GASTRO-INTESTINAL PARASITES OF OSTRICH (*Struthio camelus* Linnaeus, 1758) AND EMU (*Dromaius novaehollandiae* Latham, 1790) IN OSTRICH NEPAL PVT. LTD. GONGOLIYA, RUPENDEHI

KAMALA KHATRI
T.U. Registration No. : 5-2-50-674-2008
T.U. Examination Roll. No. : 15563
Batch: 2068/069

A thesis submitted in partial fulfillment of the requirements for the award of the degree of Masters of Science in Zoology with special paper Parasitology

Submitted to
Central Department of Zoology
Institute of Science and Technology
Tribhuvan University
Kirtipur, Kathmandu
Nepal
March, 2016

CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Kamala Khatri entitled **"Gastro-Intestinal Parasites of Ostrich (*Struthio camelus* Linnaeus, 1758*)* and Emu (*Dromaius novaehollandia*e Latham, 1790) in Ostrich Nepal Pvt. Ltd. Gongoliya, Rupendehi."** has been approved as a partial fulfillment for the requirements of Master's Degree of Science in Zoology with special paper Parasitology.

EVALUATION COMMITTEE

……	……
Supervisor	**Head of Department**
Dr. Mahendra Maharjan	**Prof. Dr. Ranjana Gupta**
Central Department of Zoology	Central Department of Zoology
Tribhuvan University	Tribhuvan University
Kirtipur, Kathmandu, Nepal	Kirtipur, Kathmandu, Nepal

……...	**…….....**
External Examiner	**Internal Examiner**

Date of Examination : 12th April, 2016

TRIBHUVAN UNIVERSITY
☎ 01-4331896
CENTRAL DEPARTMENT OF ZOOLOGY
Kirtipur, Kathmandu, Nepal.
Institute of Science and Technology
Ref.No.:

RECOMMENDATION

This is to recommend that the thesis entitled **"Gastro-Intestinal Parasites of Ostrich (*Struthio camelus* Linnaeus, 1758*)* and Emu (*Dromaius novaehollandiae* Latham, 1790) in Ostrich Nepal Pvt. Ltd. Gongoliya, Rupendehi."** has been carried out by Kamala Khatri for the partial fulfillment of Master's Degree of Science in Zoology with special paper Parasitology. This is her original work and has been carried out under my supervision. To the best of my knowledge, this thesis work has not been submitted for any other degree in any institutions.

Date: 27th March, 2016

…….

Supervisor

Dr. Mahendra Maharjan

Associate Professor

Central Department of Zoology

Tribhuvan University

Kirtipur, Kathmandu, Nepal

TRIBHUVAN UNIVERSITY
☎ 01-4331896
CENTRAL DEPARTMENT OF ZOOLOGY
Kirtipur, Kathmandu, Nepal.

Ref.No.:

LETTER OF APPROVAL

On the recommendation of supervisor **"Dr. Mahendra Maharjan"** this thesis submitted by Kamala Khatri entitled **"Gastro-Intestinal Parasites of Ostrich (*Struthio camelus* Linnaeus, 1758*)* and Emu (*Dromaius novaehollandiae* Latham, 1790) in Ostrich Nepal Pvt. Ltd. Gongoliya, Rupendehi."** is approved for the examination and submitted to the Tribhuvan University in partial fulfillment of the requirements for Master's Degree of Science in Zoology with special paper Parasitology.

Date: 27th March, 2016

……

Prof. Dr. Ranjana Gupta
Head of Department
Central Department of Zoology
Tribhuvan University
Kirtipur, Kathmandu, Nepal

DECLARATION

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the author (s) or institution (s).

Date: 27th March, 2016 ……

Kamala Khatri

T.U. Registration No. : 5-2-50-674-2008

T.U. Examination Roll No.: 15563

Batch: 2068/069

ACKNOWLEDGEMENTS

I would like to express my heartful gratitude to my supervisor Associate Prof. Dr. Mahendra Maharjan, Central Department of Zoology, T.U. for his supervision, guidance and invaluable suggestion throughout my study.

I am thankful to our honorable Head of Department Prof. Dr. Ranjana Gupta, Central Department of Zoology, T.U. for her kind cooperation and support. I am grateful to all my teachers and all the staffs of CDZ, T.U., Kirtipur, Kathmandu, Nepal for their continuous aspiration and motivation

I was very much thankful to the Managing director, the **C.P. Sharma** for the permission given to carryout this study in the **Ostrich Nepal Pvt. Ltd. Gongoliya, Rupendehi**. Hearty thanks to all the staffs and labours for their valuable help especially for **Kedar Karki, Dayanidi Gautam, Hari Gautam, Tulshi Chaudhary** who helped me in all field activities.

I would like to express my deepest gratitude to my family and relatives for their support and inspiration in my whole academic career.

Last but not list I would like to acknowledge my friends for their kind support throughout my dissertation work and all those persons who helped me directly or indirectly to complete this work.

Kamala Khatri
T. U Registration No: 5-2-50-674-2008
Symbol No- 15563
Batch 2068/69

ABSTRACT

Ostrich and emu farming have been lunched with a very new concept to Nepalese market for their product in which parasitic diseases may cause significant effect to their production. Present study was conducted to access the prevalence of gastrointestinal parasites of ostrich and emu as well as KAP of labours and management system of the farm. A total of 200 faecal samples 100 of each bird were collected from different cages of farm in wide mouth sterile vial with 2.5% potassium dichromate and examined by sedimentation and floatation technique followed by lugol's Iodine mount and direct smear. The prevalence of endoparasites of ostrich and emu were found to be 82% and 65% respectively. Protozoan (65%) and nematode (54%) showed high prevalence in ostrich than emu while cestode prevalence was found high in emu (14%) than in ostrich (10%). Among protozoan *Entamoeba* sp. (48%) showed highest prevalence rate followed by *Eimeria* sp. (15%), *Isospora* sp. (10%) and *Balantidium* sp. (4%) in ostrich and in emu *Eimeria* sp. (30%) showed highest prevalence rate than *Entamoeba* sp. (10%). Among cestode, *Houttuynia* sp. (10%) was encountered in ostrich and *Davainea* sp. (9%) and *Raillientina* sp. (5%) in emu. Likewise, among nematode, *Ascaridia* sp. showed higer prevalence rate in both ostrich (34%) followed by *Heterakis* sp. (12%), *Codiostomum* sp. (11%) and *Libyostrongylus* sp. (9%) and in emu (15%) followed by *Dromeostrongylus* sp. (10%) and *Heterakis* sp. (5%). Parasite wise association between ostrich and emu was found to be significant for *Entamoeba* sp., *Eimeria* sp. and *Ascaridia* sp. Single (33%) and double (35%) infection were almost similar in ostrich than multiple (5%) infections while in emu single infection (48%) was higher than double (16%) and multiple (1%) infections. Although the majority of labours working in the farm were aware about the various characterstics of the ostrich and emu but their practice related to hygiene and sanitation was found unsatisfactory. The labours and managers believe that the future of Ostrich and Emu farming in Nepal seems bright. This study suggested that parasitic infection is being serious problems in the farm hence needed to adopt appropriate control strategies in order to strengthen the successful ostrich and emu production in Nepal.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

LIST OF ABBREVIATIONS

Abbreviated form	Details of abbreviations
µm	Micrometer
°C	degree celcius
cm	Centimeter
D/W	Distilled Water
et al	And his associates
Gm	Gram
IUCN	International Union for Conservation of Nature
Kg	Kilogram
Km	Kilometer
Ltd	Limited
M	Meter
Mg	Milligram
Mm	Milimeter
Pvt	Private
rpm	Revolution per minute
Rs	Rupee
USA	United National of America
UK	United Kingdom

1. INTRODUCTION

1.1 Background

Ostrich and emu are big flightless birds, very good runners and good swimmer, scientifically called ratites because of the absence of keel of the breastbone (Deeming 1999, Dingle and Shanawany 1999). They have small head, big eye, long leg and neck. Emus and other flightless bird have three toes and ostriches have two toes as compared to four toes of flying birds which are made for speed, as fewer toes means less ground contact, adding more speed (Davies 1993). Ratites fight with kicks, kicking from the knees forward and down instead of backward and display elaborate, well-developed courtship, nest-building and chick rearing behaviours (Davies 1993).

Ostrich

Scientific classification

kingdom: Animalia

Phylum: Chordata

Class: Aves

Order: Struthioniformes

Family: Struthioniidae

Genus: *Struthio*

Species: *Camelus*

Ostrich was originally named by Linnaeus in 1758 as *Struthio camelus* (Bertram 1992). In which *Struthio camelus* is derived from Latin term, *Struthio* meaning "Ostrich" and *camelus* for "Camel", aduding to its dry habitat (Gotch 1995a). The word *camelus* is based on the similarities; ostrich with camels, such as their prominent eyes and eyelashes, their large and their remarkable tolerance to the desert habitat (Shanawany 1994). Ostrich (*Struthio camelus*) is the largest and heaviest living bird and sole representatives of the order struthioniformes (Alden et al. 1996). Ostrich seems to be true dinosaurs back over 120 million years where ostrich skeleton and fossils have been found (Animal corner 2013). They can tolerate wide

range of temperature (Leavy et al. 1990, Shanawany 1994). In much of their habitat temperature vary as much as 40°C between day and night.

The ostrich has the largest eye of any land animal whose eye is bigger than the world's smallest bird, the Bee Humming bird (Animal corner 2013). The ostrich weight from 63-145kg or as much as two adult human (Davies 2002). Adult male ostrich can grow to measure 2.1-2.8 m and female ostrich range from 1.7-2 m in height (Davies 2002). Ostrich has a black plumage with white wing tips. However, female and chicks have brownish, duller plumages which are used for defence (Shanawany 1994, Animal coner 2013). The massive leg muscles enables them to deliver a powerful kick which could seriously injure or even kill an attacker (Wikipedia 2015a). Ostrich contain their main musculature in the hips and thighs. The long legs enable them to run at speeds of over 70 km per hours (Diego 2012).

Ostriches are omnivorous. They mainly feed on seeds, shrubs, grass, fruits and flowers but occasionally, they also eat insects, lizard or other creature available in their harsh habitat (Wikipedia 2015a). Ostrich donot possess a crop and also lacks gallbladder (Marshall 1960) but instead has a glandular stomach called proventriculus. The proventriculus leads to a muscular stomach called ventriculus which contains grit, rocks and other materials that help to break down food and allows it to pass into the small intestine (Animal corner 2013).

Wild ostrich is sexually mature at four to five years of age while the domesticated ostrich is mature at two to three years of age in which female matures slightly earlier than the male (Shanawany 1994). During the breeding season around March/April, male ostriches fight for harems of two to seven females (Betram 1992). Ostrich eggs are around 16 cm in length weight three pounds and are glossy and cream in colour and takes about 42 days to hatch the eggs (Animal corner 2013). Ostrich eggs are largest of all eggs (Hyde 2004). The life span of an Ostrich can be of 75 years (Animal corner 2013).

Although, ostrich numbers have drastically declined over the last 200 years however, IUCN and Bird Life International have still classed as "Least Concern" (BirdLife International 2012a).

Emu

Scientific classification

kingdom: Animalia

Phylum: Chordata

Class: Aves

Order: Casuariiformes

Family: Dromaiidae

Genus: *Dromaius*

Species: *novaehollandiae*

Emu was named by ornithologist John Latham in 1790 based on greek and latin name *Dromaius novaehollandiae* under the name of "New Holland Cassowary" (Davies 2003). In which greek word *Dromaius* means for "Racer" and the latin term "*novaehollandiae*" for New Guinea" (Gotch 1995b). Emu (*Dromaius novaehollandiae*), is the second largest living bird in the world and sole representive of the Genus: *Dromaius* (Gillespie and Flanders 2009). During decade of 30, such birds were considered as pests, because they destroyed crops in search of food, being then hunted, extensively, almost reaching the extinction (Teixira 2013). They can tolerate temperature in between 10°C-30°C (Maloney 2008).

Emus are the only birds with gastrocnemius muscles (the same as human calf muscles) in the back of the lower legs and can grow two meter tall and 45 kg weight (Animal corner 2013, Warale et al. 2014). Emus have strong long legs and although they cannot fly, they can run at speed of 48km per hours due to highly specialized pelvic limb musculature (Potodkar et al. 2009). Emus have soft, long brown feathers on their plumage which has a shaggy appearance and shorter downy feathers on their heads (Animal corner 2013).

Omnivorous emu's diet includes eat fruits, seeds, growing shoots of plants, insects other small animals and donot eat dry grasses or mature leaves even if they are available (Potodkar et al. 2009). They requires stones and pebbles to assist the digestion of plant material and also eat charcoal but reasons for this is unknown (Davies 2003). There is no crop and the proventriculus has a large lumen which also suggests that it also helps in storage of food in the absence of a crop (Wikipedia 2015b).

Sexual maturity is reached after two to three years but breeding in captivity can occurs as young as 20 months (Potadkar et al. 2009). Breeding pairs form in the summer months of December and January and mating occurs in the cooler months of May and June (Animal corner 2013). In April/June the female lay (an average 11 eggs) large thick-shelled dark green eggs, shell around one milimeter thick with one nest containing the eggs of several females (Davies 2003). An average egg can measure five inches long and three inches wide and weigh between 450-650gm (Animal corner 2013). It takes 56 days to hatch the eggs (Potadkar et al. 2009).

IUCN considered emu population trend to be stable and assesses their conservation status as being of least concern (Bird Life Internationl 2012b). Due to the collision with vehicles, loss of habitat and the increase of feral dogs and pigs the emu population in New South Wales is listed as endangered species (Animal corner 2013).

1.2 Ostrich and Emu Diseases

1.2.1 Infectious Diseases

With the increase in the numbers of farmed of ratites throughout the Australia, Asia, Africa, Europe and North America, there have been a worldwide increase in the spread of parasitic and infectious diseases associated with these birds (Tully and Shane 1996).

The infectious diseases agents reported from ostriches are: Eastern Equine Encephalomyelitis (EEE), Western Equine Encephalomyelitis (WEE) and St. Louis Encephalomyelitis virus (Tully et al. 1992, Ayers 1994), Avian influenza (H7N1, H5N9, H9N2, H5N9, H5N2, H4N6,H7N1, H7N3, H10N4)(Capaul et al. 2000, Manvell et al. 2003), Adenovirus (Capual et al. 1994), Borna diseases and Anthrax (Huchermeyer 1994), Crimean- congohaemorrhagic fever (Cooper et al. 2004), *Aspergillus* sp. (Yokota et al. 2004, Sancak and Paracikoulu 2005), *Pasteurella* (Akoha 1980), *Mycoplasmosis cloacale* (Mohan 1993), *Mycobacterium avium* (Shane et al. 1993), *Clostridium* sp. (Lublin et al. 1993, Kwon et al. 2004), New caltle disease i.e. Paramyxovirus type 1, Avibirnavirus, Avipox and *Salmonella* sp. (Tully and Shane 1996) and *Bacillus anthracis* (Huchzermeyer 1997).

This infectious disease agent reported from emu includes: Eastern Equine Encephalomyelitis (EEE) (Tully and Shane 1996, Saxton-Shaw et al. 2011), Western Equine Encephalomyelitis (WEE) (Tully et. al. 1992, Ayers 1994), St. Louis Encephalomyelitis virus (Tully et. al. 1992, Ayers 1994, Day and Stank 1996), Arbovirus (Day and Stank 1996), Adenovirus and Rotavirus (Hines et al. 1995), Avian influenza (H5N2 and H7N1) (Panjgraphy et al. 1995),

(H5N1) (Amnon et al. 2011), H7N4 (Selleck et al. 2003), (H9N2) (Shinde et al. 2012), New castle disease virus I.e. Paramyxovirus Type 1 (Shinde et al. 2012, Khyalia et al. 2014), *Aspergillus* sp. (Karunkarna et al. 2010), *Salmonella* sp. (Tully and Shane 1996), *Erysipelothrix rhusiopathiae* (Griffiths and Buller 1991), *Escherichia coli* (Hines et al. 1995), *Pasteurella* sp. (Akoha 1980), *Mycoplasmosis cloacale* (Mohan 1993), *Mycobacterium avium* (Shane et al. 1993), *Clostridium sp.* (Lublin et al. 1993; Shane et al. 1993).

1.2.2 Parasitic Diseases

The ratites are the birds quite vulnerable to several types of parasitic infections, mainly the gastrointestinal parasites (Oliveira et al. 2009). The parasites cause diseases in ratites and some species may be responsible for up to 50% of mortality among offspring of ratites (Boradiman et al. 2006). The economic impact of most of ratite parasites is still undetermined (Nemejc and Lukesova 2012). Ratites are found to be frequently infected with protozoan, nematode, cestode and trematode parasites.

The major gastrointestinal parasites of ostrich includes: *Cryptosporidium* (Nemejc and Lukesova 2012), *Isospora struthionis* (Yakimoff 1940), *Isospora* sp. (Mattos et al. 2011), *Eimeria* sp. (Eslami et al. 2007, Mshelia et al. 2010), *Balantidium* sp. (Ederli and Oliveria 2008, Mattos et al. 2011), *Entamoeba* sp. (Pennycott and Patterson 2011) and *Giardia* sp. (Huchzermeyer 1999). The protozoan parasites *Cryptosporidium* sp., *Isospora* sp., *Eimeria* sp. and *Balantidium* sp. were also discovered by Ponce Gordo et al. (2002) and that of *Balantidium* sp., *Entamoeba* sp., and *Histomonas* sp., by Poudel (2012). Likewise, nematode parasites includes: *Libyostrongylus* sp. (Mshelia et al. 2010, De Andra et al. 2011; Nemejc and Lukesova 2012, Poudel 2012), *Ascaridia* sp. (Ibrahim et al. 2006;), *Codiostomum* sp. (Juarjda 2002, Blood et al. 2007, Ederli et al. 2008), *Capillaria* sp. (Ibrahim et al. 2006) and *Heterakis dispar* (Eslami et al. 2007), *Houttuynia struthionis,* a cestode and *Philophthalmus gralli,* trematode (Dingle and Shanawany 1999, Ponce Gordo et al. 2002). The different types of nematode found by Ponce Gordo et al. (2000) were *Libyostrongylus* sp., *Ascaridia* sp., *Codiostomum* sp., *Capillaria* sp. and Mattos et al. (2011) discovered *Ascaridia* sp., *Codiostomum* sp., *Capillaria* sp. and *Heterakis dispar*.

The major ectoparasites of ostrich includes: *Struthiolipeurus struthionis* (Deeming 1999, Jurjda 2002, Cooper 2005), *Struthiolipeurus nandu, S. rheae and S. stresemanni* (Yaman and Durgut 2005, Taylor et al. 2007), *Hyalomma* sp., *Ambylomma* sp., *Rhipicephalus* sp. and *Gabucinia bicaudata* (Jeffery 1996, Deeming 1999).

The major gastrointestional parasites in emu includes: Protozoan- *Cryptosporidium* sp. *Eimeria* sp. and *Giardia* sp. (Ponce Gordo et al. 2002, Foreyt 2005), *Isospora* sp. and *Entamoeba* sp. (Teixeira 2013), Coccidian (Stewart 1994, Papini et al. 2011), Cestode- *Davainea* sp. (Foreyt 2005) and *Raillietina* sp. (O'Calleghan et al. 2000), *Fasciola hepatica*, a trematode (Vaughan et al. 1997, Soares et al. 2007), nematode- *Ascaridia* sp., *Strongylida* sp. (Teixeira 2013), *Capillaria* (Jansson and Christensson 2000), *Paradeletrocephalus* sp. and *Deletrocephalus* sp. (Rickard et al. 1997) and *Dromaestrongylus bicuspis* (Foreyt 2005) and major ectoparasites of emu are *Dahlemhornia asymmetrica, Gabucinia sculpturata* (Taylor et al. 2007), *Simulim* sp. and *Cullicoides* sp. (Craig 1993).

1.3 Objectives of the Study

1.3.1 General Objective

To determine the distribution of endoparasites of ostrich and emu in Ostrich Nepal Pvt. Ltd. Gongoliya, Rupendehi.

1.3.2 Specifec Objectives

a. To determine the prevalence of gastrointestinal parasites of ostrich and emu.
b. Assessment of knowledge, attitude and practice (KAP) of labour working in the Ostrich Nepal Pvt. Ltd., Gongoliya, Rupendehi.
c. Management practices of ostrich and emu farming in the Ostrich Nepal Pvt. Ltd., Gongoliya, Rupendehi.

2. LITERATURE REVIEW

2.1 Background

Ostrich farming has been commercially practiced from 1860s at South Africa and has been successfully breed in Canada, the United States, Australia, Spain, Italy, United Kingdom and many other countries (Huchzermeyer 1994). Before 1980s ostrich farming were practiced for its feathers only but after 1980s they were farmed for hides, fats, feathers and bones which have high value in international markets (Shanawany 1994). The first successful artificial hatching take place in 1857 in Algeria (Smit 1963). The artificial incubator for ostrich eggs was invented by Arthur Douglass in 1869 (Smit 1963). Outside South Africa, only a few large-scale operations exist in USA, Australia and Europe (Deeming 1999). These birds originated from Africa and currently commercial breeding has gained economic important worldwide due to the ability of these birds to adapt to different environment (Tully and Shane 1996). In mid-1980s the economical important of ostrich was recognized as interest in farming the birds re-emerged in the USA, Australia and Europe (Deeming 1999). Thus, ostrich farming began rapidly in 1980s through the America, Europe Australia and New Zealand and into Asia (Adams and Revell 2011).

Just like ostrich farming, emu farming has become popular and lucrative agricultural industry throughout the world (Orumbayev 2015). Emu are native to Australia and first emu farming commenced in Western Australia in late 1980s with the breeding of stock captured from wild by the aboriginal community (APL 1997, Menon et al. 2014). The first commercial scale of emu farming to produce meat, leathers, and fat began in 1987 (O'Malley 1997) and then the industry spread to Europe, North America, Asia, Africa (Thompson 1997). They are also contributes as agricultural pests by destroying insects as well as maintains the floral diversity in nature by dispersing a large viable seeds (Warale et al. 2014). Currently, these ratites are farmed for commercialized of their meat, skin, feathers and eggs and more recently for their fat (Grompone et al. 2005).

2.2 Ostrich and emu farming practices in Global Context

In most part of the world ratites farming (i.e. farming of ostrich and emu) is a new field of livestock production (Nemejc 2007) with broad utilization of their production (Nemejc and Lukesova 2012). In 1999, China has imported ostrich and emu from America, Europe and

Africa to start business (Kang et al. 2006). Ostrich were introduced in Iran by mid-1998 (Eslami et al. 2007). Ostrich and emu farm has established in 1997 in Al-Qussim region, Central Soudi Arabia (Agab et al. 2002) by importing 400 breeding ostriches and emus from France. In Arabian Penisula, ostrich were hunted for their meat, while Isrealis have farmed ostrich for their hides since they obtained eggs illegally from South Africa in 1983 (Adams and Revell 2011). There are also emu farm in Isreal (Amnon et al. 2011). Emu farmed also confined to Palastine and Saudi-Arabia (Agab et al. 2002). Emu farm were also reported in Lauisiana (Veazey et al. 1994).

Recently, emu farm has gained importance in India (Khyalia et al. 2014). West Godavari district in Andhra Pradesh started emu farming for the first time spread throught the country for the commercial purpose. Presently, emu farming is being carried out in large scale in Andra Pradesh, Gujarat, Maharashtra, Tamil Nadu, Karnataka, Orissa, Kerala, Delhi and some parts of Northern India (Khyalia et al. 2014).

Ostrich have been traditionally hunted in Namibia (South West Africa) for sports and for diamonds sometime found in their gizzards (Davies, 1993). There are seven ostrich farms in three states i.e. Kano, Kaduna and Plateau of Northern Nigeria (Mshelia et al. 2011). Botswana has the world's largest population of wild ostrich, indicating that the local climate is suitable for ostrich Production (Moreki and Koloka 2010). Dzoma and Motshegwa (2009) pointed out that the largest population of wild ostrich indicates Botswana to be potential candidates for rearing ostrich. Commercial ostrich production is still in its infancy in Botswana (Moreki and Koloka 2010, Sunday and Standard 2012). Emu farming has also established in Egypt (Agab et al. 2002). Cooper et al. (2008) discussed the historical, development and practiced of ostrich farming in Egypt which has numerous strengthen and oppurtunities to develop its ostrich sector. There are 43 provinces of ostrich farming in which 12 were rared for feather in 2002-2004 (Cooper et al. 2008).

Most European countries have been also developing Ostrich farms since around 1990s by importing birds from Africa and Israel (Deeming and Angle 1996). In 1994, the first ostrich farm was established in Portugal and all races of ostrich were breeded. Likewise, ostrich and emu farmed were established in Dinant, Belgium (Alison 2012). Ostrich have been farmed in the United Kingdom since, 1991 where eggs were imported from Namibia (Deeming et al. 1993).

According to Aichinger et al. (2007), ostrich were introduced in to Brazil in 1990s. In the Rio de Janeiro of Brazil there are 13 ostrich farms in nine municipalities (Ederli and Oliviera 2015). Breeding of emus especially in the Central Western of Brazil started in 1990s (Ederlia and Oliveira 2015). In late 1890s the Florida ostrich farm opened in Jacksonvile (Jones 2007). It was as a tourist's attraction featuring ostrich races and for their feathers and in the late 1990s most ostrich farm in Florida went out of business (Jones 2007). But in 1992, ostrich were reclassed as domestic livestock and were popular and tourist destination (Jones 2007). There is a National Canadian Emu Association. Emu farm was also reported in Ranch in Volusia country (Day and Stank 1996), Routland country (Saxton-Shaw et al. 2011), Texas and North Carolina (Panjgraphy et al. 1995) and Hongkong (Perkins and Swayne 2002). Though Australia is the native of emu farming yet United States has been gained the popularity very fast due in their resistance in wide range of climatic condition (Warale et al. 2014).

Ostrich farm began in 1980s in Australia and New Zealand (Adams and Revell 2011). Emu are rared commercial in many parts of the world for their meat, fat, skin and feathers which are of high economic value (Patodkar et al. 2009, Warale et al. 2014).

