduct, Caeca, gizzard, rectum, bursa Fabricius, liver and cloaca of the host (Permin and Hansen, 1998). They completely depend upon their host causing infection and even morbidity. Especially, the protozoan and helminthes (Nematode, trematode and cestode) parasites have been reported as endoparasites in birds. The major external parasites of poultry are lice, mites and ticks which donot lead to death but production losses due to the irritation in birds such as many external parasites suck blood which causes birds to suffer from anaemic (Musa *et al.,* 2012). The prevalence and distribution of gastrointestinal

parasites have been documented in domestic ducks in households (Muhairwa *et al.,* 2007 and Hoque *et al.,* 2011).

a. Protozoan parasites

Protozoa of the genus *Cryptosporidium* parasitize fish, amphibians, reptiles, birds and mammals and their biological cycles take place on the surface of the epithelial cells in the gastrointestinal and respiratory tracts, in the bursa of Fabricius, and, less frequently, in other organs (Bartal & Thompson, 2006; Valigurova *et al.,* 2008) causing clinical and subclinical infection (Santin, 2013). Protozoan parasites does not require an intermediate host. Infection sites include the throat, esophagus, crop, trachea and intestine. Parasites like *Trichomonas, Giardia, Hexamita, Coccida* and Hemoparasites (Blood Parasites) like *Haemo proteus, Atoxoplasmosis* and *Sarcocystis* (Harrison *et al*., 2013) .The Sarcomastigophora include the genera *Histomonas, Trypanosoma* and *Entamoeba* among others. Coccidiosis is probably the most widespread and important parasitic disease in commercial as well as backyard poultry operations and as such responsible for major economic losses in the poultry industry. Coccidiosis in poultry is caused by protozoans from the following three genera: *Eimeria, Tyzzeria and Wenyonella* which belong to the phylum Apicomplexa (Permin and Hansen, 1998). In Ibadan Southwestern Nigeria, *Eimeria* sp. was the most frequently encountered followed by *Tyzzeria* sp. and *Cryptosporidium* sp. (Permin *et al*., 2002; Nnadi and George, 2010). A new species of coccidium *Eimeria mulardin* sp. has been described from the mule duck in France (Chauve *et al.,* 1991). In Chittagong ,Bangladesh, Eimeria spp.was reported in duck (Hoque *et al.,* 2014). *Tyzzeria pernicosa* has been only reported in ducks (Permin and Hansen, 1998). *Cryptosporidium hominis in North America (*Zhou *et al.*, 2004). *Entamoeba gallinarum* was detected in the domestic ducks from Egypt (El-Shabrawy, 1966). The *Cryptosporidium* species were also detected among ducks worldwide and from different organs and tissues (Tsai *et al.,* 1983; Richter *et al.,* 1994 and Mousa, 2000).

b. Helminthes

i. Nematodes

Nematodes are the most common and most important helminth species in poultry. They inhibite the internal organs like digestives tract, gizzard and proventriculus. These parasites represent seven families: Amidostomatidae, Acuariidae, Tetrameridae, Capillariidae, Dioctophymatidae, Ascaridae and anisakidae (Kavetska *et al.,* 2013). Some of the nematodes reviewed by researches are given below: In waterfowl, nematode of the genus *Amidostomum* was found in gizzard of geese (Herman *et al*., 1955). *Amidostomum mondon* has been identified from North Western Poland (Kavetska *et al.,* 2013). *Ascaridia* sp. has been reported in faecal examination of duck in Bangladesh (Hoque *et al.,*2014). *Ascaridia galli* in Ibadan South West Nigeria (Adejinmi and Oke, 2011) in Gombe, North Eastern Nigeria (Wakil *et al.,* 2014),in Tanzania (Muhairwa *et al.,* 2007) and in Egypt (Aboulaima *et*

*al.,*2011). Similarly, *heterakis* sp. has been reported from faecal examination of duck in Bangladesh (Hoque *et al.,*2014). *Heterakis gallinarum* was reported from Ibadan South West Nigeria (Adejinmi and Oke,2011), in Egypt (Aboulaima *et al.*,2011), in Tanzania (Muhairwa *et al.,* 2007). Three more species of *Heterakis i.e: Heterakis disper, Heterakis gallinarum* and *Heterakis isolanche* were identified in Tanzania (Muhairwa *et al.,* 2007). *Capillaria* sp. have been reported faecal examination of duck in Bangladesh (Hoque *et al.,*2014), in Ibadan South West Nigeria (Adejinmi and Oke,2011).*Capillaria contorta* and *Capillaria annulata* were discover from the caecum by post mortem in North Eastern Nigeria (paul *et al.,* 2014), in Tanzania from GI tract (Muhairwa *et al.,* 2007). Another species *Capillaria anseris* was also found in GI tract in Tanzania (Muhairwa *et al.,* 2007). *Echinuris* sp. were reported from Mexico and United State (Farias and Canaris, 1986). *Echinuris unicinate* were recovered from the caecum by post mortem in North eastern Nigeria (paul *et al.,* 2014).

Syngamus trachea were diagnosed in trachea of duck of Ibadan Southwest Nigeria (Adejinmi and Oke, 2011), in Northeastern Nigeria (Paul *et al.,* 2014). *Subulura brumpti* was recoverd from the caecum by post mortem in Northeastern Nigeria (Paul *et al.,* 2014), In Tanazia (Muhairwa *et al.,* 2007). In Tanazia, nematodes like *Subulura strongyilina* and *Subulura sucturia* were also discovered in GI tract by (Muhairwa, *et al.,*2007). *Tetramere* sp. were diagnosed in Mexico (Farias and Canaris, 1986). *Tetrameres fissipina* was recovered from the gizzard in Northeastern Nigeria (Paul *et al.,* 2014). *Tetrameres crami* was discovered by (Swales, 1933) in Italy. First single specimen of nematode, *Hadjelia neglecta* was originally described from a domestic duck in Brazil by Lent and Freitas, (1939) from Glades County. Farias and Canaris (1986) recovered *Epomidiostomum crami, Hystrichis uarispinosus* and *Rusguniella arctica* helminths from the gastrointestinal tracts of Mexican ducks from Mexico and the United States. From North Iran, one species of nematoda larvae i.e. *Contracaecum* larvae was found from stomach wall revealed from green winged teal (*Anas crecca*) by post mortem method (Youssefi *et.al*. 2014). Al-Labban *et al.* (2013) examined the internal organs and faecal samples of duck in Al-Diwaniya city and recorded nematode *Hystrichis tricolour* for the first time in Iraq.

ii. Trematodes

Trematodes or flukes are dorsoventrally flattened, unsegmented and leaf like parasites. They belong to the phylum Platyhelminthes, class Trematoda with two subclasses: Aspidogastrea and Digenea. All poultry trematodes belong to the subclass Digenea. Molluscans are intermediate hosts for all digenea (Permin and Hansen, 1998)**.** From Southern Iraq (Jaffar, 20 16) diagnosed Parasitic worms in digestive tract of local ducks for the first time, the result sh owed *Dietziella egregia*, *Neohematotrephus brasilianum*, *Psilocollaris* sp., *Stromitrema* sp. *Michajlovia migrate*, *Ptychogonimus megastoma*. *Hypoderaeum conoideum* was reported from Southern Iraq (Jaffar, 2016), in Mexico and the United States farias and Canaris, (1986), in Thailand (Saijuntha *et al.,* 2013) diagnosed using_ITS2 sequences to identify

juvenile and incomplete worms, from North Iran in green winged teal (*Anas crecca*) (Youssefi *et al.,* 2014). *Echinostoma* sp. was found in Mexico and the United States (Farias and Canaris, 1986), in Thailand Saijuntha *et al.,* (2013) diagnosed using ITS2 sequences to identify juvenile and incomplete worms and in Dhaka (Musa *et al.,* 2012). In Mexico and the United States Farias and Canaris (1986) recovered trematodes species such as: *Notocotylus attenuates* and *Prosthogonimus cuneatus,* from North Iran in green winged teal (*Anas crecca* (Youssefi *et al.,* 2014). *Zygocotyle lunata* from gastrointestinal tract in Mexico and theUnited States (Farias and Canaris, 1986). *Echinoparyphium recuruatum* was found in Thailand (Saijuntha *et al.,* 2013) diagnosed using ITS2 sequences to identify juvenile and in complete worms. *Echinoparyphium paraulum* and *Echinoparyphium recurvatum* were reported in Egypt (Aboulaima *et al.,* 2011). Adejinmi and Oke (2011) detected *Tracheophilus cymbium* in Nigeria.

iii. Cestodes

Poultry reared under free range conditions are likely to be infected with cestodes (tapeworms). All tapeworms of poultry have indirect life cycles with intermediate hosts such as earthworms, beetles, flies, ants or grasshoppers. The intermediate hosts are essential to complete the life cycle and infections are therefore rare in indoor systems (Permin and Hansen, 1998) .Two species of *Railietina*: *Raillietina echinobothridia* and *Raillietina tetragona* were encountered in GI tract of duck in Tanzania (Muhairwa *et al*., 2007) and from Gombe in Muscovery duck (Paul *et al.,* 2014). From Southern Iraq for the first time (Jaffar, 2016) diagnosed *Raillietina* sp.. First time in Southern Iraq Jaffar (2016) diagnosed cestode Parasitic worms in digestive tract of local ducks and Geese, recognized as: *Microsomacanthus* sp. and *Tetrabothrius* sp. From Mexico and the United States (Farias and Canaris, 1986) reported *Sobolevicantus gracilis* parasite. Jaffar (2016) encountered *Fimbriaria fasciolaris* for the first time in Southern Iraq, in Mexico and the United States (Farias and Canaris, 1986). *Diorchis* sp. and *Diorchis bulbodes* were reported in Mexico and the United States (Farias and Canaris1986). *Diorchis stefanskii* was reported from North Iran (Youssefi *et al.,* 2014). From Mexico and the United States (Farias and Canaris, 1986) recovered *Drepanidotaenia lanceolata, Echinocotyle rosseteri, Corynosoma constrictum* and *Polymorphus minutus* in ducks. Soliman (2009) survyed *Hymenolepis collaris, Trichostrongylus tennis, Filicollis anatis* in the domestic duck in Britain for the first time. Similarly, *Hymenolepis anatina* and*Hymenolepis abortiva* were recorded for the first time in England *Hymenolepis cantaniana* was observed in Nigeria (Paul *et al.,* 2014). In Egypt, during the GI tract investigation three cestodes were recorded, for the first time in ducks i.e. *Cladogynia phoeniconaiadis, Echinolepis carioca* and *Baerfainia anoplocephaloides* (Aboulaima *et al.,* 2011).

