1. INTRODUCTION

1.1 Background

Nepal is a highly diverse and unique country harbouring an extraordinary variety of landscapes, cultures and wildlife. Despite making up less than 1% of the world's total land mass, its physiographic features range from the highest terrestrial ecosystem in the world, the Himalayas, to the subtropical lowlands of the Terai. This contrast makes Nepal one of the most biodiverse countries in the world, containing within its small area of 141,181 km²: 4.2% of all mammals, 8.5% of all birds and 2.2% of all flowering plants on Earth, including threatened flagship species such as the Royal Bengal Tiger (Panthera tigris tigris), Asian Elephant (*Elephas maximus*), Greater One-horned Rhino (*Rhinoceros unicornis*) and South Asian River Dolphin (*Platanista gangetica*) (Shrestha *et al*., 2007). In addition to the vast faunal diversity, 35 forest types and 118 ecosystems are present in Nepal (GoN, MoFSC 2009). Almost 25% of the country's landmass is designated as protected area, with 10 national parks, three wildlife reserves, six conservation areas and one hunting reserve (DNPWC, 2014). In 2017, the Shuklaphanta and Parsa wildlife Reserve were upgraded to National parks (DNPWC, 2017).

The protected areas of Nepal cover mainly forested land and are located at various altitudes in the Terai, in the Himalayas and in the mountains, thus encompassing a multitude of landscape and preserving a vast biodiversity in the Paleartic and Indomalayan ecozones. Altitudes range from 67 m (220 ft) in the south- eastern Terai to 8,848 m (29,029) at Sagarmatha within a short horizontal span. This extreme altitudinal gradient has resulted in 11- bio-climatic zones ranging from lower tropical below 500m (1,600 ft) to nival zones above 5,000 m (16,000 ft) in the High Himalayas encompassing nine terrestrial eco – regions with 36 vegetation types (Shrestha *et al*., 2007). Botanist recorded 1,120 species non- flowering and 5,160 species of flowering plants. Nepal rank 10 th in terms of richest flowering plant diversity in Asia. Zoologist recorded 181 mammal species 844 bird species, 100 reptile species, 43 amphibian species, 185 freshwater fish species, and 635 butterfly species (DNPWC, 2017).

Chitwan National Park is situated in South Central Nepal, Covering 952.63 sq. km. in the Subtropical lowlands of the inner Terai (DNPWC, 2017). The area comprising the Tikauli forest from Rapti river to the foothills of the Mahabharat - extending over an area of 175 sq. km (Mahendra Deer park) by the late king Mahendra in 1959 AD. In 1963 AD, the area of south of Rapti River was demarcated as a rhinoceros sanctuary. The area was gazetted as the country's first national park in 1973 AD, recognizing its unique ecosystem of the International significance. UNESCO declared RCNP a world Heritage site in 1984 AD. In 1996 AD an area of 750 sq. km surrounding the park was declared a buffer zone, which consists of forests and private lands including cultivated lands. The park consists of a diversity of ecosystem – including the Churia hills, Ox – bow lakes, and the flood plains of the Rapti, Reu and Narayani Rivers. The churia hills rise slowly towards the east from 1500 m to more than 800 m. The western portion of the park is comprised of the lower but

more rugged Someshwor hill. The park shares its eastern boundary with the Parsa Wildlife Reserve. The chitwan valley consists of tropical and subtropical forests. Sal forests cover 70 percent of the park. Grasslands cover 20 percent of the park. There are more than 50 different types of grasses, including the elephant grass *(Saccharum* sp.) renowed for its immense height which can grow upto 8 m in height. The park is home to more than 50 mammals species, over 525 birds and 55 amphibians and reptiles.

1.2 Wild boar (*Sus scrofa* Linnaeus, 1758)

The wild boar *(Sus scrofa*), also known as the Andamanese pig or Moupin piglet (Lydekker, 1990) and 'Bandel' in Nepali is species of wild boar native to India, Nepal, Burma, Western Thailand and Sri-lanka. Wild boar (*Sus scrofa*) lies on the order Artiodactyla of the Suidae. As of 2005, upto 16 subspecies are recognize, which are divided on four regional grouping based on skull height and lacrimal bone length (Wozeccraft, 2005). Wild boar (*Sus srofa*) are cosmopolitan species. They originated in Europe and Asia, but were widely introduced to North America and are considered an invasive species in the southeastern United States and California. They are common throughout Eurasia, and inhabit every continent except Antartica (Wood and Barrett, 1979; Chapman and Trani, 2007; Oliver and Leus, 2008).

1.2.1 Physical description

Wild boars range from 153 to 240 cm in length and weigh 66 to 272 kg as adults. Females tend to be smaller than males of the same age, with the size difference becoming more apparent as the animal age. Depending on their geographical location they can have speckled or solid pelage color. Their upper canine teeth typically measure 5 to 10 cm and are larger than their lower canines. Their upper canines are usually visible even when their mouth is slosed. Their dental formula is I 3/3, C 1/1, P 4/4, m 3/3 = 44 (Webster *et al*., 1985; Ickes, 2001; Chapman and Trani, 2007; De Magalhaes and Costa, 2009).

1.2.2 Behaviour

Female wild boars are social animals that tend to live in groups. These groups, called sounders, are generally made up of several females and their offsprings. Males tend to be solitary after reaching maturity and join with groups during mating. In cooler condition, the boars may feed during the day, but foraging activities usually increase at the late evening (Graves, 1984; Webster *et al*., 1985; Boitani *et al*., 1994).

1.2.3 Home range

Their home varies with several factor including the number of individuals in the group, food resource availability, geographic range and predation threats. Females tend to occupy a smaller region and keep to covered areas within a home range to protect themselves and their young. Groups of females accept some overlap between their herd and others, but

sounders remain distinct groups. Males are inclined to occupy a larger area. They tolerate overlap of ranges with other males. On average, wild boars have territorial sizes of 1.1 to 3.9 sq. km (Graves, 1984; Boitani *et al*., 1994).

1.2.4 Food habits

Wild boars are omnivorous. They predominately eat plant matter, particularly crops, fruits, nuts, roots and green plants. They have also been known to consume bird eggs, carrion, small rodents, insects and worms. Wild boars have reportedly preyed on small calves, lambs and other livestock when the opportunity presents itself (Webster *et al*., 1985; Schley and Roper, 2003; Chapman and Trani, 2007).

1.2.5 Distribution in Nepal

The wild boars lives in grassy or scanty bush jungle of Churia hills of Nepal. This species are widely distributed across Nepal including within all protected areas of lowland Terai and parts of protected areas in the highland Churia to Annapurna ranges and also occurs extensively outside protected areas (Jnawali *et al*., 2011). It frequents forests after the rains, quite commonly in high crops. Wild boars are wide spread with a surprisingly wide altitudinal range. They are most abundant in Oak and Fir forests.

1.2.6 Conservation status

In conservation status, it was considered as least concern in global and National contest because of its wild distribution range and an abundant size (IUCN, 2011). National population size: Total > 30,000. There is no population estimates available for the sp. (wild boar) in Nepal, however it is frequently observed and speculated to be in excess of 30,000 (Jnawali *et al*., 2011).

1.2.7 Parasitic infection in wild boar

Parasites are cosmopolitan and play a significant role in the morbidity and mortality of humans as well as animals in many parts of the world. These may be transmitted to their host through ingestion, skin penetratioin, by the vectors, direct contact etc. Helminths can cause disruption of the host's nutrient absorbtion by utilizing all nutrients that passes through the intestinal tract. Most prevalent are the intestinal helminthes and infection with these are most often diagnosed by finding and identifying eggs and larval form of different helminthes parasite while examing fecal sample. Parsites play a major role in ecosystems, host population growth and regulation (Chandra and Newberne, 1997) and community biodiversity (Hudson *et al*., 1992). Parasites can impact host survival and reproduction directly through pathological effects and indirectly through pathological effects and indirectly by reducing host condition (Dobson and Hudson, 1992; Hudson *et al*., 1992; Coop and Holmes, 1996; Chandra and Newberne, 1997). Severe parasitosis can lead to blood loss, tissue damage, spontaneous abortion, congental malformation and death

(Despommier *et al*., 1995; Chandra and Newberne, 1997). Changes of human habitation to sub areas, increased use of lands for agriculture process, increased human activities and consumption of wild boar meat have increased the chances of exposure of wild boars to domestic animal and humans. Wild boar can act as a reservoirs for many important infectious diseases such as classical swine fever, brucellosis and tricchinellosis and in human diseases such as hepatitis E, tuberculosis, leptospirosis and trichinellosis (Meng *et al.,* 2009).

Wild boars are estimated to host at least 20 different parasitic worms, with maximum infection occurring in summer. Wild boars also carry parasite worms, known to infect humans including *Gastrodiscoides, Trichinella spiralis, Taenia solium and Balatidium coli* (V.G. H. *et al*., 1998). Wild boars host a variety of parasites including *Trichinella* species, *Toxoplasm gondii*, *Gongylonema* species, Lungworms (*Metastrongylus elongatus*), Kidneyworms (*Stephanurus dentatus*), Stomachworms (*Physocephalus sexalatus*), Ascarids (*Ascaris lumbricoides*), Whipworms (*Trichuris suis*) (Henry and Comley, 1970; Ickes, 2001; Ickes *et al*., 2005; Chapman and Trani, 2007; Meng *et al*., 2009). Parasites found in wild boar are *Metastrongylus apri, Dicrocoelium dendriticum, Macracanthorhynchus hirudnaceus, Gongylnema pulchrum, Physocephalus sexalatus, Taenia hydatigena* larva (Yagoob *et al*., 2014). Sato *et al*. (2008) recorded eighteen helminth parasites, including seventeen nematode sp. (*Metastrongylus elongatus, Metastrongylus salmi*, *Metastrongylus asymmetricus*, *Metastrongylus pudendotectus*, *Stephanurus dentatus, Gnathostoma doloresi*, *Physocephalus sexulata, Ascarops strongylina, Capillaria suis, Ascaris summ, Globocephallus somoensis*, *Globocephalus longimucronatus*, *Strongyloides ransomi*, *Trichuris suis, Bourgelatia diducta*, *Oesophagostomum watanabei*), and one cestoda sp (*Pseudanoplocephala nipponensis*). Disease monitoring in wild animals has recently a necessary componenet for preventing further infections and conservation. The presence of parasite in an animal, particularly in young animals resulted into reduced body weight gains and reproductive disorders. In addition to that the parasite affect the quality of animals products (meat, skin, antlers) and ultimately death (Fox, 2000).

1.3 Objectives

1.3.1 General Objective

To study the gastro-intestinal parasites of wild boar (*Sus scrofa*) in Chitwan National Park.

1.3.2 Specific objectives

- To determine the prevalence of parasites in wild boar.
- To analyze the intensity of parasitic infection in wild boar

1.4 Significance of the study

In global contest, various researches have been carried out regarding intestinal parasites of wild boar. CNP was one of the ideal habitat for many natural study sites due to its high potentials of biodiversity. It provides ideal habitat for rare and endangered species like Tiger, Elephant, One horned rhino, Hispid hare, Wild boar, Monkey, Spotted deer etc. For the study of wild boar this National Park was one of the most important places in the world. On the basis of literature survey, very few listed article have been found in relation to Gastro-intestinal parasites of domesticated pig but not any article in wild boar was found in contest of Nepal. This study will be the first attempt on the prevalence of Gastro-intestinal parasites of wild boar and their effects. The findings of the study will enable us to provide the data of parasitic infection on wild boar and also help in understanding the prevalence of Gastro-intestinal parasites as well as help to cover the research gap on this species and also help in finding the zoonotically associated diseases with reference to wild boars. So, it was realized that the research study should be launched to investigate prevalence of gastro-intestinal parasites by fecal examination. This study will provide first overview on parasites in wild boar in the vicinity of CNP.