Now ratite production spread in many countries including the USA, Australia, Israel, France, New Zealand, China, Korea, Zimbabwe, Botswana, Namibia, the United Kingdom, Belgium, Holland, Poland and Canada (AAFC 1999). Most producers today are growing ratites for their meat, the hides, feathers, fat, eggs shell and other parts of the birds as by-products (Bodger and Goulding 2003). Ostrich feathers were adopted in ancient Egypt as symbol of justice and truth (Shanawany 1994). The medical importance of ostrich was demonstrated in human through corneal transplantation of ostrich eyes to entrance vision and use of its brain tissue to heat Alzheimer's disease (Shanawany 1994). In the Arabian Penisula, ostrich were hunted for their meat, while their skins were used to make protecting clothing (Shanawany 1994).

In 2011, by exporting only six breeders to Spain earned 14000 dollors as profit by UK (Adams and Revell 2011). Japan is considered as the most important costomers for importing ostrich leather and leather products from other countries (Carbujo 2006). Portugal also exports meat, leathers, feathers, breeders and slaugheters for the Protuguses, Europeans and world markets. In 1986, South Africa exported 90000 ostrich hides to the United States alone (Vyver 1992).

It is estimated that all over 300000 birds were slaughtered in South Asian in 1997, producing 9000 to 10000 tones of meat while about 420000 hides were processed (Adams and Revell 2011). Within Europe, Belgium, Italy, Portugal and Spain have the highest ostrich meat production, but the markets in these countries are still in their infancy and are largely dependent on imports from third countries that have a favourable economy scale and low costs (Carbujo 2006). There are about 2 million ostrich worldwide (Animal corner 2013). Today, the world population of emu is estimated to be around two million, out of which one million is estimated to be spread between North America, Peru, India and China and about 750,000 in Australia (Orumbayev 2015).

2.3 Ostrich and emu farming in National Context

With a very new concept of launching varieties of ostrich product to the Nepalese market, Ostrich Nepal Pvt. Ltd was established in 2008 AD at Tilotama municipality, Gongoliya-22, Rupendehi. It has started with an investment of one billion by importing 1,500 eggs from Australia. It is the largest ostrich farm in Asia, which is located at Gongoliya covering the land of Twenty two (22) bigha (8.81 Acers) and in Suryapur, Rupendehi covering a very big mass of land of one hundred and fifty (150) bigha (60 Acers). With the increasing demand of the farmers and also to give the production a bit of commercial and scientific upgradation this farm has also established itself in Bijauri, Dang where parents ostrich are kept covering a total land of altoghter 50 bigha. This farms has various procedures been through from egg production to hatching eggs to meat packaging and customer delivery. According to the manager now the company has entered the production phase. This Dashain (2014), the company sold 20 tones of ostrich meat in National market.

As ostrich farm, emu farm was also established in Ostrich Nepal Pvt. Ltd. in 2008 AD. As a whole in Nepal there are three Ostrich farm and only one Emu farm.

It has its higher mission of producing quality goods in a price which is affordable and appropriate for all and also have visualized itself to export meat of Rs. Five billion as well as leather, fat and feather of around Rs. 2.5 billion to the international market till 2020 (http//www.ostrichnepal.com).

2.4 Diseases Prevalence in ostrich and emu

Ostrich and emu are susceptible to various diseases like coccidiasis, nematodiasis, and respiratory diseases, bacterial, fungal and viral infections. The major ignorance part in this farming is its diseases. Although coccidiasis do not directly affect ostriches but it can cause bloody diarrhoea, weight loss, growth retardation, delay in egg laying which provides direct negative impact in the farming. Careless management practices, high bird density and confinement stress are the major threats in ostrich farming (Dingle and Shanawany 1999).

2.4.1 Infectious diseases of ostriches and emus

Reports published in recent years have shown a species specificity between the ratite groups regarding many infectious diseases (Tully and Shane 1996). The descriptions of viral, fungal and bacterial diseases are discussed below:

Viral disease agents

Ostriches and emus are found to be infected with various types of viral diseases. Among them some important viral diseases reported includes Arbovirus (Day and Stank 1996), Avian influenza (Calvijo et al. 2001, Manvell et al. 2003), New Castle disease virus (Shinde et al. 2012, Khyalia et al. 2014), Adenovirus (Hines et al. 1995), Avibirnavirus (Chin and Woolcock 1994), Avipox virus (Allwright et al. 1994).

Eastern Equine Encephalomyelitis (EEE), Western Equine Encephalomyelitis (WEE) and St. Louis encephalomyelitis virus have been isolated from ratites in the USA (Ayers et al. 1994, Tully et. al. 1992). At a Ranch in Volusia country, in between 1992-1994, 204 sera of domestic emu were collected and after examination, three different types of virus i.e. EEE, St. Louis and arbovirus were isolated from the sera (Day and Stank 1996). Likewise, EEE virus was also isolated from Southern Louisiana (Tully et al. 1992) and Routland country (Saxton-Shaw et. al. 2011). Adenovirus and Rotavirus from 2-week-old-emu chick were diagnosed (Hines et al. 1995).

Ostriches and emus were susceptible to infection with several Avian Influenza Viruses (AIV). AIV have been isolated from ostriches almost all over the world including South Africa (H7N1, H5N9, H9N2); Zimbabwe (H5N2); Holland (H5N9); America (H5N2, H4N6, H7N1, H7N3, H10N4) and Canada (H7N1) (Capau et al. 2000, Calvijo et al. 2001, Clavijo et

al. 2003, Manvell et al. 1998, Manvell et al. 2003). It was first reported from China (H9N2) (Kang et al. 2006).

AIV has been isolated from emu in Texax and North Carolina (H5N2 and H7N1) (Panjgraphy et al. 1995), Hongkong (H5N1) (Perkins and Swayne, 2002) and from dead emu in the Ein Gedi Oasis near the dead sea of Israel (H5N1) (Amnon et al. 2011). In November 1997, an outbreak of highly pathogenic avian influence in emu caused by H7N4 virus nears the town of Tamworth in northern New South Wales, Australia (Selleck et al. 2003). Similarly, first AIV surveillance was undertaken in Maharastra stage, India during the period 2010-2011 (Shinde et al. 2012). A total of 202 blood samples and 467 tracheal and clocal swabs were collected from eight emu farms and AIV H9N2 was isolated (Shinde et al. 2012).

New castle disease virus (ND) is caused by paramyxovirus type 1, which affect galliforms, passeriforms and psittacines in addition to other families including ratites (Samberg et al. 1989); China (Kang et al. 2006) and Maharastra, India (Shinde et al. 2012). An adenovirus was isolated from pancreas, kidney and lung of a dead 4-month old ostrich (Capua et al. 1994). This virus was also isolated from two weeks old emu chick of approximately 200g weight from specimen of liver and intestine and from an abdominal swab (Hines et al. 1995). New castle ND was found in emu from Gujarat (Khyalia et al. 2014).

Avibirnavirus identical to infectious bursal disease virus (IBDV) has been isolated from the bursa of immature ostriches in flocks in California and Florida where high flock mortality was observed (Chin and Woolcock, 1994). Avipox virus has been diagnosed in ostriches in the USA, Israel and South Africa (Allwright et al. 1994, Perelman et al. 1988). According to Tully and Shane (1996), virus can be transmitted by mosquitoes or by direct contact with a pox lesion and immature Ostrich chicks aged between two weeks and one year are most susceptible. Borna disease virus (BDV) has been identified in Israel in ostrich chicks (two to eight weeks old) raised under intensive conditions (Weisman et al. 1994). The affected bird died within four to eight days, due to dehydration (Weisman et al. 1994).

Tully and Shane (1996), have revealed six various types of virus from ostriches and emus which includes: EEE, WEE and St. Louis have been isolated from ratites in USA, New castle disease virus, Avibirnavirus from the immature ostriches in California and Florida, Avipox

virus from ostriches in USA, Israel and South Africa. Also Cooper et al., (2004) diagnosed New castle disease, AIV, borna disease Crimean-Congo hemorahigic fever and avipox.

Fungal and bacterial disease agents

Fungi and bacteria are the primary pathogens which affect ratite species. The most common fungal and bacterial disease of ostriches and emus includes: Aspergillosis (Kyoung 2001, Brown et al. 2008), Salmonellosis (Tully and Shane 1996), Erysipelas (Grifffiths and Buller 1991), Pasteuellosis (Akoha 1980), Mycoplasmosis (Mohan, 1993), Tuberculosis (Shane et al. 1993), Clostridial enteritis (Lublin et al. 1993, Shane et al. 1993, Kwon et al. 2004).

Aspergillus is a common respiratory infection due to mismanagement in avian species (Brown et al. 2008). Weight loss, lethargy and dyspnea are observed in *Aspergillus* infections (Kyoung 2001). Several reports of *Aspergillus* sp. were reported in ostriches (Perelman and Kuttin 1992, Terizich and Vanhooster 1993, Marks et al. 1994, Huchzemeyer 1999, Sancak and Paracikoulu 2005). In 2003 was published the first report of Aspergillosis due to *A. fumigates* in Iran (Sasani et al. 2003). *A. fumigates* is the most commonly isolated agent in Aspergillosis (Arne et al. 2011). *A. fumigants* (Sancak and Paracikoulu 2003, Khosravi et al. 2008, Shathele et al. 2009), *A. niger* and *A. flavus* (Perelman and Kuttin 1992) have been isolated. Recently, *A. fumigants* and *A. niger* have been identified in Iran ostrich farm (Araghi et al. 2014). *Aspergillus* sp. has been identified as a primary cause of death in Juvenile ostrich and emu (Marks et al. 1994). Chakravarty (1976) has reported a similar case of mycotic infection (Aspergillosis) in an emu in Delhi zoo. Recently, Aspergillosis has been reported from emu in Kerala (Karunakarna et al. 2010).

Various *Salmonelloa* sp. have been isolated from gastrointestinal tracts or all ratite species but the incidence of paratyphoid, *Salmonella* sp. (Tully and Shane 1996). Emu can be infected with *S. pullorum* pathogens which persist in game fowl and develop antibodies against these pathogens (Tully and Shane 1996). Emus have been reported to be susceptible to infection by *Erysipelothrix rhusiopathiae* (Grifffiths and Buller 1991). *Escherichia coli* were other bacteria which was isolated from specimens of liver and intestine and from abdominal swab (Hines et al. 1995) and from the conjunctiva and *staphylococcus* (Woolcock et al. 2000). In 1997, Lemarchand et al., found camphylo bactor like organisms associated with rectal prolapsed and proliferative enteroproctitis in emus. Also, *E. coli* has been isolated from emu (Hines et al. 1995).

There have been rare occurances of *Pasteurella* sp. isolated in ratites species (Akoha 1980). Likewise, *Mycoplasmosis cloacale* has been isolated from tracheal swabs of ostrich and emus (Mohan 1993).

Another bacteria *Mycobacterium avium* has been diagnosed in ostriches and emus in the USA and Canada (Shane et al. 1993). A number of Clostridial organisms have been isolated from various ratite species, including *Clostridium perfringens, C. colinum, C. chauvoei* and *C. difficile* (Lublin et al. 1993, Shane et al. 1993). *C. perfringens* has also been isolated from ostrich in Korea (Kwon et al. 2004). Another rare *Bacillus anthracis* has been diagnosed in South Africa in ostrich (Snoeyenbos 1965, Huchzermeyer 1997). Tully and Shane (1996) have reported bacterial disease includes: *Salmonella* sp. in ratites, *S. pullorum* in emu, Pasteuellosis in ratites, *Mycoplasmosis cloacale* in ratites, *Mycobacterium avium* in ostriches and emus in the USA and Canada and Clostridial enteritis in ratite.

2.4.2 Parasitic disease of ostriches and emus.

As all other higher organisms ostrich and emu are also suffered from both ecto and endoparasites but under farmed condition emus are more parasites free than ostriches (Nemejc and Lukesova 2012). They may be infested with their own specific parasites as well as with external and internal parasites of other birds, some parasites of ruminants and raccoons (Eslami et al. 2007). Further details analyses are needed to determine not only the host- specific status of ratite parasites, but also the risk of infection for other animals and humans (Ponce Gordo et al. 2002). Many species can parasites both birds including nematodes, cestodes, trematodes, protozoans. Usually careless management, high bird density as well as poor hygiene contribute to parasitic infection (Chang Reissig et al. 2001).

Endo parasites of ostrich and emu

Parasites of the digestive system (proventriculus, gizzard, small intestine and large intestine) as well as those of respiratory and circulatory system infest ratites. No parasites of the nervous system of veterinary importance were reported in them (Taylor et al. 2007). They are mainly infected with protozoans and helminthes parasites have been reported. The prevalence of gastrointestinal parasites is high in places where the conditions of life and basic sanitation are unsatisfactory (Teixeira 2013).

Protozoan parasites

In birds, protozoa can be found in the blood stream, internal organs and are important that cause diseases in digestive tract of these animals, including oropharynx, intestine and cloaca (Silvanose et al. 1998). Parasite problem in ratite facilitates can cause genera ill thrift, reduction in growth, poor reproductive results and even death. A number of intestinal protozoans including *Hexamita, Giardia, Trichomonas, Cryptosporidium* (Deeming 1999, Chang Reissig et al. 2001, Ponce Gordo et al. 2002, Cooper 2005).

Coccidia

Ratites have been found to be infected with *Cryptosporidium* sp. (Ponce Gordo et al. 2002, Foreyt 2005, Oliveira et al. 2008) in their intestine. Ostrich have been found to be infected with two different types of *Cryptosporidium* sp. (Sotiraki et al. 2001, Santos et al. 2005, Nemejc and Lukesova 2012). *Cryptosporidia* sp. has also been reported in the feaces of imported ostriches in Canada (Gajadhar 1993). In Europe, *Cryptosporidium* oocysts have been found in ostriches from Greece (Sotiraki et al. 2001). From Spain, Portugal, Netherlands, Belgium, Great Britain, France (Ponce Gordo et al. 2002). *Cryptosporidium* sp. is a genus commonly found in faeces of ostrich (Huchzermeyer 2002) and the same seems not occur with emus. *Cryptosporidium* sp. cause gastrointestinal problems that result in anorexia, diarrhoea and death in all species of ratites (Craig 1993). *Toxoplasma* sp. is wide spread zoonosis caused by *Toxoplasma gondii* which has isolated in Brazil (Paula 2009).

There are some reports which showed the presence of *Isospora* sp. and *Eimeria* sp. in ratites. Only one species of *Isospora* sp. was described by Yakimoff (1940), from an ostrich at a Russian zoo and was identified as *Isospora struthionis*. Other specimens have been in ostrich as *Isospora* sp. (Jansson and Christensson 2000, Ponce Gordo et al. 2002, Mattos et al. 2011) or *Eimeria* sp. (Sotiraki et al. 2001, Ponce Gordo et al. 2002). Both genera can be differentiated on the basis of number of sporocysts (Levine 1985). Oocyst of *Isospora* sp. and *Eimeria* sp. has been reported from Nepal (Poudel 2012). Likewise, oocysts of *Eimeria* sp. have also been reported in ostrich from Negeria (Ibrahim et al. 2006, Mshelia et al. 2010), Iran (Eslami et al. 2007), Czech Republic (Nemejc and Lukesova 2012), Botswana (Mushi et al. 2003) and North America (Wade 1992) in different state of Europe (Ponce Gordo et al. 2002). *Eimeria* sp. was also reported in emu (Ponce Gordo et al. 2002, Foreyt. 2005). Coccidiosis has been described in ostrich and emus however; infection was not confirmed as an important clinical problem in ratites (Stewart 1994) and mentioned as being a common

disease mainly in pups of emus (Jurajda 2002). Likewise, author Teixeira (2013), has been revealed oocyst of coccidian of genera *Eimeria* sp. and *Isospora* sp. in emus.

Flagellate

One of the important flagellate species is *Histomonas meleagridis*, a parasite of Turkeys and other gallinaceous birds causing inflammation of caeca and liver. It may infect ostriches in close contact with such birds and cause similar disease (Deeming 1999, Jurjda 2002, Ponce Gordo et al. 2002). Recently, *Histomonas* sp. was also isolated from Nepal (Poudel 2012). A *Trichomonas* (flagellate) infection can be acquired by ostriches via contact with pigeons and doves. It causes pseudomembraneous lesions in the upper digestive tract (Deeming 1999, Jurjda 2002). Since, *Trichomonas* do not form cysts (Levine 1985) their transmission should be by ingestion of live trophozoites in faeces.

Ratite have been found susceptible with *Giardia* sp. (Ponce Gordo et al. 2002, Foreyt 2005). In ostriches *Giardia* sp. has been described (Tully and Shane 1996, Huchzermeyer 1999). Many of the reports of trophozoites and cysts of *Giardia* sp. has found in ostrich (Wade 1992, Greinger and Ritchie 1994, Stewart 1994, Huchzermeyer 1999). Cyst and trophozonts of *Giardia* sp. has been identified in emus (Teixeira 2013). *Giardia* sp. rare in ratites, which seems not to be pathogenic in these birds (Teixeira 2013). Two species of spironucleus have been described from birds: *S. meleagridis* in Turkey and *S. columbae* from pigeons (Levine 1985) *S. meleagridis* have been found in several ostriches (Ponce Gordo et al. 2002). On the basis of morphology, flagellate compatible and in vivo movement. Likewise, trophozoites and cysts of *Giardia* sp. found in ostriches (Ponce Gordo et al. 2002). *Monocercomonas* sp., *Chilomastrix gallinarum* and *Pleuromonas* sp. were fairly common parasites of ostriches that seem to be non-pathogenic for them (Ponce Gordo et al. 2002). Also, trophozoites of *Retortamonas* sp. have been found in the intestinal contexts of ostriches and seem to be non-pathogenic (Ponce Gordo et al. 2002).

Ciliates

Balantidium struthionis is a ciliate and normal inhabitant in ostrich intestine, probably capable of becoming somewhat pathogenic under favourable condition (Huchzermeyer, 1999). This parasite was isolated from ostrich (Hegner 1934, Ponce Gordo et al. 2002, Ederli and Oliveira 2008). Mattos et al. (2011) has been reported *Balantidium* sp. in the faecal sample of ostrich from Rio Grande do Sul. This species is considered as ostrich specific

(Sotiraki et al. 2001). In Sweden and Nepal, Jansson and Christensson (2000) and Poudel (2012) respectively have been found a ciliate from ostrich that they classified as *Balantidium.*

Amoeba

Entamoeba cysts forming groups include non pathogenic species, some of them describe from birds: *E. gallinarum* of the eight – nucleate mature cysts group (or E. coli –like group), inhabits the caeca of Chicken, Turkey and Partridge (Levine 1985,) and a non determined species of the one – nucleate mature cysts group (or *E. bovis* – like group) has been found in the caeca and large intestine of ostriches (Craig and Diamond 1996, Martinez Diaz et al. 2000, Ponce Gordo et al. 2002). *Entamoeba* sp. has been reported for ostriches in Spain, Portugal, Belgium, France, Great Britain, Netherlands (Ponce Gordo et al. 2002), Greece (Sotiraki et al. 2001), Scotland (Pennycott and Patterson 2001) and Sweden (Jansson and Christensson 2000). The other types of amoebae have been found were *Endolimax* and *Iodamoeba* (Sotiraki et al. 2001, Ponce Gordo et al. 2002). However, in emus, no reports have been found (Teixeira 2013). Cysts and trophozonts of *Entamoeba* sp. has discovered in emu (Teixeira 2013).

Others

Under favourable circumstances, ostriches are susceptible to infection with species of Plasmodium transmitted by mosquitoes (Fantham and Porter 1943, Deeming 1999, Jurajda 2002, Copper 2005). *Leucocytozoon struthionis,* a parasite of the circulatory system is transmitted by arthropods (black flies) and commonly infects ostrich chicks in South Africa without causing clinical diseases (Bennett et al. 1992, Huchzermeyer 1994, Deeming 1999, Cooper 2005, Taylor et al. 2007). Treatment and control has not been reported yet (Taylor et al. 2007).

Helminthes

Ratites may be affected by various microorganisms such as bacteria, fungi, virus and parasites among which had already been reported helminthes of different genera and species includes: nematodes: *Bayliscaris* sp., *Libyostrongylus* sp., *Ascaridia* sp., *Orthocerca douglassii, Paranchocerca struthionis, Deletrocephalus dimidiatus, Paradeletrocephalus, minor* and *Chandlerella quiscali* (Craig and Diamond 1996), besides *Capillaria* spp.(Jansson and Christensson 2000), cestode: *Huttuynia struthionis* and trematode: *Philophthalmus gralli* (Ponce Gordo et al. 2002).

Cestodes

Tapeworm *(Houttuynia struthionis),* that belongs to the family Davaineidae. It is a parasite of the small intestine and major endoparasites of the ostrich and rhea (Nemejc and Lukesova 2012, Ederli and Oliveira 2014) where as cestode *Davainea* sp. is major endoparsite of emu (Ederli and Oliveira 2014). *Houttuynia struthionis* causes unthriftiness is diarrhoea mainly in ostrich chicks (Jurajda 2002, Ponce Gordo et al. 2002 Blood et al. 2007). In South Africa, frequent occurance of this tapeworm has been reported in chicks and pasture raised ostriches (Dingle and Shanawany 1999, Jurajda 2002).

The tapeworm has also been spread to Europe with ostriches imported from Africa and it was diagnosed sporadically in the USA too (Jurajda 2002, Copper 2005). They are large flat, segmented white worm of about 50 to 100cm length (Deeming 1999, Dingle and Shanawany 1999). The life cycle and intermediate host of this tapeworm is unknown (Deeming 1999, Jurjda 2002, Taylor et al. 2007). Ostrich chicks are the most suspectible and show signs of

infestation very slowly: gradually loss of appetite, sometimes accompanied by mild diarrhoea ((Dingle and Shanawany 1999, Taylor et al. 2007).

Another host specific cestode parasite of emu i.e. *Davainea* sp. has been isolated in small intestine of emu (Foreyt 2005). However, there are no reports of cestode in emu or the impact of this on these birds much less it zoonotic potential (Teixeira 2013). *Raillietina beveridgei, R. chiltoni, R. dromaius* and *R. mitchelli* have been described from the small intestine of farmed and wild emus from South Australia (O'Calleghan et al. 2003). A new species differ from *R. australis* and from each other in the size and number of rostellar hooks and in the dimension of the cirrus sac (O'Calleghan et al. 2000). Teixeira (2013) recovered eggs type of cestode.

Nematodes

A nematode *Libyostrongylus* sp. (wireworm) is the parasite of small intestine and major endoparasite of ostrich is one of the most important pathogenic nematode, producing a diseases known as rotten stomach which can cause high mortalities among juvenile ostrich (Nel 1980, Foggin 1992, Lordman and Broonneberg 2004) and occasionally, also to adults (Jansson and Christensson 2000). This wire worm are very small, round, wire-like, yellowish red worms of about 3mm long, male being 4-6mm and female 5-6mm long (Taylor et al. 2007).Wireworms are very small, round, wire-like, yellowish red worms of about three milimeter long, male being 4-6 mm and female 5-6 mm long (Taylor et al. 2007). Mature worms and late larval stages lives in the crypts of the glandular portion of the proventriculus and gizzard wall (Deeming 1999). Three species of *Libyostrongylus* have been reported from ostriches: *L. douglassii, L. magnus* and *L. dentatus*. However, The *Libyostrongylus* i.e. wireworm is the species consider to be more pathogenic for ostriches (Hoberg et al. 1995), producing a disease known as "rotten stomach" which cause high mortalities among the juvenile ostriches (Nel 1980, Foggin 1992, Dingle and Shanawany 1999, Mushi et al. 2003, Mustapha 2003, Lordman and Bronneberg 2004) and Occasionally, also to adults (Jansson and Christensson 2000). In 2000, Jansson and Christensson have reported the first finding of *L. douglassii* from emus in Sweden. Of these, only *L. douglassii* has been reported in ostriches from Portugal, Spain, Belgium, Netherlands (Ponce Gordo et al. 2002), Australia (Barton and Seward 1993), Sweden (Jansson and Christensson 2000), Greece (Sotiraki et al. 2001), Czech Republic (Nemejc and Lukesova 2012), Croatia (Tisljar et al. 2007), Brazil (Bonadiman et al. 2006, Ederli et al. 2008, De Andra et al. 2011), Nigeria (Ibrahim et al.

2006, Mshelia et al. 2010), Iran (Eslami et al. 2007), New Zealand (Mckenna 2005). In Udarine, *L. magnus* has been reported in ostriches originating from Ethiopia and *L. dentatus* in USE originating from Ethiopia and *L. dentatus* in USA originating from Tanzania (Huchzermeyer 2002). Egg of *Libyostrongylus* sp. has been also reported from ostrich in Nepal (Poudel 2012). Another *Strongyloide* nematode i.e. *Dromaestrongylus* sp. is a parasite of small intestine and major endoparasite of emu (Foreyt 2005). Egg and larva of such type of *Strongyloide* have been diagnosed in emu (Teixeira 2013). Likewise, egg of *Ascaridia* sp. have been diagnosed in emus (Teixeira 2013).

The genus *codiostomum* sp. is composed of a single species *C. struthionis* nematode parasite has been found in ostrich which is slightly larger roundworm that inhabits in the large intestine and caeca of the ostriches (Huchzermeyer 1994, Deeming 1999, Dingle and Shanawany 1999, Jurajda, 2002, Blood et al. 2007, Ederli et al. 2008). *Codiostomum* sp. is about 1-1.5cm long and white (Dingle and Shanawany 1999, Taylor et al. 2007). It is relatively harmless (Huchzermeyer 1994) but heavy infections are likely to be dangerous (Jurajda 2002, Blood et al. 2007). This parasites have been isolated from Spain and Great Britian (Ponce and Gordo et al. 2002), Sweden (Jansson and Christensson 2000), Greece (Sotiraki et al. 2001), Rio Grande do Sul (Mattos et al. 2011), Brazil (Oliveira et al. 2009, Fagundes et al. 2012), South Africa (, Warmser 1930, Huchzermeyer 1994) and Czech Republic (Nemejc and Lukesova 2012). Egg like *Codiostomum* sp. has been revealed from ostrich in Nepal (Poudel 2012). Nematode *Libyostrongylus* sp. and *Codiostomum* sp. have been considered to be specific parasites of ostrich (Teixeira 2013, Ederli and Oliveira 2014). Exclusive nematode *Codiostomum* sp. was of ostrich (Dingle and Shanawany 1999).