2.2 In national context

Limited work has been done in context to Nepal on parasites specifically on domestic ducks. The gastro-intestinal parasites encountered in ducks are common parasites of domestic chickens (Fowler, 1996 and Muhairwa *et al*., 2007). A study was conducted on the mortality pattern of the village poultry in eastern hills of Nepal where chicken were necropsied and recorded infectious bursal disease, bronchitis, Coccidiosis, Ascariasis, Newcastle disease and Fowl Cholera (Jha *et al.*, 1996). Dhakal (2000) reported major outbreaks of infectious bursal disease, Newcastle disease, and Marek's disease apart from coccidiosis and chronic respiratory disease in Chitwan. Singh and Bhurtel (1998/1999) reported maximum mortality occurred before 8 weeks of age followed by 8-20 weeks and lowest mortality occurred in birds older than 20 weeks due to Gumbo disease. Collibacillosis was a major disease affecting birds younger than 8 weeks old birds and reports showed the largest number of cases to be collibacillosis followed by coccidiosis and aspergillosis (Singh and Bhurtel, 1999/2000).

3. MATERIALS AND METHOD

3.1 Study area

Parsa district is one of the popular district, out of 75 districts of Nepal in central development region and Narayani zone bordering with India. During festivals like Dashain, Tihar and Siruwa large no. of adult ducks are imported while duckling and adult ducks are also sold in market areas. The Headquarter of this district is Birgunj. Parsa borders Nepal's Bara district on the east, Chitwan district on the west, Makwanpur on the north and India's state of Bihar on the south. It lies on the geographical coordinates of 27.0° North latitude and 84.52° East longitude. It covers an area of 1,353 sq. km and 0.92% area of the nation. It has tropical climate with temperature usually ranges between 5 C to 47 C whereas the elevation ranges between 122 m to 925 m above sea level. According to 2011 census it has 601,017 population. Main languages spoken in this area are Bhojpuri (90%), Nepali language (8%), urdu (1%) and other language (1%). Parsa district comprises 82 Village Development Committees (VDCs) and one sub-metropolitan municipality i.e. Birgunj also known as gateway to Nepal. It is also known as industrial area and first cigarette factory was established here. Some 23% of people in the rural parts of Central Terai live below the poverty line (as compared to 27% overall in rural Nepal).

The present study area covers the VDC- Harpur ward no. 6(Ektanga), 7(Teliya), 8(Baderwa) and 9(Ramauli) of Parsa district. At the time of the 2001 Nepal census it had a population of 5051 people living in 665 individual households. The study area ward no.6 covers Ektanga village with 177 houses in which total population is 1362 (Female=690 & Male= 672). The main occupation of residents of this area is agriculture and animal husbandry. The majority of people are of Yadav and Tharu caste. Population of duck was found 120 with minimum of 10 and maximum of 35, raised in free range system (photo 3, 4 and 5) in backyard with poor sanitation and duck breeds such as Mallard, Peking, Indian runner, khaki campbell and Muscovy were observed. Deworming was not practiced at all. The study area ward no.7 covers Teliya village consisting of 70 houses with total population of 431 (Female=214 & Male= 217). The occupation of residents of this area is agriculture and animal husbandry. The majority of people are of Tharu & Karna caste. Population of duck was found 85 with minimum of 6 and maximum of 20, raised in free range and semi intensive system in backyard with poor sanitation and duck breeds such as Mallard, Peking, Indian runner, khaki campbell and Muscovy were observed. Deworming was not practiced at all.

The study area ward no.8 covers Baderwa village boardering with Bagbana VDC, sharing a common river called shingai river. It has 246 houses in which total population is 1603 (Female=675 & Male= 728). People are engaged in agriculture and animal husbandry while some people even work in industrial area also. The majority of people are of Sahani, Mushar & Tharu caste. Total population of duck was 150 with minimum of 12 and maximum of 30, raised in free range system in backyard with poor sanitation and duck breeds such as Mallard,

Peking, Indian runner, khaki campbell and muscovy were observed. Deworming was found practiced in 3 houses only. The study area ward no.9 covers Ramauli village consisting of 96 houses in which total population is 645 (Female=301 & Male= 344). The main occupation of residents of this area is agriculture and animal husbandry. The majority of people are of Tharu & Chamar caste. Total population of duck was found 105 with minimum of 5 and maximum of 25, raised in free range system in backyard with poor sanitation and duck breeds such as Mallard, Peking, Indian runner, khaki campbell and Muscovy were observed. Deworming was not practiced at all.

The major cast Tharu inhibiting in these four wards commonly rear duck for egg, meat and for emergency fulfillment of cash while other castes also rear hen besides, ducks. Since in above study areas, different breeds of ducks were reared together in free range system (photo 1, 2 and 3) with unhygienic pen and without deworming so they are more likely to be contaminated and infected with diseases. Similarly, imported ducks mixed with other ducks is another risk factor for infection.

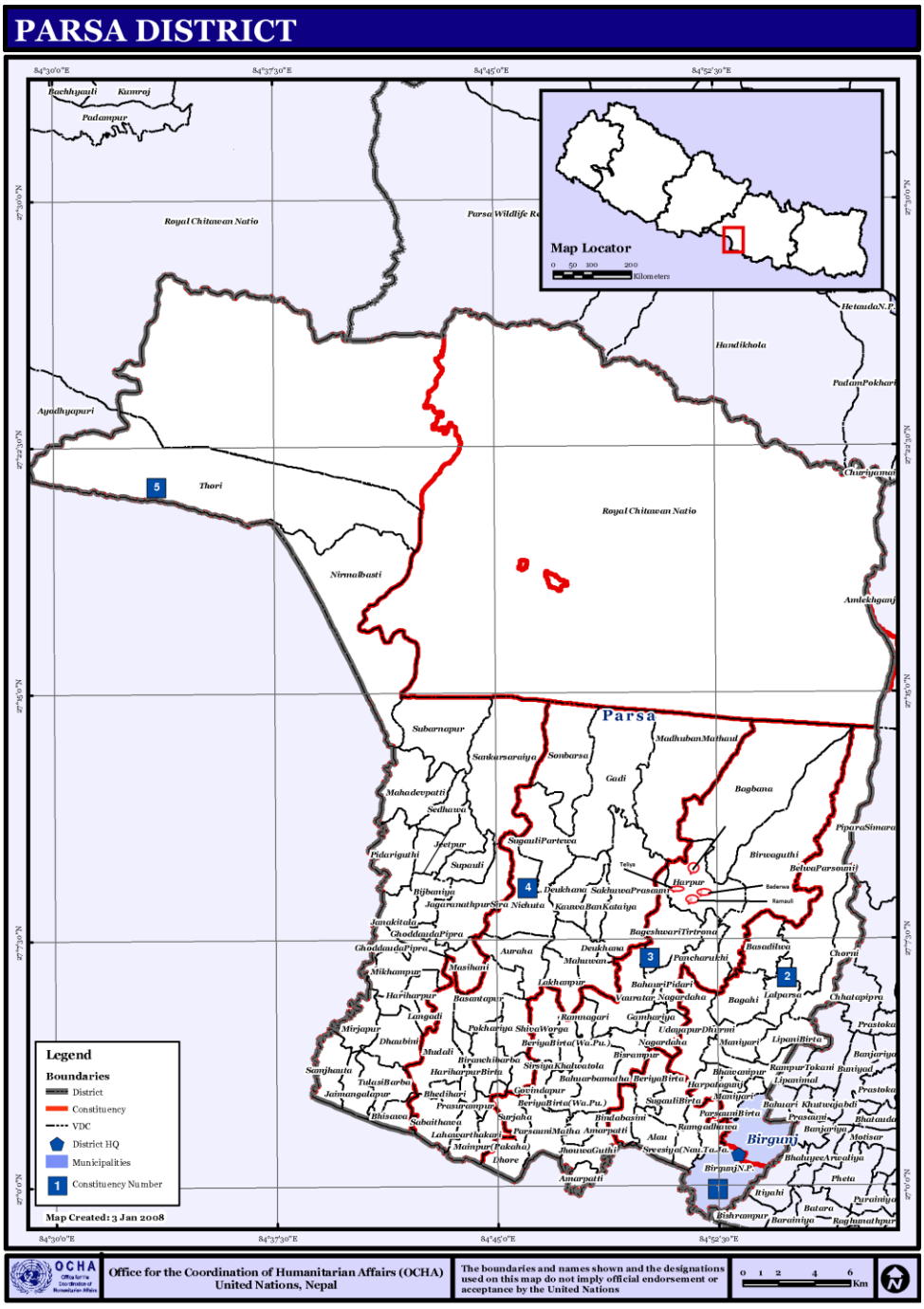

Figure 1. Map shows Parsa district with VDCs (source: LGCDP)

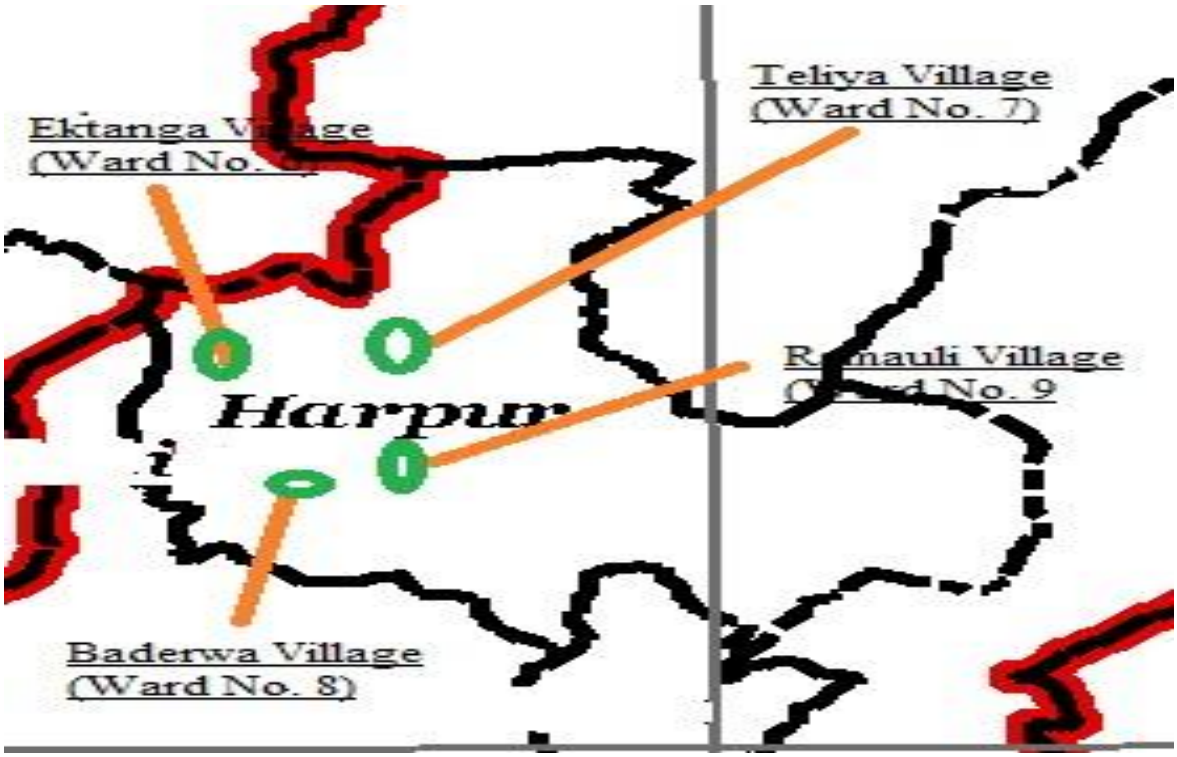

Figure 2: Map of Harpur VDC showing study area.