2. LITERATURE REVIEW

The most common source of new emerging infectious diseases that put a risk, the health of human beings and livestock are wild animals. The wild and domestic animals most commonly interact through direct competition for food, predation, pathogen exchange or hybridization (Foufopoulos *et al*., 2003). Parasites are the living organisms which depend on the host for their food, shelter and metabolic activities. Parasites can affect host survival and reproduction directly through pathological effects (blood loss, tissue damage, spontaneous abortion, congenital malformation and death) and also reduce the host's immunity by affecting on the physical condition (Thawait *et al*., 2014). In case of wild boar, a very little research work has been carried out regarding parasitic infection. Wild boars can be infected by different parasites including protozoans, trematodes, cestodes and nematodes. Here, some of the important published work related with the present work has been reviewed.

2.1 In global contest

Endoparsites are those organisms which inhabit in the gut, body cavity, liver, lungs and blood or within the internal cavities and tissue or cell of their host causing parasitic infection. Parasites usually include gastro-intestinal helminthiosis, coccidiosis, fasciolosis and mange (Meng *et al*., 2009). The suitable temperature and humidity play an important role for the development of endoparasites. Some of the protozoan and helminthes parasites have been reported in wild boar from various part of the world. The wild boars were susceptible to internal parasites because these animals seek rivers, polls or swamps for wallowing and searching for food where the higher risk of infection with snail born helminthes.

Ineson (1953) examined twenty two wild pigs from Newzealand to determine the presence and intensity of parasitic infestation and finally recorded the presence of fifteen species of parasites namely, *Balantidium* (61.9%), *Eimeria debliecki* (4.7%), *Anaplasma* (6.6%), *Cysticercus tenuicollis* (4.7%), *Hyostrongylus rubidus* (28.5%), *Ascaris suum* (42.8%), *Metastrongylus elongatus* (66.6%), *Choerostrongylus pudendodectus* (38%), *Haematopinus suis* (68.1%), *Sarcoptes scabie* var *suis* (4.5%), *Oesophagostomum dentatum* (14.2%), *Echinococcus granulosus* (10%), *Trichuris suis* (20%), *Fasciola hepatica* (2%) and *Globocephalus urosubulatus* (4%). Similarly, in Aransas National Wildlife Refuge (Coombs, 1974) examined ten feral pigs (*Sus srofa domesticus*) x European Wild boars (*Sus srofa cristatus*) and finally reported, *Gongylonema pulchrum*,*Ascaris suum*, *Globocephalus urosubulatus*, *Stephanurus dentatus*, *Sarcocystis* sp. and three sp. of *Metastrongylus*.

Similarly, in France, Humbert and Henry (1989) identified five species of nematode (*Metastrongylus asymetricus*, *Metastrongylus confuses*, *Metastrongylus elongatus*, *Metastrongylus pudendodectus*, *Metastrongylus salmi*) and two species of stomach

nematodes (*Ascarops strongylina*, *Physocephalus sexalatus*). Likewise, in Iran, Eslami and Farsad-Hamdi (1992) examined fifty seven wild boars (*Sus srofa*) from protected regions of Iran for helminthes and reported sixteen species of helminthes, out of which ten are nematodes, one acanthocephalon, two trenatodes and three larval cestodes. Correspondingly, from Finland, Roepstorffa *et al*. (1998) examined 516 swine herds and recorded the presence of *Ascaris suum*, *Oesophagostomum* sp., *Isospora suis*, *Eimeria* sp., *Trichuris* sp. and *Strongyloides ransomi*. Likewise, from North –west Poland, Balicka-Ramisz *et al*. (2000) examine fecal samples from 63 wild boars and reported the prevalence of 82.5% in wild boar. Four coccidian sps were (*Eimeria debliecki*, *Eimeria suis*, *Eimeria polita* and *Eimeria scraba*) and one *Isospora suis* are reported.

Fiere *et al*. (2001) examined forty – seven wild boars from eastern Spain and reported *Taenia hydatigena cysticercus* (19%), *Ascarops strongylina* (87%), *Physocephalus sexulatus* (6%), *Ascaris suum* (21%) and *Macracanthorhynchus hirudinaceus* (21%). No *trichinella* species were found. Correspondingly, from Eastern Stavonia, Republic of Croatia, Rimac *et al*. (2002) investigated the fecal samples of 47 wild boars (*Sus srofa*) and finally revealed the presence of 14 helminth species. The predominant nematodes include, *Metastrongylus apri*, *Metastrongylus pudendotectus*, *Globocephalus urosubulatus*, *Ascarops strongylina*, *Physocephalus sexalatus*, *Gnathostoma hispidum*, *Oesophagostomum* sp., *Trichinella* sp., the acanthocephalon species *Macracanthorhynchus hirudinaceus*, the intestinal fluke *Echinochasmus perfoliatus* (Trematode) and larval stage (*Cysticercus tenuicollis*, *Echinococcus hidatidosus*) of two tapeworm species (*Taenia hydatigena*, *Echinococcus granulosus*) cestode were recorded.

Soloyamani-Mohammadi *et al*. (2003) examined twelve wild boars (*sus scrofa*) during a survey from 2000-2001 from western Iran and recorded two cestode larva, *Cysticercus tenuicollis* (25%), *Cysticercus cellulosae* (8.3%), four nematode species, *Metastrongylus apri* (41.6%), *Metastrongylus pudendotectus* (16.6%), *Metastrongylus salmi* (8.3%), *Trichuris suis* (8.3%) and the acanthocephalon *Macrecanthorhynchus hirudinaceus.* Correspondingly, from central Spain, Isabel *et al*. (2003) compaired the helminth population in agroup of wild boars and finally identified eleven helminth species, including ten nematodes (*Ascaris suum*, *Gongylonema pulchrum*, *Oesophagostomum dentatum*, *Trichuris suis*, Globocephalus urosubulatus, *Metastrongylus* sp, *Physocephalus sexalatus*, *Simnondsia parasoxa*, *Capillaria garfiai* and *Ascarops strongylina*) and one acanthocephalon *Macracanthorhynchus hirudinaceus*. Mudim *et al*. (2004) examined fecal samples of 79 wild boars (*Sus srofa*) finally reported the prevalence of 97.5% of the samples for intestinal parasites namely, *Strongilides* (70.9%), *Ascaris suum* (46.9%), *Trichuris suis* (29.1%), *Metastrongylus* sp. (12.6%), *Strongyloides ransomi* (3.8%), *Balantidium coli* (38.o%), *Entamoeba* sp. (15.2%), *Giardia* sp. (1.3%), *Blastocystis* sp. (12.6%). Coccidian oocyst were observed in 59.5% and five species of *Eimeria* and one *Isospora* were recovered. Foata *et al*. (2005) collected and examined 160 (stomach and intestine) and 58 livers of wild boars from Corsica and reported six speces of helminth, namely one trematode *Dicrocoelium dendriticum*, the only larval stage of cestode, *Echinococcus granulosus*, three nematode species, *Ascaris suum*, *Globocephalus*

urosubulatus and *Metastrongylus* species and one acanthocephalon *Macracanthorhynchus hirudinaceus*. Likewise, Eijck and Borgsteede (2005) examined the prevalence of gastro-intestinal parasites in suking piglets, weners, fattening and sows and finally reported the infection with *Ascaris suum* (50%), *Oesophagostomum* sp. (25%) and *Trichuris suis* (37.5%). Similarly, from Estonia, Jarvis and Magi (2007) examined one hundred wild boars (*Sus srofa*) and finally reported seven helminth species, *Metastrongylus pudendotectus*, *Metastrongylus salmi*, *Metastrongylus elongatus*, Ascaris suum, *Trichuris suis*, *Dicrocoelium dendriticum* and *Taenia hydatigena* larva.

Among twenty nine Japanese wild boar (*Sus srofa leucomystax*) during hunting season 2005-2006 were examined and finally recorded the presence of eighteen helminth parasite, including 17 nematodes species. (*Metastrongylus elongatus*, *Metastrongylus salmi*, *Metastrongylus assymetricus*, *Metastrongylus pudendotectus*, *Stephanurus dentatus*, *Gnathostoma doloresi*, *Physocephalus sexulata*, *Ascarops strongylina*, *Capillaria suis*, *Globocephalus longimucronatus*, *Strongyloides ransomi*, *Trichuris suis*, *Bourgelatia diducta*, *Oesophagostomum wantabei*) and one cestode species. (*Pseudanoplocephala nipponensis*) (Sato *et al*., 2008). Similarly, from Turkey, Boral *et al*. (2009) examined 238 fecal samples. Out of 238 pigs specimen 105 were yonger than 6 months and rest are older than 6 months and finally revealed the presence of *Giardia* sp. 9 (3.7%), *Balantidium coli* cysts 4 (1.6%), *Ascaris suum* 9 (4.1%) of pigs yonger than 6 month and *Cryptosporidium* sp. 9 (6.7%), *Balantidium coli* cyst in 2(1.5%) and *Ascaris suum* in 9 (6.7%) in above 6 months. Similarly, in Italy, Moretta *et al*. (2010) examined the fecal samples of 123 wild boars and finally recorded the presence of (73.98%) *strongyles* and (33.33%) coccidian and other paraites including lungworms (8.94%), Acanthocephalon (6.55%), *Trichuris suis* (4.88%), *Capillaria* sp. (2.44%), *Spiruridae* sp. (1.63%), *Ascaris suum* (0.81%) and *Strongyloides ransomi* (0.81%).

From Turkey, Senlik *et al*. (2010) investigated the status of helminth infection in wild boars and finally twelve species of helminthes were detected, *Metastrongylus apri* (59%), *Metastrongylus salmi* (52%), *Metastrongylus pudendotectus* (52%), *Dicrocoelium dendriticum* (33%), *Globocephalus urosubulatus* (22%), *Macracanthorhynchus hirudinaceus* (19%), *Gongylonema pulchrum* (11%), *Physocephalus sexalatus* (7%), *Trichuris suis* (7%), *Ascarops strongylina* (4%), *Hyostrongylus rubidus* (4%) and *Taenia hydatigena* larva (4%). Tomass *et al*. (2012) examined seven hundred fourteen pigs from Ethopia and finally recorded the presence of *Ascaris suum* (25.9%), *Fasciola hepatica* (1.8%), *Eimeria* sp. (1.7%) and *Trichuris* sp. (0.3%). Correspondingly, from Brasil, Muller and Silva (2013) examined forty gastro – intestinal tracts of wild boars and finally reported the presence of *Ascaris suum*, *Trichostrongylus colubriformis*, *Oesophagostomum dentatum*, *Trichuris suis*. Similarly, from Iran, Yagoob *et al*. (2014) necropsied and examined the hunted wild boar and finally recorded the the presence of seven helminth species, *Metastrongylus apri* (34%), *Dicrocoelium dendriticum* (22%), *Macracanthorhynchus hirudinaceus* (19%), *Gongylonema pulchrum* (9%), *Physocephalus sexalatus* (7%), *Trichuris suis* (6%) and *Taenia hydatigena* larva (3%). Likewise, from India, Allwin *et al*. (2015) examined 90 fecal samples in total (n =30 of wild pigs, n = 30

desi pigs and n = 30 cross breed pigs) and reported the presence of four species of nematode, *Ascaris suum*, *Trichuris suis*, *Strongylus* sp., *Strongyloides* sp. Begum *et al*. (2014) examined 110 fecal samples and 20 vicera from Bangladesh and finally reported the presence of 12 types of endoparasites namely *Ascaris suum* (50.9%), *Strongyloides* sp. (29.1%), *Oesophagostomum* sp. (12.7%), *Trichuris suis* (9.1%), *Ancylostoma* sp. (3.6%), *Hyostrongylus rubidus* (1.8%), *Fasciola* sp. (12%), *Dicrocoelium* sp.(8.2%), *Schistosoma suis* (7.3%), *Eimeria* sp.(56.4%), *Balantidium coli* (40%) and *Isospora suis* (9.1%).