Another nematode known as *Capillaria* sp. has been recorded in the faecal samples of both captive and free living ostriches in North East Nigeria (Ibrahim et al. 2006), different states of Europe (Ponce Gordo et al. 2002) and Rio Grande do Sul (Mattos et al. 2011). In 2000, Jansson and Christensson have been found *Capillaria* sp. eggs in emu samples from Sweden. *Heterakis dispar*, a nematode common in poultry has been also recorded in the alimentary canal of ostriches on farm in Iran (Eslami et al. 2007) and Rio Grande do Sul (Mattos et al. 2011). It has the first report in ostriches. A gonad-infecting of great clinical importance nematode is *Bayliscaris*, which is transmitted to ostriches in the USA by skunks and raccoons through faecal material in which the eggs remain viable in the soil for years (Cooper 2005). *Bayliscaris procyonis* was identified in ostrich and emu causing cerebrospinal nematodiasis

(Kazacos et al. 1991) while Verminous encephalitis infection with *B. columnaris* in an emu (Kazacos et al. 1982, Craig 1993). *Baylisascaris* sp. has been identified in ostriches and emus (Kazacos et al. 1982, Craig 1993).

Unidentified species of *Serratospiculum* like egg has been found in ostrich faecal sample from ostrich farm of Nepal (Poudel 2012). *Dicheilonema spicularum* (Guinea worm) is a filarid nematode parasiting in the subperitoneal connective tissue (Jurajda 2002). *Struthiofilaria megalocephala* that affect body cavity of an ostrich and *Paronchocerca struthionis*, a filarid nematode is a parasite of the respiratory system recovered from the lungs of an ostrich in West Africa (Jurjda 2002). In the study conducted by Rickard et al. (1997), eggs have been found suggestive of *Paradeletrocephalus* and *Deletrocephalus* in faeces of emu. Another nematode *Ascaridia struthionis* has been reported from ostriches in Italy (Yamaguti 1961). *Ascaridia* sp. in North Eastern Nigeria (Ibrahim et al. 2006), in different state of Europe (Ponce Gordo et al. 2002), Rio Grande do Sul (Mattos et al. 2011) and in Nepal (Poudel 2012) and from emu (Teixeira 2013).

One of the host specific *Strogyloide* nematode of emu, i.e. *Dromaestrongylus* has been found in small intestine of emu (Foreyt 2005). Haemorrhagic tracheitis is caused by *Syngamus trachea* in emus. *Syngamus trachea* is transmitted by ingestion of its intermediate host with infectious larvae or eggs from the ground. The definitive hosts are gallinaceous and singing birds. Affected birds shake their heads and symptoms of dyspnoea are present (Jurajda 2002). This parasite of chickens, turkeys, game birds and various wild birds is worldwide distributed (Taylor et al. 2007). *Cyathostoma variegatum* affects trachea and bronchi of ducks and emus (Rickard et al. 1997, Nemejc and Lukesova 2012). It is a strongylid nematode 0.4-3 cm long. Females are larger than males. It has been reported to cause severe respiratory disease in young emus in Australia. A number of hosts may be involved in transmission. Filariid nematodes *Chandlerellla quiscali* were removed from the spinal cord and lateral ventricles of the brain of Emus (Stewart 1994, Foreyt 2005). This parasite is transmitted by Cullicoides midges, and viscera larval migration occurs before the bird reach one year of age. Generalized neurological signs accompany *Chandlerella* sp. infestation and diagnosis is made at necropsy (Tully and Shane 1996).

Trematode

Philophthalmus gralli is the only trematodes species described from ostrich, which has been found in the nictitating membrane of ostrich in Florida (Greve and Harrison 1980). It has been reported in cases of severe eye irritation and discharge in capitive ostriches in Florida (Kocan and Carawford 2007). An unidentified trematodes sp. has been found by Ponce Gordo, et al. (2002) in Europe. An adult fluke has been recovered from the liver of one of the birds of emu and has been identified as *F. hepatica (*Vaughan et al. 1997*,* Soares et al. 2007).

Ectoparasites of ostrich and emu

Several species of ectoparasites affect ratites of all ages, both ratite specific and non-specific parasites species. Lice and mites can be found by examining the skin and feathers, especially around the vent, legs, wings and neck (Dingle and Shanawany 1999). Birds infested with ectoparasites generally exhibit irritation and react by scratching.

Ostriches and emus have been found to be infested with different types of lice, mites, ticks and flies. These types of infestation may lead to infectious diseases in ostriches Feather lice (*Struthiolipeurus struthionis*) do not suck blood but feeds on the feathers, resulting in skin damage, pruritius and excessive feathers preening and losses in ostriches. They are narrow bodied lice with large heads (Taylor et al. 2007). The lice and eggs can be seen in feathers closed to the skin (Van Heerden et al. 1983, Jefferey 1996, Hoover et al. 1998, Jurjda 2002, Cooper 2005, Yaman and Durgut 2005, Cooper and EI Doumani 2006, Taylor et al. 2007). *Struthiolipeurus* eggs were deposited on feathers barbs on both sides along the shaft (Van Heerden et al. 1983, Deeming 1999). Other different types of lice may also have been found in ostrich including *Struthiolipeurus nandu, S. rheae* (Ponce Gordo et al. 2002, Yaman and Durgut 2005, Taylor et al. 2007, Almeida et al. 2008), *Struthiolipeurus stresemanni* (Yaman and Durgut 2005, Taylor et al. 2007) while *Dahlemhoria asymmentrica* is an emu louse (Taylor et al. 2007).

A number of ticks of various species (*Hyalomma* sp., *Ambylomma* sp., *Rhipicephalus* sp.) have been reported in ostriches their main significance being disease vectors (Jeffery 1996, Deeming 1999). High infestation is associated with areas of high rainfall and dense vegetation (Dingle and Shanawany 1999, Cooper 2005). *Riphicephalus* sp. has been reported from ostriches in Portuguse farms (Cortes et al. 1999).

Different species of mites have been found in ostriches. Ostrich quill mites or shaft mites or feather mites (*Gabucinia bicaudata*) live in the vein in the ventral groove of the feather shaft

and feeds on blood and gelatinous contents of the feather sheath. They can be visualized as small, reddish, dust like elongated particles in the feather vein (Jefferey 1996, Deeming 1999, Jurjda 2002, Ponce Gordo et al. 2002, Cooper 2005, Cooper and EI Doumani 2006, Taylor et al. 2007). Other mites that have reported in ostriches were *Gabucinia sculpturata* (Taylor et al. 2007), *Gabucinia* sp. (Poudel 2012), *Dermoglyphus pachyenemis* (Ponce Gordo et al. 2002, Poudel 2012) and *Struthiopterolichus bicaudatus* (Almeida et al. 2008). *Gabucinia sculpturata* is a mite which has been found in emu (Taylor et al. 2007). The Hippoboscid fly (*Struthiobosca struthionis*) have been discovered in these birds (Ormerod 1900, Jurjda 2002). Mosquitoes and blackflies (*Simulim* spp.) regularly feed on ostriches and emus and in addition to causing irritation they can also transmit a number of infectious diseases (Craig 1993). Some species of family of Cullicoides acts as a vector of *Plasmodium struthionis* and *Leucocytozoon struthionis* and mechanical transmitters of fowl pox virus or filariosis in ostriches and emus (Craig 1993, Deeming 1999, Mushi et al. 1999). These arthropod infestations cause blood loss, irritation and stress and transmit other parasites (Craig 1993). Infestations by lice, flies, mites and ticks can be treated by regular and through spraying with synthetic pyrethrin or by dosing or injecting with Ivermectin (Jeffery 2001) which prevent both ectoparasites and endoparsites. Most scientific publications and articles all over the world are devoted to ostriches but very few materials are focused on aspects of emu (Nemejc and Lukesova 2012).

3. MATERIALS AND METHODS

3.1 Study Area

The study was carried out at Ostrich Nepal Pvt. Ltd. which lies Gongoliya-22, Tilottama municipality, Rupendehi district, Lumbini zone, Nepal. Gongoliya is situated three km. east

from Madhaulia, Siddhartha highway. It has tropical climate, summer with a warm and winter with cool, dry and humid. The average temperature ranges from 25°C to 37°C.

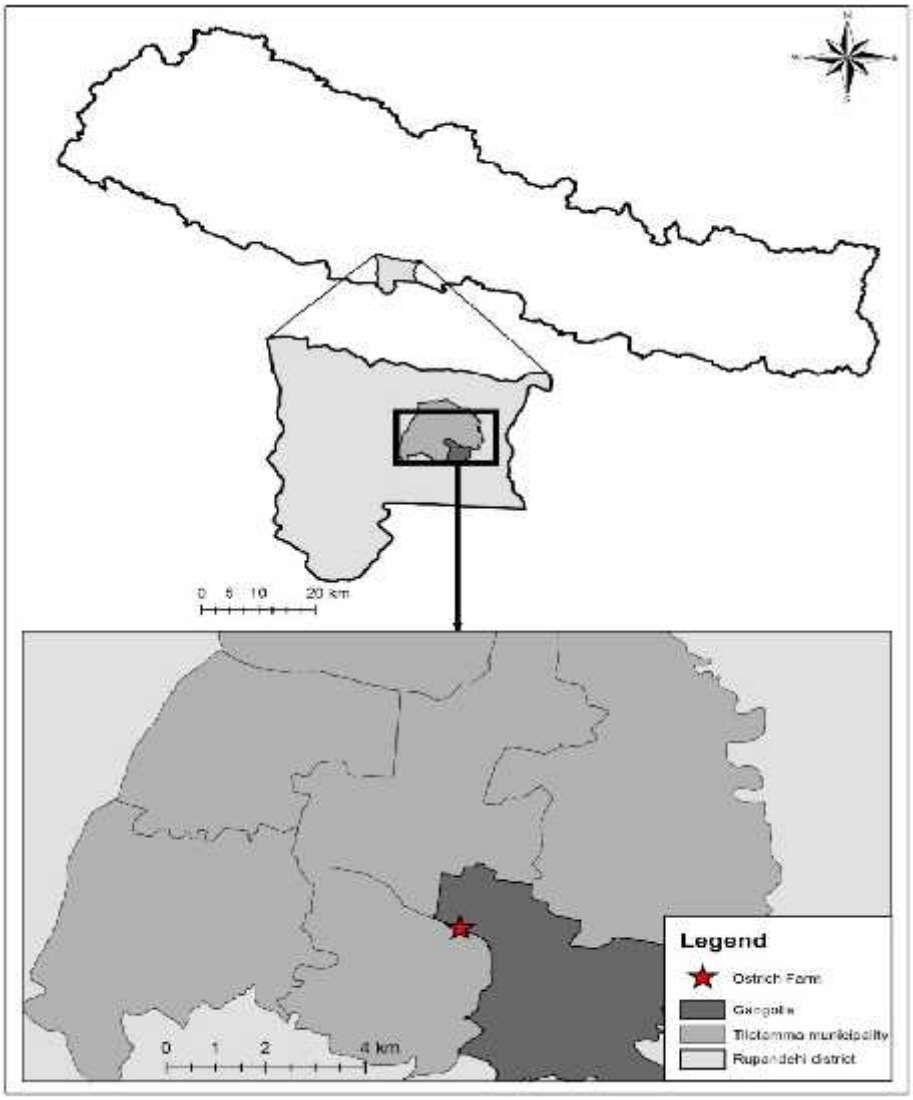

Fig:1 Map of Nepal including Gongoliya showing study area.

3.2 Materials

During the research the materials used have been listed below:

3.2.1 Materials for field

i. Sterile vial
ii Camera
iii. Polythen bag
iv. Globes

3.2.2 Materials for Laboratory

i. Beaker
ii. Gloves
iii. Volumetric flask
iv. Measuring cylinder
v. Centrifuge machine
vi. Cotton
vii. Stage micrometer
viii. Ocular micrometer
ix. Motor/Pestle
x. Slide
xi. Dropper
xii. Toothpick
xiii. Centrifuge tube
xiv. Electric microscope
xv. Mask
xvi. Glass rod
xvii. Cover slip
xviii. Tea strainer
xix. Niddle
xx. Electric balance
xxi. Refrigerator
xxii. Glass rod

3.3 Chemicals

Potassium dichromate ($K_2Cr_2O_7$)
Saturated Sodium chloride (NaCl) solution
Lugol's Iodine solution
Distilled water (D/W)
Methylene blue

3.4 Study Design

The present study was designed to assess the intestinal parasitic infection of ostrich and emu. The study was divided into following three phases to fulfill the objectives.

a. Faecal sample collection, preservation and examination for the identification of trophozoites and cysts of protozoa and eggs and larvae of helminthes parasites.
b. Questionnaire survey for assessment of the knowledge, attitude and practices (KAP) of labour working in the Ostrich Nepal Pvt. Ltd., Gongoliya, Rupendehi.
c. Questionnaire survey, observational study and secondary information collection to assess the management system of ostrich and emu farming in Ostrich Nepal Pvt. Ltd.

3.4.1 Faecal sample collection, preservation and examination.

Faecal sample collection

Fresh faecal samples were collected from ostrich and emu, using clean plastic bags by taking great care to collect only the fresh faeces of ground. All the faecal samples were collected during early morning in order to get good result and later transferred into clean, leak-proof sterile vials with 2.5% potassium dichromate. All the samples collected were labeled properly.

Preservation of samples

Collected faecal samples of ostrich and emu were preserved in 2.5% Potassium dichromate solution (5gm potassium dichromate powder dissolved in 200ml of distilled water) that help in maintaining the morphology of protozoan parasites, helminthic eggs and larvae.

Sample size

Altogether 200 sample were collected, 100 each from ostrich and emu. The samples were collected from Ostrich Nepal Pvt. Ltd., Gongoliya during months of May/July 2015. During the time period every 15 days interval, nearly 15-17 faecal samples each from ostrich and emu were collected.

These samples were transported to the laboratory of the Central Department of Zoology, Tribhuvan University, Kathmandu in preservatives and refrigerated and was conducted following techniques for the isolation and identification of eggs, cysts, trophozoites and oocysts present in faeces.

Microscopic Examination

The samples were examined at the laboratory of Central Department of Zoology, Tribhuwan University, Kirtipur by using concentration method (flotation and sedimentation) as follows:

Concentration method

Following floatation and sedimentation technique were applied for the detection of parasitic eggs, larvae, trophozoites and cysts (Poudel 2012, Teixeira 2013).

a. Differential Floatation Technique

Floatation involves suspending the specimen in a medium of greater density than that of the helminthes eggs and protozoans cysts. This technique ensures the egg float in the floatation liquid, which helps to identify the eggs (Poudel 2012).

Approximately 3 gm of faecal sample was taken in a beaker and added 20 ml of water then the sample was grinded lightly with the help of motor and pistle and filter the solution by tea strainer. The filtrate solution was poured into a centrifuge tube of 15 ml and centrifuged at 1000 rpm for 5 minutes. The tube's water was replaced with saturated sodium chloride solution and again centrifuged.

After centrifuge more saturated sodium chloride solution was added to develop convex surface at the top of the tube and one drop of methylene blue (to stained) where a cover slip can be placed for a few minutes and then cover slip was removed and placed on a slide and examined under microscope at 10X and 40X.

b. Differential Sedimentation Technique

Concentration of intestinal parasites by sedimentation techniques, using either gravity or centrifugation leads to a good recovery of cysts of protozoa and eggs of helminthes cysts (Poudel 2012).

Saturated salt solution was removed gently from the test tube after examined the flotation portion and poured the sediment content into the watch glass and stirred the content gently to mix it. One drop from the mixture was taken to prepare a second slide. The specimen was stained with iodine wet mounts solution.

In this way two slides were prepared from one sample (one from floation and one from sedimentation) were examined under 10X and 40X of microscope to detect eggs of helminthes and trophozoites or cyst of gastrointestinal protozoans.

c. Microphotography

The parasite, trophozoites eggs or cysts detected under microscope at 10X and 40X were photographed using microscopic camera for futher verification with published literature (Teixeira 2013).

3.4.2 Questionnaire survey to assess KAP towards ostrich and emu.

A questionnaire survey was conducted amongst 19 labours of Ostrich Nepal Pvt. Ltd. Details knowledge about the features of ostrich and emu, diseases prevalence in farm, veterinary facilities were included in the questionnaire. The questionnaire also contained about questions related to different attitude of labours and feeding, cleaning practices way of distribution eggs and cages.

3.4.3 Management system in the farm

Assessment of overall management system was carried out by using following methodology:

a. Questionnaire Survey

A pretested, semi structured questionnaire was used for data collection. A set of questionnaire survey was conducted amongst the major staffs and director of farm. The questionnaire includes about the management system of farm, hatchery facilities, uses of these bird and marketing condition.

b. Observational Study

Observational study was basically focused on:

i. Environmental conditions, hygiene and sanitation in an around the farm as well as waste management system.
ii. Feeding observation.
iii. Health management.

3.5 Data Analysis

The collected data were analyzed and summarized in table and percentages. The collected data was analysed by using Microsoft Excel- 2007 and SPSS version 21.

Some Photo Plates

Photo 1: Questioning with labour of farm

Photo 2: Questioning with staff of farm.

Photo 3: Stool of ostrich

Photo 4: Stool of emu

Photo 5: Collection of stool of ostrich

Photo 6: Collection of Stool of emu.

Photo 7: Sample preservation of ostrich.

Photo 8: Sample preservation of emu.

Lab work Photos:

Photo 9: Running the centrifuge mechaine

Photo 10: Microscopic observation of slide

4. RESULTS

4.1 Gatro-intestinal parasites of ostrich and emu

A total of 200 faecal samples, 100 each from ostrich and emu were collected and microscopically examined using direct smear and concentration methods. Overall proportion of parasitic burden revealed 82% and 65% in ostrich and emu respectively which is statistically significant (X^2=7.419, p=0.006) (fig-2).

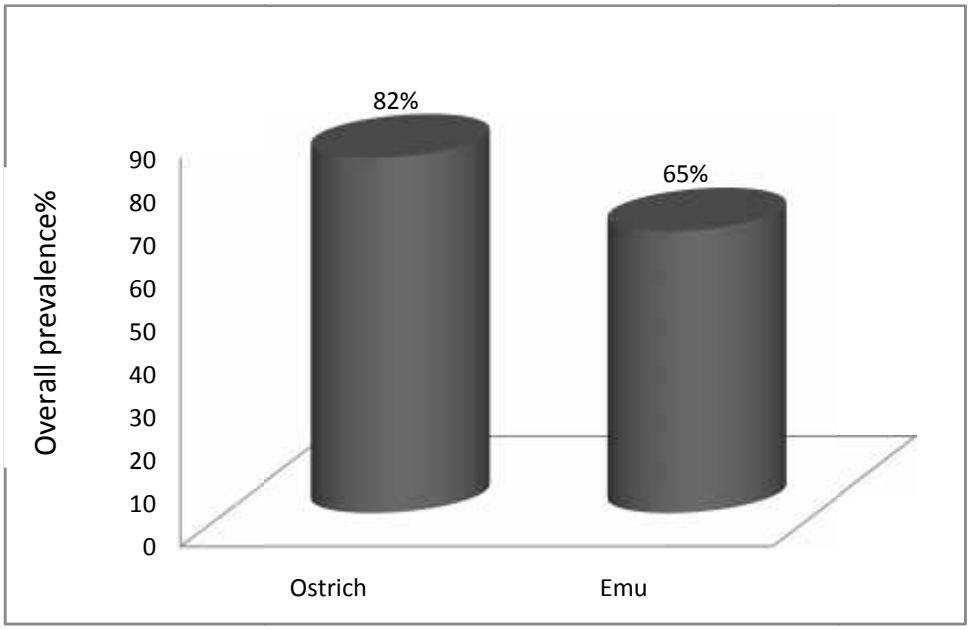

Fig: 2 Overall prevalence of gastro-intestinal parasites in ostrich and emu.

Comparasion of intestinal parasites of ostrich and emu revealed that, protozoan (65%) and nematode (54%) showed highest prevalence in ostrich as compared to emu. But cestode parasites showed comparatively higher prevalence rate in emu (14%) than in ostrich (10%). Association of protozoan (X^2=15.69, p=0.005) and nematode (X^2=13.98, p=0.005) parasites infection in ostrich and emu of Gongoliya ostrich farm show statistically significant association but association with cestode parasite is insignificant (fig-3).

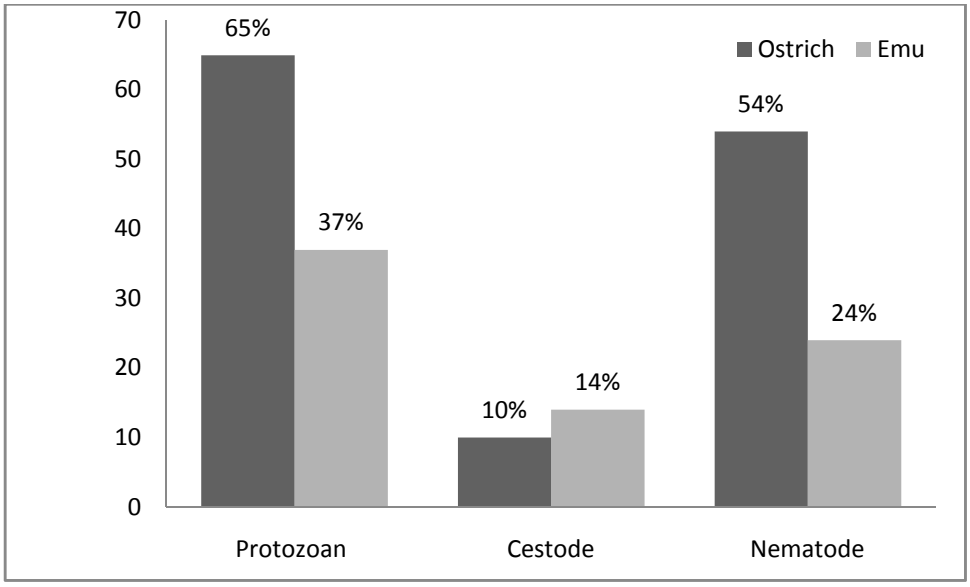

Fig: 3 Prevalence of intestional parasites in ostrich and emu.

Ostrich and emu were found to be infected with protozoan parasites particularly *Entamoeba* sp. as well as *Eimeria* sp. But the proportions of infection with these parasites were different. Ostrich were highly infected with *Entamoeba* sp. (X^2=35.066, p=0.000) while emu with *Eimeria* sp. (X^2=6.452, p=0.011) which is statistically significant. In addition ostrich were found to be infected with *Isospora* sp. as well as *Balantidium* sp. which were absent in case of emu.

Ostrich and emu were found to be infected with nematode parasites particularly *Ascaridia* sp. and *Heterakis* sp. But the proportion of infection with these parasites showed that ostrich were highly infected with both the parasites than emu. Species wise association showed that there is significant difference in proportion of *Ascaridia* (X^2=9.758, p=0.002). The host specific *Strongylus* sp. of ostrich *Libyostrongylus* sp. and emu specific *Dromaestrongylus* sp. was found almost equally infected. In addition, ostrich were found infected with *Codiostomum* sp. in the farm.

Similarly, both ostrich and emu were found infected with host specific cestode parasites. The result revealed, that 10% ostriches were found infected with Cestode i.e. *Houttuynia* sp. while emus where found infected with 9% and 5% of *Davainea* sp. and *Raillietina* sp. respectively (Table1).

During the faecal examintation some mite including *Gabucinia* sp. were also detected in ostrich and emu. The microphotograph of those mites were included in appendix (Appendix 2)

Table:1 Prevalence of gastrointestinal parasites in ostrich and emu.

1	Endoparasites	Prevalence in ostrich.	Prevalence in emu.	X^2-Value	P-Value
A.	**Protozoans**				
	a. Entamoeba sp.	48%	10%	35.066	0.000
	b. Eimeria sp.	15%	30%	6.452	0.011
	c. Isospora sp.	10%	0	10.526	0.001
	d. Balantidium sp.	4%	0	4.082	0.043
B.	**Cestodes**				
	a. Houttuynia sp.	10%	0		
	b. Davainea sp.	0	9%		
	c. Raillietina sp.	0	5%		
C.	**Nematodes**				
	a. Ascaridia sp.	34%	15%	9.758	0.002
	b. Libyostrongylus sp.	9%	0		
	c. Dromaestrongylus sp.	0	10%		
	d. Codiostomum sp.	11%	0	11.640	0.001
	e. Heterakis sp.	12%	5%	3.510	0.076

Single infection and double infection were almost similar in ostrich than multiple infection where as most of the samples were found of single infection in emu followed by double and multiple infection. While triple was only encountered in ostrich. More parasitic burden was observed in ostrich than in emu. The mixed infection in ostrich and emu is statistically significant (X^2=27.11, p=0.000) (fig-4).

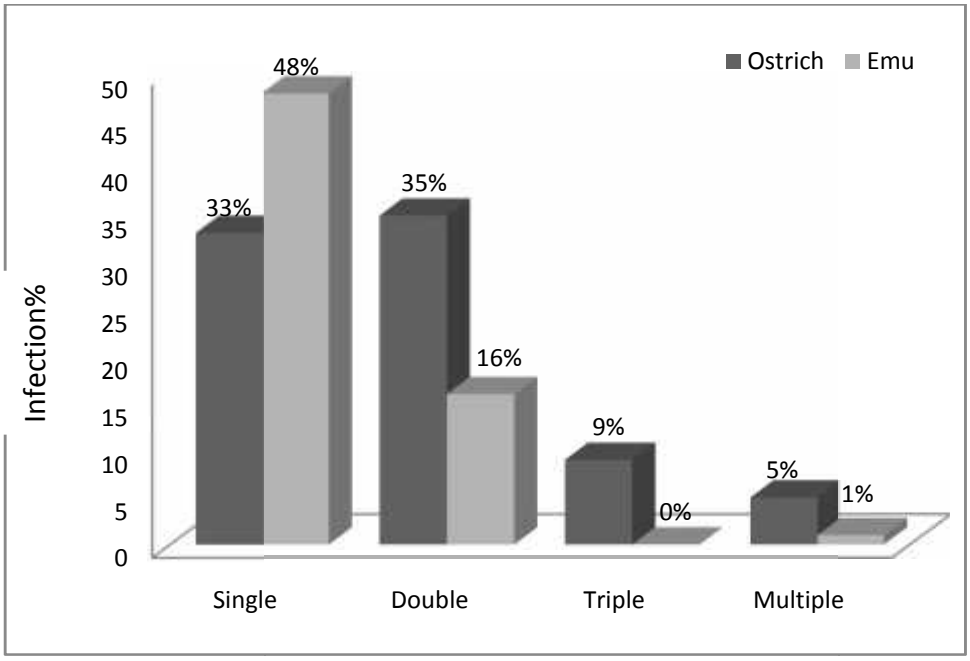

Fig: 4 Mixed Infections in ostrich and emu.