3.2 Materials

The materials used during research work have been listed below:

3.2.1 Materials for Laboratory

I. Beakers
II. Mortar/Pestle
III. Glass rod
IV. Slides
V. Cover slips
VI. Tea strainer
VII. Measuring Cylinder
VIII. Droppers
IX. Toothpicks
X. Centrifuge tubes
XI. Test tubes
XII. Electric microscope
XIII. Cottons
XIV. Gloves and Masks
XV. Stage micrometer
XVI. Oculo micrometer

3.2.2 Materials for field

I. Sterile vials
II. Forcep
III. Camera.

3.3 Chemicals required

I. Potassium dichromate (K2Cr2O7)
II. Water
IV. Zinc sulphate solution
IV. Sodium chloride solution
V. 10% Formalin
VI. Ethyl acetate

5.3 Study Design

The cross-sectional study was designed on basis of total duck population to assess the parasitic prevalence among ducks of ward no. 6 (Ektanga), 7 (Teliya), 8 (Baderwa) and 9 (Ramauli). The duck population comprised of Mallard, Peking, Indian runner, khaki Campbell, Muscovy and their cross breeds reared by farmers in conventional practice. The study included a) Selection of major duck farming households of four wards. b) Collection of fresh faecal samples in sterile vials. c) Preservation of faecal samples in 5% Potassium dichromate solution. d) Examination of faecal samples by using floatation, sedimentation and wet mount technique. e) Identification and measurement of eggs of different parasites.

5.3.1 Sample size

Out of total 200 fresh faecal samples of domestic ducks, 50 samples were collected from each four wards from October to November, 2016. Among them 105 were of male and 95 were of female ducks.

3.4.2 Sample collection

At first, in each ward 10 houses having maximum flock size (15-35) were selected for faecal sampling and house owners were convinced to help in sampling. Total 40 houses were selected from 4 wards. From each house 5 samples were collected among which male and female ducks were isolated separately in bamboo basket (photo. 7) with the help of owners overnight and samples (photo. 8) were collected in morning in sterile vial. After collection of faecal samples, the samples containing vials were marked.

3.4.3 Preservation of samples

After collection of faecal samples, they were preserved (photo.9) in 5% Potassium dichromate that help in maintaining the morphology of protozoan parasites and preventing further development of some helminthic eggs and larvae.

3.5 Microscopic Examination

The samples were examined in Central Veterinary Laboratory (CVL) Tripureshwor. The eggs of different parasites were identified according to the morphology of eggs by saline wet mount (Soulsby 1982), formal-ethyl floatation method (Acharya 2012) and zinc sulphate

sedimentation method (Foreyt, 2001) by senior veterinary experts. Photographs were taken of identified eggs using camera in CVL.

3.5.1 Saline wet mount

Small quantity of faecal was mixed in a drop of saline water placed on a clean slide using tooth pick. Any grass fiber or particles were removed and covered with coverslip. The smear was examined under microscope at 10X and 40X magnification.

3.5.2 Concentration method

Eggs/cysts/parasites are often low number in faeces so they are difficult to be detected in direct smears or mounts. Therefore, formal-ethyl sedimentation method (Acharya, 2012) and zinc sulphate floatation method (Foreyt, 2001) were performed.

a. Sedimentation technique

This technique is used for detection of trematode eggs. It provides a better result as the eggs of trematode are bit heavier than the other. Sediments of centrifuged contents were taken for eggs detection. In this method, approximately 2gm sample was dissolved in 10ml saline solution and filtered through tea stainer into a conical centrifuge tube. The suspension was centrifuged at 2000 rpm for 5 minutes, the supernatant was decanted and the sediment was washed with 10 ml of saline solution. After that, the supernatant was mixed with 10 ml of 10% formalin and allowed to stand for 5 minutes to effect fixation. 2 ml of ethyl acetate was mixed and shaked vigorously. The mixture was centrifuged at 1500 rpm for 5 minutes. The top three layers of ethyl acetate, debris and formalin were removed with a pipette. The remaining sediment was mixed with remaining fluid and transfered one drop each to a drop of saline and iodine on a glass slide, Covered with a coverslip then examined microscopically for the presence of parasitic forms (Acharya, 2012).

b. Floatation technique

This technique ensures the eggs float in the floatation liquid, which helps to separate protozoan cyst, oocysts, helminthes eggs and larva through the use of liquid with a high specific gravity. Approximately 2gm of faecal samples was taken in a beaker and 20 ml of water was added. The sample was grinded lightly with the help of pistle and the solution was filterd by tea strainer. 5 ml filtrate solution was poured into a centrifuge tube and added 15 ml zinc sulphate solution. Mixture was centrifuged at 1500 rpm for five minutes. After centrifuged, more zinc sulphate solution was added to develop convex meniscus at the top of the tube and a coverslip was placed for a five minutes. It was then removed from tube, placed on glass slide and examined microscopically at 10X and 40X (Foreyt, 2001).

3.6 Measurement of Diameter of Eggs

The eggs were identified in faecal samples of duck, on the basis of their shape and size. Eggs size were measured by using micrometry.

3.7 Eggs identification

Table 1: Identification of eggs with their characteristics

S.N.	Parasites	Size (µm)	Content of egg	Morphological characteristics of egg
		Helminthes		
1.	*Ascaridia* sp.	73-92 x 45-57	Not embryonated	Oval with thick shell.
2.	*Capillaria* sp.	53-80 x 20-35	Not embryonated	Barrel shape with bipolar plugs, thick and rough shell.
3.	*Heterakis* sp.	59-75 x 43-60	Not embryonated	Ellipsoid with thick shell.
4.	*Syngamus* sp.	78–100 x 43-60	Having 4-8 cleavage stage.	Ellipsoid with thick shell.
5.	*Echinostoma* sp.	88-116 x 58-69	Not embryonated	Ellipsoid with thin shell.
6.	*Amidostomum* sp.	110-150 x 82-90	Embryonated	Ellipsoid with thick shell.
7.	*Oxyspirura* sp.	50-65 x 30-45	Larvae	Ellipsoid with thick shell.
8.	*Prosthogonimus* sp.	27-50 x 18-31	Not embryonated	Ellipsoid and Operculated

On the basis of morphology and content of eggs as published in literature journals and books (Soulsby, 1982 and Permin and Hansen, 1998) eggs were identified.

3.8 Data analysis and statistical analysis

On the basis of laboratory experiment, the data was recorded. The recorded data were analysed using "R", version 3.3.1 software packages. Chi-square test was used for statistical analysis of data. $P<0.05$ was considered for statistically significant difference. Percentage was used to calculate prevalence.

Pictures of duck, Samples and laboratory activities.

Photo 1: Ducks in rest position during mid-day.

Photo 2: Muscovy and mallard ducks.

Photo 3: Ducks grazing in paddy field.

Photo 4: Wooden pen of duck.

Photo 5: Ducks isolated for sampling.

Photo 6: Samples for collection.

Photo 7: Samples marked and preserved in 5% Potassium dichromate.

Photo 8: Sample observation under electric microscope.

Photo 9: Sample examination (Concentration method).

4. RESULT

4.1 Gastrointestinal Parasites of duck

During the study period, a total of 200 faecal samples of domestic duck (105 males and 95 females) were taken from four wards of Harpur VDCs, 50 samples from each ward i.e. ward no.6 (Ektanga), ward no. 7 (Teliya), ward no. 8 (Baderwa) and ward no. 9 (Ramauli) and examined by using saline wet mount method, floatation method and sedimentation method.

4.1.1 Overall positive and negative cases of GI parasite in duck

Out of 200 faecal samples 147 (73.5%) were infected with eggs of one or more parasites (fig.1).

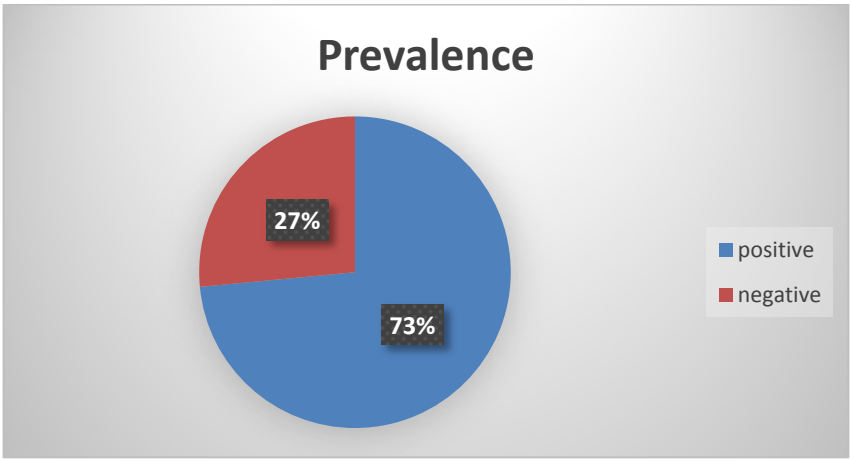

Fig.1: Overall prevalence of positive and negative cases

4.1.2 Area wise prevalence of GI parasite in ducks

Among 200 samples investigated from 4 different wards of Harpur VDCs in Parsa district i.e. .ward no.6 (Ektanga), ward no. 7 (Teliya), ward no. 8 (Baderwa) and ward no. 9 (Ramauli) 147/200 (73.5%) was found to be positive for one or more species of helminthes eggs. The highest prevalence (82%) was revealed in ward no. 8 (Baderwa) followed by ward no.9 (Ramauli) (76%), ward no.7 (Teliya) (72%) and ward no.6 (Ektanga) (64%) respectively. There was no statistical significant difference in prevalence of GI parasites among four wards (χ^2=1.3549, d.f =3, p>0.05) (Table 1).

Table 1: Area wise prevalence of GI parasite in duck.

Ward no. (Village) name	Total no. of sample	Positive cases	Prevalence %	χ^2	P-value
Ward no.6 (Ektanga)	50	32	64	1.3549	0.7161
Ward no.7 (Teliya)	50	36	72		
Ward no.8 (Baderwa)	50	41	82		
Ward no.9 (Ramauli)	50	38	76		

4.1.3 Overall general prevalence of specific GI parasites in ducks.

Out of 200 samples examined, A total of six nematodes (83.5%) and two trematodes (32%) parasitic eggs were isolated and identified whereas none of the Cestode parasitic infection were found. Among the Nematode parasites *Ascaridia* sp. 60 (30%) was found to be the most prevalent followed by *Capillaria* sp. 40 (20%), *Heterakis* sp. 36 (18%), *Syngamus* sp. 21 (10. 5%), *Amidostomum* sp. 6 (3%) and *Oxyspirura* sp. 4 (2%) respectively. Regarding Trematode parasites *Echinostoma* sp. 46 (23%) was the most frequently encountered followed by *Prosthogonimus* sp. 19 (9%).