Sen *et al*. (2015) examined 100 fecal sample of wild boars from Bangladesh and finally identified the presence of six species of nematode, *Ascaris suum* (38%), *Macracanthorhynchus hirudinaceus* (22%), *Strongyloides ransomi* (20%), *Trichuris suis* (5%), *Hyostrongylus rubidus* (5.17%) and *Oesophagostomum* sp (6.25%). Recently, from spain, Mansouri *et al*. (2016) examined 11 males and 14 female wild boar and finally recorded the presence of *cysticercus tenucollis* 1(4%), the larval stage of *Taenia hydatigen*a, 13 (52%) *Macracanthorhynchus hirudinaceus*, 17 (68%) *Metastrongylus* sp. and 20 (80%) with *Ascarops* sp. No *trichinella* sp. were recorded. Likewise, From India, Dadas *et al*. (2016) conducted a survey to determine the gastro- intestinal parasites and finally reported the presence of six parasites species, namely *Ascaris suum* (32%), *Balantidium coli* (31.85%), Trichuris suis (11.11%), *Isospora suis* (1.48%), *Strongyloides ransomi* (0.74%) and *Globocephalus urosubulatus* (0.74%). Correspondingly in the recent time, from Serbia, Stojanov *et al*. (2017) examined 52 fecal samples and reported the presence of *Metestrongylu*s sp., *Ascaris suum*, *Trichuris* sp., *Hyostrongylus* sp., *Gnathostoma hispidum*, *Physocephalus sexalatus*, *Strongyloides ransomi*, *Oesophagostomum* sp., *Globocephalus* sp., *Hyostrongylus rubidus.*, *Eimeria deblecki* and *Eimeria suis*.

2.2 In National Context

On the basis of literature survey, very poorly listed article has been found in relation to gastro-intestinal parasites of wild boar in Nepal. However, some related work on the basis of domesticated pig has been reviewed. Joshi (1991) observed the presence of *Taenia* cysts in pig in Kathmandu. Similarly Joshi *et al*. (2001) demonstrated the presence of *Cysticercosis* in domestic pig in Dharan and Kathmandu. Poudyal (1998) identified presence of *Cysticercosis* in domesticated pig in Dharan and Kathmandu. Shakya (2009) revealed the presence of *Taenia* cysts in domesticated pig in Kirtipur Municipality. Recently, from Chandragiri Municipality, Kathmandu, Khanel (2017) has reported the overall prevalence of 88.57% and presence of three genera of protozoa, *Eimeria* sp. 45 (42.8%), *Isospora* sp. 8 (7.61%), *Balantidium* sp. 25 (23.80%), two genera of trematode, *Fasciolopsis* sp.10 (9.52%), *Schistosoma* sp. 5 (4.76%), and three genera of nematode, *Ascaris* sp. 40 (38.09%), *Strongyloides* sp.15 (14.28%) and *Trichuris* sp. 8 (7.61%).

3. MATERIALS AND METHODS

3.1 Study Area

3.1.1 Chitwan National Park

The study area, Chitwan National Park is situated in South Central Nepal, Covering 952.63 sq km. in the subtropical lowlands of the inner terai (DNPWC, 2017). Its geographic location co-ordinates $27^{o}30^{'}0$"N $84^{o}20$'o"E. In altitude it ranges from about 100m (300ft) in the river valleys to 815 m (2674ft) in the churia hills (Shrestha *et al*., 2007). The area comprising the Tikauli forest – from Rapti river to the foothills of the Mahabharat – extending over an area of 175 sq. km (Mahendra Deer Park) by the late king Mahendra in 1959 AD. In 1963 AD the area of south of Rapti River was demarcated as a rhinoceros sanctuary. The area was gazette as the country's first national park in 1973 AD, recognizing its unique ecosystem of the Internatioinal Significance. UNESCO declared CNP a world heritage in 1984 AD. In 1996 AD an area of 750 sq. km surrounding the park was declared as buffer zone, which consists of forest and private lands and cultivated lands. The Chitwan valley consists of Tropical and subtropical forests. Sal forests covers 70 percent of the park. Grasslands cover 20 percent of the park. There are more than 50 different types of grasses, including the elephant grass (*Saccharum* sp.), renowed for its immense height. The park is home to more than 50 mammals sp., over 525 sp. birds and 55 amphibians and reptiles. It provides habitat for wide range of vertebrates which include endangered species such as wild elephant (*Elephas maximus*), Bengal Tiger (*Panthera tigris*), Spotted Deer (*Rusa alfredi*), Blue Bull (*Boselephus trogocumelius*), Barking Deer (*Muntiacus muntjak*), Hog Deer (*Hyelophus porcinus*), Wild Boar (*Sus srofa*), Jackal (*Canis mesomelus*), Crocodile (*Crocodylus porusus*), Cobra (*Naja naja*) etc.

Features: The park consists of a diversity of a diversity of ecosystem – including the Churia hills, Ox – bow lakes and the flood plains of the Rapti, Reu and Narayani Rivers. The churia hills rise slowly towards the east from 1500 m to more than 800 m. The western portion of the park is comprised of the lower but more rugged Someshwor hill. The park shares its eastern boundary with the Parsa Wildlife Reserve (DNPWC, 2017).

Climate: The park has arrange of climatic seasons each offering a unique experience. October through February with average temperature of 25^{o}c offer an enjoyable climate. From March to June temperatures can reach as high as 43^{o}c, the hot humid days give way to the monsoon season that typically lasts from late June until September (DNPWC, 2017).

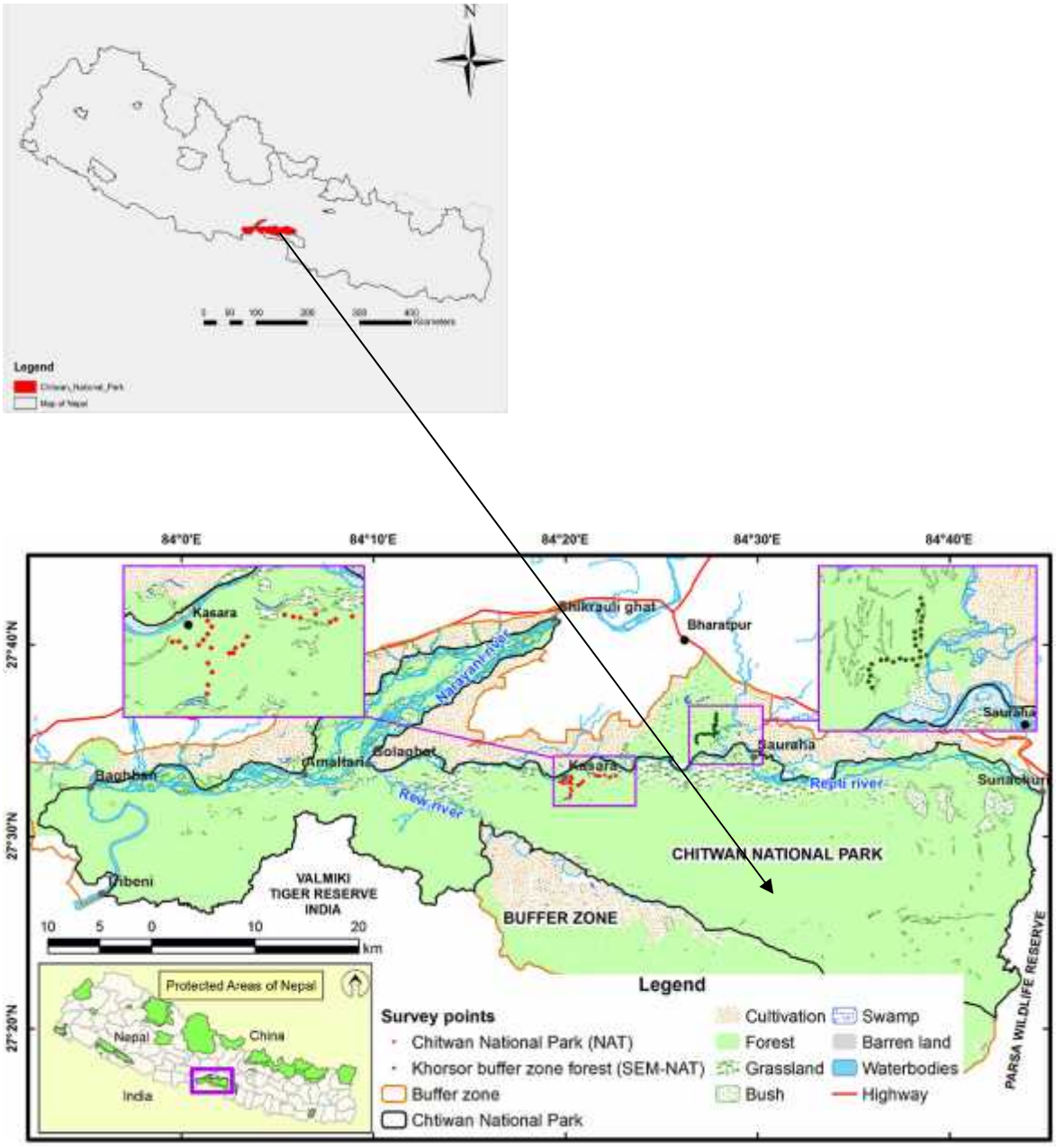

Figure 1: Map showing study area in Chitwan National Park (www.google.com).

3.2 Instruments and Materials

Following instruments, materials and chemicals were used to carry out the research.

3.2.1 Materials and Chemicals

The materials used during the research were centrifuge machine, measuring cylinder, Volumetric flask, electric microscope, glass rod, stage micrometer, ocular micrometer, refregerator, tea strainer, motor and pestle. The chemicals required were 10% formalin, distilled water, saturated Sodium chloride solution, Methylene blue.

3.3 Study Design

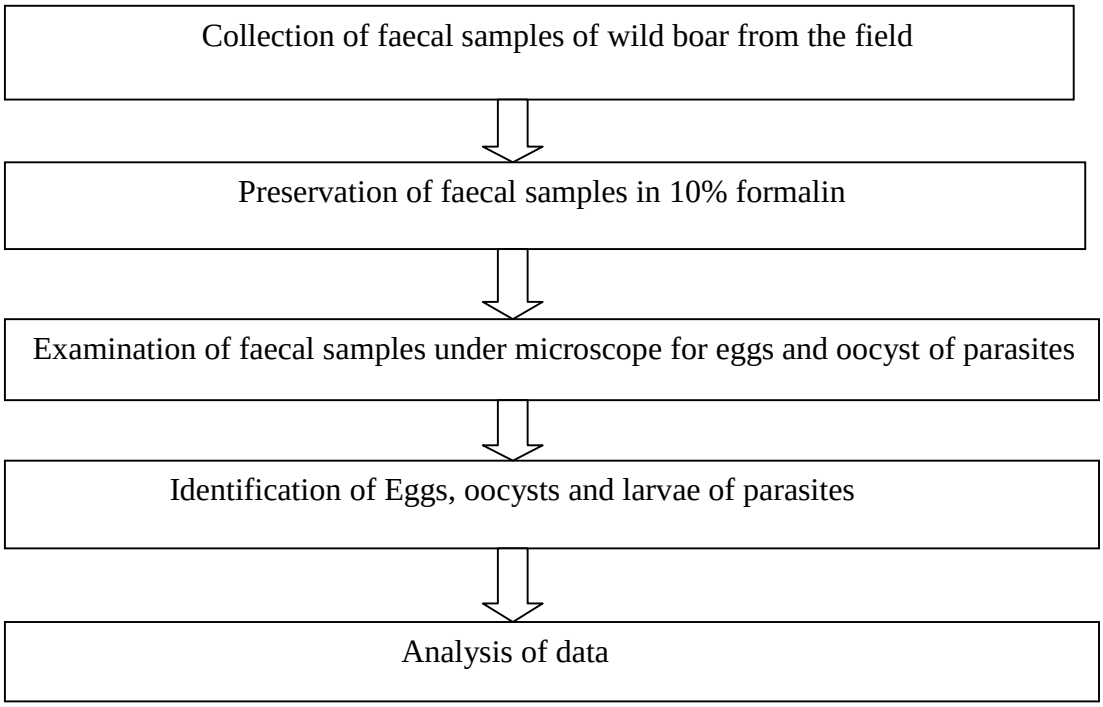

Figure 2: Research flow chart

Glimpse of photograph during field and lab work

Photo 1: Juvenile of wild boar

Photo 2: Wild boar with juvenile

Photo 3: Fecal sample collection

Photo 4: Juvenile at Kasara

Photo 5: Examination under microscope

Photo 6: Measurement of size of parasite

3.3.1 Sample collection method

A sum total of 100 fecal samples were collected from wild boars at CNP for a time span of two months ranging from April 2017 to May 2017. Fresh fecal samples were collected from the dropping ground. Proper care were taken when collecting the fecal samples from the ground to prevent contamination.