4.2 Assessment of knowledge, Attitude and Practice (KAP) of labour working in the Ostrich Nepal Pvt. Ltd. Gongoliya

The questionnaire survey was carried out among 19 labours working in the farm to assess their knowledge, attitude and practice using structured questionnaire.

Table: 2 Socio-demographic character of labour

Variables	**Characteristic (Range)**	**Proportion (N=19)**
Age group	Early adulthood(19-45 years old)	42.1%
	Midlife (46-60 years old)	52.6%
	Mature adulthood (60 above)	5.3%
Gender	Female	15.8%
	Male	84.2%
	Illitrate	5.3%
Education	Primary level (1-5 class)	26.3%
	Lower secondary level (1-8 class)	36.8%
	Secondary level (1-10 class)	31.6%
Work duration	2 and half years	63.2%
	4 and half years	5.3%
	Upto 7 years	31.6%

Among all the labours, majority (52.6%) belongs to Midlife followed by early adulthood (42.1%) and mature adulthood (5.3%). Gender wise distribution showed that (84.2%) of male were engaged in ostrich farm than female (15.8%). About, 5.3% labours were illiterate while rests all were literate. Maximum 63.2% labour were engaged from last two and half years followed by upto seven year (31.6%) and four and half years(5.3%) in overall care of the ostrich and emu.(Table2)

4.2.1 Knowledge of labour in relation to ostrich and emu farming

Most of the labours had knowledge about special features of ostrich and emu. Maximum (68.4%) of labours had knowledge about three features i.e. ostrich is largest and emu is second largest bird, ostrich has two toes while emu has three toes and both are flightless bird but 26.3% of labours had knowledge on more than three features thus added that they had small head, big eye, long neck and legs. Whereas, 5.3% had no knowledge about their features which was statistically insignificant with different age group and gender wise while significantly associated with level of education (X^2=24.596, p=0.005) and duration of work (X^2=12.23, p=0.016). Labours those who were literate and were working last two and half years had knowledge on special features of ostrich and emu (Table3).

Almost all labours 94.7% had knowledge on both similarity and dissimilarity between ostrich and emu. They put the view on similarity that both are flightless bird, both have small head, big eye, long neck and legs and in dissimilarity they said that ostrich has two toes while emu has three toes and ostrich is largest bird while emu is second largest bird in the world. The association was statistically insignificant with different age group and duration of work and was statistically significant with gender wise (X^2=5.630, p=0.018) and level of education (X^2=19.00, p=0.05). Mostly, male and those who are literate had knowledge about similarity and dissimilarity (Table3).

Most of labours had knowledge on their eggs. About 63.2% of labours have knowledge on two features thus, said that ostrich egg is white in colour and weight maximum 2.5kg and that of emu egg is green in colour and weight about 500gms. Likewise, 31.6% labour had more than two features. Futhermore, they said ostrich egg hatch within 42 days and emu egg hatch within 52 days. Also outer covering egg of both bird are used for decoration purpose. This association was found statistically significant with various level of education (X^2=19.724, p=0.003).

Ostrich farm of Gongoliya was found to be prevalence with diseases like Mycotoxicosis, Constipation, Diarrhoea and Colistodium. But only 11(57.9%) of labours had known few of these diseases. In the reasons of weight loss of these bird, 42.1% of labour thought is due to diseases where as 36.8% of labours told due to imbalance diet but 10.5% put their view on both the reasons and rest 10.5% where totally unknown about it(Table3).

Majority of labours, 73.7% told about the veterinary facilities given to the bird. According to them use of drugs, regular checkup are main facilities with a residential veterinarian.

Table 3 Knowledge of labour in relation to ostrich and emu farming

Knowledge related parameters	**Proportion (N=19)**	**Age P-value**	**Gender P-value**	**Education P-value**	**Work duration P-value**
Special features of ostrich and emu.					
a. Three features	68.4%				
b. More than three features	26.3%	0.520	0.43	**0.000**	**0.016**
c. Don't know	5.3%				
Similarity and dissimilarity.					
a. Having knowledge on both	94.7%	0.484	**0.018**	**0.000**	0.735
b. Don't know	5.3%				
Knowledge about their egg.					
a. Two features	63.2%				
b. More than two features		0.682	0.054	**0.003**	0.574
c. Don't know	31.6%				
	5.3%				
Diseases prevalence in farm.					
a. Two diseases	57.9%	0.622	0.348	0.081	0.195
b. Don't know	42.1%				
Reasons of weight loss.					
a. Diseases	42.1%				
b. Imbalance diet	36.8%				
c. Both	10.5%	0.68	0.530	0.103	0.067
d. Don't know	10.5%				
Veterinary facilities.					
a. Two facilities	73.7%				
c. Don't know	26.3%	0.096	0.084	0.360	0.771

4.2.2 Attitude of labour in relation to ostrich and emu farming.

Almost all the labours agreed that ostrich and emu can grow in different parts of Nepal. Most of labours thought that people will start consuming ostrich meat against chicken and other meat in the coming days. Some of them told ostrich meat is of cholesterol free, good for heart diseases patients and pregnant women. The association is statistically significant with gender (X^2=4.460, p=0.035). Maximum 73.7% of labours thought that ostrich and emu die in the farm were due to diseases while rests all were disagreed. About 36.8% of labours agreed that visitors carry various diseases dreadful to them. About, 26.3% of labours agreed that feed prepared for ostrich and emu might be contaminated with pathogenic sources (Table4).

Table: 4 Attitude of labour in relation to ostrich and emu farming.

Attitude related parameters	**Proportion (N=19)**	**Age P-value**	**Gender P-value**	**Education P-value**	**Work duration P-value**
Ostrich and emu can grow in different part of Nepal. a. Agree b. Disagree	100%				
People will start consuming ostrich meat against chicken and other meat. a. Agree b. Disagree	78.9% 21.1%	0.316	0.035	0.260	0.799
Ostrich and emu died in the farm were due to diseases. a. Agree b. Disagree	73.7% 26.3%	0.222	0.764	0.252	0.622
Visitors can carry various diseases dreadful to ostrich and emu. a. Agree b. Disagree	36.8% 63.2%	0.731	0.149	0.626	0.405
Feed prepared for ostrich and emu are decontaminated. a. Agree b. Disagree	73.7% 26.3%	0.161	0.764	0.889	0.774

4.2.3 Practice of labour in relation to ostrich and emu farming

Among 19 labours, those who were involved in feed preparation were found not wearing Apron, Gloves or Masks but in the slaughter house, labours were wearing Apron, mask, Cap and Gloves. It was noticed that, as the adult ostrich are dangerous so, the prepared food were taken in tracter and dropped in the yard for feeding. While for the emus since, food were carried in hand and dropped on ground as they loves ground picking. The farms provide single sources of water. Each water buckets were kept in the sides of cages so that water can be filled with pipes from outsides whenever necessary. In the breeding seasons ostrich start laying eggs from March to April while Emu start from December to January. Labours collect eggs laid by these birds. Then the eggs are separated. Well and full developed eggs are taken to hatchery room for hatching while those eggs whose weight is less than 12gm. and scratched eggs are sold. They told that full egg cost Rs.2000 and empty egg for decoration cost Rs.1000.

Occasionally, the bird dies in the farm in that case, maximum labours told that birds used to buried but some of them added that mature and fresh dead bird were buried only after skinning. After working in the farm labour found washing hand with soap and water.

Usually, the birds are shifted in different cages according to different criteria. In the farm there are total seven cages for ostrich and five cages for emu. Among these cages, in one cage Parent bird lying eggs of ostrich were kept but two cages for parent emu. Likewise, those ostriches which were ready for slaughters were kept in two cages while, for emu kept in only one cage. Those ostriches of Age group between one to five monthes were kept in three cages. Also emu of one to four monthes were arranged in two cages, while injured and sick birds of both ostrich and emu were also isolated from herd and kept in single cage.

4.3 Management practices of ostrich and emu farming in Gongoliya, Rupendehi

The questionnaire survey was carried out among staffs involved in management system similarly; observation was made in and around ostrich farm regarding management practice in ostrich and emu farming.

According to the management team, it was known that at present there are about 3500 ostriches and 1500 emus. Ostrich and emu have been managed at 22 bighas (around 13.54

hectares) area of land in seven cages of ostriches (each cage contain 200-300 ostriches) and five cages of emus (each cage contain 200-300) including farm office and housing. Height of each cage was managed above five feet. Ostriches and emus in the farm were kept for commericial purposes but it is not highly commercialized yet. Both ostriches and emus were provided with premix based compounded foods once a day in morning. Woven wires and poles were used as fencing materials. Colony configuration of breeding was practiced in the farm as a means of Reproductive practices. At present, near about 500 visitors comes to visit this farm in a day. The visitors in the farm were first sprayed with virgon before entering in the farm as decontaminants. Feeding and teasing for the birds are strictly prohibited in the farm by visitors. Besides, ostirch and emu farming, Kangaooes as well as fish farming have also been pacticed these days.

There is hatchery facility of these birds within the farm. Before, transporting eggs to hatchery ward, all the selected eggs were first cleaned by virgon with water of 42°C temperature. Then, was stored in AC room at 16 °C - 18 °C temperature for one week with 75-80% relative humidity (RH). After that eggs are transfer to incubator and incubate at 36 degree centgrate with 28-34% RH. After 15 days, eggs are scanned to see wheather it is fertilized or not if not then they are sold otherwise go on futher procedure. Once again within 35 days it was scanned to see development of chicks. It takes about 42 and 52 days for hatching ostrich and emu eggs respectively. Hatched chicks are then, transfor to next room with specific feed prepared for them.

In the farm, ivermectin antihelminthes drugs is given every interval of six months for deworming. No any diagnosed have been made for the treatment of disease. It was also found that no faecal examination was done till date for the diagnosed and treatment of parasitic diseases.

According to the staffs, hygiene and sanitation of ostrich and emu were mentioned by removing dropping regularly for chicks while in case of large birds dropping generally not removed. This might enhance the infection for disease transmission among birds. But according to them, eggs of these birds were not found infected with any disease. Ostrich were rared for their meat, skin leather, feather and eggs for decoration purpose. Likewise, emu were mainly rared for their meat, fat and egg for decoration purpose. There was high demand of their meat in the market. It has been known that ostrich meat with bone cost Rs.1000, without bone Rs.1700 and of emu meat cost Rs.990. It is being exported in Kathmandu,

Pokhara, Narayanghat and Butwal but was not able to fulfill the demand in the western part of country. Also not exported in international context.

4.3.1 Feeds supplement for ostriches and emus:

In wild state, ostriches mainly feed on seeds, grains, shrubs, grass, fruits and flowers; occasionally they also feed on insects such as locusts, worms, rodents, frog, lizards and field mice available in their harsh habitat. While emu eat fruits, seeds, growing shoots of plants, insects, other small animals and animal droppings but in wild condition they don't eat dry grasses or mature leaves even if they are available. In the captive state they were provided with premix based compounded foods which include grasses, wheat, maize, soyameals, vitamins and minerals and others (Table-5). But grasses are not given for emu as a food (Table-6).

Table: 5 Composition of feeds given to ostriches in the farm.

Composition of feeds	**Percentage**
Grass	50%
Wheat	12%
Maize	18%
Soyameal	17%
Vitamins and minerals	1%
Others (oil, NaCl, refined sugarcane juice)	2%

Table: 6 Composition of feeds given to emus in the farm.

Composition of feeds	**Percentage**
Wheat	32%
Maize	38%
Soyameal	27%
Vitamins and minerals	1%
Others (oil, NaCl, refined sugarcane juice)	2%

Extra vitamins and minerals were provided to Ostriches and Emus along with the foods. A deficiency of vitamin E and/or selenium causes the degeneration of the muscles, also reffered to as 'white muscles diseases'. The lack of calcium or phosphorus in the ration can lead to the development of soft bones leading to frequent and multiple fractures. Ostriches and emus fed on grain rations without vitamin supplement can develop vitamins B deficiencies, mainly affecting the skin of head. So, in the farm vitamins and minerals were added in the feed according to the schedule prepared by Pro Bio-Tech Industries Pvt. Ltd. in order to overcome the nutrients deficiencies in ostriches and emus and table included in appendix (Appendix 2).

Photos of Parasites of ostrich.

Cysts, Oocysts and Trohozoite of Protozoan Parasites:

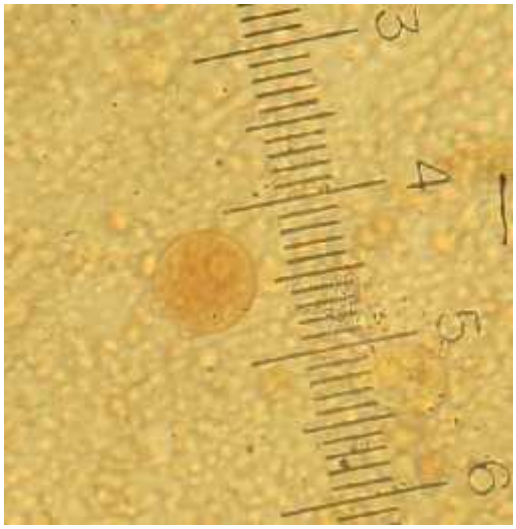

Photo 11: *Entamoeba* sp. *(40X)*

Photo 12:*Eimeria* sp. (40X)

Photo 13: *Isospora* sp. (40X)

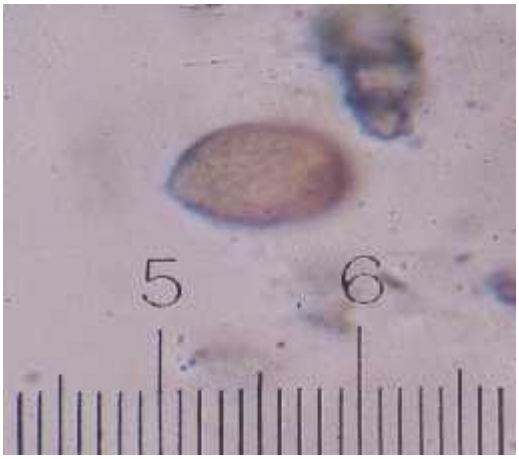

Photo 14: *Balantidium* sp. (40X)

Cestode Parasites:

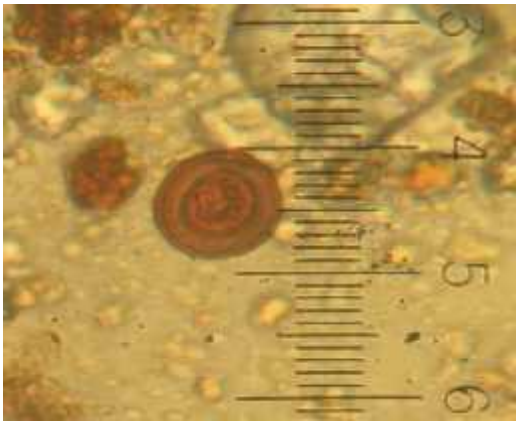

Photo 15: *Houttuynia* sp. *(40X)*

Nematode Parasites:

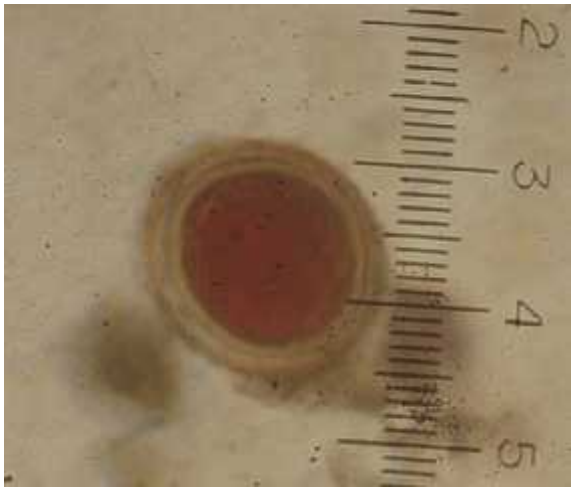

Photo 16: *Ascaridia* sp. (40X)

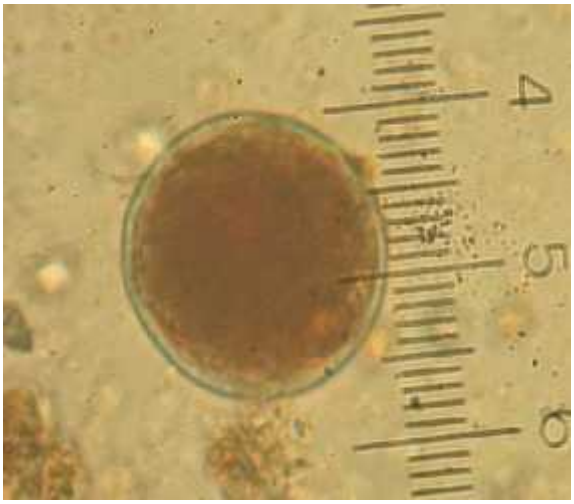

Photo 17: *Codiostomum* sp. (40X)

Photo 18: *Libyostrongylus* sp. *(40X)*

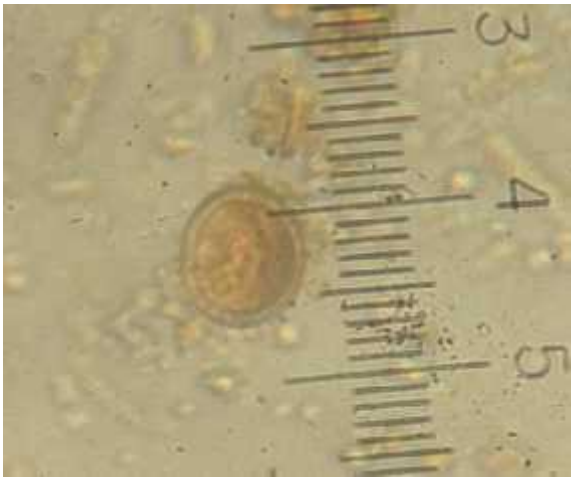

Photo 19: *Heterakis* sp. (40X)

Photos of Parasites of emu.

Protozoan Parasites:

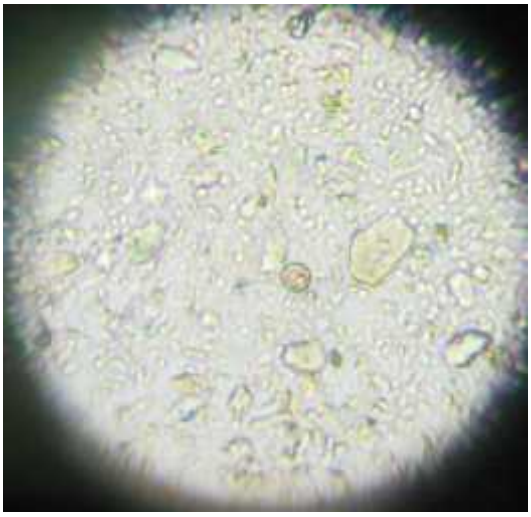

Photo 20: *Entamoeba* sp. (10X)

Photo 21: *Eimeria* sp. (10X)

Eggs of Cestode Parasites:

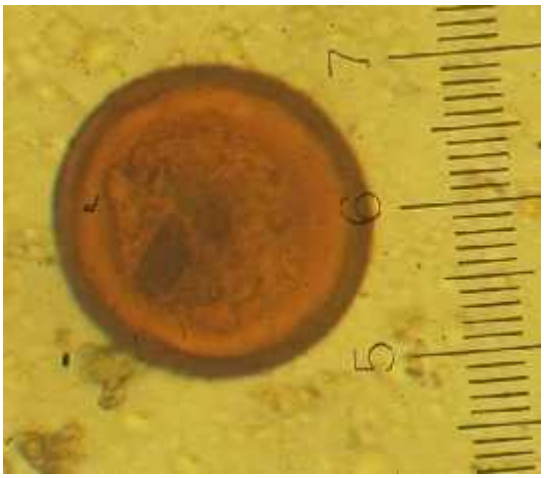

Photo 22: *Davainea* sp. (40X)

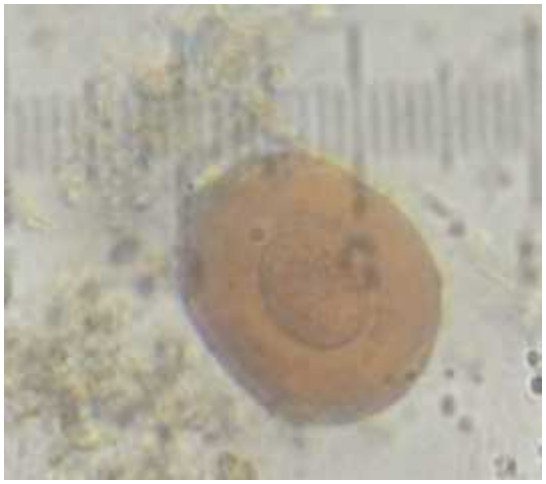

Photo 23: *Raillietina* sp. (40X)

Eggs of Nematode Parasites:

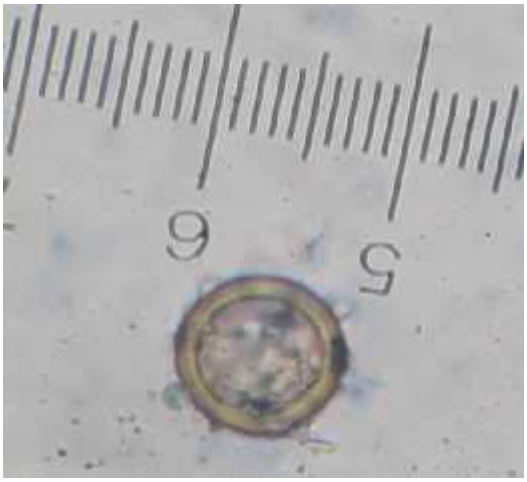

Photo 24: *Ascridia* sp. (40X)

Photo 25: *Dromeostrongylus* sp. (40X)

Photo 26: *Heterakis* sp. (40X)

5. DISCUSSION

The present study revealed the high prevalence of gastrointestinal parasites in ostrich and emu. The samples of both ostrich and emu were found to be positive either for protozoan or helminths. The overall prevalence of endoparasites of ostriches and emus were 82% and 65% respectively which was lowered as compared to the prevalence rates of 100%, 92.85% and 88% obtained by the previous studies Bonadiman et al. (2006), Fagundes et al. (2012) and Ibirahm et al. (2006) respectively. But in case of ostrich in present study was higher than 78.8% obtained by Sotiraki et al. (2001) and lowered than 86.96% obtained by Poudel (2012) in Nepal. The prevalence of gastrointestinal parasites is high in places where the condition of life and basic sanitation are unsatisfactory (Teixeira 2013). Both protozoa and helminthes parasites are transmitted by mainly contaminated water or food while other helminthes genus *strongyloides* are transmitted by larvae present in the soil through skin penetration (Neves 2005).

Cryptosporidium sp. has been reported in ostrich from Canada (Gajadhar 1993), Greece (Sotiraki et al. 2001), Spain, Protugal, Netherland, Belgium, Britain, France (Ponce Gordo et al. 2002). Two species of *Cryptosporidium* sp. have been reported from ostriches (Sotiraki et al. 2001, Santos et al. 2005, Nemejc and Lukesova 2012). Both ostrich and emu in Ostrich Nepal Pvt. Ltd. at Gongoliya, Rupendehi were negative for this parasite. *Isospora struthionis* is only one species of *Isospora* sp. described from an ostrich at a Russian Zoo (Yakimoff 1940). *Isospora* sp. have been reported from ostrich (Jansson and Christensson 2000, Ponce Gordo et al. 2002, Mattos et al. 2011) and oocyst of *Eimeria* sp. have also been reported in ostrich from Negeria (Ibrahim et al. 2006; Mshelia et al. 2010), Iran (Eslami et al. 2007), Czech Republic (Nemejc and Lukesova 2012), Botswana (Mushi et al. 2003), North America (Wade 1992) in different state of Europe (Ponce Gordo et al. 2002). Likewise, both *Isospora* sp. and *Eimeria* sp. have been reported in emu (Papini et al. 2011, Teixeira 2013). In the present study, 15% of *Eimeria* sp. and 10% of *Isospora* sp. from ostrich and 30% of *Eimeria* sp. from emu were isolated from faecal examintation. The prevalence rate of present study of *Eimeria* sp. was less than the prevalence rate (43.8%) as obtained by Mshelia et al. (2010). But the prevalence of both *Eimeria* sp. and *Isospora* sp. of ostrich and *Eimeria* sp. of emu were higher than the prevalence rate of *Eimeria* sp. (7.61%) and *Isospora* sp. (3.26%) as obtained by Poudel (2012).

Histomonas sp. has been reported in ostrich (Deeming 1999, Ponce Gordo et al. 2002). Ratites have been found susceptible with *Giardia* sp. (Ponce Gordo et al. 2002, Foreyt 2005). There are many reports of trophozoits and cysts of *Giardia* sp. in ostrich (Wade 1992, Greinger and Gitchie 1994, Stewart 1994, Huchzermeyer 1999) and in emu (Teixeira 2013). In Nepal, 1.09% *Histomonas* sp. was reported by Poudel (2012) but these parasite were negative in present study.

