I

INTRODUCTION

Man gives pride of place to himself and to the apes, monkeys and lemurs because all of them are higher mammals. These animals have many of the same structural characters as man. Some of them resemble him more in one feature, some in another. They are grouped with man in a common natural order the Primates, the first the highest of animals according to their superior development of brain. At the other end of the scale is man, who in mental endowment stands alone and unapproachable among all creatures. The immeasurable superiority of the human intellect marks the line of cleavage between man and animal.

If we look for obviously distinctive characters in the animals, which we class as primates, we find them in the structure of their hands and feet, which are designed to serve the express purpose of grasping organs. As such they are admirably adapted to the particular habits and mode of life of animals (Prater, 1980).

About 200 species of primates are recognized. They are grouped into more than 50 genera and almost 100 extinct genera are also known (Tattersall, 1993). The macaque is a member of the sub family Cercopithecinae and family Cercopithecidae of primate order of mammalian.

Three species of macaques have been reported from Nepal, the rhesus monkey (*Macaca mulatta),* Assamese monkey (*Macaca assamensis)* and Langur monkey (*Presbytis entellus*) (Chalise, 2004).

The rhesus monkeys, *Macaca mulatta* are the most common of all these species in the world. They are distributed in South and East Asia i.e Afganistan, Bangladesh, Burma, China, Hong-Kong, India, Nepal, Srilanka, Thailand, etc. In Nepal, they are usually found in jungles of religious spots like Pashupatinath temple, Swayambhunath temple, Dakshinkali, Ram temple and Nilbarahi and also

natural forests as Gokarna and Charkoshi Jhadi (terai). They are even found in some localities of Kathmandu Valley such as Tripureshwor, Thapathali, Sankhu and Pulchowki Dada(Chalise 1998, Yadav 2004).

Macaca mulatta are commonly called as Rato Bandar in Nepali, Rhesus Monkey in English, Lal Bandar in Hindi, Makkad in Marathi, Baojha in Hindko, Mankad in Oriya, Kathi in Telugu and Bandar in Urdu (Primate Taxonomy SAZARC).

The rhesus macaque *(Macaca mullata*) has a rather short tail, uniformly well brown hair with much bright colour, more reddish – hind parts. The face which is bare, is light pink, flesh colored or reddish. The ears are pointed and protruding. It possesses special pads on their limbs. Fore limbs and hind-limbs are of equal size. They are mostly arboreal in habitat (Napier and Napier, 1985). The weight of male rhesus monkey ranges from 5.6-10.9 kg and in female the weight ranges from 3.0-10.7 kg. The head and body length in males reach upto 48.5-63.5 cm and in females it ranges from 47.0-53.1 cm. The tail length in male ranges from 20.3-30.5 cm while in females it ranges from 19.0-28.5 cm (Roonal and Mohnot, 1977).

The helminthes (Helminth = worm) are worm like parasites. These are multicellular and bilaterally symmetrical elongated, flat or round bodies. Helminths are broadly classified into Flatworms or Platyhelminths (Platy = flat), which include flukes and tape worms and Round worms or Nematodes (Nemato = thread), which include nematodes.

Since helminth parasites are the causative agent of a terrible and list of debilitating, deforming and killing diseases of primates, the studies in these regards are very important from epidemiological point of view. Further more, some helminth infection particularly due to intestinal parasites are one of the major causes of gross health problem.

In the wild many primates scavenge about villages and share not only food but also the parasites of the human inhabitants. Danger from imported animals,

therefore, is usually during the first few months after the animals arrival in the country. If the parasites are effectively eliminated during the initial quarantine adaptation period, the danger of transmission can be eliminated. The most serious danger that the arthropods pose in their role as an intermediate biological host for parasitic diseases and as a mechanical vector for infectious organism. Parasites that need an intermediate host are self limiting but those having a direct cycle become a continual problem. These include protozoa, nematodes, cestodes, trematodes and arthropods. Possible human infection from primate carrier is a constant threat.

Significance of the Study

Monkeys make up the majority of the Primate order and are a wonderfully diverse and interesting group. Rhesus monkeys inhabit village and towns as well so they may interact with domestic livestock and humans by serving as reservoirs, monkeys may also be vectors, and humans may also be trans species host. Most parasites have little effect on their hosts, but the potential for trans species infections may be an important management concern. Rhesus monkeys are always used as experimental animals by medico-biological institute. So this species is targeted for the study purpose. Being higher primates many organ system are similar to man. Studies on intestinal helminth parasites of monkeys (Rhesus) have not been carried out as yet in detail from Nepal. Only one minor study has been done before. Therefore, this study was carried out in attempt to explore "Intestinal helminth parasites of Rhesus monkeys"

II

AIMS AND OBJECTIVES

General Objective

Intestinal helminth parasites of *Macaca mulatta* (Zimmermann) from Pashupati (Kathmandu district) and Nilbarahi area (Bhaktapur district) of Nepal.

Specific Objectives

- Identification of eggs/ova.
- To compare the prevalence of intestinal helminth parasites between the monkeys of Nilbarahi and Pashupatinath areas.
- To determine the general prevalence rate of intestinal helminth parasites.
- To determine the class-wise prevalence rate of intestinal helminth parasites.
- To determine the species-wise prevalence rate of intestinal helminth parasites.
- To determine the zoonotically infective helminthes of monkey.
- To develop a background for the further studies.

III

REVIEW OF LITERATURE

Parasites are living organisms which receive nourishment and shelter from other organisms where they live. Intestinal parasites are endo parasites that live in the intestinal wall derive nutrition from the food in the lumen and the intestinal wall in the process of which they harm the host. Most of the parasites follow a specific route in different parts of the body before they are established in the intestine by which they cause variety of disorders. The intestinal parasites are generally the protozoans and helminthes.

GLOBAL CONTEXT

Horii *et al.*, (1981) The incidence of eggs in individual faeces and the EPG of gastrointestinal nematodes for individually discriminated Japanese monkey of the Koshima troop were investigated monthly from October 1974 to June 1979. Eggs of 4 nematode species (*Oesophagostomum aculeatum, Trichuris trichiura, Streptopharagus pigmentatus* and *Strongyloides fulleborni*) were frequently found and a few cestode segments of *Berticella* sp. were occasionally found. *Strongyloides fulleborni* had a high incidence (100%) in young monkeys, suggesting that its incidence might vary with the monkey's age.

Joseph *et al.*, (1999) Information on the parasitic load of two endangered primates, Lion-tailed Macaque and Nilgiri Langur, inhabiting Silent Valley National Park were collected during the period 1994-95. Parasitic load within these primate species in captivity were also ascertained and compared with that of wild. The major intestinal parasites identified from the wild samples were *Trichuris* sp. and *Oesophagostomum* sp.

Eberhard *et al.*, (2001) suggested that *Oesophagostomum bifurcum* found in human and monkeys in the same geographical region of northern Ghana and Togo are not likely to represent zoonotic infection acquired from monkeys.

Plesker *et al.*, (2001) diagnosed 19 pig tailed macaques (*Macaca nemestrina*) at the Paul Ehrlich Institute, Germany and found three hydatid cysts in the liver which was confirmed as *Echinococcus granulosus*.

Gillespie *et al.*. (1997 to 2003) collected 2,103 faecal samples from free-ranging individuals of the 3 colobus monkey's of Uganda to determine the prevalence of gastrointestinal parasites. Seven nematodes (*Strongyloides fulleborni, Strongyloides stercoralis* and *Oesophagostomum* sp), 1 cestode (*Berticella* sp.), 1 trematode (Dicrocoeliidae) and 3 protozoans (*Entamoeba coli, Entamoeba histolytica* and *Giardia lamblia*) were detected.

Hobbs *et al.*, (2003) found abdominal cysticercosis in rhesus macaque in Oregon National Primate Research Center, USA.

Michaud *et al.*, (2003) found that helminth parasites shared by non-human primates and man in Peru were *Ancylostoma brazilliensis, Ascaris lumbricoides, Necator americanus, Hymenolepsis diminuta and Trichuris* sp.

Ponnudurai *et al.*, (2003) examined 108 faecal samples of monkey in Tamil Nadu, out of which 56 (51%) samples were positive for parasitic infection. Among the Parasitic infections, *Enatamoeba* sp. accounted for 14%, Oesophagostomum sp. 28% and *Strongyles* sp. 14%. The incidence of 3 parasites was seen as mixed infections in 7%.

Phillips *et al.*, (2004) collected faecal samples from 86 individuals of non-human primates from Tambopata Research Center, Tambopata National Reserve, Peru and analysed a concentration test, the result of which indicate the presence of various protozoans, *Ancylostoma* sp, *Ascaris* sp, *Strongyloides stercoralis, Trichuris trichiura, Prosthenorchis elegans* and *Schistosoma mansoni*.

Van Leishout *et al.*, (2005) examined 349 faecal samples of different primates from Ghana and found high prevalence of *Oesophagostomum bifurcum* (75.99%).

Gruijter *et al.*, (2006) compared adult *Oesophagostomum bifurcum* from human and non-human primates from Ghana and found significant differences in morphological characters between *Oesophagostomum bifurcum* worm from humans, the Mona, Patas or Green Monkey. These findings suggests that *Oesophagostomum bifurcum* from different spcies of primate host represent distinct population variants.

IN CONTEXT OF NEPAL

Limbu *et al.*, (2006) reported Strongyles and Paramphistome groups in Rhesus monkey (*Macaca mulatta*) for the first time in Nibarahi in the community forest.

IV

MATERIALS AND METHODS

❖ Study Area

The study area includes the Pashupati of Kathmandu district and Nilbarahi of Bhaktapur district.

Background Information of Pashupati Area

Pashupati is an ancient religious place at a distance on 5km, northeast of Kathmandu city. This area lies 1302.79m above sea level. Physically, it is situated between 85°20'57" to 85°21'04" and 27°42'20" to 27°42'26" east longitude and north latitude respectively (Pashupati Vikas Kosh). This temple is about 1700 years old (Kantipur, 1998). Most of the Pashupati areas are under the influence of human community. Hence, once completely living wild rhesus monkeys are currently in provisioned stage. The forest in this area is sub-tropical type. Pashupati site is associated with parkland and walled garden inside. It is located on the bank of river Bagmati in the east, and the parkland habitat is situated next to the temple. Parkland habitat of Pashupati has a great variety of trees and shrubs providing many natural foods to the monkeys. The monkeys are basically provisioned one, obtaining much of their food from the people at the temple and near by bazaars.

Background Information of Nilbarahi Area

Like Pashupati, Nilbarahi is also an ancient religious place at distance on 12 km east of Kathmandu city. It is located at Bhaktapur district. It lies 1335m above sea level. Physically, it is situated 85°23'30" to 85°24'30" and 27°40'30" to 27°42'30" east longitude and north latitude respectively.

This area occupies 252 ropani. Forests occupy most of the Nilbarahi area, only a few of its part are under the influence of human community. There is majority of Newars and a few numbers of Chhetris. This place is famous for Nilbarahi temple, which was built in Lichhawikal. There are about 500 monkeys,

which are divided in 4-5 groups. The monkeys are depended on natural foods (Information from local people).

❖ Collection of Stool Samples of Monkey

Stool samples of monkey were collected from June 2006 to December 2006. To prevent the repetition the samples were collected from different places of the study site. All together 202 samples were collected from both areas.

Before the collection of samples the vials were properly cleaned with detergent and were dried to make sure that the condition of samples were good. After collection of samples, they were preserved in 5% formalin or 2.5 % potassium dichromate according to the availability and kept in a refrigerator.

Materials Required

Weighing scale, beaker, motor and pistle, slide, cover-slip, dropper, pipette, gloves, plastic-tube, tea strainer, cello tape, toothpick, Sodium chloride mixture (specific gravity1.2), Zinc sulphate mixture (specific gravity 1.3), Iodine, saline water, methylene blue, centrifuge machine, refrigerator and microscope.