3.3.2 Preservation of samples

After collection of fecal samples about 20-30 gm of feces were placed in clean 50ml vials and mixed with 10% formalin and stored at 4^0c in laboratory facilities provided by Department of Zoology, Kirtipur, Kathmandu.

3.3.3 Examination of fecal sample

All the fecal samples so collected were processed using standard sedimentation, floatation and direct smear technique as described by Soulsby (1982) followed by microscopic examination for the presence of helminth ova and protozoan cyst/oocysts.

3.3.3.1 Direct smear method

Two mg of fecal samples were mixed in a drop of saline on a slide and coverslip was applied. The entire field of coverslip was examined under low microscope and eggs were visualized and counted (Soulsby, 1982).

3.3.3.2 Differential floatation (D.F.) Technique

The D.F. technique is widely used for the detection of nematode and cestode egg. Three gm of fecal sample was taken in a beaker and 42 ml of water was added. With the help of mortar and pestle, the sample was grinded lightly and filtered with a tea strainer. The filtered sample was poured into a centrifuging tube of 15 ml and centrifuge at 1000 rpm for 5 minutes. The tube was taken out and the upper part of water was removed with the help of pipette. The tube was noted then filled with the saturated sodium chloride (Nacl) solution and again centrifuge at 1000 rpm for 5 minutes. More saturated sodium chloride solution was added to develop convex surface at the top of the tube and one drop of methylene blue was added. A cover slip was placed over the top of the tube so that the Nacl touches the cover the slip for a few minutes and then the cover slip was placed on a slide and examined under microscope (10x x 40x) (Soulsby, 1982).

3.3.3.3 Sedimentation technique

Sedimentation was used to isolate of flukes, some other tapeworms and nematodes whose eggs didnot float readily in common floatation solution. Three gm of fecal was weighted. Sample was grinned with water (45-50 ml) using mortar and pestle. The Sample was filtered with a tea strainer, filterate was allowed to stand for 5 minutes in a beaker. The supernant was removed and sediment was resuspended with water (till the suspension becomes clear). The suspension was then allowed to sediment for next 5 minutes. The suspenant was drawn off. A drop of sediment was placed on clear slide, and few drop of methylene blue was added into it. The fecal smear was covered with cover slip and examined using a microscope (Soulsby, 1982).

3.4 Identification of oocysts, eggs and larvae of parasites

Oocyst, eggs and larvae were identified on the basis of morphological characters (shape and size) as described by Yamaguti (1961), Soulsby (1982), Sloss *et al*. (1994) and other published and unpublished articles and also from internet sources. Caliberation obtained using Ocular and Stage micrometer was used to measure length and breadth of eggs, Oocysts and larvae.

3.5 Intensity calculation of parasite

Intensity of parasites was calculated depending on the number of eggs /oocysts and larvae found per field.

Light infection= < 2 eggs/oocysts /larvae per field
Mild infection= 2 - 4 eggs /oocysts/larvae per field
Moderate infection= 4 - 6 eggs/oocysts/larvae per field
Heavy infection= > 6 eggs /oocysts/larvae per field

3.6 Data analysis

Since the study was mainly focused on identification of different parasites, the data were analyzed by using MS-EXCEL 2007 and statistical analysis was performed using “R” version 3.3.1 software packages. Chi-square test was used for statistical analysis of data. In all cases 95% confidence interval (CI) and $P < 0.05$ was considered for statistically significant difference.

4. RESULTS

4.1 Overall Prevalence of Gastro - Intestinal Parasites in wild boar

Out of 100 fecal samples of wild boar (*Sus scrofa*), 95 (95%) samples were found to be positive for parasitic infection in wild boar of CNP. There is significant difference in the general prevalence of parasites.

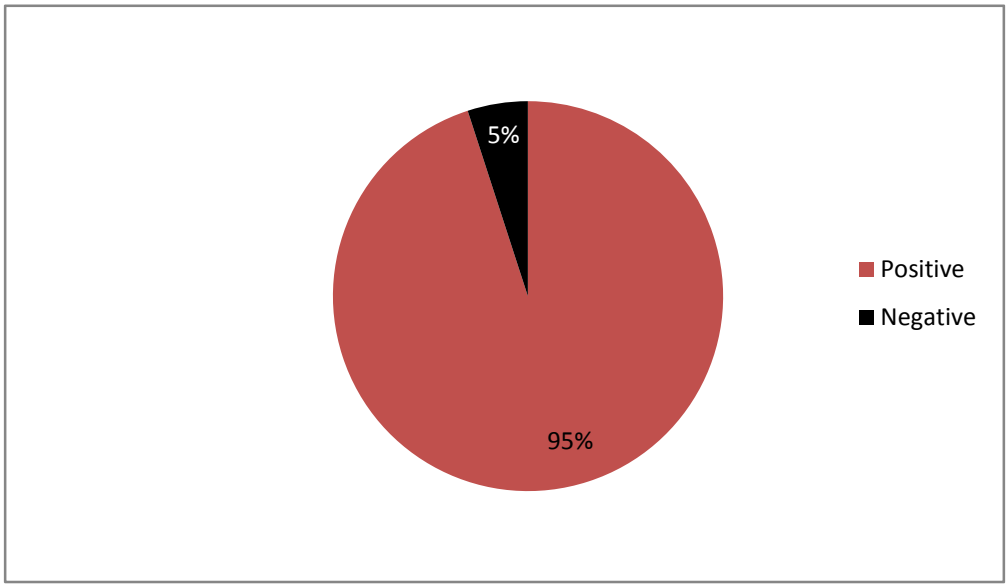

Fig 3: General prevalence of intestinal parasites

4.2 Distribution of GI parasites in wild boar.

Out of 100 sample examined, nine genus of parasites were identified with Protozoan, *Eimeria* sp. with micropyle 40 (40%) and *Eimeria* sp. without micropyle 70 (70%). Similarly, in Trematode, *Fasciola* sp. 12 (12%) and in Nematode, *Ascaris* sp. 7 (7%), *Stephanurus* sp. 44 (44%), *Strongyloides* sp. 56 (56%), *Strongyle* sp. 49(49%), *Metastrongylus* sp. 12 (12%), *Trichuris* sp. 6 (6%) and *Globocephalus* sp. 38 (38%). There is highly significant difference between the genus wise prevalence of parasites on wild boar ($\chi^2 = 208.34$, df = 9, $P < 0.05$).

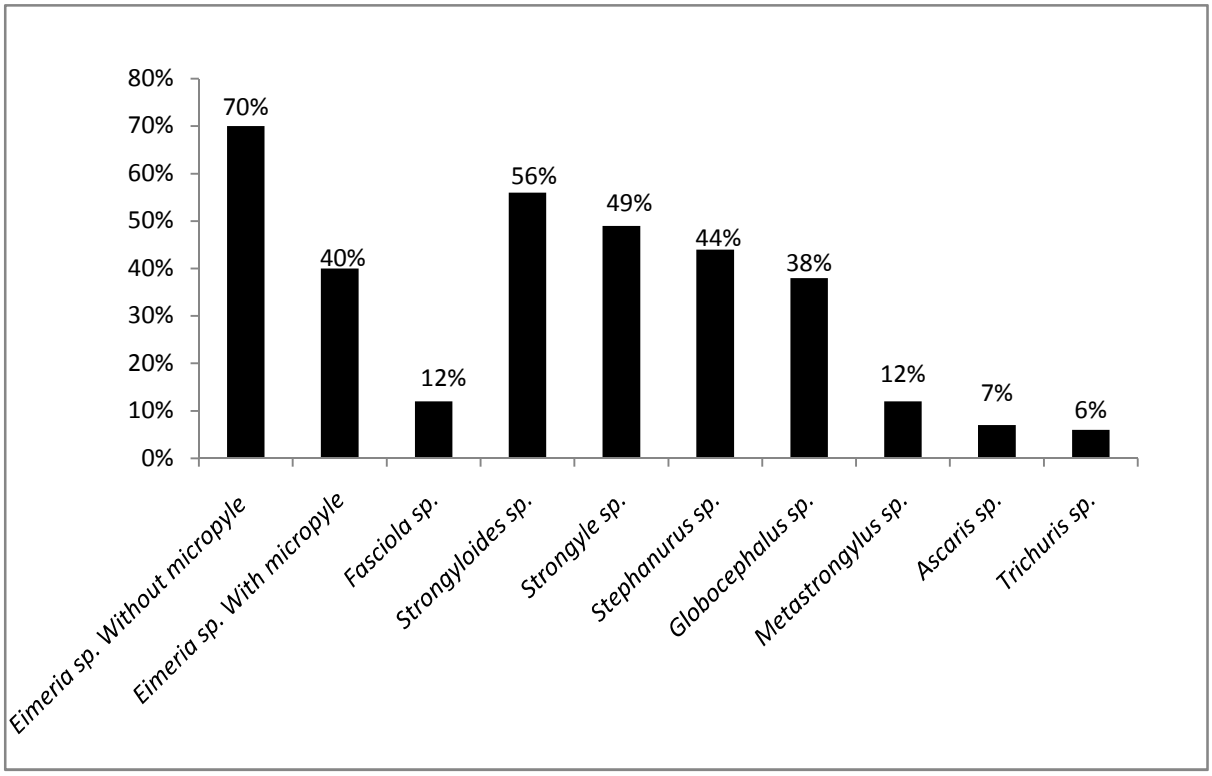

Fig 4: Genus wise parasitic prevalence of wild boar

4.2.1 Prevalence of Protozoan parasites

Out of total 100 samples, protozoan parasites with the genus *Eimeria* sp. without micropyle showed the highest prevalence 70% followed by *Eimeria* sp. with micropyle 40%. There is high significant difference between *Eimeria* sp. without micropyle and with micropyle sp. ($\chi^2 = 21.662$, $P < 0.05$).

Table 1: Prevalence of protozoan parasites

S.N	Name of parasites	Prevalence
1	*Eimeria* sp. without micropyle	70%
2	*Eimeria* sp. with micropyle	40%

4.2.2 Prevalence of helminth parasites

Out of 100 samples, 80 samples were found to be positive for helminth parasites. Eight genus of helminth were identified.Out of which trematode (1) *Fasciola* sp. 12 (12%) and nematode (7) with genus *Strongyloides* sp. 56% followed by *Strongyle* sp. 49%, *Stephanurus* sp. 44%, *Globocephalus* sp. 38%, *Metastrongylus* sp. 12%, *Ascaris* sp.7% and *Trichuris* sp. 6%. Helminth parasitic infection in wild boar were found to be highly significant ($\chi^2 = 149.7$, $P < P0.05$).