The prevalence rate (80%) obtained by Ponce Gordo et al. 2002 was much higher than the present study (4%). This prevalence rate was also less than the prevalence rate 60% and 5.43% as obtained by Ederli and Oliveira (2008) and Poudel (2012) respectively. *Entamoeba* sp. have been reported from ostrich in Spain, Portugal, Belgium, France, Great Britain, Netherlands (Ponce Gordo et al. 2002), Greece (Sotiraki et al. 2001), Scotland (Pennycott and Patterson 2001), Sweden (Jansson and Christensson 2000) and cysts and trophozoites of *Entamoeba* sp. have also been discovered in emu (Teixeira 2013). The prevalence rate of *Entamoeba* sp. (48%) in ostrich and 10% in emu at present study of Gongoliya was less than the prevalence rate (50.6%) at same place obtained by Poudel (2012). The present study was also less than the prevalence rate (90%) obtained by Ponce Gordo et al. (2002). Other types of amoeba *Endolimex* and *Iodamoeba* have also been found in ostrich (Sotiraki et al. 2001, Ponce Gordo et al. 2002).

The present study was positive for both *Houttuynia* sp. and *Davainea* sp.parasites. The prevalence rate 10% of *Houttuynia struthionis* from ostrich was higher than the prevalence rate (4.35%) as obtained by the unidentified cestode cysts by Poudel (2012). Prevalence rate (9%) of *Davainea* sp. was isolated from emu in this study. Different types of *Raillietina* sp. i. e. *Raillietina beveridgei, R. chiltoni, R. dromaius* and *R. mitchelli* have been discovered earlier (O'Calleghan et al. 2003). The prevalence rate (5%) of *Raillietina* sp. was discovered from emu in the present study.

Libyostrongylus sp. with prevalence rate 9% was isolated in the present study but no adult worms were recovered. The prevalence of *Libyostrobgylus* sp. in the present study was less than the prevalence rate of previous studies obtained by Sotirako et al. (2001) (43.45%), Ponce Gordo et al. (2002) (20%), Eslami et al. (2005) (40%), Ibhrahim et al. (2006) (100%), De Andra et al. (2011) (61-97%) and Poudel (2012) (14.13%). Egg and larva of *Strongyloide* have been diagnosed in emu (Teixeira 2013). *Dromaestrongylus* sp. with prevalence rate (10%) was isolated in present study in emu but no adult worms and larvae were recovered.

Codiostomum struthionis nematode parasites have been found in ostrich which is slightly large roundworm that inhabits in the large intestine and caeca of ostriches (Huchzermeyer 1994, Deeming 1999, Dingle and Shanawany 1999, Juarjda 2002, Blood et al. 2007, Ederli et al. 2008). It is relatively harmless (Huchzermeyer 1994) but heavy infections are likely to be dangerous (Jurajda 2002, Blood et al. 2007). This parasite has been isolated from Spain and Great Britian (Ponce Gordo et al. 2002), Sweden (Jansson and Christensson 2000), Greece (Sotiraki et al. 2001), Rio Grande do Sul (Mattos et al. 2011), Brazil (Oliveria et al. 2009, Fagundes et al. 2012), Czech Republica (Nemejc and Lukesova 2012). The prevalence rate of *Codiostomum* sp. in the present study was found to be 11% which was higher than as obtained by Ponce Gordo et al. (2002) (less than one) and Poudel (2012) (6.52%) but less than as obtained by Fagundes et al. (2012) (56%). This parasite was negative for emu in present study.

Another nematode *Capillaria* sp. have been recorded in faecal sample of ostrich in North East Nigeria (Ibrahim et al. 2006), different states of Europe (Ponce Gordo et al. 2002) and Rio Grande do Sul (Mattos et al. 2011) and Jansson and Christensson (2000) found Capillaria spp. in emu faecal sample. This parasite was negative for both the faecal sample of ostrich and emu in present study.

Likewise, nematode *Ascaridia struthionis* has been reported from ostrich in Italy (Yamaguti 1961), *Ascaridia* sp. in North East Nigeria (Ibrahim et al. 2006), different states of Europe (Ponce Gordo et al. 2002) and Rio Grande do Sul (Mattos et al. 2011) and in Nepal (Poudel 2012) and from emu (Teixeira 2013). The prevalence rate in present study was found to be 34% in ostrich and 15% in emu. The prevalence rate of both ostrich and emu was higher as compared to previous finding (Ibrahim et al. 2006 and Ponce Gordo et al. 2002) whose prevalence rate was less than one. But present study was seems to be less prevalence with the prevalence rate (43.48%) of Poudel (2012). *Serratospiculum* egg like nematode has been isolated by Poudel (2012), which was negative in present study. *Heterakis dispar* is nematode common in poultry has also recorded from ostrich in Iran (Eslami et al. 2007) and Rio Grande do Sul (Mattos et al. 2011). This species was absent in the study of Poudel (2012) but prevalence rates with 12% and 15%was positive in ostrich and emu respectively. This might be due to contact with the wild birds. It is quite similar with *Ascaridia* sp.

The only trematode *Philophthalmus gralli* has been described from ostrich, which was found in the nictitating membrane of ostrich in Florida (Greve and Harrison 1980). An unidentified

trematode spp. has been found by Ponce Gordo et al. (2002). This parasite was not found in the present study. An adult fluke of *Fasciola hepatica* has been recovered from emu (Vaughan et al. 1997, Soares et al. 2007). But in the present study none of them harbour trematode parasites.

The mites found during faecal examination were probably due to contamination of feather mites and quill mites during defecation. Feather mites and quill mites are discovered in ostrich (Jurjda 2002, Cooper and EI Doumani 2006, Taylor et al. 2007and some in emu (Taylor et al. 2007).

As compared to the previous study carried out in same place ostrich Nepal Pvt. Ltd. Gongoliya in 2012 (Poudel 2012), the parasitic prevalence showed not much remarakable difference. Prevalance of coccidian parasite showed almost 2-3 fold increase. Similarly Codiostomum nematode parasite also showed 2 fold increases. While rest of the common parasitic prevalence showed almost similar. The reason behind the highly prevalence of these parasites could be due to poor management system of the birds and also could be the ineffective use of anthelminthic. During the study it was found that ivermectin drug has been used as antihelmintic mixing in their feed in every interval of six months. The drug could be ineffective against the coccidian parasites.

This crossectional study was conducted to determine KAP of labours working in the Gongoliya ostrich and emu farm. Among all the labours, about half of labours were from midlife and most of them were male. From the survey study, it was found that most of the labours were literate and more than half of them were engaged from two and half years.

More than half of the labours have knowledge about three features of ostrich and emu. There is statistically, significant association with various level of education and duration of work ($P<0.005$) compared to age and sex group of labours. Those who were literate and were working last two and half years had knowledge on special features of ostrich and emu. Likewise, most of them had knowledge on both similarity and dissimilarity between ostrich and emu which is statistically significant between gender wise and different level of education ($P<0.005$). Similarly, about the knowledge of their eggs, most of them had idea on it which showed statistically significant with various level of education ($P<0.005$). Almost half of labours have idea about common diseases of ostriches and emus in the farm of Gongoliya. Since, ostrich and emu can grow in various climatic conditions (Warale et al.

2014). Such types of climatic conditions can be found in Nepal. So, all the labours were agreed that these birds can grow in Nepal.

Fatiregun and Saani (2008) in Neigeria reported that wearing of personal protective equipment was not a routine practices among the workers of poultry farm. According to Fatiregun and Saani (2008) only 11.4% always used face masks, gloves (10.7%) and boots (16.7%). The result concluded that, 100% of labours were not found wearing Apron, Gloves and masks while in slaughter house 100% of labours were using apron, gloves, cap and masks. The food prepared for ostrich were taken in tracter and dropped in yard and for emu taken in hand dropped on ground in the morning. Water is provided whenever necessary. Many author reported that higher consumption of feed was found during the early hours of day or in morning (Sambraus 1994, Mckeegan and Deeming 1997). They drank water more in afternoon (Ahmed and Salih 2012). The study conducted by Sultana et al. (2012) showed that much less of workers told that dead poultry were buried under the soil while all the labours of Gongoliya put their view that all the dead birds were buried.

Ostrich and emu production in Nepal is still in its nascent stage, but development process is going on day by day. Various scientific researches are needed on the management system of ratite in order to enrich the farming system and overall economy of country.

In 2012 there have been found 890 ostriches and 200 emus managed in 20 bighas but in 2015 there were 3500 ostriches and 1500 emus managed in seven cages for ostriches and five cages for emus within 22 bighas land areas. In between there years it was noticed that number of ostrich and emu have been increased drastically. It could be possible because at the first they have imported eggs and chicks of both birds from Australia but now they have been producing eggs and introduced hatching facilities in the farm. Thus, able to produced large number of birds. Recently, along with ostrich and emu they have been keeping some kangaroos and fish farming as a extra livestocks in the farm of Gongoliya. Even though practiced of keeping ostrich with other animals favours the predeposition of the birds to cross transmission of diseases (Moreki et al. 2011).

In Neigeria, 29% of farm used Ivermectin and Fenbendazole as anthelmintic drugs (Meshelia et al. 2011). The present result showed that the Ivermectin drug has been used to treat for both ecto and endoparasites. Currently, they have been producing bird upto the age of slaughtering and exporting meat to different part of Nepal. It has known that the ostrich meat

with bone and without bone cost Rs. 1000 and Rs. 1700 respectively and of emu cost Rs. 990. The farm in Gongoliya has provided premix based compound food with sole grass and cereal bran for ostrich and only premix based compound food with cereal bran for emu. Extra vitamins and minerals have also supplied along with the feeds in order to overcome the nutrients deficiencies in both Ostrich and Emu. Calcium and Phosphorus are important minerals in bone formation as well as egg shell formation (Moreki et al. 2012).

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The overall prevalence of gastrointestional parasites of ostrich and emu were found to be 83% and 65% respectively. Protozoan (65%) and nematode (54%) showed high prevalence in ostrich than emu while cestode prevalence was found high in emu (14%) than in ostrich (10%). Four genera of protozoan parasites were identified infecting ostrich among them *Entamoeba* sp. (48%) showed the highest prevalence followed by *Eimeria* sp. (15%), *Isospora* sp. (10%) and *Balantidium* sp. (4%) and two genera were encountered in emu in which *Eimeria* sp. (30%) was highly prevalence than *Entamoeba* sp. (10%). In case of helminthes parasites cestode and nematode parasites where encountered. Among cestode, ostrich and emu were infected with their own host specific parasites. Ostrich was infected with *Houttyunia* sp. (10%). and emu were found infected with *Davainea* sp. (9%) and *Raillietina* sp. (5%). Four different genera of nematode were observed in ostrich in which Ascaridia (34%) was highly prevalent followed by *Heterakis* sp. (12%), *Codiostomum* sp. (11%) and *Libyostrongylus* sp. (9%). In emu three genera of nematode were revealed. *Ascaridia* sp. (15%) showed higher prevalence followed by *Dromaestrongylus* sp. (10%) and *Heterakis* sp. (5%). Single (33%) and double (35%) infections were almost similar in ostrich than multiple (5%) infection where as most of the samples were found of single (4%) infection in emu followed by double (16%) and multiple (1%) infection while triple (9%) was only encountered in ostrich. More parasitic burden was observed in ostrich than in emu. Parasitic wise association between ostrich and emu was found to be significant for *Entamoeba* sp., *Eimeria* sp. and *Ascaridia* sp.

A questionnaire surveys with 19 labours were conducted to assess their knowledge, attitude and practice. Majority of them had knowedge on feather, similarity and dissimilarity and idea about their eggs of ostrich and emu. They were found wearing protective equipment during slaughtering birds but not during making feeds for them and 100% were agreed that farm can grow in Nepal. The health practices, hygiene and sanitation adopted in Ostrich farming were not much satisfactory. This can lead to the high prevalence of endoparasites. Therefore, effective antihelminthes medication and management strategy should be conducted in order to upgrade the health status and hence to maximize the benefit from Ostrich farming.

6.2 Recommendations

On the basis of conclusion following recommendations have been made to reduce the risk of gastrointestinal parasites in the farm and to enrich the economy.

a. Overcrowing of birds should be checked in different cages and sick and injured ostrich and emu also must kept in their own separate cages.
b. Dropping must be removed from the cages regularly and Deworming must be done in regular interval for theeffective control of endoparasites.
c. Faecal examination must be done to determine actual parasitic infections in birds.
d. Labours should encourage wearing personal protective equipments.

7. REFRENCES

AAFC. 1999. Snapshot of the Canadian Ostrich, Emu and Rhea Industries. Agriculture and Agri-Food Canada, Ottawa, Ontario.

Adams, J. and Revell, B.J. 2011. Ostrich Farming:- A Review and Feasibility study of opportunities in the Eu. http://www.macaulay.ac.uk. accessed on 11 January 2016.

Ahmed, F.A.M. and Salih, R.R.M. 2012. Some behavioral Traits of Red Neck Ostrich Under Captive Conditions. Veterinary Science and Techonology **3**(2): 117.

Aichinger, A., Martins, N.R., Souza, J.D., Resende, J.S., Muniz, R., Ferreira, W.M. 2007. O avestruz no Brasil e no mundo. Rev Vet Zootec Minas **27**(1): 36-39.

Akoha, A. 1980. An outbreak of Pasteurellosis in Akano zoo. Journal of Wildlife Diseases **16**: 3-5.

Alden, P.A., Estes, R.D., Schlitter, D. and Mc Bride, B. 1996. African Birds. In Collins Guide to African Wild Life, Harper Collins Publisher, London: 638-663.

Alison. 2012. Autrucherie Du Pont D'Amour Ostrich farm, Dinant Belgium. http://www.cheeseweb.eu. accessed on18 December, 2015.

Allwright, D.M., Burger, W.P., Gayer, A. and Wessels, J. 1994. Avian pox in ostriches. Journal of the South African Veterinary Association **65**: 23-25

Almeida, M.A., Duarte, L.F., Rocha, J.S., Silva, M.S., Guimaraes, J.E. and Ayres, M.C. 2008. Occurrence of Ectoparasites in Ostriches (*Struthio camelus*) reared in Semiarid region of Bahia. Revista Brasileira Veterinary Parasitology **17**(3): 155-157.

Amnon I., Shkoda I., Lapin E., Raibstein I., Rosenbluth E., Neggi S. et al. 2011. Isolation and Identification of Highly pathogenic Avain influenza Virus Subtypes H5N1 from Emus from the Ein Gedi Oasis by the Dead sea. Avian Diseases **55**(3): 499-502.

Animal Corner 2013. Ostrich at animal corner. http://www.animalcorner.co.uk. accessed on 15 November 2015.

APL 1997. National Residue Survey (Ratite Slaughter). Australian Parliamentary Library Bills Digest **154**: 1996–1997.

Arne, P., Thierry, S., Wang, D., Deville, M., Le Loch, G., Desoutter, A., et al. 2011. Aspergillus Fumigatus in Poultry. International Journal of Microbiology **2011**(2011): 1-14. Doi: 10.1155/2011/746356.

Araghi, M., Ghaniei, A. and Heidari, T. 2014. Aspergillosis Outbreaks in Ostrich Flocks of Eastern Iran during 2010-2012. Bulgarian Journal of Veterinary Medicine **17**(4): 325-330.

Ayers, J.R., Lester, T.L. and Angulo, A.B. 1994. An epizootic attributable to Western Equine Encephalitis virus infection in emus in Texas. American veterinary medical Association **205**: 600-601.

Barton, N.J. and Seward, D.A. 1993. Detection of *libyosttrongylus douglassii* in Ostriches in Australia. Australia Veterinary Journal **70**: 31-32.

Bennett, G.F., Huchzermeyer, F.W., Burger, W.P. and Earle, R.A. 1992. The Leucocytozoidae of South African birds. Redescription of *Leucocytozoon struthionis* Walder, 1912. Ostrich **63**: 83-85.

Bertram, B.C.R. 1992. The Ostrich Communal Nesting System. Princeton University Press, Princeton, New Jersey.

Birdlife International 2012a. *Struthio camelus*. IUCN Red List of Threatened Species. Version 2013.2. International Union for Conservation of Nature. accessed 17 November 2015.

Birdlife International 2012b. *Dromaius novaehollandiae*. IUCN Red List of Threatened Species. Version 2013.2. International Union for Conservation of Nature. accessed on 17 November 2015.

Blood, D.C., Studdert, V.P. and Gay, C.C. 2007. Saunders Comprehensive Veterinary Dictionary 3rd ed. Saunders Ltd., Philadelphia, 2172 p.

Bodger, J. and Goulding, B. 2003. Distribution of meat products from prospective Australian animal industries: Crocodiles, emus, game birds, rabbits, hares and snails, RIRDC Publication, Rural Industries Research and Development Corporation, Canberra.

Bonadiman, S.F., Ederli, N.B., Soares, A.K.P., de Moraes Neto, A.H.A., Santos, C.P. and Da Matta, R.A. 2006. Occurrence of *Libyostrongylus* sp. (Nematode) in Ostriches (*Struthio camelus* Linnaeus, 1758) from the North Region of the Rio de Janeiro, Brazil. Veterinary Parasitology **137**(1-2): 175-179.

Brown, T., Jordan, F.T. and Wood, A.M. 2008. Fungal diseases. In: Poultry Diseases. 6th ed. Saunders Elsevier, p. 428.

Capau, I., Gough, R.E., Scaramozzino, P., Lelli, R. and Gatti, A. 1994. Isolation of an adenovirus from an Ostrich (*Struthio camelus*) causing pancreatitis in experimentally infected guinea fowl (*Numida meleagris).* Avian Diseases **38**(3): 642-646.

Capua, I., Mutinelli, F., Bozza, M.A., Terrogino, C., Cactali, G. 2000. Highly pathogenic avian influenza (H7N1) in Ostriches (*Struthio camelus*). Avian Pathology **29**: 643–646. Doi: 10.1080/03079450020016913.

Carbajo, E. 2006. Ostrich Production to Mature. World Poultry **22**(8): 24-26.

Chakravarty, I. 1976. A case history of mycotic infection (aspergillosis) in an emu (*Dromaius novaehollandae*) in Delhi zoo. Indian. Veterinary Journal **53**: 881-882.

Chang Reissig, E., Olaechea, F. and Robles, C.A. 2001. Parasitological findings of Lesser Rhea (*Pterocnemia pennata*) in Faeces from Northern Patagonia, Argentina. Archivos de Medicine Veterinaria **33**: 247-251.

Chin, R.P. and Woolcock, P. 1994. Identification of Birnavirus-like particles from the intestines of 8-week-old ostriches. In Proceeding Western Poultry Disease Conference. Sacramento, California, 27 February-1 March. Western Poultry Disease Conference, Divis, California, 110 p.

Clavijo, A., Riva, J., Copps, J., Robinson, Y. and Zhou, E.M. 2001. Assessment of the pathogenicity of an emu-origin influenza A H5 virus in ostriches (*Struthio camelus*). Avian Pathology **30**: 83-89.

Clavijo, A., Riva, J. and Pasick, J. 2003. Pathogenicity of a Ratite. Origin Influenza A H5 Virus in Ostriches (*Struthio camelus*). Avian Diseases **47**(3): 1203-1207.

Cooper, R.G. 2005. Bacterial, Fungal and Parasitic Infections in the Ostrich (*Struthio camelus domesticus*). Animal Science Journal, **76**: 97-106.

Cooper, R.G., Horbanczuk, J.O. and Fujihera, N. 2004. Viral disease of the Ostrich (*Struthio camelus domesticus*). Animal Science Journal **75**(2): 89-95.

Cooper, R.G. and EI Doumani, H.A.A. 2006. The Presence of quill mites (*Ganucinia bicaudata*) and lice (*Struthiolipeurus struthionis*) in Ostrich wing feathers. Journal of South African Veterinary Association **77**(1): 9-11.

Cooper, R.G., Mahrose, K.M., EI-Shafei, M. and Marai, I.F. 2008. Ostrich (*Struthio camelus*) production in Egypt. Tropical Animal Health and Production **40**(5): 349-355.

Cortes, H., Caeiro, V. and Vila-Vicosa, M. 1999. Ectoparasites encontrados na avestruz (*Struthio camelus* Linnaeus 1766) em Portugal. *In* Hernandez, S., Martinez, A., Martinez, M.S., Moreno, T., Becerra, C., Acosta, I. et al. (eds.). IV Congreso Iberico de Parasitologia, Graficas Minerva de Cordoba, S.I., Cordoba, 16 p.

Craig, T. 1993. Natural parasites of ratites. In Proceeding Annual Ratire Conference. Collage Station, Texas, 9-10 September. College of Veterinary Medicine, Texas A and M. University.

Craig, T.M. and Diamond, P.L. 1996. Parasites of Ratites. *In* Tully, T.N. and Shane, S.M. (eds). Ratite management. Medicine and Surgery. Krieger Publishing Company, Malabar, FL. p. 115-126.

Davies, K. 1993. Emus and Ostriches: Nowhere to hide. Poultry Press 3(4): 1.

Davies, S.J.J.F. 2002. Species accounts, in Ratites and Tinamous partII- Bird Families of the World, C.M. Perrins, W.J. Bock, and J. Kikkawa, (eds)., Oxford University Press, New York NY, USA. p. 211-227.

Davies, S.J.J.E. 2003. Birds I Tinamous and Ratites to Hoatzirs. In Hutchins Mich ael. Grzimek's Animal Life Encyclopedia 2th ed. Farmington Hills, MI: Gale Group. 99p.

Day, J.F. and Stark, L.M. 1996. Eastern equine encephalitis transmission to emus (*Dromaius novaehollandiae*) in Volusia Country, Florida: 1992 through 1994. Journal of the American Mosquito Control Association, **12**(3part1): 429-436.

De Andra de, J.G., Lelis, R.T., Lelis, R.T. Damatta, R.A. and Santos, C. de P. 2011. Occurrence of nematodes and anthelmintic management of Ostrich farms from different Brazilian states: *Libyostrongylus douglassii* dominates mixed infections. Veterinary Parasitology **178**(1-2): 129-133.

Deeming, D.C. 1999. The Ostrich: Biology, Production and Health 1st ed. CABI Publishing, London, 358 p.

Deeming, D.C. and Angel C.R. 1996. Introduction to the ratites and farming operations around the world. In Deeming, D.C. (eds.). Improving our understanding of ratites in a farming Environment. Ratite Conference. Oxfordsshire, UK, p. 1-4.

Deeming, D.C., Ayers, L. and Ayers, F.J. 1993. Observations on the commercial production of ostrich (*Struthio camelus*) in the United Kingdom: incubation. Veterinary Record **132**: 602-607.

Diego, S. 2012. Zoo's Animal Bytes: Ostrich. http//www.sandiegozoo.org. Assessed on 17 December 2015.

Dingle, J. and Shanawany, M.M. 1999. Ostrich production systems. FAO Animal Production and Health Paper 144 1st ed. FAO, Rome, 256 p.

Dzoma, B.M. and Motshegwa, K. 2009. A retrospective study of egg production, fertility and hatchability of farmed ostriches in Botswana. International Journal of Poultry Science **8**(7): 660 – 664.

Ederli, N.B. and Oliviera, F.C.R. 2008. *Balantidium* sp. in Ostriches (*Struthio camelus* L., 1758) in the state of Rio De Jeneiro, Brazil. Revista Brasileira de Parasitologia Veterinaria **17**: 327-330.

Ederli, N.B. Oliviera, F.C.R., and De Azevedo Rpdriguez, M.L. 2008. Futher study of *Codiostomum struthionis* (Nematoda, Strongylidae) Parasite of Ostriches (*Struthio Camelus*). Veterinary Parasitology **157**: 257-283.

Ederli B. N. and de Oliveira F. C. R. 2014. Comparative morphology of the species of *Libyostrongylus* and *Codiostomum*, parasites from Ostrich (*Struthio camelus),* with identification key to the species. Brazil Journal Veterinary Parasitology Jaboticabal **23**(3):291-300.

Ederli, N. B. and Oliveira, F.C.R. 2015. Gastrointestinal nematodes in Ostriches, *Struthio camelus,* in different region of the state of Rio de Janeiro, Brazil. Veterinary Parasitology **24**(2): 168-173.

Eslami, A., Rahmat, H., Meshgi, B. and Ranjbar-Bahadori, S. 2007. Gastrointestinal Parasites of Ostrich (*Struthio camelus domesticus*) raised in Iran. Iranian Journal of Veterinary Research **8**: 80-82.

Fagundes, T.F., Soleiro, C.A. and Menezes, A.A. 2012. The occurance of *codiostomum struthionis* in Ostriches (*Struthio camelus*) of different ages and during the dry and rainy seasons at two farms in the State of Rio de Janeiro, Brazil. Veterinary Parasitology, **183**(3-4): 269-273.

Fantham, H.B. and Porter, A. 1943. *Plasmodium struthionis*, sp. n., from Canadian Speckled Trout (*Salvelinus Fontinalis*), together with a record of Sarcocystis in the Eel Pout (*Zoarces angularis*). Proceedings of the Zoological Society, London **113**: 25-30.

Fatiregun, A.A. and Saani, M.M. 2008. Knowledge, Attitudes and Compliance of Poultry workers with preventive measures for avian influenza in Lagelu Oyo State Neigeria. Journal Infection Developing Countries **2**(2): 130-134.

Foggin, C.M. 1992. Veterinary Problems of Ostriches. *In* Hallam, M.G. (eds.). The Tropaz introduction to Practical Ostriches farming p. 61-96.

Foreyt, W.J., 2005. Parasites of ratites. Parasitology Veterinaryn –Reference Manual 5th ed. Roca: São Paulo, p. 181-184.

Gajadhar, A.A. 1993. *Cryptosporidium* species in imported Ostriches and Consideration of possible implications for birds in Canada. Canadian Veterinary Journal **34**: 115-116.

Gillespie, J and Flanders, F. 2009. Modern Livestock and Poultry Production. Cengage Learning. 908 p.

Gotch, A.F. 1995a. Ostrich. Latin Names Explained. A Guide to the Scientific classifications of Reptiles, Birds and Mammals. London: Facts of File, 176 p.

Gotch, A.F. 1995b. Emu. Latin Names Explained. A Guide to the Scientific classifications of Reptiles, Birds and Mammals. London: Facts of File, 179 p.

Greiner, E.C. and Ritchie, B.W.1994. Parasites. *In*: Ritchie, B.W., Harrison, G.L., Harrison, L.R. (eds), Avian Medicine: Principles and Application. Lake Worht, FL, Wingers Publishing, p. 1014-1019.