❖ Examination of Stool Samples

Examination of stools was first carried by naked eyes to know whether there were adult worms {*Ascaris lumbricoides*, hookworm, *Trichuris trichiura*, *Eanterobius vermicularis* various intestinal flukes or a part of it (segment of tapeworms)}. After that microscopial examination of stool was carried out to identify helminth eggs and larvae. This was done by wet mount of fresh stool, preserved specimen or faecal concentrates.

Direct Smear

For the purpose of direct smear the following process were carried out, they were :-

1. Saline Direct wet mount.
2. Wet mount.
3. Iodine wet mount.

Concentration Method

After direct routine examination, concentration technique was performed because this technique increases the ability to detect helminth eggs and larvae by decreasing the amount of background materials in the preparation and by an actual concentration of organisms.

Following two methods were followed:-

1. Floatation Techniques

In the floatation technique, the suspending fluid (sodium chloride or zinc sulphate) has a higher specific gravity than the parasitic forms, which therefore, rise to the surface. All the helminthic eggs float in such a solution except the following:- unfertilized eggs of *Ascaris lumbricoides,* eggs of *Taenia solium* and *Taenia saginata,* eggs of intestinal fluke. The *Strongloides* larvae do not float in salt solution.

From this process eggs of Nematode, Cestode and Coccidia can be detected. For detection of lung worm half saturated salt solution is used.

Method

3 gm of stool sample was taken in a beaker and 42ml of water was added. With the help of motor and pistle, the sample was grinded lightly and filtered with a tea strainer. The filtered sample was poured into plastic tube of 15ml and centrifuged at 1000 rpm for 5 minutes. The tube was taken out and the upper part of the water was removed with the help of a pipette. The tube was noted filled with sodium chloride solution and centrifuged at 1000 rpm for five minutes. More Nacl solution was added upto the tip of the tube. A cover slip was placed over the top of the tube so that the Nacl touches the coverslip for a few minutes and then the coverslip was placed on a slide and examined at 10x.

2. Sedimentation Technique

The technique is used for the detection of trematode eggs. It provides good results as the eggs of trematode is bit heavier than the other eggs and deposited at the bottom (Source: *Veterinary Lab. Techniques*, 2003).

Method

3 gm of stool sample was taken in a beaker, 42 ml of water was added and grinded lightly with the help of motor and pistle. The sample was filtered with a tea strainer and the filtered sample was poured in a plastic test tube, centrifuged at 1000 rpm for 5 minutes. The tube was taken out and the upper water was removed with the help of a pipette. Zinc Sulphate solution was filled in the tube and again centrifuged at 1000 rpm for 5 minutes. A drop of deposited materials was taken out from the test tube with the pipette and placed on the slide, added drop of methylene blue into it and examined under the microscope at 4x and 10x.

Identification of the eggs

The identification of the eggs was confirmed by comparing the structure, color and size of eggs with that of Soulsby (1982), Georgi (1969), Eggs were also compared with that of the chart (Investigatio coprologica animalium domesticorum / Magnoum / Bos et ovis, Ianssen Pharmaceutica Ex. Scientia Progressus) at Central Veterinary Laboratory, Tripureshwor.

The identification of the eggs are the joint effort of the author and of Ms. Mary Dhoubadel.

V

RESULTS

The results obtained are presented in three parts :

A. Description of the eggs

B. Prevalence rate of helminth parasites

C. Zoonotically infective helminthes of *Macaca mulatta*

A. DESCRIPTION OF THE EGGS

Altogether 18 species of helminth eggs were detected from the faecal samples of monkeys. Out of 18 species, 16 species belong to class Nematoda, 1 belong to class Trematoda and 1 belongs to class Acanthocephala (at present has the status of phylum). The detected helminthes are shown in Table 1.

Table 1 :- Helminth parasites detected from *Macaca mulatta*.

CLASS	SPECIES
Nematoda	*Strongyloides fulleborni* *Toxocara canis* *Oxyuris* sp. *Ascaris lumbricoides* *Dictyocaulus* sp. *Chabertia* sp. *Toxascaris leonina* *Ostertagia* sp. *Trichurus ovis* *Trichuris trichiura* *Trichostrongylus* sp. *Capillaria* sp. *Oesophagostomum* sp. *Ancylostoma duodenale* *Haemonchus contortus* *Cooperia* sp.
Trematoda	*Dicrocoelium* sp.
Acanthocephala	*Prosthenorchis elegans*

Plate No. 1 **ò640**
An Egg of *Toxocara canis* **75«-×90«**

Plate No. 2 **×400**
An Egg of *Toxascaris leonina* **60µ b× 75µ**

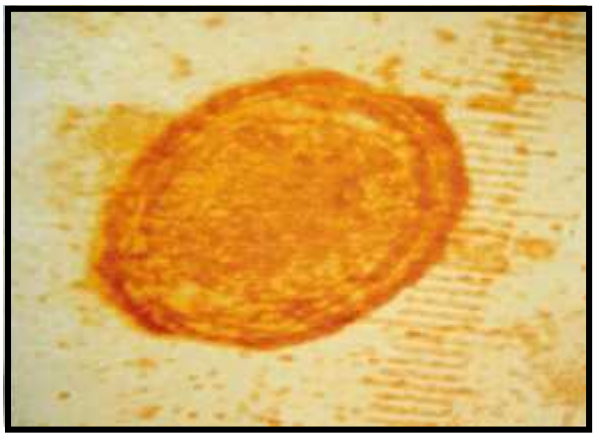

Plate No. 3 **×400**
Fertilized Egg of *Ascaris lumbricoides* **35« b× 45«**

Plate No. 4 **×400**
Unfertilized Egg of *Ascaris lumbricoides* **38« ×78«**

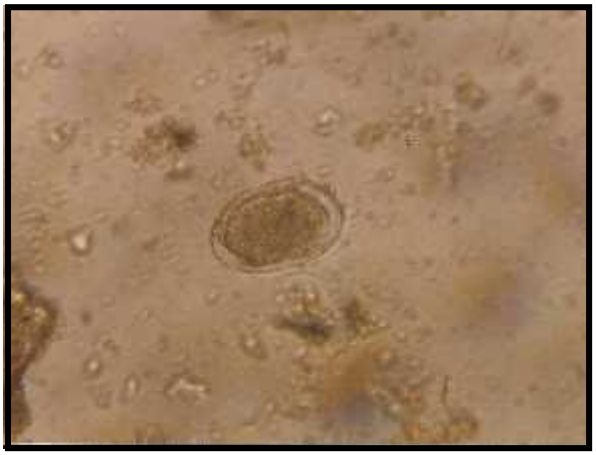

Plate No. 5 **×400**
An Egg of *Ostertagia* sp. **40« × 74«**

Plate No. 6
An Egg of *Oxyuris* sp. **×400**
40« × 80«

A. DESCRIPTION OF THE EGGS RECOVERED

1. *Toxocara canis*

Class	-	Nematoda	Rudolphi, 1808
Order	-	Ascaridida	Skrjabin and Schulz, 1940
Family	-	Ascaridae	Baird, 1853
Genus	-	*Toxocara*	Stiles, 1905
Species	-	*canis*	(Werner, 1782) Johnston, 1916

Toxocara canis infection of dogs is high throughout the world, even approaching cent percent for some population of pups. Toxocariasis (visceral larva migrans) in humans is widely distributed throughout the world, in both temperate and tropical countries. Most of the infections in man are produced by the larvae of the dog ascarid *Toxocara canis* and less frequently by ascarid of other animals.

Toxocara canis completes its life cycle in a single host. The adults usually inhabit the intestinal tract of dog, wild jackal, fox etc. The adult worms are not found in man. The females are relatively longer than the males and measure 6 to 10 cm in length and 4 to 6 mm in breadth.

In context of Nepal

In 1970, Singh reported *Toxocara canis* in dogs from Kathmandu.

In 2003, Khaniya and Sah reported *Toxocara canis* in dogs from Kathmandu.

In 2004, Khanal reported *Toxocara canis* in cat from Nawalparasi and Chitwan districts.

In the present study, *T. canis* reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

The egg is round with the characteristic pitted shell and measures 75 by 85 « m. The eggs do not contain any embryo at the time of their excretion in the faeces.

2. *Toxascaris leonina*

Class	-	Nematoda	Rudolphi 1808
Order	-	Ascaridida	Skrjabin and Schulz, 1940
Family	-	Ascaridiae	Baird, 1853
Genus	-	*Toxascaris*	Leiper, 1907
Species	-	*leonina*	(V Linstaw, 1902) Leipier, 1907
Synonym	-	*Toxascaris limbata*	

Toxascaris leonina occurs in the small intestine of dog, cat, fox, wild felidae and canidae in most parts of the world. The males are up to 7cm long and the females are up to 10cm.

The infective stage is the egg containing a second-stage larva. This stage, under optimal conditions outside the host, is regarded in three to six days. After ingestion and hatching, second-stage larvae enter the wall of the intestine and remain in this site for about two weeks. Moulting to third-stage larvae commences about 11 days after infection and is followed fairly quickly by a moult to the fourth larval stage. Fourth-stage larvae are present in numbers three to five weeks after infection and may measure up to 8mm in length. At this stage they are in the mucosa and in the lumen of the intestine. Fifth stage larvae are produced in the mucosa and the lumen of the intestine. Fifth stage larvae are produced about six weeks after infection and eggs are produced from 74 days onwards (Sprent 1959).

No migration of larvae occurs, as compared with *T.cati*. Larvae of *T.leonina* may occur in mice. In this animal, third-stage larvae are distributed in many tissues and if an infected mouse is eaten by a dog or cat, the larvae are digested from the mouse tissues and develop to maturity in the wall and lumen of the intestine of the final host.

In context of Nepal

In 1970, Singh reported *Toxascaris leonina* in leopard from Kathmandu.

In 1999, Gautam *et al.*, reported *Toxascaris leonina* 6.7% in pet dogs from Kathmandu.

In 2003, Khaniya and Sah reported *Toxascaris leonina* in dogs from Kathmandu.

In 2004, Khanal reported *Toxascaris leonina* in cat from Nawalparasi and Chitwan districts.

In the present study, *T. leonina* reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

The eggs are more or less round with smooth sides, brown or pale black in color. They have a thick shell and contain a single cell when deposited in faeces but they may have undergone the first cell division. It measures 75-85 « m in length and 60-75 « m in breadth.

3. *Ascaris lumbricoides*

Class	-	Nematoda	Rudolphi, 1808
Order	-	Ascaridida	Skrjabin and Schulz, 1940
Family	-	Ascarididae	Baird, 1853
Genus	-	*Ascaris*	Linnaeus, 1758
Species	-	*lumbricoides*	

Ascaris lumbricoides has a worldwide distribution. Nearly one fourth of world population is infected with the parasite. The parasite is found most commonly in countries with poor sanitary conditions. It is the largest intestinal nematode parasitising the human.

The large intestinal roundworm was observed and reported by many people in the ancient times. The roundworm was referred to as *Lumbricus teres* by Romans as it was confused with the common earthworm. The life cycle of *Ascaris lumbricoides* was known only in the year 1916.

Freshly passed adult worms in the stool are pink in colour and look like earthworms. Adult male measures 15cm to 30cm in length and 3mm to 4mm in diameter whereas females are relatively larger than the males. A female measures 20cm to 40cm in length and 2mm to 6mm in diameter.

In context of Nepal

In 1965, Sharma *et al.*, reported *Ascaris* species in human from Kathmandu.

In 1965, Sharma reported *Ascaris lumbricoides* in human from Bhaktapur.

In 1975, Saulsa reported *Ascaris lumbricoides* in human from Pokhara.

In 1977, Shakya reported *Ascaris lumbricoides* in human from Surkhet.

In 1980, Khetan reported *Ascaris lumbricoides* in human from Narayani

In 1981, Bol reported *Ascaris lumbricoides* in human from Narayani.

In 1982, IFP and PCP reported *Ascaris lumbricoides* in human from Panchkhal.

In 1982, ADPCD reported *Ascaris suis* in pigs from Kathmandu.

In 1982, ADPCD reported *Neoascaris vitulorum* in buffalo from Kathmandu.