Table 2: Prevalence of helminth parasites

Class	Name of parasites	Prevalence
Trematode	*Fasciola* sp.	12%
Nematode	*Strongyloide*s sp.	56%
	Strongyle sp.	49%
	Stephanurus sp.	44%
	Globocephalus sp.	38%
	Metastrongylus sp.	12%
	Ascaris sp.	7%
	Trichuris sp.	6%

4.2.3 Trematodes

Out of 100 samples, prevalence of trematodes was observed only in 12 samples i.e presence of *Fasciola* sp. only.

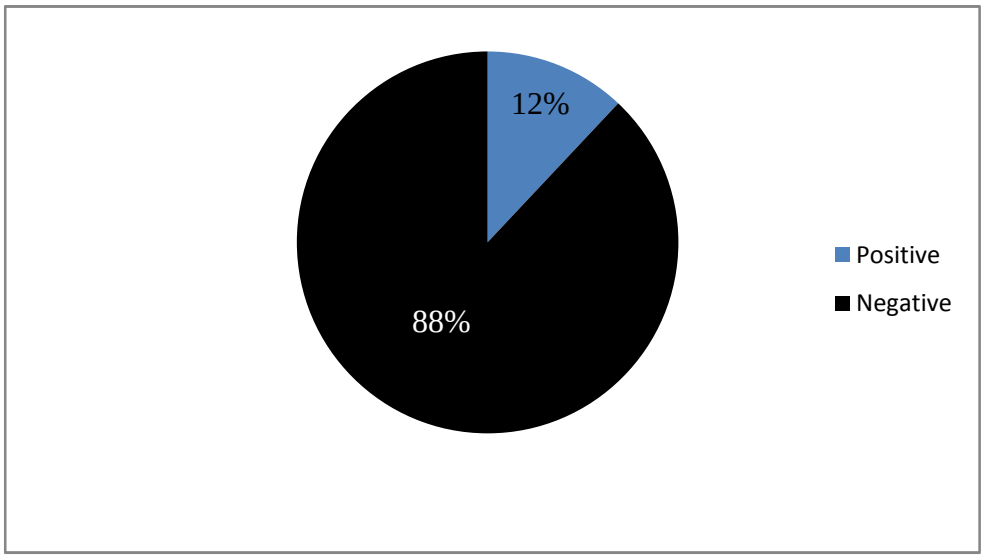

Fig 5: Prevalence of Trematode parasite in wild boar of CNP.

4.2.4 Nematode

Among 100 samples, 80 samples were found to be positive for nematodes. Seven genus of nematodes were identified. Among them *Strongyloides* sp. 56 (56%) accounts highest prevalent in wild boar at CNP followed by *Strongyle* sp. 49 (49%), *Stephanurus* sp. 44 (44%), *Globocephalus* sp. 38 (38%), *Metastrongylus* sp. 12 (12%), *Ascaris* sp. 7 (7%) and *Trichuris* sp. 6 (6%). Nematode parasitic infection in wild boar were found to be statistically significant ($\chi 2=129.08$, $P < 0.05$).

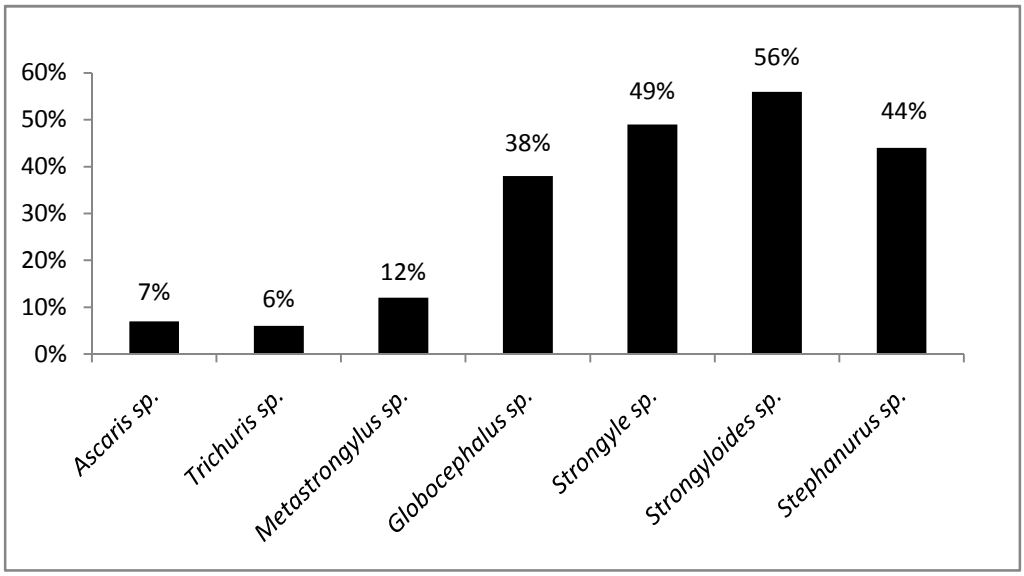

Fig 6: Prevalence of nematode parasites in wild boar of CNP.

4.3 Mixed infection

Out of 100 samples, 95 samples were found to be infected with different intestinal parasites of wild boar. Double infection showed the highest rate 48 (50.52%) followed by multiple infection 19 (20%), triple infection 18 (18.94%) and single infection 10 (10.52%). The result revealed the significant difference in mixed infection ($\chi 2 = 46.75$, $P < 0.05$).

Table 3: Mixed parasitic infection in wild boar

S.N.	Types of infection	Total 95 (100%)
1	Single	10 (10.52%)
2	Double	48 (50.52%)
3	Triple	18 (18.94%)
4	Multiple	19 (20%)

4.4 Intensity of Parasites in wild boar of Chitwan National Park

Intensity of parasitic infection has been assessed based upon the number of eggs/oocyst/cysts and larva found per microscopic field. Among protozoans, maximum number of positive samples were found with light intensity followed by mild, moderate and heavy intensity. In heavy intensity of protozoan, *Eimeria* sp. without micropyle showed higher intensity over *Eimeria* sp. with micropyle. Similarly, in case of trematodes light intensity is followed by mild intensity. In case of nematodes, *Stephanurus* sp. possesses the highest intensity followed by *Strongyloides* sp., *Strongyle* sp., *Metastrongylus* sp. and *Globocephalus* sp. No heavy intensity was found between *Ascaris* sp. and *Trichuris* sp. Maximum number of nematode samples revealed the light intensity followed by mild and moderate.

Table 4: Intensity of parasites in wild boar

Class	Parasites	Light	Mild	Moderate	Heavy
Sporozoa	*Eimeria* sp. with micropyle	18 (45%)	10 (25%)	7 (17.75%)	5 (12.5%)
	Eimeria without micropyle sp.	34 (48.57%)	17 (24.28%)	12 (17.14%)	7 (10%)
Trematode	*Fasciola sp.*	8 (66.66%)	4 (33.33%)	-	-
Nematode	*Ascaris sp*	4 (57.14%)	3 (42.85%	-	-
	Stephanurus sp.	10 (22.72%)	13 (29.54%)	6 (13.63%)	15 (34.09%)
	Trichuris sp.	4 (66.66%)	2 (33.33%)	-	-
	Metastrongylus sp.	2 (16.66%)	7 (58.33%)		3 (25%)
	Globocephalus sp.	8 (21.05%)	12 (31.57%)	10 (26.31%)	8 (21.05%)
	Strongyloides sp.	18 (32.14%)	12 (21.42%)	8 (14.28%)	18 (32.14%)
	Strongyle sp.	18 (36.73%)	7 (14.28%)	10 (20.40%)	14 (28.57%)

Photographs of identified Gastro-intestinal parasites

Photo 7: *Ascaris* sp. **(**50um x48um)

Photo 8: *Trichuris* sp. (55um x26um)

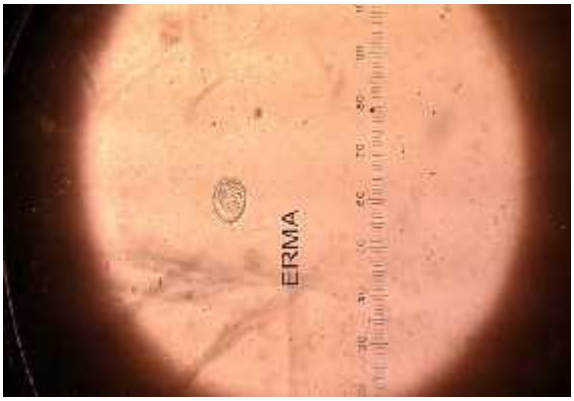

Photo 9: *Eimeria* sp. without micropyle (24um x 16um)

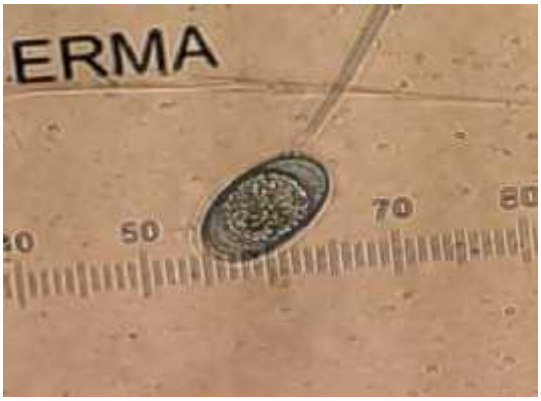

Photo 10: *Eimeria* sp. with micropyle (26um x16um)

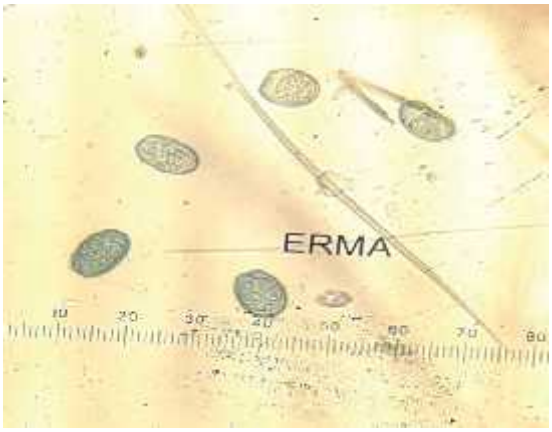

Photo11: *Eimeria* sp. showing (with or without) micropyle

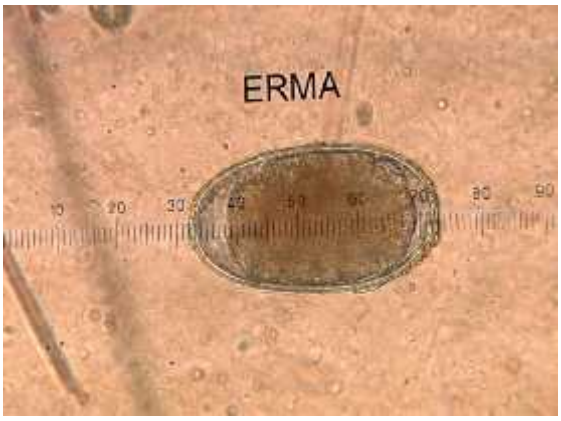

Photo 12: *Stephanurus* sp. (98um x60um)

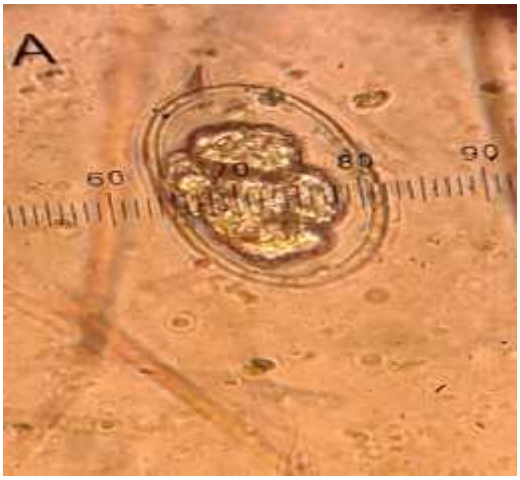

Photo 13 :*Globocephalus* sp.(55um x 45um)