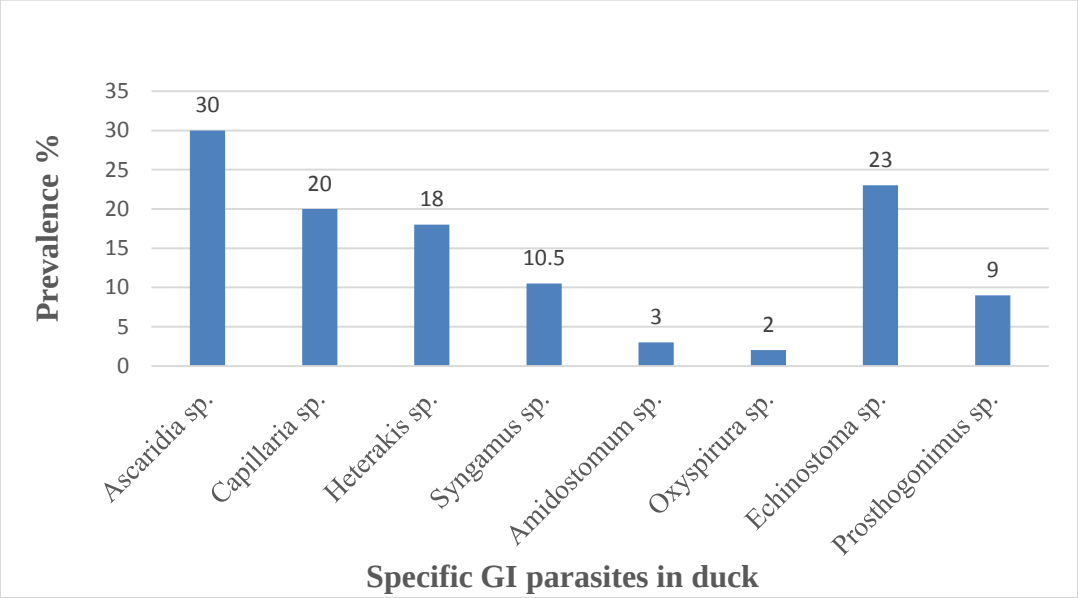

Fig.2: Specific GI parasites in ducks

4.1.4 Area wise comparative study on diversity of gastrointestinal parasites of ducks

Area wise distribution of parasites showed that the highest prevalence of nematode was revealed in ward no.8 (Baderwa) (88%) followed by equal prevalence in ward no.7 (Teliya) and ward no.9 (86%) and ward no.6 (Ektanga) (74%). Among nematodes, *Syngamus* sp. showed highest prevalence (33.33%) in Ektanga and lowest (9.5%) in Baderwa, *Capillaria*

sp. showed maximum prevalence (30%) in Ektanga and minimum (20%) in Teliya. High prevalence rate of *Ascaridia* sp. (35%) was found in Teliya and low in Ektanga (16.66), *Heterakis* sp. (33.33%) in Baderwa and (13.88%) in Ektanga. Similarly, high prevalence of *Amidostomum* sp. (50%) was found in Baderwa and low in Ektanga (16.66%) but *Amidostomum* sp. parasite was not detected in Teliya. The prevalence of *oxyspirura* sp. was observed similar in Ektanga (50%) and Ramauli (50%) but remaining two were free from it.

Table 2: Area wise comparative study on diversity of gastrointestinal parasites of ducks

S.N.	Nematodes and % prevalence	Location				
		Ward no.6 (Ektanga)	**Ward no.7 (Teliya)**	**Ward no.8 (Baderwa)**	**Ward no.9 (Ramauli)**	**Total (n)=200**
1.	*Syngamus* sp.	7(33.33)	6(28.57)	2(9.520	6(28.57)	21(10.5)
2.	*Capillaria* sp.	12(30)	8(20)	11(27.5)	9(22.5)	40(20)
3.	*Ascaridia* sp.	10(16.66)	21(35)	16(26.66)	13(21.66)	60(30)
4.	*Heterakis* sp.	5(13.88)	8(22.22)	12(33.33)	11(30.55)	36(18)
5.	*Amidostomum* sp.	1(16.66)	0	3(50)	2(33.33)	6(3)
6.	*Oxyspirura* sp.	2(50)	0	0	2(50)	4(2)
Trematodes and % prevalence						
1.	*Prosthogonimus* sp.	3(16.66)	2(11.11)	5(27.77)	8(44.44)	18(9)
2.	*Echinostoma* sp.	8(17.39)	15(32.60)	13(28.26)	10(21.73)	46(23)

Prevalence of trematode parasite were found equal in Baderwa (36%) and Ramauli (36%) followed by Teliya (34%) and Ektanga (22%). *Prosthogonimus* sp. (44.44%) was highly prevalent in Ramauli and least in Teliya (11.11%). *Echinostoma* sp. was observed maximum (32.60%) in Teliya and minimum (17.39%) in Ektanga (Table 2).

4.1.5 Overall sex wise prevalence of gastro-intestinal helminths in ducks

Out of 200 samples collected, 105 were male and 95 were female. Sex wise 77 males (73.33%) and 70 females (73.68%) were found to be infected with one or more parasite. The prevalence of GI parasite in duck in relation to gender revealed that female were highly infected than male as summarized in (Table 3).

Table 3: Overall sex wise prevalence of gastro-intestinal helminths in ducks

Determinant	Parameter	Duck examined =(200)	Duck infected	Incidence (%)	χ^2	p-value
Sex	Male	105	77	73.33	1.5018	1
	Female	95	70	73.68		

The study showed the higher percentage of females infected with GI parasite than male but there was statistical in significant difference in sex wise prevalence of GI parasite in duck (χ^2=1.5018, p>0.05).

4.1.6 Sex wise prevalence of GI parasites in different study areas

Table 4: Sex wise prevalence of GI parasites in different study areas

Ward no. (village)	Sex	No. of samples examined	No. of positive samples	Incidence (%)	χ^2	p-value
Ward no.6 (Ektanga)	Male	28	20	71.42	1.135	0.28
	Female	22	12	54.54		
	Total	50	32	64		
Ward no.7 (Teliya)	Male	25	16	64	0.825	0.36
	Female	25	20	80		
	Total	50	36	72		
Ward no.8 (Baderwa)	Male	26	20	76.92	0.256	0.61
	Female	24	21	87.5		
	Total	50	41	82		
Ward no.9 (Ramauli)	Male	26	21	80.76	0.25	0.61
	Female	24	17	70.83		
	Total	50	38	76		

Sex wise distribution of parasites among different wards showed highest prevalence (80.76%) in male duck of Ramauli and least (64%) in Teliya. Similarly, among females the highest prevalence (87.5%) was revealed in Baderwa and least (54.54%) in Ektanga. There was no statistical significant difference in prevalence of GI parasites between male and female duck of each ward as result shown in (Table 4).

4.1.7 Types of infection

Table 5: Types of infection

S.N.	Type of infection	Ward no.6 (Ektanga) %	Ward no.7 (Teliya) %	Ward no.8 (Baderwa) %	Ward no.9 (Ramauli) %	Total (%) N=200	χ^2	p-value
1.	Single	18(36)	14(28)	21(42)	18(36)	71(35.5)	2.0864	0.5547
2.	Double	12(24)	19(38)	18(36)	19(38)	68(34)	0.352	0.9498
3.	Multiple	2(4)	3(6)	2(4)	1(2)	8(4)	-	-

In different study area, ducks were found to be infected with single, double and multiple gastrointestinal parasites. Single infection was most prevalent in ducks of Baderwa (42%) than least (28%) in Teliya. Double infection was equally identified in Teliya and Ramauli (38%) with minimum (24%) in Ektanga. Likewise, Multiple infection was observed higher (6%) in Teliya and least (2%) in Ramauli (Table 4). There was no statistical significant difference in prevalence of infection among different study area (chi=2.0864, d.f=3, p>0.05 for single, chi=0.352, d.f= 3, p>0.9498 for double). Since ducks are prone to one or more GI parasites at same time, the prevalence rate (35.5%) was noted for single infection followed by double (34%) and multiple (4%). The study showed the effects of study area on infection status of parasites as summarized in fig.3

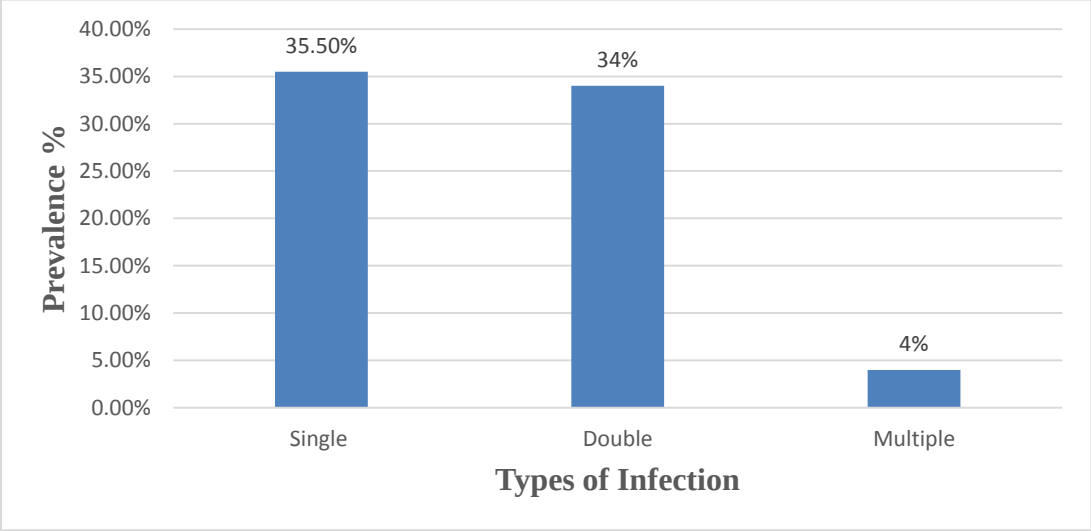

Fig.3: Overall infection status in GI parasites in duck.

4.1.8 Intensity of parasitic infection

Heavy infection parasite was considered in those sample which has 6 or more eggs observed per sample. Among total positive samples heavy infection was revealed for *Capillaria* sp. (4.5%), *Echinostoma* sp. (6%), *Ascaridia* sp. (1.5%) and *Prosthogonimus* sp. (0.5%). While prevalence of light infection i.e.< 2 egg per sample was found minimum for *Amidostomum* sp. (1.5%) and *Oxyspirura* sp. (1.5%) and moderate infection i.e. 2-4 egg per sample was observed low in *Oxyspirura* sp. (0.5%) and *Amidostomum* sp. (1.5%) in (Table 5).

Table 6: Overall intensity of parasitic infection (%) positive.