In 1988, Gupta reported *Ascaris lumbricoides* in human from Kirtipur.

In 1997-98, Sharma reported Ascariosis 43.69% in animals from Panchthar district.

In the present study, *A. lumbricoides* reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

Both fertilized and unfertilized eggs are present in the faeces.

Fertilised Eggs

These eggs are oval to sub spherical in shape and measure 45μm to 70μm in length and 35μm to 50μm in breadth. They are bile-stained and golden brown in colour.

Unfertilised Eggs

These eggs are brown thin-shelled ellipsoidal and measure 78μm to 105μm in length and 38μm to 55μm in breadth. These are heaviest of all the helminthic eggs, hence do not float in saturated salt solution.

4. Oxyuris sp.

Class	-	Nematoda	Rudolphi, 1808
Order	-	Ascaridida	Skrjabin and Schultz, 1940
Family	-	Oxyuridae	Cobbold, 1864
Genus	-	*Oxyuris*	Rudolphi, 1803

Wordwide in distribution. Infection with the horse pinworm, *Oxyuris equi* is extremely common and, although of limited pathogenic significance in the intestine, the female parasites may cause an intense and pruritis during the process of egg- laying.

Mature females are large white worms with pointed tails which may reach 10.0 cms in length whereas the mature males are generally less than 1.0cm long.

In context of Nepal

In 2003, Rabwin, Joshi and Chhetri reported *Oxyuris equi* in horse from Kyanjin Gompa, Langtang.

In 1982, ADPCD reported *Oxyuris equi* in horse from Kathmandu.

In the present study, *Oxyuris* sp. reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

Eggs are asymmetrical, 80µm to 90µm in length and 40µm to 45µm in breadth, flattened on one side with operculum, which is often plugged with mucus at one pole and passed in the faeces in an advanced morula stage.

5. *Ostertagia* sp.

Class	-	Nematoda	Rudolphi, 1808
Order	-	Strongylida	(Diesing,1851) Molin, 1861
Family	-	Trichostrongylidae	Leiper, 1912
Genus	-	*Ostertagia*	Ransom,1907

Distribution is worldwide, *Ostertagia* is especially important in temperate climates and in sub-tropical regions with winter rainfall. This genus is the major cause of parasitic gastritis in ruminants in temperate areas of the world.

The adults are slender reddish-brown worms up to 1.0 cm long. Hence, they are commonly called as brown stomach worm or brown hair worm.

In context of Nepal

In 1982, ADPCD reported *Ostertagia* sp in pig cattle and buffalo from Kathmandu.

In 1997, *Ostertagia nianquingtangluaensis* in goat and ship from western hills of Nepal.

In 1997, Joshi reported *Ostertagia leptospicularis* in sheep from western hills of Nepal.

In 1999, Acharya reported *Ostertagia* sp. in sheep and goat of IAAS live stock, central lab, Tripureshwor.

In 1999, Joshi reported *Ostertagia* sp. in sheep and goat from Kaski district, Pokhara.

In the present study, *Ostertagia* sp. reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

The egg measures 74-90μm in length and 40-45μm in size and are elliptical in shape.

Plate No. 7 **×640**
An Egg of *Haemonchus contortus* **44« × 74«**

Plate No. 8 **×640**
An Egg of *Cooperia* sp. **36« × 77«**

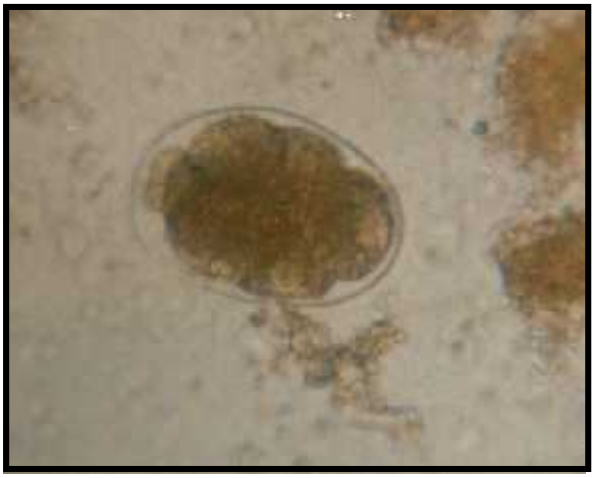

Plate No. 9 **×400**
An Egg of *Ancylostoma duodenale* **40« × 60«**

Plate No. 10 **×400**
An Egg of *Dictyocaulus* sp. **69« × 112«**

Plate No. 11 **×640**
An Egg of *Chabertia* sp. **50« × 90«**

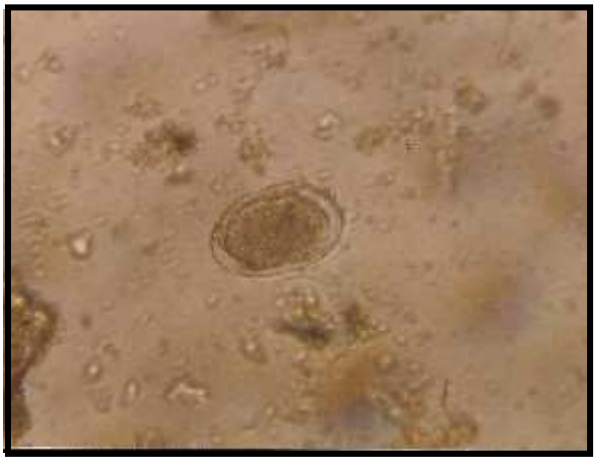

Plate No. 12 **×400**
An Egg of *Oesophagostomum* sp. **30« × 60«**

6. *Haemonchus contortus*

Class	-	Nematoda	Rudolphi, 1808
Order	-	Strongylida	(Diesing, 1851) Molin, 1861
Family	-	Trichostrongylidae	Leiper, 1912
Genus	-	*Haemonchus*	Cobb, 1898
Species	-	*contortus*	Rudolphi, 1803

It has a worldwide distribution. Commonest parasite of domestic sheep throughout the world.

This parasite, commonly called the twisted stomach worm or the sheep wireworm, is a blood sucking nematode occurring in the fourth stomach (abomasum) and occasionally in duodenum of sheep and other ruminants. It has been reported from man once in Brazil and three times in northern Australia. Infection of man is accidental.

Haemonchus contortus is of considerable interest to veterinarians, since it can be lethal in heavy infections. Presence of thousands of worms in a single host is common. Disease is haemonchiasis.

Freshly acquired specimens are generally reddish due to the host's blood contained within. The adult worms are distinguished by a single curved lancet (i.e "blood hooklet") in the depth of the small buccal cavity and by a pair of spine-like cervical papillae. Male (10-20mm by 0.4mm) are smaller than the female (18-30mm by 0.5mm).

In context of Nepal

In 1967-92, Mainali reported *Haemonchus* sp. from Lulu cattle.

In 1973, Singh *et al.*, reported *Haemonchus* sp. in cattle, sheep and buffalo from Kathmandu.

In 1978, Joshi reported *Haemonchus* species in goats from Jamunapari of Nuwakot district.

In 1997, Joshi reported *Haemonchus contortus* in sheep and goat from Western hills of Nepal.

In 1999, Acharya reported *Haemonchus contortus* in sheep and goat of IAAS livestock farm from Central Lab., Tripureshwor.

In 1999, Joshi reported *Haemonchus contortus* in sheep and goat from Kaski district Pokhara.

In the present study, *Haemonchus contortus* reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs:-

The eggs are oval, thin-shelled, hyaline, elongated and measure 75-90μ by 40-50μ. They are already segmented (embryonated) when deposited and resemble those of *Trichostrongylus*.

7. *Cooperia* sp.

Class	-	Nematoda	Rudolphi, 1808
Order	-	Strongylida	(Diesing, 1851) Molin,1861
Family	-	Trichostrongylidae	Leiper, 1912
Genus	-	*Cooperia*	Ransom, 1907

Worldwide in distribution. In temperate areas, members of the genus *Cooperia* usually play a secondary role in the pathogenesis of parasitic gastroenteritis of ruminants although they may be the most numerous trichostrongyle present. However, in some tropical and sub-tropical areas some species are responsible for severe enteritis in calves.

Adults are reddish when fresh. Male measures 4.5-4mm in length whereas female measures 5.8-6.2mm in length.

In context of Nepal

In 1982, ADPCD reported *Cooperia* sp.in goat sheep and buffalo from Kathmandu.

In 1997, Joshi reported *Cooperia curticei* in sheep from Western hills of Nepal.

In 1997, Joshi reported *Cooperia punctata* in sheep from Western hills of Nepal.

In 1999, Acharya reported *Cooperia* sp.in sheep and goat of IAAS livestock farm of Central Lab, Tripureshwor.

In the present study, *Cooperia* sp. reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

Eggs are 70-82 « m to 35-41 « m in size, their sides are parallel and have less than 16 pale yellow blastomeres when laid.

8. *Ancylostoma duodenale*

Class	-	Nematode	Rudolphi, 1808
Order	-	Strongylida	(Diesing, 1851) Molin, 1861
Family	-	Ancylostomidae	Looss, 1905
Genus	-	*Ancylostoma*	(Dubini, 1843) Creplin, 1845
Species	-	*duodenale*	Dubini, 1843

Worldwide in distribution mostly in areas with warm and moist climate *Ancylostoma duodenale*, also known as the old world hookworm. The hook worm causes ancylostomiasis in humans.

The first accurate description of the parasite was given by an Italian physician Dubini (1843), from the autopsy material of a Milanese woman in 1838. Looss (1896) first described the mode of infection and the pathogenesis of the hookworm disease in man.

The worms are cylindrical, greyish white and slightly curved. The anterior end of the worm is bent slightly, in the same direction of the body curve and gives its name "hookworm". Males (8mm in length) are smaller than females (12.5mm in length).

Life cycle is completed in a single host. No intermediate host is needed.

In context of Nepal

In 1965, Sharma reported *Ancylostoma duodenale* in human from Bhaktapur.

In 1971, Sharma *et al.,* reported *Ancylostoma duodenale* in human from Kathmandu .

In 1977, Shakya reported *Ancylostoma duodenale* in human from Surkhet.

In 1980, Khetan reported *Ancylostona duodenale* in human from Narayani.

In 1980, IFP and PCP reported *Ancylostoma duodenale* in human from Panchkhal.

In 1981, Bol *et al.,* reported *Ancylostoma duodenale* in human from Lalitpur.

In 1982, ADPCD reported *Ancylostoma* sp. in dog and cat from Kathmandu.

In 1986, Morel reported *Ancylostoma duodenale* in human from Eastern hills of Nepal.

In 1988, Gupta reported *Ancylostoma* sp. in dog and cat from Kathmandu.

In 2004, Khanal reported *Ancylostoma* sp. in cat from Nawalparasi and Chitwan districts.

In the present study, *A. duodenale* reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

The eggs are oval (60μm in length and 40 μm in breadth), thin-shelled and non bile stained. The eggs usually contain seven to eight blastomeres. A clear space is always present between the segmented ovum and the egg shell.

9.*Dictyocaulus* sp.

Class	-	Nematoda	Rudolphi, 1808
Order	-	Strongylida	(Diesing, 1851) Molin, 1861
Family	-	Dictyocaulidae	Skrjabin,1941
Genus	-	*Dictyocaulus*	Railliet and Henry, 1907

Worldwide in distribution, but especially important in temperate climates. This genus living in the bronchi of cattle, sheep, horses and donkey are the major cause of parasitic bronchitis in these hosts.

The adults are slender thread-like worms. Males are 3-8cm in length and females are 5.0-11.0cm in length. Their location in the trachea and bronchi and their size are diagnostic.

In context of Nepal

In 1982, ADPCD reported *Dictyocaulus* sp. in goat and sheep from Kathmandu.

In the present study, *Dictyocaulus* sp. reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

Eggs are 112-138μm to 69-90μm in size, ellipsoidal and contain fully developed larva when laid or first stage larva may pass in faeces.

10. *Chabertia* sp.