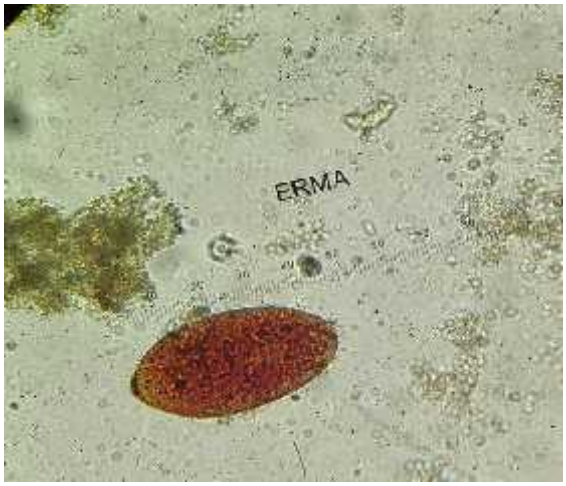

Photo 14: *Fasciola* sp. (110um x 60um)

Photo 15: *Strongyloide* sp. (55um x 36um)

Photo 16: *Strongyle* sp. (80um x 60um)

Photo 17: *Metastrongylus* sp.(57um x 34um)

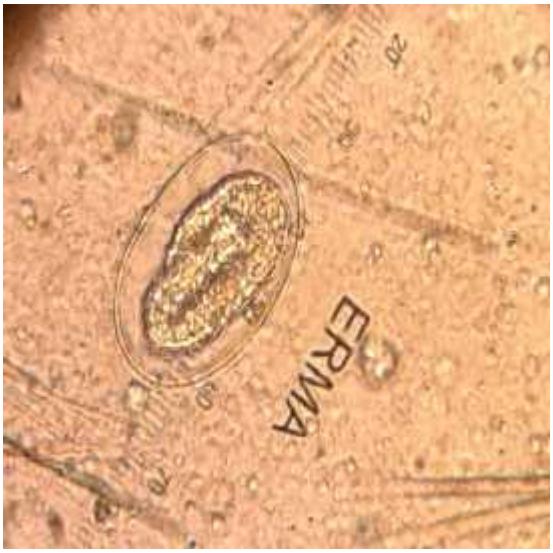

Photo18: Larva of Strongyle sp.

Photographs of unidentified gastro-intestinal parasites

Photo 19: unindentified (91um x 60um)

Photo 20: unidentified (100um x 36um)

Photo 21: unidentified (90um x 60um)

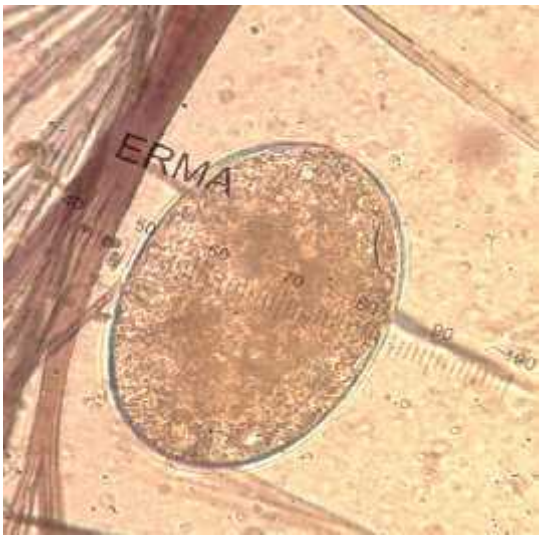

Photo 22: unidentified (122um x 84um)

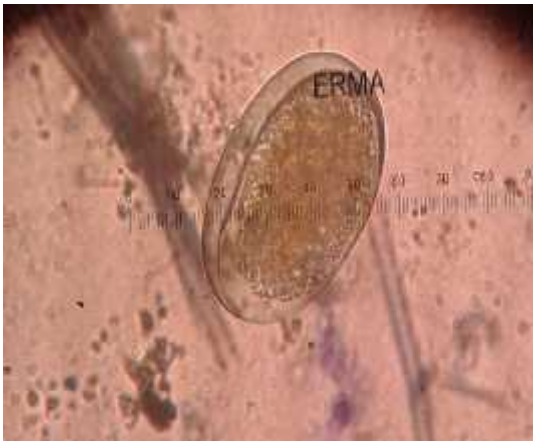

Photo 23: unidentified (122um x 84um)

Photo24: unidentified (88um x86um)

5. DISCUSSION

National park is an area of land of unusual ecological and scenic interest set aside by government, where flora and fauna are protected as far as possible in their wild state for their scientific, educational and recreational value and for the benefit of the nation and mankind as a whole (DNPWC, 1973). Wild animals are concurrently infected with multiple parasites and interactions among these parasites may influence both diseases dynamics and host fitness. However, the sublethal cost of parasite infection are difficult to measure and the effects of concomitant infections with multiple parasite species on individual physology and fitness are poorly described for wild host. Both microparasites (eg. Bacteria, viruses) and macroparsites (eg, helminths, arthopods) can have far reaching effects on the fitness of their hosts, ranging from reducing body condition below levels critical for reproduction to causing castration or direct mortality (Stien, 2011). Wild boars are inhabits a diverse array of habitats including heavily brushed areas providing shelter from predators, water for drinking and bathing purpose and swampy areas (Henry and Conley, 1970; Ickes, 2001; Ickes *et a*l., 2005; Chapman and trani, 2007; Meng *et al*., 2009).

Wild boars are estimated to host at least 20 different parasitic worms, with maximum occuring in summer (Heptner *et al*., 1998).Wild boars host a variety of parasites including *Trichinella* species, *Toxoplasm gondii*, *Gongylonema* species, lungworms (*Metastrongylus elongatus*), kidneyworms (*Stephanurus dentatus*), stomachworms (*Physocephalus sexalatus*), Ascarids (*Ascaris lumbricoides*), whipworms (*Trichuris suis*) (Henry and Conley, 1970; Ickes, 2001; Ickes *et al*., 2005; Chapman and trani, 2007; Meng *et al*., 2009). The current epoch of ecological time is driven by human interference. Multiple anthropogenic stressors – including climate change, pollution, ocean acidification, habitat loss and fragmentation, urbanization, agriculture expansion and intensification, together with other changes in the use of water and land resources are directly or indirectly impacting all species on earth (Faye *et al*., 2006). These changes may be lead to the crossing or corrosion of critical thresholds or planetary boundaries that include physological stress or complete system dysfunction, with negative consequences for individuals, populations and species. Such processes will have significant impacts on parasite natura history and infectious disease risk (Harvel *et al*., 2002).

The current study aimed to evaluate the prevalence of gastro-intestinal parasite of wild boars in CNP. Out of 100 fecal sample examination for gastro-intestinal parasites, 95 samples were found to be infected with an overall prevalence of 95%. On parasitological examination wild boars were found to be harboring different parasites which include one genus protozoan, one genus of trematode and seven genus of nematodes.With respect to species wise prevalence, *Eimeria* sp without micropyle (70%) was found to be the most prevalent parasite followed by *Strongyloides* sp. (56%), *Strongyle* sp. (49%), *Stephanurus* sp. (44%), *Eimeria* sp. with micropyle (40%), *Globocephalus* sp. (38%), *Metastrongylu*s sp. (12%), *Fasciola* sp. (12%) and least prevalence of about 7% and 6% was noted for

Ascaris sp. and *Trichuris* sp. Overall *Eimeria* sp. was found to be most prevalent parasite as earlier reported by researcher (Balicka-Ramisz *et al*., 2000) of 82.5% prevalence. But the researcher, (Ineson, 1953; Moretta *et al*., 2010; Tomass *et al*., 2012) reported the low prevalence of *Eimeria* sp. following 4.75%, 33.33% and 1.7% respectively. High prevalence of *Eimeria* species in the study area may be due to the overcrowding of other animals and habitat because oocyst require moist condition to undergo sporulation. The variation might be due to the difference in sample size, selection of samples, techniques of sample collection, period and place of the study, environment factors etc. The prevalence of trematode i.e *Fasciola* sp. was 12% which was similar to the report of (Begum *et al*., 2014). However, the report from Northen Ethopia, Tomass *et al*. (2012) indicates low prevalence just only 1.8%. Factors such as presence of reservoir hosts, presence of snail intermediate host, and ability of *Fasciola hepatica* to colonise and to adopt new hosts contribute for its spread in livestock in an area. No any cestodes were recorded in the present study in wild boar which supported the findings of the result of (Roepstorffa *et al*., 1998; Tomass *et al*., 2012; Allwin *et al*., 2015). Most of the studies on gastro-intestinal nematode ecology in wild boar have conducted that temperature and humidity play an important role in the survival and transmisson of parasites, eggs and larvae (Kutz *et al*., 2004). The nematode species identified in the fecal examination of wild boar of CNP includes *Strongyloides* sp. (56%) followed by *Strongyle* sp. (49%), *Stephanurus* sp. (44%), *Globocephalus* sp. (38%), *Metastrongylus* sp. (12%), *Ascaris* sp. (7%) and *Trichuris* sp. (6%).

Ascaris sp. (large roundworm) is the most important gastro-intestinal worm of pigs. It is more common in growing pigs than in adult pigs (Lee, 2012). Heavily infested pigs may have upto twenty five worms blocking the small intestines and bile duct causing loss of appetite, vomiting, icterus and death if the small intestine is ruptured. Growth rate and feed efficency can be depressed by upto 10% (Lee, 2012). The prevalence rate of *Ascaris* sp. in the present study was 7 (7%) which was nearly similar to the report of (Boral *et al*., 2009). However, the researcher, (Ineson, 1953; Eijck *et al*., 2005; Begum *et al*., 2014 Mundim *et al*., 2015; Sen *et al.,* 2015; Dadas *et al.,* 2016) obtained the higher prevalence rate following 42.8%, 50%, 50.9%, 46.9%, 38% and 32.9%. On the cotrary, the report from (Fiere *et al*., 2001; Moretta *et al*. 2010) indicates low prevalence just only 2% and 0.81%.

Pigs are considered the natural hosts of *Trichuris suis* (whipworm) although primates and humans may be infected.*Trichuris* infection is a fairly common problem in pigs (Lee, 2012). This parasite have direct life cycle and animals become infected after ingestion of infective eggs. The present prevalence rate of *Trichuris* sp. was 6% which was nearly similar to the report of (Senlik *et al*., 2010; Yagoob *et al*., 2014; Sen *et al*., 2015) following the prevalence of 7%, 6%, and 5% respectively. But, the report from (Ineson, 1953; Soloyamani-Mohammadi *et al*., 2003; Mudim *et al*., 2004; Eijck and Borgsteede, 2005; Begum *et al*., 2014*;* Dadas *et al.,* 2016) indicates the higher prevalence rate of 20%, 8.3%, 29.1%, 37.5%, 9.1% and 11.11%. On contrary, the researcher, (Moretta *et al*., 2010; Tomass *et al*., 2012) reports the lower prevalence of *Trichuris* sp. just only

4.88% and 0.3%. Similarly, *Globocephalus* is a genus of hookworms that affects swine and wild boars worldwide. The most relevant species of veterinary importance is *Globocephalus urosubulatus*. The life cycle is not completely elucidated (Junguera, 2017). Most probably they have a direct life cycle without intermediate host. Pigs get infected after ingesting the infective larva released from eggs to the environment. The present prevalence rate of *Globocephalus* sp. was 38% which was higher than the earlier reported by (Senlik *et al*., 2010; Dadas *et al*., 2016) following 22% and 0.74% prevalence respectively.