Parasites	Light (<2)	Moderate (2-4)	Heavy (>6)
Nematodes			
Oxyspirura sp.	3(1.5)	1(0.5)	0
Syngamus sp.	10(5)	11(5.5)	0
Amidostomum sp.	3(1.5)	3(1.5)	0
Capillaria sp.	8(4)	23(11.5)	9 (4.5)
Ascaridia sp.	40(20)	17(8.5)	3(1.5)
Heterakis sp.	20(10)	16(8)	0
Trematodes			
Prosthogonimus sp.	12(6)	5(2.5)	1(0.5)
Echinostoma sp.	11(5.5)	21(10.5)	12(6)

4.1.9 Area wise parasitic intensity

In each four wards, there was comparative study on parasitic intensity. In ward no.6 moderate intensity of parasite was found higher (44%) followed by light intensity (38%) and heavy intensity (14%). While prevalence of light intensity was reported high (64%) in ward no.8 in comparison to moderate intensity (48%) and heavy intensity (4%). Similarly, In ward no.7 light intensity was revealed (58%) followed by moderate intensity (50%) and heavy intensity (16%). Likewise, moderate intensity (56%) was found higher in ward no.9 followed by light intensity (54%) and heavy intensity (12%). Hence among four study area light intensity (64%) was reported higher in ward no.8, higher moderate intensity (56%) in Ramauli and higher heavy intensity (16%) in Teliya fig.4.

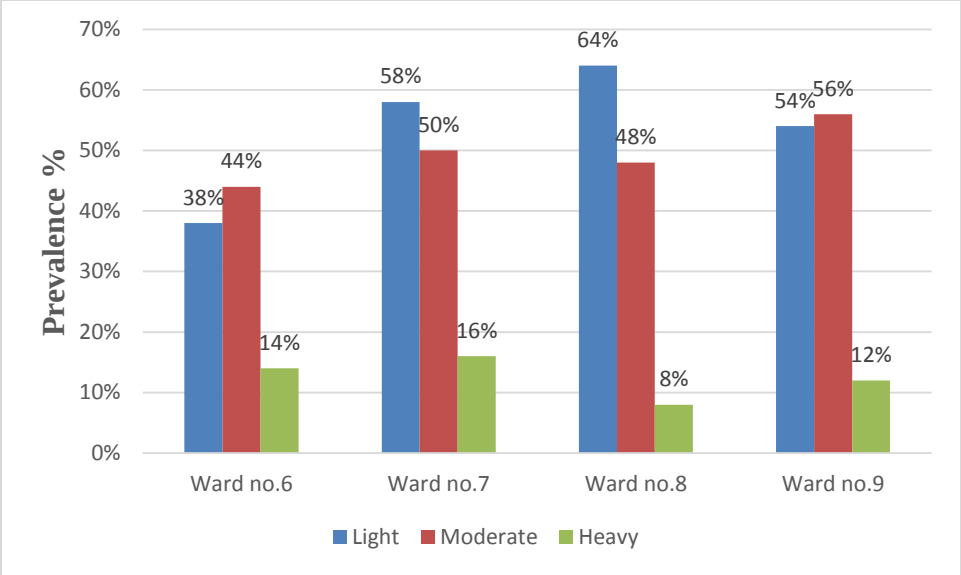

Fig.4: Area wise parasitic intensity

4.1.10 Overall prevalence of intensity of parasite

Overall intensity of parasite was measured as light, moderate and heavy. In the analysis light infection (53.5%) was revealed followed by moderate intensity (49.5%) and heavy intensity (12.5%). Overall prevalence of parasitic intensity was summarized in fig.5. There were significantly difference between intensity of parasite (χ^2=21.517, d.f =2 and p=2.126e-05).

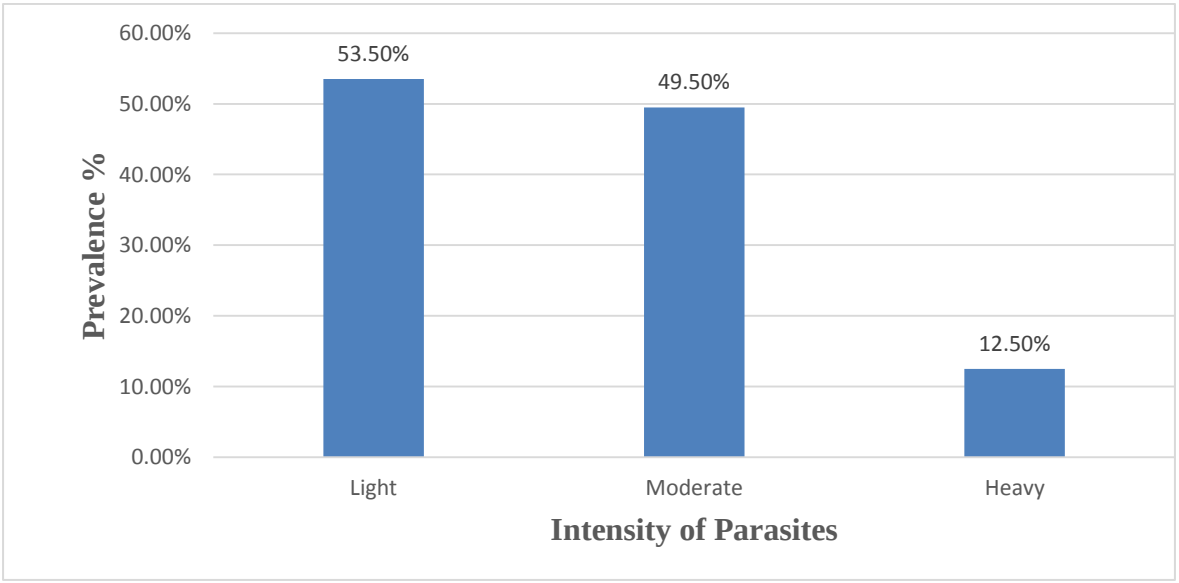

Fig.5: Overall intensity of parasite

Eggs of GI parasites in duck under 10X and 40X electronic microscope.

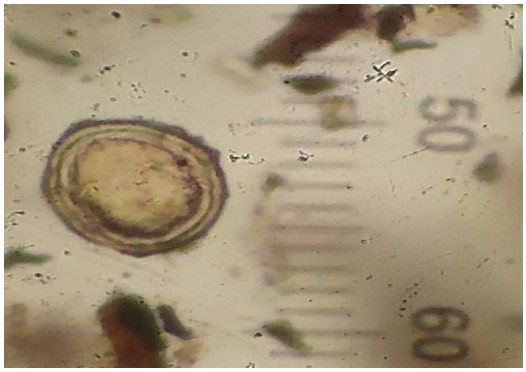

Photo 10: *Ascaridia* sp. egg
(72.59 µm)

Photo 11: *Capillaria* sp. egg
(82.96 µm)

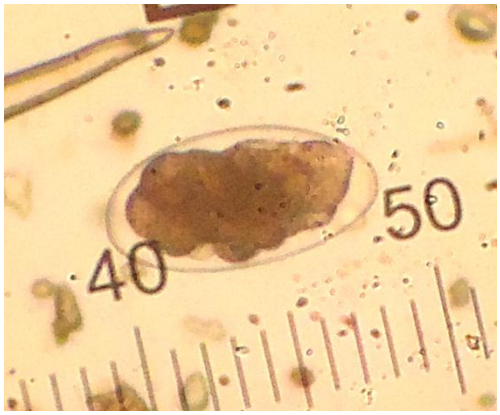

Photo 12: *Syngamus* sp. egg
(93.33 µm)

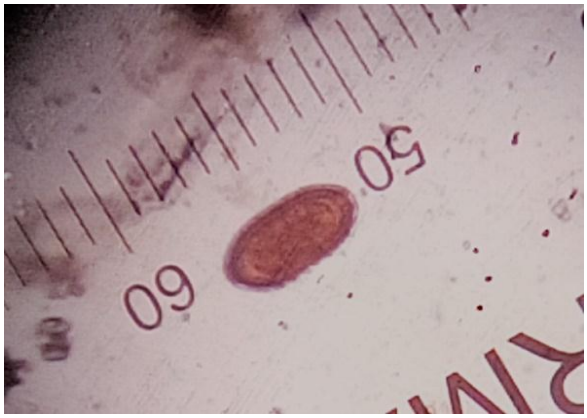

Photo 13: *Heterakis* sp. egg
(62.22 µm)

Photo 14: *Amidostomum* sp. egg
(103.52 µm)

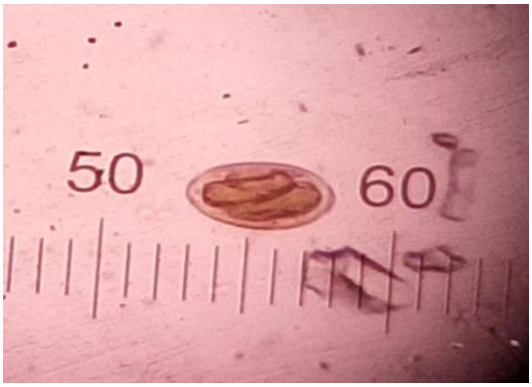

Photo 15: *Oxyspirura* sp. egg
(62.22 µm)

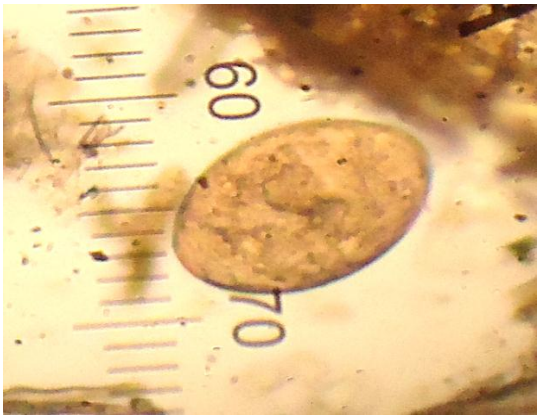

Photo 16: *Echinostoma* sp. egg
(103.52 µm)

Photo 17: *Prosthogonimus* sp. egg
(51.85 µm)

5. DISCUSSION

In the present study, gastrointestinal parasites were found to be 73.5% in duck of 4 different wards of Harpur VDCs i.e. ward no.6 (Ektanga), ward no. 7 (Teliya), ward no.8 (Baderwa) and ward no.9 (Ramauli). The prevalence rate was low as compared to 95.4% in Nigeria (Adejinmi and Oke (2011) and 96.7% in Bangladesh (Farjana *et al*., 2004) but the prevalence rate was higher than 47.5% (Al-Labban *et al*., 2013) in Iraq and 52% (Muhairwa *et al.,* 2007) in Tanazia. The result 70.50% and 79% reported by Farias and Canaris (1986) from Maxico and United states and Yousuf *et al*., (2014) from North Iran concur with present study. This disparity might be due to variations in the method of study, climatic condition and husbandry practices. The presence of water sources like pond, canal, paddy field and intermediate host might be the cause of high prevalence rate of GI parasites in ward no.8 (Baderwa) than other pocket areas. Statistically, difference in prevalence of GI parasitic infection among study area was found to be insignificant (χ^2=1.3549, P>0.05, d.f =3). It might be because of similar climate, food resources and environment. The high prevalence of nematode infections recorded in ward no.8 could be an indication of a high incidence of the infective stages and intermediate hosts of the parasites such as beetles, ants, earthworms and snails which form part of the diet of duck and helps in indirect life cycle of nematodes (Permin and Hanson, 1998).