Class	-	Nematoda	Rudolphi, 1808
Order	-	Strongylida	(Diesing, 1851) Molin, 1861
Family	-	Trichonematidae	Witenberg, 1925
Genus	-	*Chabertia*	Railliet and Henry, 1909

Worldwide in distribution. Commonly known as large mouthed bowel worm. *Chabertia* sp. is present, usually in low numbers, in the majority of sheep and goats. It contributes to the syndrome of parasitic gastroenteritis and only occasionally occurs in sufficient numbers to cause clinical disease on its own.

The adult worms are stout and are white in colour. Males are 13.0-14.0mm in length and females are 17.0-20.0 mm in length. The life-cycle is direct. Worms are found attached to the mucosa of colon which is congested, swollen and covered with mucus, punctiform haemorrhages may be present.

In context of Nepal

In 1973, Singh reported *Chabertia ovina* in sheep, cattle and goat from Kathmandu.

In 1997, Joshi reported *Chabertia ovina* in goat and sheep from Western hills of Nepal.

In 1999, Acharya reported *Chabertia ovina* in sheep and goat of IAAS livestock farm, Central Lab., Tripureshwor.

In the present study, *Chabertia* sp. reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

Eggs are laid in morula stage and it measures 90-105µm in length and 50-55µm in breadth. Oval in shape.

11.*Oesophagostomum* sp.

Class	-	Nematoda	Rudolphi,1808
Order	-	Strongylida	(Diesing, 1851) Molin, 1861
Family	-	Trichonematidae	Witenberg, 1925
Genus	-	*Oesophagostomum*	Molin, 1861

Oesophagostomum sp. are the natural intestinal parasite of apes and monkeys in Africa, Asia and South America. Human oesophagostomiasis has been reported from East and West Africa and South America.

The adult is very small and is covered with a cuticula. The male measures 8-10mm in length and 0.35mm in breadth. Females are 8.5 to 10mm long and 0.35mm thick.

The parasite causes dysentry in these animals. Certain species of *Oesophagostomum* also parasitise the intestine of swine and sheep and produce tumour like nodules in the intestine, hence are commonly known as nodular worms. The man acquires infection by ingestion of the third stage larva of *Oesophagostomum* sp. in man. The nematode causes oesophagostomiasis in man. The condition in man is self limiting. It is characterized by production of a solitary tumour – like exudative nodule in the wall of the intestine, especially in the intra-caecal region. The condition is diagonosed by demonstration of the worm in the biopsy specimen of the nodules.

In context of Nepal

In 1982, ADPCD reported *Oesophagostomum* sp. in pig, cattle and buffalo from Kathmandu.

In 1997, Joshi reported *Oesophagostomum venulosum* in goat from Western hills of Nepal.

In 1997, Joshi reported *Oesophagostomum asperum* in goat and sheep from Western hills of Nepal.

In 1999, Acharya reported *Oesophagostomum* sp. in sheep and goat of IAAS livestock farm from Central Lab., Tripureshwor.

In 2003, Thakur reported *Oesophagostomum* sp. in pigs from Eastern hills of Nepal.

In the present study, *Oesophagostomum* sp. reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

The eggs are usually indistinguishable from those of *Ancylostoma* and *Necator*. They measure 60-63μm by 30-40μm. The eggs are oval, thin-shelled and non-bile stained. A clear space is always present between the segmented ovum and the egg shell.

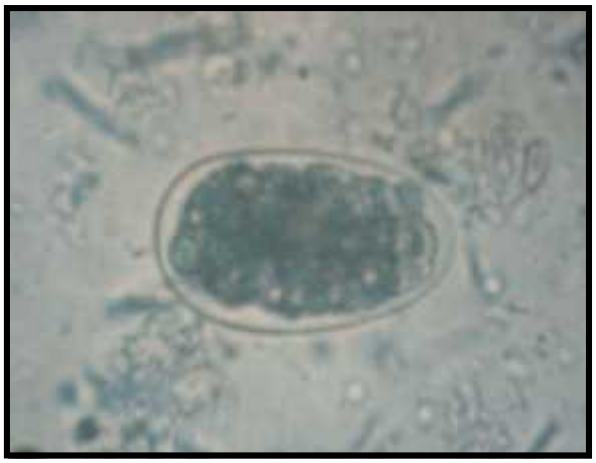

Plate No. 13 **×640**
An Egg of *Trichostrongylus* sp. **41« × 87«**

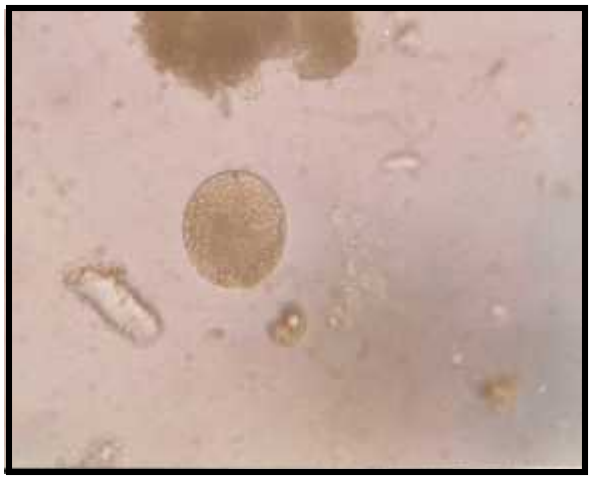

Plate No. 14 **×400**
An Egg of *Strongyloides fulleborni* **35« × 50«**

Plate No. 15 **×400**
An Egg of *Capillaria* sp. **24« × 44«**

Plate No. 16 **×400**
An Egg of *Trichuris trichiura* **22« × 50«**

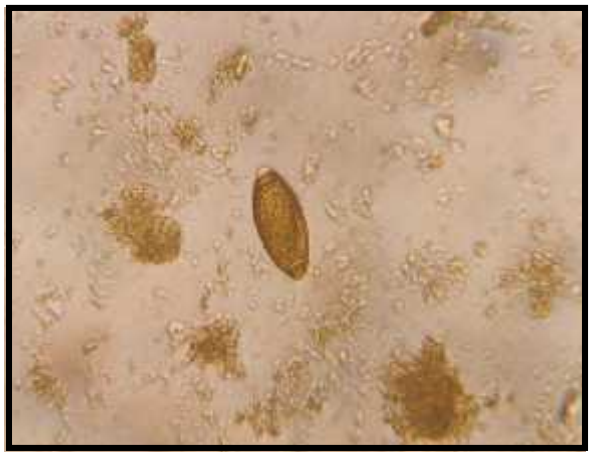

Plate No. 17 **×400**
An Egg of *Trichuris ovis* **30« × 70«**

12.*Trichostrongylus* sp.

Class	-	Nematoda,	Rudolphi, 1808
Order	-	Strongylida ,	(Diesing, 1851) Molin,1861
Family	-	Trichostrongyloidae	Leiper, 1912
Genus	-	*Trichostrongylus*	Looss, 1905

The infection of *Trichostrongylus* is prevalent through out the world. The infection in man has been recorded most frequently in Japan, Korea, Egypt & Central Africa. In India, Chandler found 14 to 18 percent of the population residing in the sheep and goat rearing areas of Kashmir to suffer from the infection. Maplestone and Bhaduri (1940) showed that approximately 6% of dogs in Calcutta harboured the parasite in their intestinal tract. A wide variety of animals particularly the herbivorous animals, are infected by the worm. The herbivorous animals are common reservoir host. Man acquires infection from these animals as accidental host.

The male measures 4 to 5mm in length and female measures 4 to 6.5mm in length. In animals, the massive infection by *Trichostrongylus* results in the development of profound weakness of the limbs. The anaemia are unable to stand and may die of the infection. The anaemia and emaciation, which are features of *Trichostrongylus* infection in man are absent in animals. This infection is often nick-named as pseudo-hook worm disease.

In context of Nepal

In 1967-92, Mainali reported *Trichostrongylus* sp. from Lulu cattle.

In 1973, Singh reported *Trichostrongylus* in cattle and buffalo from Kathmandu.

In 1978, Joshi reported *Trichostrongylus* sp. in goats from Jamunapari of Nuwakot district.

In 1997, Joshi reported *Trichostrongylus orientalis* in goat and cattle from Western hills of Nepal.

In 1997, Joshi reported *Trichostrongylus axei* in cattle and goat from Western hills of Nepal.

In 1997, Joshi reported *Trichostrongylus colubiformis* in cattle and goat from Western hills of Nepal.

In 1999, Joshi reported *Trichostrongylus* sp. in sheep and goat from Kaski district, Palpa.

In 1999, Acharya reported *Trichostrongylus* sp. in sheep and goat of IAAS livestock farm from Central Lab., Tripureshwor.

In 2003, Thakur reported *Trichostrongylus axei* in pigs from Eastern hills of Nepal.

In 2003, Rabwin, Joshi and Chhetri reported *Trichostrongylus* sp. in Western hills of Nepal.

In the present study, *Trichostrongylus* sp. reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

Eggs are oval and bilaterally symmetrical. These are relatively larger (63 to 115μm by 40μm) than those of hook worm ova. The shell has a thin transparent outer chitinous layer and a thin inner layer. The embryonic mass is multisegmented and varies from 16 to 32 in number. The space between the egg shell and embryonic mass is relatively conspicuous.

13.*Strongyloides fulleborni*

Class	-	Nematoda	Rudolphi, 1808
Order	-	Rhabditida	Chitwood, 1933
Family	-	Strongyloididae	Chitwood and Mc. Intosh, 1934
Genus	-	*Strongyloides*	Grassi, 1879
Species	-	*fulleborni*	Von Linstow, 1905
Synonyms	-	*Anguillula stercoralis*	

Strongyloides fulleborni, a natural parasite of monkeys and apes has been reported in Africa and parts of Asia. The species causes "swollen belly syndrome" in infants in Western Papua New Giunea. It is a serious life threatening condition chracterised by diarrhoea, respiratory distress and edema. The infection is transmitted from mothers to infants through milk by breast feeding. In the parasitic phase the adult females are readily discovered but not the males. Adult female are hardly visible to the naked eyes and measures 2.5mm by 0.04mm. Life cycle is completed in the single host. The life cycle is unique due to its potential for autoinfection and multiplication within the infected host. *Strongyloides* sp. shows two distinct life cycles, one within the host body and other free living in the soil. Infection occurs mainly through penetration of the skin and ocassionally through buccal mucosa by the infective filariform larva.

Blackie (1932) was the first to report *S. fulleborni* infection in a man from Zimbabwe. Subsequently, endemic infections by the parasite have been recorded from other parts of Zambia and Africa. Brown and Girardean (1977) were the first to report transmammary transmission of *Strongyloides* larvae to infants.

In Context of Nepal

In 1973, Singh *et al.*, reported *Strongyloides* sp. in goat and sheep from Kathmandu.

In 1977, Shakya reported *Strongyloides stercoralis* in human from Lalitpur.

In 1997, Joshi reported *Strongyloides papillosus* in goat and sheep from Western hills of Nepal.

In 1999, Acharya reported *Strongyloides papillosus* in sheep and goat of IAAS livestock farm from Central Lab., Tripureshwor.

In 2003, Khakural and Khakural reported Strongyles in farm ruminant from Maidi VDC, Dhading.

In 2003, Rabwin, Joshi and Chhetri reported Strongyles in horse from Kyanjingompa, Langtang.

In the present study, *S. fulleborni* reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

The eggs are characteristically smaller, shorter and measure 35 by 50μm. They are oval transparent and very thin shelled, blunt ends, contain fully develop embryos when passed in the faeces.

14. *Capillaria* sp

Class	-	Nematoda	Rudolphi, 1808
Order	-	Enoplida	Schurmans,Stekhoven and Deconinck, 1933
Family	-	Capillariidae	Neveu-Lemaire,1936
Genus	-	*Capillaria*	Zeder, 1800

Capillariasis is a newly recognized zoonotic helminthic infection of man caused by a few species of the genus *Capillaria*. There are more than 200 recognised species in the genus *Capillaria*.