Greve, J.H. and Harrison, G.J. 1980. Conjunctivitis caused by Eye flukes in captive-reared Ostriches. Journal of American Veterinary Medicine Association **177**: 909-910.

Griffiths, G. and Buller, N. 1991. *Erysipelothrix rhusiopathiae* infection in semiintensively farmed emu. Australian veterinary Journal **68**: 121-122.

Grompone. M.A., and Irigaray, G.M. 2005. Composition and thermal properties of Rhea oil and its fractions. European Journal of Lipid Science and Technology **107***:* 762–6.

Hegner, R. 1934. Specificity of the genus *Balantidium* based on size and shape of body and macronucleus with description of six new species. American Journal of Hygiene **19**: 38-67.

Hines, M.E., Styer, E.L., Baldwin, C.A. and Cole, J.R. 1995. Combined adenovirus and rotavirus enteritis with *Escheichia coli* Septicemia in an emu chick (*Dromaius novaehollandiae*). Avian Diseases **39**(3): 646-651.

Hoberg, E.P., Lloyd, S. and Omar, H. 1995. *Libyostrongylus dentatus* n. sp. (Nematoda: Trichostrongylidae) from Ostriches in North America, with Comments on the genera *Libyostrongylus* and *Paralibyostrongylus*. Journal of Parasitology **81**: 85-93.

Hoover, J.P., Lochner, F. K. and Mullins, S.B. 1998. Quill mites in an Ostrich with rhinitis, sinusitis and air sacculitis. Companion Animal Practical **2**: 23-26.

Huchzermeyer, F.W. 1994. Ostrich Disaeses. Agricultural Research Council, Pretoria, South Africa.

Huchzermeyer, F.W. 1997. Animal health risks associated with Ostrich products. Revista Science and Technology **16**(1): 111-116.

Huchzemeyer, F.W., 1999. Veterinary Problems in the Ostrich: Biology, Production and Health, CAB International, p. 303–305.

Huchzermeyer, F.W. 2002. Diseases of farmed Crocodiles and ostriches. Revista Science and Technology **21**: 265-276.

Hyde K. 2004. Zoology: An Inside view of Animal 3rd ed. Dubuque, IA: Kendall Hunt Publishing.

Ibrahim, U.I., Mbaya, A.W., Geidam, Y.A. and Geidam, A.M. 2006. Endoparasites and Association Worm Burden of Captive and free living ostriches (*Struthio camelus*) in the

Semi-Arid Region of North Eastern Neigeria. International Journal of Poultry Science **5**(2): 1128-1132.

Jansson, D.S. and Christensson, D. 2000. Gastrointestionala parasite hos Strutsfaglar I Sverige. Svensk Veterinar tidning **52**: 621-626.

Jeffery, J.S. 1996. Husbandary and Medical Management of Ostriches. Wildlife and Exotic Animal Teleconsultants, College station, Texas p. 9-110.

Jeffery, J.S. 2001. Ostrich production. Texas Agricultural Extension Services Bulletin. Texal A and M University, Texas: p. 1-4.

Jones, L.D. 2007. O, Those Ostriches. My Florida Story. Adventures with history and Culture in the Sunshine State. http://www.myfloridahistory.blogspot.com. accessed on 30 December 2015.

Jurajda, V. 2002. Chov a nemoci pstrosv 1st ed. Veterinarni a Farmaceuticka Univerzita Bron, Brno, 92p.

Kang, W., Pang, W., Hao, J. and Zhao D. 2006. Isolation of avian influenza virus (H9N2) from emu in China. Veterinary Journal **59**(3): 148-152.

Karunakaran, S., Krishnan N.G., Divakaran N.N. and Mini M. 2010. Systemic Aspergillosis in Emu Chicks in an organized farm in Kerala. Veterinary World **3**(10): 453-455.

Kazacos, K.R., Winterfield, R.W., Thacker, H.L. 1982. Etiology andepidemiology of verminous encephalitis in an emu. Avian Diseases **26**: 389-391.

Kazacos, K.R., Fitzgerald, S.D., Reed, W.M. 1991. *Baylisascaris procyonis* as a cause of cerebrospinal nematodiasis in ratites. Journal of Zoological Wildlife Medicine **22**: 460-465.

Kocan, A.A. and Crawford, J.A. 2007. The Oklahoma state Ostrich Book (online). http://instruction.cvhs.okstate.edu/kocan/ostrich. accessed on 10 November 2015.

Khosravi, A.R., Shokri, H., Ziglari, T., Naeini, A.R., Mousavi, Z. and Hashemi, H. 2008. Outbreak of severe disseminated aspergillosis in a flock of ostrich (*Struthio camelus*). Mycoses **51**: 557-559.

Khyalia, M.K., Pandey, V.S. and Prajapati, K.S. 2014. Study on Seroprevalence of various diseases in Emu in Gujarat. International Journal of Advanced Multidisciplinary Research **1**(4): 24-27.

Kwon, Y.K., Lee, Y.J. and Mo, J.P. 2004. An Outbreak of necrotic enteritis in the Ostrich farm in Korea. Journal Veterinary Medical Science **66**(12): 1613-1615.

Kyoung, O.H. 2001. Aspergillosis in an ostrich (*Struthio camelus*). Journal of Veterinary Clinics **18**: 174-177.

Leavy, A., Perelman, B., Grevenbroek, M.V., Creveld, C.V., Agbaria, R. & Yagil, R. 1990. Effect of water restriction on renal function in ostriches (*Struthio camelus*). Avian Pathology **19**: 385-393.

Levine, N.D. 1985. Veterinary Protozoology. Iowa State University Press, Ames, IA, 414 p.

Lordman, W.J. and Bronneberg, R.G. 2004. *Libyostrongylus douglassii* in Ostriches (*Struthio camelus*) in the Netherlands. Veterinary Parasitology **92**: 173-179.

Lublin, A., Mechanis, Horowitz, H.I. and Weisman, Y. 1993. A paralytic- like disease of the ostrich (*Struthio camelus masaicus*) associated with *Clostridium chauvoei* infection. Veterinary. Record **132**: 273-275.

Maloney, S.K. 2008. Thermoregulation in ratites. Australian Journal of Experimental Agriculture **48**(0): 2193-1301.

Manvell, R.J., Jørgensen, P.H., Nielsen. O.L. and Alexander. D.J. 1998. Experimental assessment of the pathogenicity of two avian influenza A H5 viruses in ostrich chicks (*Struthio camelus*) and chickens. Avian Pathology **27**: 400-404.

Manvell, R.J., English, C., Jørgense, P.H. and Brown, L.H. 2003. Pathogenesis of H7 influenza A viruses isolated from ostriches in the homologous host infected experimentally. Avian Diseases **47**:1150-1153.

Marks, S.L., Stauber, E.H. and Ernstrom, S.B. 1994. Aspergillosis in an ostrich. Journal of the American Veterinary Medical Association **204**: 784-785.

Marshall, A.J. 1960. Biology and Comparative Physiology of Birds, Academic Press, 446 p.

Martinez Diaz, R., Herrera, S., Castro, A. and Ponce, F. 2000. *Entamoeba* sp. (Sarcomastigophora: Endamoebidae) from Ostriches (*Struthio camelus*). Veterinary Parasitology **92**: 173-179

Mattos, M.J.T., Ribeiro, V.S.and Marques, S.M.T. 2011. Gastrointestinal Parasitism and aspects of the management of Ostriches (*Struthio camelus*) of small properties of Rio Grande do Sul, Brazil. Veterinary in Focus Canoes **8**(2): 143-151.

Mckeegan , D.E.F. and Deeming, D.C. 1997. Effects of gender and group size on the time-activity budgets of adult breeding ostriches (*Struthio camelus*) in a farming environment. Applied Animal Behaviorial Science **51**: 159-177.

Mckenna, P.B. 2005. *Libyostrongylus* infections in Ostriches- a brief review with particular reference to their detection in New Zealand. New Zealand Veterinary Journal **53**: 267-270.

Menon, D.G., Bennett, D.C. and Cheng, K.M. 2014. Understanding the Behavior of Domestic Emu: A means to Improve Their Managements and Welfare-Major Behaviors and Activity Time Budgets of Adult Emus. Journal of Animals **2014**: 1-8.

Mertin, J.W. and Schlater, J.L. 1991. Exotic ectoparasites of Ostriches recently imported into the United States. Journal of Wildlife Diseases **27**: 180-182.

Mohan, R. 1993. Mycoplasma in ratites. In Proceeding Association of Avian Veterinarians (AAV). Nashville, Tennessee, 31 August-4 September. AAV Publications, Orlando, Florida, p. 294-296.

Moreki, J.C., Kebonye, N.M. and Tiroesele, B. 2012. Commerical Ostrich Farming in Botswana: A case study of Dibete Ostrich Multiplication unit. Life Science Biomedicine **2**(5): 192-195.

Moreki J.C. and Koloka O.A. 2010. A critical review of Botswana's ostrich industry. http://www.world-ostrich.org/pastnewsletters/news90.htm. accessed on 12 November 2015.

Mshelia WP, Abdu PA, Abdussamad AM, and Wakawa AM (2010). Prevalence of endoparasites in Ostriches (*Struthio camelus*) raised in selected states of Northern Nigeria. Conference on International Research on Food Security, Natural Resource Management and Rural Development. Tropentag, September 14-16, Zurich. 2010.

Mshelia, W.P., Abdu, P.A., Abdussamad, A.M., Wakawa, A.M. and Malumfashi, A.I. 2011. Ostrich management practices in three states of Norhtern Negeria. Veterinary World, **4**(2): 64-67.

Mushi, E.Z., Binta, M.G., Chabo, R.G., Isa, J.F.W. and Phuti, M.S. 1999. Limb Deformities of Farmed ostrich (Struthio camelus) Chicks in Botswana. Tropical Animal Health and Production **31**: 397-404.

Mushi, E.Z., Binta, M.G., Chabo, R.G. and Toto, P.A.S. 2003. A note on Endoparasites of Wild Ostriches (*Struthio camelus*) in the Mokolodi Nature Reserve, Gaborone, Botswana. Journal of the South African Ratite Association **74**(1): 22-23.

Mustapha, P. 2003. How to raise and market Ostriches 1st ed. Acacis Publisher, Nairobi, p. 1-49.

Nel, C.J. 1980. Dosing of Ostriches for internal parasites. Elsenburg Journal **4**: 31-33.

Nemejc K. 2007. Ostrich Farm Management and its Perspectives in Conditions of the Czech Republic, B. Sc. Thesis, Institute of Tropics and Subtropics, Czech University of Life Science Prague, The Czech Republic.

Nemejc, K. and Lukesova, D. 2012. Parasitic Fauna of Ostriches, Emus and Rheas. Agricultura Tropica ET Subtropica **45**(1): 45-50.

Neves, D.P. 2005. Human parasitology. 11th ed. São Paulo, Atheneu, 494 p.

O'Callaghan, M.G., Davies, M. and Andrews, R.H. 2000. Species of *Raillientina* Fuhrmann 1920 (Cestoda: Davaineidae) from the emu (*Dromaius novaehollandiae*). Transactions of the Royal Society of South Australia Incorporated **124**(2): 105-116.

O'Callaghan, M.G., Davies, M. and Andrews, R.H. 2003. Cysticercoids of five species of *Raillientina* Fuhrmann, 1920 (Cestoda: Davaineidae) in ants, Pheidole species from emu farms in Australia. Systematic Parasitology **55**(1): 19-24.

Oliveira, F.C.R., Ederli, N.B., Ederli, B.B., Albuquerque, M.C. and Santos, M.D. 2008. Ocorrencia de oocistos de *Cryptosporidium* spp. (Apicomplexa, Cryptosporidiidae) em avestruzes, *Struthio camelus* L., 1758 (Aves,Struthionidae) criadas nas regioes norte e baixada litorânea do Estadodo Ride Janeiro. Brasil Revista Brasileira de Parasitologia Veterinaria **17**(1): 322-325.

Oliveira, F.C., Ederli, N.B., Lopes, C.W. and Rodrigues, M. de L. 2009. Pathological finding in the Caeca of naturally infected Ostriches (*Struthio camelus* Linnaeus 1758) (Aves, Struthionidae) Parasitized by *Codiostomum struthionis* (Horst 1885) Railliet and Henry 1911 (Nematode, strongylidae). Veterinary Parasitology **165**(1-2): 175-178.

O'Malley, P 1997. A handbook for farmer: emu farming, RIRDC, <http://www.rirdc.gov.au/pub/handbook/emu.html>, updated December 1997 and accessed on 14 April 2015.

Ormerod 1900. Ostrich fly: *Hippobosca struthionis* n. sp. Agricultural Journal, Department of Agriculture, Cape Colony **2**: 293-294.

Orumbayev A. 2015. A study on Breeding Proportions of Emu. International Journal of Poultry Science **14**(2): 89-91.

Patodkar, V.R., Rahane, S.D., Shejal, M.A. and Belhekar, D. R. 2009. Behavior of emu bird (*Dromaius novaehollandiae*). Veterinary World **2**(11): 439-440.

Panjgarphy, B., Senne, D.A. and Pearson, J. E. 1995. Presence of avian influenza virus (AIV) subtypes H5N2 and H7N1 in emus (*Dromaius novaehollandiae*) and rheas (Rhea Americana) Virus isolation and Serologic finding. Avian Diseases **39**(1): 64-67.

Papini, R., Girivetto, M., Marangi, M., Mancianti, F. and Giangaspero, A. 2011. Endoparasite Infections in Pet and Zoo Birds in Italy. The Scientific World Journal, p. 1-9.

Paula A.A., Francisco, Paulo and Costa da R. 2009. Prevalence of Toxoplasm gondii antibodies in Ostriches (*Struthio camelus*) from commercial breeding facilities in the states of Sao Paulo Brazil. Brazilian Journal of Veterinary Research and Animal Science **46**(3): 175-180.

Pennycott, T. and Patterson, T. 2001. Gastrointestinal Parasites in Ostriches (*Struthio camelus*). Veterinary Record **148**: 155-156.

Perelman, B. and Kuttin, E.S. 1992. Aspergillosis in Ostriches. Avian Pathology **21**: 159-163.

Perkins, L.E. and Swayne, D.E. 2002. Pathogenicity of a Hong Kong –Origin H5N1highly pathogenic Avian influenza virus for emus, geese, ducks and pigeons. Avian Diseases: **46**(1): 53-63.

Ponce Gordo, F., Herrera, S., Castro, A.T., Garcia Duran, B. and Martinez Diaz, R. A. 2002. Parasites from Farmed Ostriches (*Struthio camelus*) and Rheas (*Rhea americaba*) in Europe. Veterinary Parasitology **107**: 137-160.

Poudel, Y. 2012. Parasitic Impediments of Ostrich farming in Gongoliya, Rupendehi. M.Sc. Thesis. Central Department of Zoology, Tribhuwan, University, Kathmandu, Nepal.

Rickard, L.G., Steinohrt, L.A. and Black, S.S. 1997. Subclinical cyathostomiasis and unidientified helminthiasis in a Juvenile emu (*Dromaius novaehollandiae*). Avian Diseases, **41**: 993-996.

Samberg, Y., Hadesh, D., Perelman, B. and Meroz, M. 1989. Newcastle disease in ostrich (*Struthio camelus*): field case and experimental infection. Avian Pathology **18**: 221-226.

Sambraus, H.H. 1994. The circadian rhythm in the Behaviour of Ostriches (*Struthio camelus*) kept in pens. Berliner and Muenchener Tieraerztliche Wochenschrift **107**: 339-341.

Sancak, A.A. and Paracikoulu, J. 2005. Aspergillosis and Gastric impaction in an ostrich. Turkish Journal of Veterinary and Animal Sciences **29**: 933-935.

Santos, M.M., Peiro, J.R. and Meireles, M.V. 2005. Cryptosporidium infection in Ostriches (*Struthio camelus*) in Brazil: Clinical and Molecular Studies. Revista Brasileira de Cienica Avicota **7**: 113-117.

Sasani, F., Khosravi, A.R.., Dordari, M., Moghadam, Rajabi and Hajibabaie, A. 2003. Pulmonary aspergillosis in ostrich. Archives of Razi Institute **55**: 117-120.

Saxton-shaw, K. D., Ledermann, J. P., Kenney, J. L., Berl, E., Graham A. C., Russo J.M. et al. 2011. The First Outbreak of Eastern Encephalitis in Vermont: Outbreak Description and Phylogenetic Relation ships of the Virus Isolate. Plos One **10**(6): e 0128712.

Selleck, P.W., Arzey, G., Kirkland, P.D., Reece, R.L., Gould, A.R., Daniels, P.W. et al. 2003. An Outbreak of Highly Pathogenic Avian Influenza in Australia in 1997 Caused by and H7N4 Virus. Avian Diseases **47**(3): 806-811.

Shanawany, M.M. 1994. The Importance of Light for ostriches. Ostrich Update **3**: 52-54.

Shane, S.M., Camus, A.C., Strain, M.G., Thoen, C.O. and Tully, T.N. 1993. Tuberculosis in commercial emus (*Dromaius novaehollandiae*). Avian Diseases **37**: 1172-1176.

Shathele, M.S., Fadlelmula, F.A. Al-Hizab, F.A. and Zaki, M.M. 2009. Fatal aspergillosis in an ostrich (*Struthio camelus*) predisposed by pulmonary haemangioma in the Kingdom of South Arabia. International Journal of Zoological Research **5**: 80-85.

Shinde, P.V., Koratkar, S.S., Pawar, Kale, S.D., Rawankar, A.S. and Mishra, A.C. 2012. Serologic evidence of avian influenza H9N2 and Paramyxovirus type 1 infection in emus (Dromaius novaehollandiae) in India. Avian Diseases **56**(1): 257-260.

Silvanose, C.D., Samour, J.H., Naldo, J.L., and Bailey, T.D. 1998. Oro-pharyngeal protozoa in captive bustard: clinical and pathological consideration. Avain Pathology **27**(526-530).

Smit, D.J. 1963. Ostrich Farming in the Iittle Karoo. Department of Agricultural Technical Services, Pretoria, South Africa, Bulletin no. 358.

Snoeyenbos, G.H. 1965. In: *Anthrax*, Biester, H.E. and Schwarte, L.H. eds. In Diseases of poultry, 5th ed. Iowa State University Press, Arnes, Iowa, p. 432-435.

Soares, M.P., Da Silva, S.S., Nizoli, L.Q., Felix, S.R.and Schild, A.L. 2007. Chronic Fascioliasis in Farmed and Wild Greater Rheas (*Rhea Americana*). Veterinary Parasitology **145**: 168-171.

Sotiraki, S.T., Georgiades, G., Antoniadon-Sotiriadou, K. and Himonas, C.A. 2001. Gastrointestinal Parasites in Ostriches (*Struthio camelus*). Veterinary Record **148**: 84-86.

Stewart, J.S. 1994. Ratites. In: Ritchie B.W., Harrison, L.R. eds. Avian medicine: Principles and application. Wingers Publishing ,Florda. USA.

Sultana, R., Rimi N.A., Azad, S., Islam, M.S., Khan, M.S., Gurley, E.S., et al. 2012. Bangladesh backyard Poultry raisers Perceptions and practices related to zoonotic transmission of avian Influenza. Journal of Infection in Developing Countries **6**(2): 156-165.

Sunday Standard 2012. Ostrich farmers association praying EU grants abattoir license. http://www.sundaystandard.info/article.php?NewsID=14621and GroupID=3. accessed on 16

Taylor, M.A. Coop, R.L. and Wall, R.L. 2007. Veterinary Parasitology 3rd ed. Blackwell Publishing, UK, 874 p.

Teixeira, D.S.T. 2013. Enteroparasites attacking observed in faeces of Emu, *Dromaius novaehollendiae* Latham, 1790. (Birds: Struthioniforms). M.Sc. Thesis. Center of the non-

Agricultural Science and Techonology of the Universidade Esta dual de Norte Fluminanse Darcy Ribeiro.

Terzich, M. and Vangooser, S. 1993. Postmortem findings of ostriches submitted to the Oklahoma Animal Disease Diagnostic Laboratory. Avian Diseases **37**: 1136-1141.

Thompson, R.S. 1997. Raising emus and ostriches. Farming Systems Information Center, http://afsic.nal.usda.gov/. accessed on 15 December 2015

Tisljar, M., Beck, R., Copper, R.G., Marinculic, A., Tudja, M., Lukoc-Novak, I. et al. 2007. First finding of Libyostrongylosis in farmed-reared Ostriches (*Struthio camelus*) in Croatia: Unusual histopathological finding in the brain of two Ostriches, naturally infected with *Libyostrongylus douglasi*. Veterinary Parasitology **147**: 118-124.

Tully, T.N., Shane, S.M., Poston, R.P., England, J.J., Vice, C.A., Cho, D.Y. et al. 1992. Viscerotropic Eastern Encephalitis in a flock of emus (*Dromaius novaehollandiae*). Avian Disease **36**: 808-819.

Tully, T.N. and Shane , S.M. 1996. Husbandary Practices as related to infectious and Parasitic Diseases of farmed raratie. Revue Scientificque Technque International Office of Epizootics **15**: 73-89.

Van Heerden, J., Hayes, S.C. and Williams, M.C. 1983. Suspected vitamins e- Selenium deficiency in two Ostriches. Journal of the South African Veterinary Association **54**: 53-54.

Vaughan, J.L., Charles, J.A., and Boray, J.C. 1997. Fasciola hepatica infection in farmed emus (*Dromaius novaehollandiae*). Australian Veterinary Journal **75**(11): 811-813.

Veazey, R.S., Vice, D.Y., Tully, T.N. and Shane, S.M. 1994. Pathology of Eastern Equine Encephalitis in Emus (*Dromaius novaehollandiae*). Veterinary pathology **31**: 109-111.

Vyver, A. van der 1992. Viewpoint: The world ostrich industry will South Africa maintain its domination. Agrekon **31**: 47-49.

Wade, J.R. 1992. Ratite pediatric medicine and surgery. Association of Avian Veterinarians: 340-353.

Warale, R.H., Chaughan, H.D., Parmar, D., Kulkarni, R.C., Srivastava, A.K., Makwana, R.B., et al. 2014. Emu farming: An alternative to Indian Poultry. Trends in veterinary and Animal Science **1**: 9-14.

Warmser, M.F. 1930. Ostrich industry in South Africa. M.Sc. Thelsis. University of South Africa, Pretoria.

Weisman, Y., Malkinson, M., Pearl, S., Ashash, S., Meir, R., Nir, A. et al. 1994. Borna disease in ostriche (Abs). In Proceedings Western Poultry Disease Conference. Sacramento, California, 27 February-1 March. Western Poultry Disease Conference, Davis, California: 22 p.

Wikepedia 2015. Emu. https://en.wikipedia.org/wiki/Emu. (accessed on 11 March 2016)

Wikepedia 2015. Ostrich. https://en.wikipedia.org/wiki/Ostrich. (accessed on 11 March 2016)

Woolcock, P.R., Shivaprasad, H.L. and Rosa, M.D. 2000. Isolation of avian influenza virus (H1N7) from an Emu (*Dromaius novaehollandiae*) with conjunctivitis and respiratory diseases. Avian diseases **44**: 737-744.

Yakimoff, W.L. 1940. *Isospora struthionis* n. sp., Coccidie de 1' autruche africaine. Annales de la Societe Belge de Medicine Tropicale **20**: 137-138.

Yokota, T.T., Shibahara, Y., Wada, R., Hiraki, Y., Ishikawa and Kadota, K. 2004. *Aspergillus fumigatus* infection in an ostrich (*Struthio camelus*). Journal of Veterinary Medical Science **66**: 201-204.

Yamaguti, S. 1961. Systema Helminthum. Vol. III. The Nematodes of Vertebrates Pt. II and I Interscience Publishers, New York and London, 1261 p.

Yaman, M. and Durgut, R. 2005. Parasitic Infestations in Ostriches and Therapy. Turkiye Parazitology Dergisi **29**: 103-109.

APPENDIX 1

Demographic information

Name: **Farm:**

Age: **No. of Ostriches:**

Sex: **No. of Emus:**

Education: **Responsibility:**

Duration of work:

A. Knowledge related information:

1. Do you know some special features of Ostrich and Emu?
2. Can you tell me similarity and dissimilarity in between Ostrich and Emu?
3. What do you want to tell about the egg of these bird?
4. Mostly from which diseases they are suffering?
5. If they are suffering then was there problem of weight loss in Ostrich and Emu?
6. What are the veterinary facilities given to them?

B. Attitude related information:

1. Do you agree Ostrich and Emu can grow in different parts of Nepal?
2. Do you think people will start consuming Ostrich meat against chicken and other meat?
3. Is Ostrich and Emu died in the farm were due to diseases?
4. Do you agree visitors can carry various diseases dreadful to Ostrich and Emu?
5. Do you think feed prepared for Ostrich and Emu are decontaminated?

C. <u>Practice related information:</u>

1. How many cages of which height are made here for raring of Ostriches and Emus?

2. At what time do you provide food for them?

3. At which time do you provide water for them?

4. What is the sources of water?

5. What are the feeding practices adopted in these farm?

APPENDIX 2

2.1 Ectoparasites of ostrich and emu encountered during faecal examination

Different types of ectoparasites infect the ostrich and emu. Generally ectoparasites infect external part of body. In present study different types of mites were recovered during faecal examination as shown in (Photo 27-32).