Diversity of bird endoparasite assemblages may be related with many factors, which may include home range, behaviour, size and roosting habit of the host (Begum and Sehrin, 2012). During the study, the overall prevalence of nematode was observed 83.5% which was slightly higher than 77.3% reported by kavetska *et al.,* (2013) from North west Poland, 10% (AL-Labban *et al.,* 2013) from Iraq and 2.72% (Aboulaima *et al.,* 2011) in Egypt. Nematode eggs isolated and identified in present study were *Capillaria* sp., *Syngamus* sp., *Ascaridia* sp., *Heterakis* sp., *Amidostomum* sp. and *Oxyspirura* sp.. Among six different identified gastrointestinal parasites in present study, the prevalence rate of *Ascaridia* (30%) was highest. The prevalence rate of *Ascaridia* (30%) was higher than 23.4% (Muhairwa *et al.,* 2007) in Tanazia and 14% (Hoque *et al.,* 2014) from Bangladesh. The prevalence rate in this study was lower as compared with 85.67% and 46.85 reported in previous study (Paul *et al.,*(2014) from Gombe and Adejinmi and Oke, (2011) from Nigeria. The possible migration of *Ascaradia* sp. to liver, trachea and lung for development also suggest low prevalence (Michel, 1974) and even difference in ecology or they may be in their juvenile stage. The prevalence rate of capillaria sp. (20%) was consistence with the finding 21.7% and 36.83% of Adjenim and Oke, (2011) and Paul *et al.,* (2014) but differ with 8% and 7.3% observed in study of Hoque *et al.,* (2014) and Muhairwa *et al.,* (2007) from Tanazia. The larva of *capillaria* sp. develops inside the earthworm and becomes infective within two to four weeks and can survive inside it for years (Davis *et al.,* 1971). There was not much difference in prevalence rate of *Capillaria* sp. among four study areas due to same geographical area and

ecology. Different species of *Capillaria* i.e: *Capillaria anatis* (0.5%) , *Capillaria annulata* (3.1%) and *Capillaria contorta* (7.3%), were reported by Muhairwa *et al.,* (2007) from Tanazia, similarly, *Capillaria contorta* (36.83%) and *Capillaria annulata* (21.83%) were observed in previous study of Paul *et al.,* (2014) from Gombe but present study was done upto genus level only because identification to species level is impossible without genetic sequencing or access to the adult worms. The prevalence rate (10.5%) of *Syngamus* sp. infection present in present study was similar with 7.4% of previous study of Adejinmi and Oke, (2011) but contradicts with 0.67% of Paul *et al.,* (2014).

In the present study, the rate of *Heterakis* infection (18%) was low in comparison to 23.4% and 79.50% observed in study of Adejinmi and Oke (2011) and Paul *et al.,* (2014) but prevalence rate was higher than 1.8% and 4% in previous study of Aboulaima *et al*., (2011) from Egypt and Hoque *et al*., (2014). The result of present study concur with *Heterakis gallinarum* (14.1%) of Muhairwa *et al*., (2007). Some other species like *Heterakis dispar* (0.5%) and *Heterakis isolanche* (2.6%) were also reported in study of Muhairwa *et al*., (2007) Tanazia. The low prevalence rate may be due to difference in sampling method, study method and study was not possible upto species level only on the basis of morphology of eggs. *Heterakis* sp. are seen less in winter season in temperate region (Permin and Jorgen, 1998). *Heterakis gallinarum* is non-pathogenic, but a vector for *Histomonas meleagridis* which is highly pathogenic etiologic agent of "Black-head" disease lethal to chickens, duck, turkeys, pheasants and other fowls (Cheng, 1973).The prevalence rate of *Amidostomum* sp. was 3% very much low compared with 49.4% and 98% of previous study (Kavetska *et al*., 2013 and Herman *et al*., 1955). Present study highlighted low prevalence of *Amidostomum* sp. than other findings may be due to difference in study design as they had collected sample according to season, age, breed and sex of duck. Samples of present study were collected in the middle of winter season during which beetles or other arthropods were not much available which agrees with Anisuzzaman *et al.* (2006) who commented highest prevalence of *A. anseris* in summer season.

In present study, the infection of *Oxyspirura* sp. was found (2%), this is the first record of this parasite in duck. This parasite is located under the nictitating membrane, in the naso-lacrimal ducts or conjunctival sacs and the eggs are passed through the lacrimal duct, swallowed and passed out with the faeces developing the intermediate stages in cockroaches (*Pycnoscelus surinamensis*) affecting chickens, turkeys, guineafowl and peafowl in tropical and subtropical area (Permin and Hanson, 1998). The gastro-intestinal parasites encountered in domestic chickens are common parasites of ducks (Fowler, 1996; Muhairwa *et al*., 2007). *Echinuris* sp. were reported from Mexico and United states (Farias and Canaris, 1986). *Echinuris uncinata* were recovered from the caecum by post mortem in Northeastern Nigeria (Paul *et al*., 2014). *Subulura brumpti* was recovered from the caecum by post mortem in Northeastern Nigeria (Paul *et al.,* 2014), in Tanazia (Muhairwa *et al*.,

2007). In Tanazia, nematodes like *Subulura strongyilina* and *Subulura sucturia* were also discovered in gastrointestinal tract by Muhairwa, *et al.,* (2007). *Tetramere* sp. were diagnosed in Mexico (Farias and Canaris, 1986). *Tetrameres fissipina* was recovered from the gizzard in Northeastern Nigeria (Paul *et al.,* 2014). *Tetrameres crami* was found in Italy (Swales, 1933). *Hadjelia neglecta* was originally described from a domestic duck in Brazil by (Lent and Frietas, 1939) from Glades County. Farias and Canaris (1986) recovered *Epomi diostomum crami*, *Hystrichis uarispinosus* and *Rusguniella arctica* helminths from the gastr ointestinal tract of Mexican ducks from Mexico and the United States. From North Iran, *Contracaecum* larvae was found from stomach wall revealed from green winged teal (*Anas crecca*) by post mortem method (Youssefi *et.al*., 2014). Al-Labban *et al*., (2013) examined the internal organs and faecal samples of duck in Al-Diwaniya city and recorded nematode *Hystrichis tricolour* for the first time in Iraq. These nematode parasites were not isolated from present study.

The trematode species identified in the faecal and post mortem examination of domestic and wild ducks are *Dietziella egregia, Neohematotrephus brasilianum, Psilocollaris* sp., *Stromitr ema* sp., *Michajlovia migrate, Ptychogonimus megastoma*. *Hypoderaeum conoideum* from Southern Iraq (Jaffar, 2016), in Mexico and the United States (farias and Canaris, 1986), in Thailand (Saijuntha et al., 2013). *Notocotylus attenuates* and *Prosthogonimus cuneatus* in Mexico and the United States (Farias and Canaris, 1986), from North Iran in green winged teal (*Anas crecca*) (Youssefi *et al.,* 2014). *Zygocotyle lunata* in Mexico and the United State (Farias and Canaris, 1986). *Echinoparyphium recuruatum* was reported in Thailand (Saijunth a *et al*., 2013). *Echinoparyphium paraulum* and *Echinoparyphium recurvatum* were reported in Egypt (Aboulaima *et al*., 2011). *Tracheophilus cymbium* in Nigeria (Adejinmi and Oke, 2011). *Echinostoma* sp. Farias and Canaris (1986) in Mexico and the United States, in Thailand (Saijuntha *et al*., 2013) and in Dhaka (Musa *et al*., 2012). However, in the present study *Echinostoma* sp. and *Prosthogonimus* sp have been only observed. Among trematodes, *Echinostoma* sp. *and Prosthogonimus* sp. have been reported in duck (Permin and Hanson, 1998). *Echinostoma* sp. was found with 23% of prevalence rate in present study which was similar to 30% in the study Musa *et al*., (2012) in Dhaka. It is higher than prevalence rates of 10.8% as compared to Farias and Canaris (1986). *Echinostoma* sp. has three hosts in their life cycle: first intermediate host (Snail sp. such as *Lymnaea* sp.), second intermediate host (tadpoles and small freshwater fish) and a definitive host (duck) (Huffman and Fried, 1990). The high prevalence of *Echinostoma* sp. might be due to the availability of snail intermediate hosts as they are set free to graze in paddy field and nearby water resources. From the present study, *prosthogonimus* sp. infection was found higher 9% as compared to 0.8% in previous study of Farias and Canaris, (1986) in Mexico. The prevalence rate was found high due to presence of intermediate host snail and dragonfly.

About finding of cestode, the present study is in close agreement with the observations of Muhairwa *et al.*, (2007), Farias and Canaris, (1986) and Adejinmi and Oke (2011), who despite the high prevalence of gastro-intestinal helminths did not find cestodes in adult ducks. Diagnosis of *Raillietina* sp. is usually done by post-mortem upon autopsy, since proglottids are seen in faeces rather than eggs (Ritchie *et al.*, 1997) might be reason for absence of *Raillietina* sp. or might be because of inavailability of earthworm, beetles, flies, ant or grasshopper as samples were collected during winter season.

In this study, out of total male (105) 73.33% and female (95) 73.68% were positive for gastrointestinal parasites. This result is similar to the result of Yousuf *et al*., (2009) in Bangladesh who reported that maximum number of females were highly infected with gastrointestinal parasites than male in comparison to the study of Adang *et al*., (2014) who revealed that males were highly infected than female which contradicts with present study. It may be due to laying of eggs by the females without getting proper household balanced nutritional supply, poor immune status to combat the parasitic infection and some hormonal influence (Islam *et al*., 2008). Generally, malnourished individuals are more susceptible to any parasitic infection and carry more parasites (Soulsby, 1982 and Permin and Hansen, 1998). There was no significant differences (χ^2=1.5018, P>0.05) in the overall sex wise prevalence of gastrointestinal parasite in duck in present study. On the basis of comparative study done in different area sex wise prevalence of gastrointestinal parasites revealed that Male duck of ward no.9 (80.76%) and female duck of ward no.8 (87.5%) were highly infected. Hence, There was also no significant differences in prevalence of gastrointestinal parasites between male and female of four wards (χ^2=1.135, P=0.28 for Ektanga, χ^2=0.825, P=0.36 for Teliya, χ^2=0.256, P=0.61 for Baderwa and χ^2=0.25, P=0.61 for Ramauli).