The worms of this genus are closely related to *Trichuris* but they are small and slender and the posterior part of the body is not conspicuously thicker than the anterior part. Life cycle is of direct type. Hosts are infected through the contaminated foods and water with egg with infective larva.

In context of Nepal

In 1967-92, Mainali reported *Capillaria* sp. from Lulu Cattle.

In 1982, ADPCD reported *Capillaria* sp. in poultry from Kathmandu.

In 2004, Khanal reported *Capillaria aerophila* in cat from Nawalparasi and Chitwan districts.

In the present study, *Capillaria* sp. reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

The eggs are more or less similar to that of *Trichuris* sp. but in comparison to *Trichuris* egg, the shell is almost colourless, the egg is barrel shaped, with the sides nearly parallel. The size of egg is smaller than that of *Trichuris trichura* i.e 44µm-50µm by 24µm-33µm. The color is pale brown but not bile stained. They had fine striations in the egg shell.

15.*Trichuris trichiura*

Class	-	Nematoda	Rudolphi 1808.
Order	-	Enoplida	Schurmans, Stekhoven and Deconinck, 1933
Family	-	Trichuridae	Ralliet, 1915
Genus	-	*Trichuris*	Roederer, 1761
Species	-	*trichiura*	Linnaeus, 1771
Synonymes	-	*Trichocephalus trichiura*	(Linnaeus, 1771) Blanchard, 1895.
			Trichocephalus hominis Schrank, 1888.

World wide in distribution, but more common in the warm moist region of the world.

Trichuris trichiura, also called the whip worm, gets its name from its characteristic whip-like shape. The length of the body ranges from 30mm-40mm in male and 40-50mm in female. The worm feed on epithelial cells and blood. Life cycle is direct with no intermediate host. Copulation occurs in the lumen of the host's intestine, after which the female lays eggs which get eliminated along with the faeces. Development of the eggs takes place in the moist soil and the infective juveniles are formed in about 3 weeks. Man becomes infected by taking food and water contaminated with the embryonated eggs which hatch in the intestine. The liberated juveniles grow into adults within a month. The life span of the adult worms is several years. In host heavy infection results in anaemia, abdominal pain and bloody stool but light infection is asymptomatic.

In context of Nepal

In 1965, Sharma reported *Trichuris trichiura* in human from Bhaktapur.

In 1977, Shakya reported *Trichuris trichiura* in human from Surkhet.

In 1981, Bol *et al*, reported *Trichuris trichiura* in human from Lalitpur.

In 1981, IFP and PCP reported *Trichuris trichiura* in human from Panchkhal.

In 1988, Gupta reported *Trichuris trichiura* in human from Kirtipur.

In 2004, Khanal reported *Trichuris* sp. in cat from Nawalparasi and Chitwan districts.

In the present study, *Trichuris trichiura* reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

Eggs are barrel-shaped with a colourless protruding mucous plug at each end. These are yellowish brown and double shelled. The outer shell is bile-stained. These measures 50μm to 54μm in length and 22μm to 23μm in breadth. These float in the saturated salt solution. The eggs contain an unsegmented ovum each, when passed in the faeces. These freshly passed eggs are not infective to human.

16. *Trichuris ovis*

Class	-	Nematoda	Rudolphi, 1808
Order	-	Enoplida	Schurmans, Stekhoven and Deconick 1933
Family	-	Trichuridae	Railliet, 1915
Genus	-	*Trichuris*	Roederer, 1761
Species	-	*ovis*	Abildgaard, 1795

Worldwide in distribution. It is commonly known as whip-worm. Definitive hosts are goat, sheep, cattle.

The adults are usually found in the caecum but are only occasionally present in sufficient numbers to be clinically significant. Males are 50mm-80mm in length and females are 35mm-70mm in length.

In context of Nepal

In 1997, Joshi reported *Trichuris ovis* in goat and and sheep from Western hills of Nepal.

In 2004, Khanal reported *Trichuris* sp. in cat from Nawalparasi and Chitwan districts.

In the present study, *T. ovis* reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

The eggs are 70μm to 80μm in length and 30μm to 42μm in breadth, unsegmented, brown in colour, barrel shaped with a transparent plug at either pole.

Plate No. 18 **×640**
An Egg of *Dicrocoelium* sp. **26 « × 42 «**

Plate No. 19 **×400**
An Egg of *Prosthenorchis elegans* **42 « × 65 «**

17. *Dicrocoelium* sp.

Class	-	Trematoda	Rudolphi, 1808
Order	-	Prosostomata	Odhner, 1905
Family	-	Dicrocoeliidae	Odhner, 1911
Genus	-	*Dicrocoelium*	Dujardin, 1845

Dicrocoeliasis is a less frequent zoonotic infection of the human. *Dicrocoelium* infection of sheep, deer, and other herbivorous and omnivorous animals has been recorded most commonly from Europe, Turkey, northern Asia, northern Africa, parts of South America and less frequently from South and North America.

Life cycle is completed in different classes of host. The adult fluke is lancet-shaped, are transparent and measures 5 to 15mm in length and 1.5 to 2.5 mm in breadth. The eggs hatch always inside the snail to release the miracidia. The later undergo through two generations of sporocysts to develop into cercariae. Redia stage is absent. The cercaria is spinous.

In context of Nepal

In 2007, Mukhia reported *Dicrocoelium lanceatum* in buffalo from Nepal.

In the present study, *Dicrocoelium* sp. reported from Rhesus monkey is for the first time from Nepal.

Description of the eggs

Eggs are operculated, yellowish brown, thick shelled and measure 38μm to 45μm by 22μm to 30μm. The eggs are mature containing the miracidia when freshly laid.

18. *Prosthenorchis elegans*

Phylum	-	Acanthocephala	Rudolphi, 1808
Order	-	Archiacanthocephala	Meyer, 1931
Family	-	Oligacanthorhynchidae	Meyer, 1931
Genus	-	*Prosthenorchis*	Travassos, 1915
Species	-	*elegans*	Diesing, 1851

Prosthenorchis elegans (Diesing, 1851) and *P. specula* (Olfers and Rudolphi, 1819) are very important parasites in the small intestine, particularly in the terminal portion of the ileum but also the caecum and colon, of Central and South American monkeys, *P. elegans* is very common and *P. specula* is less common. These parasites are now found throughout the world where primates are kept in captivity and where they have introduced the parasites.

Adults are 2-5 cm long and the proboscis is globular with five to seven rows of hooks. The intermediate host are cockroaches (*Blatella germanica*) which may be common in primate colonies.

This species has not been reported as yet from Nepal in any host.

Description of the eggs

The eggs measure 65-81μm by 42-53μm containing the thick outer and thin inner shells enclosing the embryo (acanthor). Eggs are oval in shape.

B. PREVALENCE RATE OF HELMINTH PARASITES

❖ General prevalence rate

A total of 202 faecal samples were examined from Pashupati area of Kathmandu district and Nilbarahi area of Bhaktapur district. Out of this 202 samples examined, 124 samples were found to be positive for one or more than one helminth parasite and the remaining 78 were neagative. Therefore, the positive percentage was found to be 61.38% and the negative percentage was 38.61%.

Table 2:- General prevalence rate of helminthes.

Total Samples Examined	Positive samples for helminthes		Negative samples for helminthes	
	No.	Percentage(%)	No.	%
202	124	61.38	78	38.61

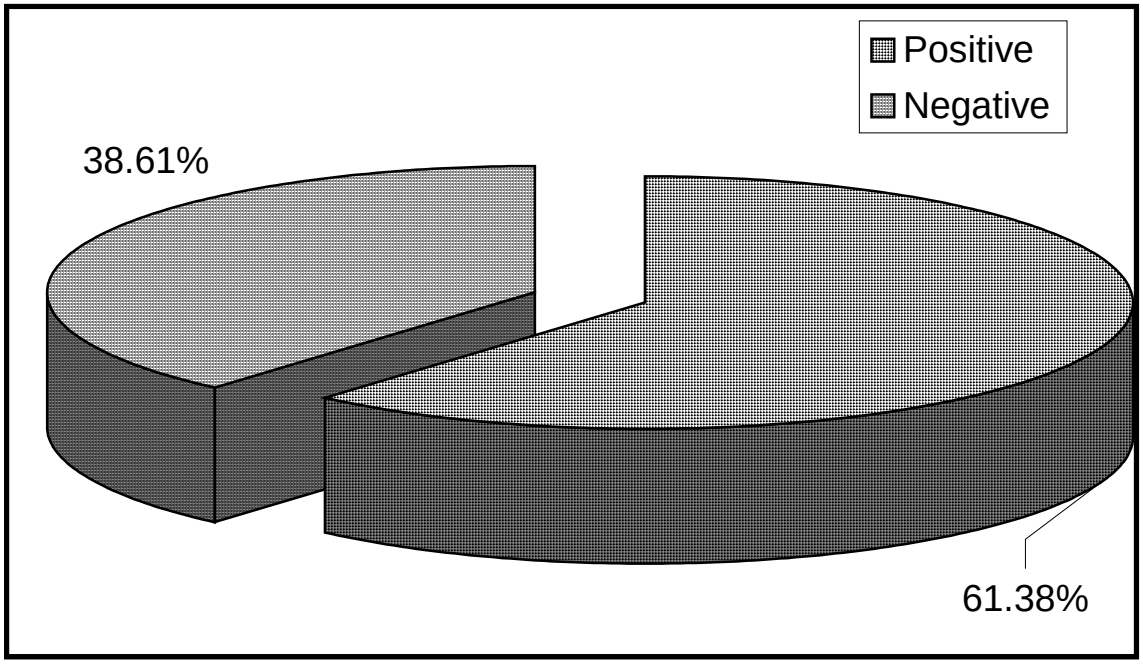

Figure No. 1 :- Pie chart analysis of positive samples vs negative.

❖ Class-wise prevalence rate

Out of 124 positive samples, 111 samples (89.51%) were positive for nematodes, 7 samples (5.64%) were positive for acanthocephala and 6 samples (4.83%) were positive for trematodes. Statistically, significance difference was found in class wise parasitic infection (χ^2=371.19, P < 0.05).

Table 3:- Class-wise prevalence rate

S.N.	Class	Identified helminth parasite	
		No.	%
1.	Nematode	111	89.51
2.	Acanthocephala	7	5.64
3.	Trematode	6	4.83
Total		124	

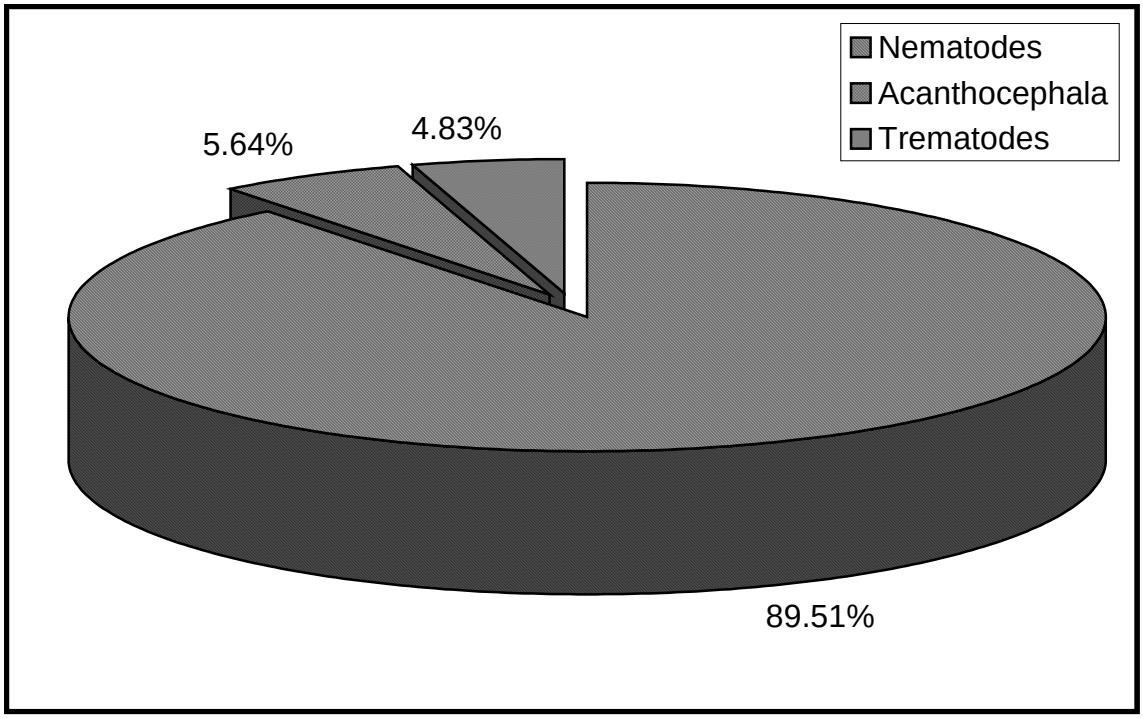

Figure No.2:- Pie chart analysis of nematodes, acanthocephala and trematodes.