Strongyloides sp. (Intestinal threadworm) causes strongyloidiasis. *Strongyloides* worms may be present in a host as a parasitic and free living form in the soil. They have direct life cycle and causes infection by ingestion of contaminated vegetation and drinks with the larva of this species (Staphen and Gareth, 2003). The present prevalence rate of *Strongyloides* sp. was 56% which was higher than the earlier reported by (Mudim *et al*., 2004; Moretta *et al*., 2010; Begum *et al*., 2014; Dadas *et al*., 2016) following 3.8%, 0.81%, 29.1% and 0.74%, respectively. Since wild boars were associated with feeding of earthworms, beetles, bugs and numerous larvae which functioned intermediate or paratenic hosts for various helminthic fauna (Coobs and Spinger, 1974) and also habitat overlap and competition for food also contribute the higher prevalence of *Strongyloides* in animals (Ezenwa, 2002).

Metastrongylus is a genus of nematodes of the family Metastrongyloidae, usually found as lungworms in pigs and sometimes causing parasitic bronchitis. The life cycle is indirect. Infection only occurs where pigs have access to earthworms.The present prevalence was 12%, which was similar to the report of (Mudim *et al*., 2004) who had revealed the prevalence of 12.6%. However, the report from (Ineson, 1953; Yagoob *et al*., 2014; Mansouri *et al*., 2016)) indicates the higher prevalence rate of 66.6%, 34% and 68%, respectively. The difference in prevalence rate might be due to the improper geographical distribution of different earthworm species which form part of diet of wild boars and act as intermediate hosts for these parasites. *Stephanurus* sp. (kidneyworm) is a *strongyloide* nematode of pigs. The prevalence of *Stephanurus* sp. was 44%. The high prevalence rate might be due to the high persistant rainfall and high humidity.

In the study, the eggs were doubted either as *Hyostrongylus* sp. or *Oesophagostomum* sp. Therfore, those eggs were considered as *Strongyle* group. Both of these worms have direct life cycle. The prevalence of *Strongyle* sp. in the present study was 49% which was higher to the earlier reported by (Ineson, 1953; Eijck and Borgsteede, 2005; Senlik *et al*., 2010; Sen *et al*., 2015). Habitat overlaping, competition for food and overcrowding have a significant effect on *strongyle* abundance (Ezenwa, 2002). In the present study the mixed infection was higher on double infection (50.52%) followed by multiple infection (20%), triple infection (18.94%) and single infection (10.52%). The mixed parasitic infection were more common in wild boar due to common overlaping habitat, its feeding pattern, climatic condition, competition for food and parasite exchange between between domestic and wild boars.The intensity of different parasites in wild boars of CNP was

observed in the study. According to the results, maximum numbers of wild boars were found to be infected with light infection which is asymptomatic condition and cannot cause disease in the animals while less number of wild boars were infected with moderate and heavy infection revealed by *Eimeria* sp., *Stephanurus* sp., *Metastrongylus* sp., *Globocephalus* sp., *Strongyloides* sp., *Strongyle* sp. The heavy and moderate infection is symptomatic and can cause serious diseases in animals.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The present study showed that overall prevalence of gastro-intestinal parasites of wild boar (*Sus scrofa*) was 95% with higher prevalence rates of protozoa (85%) followed by nematodes (80%) and trematode (12%) but no any cestode were recorded during the study period. Nine different parasitic species were revealed in wild boar of CNP such as *Eimeria* sp. (with or without) micropyle among protozoan; *Fasciola* sp. among trematode and *Strongyloides* sp., *Stephanurus* sp., *Metastrongylus* sp., *Ascaris* sp., *Trichuris* sp., *Globocephaus* sp. and *Strongyle* sp. among nematodes. Out of all these identified gastrointestinal parasites, *Eimeria* sp. without micropyle (70%) showed higher prevalence followed by *Strongyloides* sp. (56%), *Strongyle* sp.(49%), *Stephanurus* sp. (44%), *Eimeria* sp. with micropyle (40%), *Globocephalus* sp.(38%), *Metastrongylus* sp. (12%), *Fasciola* sp. (12%), *Ascaris* sp. (7%) and *Trichuris* sp. (6%). In mixed infection, double infection showed the highest rate 48 (50.52%) followed by triple infection 18 (18.94%) and single infection 10 (10.52%). Similarly, in intensity of parasitic load maximum number of samples revealed the light intensity followed by mild, moderate and heavy intensity. The results indicated the highly significant difference in the prevalence of parasites on examination samples of wild boar. Damages associated with the presence of parasites in wild boars are difficult to estimate. This problem requires a systematic and continuous investigation in the future. Damages resulting from reduced weight, low fertility, Burdening of the immune system and increased susceptibility to other infectious diseases can be assesed directly or indirectly. In that respect, development of an appropriate methodology adjusted to our conditions is necessary for determining the actual damage in the segment of the ecosystem and improving the wild life welfare. Though there are some studied of gastrointestinal parasites that have been done in wild and captive but this is the first attempt of study of gastrointestinal parasites of wild boar in wild condition in CNP.

6.2 Recommendations

On the basis of conclusion the following recommendations are made to reduce the risk of Gastro-intestinal parasites to wild boar.

- Molecular techniques should be applied for accurate identification of parasites upto species level.
- National parks should establish veterinary laboratory and gastrointestinal parasites should not be neglected by the conservation biologist because they are one of the main threats for wild animals.
- Seasonal study of parsitic prevalence in wild boar should be conducted to know the prevalence of parasites in a season-wise pattern.
- Gastro-intestinal parasites have shown intense infection in wild boar but these parasites have a high possibility of infecting other wild animals as well. Therefore, similar studies should be carried out in other wild animals also.
- National parks should be strictly prohibited for domestic animals since they are the major source of infection to wild animals.

7. REFERENCES

Allwin, B., Jayathagaraj. M.G., Palanivelrajan, M., Gomathinayagam, S., Raman, M., and Bino Sundar, S.T. 2015. Prevalence of helminthic fauna in wild pigs in comparison with domestic pigs: A study in the adjoining areas of Mudumalai, Anamali and Sathyamangalam tiger reserves, Tamil Nadu South India. Journal of Parasitology and Vector Biology**, 7**(3): 46-52.

Balicka-Ramisz, A., Ramisz, A., Pilarczyk, B. and Cisek, A. 2000. Protozoa from *Eimeria* genus in wild animals in Poland. Medycyna Waterynaryina 2000, **56**: 723-724.

Begum, N., Dey, T.R., Dey, A.R., Akther, S. and Barmon, B.C. 2014. Prevalence of end parasites of pig at Mymensingh, Bangladesh. Journal of Agriculture and Veterinary Science, **7**(3): 31-38.

Bhandari, B.B. 2009. Wise use of Wetlands in Nepal. Banko Janakari, **19**(3): 10-17.

Boitani, L., Mattei, L. and Nonis, F. 1994. Spatial and activity patterns of wild boars in Tuscany, Italy. Journal of Mammalogy, **75**(3): 600-612.

Boomker, J., Horak, I.G. and Maclvor, K.M. 2013. Helminth parasites of grysbok, common duikers and Angora and Boer goats in the valley Bushveld in the Eastern Cape Province. Onderstepoort. Journal of Veterinary Research, **56**: 165-172.

Boral, O., Uysal, H.K., Metiner, K. and Ilgaz, A. 2009. Investigation of intestinal parasites in pigs feces that are also human pathogens. Turkiye Parazitolojii Dergisi, **33**(2): 218-221.

Chandra, R. K. and Newberne, P. M. 1977. Nutrition, Immunity and Infection. Journal of Animal Science, **44**: 333-341.

Chapman, B. and Trani, M. 2007. Feral pig (*Sus scrofa*). European Journal of Wildlife Research, **4**: 540-544.

Coombs, D. 1974. Parasites of Feral Pig x European wild boar hybrids in Southern Texas. Department Of Veterinary Parasitology, **10**: 436-444.

Coop, R. L. and Holmes, P. H. 1996. Nutrition and parasite interaction. International Journal Parasitol, **26**: 951-962.

Dadas, S., Mishra, S., Jawalagatt, V., Gupta, S., Vinay, T.S. and Gudewar, J. 2016. Prevalence of Gastrointestinal in pigs (*Sus scrofa*) of Mumbai Region. International Journal of Science, Environment and Technology, **5**: 822 – 826.

DeMagalhaes, J. and Costa, J. 2009. A database of vertebrate longevity records and their relation to other life - history traits. School of Biological Science, **22**: 1770-1774.

Despommier, D. D., Gwazda, R. W. and Hotez, P. J. 1995. Parasitic Diseases. International Journal of Parasitol, **5**: 45-54.

Department of National Park and Wildlife Conservation, 2029 (1973). Nepal Gazette, (2030).

DNPWC. 2014. Department of National Park and Wildlife Conservation, Kathmandu, Nepal.

DNPWC. 2017. Department of National Park and wildlife Conservation. The Himalayan Times, 3 March, 2017.

Dobson, A. P. and Hudson, P. J. 1992. Regulation and stability of a free-living host-parasite system: *Trichostrongylus tenuis* in red grouse: 2 population models. Journal of Animal Ecology**, 61**: 487–498.

Eijck, I.A.J.M. and Borgsteede, F.H.M. 205. A survey of gastrointestinal pig parasites on free-range, organic and convential Pig farms in the Netherlands. Veterinary Reseach Communication, **29**(5): 407-414.

Eslam, A. and Farsad-Hamdi, S. 1992. Helminth Parasite of Wild Boar *Sus scrofa*, in Iran. Department of Pathology, Faculty of Veterinary Medicine, Tehran, University. Journal of wild life diseases**, 28**(2): 316-318.

Ezenwa, V.O. 2002. Habitat overlap and gastro-intestinal parasitism in sympatric African Bovids. African Journal Ecology, **126**: 379-388.

Faye, O., Mouchet, J., Julvez, J. and Manguin, S. 2006. Ecological and evolutionary responses to recent climate change. Journal of Ecological Society, **37**: 637-669.

Fiere, I., Hernandez-de-lujan, S. and Muela, N. 2001. Helminths of Wild Boar in Spain. Journal of Wildlife Diseases, **37**(4): 840-843.

Foata, J., Culioli, J.L. and Marchad, B. 2005. Helminth Fauna of Wild boar in Corsica. Acta Parasitologica, **50**(2): 168-173.

Foufopoulos, J., Altizer, S. and Dobson, A. 2003. Interactions between wild life and domestic livestock in the tropics. Chapter8. CRC Press, **23**: 219-244.

Fox, M.T. 2000. Pathophysiology of infection with gastro-intestinal nematodes in domestic ruminants: Veterinary Parasitology, **72**: 285-308.

Government of Nepal. Nepal Fourth National Report To The Convention on Biological Diversity (2009). Government of Nepal, Ministry of Forest and Soil Conservation.

Graves, H. 1984. Behaviour and ecology of wild and feral swine (*Sus scrofa*). Journal of Animal Science, **58**: 482-492.

Harvel, C.D., Mitchell, C.E., Dobson, A.P., Ostefeld, R.S., Samuel, M.d. and Ward, J.R. 2002. Climate warming and diseases risk for terrestrial amd marine biota. International Journal of Animal Ecology, **296**: 2158-2162.

Henry, V. and Conley, R. 1970. Some parasites of European wild hogs in the Southern Appalachains. The Journal of Wildlife Management, **34**: 913-917.

Hepter, V.G., Noisimovich, A.A., Bannikov, A.G. and Hoffman, R.S. 1998. Mammals of Soviet Union, Washington D.C: Smithsonian Institution libraries and National Science Foundation, **1**: 19-82.

Hudson, P. J., Dobson, A. P. and Newborn, D. 1992. Do parasites make prey vulnerable to predation: Red grouse and parasites. Journal of Animal Ecology, **61**: 681–692.