Ectoparasites of ostrich

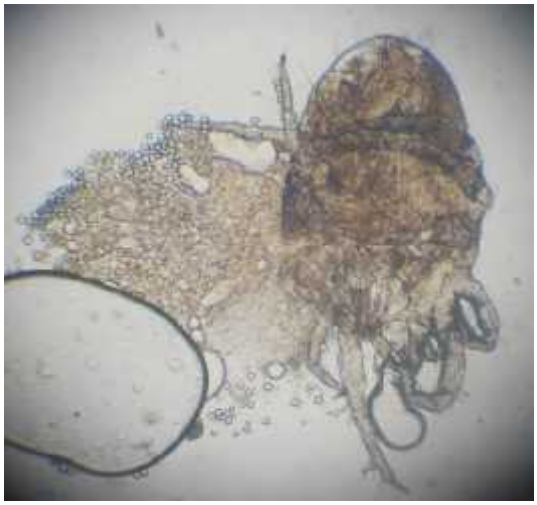

Photo 27: Unidentified sp. Mite (40X)

Photo 28: *Gubicinia* sp. (10X)

Ectoparasites (Unidentified mite) of emu

Photo 29: Unidentified sp. mite (40X)

Photo 30 : Unidentified sp. of mite (40X)

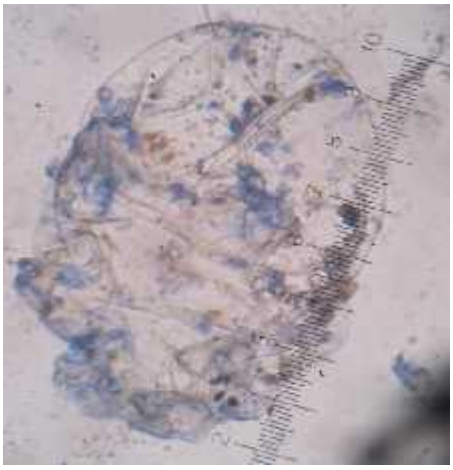

Photo 31: unidentified sp. mite (10X)

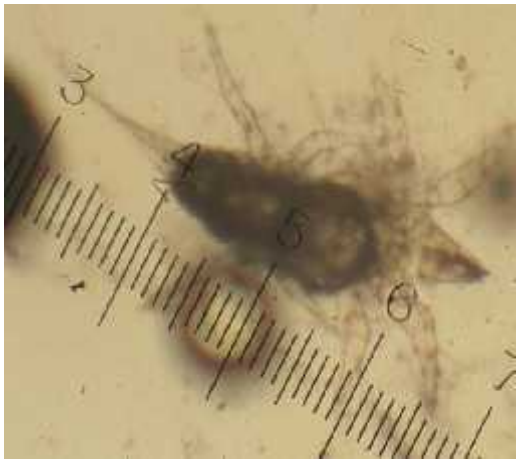

Photo 32: unidentified sp. mite (40X)

2.2 Extra vitamins and minerals supplement for ostriches and emus along with feeds

The schedule provide by Pro Bio-Tech Industries Pvt. Ltd. of extra vitamins and minerals supplement for ostriches and emus along with feeds is shown in table (Table 7).

Table: 7 Extra vitamins and minerals supplied along with the feeds.

Each 1.5kg contains:

Vitamin A(miu)	Vitamin A 1000	12
Vitamin D3(miu)	Vitamin D3 500	3.6
Vitamin E (g)	Vitamin E-50 (50%)	150
Thiamine (B1) (g)	Thaimine Mononitrate (98%)	1.8
Riboflavin (B2) (g)	Riboflavin (80%)	4.8
Niacin (B3) (g)	Niacin (99.5%)	12
Panthothenic Acid (B5)	D-CALPAN (98%)	4.2
Pyridoxine (B6)	Pyridoxine HCL (99%)	1.2
Folic Acid (B9)	Folic Acid 100 (97%)	0.9
Cyanoc (B12)	Vitamin B12 10000 (1%)	0.01
Biotin (H2)	Biotin HP (10%)	0.12
Menodione (k)	Menodione (31.2%)	0.18
Cobalt	Cobalt Sulphat 21%	0.06
Iodine	Potassium Iodide 68%	0.21
Iron	Ferrous Sulphate 30%	7
Manganese	Manganese Oxide 52%	24
Copper	Copper Sulphate 25%	1.2
Zinc	Zinc Sulphate Mono 35%	18
Magnesium	Magnesium Oxide 56%	12
Choline Choride	Choline Chloride 60%	100
Lysine	Lysine Mono HCL	300
Methionine	DL Methionine	225
Anti-Oxidant	Eurotiox-32	25
Vitamin C		100gms

Source: Pro Bio-Tech Industries Pvt. Ltd.

1. INTRODUCTION

1.1 Background

Ostrich and emu are big flightless birds, very good runners and good swimmer, scientifically called ratites because of the absence of keel of the breastbone (Deeming 1999, Dingle and Shanawany 1999). They have small head, big eye, long leg and neck. Emus and other flightless bird have three toes and ostriches have two toes as compared to four toes of flying birds which are made for speed, as fewer toes means less ground contact, adding more speed (Davies 1993). Ratites fight with kicks, kicking from the knees forward and down instead of backward and display elaborate, well-developed courtship, nest-building and chick rearing behaviours (Davies 1993).

Ostrich

Scientific classification

kingdom: Animalia

Phylum: Chordata

Class: Aves

Order: Struthioniformes

Family: Struthioniidae

Genus: *Struthio*

Species: *Camelus*

Ostrich was originally named by Linnaeus in 1758 as *Struthio camelus* (Bertram 1992). In which *Struthio camelus* is derived from Latin term, *Struthio* meaning "Ostrich" and *camelus* for "Camel", aduding to its dry habitat (Gotch 1995a). The word *camelus* is based on the similarities; ostrich with camels, such as their prominent eyes and eyelashes, their large and their remarkable tolerance to the desert habitat (Shanawany 1994). Ostrich (*Struthio camelus*) is the largest and heaviest living bird and sole representatives of the order struthioniformes (Alden et al. 1996). Ostrich seems to be true dinosaurs back over 120 million years where ostrich skeleton and fossils have been found (Animal corner 2013). They can tolerate wide

range of temperature (Leavy et al. 1990, Shanawany 1994). In much of their habitat temperature vary as much as 40°C between day and night.

The ostrich has the largest eye of any land animal whose eye is bigger than the world's smallest bird, the Bee Humming bird (Animal corner 2013). The ostrich weight from 63-145kg or as much as two adult human (Davies 2002). Adult male ostrich can grow to measure 2.1-2.8 m and female ostrich range from 1.7-2 m in height (Davies 2002). Ostrich has a black plumage with white wing tips. However, female and chicks have brownish, duller plumages which are used for defence (Shanawany 1994, Animal coner 2013). The massive leg muscles enables them to deliver a powerful kick which could seriously injure or even kill an attacker (Wikipedia 2015a). Ostrich contain their main musculature in the hips and thighs. The long legs enable them to run at speeds of over 70 km per hours (Diego 2012).

Ostriches are omnivorous. They mainly feed on seeds, shrubs, grass, fruits and flowers but occasionally, they also eat insects, lizard or other creature available in their harsh habitat (Wikipedia 2015a). Ostrich donot possess a crop and also lacks gallbladder (Marshall 1960) but instead has a glandular stomach called proventriculus. The proventriculus leads to a muscular stomach called ventriculus which contains grit, rocks and other materials that help to break down food and allows it to pass into the small intestine (Animal corner 2013).

Wild ostrich is sexually mature at four to five years of age while the domesticated ostrich is mature at two to three years of age in which female matures slightly earlier than the male (Shanawany 1994). During the breeding season around March/April, male ostriches fight for harems of two to seven females (Betram 1992). Ostrich eggs are around 16 cm in length weight three pounds and are glossy and cream in colour and takes about 42 days to hatch the eggs (Animal corner 2013). Ostrich eggs are largest of all eggs (Hyde 2004). The life span of an Ostrich can be of 75 years (Animal corner 2013).

Although, ostrich numbers have drastically declined over the last 200 years however, IUCN and Bird Life International have still classed as "Least Concern" (BirdLife International 2012a).

Emu

Scientific classification

kingdom: Animalia

Phylum: Chordata

Class: Aves

Order: Casuariiformes

Family: Dromaiidae

Genus: *Dromaius*

Species: *novaehollandiae*

Emu was named by ornithologist John Latham in 1790 based on greek and latin name *Dromaius novaehollandiae* under the name of "New Holland Cassowary" (Davies 2003). In which greek word *Dromaius* means for "Racer" and the latin term "*novaehollandiae*" for New Guinea" (Gotch 1995b). Emu (*Dromaius novaehollandiae*), is the second largest living bird in the world and sole representive of the Genus: *Dromaius* (Gillespie and Flanders 2009). During decade of 30, such birds were considered as pests, because they destroyed crops in search of food, being then hunted, extensively, almost reaching the extinction (Teixira 2013). They can tolerate temperature in between 10°C-30°C (Maloney 2008).

Emus are the only birds with gastrocnemius muscles (the same as human calf muscles) in the back of the lower legs and can grow two meter tall and 45 kg weight (Animal corner 2013, Warale et al. 2014). Emus have strong long legs and although they cannot fly, they can run at speed of 48km per hours due to highly specialized pelvic limb musculature (Potodkar et al. 2009). Emus have soft, long brown feathers on their plumage which has a shaggy appearance and shorter downy feathers on their heads (Animal corner 2013).

Omnivorous emu's diet includes eat fruits, seeds, growing shoots of plants, insects other small animals and donot eat dry grasses or mature leaves even if they are available (Potodkar et al. 2009). They requires stones and pebbles to assist the digestion of plant material and also eat charcoal but reasons for this is unknown (Davies 2003). There is no crop and the proventriculus has a large lumen which also suggests that it also helps in storage of food in the absence of a crop (Wikipedia 2015b).

Sexual maturity is reached after two to three years but breeding in captivity can occurs as young as 20 months (Potadkar et al. 2009). Breeding pairs form in the summer months of December and January and mating occurs in the cooler months of May and June (Animal corner 2013). In April/June the female lay (an average 11 eggs) large thick-shelled dark green eggs, shell around one milimeter thick with one nest containing the eggs of several females (Davies 2003). An average egg can measure five inches long and three inches wide and weigh between 450-650gm (Animal corner 2013). It takes 56 days to hatch the eggs (Potadkar et al. 2009).

IUCN considered emu population trend to be stable and assesses their conservation status as being of least concern (Bird Life Internationl 2012b). Due to the collision with vehicles, loss of habitat and the increase of feral dogs and pigs the emu population in New South Wales is listed as endangered species (Animal corner 2013).

1.2 Ostrich and Emu Diseases

1.2.1 Infectious Diseases

With the increase in the numbers of farmed of ratites throughout the Australia, Asia, Africa, Europe and North America, there have been a worldwide increase in the spread of parasitic and infectious diseases associated with these birds (Tully and Shane 1996).

The infectious diseases agents reported from ostriches are: Eastern Equine Encephalomyelitis (EEE), Western Equine Encephalomyelitis (WEE) and St. Louis Encephalomyelitis virus (Tully et al. 1992, Ayers 1994), Avian influenza (H7N1, H5N9, H9N2, H5N9, H5N2, H4N6,H7N1, H7N3, H10N4)(Capaul et al. 2000, Manvell et al. 2003), Adenovirus (Capual et al. 1994), Borna diseases and Anthrax (Huchermeyer 1994), Crimean- congohaemorrhagic fever (Cooper et al. 2004), *Aspergillus* sp. (Yokota et al. 2004, Sancak and Paracikoulu 2005), *Pasteurella* (Akoha 1980), *Mycoplasmosis cloacale* (Mohan 1993), *Mycobacterium avium* (Shane et al. 1993), *Clostridium* sp. (Lublin et al. 1993, Kwon et al. 2004), New caltle disease i.e. Paramyxovirus type 1, Avibirnavirus, Avipox and *Salmonella* sp. (Tully and Shane 1996) and *Bacillus anthracis* (Huchzermeyer 1997).

This infectious disease agent reported from emu includes: Eastern Equine Encephalomyelitis (EEE) (Tully and Shane 1996, Saxton-Shaw et al. 2011), Western Equine Encephalomyelitis (WEE) (Tully et. al. 1992, Ayers 1994), St. Louis Encephalomyelitis virus (Tully et. al. 1992, Ayers 1994, Day and Stank 1996), Arbovirus (Day and Stank 1996), Adenovirus and Rotavirus (Hines et al. 1995), Avian influenza (H5N2 and H7N1) (Panjgraphy et al. 1995),

(H5N1) (Amnon et al. 2011), H7N4 (Selleck et al. 2003), (H9N2) (Shinde et al. 2012), New castle disease virus I.e. Paramyxovirus Type 1 (Shinde et al. 2012, Khyalia et al. 2014), *Aspergillus* sp. (Karunkarna et al. 2010), *Salmonella* sp. (Tully and Shane 1996), *Erysipelothrix rhusiopathiae* (Griffiths and Buller 1991), *Escherichia coli* (Hines et al. 1995), *Pasteurella* sp. (Akoha 1980), *Mycoplasmosis cloacale* (Mohan 1993), *Mycobacterium avium* (Shane et al. 1993), *Clostridium sp.* (Lublin et al. 1993; Shane et al. 1993).

1.2.2 Parasitic Diseases

The ratites are the birds quite vulnerable to several types of parasitic infections, mainly the gastrointestinal parasites (Oliveira et al. 2009). The parasites cause diseases in ratites and some species may be responsible for up to 50% of mortality among offspring of ratites (Boradiman et al. 2006). The economic impact of most of ratite parasites is still undetermined (Nemejc and Lukesova 2012). Ratites are found to be frequently infected with protozoan, nematode, cestode and trematode parasites.

The major gastrointestinal parasites of ostrich includes: *Cryptosporidium* (Nemejc and Lukesova 2012), *Isospora struthionis* (Yakimoff 1940), *Isospora* sp. (Mattos et al. 2011), *Eimeria* sp. (Eslami et al. 2007, Mshelia et al. 2010), *Balantidium* sp. (Ederli and Oliveria 2008, Mattos et al. 2011), *Entamoeba* sp. (Pennycott and Patterson 2011) and *Giardia* sp. (Huchzermeyer 1999). The protozoan parasites *Cryptosporidium* sp., *Isospora* sp., *Eimeria* sp. and *Balantidium* sp. were also discovered by Ponce Gordo et al. (2002) and that of *Balantidium* sp., *Entamoeba* sp., and *Histomonas* sp., by Poudel (2012). Likewise, nematode parasites includes: *Libyostrongylus* sp. (Mshelia et al. 2010, De Andra et al. 2011; Nemejc and Lukesova 2012, Poudel 2012), *Ascaridia* sp. (Ibrahim et al. 2006;), *Codiostomum* sp. (Juarjda 2002, Blood et al. 2007, Ederli et al. 2008), *Capillaria* sp. (Ibrahim et al. 2006) and *Heterakis dispar* (Eslami et al. 2007), *Houttuynia struthionis,* a cestode and *Philophthalmus gralli,* trematode (Dingle and Shanawany 1999, Ponce Gordo et al. 2002). The different types of nematode found by Ponce Gordo et al. (2000) were *Libyostrongylus* sp., *Ascaridia* sp., *Codiostomum* sp., *Capillaria* sp. and Mattos et al. (2011) discovered *Ascaridia* sp., *Codiostomum* sp., *Capillaria* sp. and *Heterakis dispar*.

The major ectoparasites of ostrich includes: *Struthiolipeurus struthionis* (Deeming 1999, Jurjda 2002, Cooper 2005), *Struthiolipeurus nandu, S. rheae and S. stresemanni* (Yaman and Durgut 2005, Taylor et al. 2007), *Hyalomma* sp., *Ambylomma* sp., *Rhipicephalus* sp. and *Gabucinia bicaudata* (Jeffery 1996, Deeming 1999).

The major gastrointestional parasites in emu includes: Protozoan- *Cryptosporidium* sp. *Eimeria* sp. and *Giardia* sp. (Ponce Gordo et al. 2002, Foreyt 2005), *Isospora* sp. and *Entamoeba* sp. (Teixeira 2013), Coccidian (Stewart 1994, Papini et al. 2011), Cestode- *Davainea* sp. (Foreyt 2005) and *Raillietina* sp. (O'Calleghan et al. 2000), *Fasciola hepatica*, a trematode (Vaughan et al. 1997, Soares et al. 2007), nematode- *Ascaridia* sp., *Strongylida* sp. (Teixeira 2013), *Capillaria* (Jansson and Christensson 2000), *Paradeletrocephalus* sp. and *Deletrocephalus* sp. (Rickard et al. 1997) and *Dromaestrongylus bicuspis* (Foreyt 2005) and major ectoparasites of emu are *Dahlemhornia asymmetrica, Gabucinia sculpturata* (Taylor et al. 2007), *Simulim* sp. and *Cullicoides* sp. (Craig 1993).

1.3 Objectives of the Study

1.3.1 General Objective

To determine the distribution of endoparasites of ostrich and emu in Ostrich Nepal Pvt. Ltd. Gongoliya, Rupendehi.

1.3.2 Specifec Objectives

a. To determine the prevalence of gastrointestinal parasites of ostrich and emu.
b. Assessment of knowledge, attitude and practice (KAP) of labour working in the Ostrich Nepal Pvt. Ltd., Gongoliya, Rupendehi.
c. Management practices of ostrich and emu farming in the Ostrich Nepal Pvt. Ltd., Gongoliya, Rupendehi.

2. LITERATURE REVIEW

2.1 Background

Ostrich farming has been commercially practiced from 1860s at South Africa and has been successfully breed in Canada, the United States, Australia, Spain, Italy, United Kingdom and many other countries (Huchzermeyer 1994). Before 1980s ostrich farming were practiced for its feathers only but after 1980s they were farmed for hides, fats, feathers and bones which have high value in international markets (Shanawany 1994). The first successful artificial hatching take place in 1857 in Algeria (Smit 1963). The artificial incubator for ostrich eggs was invented by Arthur Douglass in 1869 (Smit 1963). Outside South Africa, only a few large-scale operations exist in USA, Australia and Europe (Deeming 1999). These birds originated from Africa and currently commercial breeding has gained economic important worldwide due to the ability of these birds to adapt to different environment (Tully and Shane 1996). In mid-1980s the economical important of ostrich was recognized as interest in farming the birds re-emerged in the USA, Australia and Europe (Deeming 1999). Thus, ostrich farming began rapidly in 1980s through the America, Europe Australia and New Zealand and into Asia (Adams and Revell 2011).

Just like ostrich farming, emu farming has become popular and lucrative agricultural industry throughout the world (Orumbayev 2015). Emu are native to Australia and first emu farming commenced in Western Australia in late 1980s with the breeding of stock captured from wild by the aboriginal community (APL 1997, Menon et al. 2014). The first commercial scale of emu farming to produce meat, leathers, and fat began in 1987 (O'Malley 1997) and then the industry spread to Europe, North America, Asia, Africa (Thompson 1997). They are also contributes as agricultural pests by destroying insects as well as maintains the floral diversity in nature by dispersing a large viable seeds (Warale et al. 2014). Currently, these ratites are farmed for commercialized of their meat, skin, feathers and eggs and more recently for their fat (Grompone et al. 2005).

2.2 Ostrich and emu farming practices in Global Context

In most part of the world ratites farming (i.e. farming of ostrich and emu) is a new field of livestock production (Nemejc 2007) with broad utilization of their production (Nemejc and Lukesova 2012). In 1999, China has imported ostrich and emu from America, Europe and

Africa to start business (Kang et al. 2006). Ostrich were introduced in Iran by mid-1998 (Eslami et al. 2007). Ostrich and emu farm has established in 1997 in Al-Qussim region, Central Soudi Arabia (Agab et al. 2002) by importing 400 breeding ostriches and emus from France. In Arabian Penisula, ostrich were hunted for their meat, while Isrealis have farmed ostrich for their hides since they obtained eggs illegally from South Africa in 1983 (Adams and Revell 2011). There are also emu farm in Isreal (Amnon et al. 2011). Emu farmed also confined to Palastine and Saudi-Arabia (Agab et al. 2002). Emu farm were also reported in Lauisiana (Veazey et al. 1994).

Recently, emu farm has gained importance in India (Khyalia et al. 2014). West Godavari district in Andhra Pradesh started emu farming for the first time spread throught the country for the commercial purpose. Presently, emu farming is being carried out in large scale in Andra Pradesh, Gujarat, Maharashtra, Tamil Nadu, Karnataka, Orissa, Kerala, Delhi and some parts of Northern India (Khyalia et al. 2014).

Ostrich have been traditionally hunted in Namibia (South West Africa) for sports and for diamonds sometime found in their gizzards (Davies, 1993). There are seven ostrich farms in three states i.e. Kano, Kaduna and Plateau of Northern Nigeria (Mshelia et al. 2011). Botswana has the world's largest population of wild ostrich, indicating that the local climate is suitable for ostrich Production (Moreki and Koloka 2010). Dzoma and Motshegwa (2009) pointed out that the largest population of wild ostrich indicates Botswana to be potential candidates for rearing ostrich. Commercial ostrich production is still in its infancy in Botswana (Moreki and Koloka 2010, Sunday and Standard 2012). Emu farming has also established in Egypt (Agab et al. 2002). Cooper et al. (2008) discussed the historical, development and practiced of ostrich farming in Egypt which has numerous strengthen and oppurtunities to develop its ostrich sector. There are 43 provinces of ostrich farming in which 12 were rared for feather in 2002-2004 (Cooper et al. 2008).

Most European countries have been also developing Ostrich farms since around 1990s by importing birds from Africa and Israel (Deeming and Angle 1996). In 1994, the first ostrich farm was established in Portugal and all races of ostrich were breeded. Likewise, ostrich and emu farmed were established in Dinant, Belgium (Alison 2012). Ostrich have been farmed in the United Kingdom since, 1991 where eggs were imported from Namibia (Deeming et al. 1993).

According to Aichinger et al. (2007), ostrich were introduced in to Brazil in 1990s. In the Rio de Janeiro of Brazil there are 13 ostrich farms in nine municipalities (Ederli and Oliviera 2015). Breeding of emus especially in the Central Western of Brazil started in 1990s (Ederlia and Oliveira 2015). In late 1890s the Florida ostrich farm opened in Jacksonvile (Jones 2007). It was as a tourist's attraction featuring ostrich races and for their feathers and in the late 1990s most ostrich farm in Florida went out of business (Jones 2007). But in 1992, ostrich were reclassed as domestic livestock and were popular and tourist destination (Jones 2007). There is a National Canadian Emu Association. Emu farm was also reported in Ranch in Volusia country (Day and Stank 1996), Routland country (Saxton-Shaw et al. 2011), Texas and North Carolina (Panjgraphy et al. 1995) and Hongkong (Perkins and Swayne 2002). Though Australia is the native of emu farming yet United States has been gained the popularity very fast due in their resistance in wide range of climatic condition (Warale et al. 2014).

Ostrich farm began in 1980s in Australia and New Zealand (Adams and Revell 2011). Emu are rared commercial in many parts of the world for their meat, fat, skin and feathers which are of high economic value (Patodkar et al. 2009, Warale et al. 2014).

Now ratite production spread in many countries including the USA, Australia, Israel, France, New Zealand, China, Korea, Zimbabwe, Botswana, Namibia, the United Kingdom, Belgium, Holland, Poland and Canada (AAFC 1999). Most producers today are growing ratites for their meat, the hides, feathers, fat, eggs shell and other parts of the birds as by-products (Bodger and Goulding 2003). Ostrich feathers were adopted in ancient Egypt as symbol of justice and truth (Shanawany 1994). The medical importance of ostrich was demonstrated in human through corneal transplantation of ostrich eyes to entrance vision and use of its brain tissue to heat Alzheimer's disease (Shanawany 1994). In the Arabian Penisula, ostrich were hunted for their meat, while their skins were used to make protecting clothing (Shanawany 1994).

In 2011, by exporting only six breeders to Spain earned 14000 dollors as profit by UK (Adams and Revell 2011). Japan is considered as the most important costomers for importing ostrich leather and leather products from other countries (Carbujo 2006). Portugal also exports meat, leathers, feathers, breeders and slaugheters for the Protuguses, Europeans and world markets. In 1986, South Africa exported 90000 ostrich hides to the United States alone (Vyver 1992).

It is estimated that all over 300000 birds were slaughtered in South Asian in 1997, producing 9000 to 10000 tones of meat while about 420000 hides were processed (Adams and Revell 2011). Within Europe, Belgium, Italy, Portugal and Spain have the highest ostrich meat production, but the markets in these countries are still in their infancy and are largely dependent on imports from third countries that have a favourable economy scale and low costs (Carbujo 2006). There are about 2 million ostrich worldwide (Animal corner 2013). Today, the world population of emu is estimated to be around two million, out of which one million is estimated to be spread between North America, Peru, India and China and about 750,000 in Australia (Orumbayev 2015).

2.3 Ostrich and emu farming in National Context

With a very new concept of launching varieties of ostrich product to the Nepalese market, Ostrich Nepal Pvt. Ltd was established in 2008 AD at Tilotama municipality, Gongoliya-22, Rupendehi. It has started with an investment of one billion by importing 1,500 eggs from Australia. It is the largest ostrich farm in Asia, which is located at Gongoliya covering the land of Twenty two (22) bigha (8.81 Acers) and in Suryapur, Rupendehi covering a very big mass of land of one hundred and fifty (150) bigha (60 Acers). With the increasing demand of the farmers and also to give the production a bit of commercial and scientific upgradation this farm has also established itself in Bijauri, Dang where parents ostrich are kept covering a total land of altoghter 50 bigha. This farms has various procedures been through from egg production to hatching eggs to meat packaging and customer delivery. According to the manager now the company has entered the production phase. This Dashain (2014), the company sold 20 tones of ostrich meat in National market.

As ostrich farm, emu farm was also established in Ostrich Nepal Pvt. Ltd. in 2008 AD. As a whole in Nepal there are three Ostrich farm and only one Emu farm.

It has its higher mission of producing quality goods in a price which is affordable and appropriate for all and also have visualized itself to export meat of Rs. Five billion as well as leather, fat and feather of around Rs. 2.5 billion to the international market till 2020 (http//www.ostrichnepal.com).

2.4 Diseases Prevalence in ostrich and emu

Ostrich and emu are susceptible to various diseases like coccidiasis, nematodiasis, and respiratory diseases, bacterial, fungal and viral infections. The major ignorance part in this farming is its diseases. Although coccidiasis do not directly affect ostriches but it can cause bloody diarrhoea, weight loss, growth retardation, delay in egg laying which provides direct negative impact in the farming. Careless management practices, high bird density and confinement stress are the major threats in ostrich farming (Dingle and Shanawany 1999).

2.4.1 Infectious diseases of ostriches and emus

Reports published in recent years have shown a species specificity between the ratite groups regarding many infectious diseases (Tully and Shane 1996). The descriptions of viral, fungal and bacterial diseases are discussed below:

Viral disease agents

Ostriches and emus are found to be infected with various types of viral diseases. Among them some important viral diseases reported includes Arbovirus (Day and Stank 1996), Avian influenza (Calvijo et al. 2001, Manvell et al. 2003), New Castle disease virus (Shinde et al. 2012, Khyalia et al. 2014), Adenovirus (Hines et al. 1995), Avibirnavirus (Chin and Woolcock 1994), Avipox virus (Allwright et al. 1994).