❖ **Comparative prevalence rate of helminth parasites of *Macaca mulatta* in Pashupati and Nilbarahi areas.**

Prevalence rate of helminth parasites of *Macaca mulatta* in Pashupati is found to be more (64.70%) than that in Nilbarahi (58.00%). Statistically, no significant difference was found in area-wise parasitic infection (χ^2=17.77, P > 0.05)

Table 4:- Area-wise prevalence rate of helminthes.

Study Area	Total samples examined	Positive samples for helminthes	
		No.	%
Pashupati	102	66	64.70
Nilbarahi	100	58	58.00
Total	202		

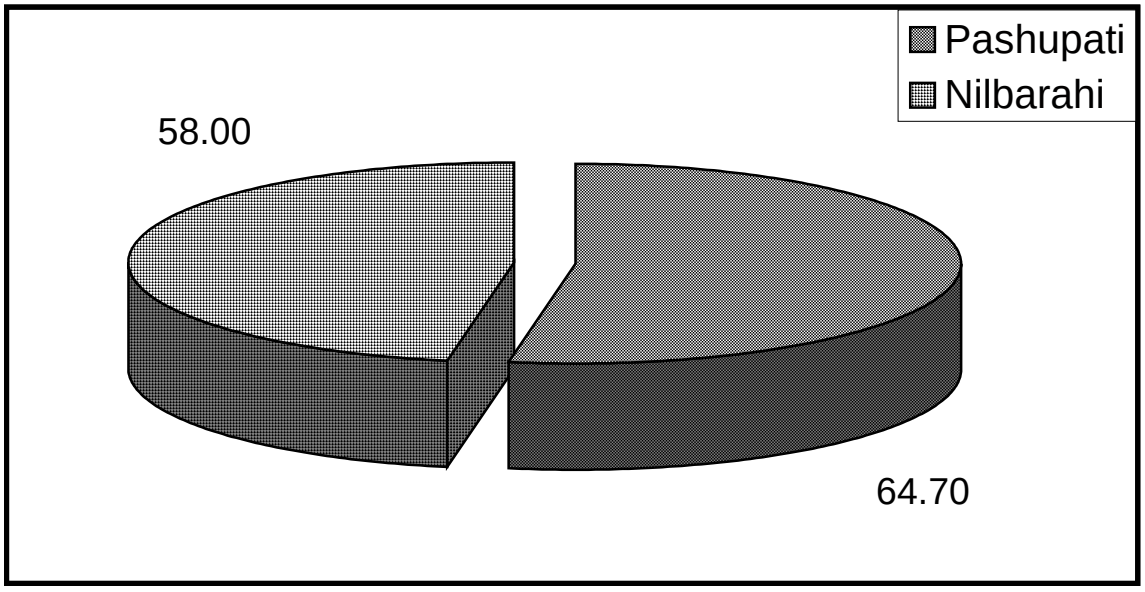

Figure No.3 :- Pie chart analysis of area-wise prevalence rate

❖ Prevalence rate of specific nematode parasites

Out of the 124 positive samples, 111 samples were positive for different types of nematodes. The nematodes with the largest prevalence percentage was of *Strongyloides fulleborni* with 51.61% prevalence. The least prevalence rate were of *Toxocara canis* and *Cooperia* sp. with prevalence percentage 0.80%.

Table 5 :- Prevalance rate of specific nematode parasites

S.N	Name of the species	Total samples examined	Positive samples	
			No.	%
1.	*Strongyloides fulleborni*	202	64	51.61
2.	*Oxyuris* sp.	202	14	11.29
3.	*Ascaris lumbricoides*	202	13	10.48
4	*Dictyocaulus* sp.	202	9	7.25
5.	*Chabertia* sp.	202	8	6.45
6.	*Toxascaris leonina*	202	8	6.45
7.	*Ostertagia* sp.	202	8	6.45
8.	*Trichuris ovis*	202	8	6.45
9.	*Trichuris trichiura*	202	7	5.64
10.	*Trichostrongylus* sp.	202	6	4.83
11.	*Capillaria* sp.	202	5	4.03
12.	*Oesophagostomum* sp.	202	5	4.03
13.	*Ancylostoma duodenale*	202	3	2.41
14.	*Haemonchus contortus*	202	3	2.41
15.	*Cooperia* sp.	202	1	0.80
16.	*Toxocara canis*	202	1	0.80

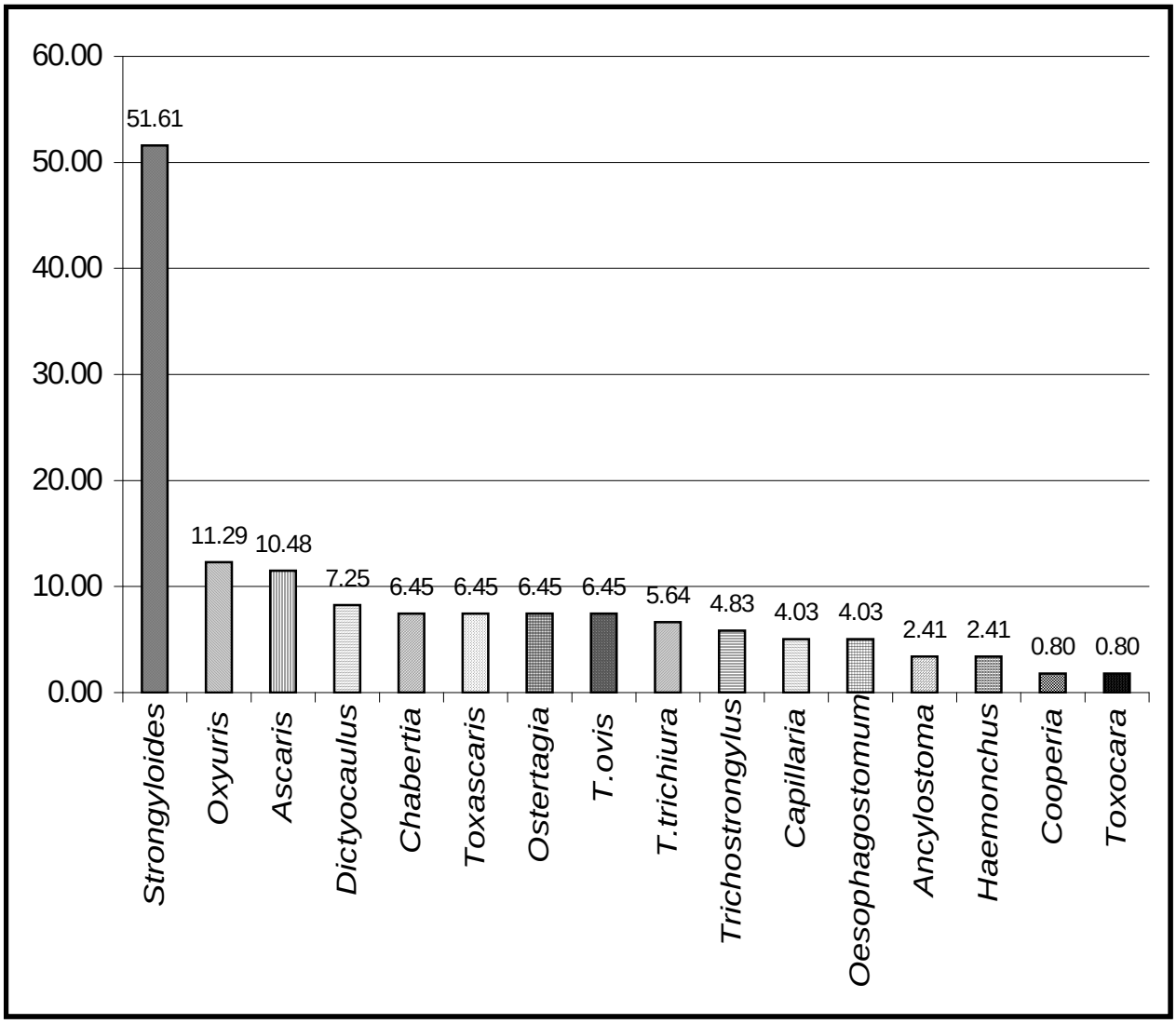

Figure No. 4:- Bar diagram illustrating the prevalence rate of nematodes.

❖ **Prevalence rate of specific helminthes**

Out of 202 stool samples, Nematode *Stongyloides fulleborni* was found to be the most prevalent with prevalence rate 51.61% while the nematodes *Cooperia* species and *Toxocara canis* were found to be the least prevalent with prevalence rate 0.80%. Only one trematode - *Dicrocoelium* sp. and one acanthocephala - *Prosthenorchis elegans* were found with 4.83% and 5.64% respectively.

Table 6:- Prevalence rate of specific helminthes

S.N	Name of the species	Total samples examined	Positive samples	
			No.	Percentage (%)
1.	*Strongyloides fulleborni*	202	64	51.61
2.	*Oxyuris* sp.	202	14	11.29
3.	*Ascaris lumbricoides*	202	13	10.48
4	*Dictyocaulus* sp.	202	9	7.25
5.	*Chabertia* sp.	202	8	6.45
6.	*Toxoscaris leonina*	202	8	6.45
7.	*Ostertagia* sp.	202	8	6.45
8.	*Trichuris ovis*	202	8	5.64
9.	*Prosthenorchis elegans*	202	8	5.64
10.	*Trichuris trichura*	202	8	4.83
11.	*Dicrocoelium* sp.	202	7	4.83
12.	*Trichostrongylus* sp.	202	7	4.03
13.	*Capilleria* sp.	202	6	4.03
14.	*Oesophagostomum* sp.	202	6	2.41
15.	*Ancylostoma duodenale*	202	5	2.41
16.	*Haemonchus contortus*	202	5	0.80
17.	*Cooperia* sp.	202	3	0.80
18.	*Toxocara canis*	202	3 1	