Humbert, J.F. and Henry, C. 1989. Studies on the Prevalence and the transmission of lung and stomach Nematodes of the wild boar (*Sus scrofa*) in France. Journal of Wildlife Diseases, **25**(3): 335-341.

Ickes, K., Paciorek, C. and Thomas, S. 2005. Impacts of nest construction by native pigs (*Sus scrofa*) and lowland Malaysian rain forest saplings. Ecology, **86**(6): 1540-1547.

Ickes, K. 2001. Hyper – abundance of native wild pigs (*Sus scrofa*) in a lowland dipterocarp rain forest of Peninsular Malaysia. Biotropica, **33**(4): 682–690.

Ineson, M.J. 1953. A comparision of the parasites of wild and domestic pigs in Nezealand. Transaction and Proceedings of the Royal Society of Newzealand, **82**: 579-584.

Isabel, G., Gortazar, C., Vicente, J., Hofle, U. and Fierro, Y. 2003. Wild boar helminthes risk in animal translocations. Veterinary Parasitology, **115**(4): 335-341.

IUCN (2011). IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission IUCN, Gland, Switzerland and Cambridge, UK, 300 pp.

Jarvis, T. and Magi, E. 2007. Helminths of wild boar in the isolated population close to the northern border of its habitat area. Veterinary Parasitology, **150**(4): 366-369.

Jnawali, S.R., Baral, H.S., Lee, Samantha., Acharya, K.P., Upadhya, G., Pandey, M. *et al*., 2011. The status of Nepal Mammals: The National Red list Series, Department of National Parks and Wildlife Conservation Kathmandu, Nepal.

Joshi, D.D. 1991. Current practices of livestock slaughtering and meat marketing in Kathmandu, Lalitpur and Bhaktapur. National zoonoses and Hygiene Research Centre, Chagal, Kathmandu.

Joshi, D.D., Poudyal, P.M., Maharjan, M., Neave, L., Jimba, M. and Mishra, P.N. 2001. Epidemiology status of Taenia/ Cysticercois in pigs and human in Nepal. Journal of the Institute of Medicine, **23**:1-12.

Junguera, P. 2017. Parasitic hookworms of Pigs. Biology Prevention and Control, Globocephalus. Journal of Veterinary Science, **42**: 352-358.

Khanel, M. 2017. Prevalence of gastrointestinal parasites in pigs (*Sus domesticus* Linnaeus, 1758) of Chandragiri Municipality, Kathmandu. M.Sc. Thesis. Central Department of Zoology, Tribhuwan University, Kathmandu, Nepal.

Kutz, S.J., Hoberg, E.P., Nagy, J., Polley, L. and Elkin, B. 2004. Emerging parasitic infections in Arctic ungulates. Integrative and Comparative Biology, **44**: 109-118.

Lee, A. 2012. Pig Health Coordinator, Menangle. Department of Primary industries. Animal Biosecurity Primefact, 1149 first edition.

Lydekker, R. (1990). The great and Small game of India, Burma and Tibet. London Research ward, **44**: 258-256.

Mansouri, M., Sarkari, B. and Mowlavi, G.R. 2016. Helminth Parasites of wild boars (*Sus scrofa*) in Bushehr Province, Southwestern Iran. Iran Journal Parasitol, **11**:3 77-382.

Meng, X., Lindsay, D. and Sriranganathan, N. 2009. Wild boars as a source of infectious diseases in livestock and humans. Biological Science, **364**: 2697–2707.

Moretta, I., Veronesi, F., Paola, R.D., Battistacci, L. and Moretti, A. 2010. Parasitological survey on wild boar (*Sus scrofa*) shot in the hunting season 2009 – 2010 in Umbria (Central Italy). Large Animal Review, **17**: 187-192.

Muller, G. and Silva da Silva, D. 2013. Parasitic helminths of the digestive system of wild boars in captivity. Journal of Parasitology Veterinaria, **22**: 102-116.

Mundim, A.V., Mundim, M.J.S., Satos, A.L.Q., Cabral, D.D., Faria, E.SM. and Moraes, F.M. 2004. Helminths and protozoa in wild boars (*Sus scrofa*) feces raised in captivity. Journal of Wildlife diseases, **56**: 1678-1690.

Oliver, W. and Leus, K. 2008."IUCN Red list of Threatened species. Version 2013.2." (online). http: //www.iucnredlist.org/details/41775/0. *Sus srofa* Accessed November 01, 2013.

Packer, C., Holt, R. D., Hudson, P. J., Lafferty, K. D. and Dobson, A. P. 2003. Keeping the herds healthy and alert: Implications of predator control for infectious disease, **6**: 1–6.

Poudel, S.R., Gupta, R. and Ratala, D.R. 2014. Sero – prevalence of Brucellosis in pigs in 6 VDCs of Rupendehi district of Nepal. Nepalese Journal of Zoology, **2**(1).

Poudyal, P.M. 1998. Prevalence of *Taenia solium* in pigs and its public health importance in Kathmandu Metropolitan city and Daharan Municipality, Sunsari district of Nepal. M.Sc. Thesis. Central Department of Zoology, Tribhuwan University, Kathmandu, Nepal.

Rimac, D., Rajkovic-Janje, R., Dragicervic, P., Bosnic, S. and Vinkovic, B. 2002. Prevalence of helminth in wild boar from hunting grounds in eastern Croatia. Croatia Veterinary Institute, **48**: 261-270.

Roepstarffa, A., Nilssonb, O., Oksanenc, A., Gjerded, B., Richtere, S.H., Ortenbergf, E.J *et al*. 1998. Intestinal parasites in swine in the Nordic countries: Prevalence and geographical distribution.Veterinary Parasitology, **76**(4): 305-319.

Sato, H., Suzuki, K. and Yokoyama, M. 2008. Visceral helminthes of wild boars (*Sus scrofa leucomystix*) in Japan, with reference to a new species of the genus *Morgascaridia Inglis*, (Nematode; Schneidernematidae). Journal of Helminthology, **82**: 159-168.

Schley, L., and Roper, T. 2003. Diet of wild boar (*Sus srofa*) in western Europe, with particular reference to consumption of agricultural crops. Mammal Review, **33**: 43-56.

Senlik, B., Cirak, V.Y., Girisgin, O. and Akyol, C.V. 2010. Helminth infections of wild boars (*Sus scrofa*) in the Bursa province of Turkey. Journal of Helminthology, **85**(4): 404-408.

Sen, P., Azam, M.D., Tasneem, M., Shafiql, M.D., Rakib, T.M., Alim, A., *et al.* 2015. Occurance of gastrointestinal parasitic infections in pig of Dinajpur district, Bangladesh. Scientific Journal of Veterinary Advances, **4**: 284-289.

Shakya, M. 2009. Prevalence of *Taenia solium* in pigs and its public health importance in Kirtipur Municipality. M.Sc. Thesis. Central Department of Zoology, Tribhuwan University, Kathmandu, Nepal.

Shrestha, S., Bhuju, U.R., Shakya, P.R. and Basnet, T.B. 2007. Nepal Biodiversity Resource Book Protected Areas, Ramsar sites and World Heritage sites. International Central For Integrated Mountain Development, Ministry of Environment Science and Technolgy, in Cooperation with United Nations Environment Programme, Regional office for Asia and the pacific, Kathmandu.

Sloss, M.W., Kemp, R.L. and Zajac, A.M. 1994. Veterinary Clinical Parasitology, Sixth edition, International Book Distributing Company, Lucknow, India.

Solaymani-Mohammadi, S., Mobedi, I., Rezaian, M., Massoud, J., Mohebali, M., Hooshyar, H. *et al*. 2003. Helminth Parasite of Wild Boar (*Sus scrofa*), in Lauristan province, Western Iran and their public health significance. Journal of Helminthology, **77**: 263-267.

Soulsby, E.J.L. 1998. Helminths, arthropods and protozoa of domesticated animals.7th Edition Bailliere Tindall, London, UK.

Soulsby, E.J.L. 2012. Helminths, arthropods and protozoa of domesticated animals. 7th Edition East-West Press, New Delhi, 781.

Staphen, L.C.J. and Gareth, H.W. 2003. Pathology and diagnosis of internal parasites in ruminants. Post Graduate Foundation in Veterinary Science, University of Sydney, **16**: 309-338.

Stein, R.A. (2011). Super spreads in infectious diseases. International Journal of Infectious diseases. Official publication of the International Society for Infectious diseases, **15**(8):510-515.

Stojanov, I., Pavlovic, I., Ivan, P., Jasna, P., Radomiv, R., Doroteja, M. *et al.* 2017. Determination of endoparasites by fecal examination in the wild boar population in Vojvodina (Serbia). Scientific Journal of Veterinary Medicine, **41**(1): 1-8.

Thawait, V.K., Maiti, S.K. and Dixit, A.A. 2014. Prevalence of gastrointestinal parasites in captive wild animals of Nandan Van Zoo, Rajpur, Chhatisgarh, India. Veterinary, **7**(7): 448-451.

Tomass, Z., Imam, E., Kifleyohannes, T., Tekle, Y. and Weldu, K. 2012. Prevalence of gastrointestinal parasites and *Cryptosporidium* sp. in extensively managed pigs in Mekelle and Urban areas of Southern zone of Tigery region, Northen Ethiopia. Vet World, **6**(7): 433–439.

V.G, H., Nasimovinch. A.A., Bannikov, A.G. and Hoffman, RS. 1998. Mammals of the Soviet Union. Smithonian Institution and National Science Foundation, **1**: 19-88.

Webster, W., Parnell, I. and Biggs, W. 1985. Mammals of the Carolinas, Virginia and Maryland: The University of North Carolina Press, **14**: 23-34.

Wood, G. and Barrett, R. 1979. Status of wild pigs in the United States. Wildlife Society Bulletin, **7**(4): 237-246.

Wozencraft, W.C. 2005. Mammals species of the world: A taxonomic and Geographic References (3rd edition). John Hopkins University Press, 532-628 pp.

Yagoob, G., Saeed, M. and Ali, O. 2014. Helminth Parasite of a hunted wild boar (*Sus scrofa*) in the Talesh city, North of Iran. Bulletin of Environment. Pharmacol Life science, **3**(3): 247-250.

Yamagutti, S. 1961. Systemahelminthum. The nematodes of vertebrates. Volum III. Interscience publishers incorporation, New York, 1261.

ANNEX – 1

Table 5: Size of eggs/ cysts/oocysts of different Gastro - intestinal parasites of wild boar.

Name of Parasites	**Size in um**		**Remarks**
	Length	**Breadth**	
Eimeria with micropyle sp.	24um-30um	18um-22um	Oval in shape
Eimeria without micropyle sp.	22um - 28um	16um - 20um	Sporulated oocysts have four sporocysts with two sporozoites each.
Ascaris sp.	50 - 70 um	40 - 60um	Thick walled, golden brown, thin inner yolk membrane, uneven lumpy aliminous outer wall unsegmented, granular contents.
Fasciola sp.	130-150 um	63 - 90 um	Oval, has operculum at one end, unsegmented, bile stained
Trichuris sp.	50 - 68 um	21 - 31 um	Thick shell, two transparent polar plugs unsegmented, brownish granular contents.
Metastrongylus sp.	51 - 63 um	32 - 42 um	Wall thick, deep grey with slightly wrinkled surface.
Globocephalus sp.	55 - 63 um	38 - 45 um	Ovoid, thin membrane 4-8 cells when shed with feces.
Strongyle sp.	50 - 85 um	26 - 47 um	Wall thin, smooth colorless, slightly to strongly barrel shaped, blastomeres present.
Strongyloides sp.	40 - 55 um	20 - 30 um	Single cell, grayish green short, thick L1 larva present.
Stephanurus sp.	90 - 114 um	53 - 70 um	Wall thin, transparent, blastomeres present.