In the present study, three types of infection i.e. single, double and multiple infection were observed. Among study area single infection was observed high in ward no.8 (Baderwa) 42% followed by double infection (36%) and multiple infection (4%). Likewise,in ward no.6 (Ektanga) also single infection was found higher (36%) followed by double infection (24%) and multiple infection (4%). In ward no.7 (Teliya) single infection was observed (28%), double (38%) and multiple (6%) while (36%) single, (38%) double and (2%) multiple infection in ward no.9 (Ramauli). Single parasitic infections were recorded to be more common in duck in this study, which agrees with the observations of Muhairwa *et al*. (2007) in Tanazia, Yousuf *et al*. (2009) and Adejinmi and Oke (2011) in Nigeria but this study contradicts with the study of Paul *et al*., (2014) in Gombe where mixed infection was recorded higher. This may conclude that the first parasite to infect the host may acquire higher micro-habitat and establishment than the late entrants. Kennedy (1975), argued that food preference at a particular time may determine the establishment of single or mixed infections and older birds have strong immune system. The limitation of mixed infections to only a maximum of three helminths per bird indicates that both host species could be less susceptible to mixed infections (Adang *et al*., 2014). There was insignificant differences in

prevalence of infection among different study area (χ^2=2.0864, d.f=3, P=0.5547 for single; χ^2=0.352, d.f=3, P=0.9498 for double).

The intensity of parasites in ducks of four wards were observed in this study which revealed light intensity (64%) as higher in ward no.8, higher moderate intensity (56%) in ward no.9 and higher heavy intensity (16%) in ward no.7. According to overall study, maximum numbers of ducks were found to be infected with light infection which is asymptomatic condition and cannot cause the diseases while less numbers of ducks were infected with heavy infection revealed by *Capillaria* sp., *Ascaridia* sp., *Echinostoma* sp. and *Prosthogonimus* sp.. The heavy infection is symptomatic condition and cause serious diseases. Other researchers have recorded intensity of parasites by mean density where no. of worms per bird was calculated (Farjana *et al.*, 2008; Saijuntha *et al*., 2013 and Musa *et al*., 2012). There were significantly difference between intensity of parasites (χ^2=21.517, d.f= 2, P< 0.05). As a whole, there is maximum chance in decrease of productivity of poultry product if diagnosis and treatment is not done on time. Due to the absence of well equipped laboratory in Central Department of Zoology, it was impossible to do further study. Since study was carried out in small flock size within limited time period, result could not include all aspects.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

From the present study, it is clear that gastrointestinal parasites are highly prevalent (73.5%) in domestic duck of four wards of Harpur VDC i.e. ward no.6 (Ektanga), ward no.7 (Teliya), ward no.8 (Baderwa) and ward no.9 (Ramauli). Finding of this study showed that gastrointestinal nematodes parasites were more prevalent than trematode helminthes in different study areas but none of cestode parasites were found. Eight different parasitic genera were identified in duck of different wards such as *Ascaridia* sp. 60 (30%), *Echinostoma* sp. 46 (23%), *Capillaria* sp. 40 (20%), *Heterakis* sp. 36 (18%), *Syngamus* sp. 21 (10.5%), *Prosthogonimus* sp. 19 (9%), *Amidostomum* sp. 6 (3%) and *Oxyspirura* sp. 4 (2%) from Harpur VDC of Parsa district. This prevalence rate showed that ducks were highly susceptible to endoparasites. The higher prevalence of GI parasites was in ward no.8 (82%) followed by ward no.9 (76%), ward no.7 (72%) and the lowest was in ward no.6 (64%). The GI parasites were found to be more prevalent in female (73.68%) as compared to male (73.33%). Single infection was more prevalent in ward no.8 (42%), double infection was equally found in ward no. 7 and 9 (38%) while multiple infection was observed more in ward no. 7 (6%). Overall *Capillaria* sp. (4.5%), *Echinostoma* sp. (6%), *Ascaridia* sp. (1.5%) and *Prosthogonimus* sp. (0.5%) revealed heavy infection in different study areas. Among nematodes identified, *Ascaridia* sp. was found to be most prevalent in all study areas. Deworming practice was only found in some houses of ward no.6 and most farmers were unaware about diseases and their symptoms.

6.2 Recommendations

Based on the outcome of present study, the following recommendations have been made to reduce the risk of gastrointestinal parasitic in poultry duck and domestic duck of rural area.

- Season-wise study and further identification on species level of parasites could be done.
- Establishment of well-equipped laboratory in Central Department of zoology,TU.

REFERENCES

Aacharya, T. 2012. Formal ether sedimentation technique for the concentration of stool parasites. In laboratory diagnosis of parasitic disease, Parasitology, Nepal.

Aboulaima, M., El-Bahy, N., Hilali, M., Yokoyama, N. and Igarashi, I., 2011. Prevalence of the enteric parasites of ducks from Behera governorate, Egypt. Journal of Protozoology Research, **21**(2): 36–44.

Adang, K.L., R. Asher and A. Abba, 2014. Gastrointestinal helminths of chickens *Gallus gallus* domestica and ducks *Anas platyrhynchos* slaughtered at Gombe State, Nigeria. Asian Journal of Poultry Science, **8**: 32-40.

Adejinmi, J.O. and Oke, M. 2011. Gastro-intestinal parasites of domestic ducks (*Anas platyrhynchos*) in Ibadan Southwestern Nigeria. Asian Journal of Poultry Science, **5**(1): 46–50.

Ahmed, S. 1969. Survey on the type of helminths commonly found in the country ducks. Pakistan Journal of Veterinary Science, **3**: 110-112.

AHRD**.** 2000. Annual Report 1999/2000. Nepal Agriculture Research Council, Ministry of Agriculture and Co-operatives, Government of Nepal.

Aiello, S. E. 1998. The Merk Veterinary Manual. 8th ed. National Publishing, Philadelphia.

Ajayi, S.A. and Ajayi, S.T. 1983. Incidence of blood and gastrointestinal parasites of domestic animals on Jos Plateau. Proceedings of the National Workshop on Diseases of Livestock and Poultry, 24- 27January, 1983, Nigeria.

Al-Labban, N. Q. M., Dawood, Kh. A., and Jassem, Gh. A., 2013. New parasites of local duck recorded in Iraq with histopathological study. AL-Qadisiya Journal of Veterinary Medical Science, **12**(1): 152-161.

Anisuzzaman; Alim, M.A.; Rahman, M.H. and Mondal, M.M.H. 2005. Helminth parasites in indigenous ducks: Seasonal dynamics and effects on production performance, Journal of the Bangladesh Agricultural University, **3**(2): 283-290.

Baghel, L.K., Santra, A.K., jogi, S., Chourasia, S.K. and Mukhergee, K. 2010. Phenotypic characterization of Muscovy duck (Cairina moschata) in terms of feather, bill and colour. Environment and ecology, **28**(1): 1050-1052.

Barta, J.R. and Thompson, R.C.A. 2006. What is cryptosporidium? Reappraising its biology and phylogenetic affinities. Trends in parasitology, **20**: 4663-4668.

Begon, M., Hazel, S.M., Baxby, D., Brown, K., Cavanagh, R. and Chantrey, J., *et al*. 1999. Transmission dynamics of a zoonotic pathogen within and between wildlife host species. Proceedings of the Royal Society, London Biological science. **266**(1432): 1939-1945.

Begum, A. and Sehrin, S. 2012. Gastrointestinal helminths in pigeon (*Columba livia* Gmelin,1789). Journal of Asian Society Bangladesh, **38**(1): 93-98.

Bhattarai, T.C. 2008. Poultry production scenario of Nepal. Paper presented in Poultry Entrepreneur's Forum, Kathmandu with collaboration with World Poultry Science Association.

Chauve, C.M., Gounel, J.M. and Reynaud, M.C. 1991. Coccidia of the mule ducks: preliminary survey in three farms of the south-west region of France. Avian Pathology, **20**: 713-719.

Cheng, T. 1973. General parasitology. Academic Press, New York, San-Francisco and London.

Collier, L., Balows, A. and Sussman, M. 1998. Parasitology in Topley and Wilson's Microbiology and Microbial Infections, 9th edition, volume 3, Arnold publication, UK.

Davis, J.W., Anderson, R.C., Karstad, L. and Trainer, D.O. 1971. Infectious and parasitic diseases of wild birds. Iowa State University Press, USA, 185-233 pp.

Delgado, C., Narrod, C. and Tiongco, M. 2008. Determinants and implications of the growing scale of livestock farms in four fast-growing developing countries. International food policy research institute Research Report No. 157. Washington, D. C.

Dhakal, I.P. 2000. Present scenario of poultry farming in Chitwan district of Nepal. Proceeding of the workshop on Avian Health in Chitwan, pp. 1-7.

Dhaubhadel, T.S. 1992. The role of monogastric and small stock, in J .B. Abington (Ed.), "Sustainable livestock production in the mountain agro-ecosystem of Nepal", Animal Production and Health Paper 105, Food and Agriculture Organization of the United Nations, Rome.

El-Shabrawy, N. 1966. Studies on some protozoa investigated in ducks and geese in Egypt with particular reference to a new blood parasite in the goose, *Cygnopsis cygnoides*. M. V. Sc. Cairo University, Egypt.

Eshetu Y, Mulualem E, Ibrahim H, Berhanu A, Aberra K (2001). Study of gastro-intestinal helminths of scavenging chickens in four rural districts of Amhara region, Ethiopia. Scientific and Technical Revue (International Office of epizootics), **20**(3): 791-796.

Farias, J.D. and Canaris, A.G. 1986. Gastrointestinal helminthes of the Mexican duck *Anas platyrhynchos* drazi ridgway, from North Central Mexico and Southwestern United States. Journal of Wildlife diseases, **22**: 51-54.

Fantham, H.B. 1924. Some parasitic protozoa found in South Africa. South African Journal of Science, **21**: 435- 444.

FAO. 1979. Nepal-Proposed improvement of duck culture in Pokhara, Bhairawa and Hetauda fisheries development centres, A report prepared for the Integrated Fishery and Fish Culture Development Project (Pokhara) by Ukrit Im erb, FAO Consultant.

FAO. 2007. Statistical databases. FAO, Rome.

FAO. 2014. Poultry Sector Nepal. FAO Animal Production and Health Livestock Country Reviews. No. 8. Rome.

Farjana, T., Alim, M.A., Das, P.M. and Mondal, M.M.H. 2004. Helminth infection in ducks at free-range and semi intensive farming in two districts of Bangladesh. Bangladesh Journal of veterinary, **38**: 125-134.

Farzana, T., Islam, K.R. and Mondal, M.M.H., 2008. Population density of helminths in ducks: effects of host's age, sex, breed and season .Bangladesh Journal of Veterinary Medicine. **6**(1), 45–51.

Forester, D.J., Kinsella, J.M., Mertins, J.W., Price, R.D. and Turnbull, R.E. 1994. Parasitic helminthes and arthropods of fulvous whistling-ducks in Southern Florida. Journal of Helminthology Society Washington, **61**(1): 84-88.

Foreyt, W.J. 2001. Veterinary parasitology reference manual. Ames, Iowa State University Press.

Fowler, N.G. 1990. How to carry out a field investigation in Poultry diseases, FTW (ed) Bailliere Tindall, London, pp 370-400.