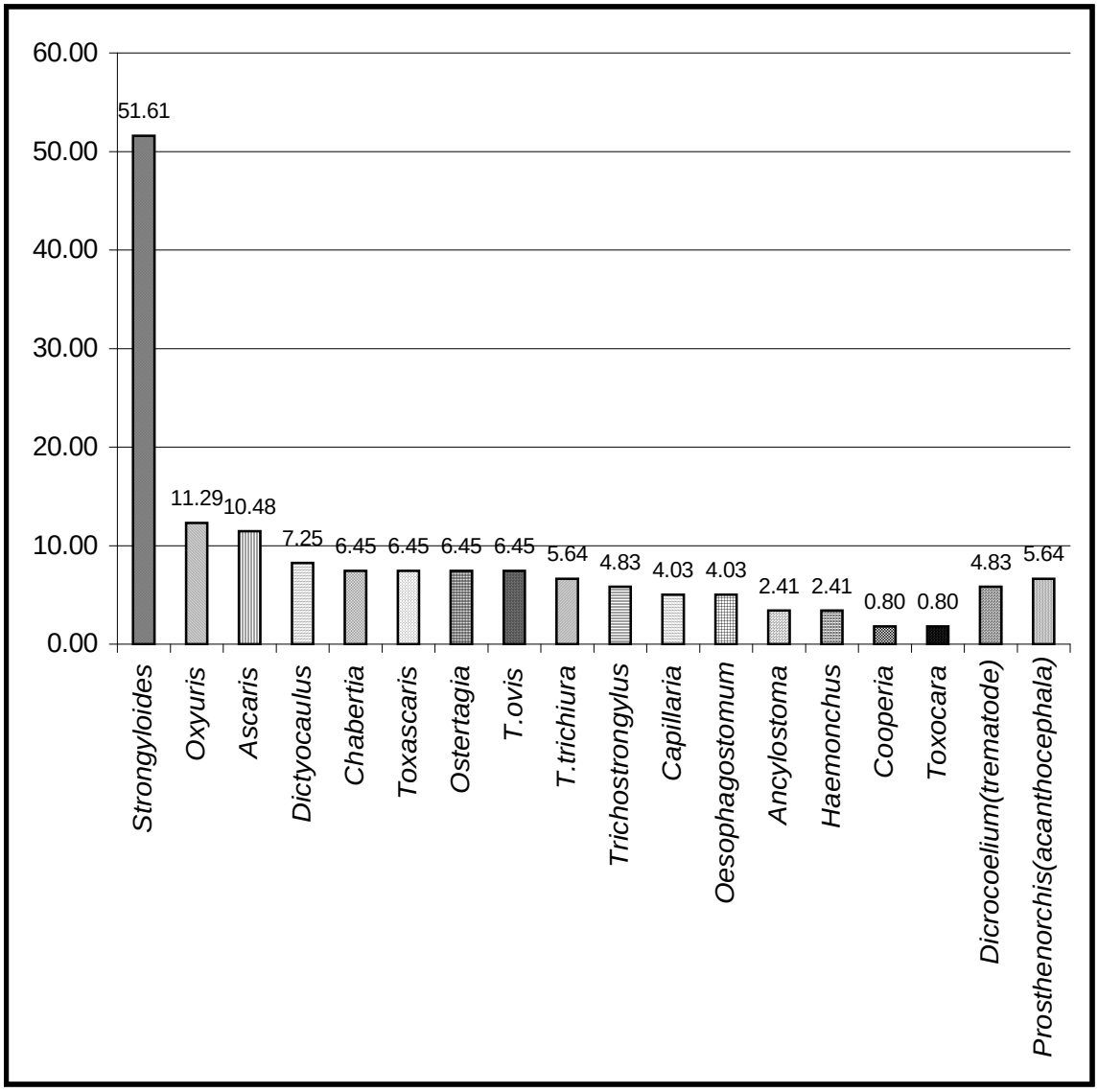

Figure No. 5:- Bar diagram illustrating the prevalence rate of specific helminthes.

C. ZOONOTICALLY INFECTIVE HELMINTHES OF MONKEY

Zoonoses are those disease and infections which are transmissible between man and animals. Since, monkeys belong to Primate order and many organ system of monkeys are similar to human so they may harbour many zoonotically infective helminth. In the present study, 1 trematode i.e *Dicrocoelium* sp. and 10 nematodes namely *Strongyloides fulleborni*, *Oesophagostamum* sp, *Capillaria* sp., *Trichostrongylus* sp., *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Haemonchus contortus*, *Cooperia* sp. *Ostergia* sp. and *Toxocara canis* which are already known to be zoonotically infective were found. (Parija, 1980).

- **Prevalence rate of zoonotically infective helminthes of *Macaca mulatta*.**

Out of total samples (202), 108 samples were positive to zoonotically infective helminthes, 16 were negative to zoonotically infective helminthes and the 78 were negative to any helminthes.

Table 7 :- Prevalence rate of zoonotically infective helminth parasites.

Total no. of stool samples examined	Negative to any helminth eggs	Positive to the helminth eggs					
		Helminth (Overall)		Zoonotically infective helminth		Zoonotically non-infective helminth	
		No.	%	No.	%	No.	%
202	78	124	61.38	108	87.09	16	12.90

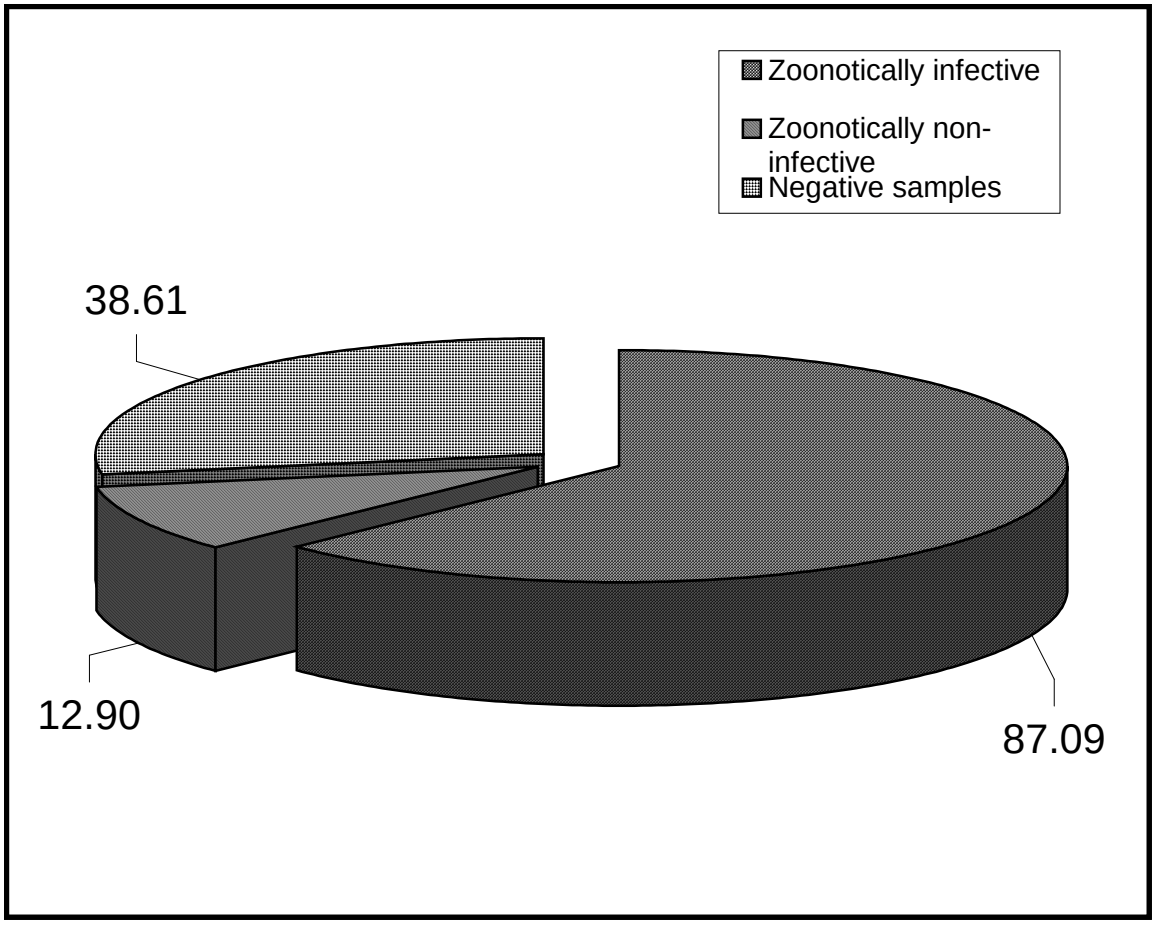

Figure No. 6:- Pie chart analysis illustrating zoonotically infective, zoonotically non – infective and negative samples for helminth eggs.

❖ **Species wise prevalance rate of zoonotically infective helminthes of monkey.**

While going through the species – wise prevalence rate, out of total sample of zoonotically infective helminthes (108), *Strongyloides fulleborni* (64 samples) was found to be the most prevalent with prevalence percentage 51.61. *Toxocara canis* (1 sample) and *Cooperia* sp. (1 sample) were found to be the least prevalent with prevalence percenage 0.80.

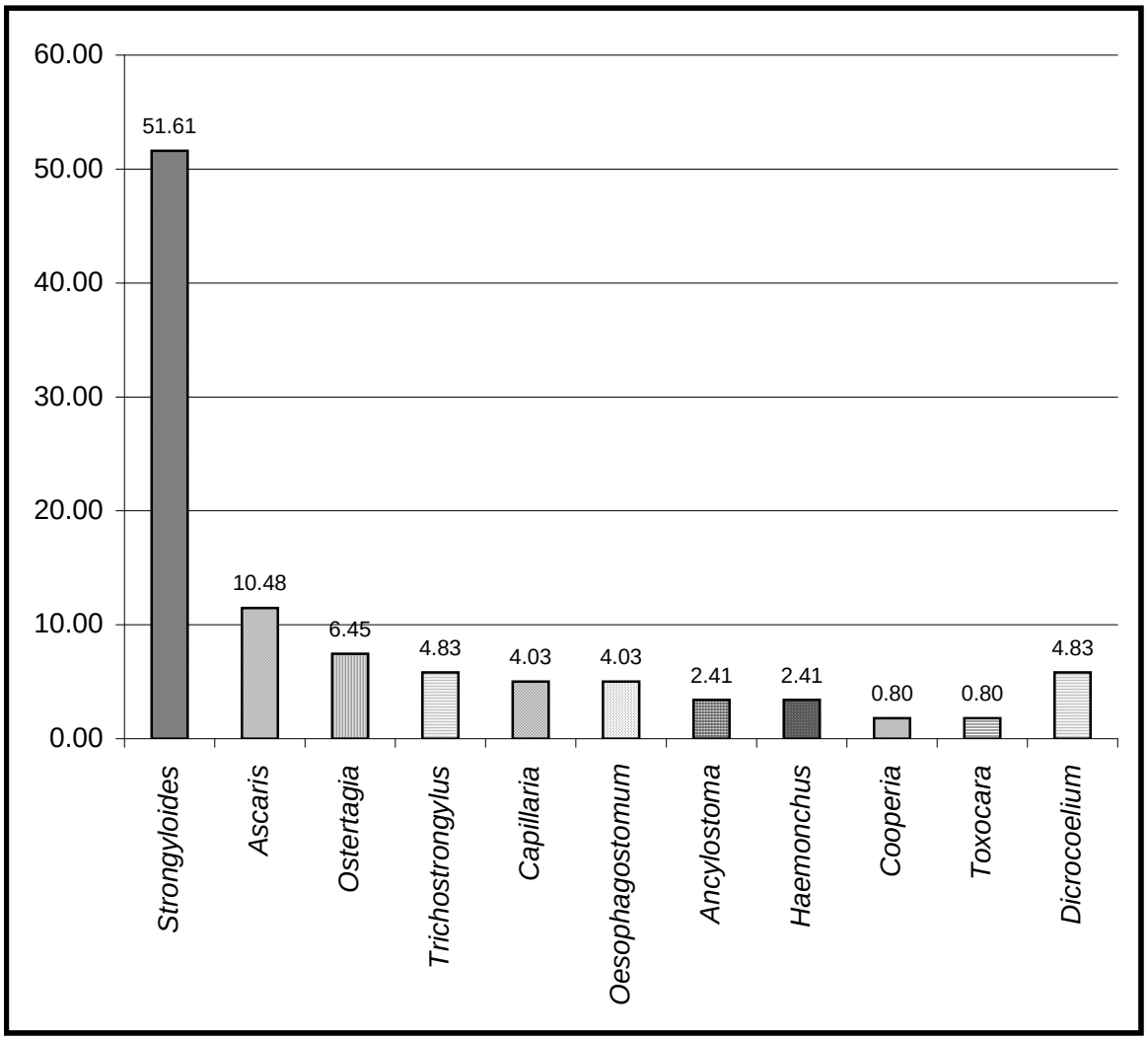

Figure No. 7:- Bar diagram analysis of zoonotically infective helmintes of monkey (*Macaca mulatta*)

Plate No. 20
Monkeys of Pashupati Area

Plate No. 21
Monkeys of Nilbarahi Area

Plate No. 22
Lab work at CVL., Tripureshwor

Plate No. 23
Lab work at T.U., Kirtipur

Plate No. 24
Collection of stool samples at Nilbarahi

Plate No. 25
Collection of stool samples at Pashupati

VI

DISCUSSION AND CONCLUSION

It is well known that intestinal parasites are cosmopolitan in distribution and all animals, whether humans, domestic animals or wild animals bear different kinds of parasites. Many researches have been carried out regarding the intestinal parasites of humans because we are always eager to know about our health. Vetenarians are always interested to research about domestic animals, whereas very little attention is paid to the wild animals.

In the present thesis, the study of intestinal helminth parasite of monkeys who belong to the wild life population has been carried out. The research so far has not been adequate enough, especially in the Nepalese context. Despite the inadequacy of the research work in Nepal, it is considered quite justified to compare it with the statistics of the international research work.

In the present study, 202 faecal samples were examined from the two study sites. Out of the 202 faecal samples examined, 124 samples were found to be positive for one or more than one helminth parasites and the remaining 78 were negative. Hence, the positive percentage was 61.38 and the negative percentage was 38.61. Thus, the percentage of the negative helminth parasite was much lower than that of the positive one. This is quite natural in view of the fact that (1) the monkeys eat food and water most of which are contaminated, (2) and that they are not dewormed. Ponnudurai *et al.*, (2003) found that 51% of the monkeys in Tamil Nadu tested positive for helminth parasitic infection, while the present study under taken here has found to be 61.38%. This difference in the prevalence rate could be attributed to the differences in climate and topography.

Of the 124 positive samples, 111 (89.51%) were positive for nematodes, 7 (5.64%) were positive for acanthocephala and 6 (4.83%) were positive for

trematodes. The eggs of 18 helminth species (16 nematodes, 1 trematode and 1 acanthocephala) were identified. The present study found nematodes to be the most prevalent. This is natural because nematodes are found almost every where and for the transmission to take they usually don't need vector. Moreover they can also penetrate though soft skin. Horii *et al.,* (1981) had discovered only 1 cestode species and 4 nematode species. In his research also nematode was most prevalent. Joseph *et al.,* (1999) had also discovered only nematode. The research of Gillespie *et al.,* (1997-2003) had also discovered only 1 cestode, 1 trematode and 7 nematodes. Von Leishout *et al.,* (2005) also found high prevalence of nematode i.e. 75.99%.

Out of the total 202 samples, 102 were examined from Pashupati area and 100 from Nilbarahi area. The parasitization rate of helimnth parasites was more in Pashupati (64.70%) than that in Nilbarahi (58.00%). The high prevalence in Pashupati area is quite natural because the monkeys come regularly in contact with humans. Pashupati being densely populated with humans and animals, the infection could be attributed to themselves. The monkeys there depend on the food brought by the people. Therefore their food could also be contaminated whereas the monkeys in Nilbarahi don't come in contact with that many humans and they eat mostly natural food. Therefore, this reduces their risk of eating contaminated food and the natural food they eat could also have raised their resistance power.

Of the same 124 positive samples, 111 tested positive for the different nematodes. The nematodes with the largest prevalence percentage was of *Strongyloides fulleborni* with 51.61%. the least prevalence rates were of *Toxocara canis* and *Cooperia* sp. with prevalence rate of 0.80%. The prevalence rates of other species of nematodes were as follows:O*xyuris* sp. 11.29%, *Ascaris lumbricoides* 10.48%, *Capillaria* sp. 10.48%, *Dictyocaulus* sp. 7.25%, *Chabertia* sp. 6.45%, *Toxascaris leonina* 6.45%, *Ostertagia* sp. 6.45%, *Trichuris ovis* 6.45%, *Trichuris trichiura* 5.64%, *Trichostrongylus* sp. 4.83%, *Capillaria* sp. 4.48%,

Oesophagostomum sp. 4.03%, *Ancylostoma duodenale* 2.41%, *Haemonchus contortus* 2.14%, *Cooperia* sp. 0.80% and *Toxocara canis* 0.80%.

In the present study, 16 different kinds of nematodes were detected while Horii *et al.,* (1981) found 4 different kinds of nematodes whereas Gillespie *et al.,* (1997 to 2003) found seven kinds of nematodes, Michaud *et al.,* (2003) found 2 kinds of nematodes, Phillips *et al.,* (2004) found 4 kinds of nematodes. In the present study many kinds of nematodes were detected. Such differences may be due to the topography and climate. The distribution of parasites is also dependent upon the distribution of the intermediate host. Public awareness may also be the reason for the different result, which is mainly due to illiteracy and poverty. *Strongyloides fulleborni* is found to be the most prevalent which is quite natural because *Strongyloides fulleborni* are natural prarasites of monkeys and apes. Horii *et al.,* (1981) also found high incidence of *Strongyloides fulleborni* i.e. 100% in young monkeys of the Koshima troop. The prevalence rate of *Cooperia* sp. and *Toxocara canis* were found to be the least. This results from *Toxocara canis* being dog's parasite and *Cooperia* sp. being the ruminant's parasite.

Other helminth parasites detected were trematode (*Dicrocoelium* sp.) and acanthocephalan (*Prosthenorchis elegans*).

Prosthenorchis elegans is reported for the first time from Nepal, but Phillips *et al.,* (2004) had reported *Prosthenorchis elegans* from non-human primates of Peru. Gillespie *et al.,* (1997 to 2003) had reported trematode (Dicrocoliidae) from the colobus monkey of Uganda.

In the present study, the prevalence rate of zoonotically infective helminthes was 87.09% were as the prevalence rate of zoonotically non- infective helminthes was 12.90%. The prevalence rate of zoonotically infective helminthes was high because monkeys of the study area come into frequent contact with humans and domestic animals.

During faecal samples examinatioin for intestinal helminth parasites of monkey some identified and unidentified protozoans were also detected. This is shown in the Annex.

All the genus and species of the intestinal helminth parasites observed in the Rhesus monkey are reported here for the first time from Nepal.Whereas, *Prosthenorchis elegans* is reported for the first time from Nepal.

VII

RECOMMENDATIONS

1. Monkeys should be regularly dewormed to improve their health.
2. Monkeys should be dewormed to reduce the transmission of zoonotically infectious diseases.
3. Local people of the study area are unaware of many zoonotic diseases which may be transmitted through monkeys, so they should be alert through awareness programs.
4. More research work should be focused in this field because scanty work has been done on it.

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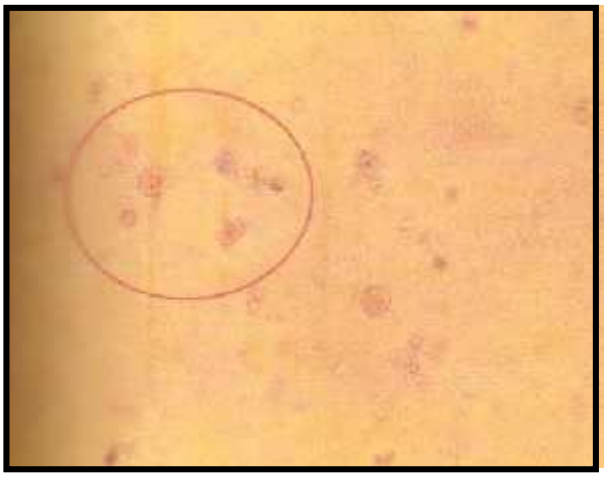

Plate No. 26
Trophozoite of *Giardia lamblia*

Plate No. 27
Cyst of *Giardia lamblia*

Plate No. 28
Cyst of *Entamoeba histolytica*

Plate No. 29
An unidentified protozoan egg

ANNEX

SOME PROTOZOAN PARASITES DETECTED FROM STOOL SAMPLES OF *Macaca mulatta* FROM PASHUPATI AND NILBARAHI AREAS

Table 8:-Prevalence rate of identified and unidentified protozoan parasites.

S.N.	Total no.of stool samples examined	Total no. of stool samples +ve to protozoan parasites	Protozoan parasites	No.	%
1	202	86	*E. histolytica*	42	48.83
2			*G. lamblia*	19	22.09
3			Unidentified	25	29.06

Description of the identified protozoan parasites are given below:

(a) Entamoeba histolytica

Phylum	-	Sarcomastigophora	Honigberg and Balamuth, 1963
Class	-	Lobosea	Carpenter, 1861
Order	-	Amobeida	Ehrenberg, 1830
Family	-	Endamoebidae	Calkins, 1926
Genus	-	*Entamoeba*	Casagrandi and Barbagallo, 1895
Species	-	*histolytica*	Schaudinn, 1903

Entamoeba histolytica causes amoebiasis. The infection is worldwide in distribution. The parasite is the third leading parasitic cause of death in the developing countries.

Entamoeba histolytica was described first by Losch (1875) in the stool of a Russian suffering from dysentery. The trophozoits of *E. histolytica* was demonstrated in the pus of liver abscess by Kartulis in the year 1886. Walker and Sellards (1913) conclusively proved *E. histolytica* to be the causative agent of amoebic dysentery.

Infection of dog and other primates by *E. histolytica* is frequently seen. *E. histolytica* exists only in trophozoite form in the intestine of dogs. These animals however seem to play no role in the transmission of amoebiasis to the human. The non-human primates have amoeba morphologically identical to *E. histolytica*. The infections from the non-human primates to man have been suggested.

E. histolytica inhabits mucosa and submucosa of the large intestine and exists in the trophozoite, precyst and cyst stages during its life cycle.

Trophozoite: Trophozoite, the vegetative form of the parasite measures 10 to 60 « m in diameter. Cytoplasm is clearly differentiated into ectoplasm and endoplasm. Trophozoites are actively mobile with the help of pseudopodia.

Pre-cyst: Pre cyst measures 10 to 20 « m in diameter and like the trophozoite, contains a single nucleus and glycogen particles.

Cyst: Cyst is spherical, less commonly sub spherical or ovoid and measures 10 to 15 « m with an average diameter of 12 « m.

(b) Giardia lamblia

Phylum	–	Sarcomastigophora	Honigberg & Balamuth, 1963
Class	–	Zoomastigophorea	Calkins, 1909
Order	–	Diplomonadida	Wenyon, 1926
Family	–	Hexamitidae	Kent, 1880
Genus	–	*Giardia*	Kunstler, 1882
Species	–	*lamblia*	Stiles, 1915
Synonyms	–	*Giardia intestinalis*	
		Lamblia intestinalis	

Giardia lamblia is the only intestinal flagellate known to cause endemic and epidemic diarrhoea in humans. The parasite is found both in temperate and tropical countries.

The first reported observation of *Giardia* infection in human is attributed to Leeuwenhoek in the year 1681. but it was only Lambl who provided the first description of the species in the year 1859 and designated it as *Giardia intestinalis*. To honour Prof. A Giard of Paris and Dr. F. Lambl of Prague, Stiles (1915) coined a new binomial, *Giardia lamblia*, which is now accepted nomenclature in the American countries.

About forty species of the genus *Giardia* have been described from a wide variety of mammalian species including rodent, rabbit, dog, monkey and amphilians. *Giardia* cyst of human origin can cause infection in dog, cat and beaver which are suggested to be potential reservoirs for transmission of zoonotic infection to humans.

Giardia intestinalis exists in two stage during its life cycle. These are, trophozoite and cyst.

Trophozoite: Trophozoites inhabit the upper duodenum and jejunum of the small intestine. These trophozoits are flattened, tear drop shaped structures measuring 10-12 « m in length, 5-7 « m in width and 2 « m in thickness. Dorsal surface is smooth and rounded whereas ventral surface is concave. Eight flagella are present in pairs which are directed posteriorly. The presence of two parabasal bodies and a paired nuclei gives face like appearance to *Giardia* . The flagella are responsible for motivity of trophozoits, which helps in the locomotion.

Cyst: Cyst is an oval shaped structure measuring 10-20 « m in diameter and is surrounded by a thick cyst wall. It contains four nuclei. A pair of axostyle is present in the middle of cyst with two parabasal bodies across it. The cyst which are excreted in the faces are infective to other susceptible hosts.