Harrison, C. and Greensmith, A. 1993. Birds of the World, 1 edition. Dorling Kindersly publishing, London, UK, pp. 416.

Herman, C. M., Steenis, J. H. and Wehr, E. E. 1955. Causes of winter losses among Canada geese. Transaction of the North America Wildlife Conference, **20**: 161–165.

Hoque, M.A., Hassan, M.M., Islam, A., Alim, A.,Yamage, M., and Khan, S.A. *et al*., 2014. A survey of gastro-intestinal parasitic infection in domestic and wild birds in Chittagong and Greater Sylhet, Bangladesh. Preventive Veterinary Medicine, **117**(1): 305-312.

Hoque, M.A., Skerratt, L.F., Rahman, M.A., Alim, M.A., Grace, D. and Gum-mow, B., *et al*., 2011. Monitoring the health and production of household Jinding ducks on Hatia Island of Bangladesh. Tropical Animal and Health Production, **43**(2), 431–440.

Hossain, Tanveer, S., Sugimoto, Hideki, Ahmed and Jashim, G. *et al* 2005: Effect of Integrated Rice-Duck Farming on Rice Yield, Farm Productivity & Rice-Provisioning Ability of Farmers: Asian Journal of Agriculture and Development, **2**(1): 25-30.

Huffman, J.E. and Fried, B. 2012. The biology of Echinoparyphium (Trematoda, Echinostomatidae). Acta Parasitologica, **57**(3): 199–210.

Islam, M.R., Shaikh, H. and Baki, M.A. 1988. Prevalence and pathology of helminth parasites in domestic ducks of Bangladesh. Veterinary Parasitology, **29**(1): 73-77.

Islam, A., Anisuzzaman, Majumder, S., Islam, M.A., Rabbi, A.K.M.A. and Rahman, M.H. 2012. Efficacy of antihelmintics against nematodes in naturally infected free range ducks. Eurasian Journal of Veterinary Science, **28**(4): 229-232.

Jaffar, I.F. 2016. Diagnostic and taxonomical study of digestive tract parasites in duck and geese in Basrah governorate. Lambert Academic Publishing, Southern Iraq.

Jha, V. C., Rai, L. B. and Thapa, P. B**.** 1996. Report on mortality pattern of poultry in the eastern hills of Nepal, Veterinary Review, **11**(1): 14-17.

Jordan, F. T. W. and Pattison, M. 1998. Poultry Diseases. 4th edition, WB Saunders, London. Life science, **4**(3): 63-66.

Kavetska, K. M., Kalisińska, E., Kornyushin, V.V. and Kuzmin. Y. 2004. Stomach nematodes of wild ducks (subfamily Anatinae) from Northwestern Poland. Acta Parasitologica, **49**(2): 140–147.

Kennedy, C. R. 1975. Ecological animal parasitology. Blackwell scientific publications, Oxford, London, Edinburgh, Melbourne.

Kinsella, J. M., and D. J. Forrester. 1972. Helminths of the Florida duck, *Anas platyrhynchos fulvigula*. Proceedings of the Helminthological Society of Washington. **39**(2):173-176.

Krizanauskiene, A., Hellgren, O. Kosarevt, V., Sokolov, L., Bensch, S. and Valkiunas, G. 2006. Variation in host specificity between species of avian hemosporidian parasites: evidence from parasite morphology and cytochrome B gene sequences. Journal of Parasitology, **92**(6): 1319-1324.

Latif, M.A, Alam, M.J. and Rahman, M.A. 1993. Integrated duck cum fish farming in Bangladesh. Journal of the world aquaculture society, **24**(3): 402-409.

Lent, H., and J. F. T. de Freitas. 1939. Novo nematodeo parasite do pato domestic (Spiruroidea). Bol. BioL, S. Paulo **4**(2): 177-180.

McDonald, M. E. 1969. Catalogue of helminths of waterfowl (Anatidae). Bureau of Sport Fisheries Special Scientific Report No. 126. Washington, D.C. 692 pp.

Michel, J.F. 1974. Arrested development of nematodes and some related phenomena in advances in parasitology in Ben Dawes (Ed) publication: Academic Press London and New York, 277-366 pp.

Mondal, D. 2015. Zoonotic Implication of duck and chicken diseases on public health concern. Sikkim Manipal University, Medical journal, **2**(1): 317-329.

Morner, T. 2002. Health monitoring and conservation of wildlife in Sweden and Northern Europe. Annals of the New York Academy of Sciences, **969**: 34-38.

Mousa, A.A.S. 2000. Studies on cryptosporidiosis in ducks in Kafr El-Sheikh province. M. V. SC. Poultry diseases. Facts about Veterinary Medicine, Tanta University, Egypt.

Muhairwa, A.P., Msoffe, P.L., Ramadhani, S., Mollel, E.L., Mtambo, M.M.A. and Kassuku, A.A., 2007. Prevalence of gastro-intestinal helminths in free-range ducks in Morogoro Municipality, Tanzania. Livestock Research for Rural Development. **19**(4).

Musa, S., Rahman, T. and Khanum, H. 2012. Prevalence and intensity of parasites in domestic ducks. Dhaka University Journal of Biology Science, **21**(2): 197-199.

Nagwa, E.A., El-Akabawy, L.M., El-Madawy, R.S. and Toulan, E.I. 2013. Studies on intestinal protozoa of poultry in Gharbia governorate, Benha University. Department of parasitology, faculty of Veterinary Medicine, **25(**2):78-83.

Nnadi. P.A. and George, S.O. 2010. A cross sectional survey on parasites of chicken in selected villages in the sub humid zones of South Easter Nigeria. Journal of parasitology, **14**(1):1-6.

Narrod, C. 1997. Technology transfer in the poultry industry: An examination of supply factors and externalities associated with increased production. Ph.D. Dissertation. Philadelphia, University of Pennsylvania.

Narrod, C., and C. Pray. 2001. Technology transfer, policies, and the global livestock revolution. In Proceedings of the International Agricultural Trade Research Consortium Symposium on Trade in Livestock Products. , Auckland, New Zealand.

North American Waterfowl Management Plan (NAWMP) 2012. People conserving waterfowl and wetlands. http://www.nawmp.ca/org. Accessing on 7th july 2015.

Nowak, M., Kavetska, K., Królaczyk, K. Stapf, A. Korna S. and Basiaga, M. *et al*., 2011. Comparative study of cestode of geese. North America Veterinarian, **7**: 47–48.

NWPS, 1990. http;/www.scribed.com/document/62296613/NWPS-mallard-duck.

Pandey and Jiang, 1992. Observation of helminth parasites of domestic fowls in Zimbabwe. Zimbabwe veterinary, **20**: 15-17.

Paul, B.T., Lawal, J.R., Ejeh, E.F. , Ndahi, J.J. , Peter, I.D. and Wakil, Y. *et al*., 2015. Survey of Helminth Parasites of Free Range Muscovy Ducks (*Anas platyrhynchos*) Slaughtered in Gombe, North Eastern Nigeria. International Journal of Poultry Science **14** (x): xx-xvi.

Permin, A., Magwisha, H. and Kassuku A.A. 1997. A cross-sectional study of helminths in rural scavenging poultry in Tanzania in relation to season and climate. Journal of Helminthology, **71** (3): 233-240.

Permin, A., Esmann, J.B., Hoj, C.H., Hove, T. and Mukaratirwa, S. 2002. Ecto-endo and haemoparasites in free-range chickens in the Goromonzi District in Zimbabwe. Preventive Veterinary Medicine, **45**: 213-224.

Permin, A. and Hansen, J.W. 1998. Epidemiology, Diagnosis and Control of Poultry Parasites. Food and Agriculture Organization of the United Nations, Rome, ISBN 92-5-104215-2.

Qadir, A.N.M.A. 1979. Helminth parasites of domestic ducks (*Anas boschas domesticus)* of Mymensingh district, Bangladesh. Bangladesh Veterinary Journal, **13**: 43-45.

Richter, D., Wiegand-Tripp, G., Burkhardt, E. and Kaleta, E.F. 1994. Natural infections by *Cryptosporidium* sp. in farm-raised ducks and geese. Avian Pathology, **23**(2): 277-286.

Ritchie, B.W., Hsarrison, G.J., Zantop, D. and Harrison, L.R. 1997. Avian medicine: principles and application, abridged edition. Idaho Falls, ID: Wingers Publishing, 1007-1028 pp.

Santin, M. 2013. Clinical and subclinical infections within animals. Cryptosporidium. Journal of veterinary, **61**(1): 1-10.

Sharma, B. 2010. Review paper: Poultry production, management and bio-security measures. Journal of Agriculture and Environment, 11.

Saijuntha, W., Tantrawatpan, C., Sithithaworn, P., Duenngai, K.,Agastsuma, T. and Andrewa, R.H. *et al*., 2013. Zoonotic Echinostome Infection in Free Grazing Ducks in Thailand. Korea journal of Parasitology, **51**(6): 663-667.

Singh, U. M. and Bhurtel, R. 1998/99. Study of mortality of chicken at Khumaltar Poultry Farm, Annual Report, Animal Health Research Division, Nepal Agriculture Research Council, pp. 9-11.

Soliman, K.W. 1955. Observation on some helminth parasites from ducks in Southern England. Journal of Helminthology, **29**(1-2): 17-26.

Soulsby, E.J.L., 1982. Helminths, Arthropods and Protozoa of Domesticated Animals, 7th ed. Bailiere Tindal, London, UK. pp: 809.

Statistical information on Nepalese agriculture 2014/2015. Government of Nepal, Ministry of Agriculture development. Agri-Business promotion and statistics Division statistic section, Singha Durbar, Kathmandu, Nepal.

Swales, W. E. 1936. A nematode parasite of ducks in Canada. Morphological and biological studies. Canadian Journal of Research, **14**: 151-163.

Taylor, M.A., Coop, R.L. and Wall, R.L. 2007. Veterinary parasitology. Text book, 3rd ed., Blackwell Publishing.

Valiqurova, A., Jirkum, M., Koudela, B., Gelnar, M., Modry, D. and Slapeta, J. 2008. Cryptosporidia: epicellular parasites embraced by the host cell membrane. International journal of parasitology, **38**(8-9): 913-922.

Wiersch, S.C., Lubjuhn T., Maier, W.A. and Kampen, H. 2007. Haemosporidian infection in passerine birds from Lower Saxony. Journal of Ornithology, **148**(1): 17–24.

William, R. B. 2005. Avian malaria: clinical and chemical pathology of *Plasmodium gallinaceum i*n the domestic fowl, *Gallusgallus.* Avian Pathology, **34**(1): 29 – 47.

Youssefi, M.R. 2014. Gastrointestinal helminthes of green winged teal (*Anas crecca*) from North Iran. Asian Pacific Journal of tropical biomedicine, **4**(1): 143-147.

Yousuf, M.A., Das, P.M., Anisuzzaman and Banowary 2009. Gastro-intestinal helminths of ducks: some epidemiologic and pathologic aspects. Journal of Bangladesh Agriculture University, **7**(1): 91–97.