Eastern Equine Encephalomyelitis (EEE), Western Equine Encephalomyelitis (WEE) and St. Louis encephalomyelitis virus have been isolated from ratites in the USA (Ayers et al. 1994, Tully et. al. 1992). At a Ranch in Volusia country, in between 1992-1994, 204 sera of domestic emu were collected and after examination, three different types of virus i.e. EEE, St. Louis and arbovirus were isolated from the sera (Day and Stank 1996). Likewise, EEE virus was also isolated from Southern Louisiana (Tully et al. 1992) and Routland country (Saxton-Shaw et. al. 2011). Adenovirus and Rotavirus from 2-week-old-emu chick were diagnosed (Hines et al. 1995).

Ostriches and emus were susceptible to infection with several Avian Influenza Viruses (AIV). AIV have been isolated from ostriches almost all over the world including South Africa (H7N1, H5N9, H9N2); Zimbabwe (H5N2); Holland (H5N9); America (H5N2, H4N6, H7N1, H7N3, H10N4) and Canada (H7N1) (Capau et al. 2000, Calvijo et al. 2001, Clavijo et

al. 2003, Manvell et al. 1998, Manvell et al. 2003). It was first reported from China (H9N2) (Kang et al. 2006).

AIV has been isolated from emu in Texax and North Carolina (H5N2 and H7N1) (Panjgraphy et al. 1995), Hongkong (H5N1) (Perkins and Swayne, 2002) and from dead emu in the Ein Gedi Oasis near the dead sea of Israel (H5N1) (Amnon et al. 2011). In November 1997, an outbreak of highly pathogenic avian influence in emu caused by H7N4 virus nears the town of Tamworth in northern New South Wales, Australia (Selleck et al. 2003). Similarly, first AIV surveillance was undertaken in Maharastra stage, India during the period 2010-2011 (Shinde et al. 2012). A total of 202 blood samples and 467 tracheal and clocal swabs were collected from eight emu farms and AIV H9N2 was isolated (Shinde et al. 2012).

New castle disease virus (ND) is caused by paramyxovirus type 1, which affect galliforms, passeriforms and psittacines in addition to other families including ratites (Samberg et al. 1989); China (Kang et al. 2006) and Maharastra, India (Shinde et al. 2012). An adenovirus was isolated from pancreas, kidney and lung of a dead 4-month old ostrich (Capua et al. 1994). This virus was also isolated from two weeks old emu chick of approximately 200g weight from specimen of liver and intestine and from an abdominal swab (Hines et al. 1995). New castle ND was found in emu from Gujarat (Khyalia et al. 2014).

Avibirnavirus identical to infectious bursal disease virus (IBDV) has been isolated from the bursa of immature ostriches in flocks in California and Florida where high flock mortality was observed (Chin and Woolcock, 1994). Avipox virus has been diagnosed in ostriches in the USA, Israel and South Africa (Allwright et al. 1994, Perelman et al. 1988). According to Tully and Shane (1996), virus can be transmitted by mosquitoes or by direct contact with a pox lesion and immature Ostrich chicks aged between two weeks and one year are most susceptible. Borna disease virus (BDV) has been identified in Israel in ostrich chicks (two to eight weeks old) raised under intensive conditions (Weisman et al. 1994). The affected bird died within four to eight days, due to dehydration (Weisman et al. 1994).

Tully and Shane (1996), have revealed six various types of virus from ostriches and emus which includes: EEE, WEE and St. Louis have been isolated from ratites in USA, New castle disease virus, Avibirnavirus from the immature ostriches in California and Florida, Avipox

virus from ostriches in USA, Israel and South Africa. Also Cooper et al., (2004) diagnosed New castle disease, AIV, borna disease Crimean-Congo hemorahigic fever and avipox.

Fungal and bacterial disease agents

Fungi and bacteria are the primary pathogens which affect ratite species. The most common fungal and bacterial disease of ostriches and emus includes: Aspergillosis (Kyoung 2001, Brown et al. 2008), Salmonellosis (Tully and Shane 1996), Erysipelas (Grifffiths and Buller 1991), Pasteuellosis (Akoha 1980), Mycoplasmosis (Mohan, 1993), Tuberculosis (Shane et al. 1993), Clostridial enteritis (Lublin et al. 1993, Shane et al. 1993, Kwon et al. 2004).

Aspergillus is a common respiratory infection due to mismanagement in avian species (Brown et al. 2008). Weight loss, lethargy and dyspnea are observed in *Aspergillus* infections (Kyoung 2001). Several reports of *Aspergillus* sp. were reported in ostriches (Perelman and Kuttin 1992, Terizich and Vanhooster 1993, Marks et al. 1994, Huchzemeyer 1999, Sancak and Paracikoulu 2005). In 2003 was published the first report of Aspergillosis due to *A. fumigates* in Iran (Sasani et al. 2003). *A. fumigates* is the most commonly isolated agent in Aspergillosis (Arne et al. 2011). *A. fumigants* (Sancak and Paracikoulu 2003, Khosravi et al. 2008, Shathele et al. 2009), *A. niger* and *A. flavus* (Perelman and Kuttin 1992) have been isolated. Recently, *A. fumigants* and *A. niger* have been identified in Iran ostrich farm (Araghi et al. 2014). *Aspergillus* sp. has been identified as a primary cause of death in Juvenile ostrich and emu (Marks et al. 1994). Chakravarty (1976) has reported a similar case of mycotic infection (Aspergillosis) in an emu in Delhi zoo. Recently, Aspergillosis has been reported from emu in Kerala (Karunakarna et al. 2010).

Various *Salmonelloa* sp. have been isolated from gastrointestinal tracts or all ratite species but the incidence of paratyphoid, *Salmonella* sp. (Tully and Shane 1996). Emu can be infected with *S. pullorum* pathogens which persist in game fowl and develop antibodies against these pathogens (Tully and Shane 1996). Emus have been reported to be susceptible to infection by *Erysipelothrix rhusiopathiae* (Grifffiths and Buller 1991). *Escherichia coli* were other bacteria which was isolated from specimens of liver and intestine and from abdominal swab (Hines et al. 1995) and from the conjunctiva and *staphylococcus* (Woolcock et al. 2000). In 1997, Lemarchand et al., found camphylo bactor like organisms associated with rectal prolapsed and proliferative enteroproctitis in emus. Also, *E. coli* has been isolated from emu (Hines et al. 1995).

There have been rare occurances of *Pasteurella* sp. isolated in ratites species (Akoha 1980). Likewise, *Mycoplasmosis cloacale* has been isolated from tracheal swabs of ostrich and emus (Mohan 1993).

Another bacteria *Mycobacterium avium* has been diagnosed in ostriches and emus in the USA and Canada (Shane et al. 1993). A number of Clostridial organisms have been isolated from various ratite species, including *Clostridium perfringens, C. colinum, C. chauvoei* and *C. difficile* (Lublin et al. 1993, Shane et al. 1993). *C. perfringens* has also been isolated from ostrich in Korea (Kwon et al. 2004). Another rare *Bacillus anthracis* has been diagnosed in South Africa in ostrich (Snoeyenbos 1965, Huchzermeyer 1997). Tully and Shane (1996) have reported bacterial disease includes: *Salmonella* sp. in ratites, *S. pullorum* in emu, Pasteuellosis in ratites, *Mycoplasmosis cloacale* in ratites, *Mycobacterium avium* in ostriches and emus in the USA and Canada and Clostridial enteritis in ratite.

2.4.2 Parasitic disease of ostriches and emus.

As all other higher organisms ostrich and emu are also suffered from both ecto and endoparasites but under farmed condition emus are more parasites free than ostriches (Nemejc and Lukesova 2012). They may be infested with their own specific parasites as well as with external and internal parasites of other birds, some parasites of ruminants and raccoons (Eslami et al. 2007). Further details analyses are needed to determine not only the host- specific status of ratite parasites, but also the risk of infection for other animals and humans (Ponce Gordo et al. 2002). Many species can parasites both birds including nematodes, cestodes, trematodes, protozoans. Usually careless management, high bird density as well as poor hygiene contribute to parasitic infection (Chang Reissig et al. 2001).

Endo parasites of ostrich and emu

Parasites of the digestive system (proventriculus, gizzard, small intestine and large intestine) as well as those of respiratory and circulatory system infest ratites. No parasites of the nervous system of veterinary importance were reported in them (Taylor et al. 2007). They are mainly infected with protozoans and helminthes parasites have been reported. The prevalence of gastrointestinal parasites is high in places where the conditions of life and basic sanitation are unsatisfactory (Teixeira 2013).

Protozoan parasites

In birds, protozoa can be found in the blood stream, internal organs and are important that cause diseases in digestive tract of these animals, including oropharynx, intestine and cloaca (Silvanose et al. 1998). Parasite problem in ratite facilitates can cause genera ill thrift, reduction in growth, poor reproductive results and even death. A number of intestinal protozoans including *Hexamita, Giardia, Trichomonas, Cryptosporidium* (Deeming 1999, Chang Reissig et al. 2001, Ponce Gordo et al. 2002, Cooper 2005).

Coccidia

Ratites have been found to be infected with *Cryptosporidium* sp. (Ponce Gordo et al. 2002, Foreyt 2005, Oliveira et al. 2008) in their intestine. Ostrich have been found to be infected with two different types of *Cryptosporidium* sp. (Sotiraki et al. 2001, Santos et al. 2005, Nemejc and Lukesova 2012). *Cryptosporidia* sp. has also been reported in the feaces of imported ostriches in Canada (Gajadhar 1993). In Europe, *Cryptosporidium* oocysts have been found in ostriches from Greece (Sotiraki et al. 2001). From Spain, Portugal, Netherlands, Belgium, Great Britain, France (Ponce Gordo et al. 2002). *Cryptosporidium* sp. is a genus commonly found in faeces of ostrich (Huchzermeyer 2002) and the same seems not occur with emus. *Cryptosporidium* sp. cause gastrointestinal problems that result in anorexia, diarrhoea and death in all species of ratites (Craig 1993). *Toxoplasma* sp. is wide spread zoonosis caused by *Toxoplasma gondii* which has isolated in Brazil (Paula 2009).

There are some reports which showed the presence of *Isospora* sp. and *Eimeria* sp. in ratites. Only one species of *Isospora* sp. was described by Yakimoff (1940), from an ostrich at a Russian zoo and was identified as *Isospora struthionis*. Other specimens have been in ostrich as *Isospora* sp. (Jansson and Christensson 2000, Ponce Gordo et al. 2002, Mattos et al. 2011) or *Eimeria* sp. (Sotiraki et al. 2001, Ponce Gordo et al. 2002). Both genera can be differentiated on the basis of number of sporocysts (Levine 1985). Oocyst of *Isospora* sp. and *Eimeria* sp. has been reported from Nepal (Poudel 2012). Likewise, oocysts of *Eimeria* sp. have also been reported in ostrich from Negeria (Ibrahim et al. 2006, Mshelia et al. 2010), Iran (Eslami et al. 2007), Czech Republic (Nemejc and Lukesova 2012), Botswana (Mushi et al. 2003) and North America (Wade 1992) in different state of Europe (Ponce Gordo et al. 2002). *Eimeria* sp. was also reported in emu (Ponce Gordo et al. 2002, Foreyt. 2005). Coccidiosis has been described in ostrich and emus however; infection was not confirmed as an important clinical problem in ratites (Stewart 1994) and mentioned as being a common

disease mainly in pups of emus (Jurajda 2002). Likewise, author Teixeira (2013), has been revealed oocyst of coccidian of genera *Eimeria* sp. and *Isospora* sp. in emus.

Flagellate

One of the important flagellate species is *Histomonas meleagridis*, a parasite of Turkeys and other gallinaceous birds causing inflammation of caeca and liver. It may infect ostriches in close contact with such birds and cause similar disease (Deeming 1999, Jurjda 2002, Ponce Gordo et al. 2002). Recently, *Histomonas* sp. was also isolated from Nepal (Poudel 2012). A *Trichomonas* (flagellate) infection can be acquired by ostriches via contact with pigeons and doves. It causes pseudomembraneous lesions in the upper digestive tract (Deeming 1999, Jurjda 2002). Since, *Trichomonas* do not form cysts (Levine 1985) their transmission should be by ingestion of live trophozoites in faeces.

Ratite have been found susceptible with *Giardia* sp. (Ponce Gordo et al. 2002, Foreyt 2005). In ostriches *Giardia* sp. has been described (Tully and Shane 1996, Huchzermeyer 1999). Many of the reports of trophozoites and cysts of *Giardia* sp. has found in ostrich (Wade 1992, Greinger and Ritchie 1994, Stewart 1994, Huchzermeyer 1999). Cyst and trophozonts of *Giardia* sp. has been identified in emus (Teixeira 2013). *Giardia* sp. rare in ratites, which seems not to be pathogenic in these birds (Teixeira 2013). Two species of spironucleus have been described from birds: *S. meleagridis* in Turkey and *S. columbae* from pigeons (Levine 1985) *S. meleagridis* have been found in several ostriches (Ponce Gordo et al. 2002). On the basis of morphology, flagellate compatible and in vivo movement. Likewise, trophozoites and cysts of *Giardia* sp. found in ostriches (Ponce Gordo et al. 2002). *Monocercomonas* sp., *Chilomastrix gallinarum* and *Pleuromonas* sp. were fairly common parasites of ostriches that seem to be non-pathogenic for them (Ponce Gordo et al. 2002). Also, trophozoites of *Retortamonas* sp. have been found in the intestinal contexts of ostriches and seem to be non-pathogenic (Ponce Gordo et al. 2002).

Ciliates

Balantidium struthionis is a ciliate and normal inhabitant in ostrich intestine, probably capable of becoming somewhat pathogenic under favourable condition (Huchzermeyer, 1999). This parasite was isolated from ostrich (Hegner 1934, Ponce Gordo et al. 2002, Ederli and Oliveira 2008). Mattos et al. (2011) has been reported *Balantidium* sp. in the faecal sample of ostrich from Rio Grande do Sul. This species is considered as ostrich specific

(Sotiraki et al. 2001). In Sweden and Nepal, Jansson and Christensson (2000) and Poudel (2012) respectively have been found a ciliate from ostrich that they classified as *Balantidium.*

Amoeba

Entamoeba cysts forming groups include non pathogenic species, some of them describe from birds: *E. gallinarum* of the eight – nucleate mature cysts group (or E. coli –like group), inhabits the caeca of Chicken, Turkey and Partridge (Levine 1985,) and a non determined species of the one – nucleate mature cysts group (or *E. bovis* – like group) has been found in the caeca and large intestine of ostriches (Craig and Diamond 1996, Martinez Diaz et al. 2000, Ponce Gordo et al. 2002). *Entamoeba* sp. has been reported for ostriches in Spain, Portugal, Belgium, France, Great Britain, Netherlands (Ponce Gordo et al. 2002), Greece (Sotiraki et al. 2001), Scotland (Pennycott and Patterson 2001) and Sweden (Jansson and Christensson 2000). The other types of amoebae have been found were *Endolimax* and *Iodamoeba* (Sotiraki et al. 2001, Ponce Gordo et al. 2002). However, in emus, no reports have been found (Teixeira 2013). Cysts and trophozonts of *Entamoeba* sp. has discovered in emu (Teixeira 2013).

Others

Under favourable circumstances, ostriches are susceptible to infection with species of Plasmodium transmitted by mosquitoes (Fantham and Porter 1943, Deeming 1999, Jurajda 2002, Copper 2005). *Leucocytozoon struthionis,* a parasite of the circulatory system is transmitted by arthropods (black flies) and commonly infects ostrich chicks in South Africa without causing clinical diseases (Bennett et al. 1992, Huchzermeyer 1994, Deeming 1999, Cooper 2005, Taylor et al. 2007). Treatment and control has not been reported yet (Taylor et al. 2007).

Helminthes

Ratites may be affected by various microorganisms such as bacteria, fungi, virus and parasites among which had already been reported helminthes of different genera and species includes: nematodes: *Bayliscaris* sp., *Libyostrongylus* sp., *Ascaridia* sp., *Orthocerca douglassii, Paranchocerca struthionis, Deletrocephalus dimidiatus, Paradeletrocephalus, minor* and *Chandlerella quiscali* (Craig and Diamond 1996), besides *Capillaria* spp.(Jansson and Christensson 2000), cestode: *Huttuynia struthionis* and trematode: *Philophthalmus gralli* (Ponce Gordo et al. 2002).

Cestodes

Tapeworm *(Houttuynia struthionis),* that belongs to the family Davaineidae. It is a parasite of the small intestine and major endoparasites of the ostrich and rhea (Nemejc and Lukesova 2012, Ederli and Oliveira 2014) where as cestode *Davainea* sp. is major endoparsite of emu (Ederli and Oliveira 2014). *Houttuynia struthionis* causes unthriftiness is diarrhoea mainly in ostrich chicks (Jurajda 2002, Ponce Gordo et al. 2002 Blood et al. 2007). In South Africa, frequent occurance of this tapeworm has been reported in chicks and pasture raised ostriches (Dingle and Shanawany 1999, Jurajda 2002).

The tapeworm has also been spread to Europe with ostriches imported from Africa and it was diagnosed sporadically in the USA too (Jurajda 2002, Copper 2005). They are large flat, segmented white worm of about 50 to 100cm length (Deeming 1999, Dingle and Shanawany 1999). The life cycle and intermediate host of this tapeworm is unknown (Deeming 1999, Jurjda 2002, Taylor et al. 2007). Ostrich chicks are the most suspectible and show signs of

infestation very slowly: gradually loss of appetite, sometimes accompanied by mild diarrhoea ((Dingle and Shanawany 1999, Taylor et al. 2007).

Another host specific cestode parasite of emu i.e. *Davainea* sp. has been isolated in small intestine of emu (Foreyt 2005). However, there are no reports of cestode in emu or the impact of this on these birds much less it zoonotic potential (Teixeira 2013). *Raillietina beveridgei, R. chiltoni, R. dromaius* and *R. mitchelli* have been described from the small intestine of farmed and wild emus from South Australia (O'Calleghan et al. 2003). A new species differ from *R. australis* and from each other in the size and number of rostellar hooks and in the dimension of the cirrus sac (O'Calleghan et al. 2000). Teixeira (2013) recovered eggs type of cestode.

Nematodes

A nematode *Libyostrongylus* sp. (wireworm) is the parasite of small intestine and major endoparasite of ostrich is one of the most important pathogenic nematode, producing a diseases known as rotten stomach which can cause high mortalities among juvenile ostrich (Nel 1980, Foggin 1992, Lordman and Broonneberg 2004) and occasionally, also to adults (Jansson and Christensson 2000). This wire worm are very small, round, wire-like, yellowish red worms of about 3mm long, male being 4-6mm and female 5-6mm long (Taylor et al. 2007).Wireworms are very small, round, wire-like, yellowish red worms of about three milimeter long, male being 4-6 mm and female 5-6 mm long (Taylor et al. 2007). Mature worms and late larval stages lives in the crypts of the glandular portion of the proventriculus and gizzard wall (Deeming 1999). Three species of *Libyostrongylus* have been reported from ostriches: *L. douglassii, L. magnus* and *L. dentatus*. However, The *Libyostrongylus* i.e. wireworm is the species consider to be more pathogenic for ostriches (Hoberg et al. 1995), producing a disease known as "rotten stomach" which cause high mortalities among the juvenile ostriches (Nel 1980, Foggin 1992, Dingle and Shanawany 1999, Mushi et al. 2003, Mustapha 2003, Lordman and Bronneberg 2004) and Occasionally, also to adults (Jansson and Christensson 2000). In 2000, Jansson and Christensson have reported the first finding of *L. douglassii* from emus in Sweden. Of these, only *L. douglassii* has been reported in ostriches from Portugal, Spain, Belgium, Netherlands (Ponce Gordo et al. 2002), Australia (Barton and Seward 1993), Sweden (Jansson and Christensson 2000), Greece (Sotiraki et al. 2001), Czech Republic (Nemejc and Lukesova 2012), Croatia (Tisljar et al. 2007), Brazil (Bonadiman et al. 2006, Ederli et al. 2008, De Andra et al. 2011), Nigeria (Ibrahim et al.

2006, Mshelia et al. 2010), Iran (Eslami et al. 2007), New Zealand (Mckenna 2005). In Udarine, *L. magnus* has been reported in ostriches originating from Ethiopia and *L. dentatus* in USE originating from Ethiopia and *L. dentatus* in USA originating from Tanzania (Huchzermeyer 2002). Egg of *Libyostrongylus* sp. has been also reported from ostrich in Nepal (Poudel 2012). Another *Strongyloide* nematode i.e. *Dromaestrongylus* sp. is a parasite of small intestine and major endoparasite of emu (Foreyt 2005). Egg and larva of such type of *Strongyloide* have been diagnosed in emu (Teixeira 2013). Likewise, egg of *Ascaridia* sp. have been diagnosed in emus (Teixeira 2013).

The genus *codiostomum* sp. is composed of a single species *C. struthionis* nematode parasite has been found in ostrich which is slightly larger roundworm that inhabits in the large intestine and caeca of the ostriches (Huchzermeyer 1994, Deeming 1999, Dingle and Shanawany 1999, Jurajda, 2002, Blood et al. 2007, Ederli et al. 2008). *Codiostomum* sp. is about 1-1.5cm long and white (Dingle and Shanawany 1999, Taylor et al. 2007). It is relatively harmless (Huchzermeyer 1994) but heavy infections are likely to be dangerous (Jurajda 2002, Blood et al. 2007). This parasites have been isolated from Spain and Great Britian (Ponce and Gordo et al. 2002), Sweden (Jansson and Christensson 2000), Greece (Sotiraki et al. 2001), Rio Grande do Sul (Mattos et al. 2011), Brazil (Oliveira et al. 2009, Fagundes et al. 2012), South Africa (, Warmser 1930, Huchzermeyer 1994) and Czech Republic (Nemejc and Lukesova 2012). Egg like *Codiostomum* sp. has been revealed from ostrich in Nepal (Poudel 2012). Nematode *Libyostrongylus* sp. and *Codiostomum* sp. have been considered to be specific parasites of ostrich (Teixeira 2013, Ederli and Oliveira 2014). Exclusive nematode *Codiostomum* sp. was of ostrich (Dingle and Shanawany 1999).

Another nematode known as *Capillaria* sp. has been recorded in the faecal samples of both captive and free living ostriches in North East Nigeria (Ibrahim et al. 2006), different states of Europe (Ponce Gordo et al. 2002) and Rio Grande do Sul (Mattos et al. 2011). In 2000, Jansson and Christensson have been found *Capillaria* sp. eggs in emu samples from Sweden. *Heterakis dispar*, a nematode common in poultry has been also recorded in the alimentary canal of ostriches on farm in Iran (Eslami et al. 2007) and Rio Grande do Sul (Mattos et al. 2011). It has the first report in ostriches. A gonad-infecting of great clinical importance nematode is *Bayliscaris*, which is transmitted to ostriches in the USA by skunks and raccoons through faecal material in which the eggs remain viable in the soil for years (Cooper 2005). *Bayliscaris procyonis* was identified in ostrich and emu causing cerebrospinal nematodiasis

(Kazacos et al. 1991) while Verminous encephalitis infection with *B. columnaris* in an emu (Kazacos et al. 1982, Craig 1993). *Baylisascaris* sp. has been identified in ostriches and emus (Kazacos et al. 1982, Craig 1993).

Unidentified species of *Serratospiculum* like egg has been found in ostrich faecal sample from ostrich farm of Nepal (Poudel 2012). *Dicheilonema spicularum* (Guinea worm) is a filarid nematode parasiting in the subperitoneal connective tissue (Jurajda 2002). *Struthiofilaria megalocephala* that affect body cavity of an ostrich and *Paronchocerca struthionis*, a filarid nematode is a parasite of the respiratory system recovered from the lungs of an ostrich in West Africa (Jurjda 2002). In the study conducted by Rickard et al. (1997), eggs have been found suggestive of *Paradeletrocephalus* and *Deletrocephalus* in faeces of emu. Another nematode *Ascaridia struthionis* has been reported from ostriches in Italy (Yamaguti 1961). *Ascaridia* sp. in North Eastern Nigeria (Ibrahim et al. 2006), in different state of Europe (Ponce Gordo et al. 2002), Rio Grande do Sul (Mattos et al. 2011) and in Nepal (Poudel 2012) and from emu (Teixeira 2013).

One of the host specific *Strogyloide* nematode of emu, i.e. *Dromaestrongylus* has been found in small intestine of emu (Foreyt 2005). Haemorrhagic tracheitis is caused by *Syngamus trachea* in emus. *Syngamus trachea* is transmitted by ingestion of its intermediate host with infectious larvae or eggs from the ground. The definitive hosts are gallinaceous and singing birds. Affected birds shake their heads and symptoms of dyspnoea are present (Jurajda 2002). This parasite of chickens, turkeys, game birds and various wild birds is worldwide distributed (Taylor et al. 2007). *Cyathostoma variegatum* affects trachea and bronchi of ducks and emus (Rickard et al. 1997, Nemejc and Lukesova 2012). It is a strongylid nematode 0.4-3 cm long. Females are larger than males. It has been reported to cause severe respiratory disease in young emus in Australia. A number of hosts may be involved in transmission. Filariid nematodes *Chandlerellla quiscali* were removed from the spinal cord and lateral ventricles of the brain of Emus (Stewart 1994, Foreyt 2005). This parasite is transmitted by Cullicoides midges, and viscera larval migration occurs before the bird reach one year of age. Generalized neurological signs accompany *Chandlerella* sp. infestation and diagnosis is made at necropsy (Tully and Shane 1996).

Trematode

Philophthalmus gralli is the only trematodes species described from ostrich, which has been found in the nictitating membrane of ostrich in Florida (Greve and Harrison 1980). It has been reported in cases of severe eye irritation and discharge in capitive ostriches in Florida (Kocan and Carawford 2007). An unidentified trematodes sp. has been found by Ponce Gordo, et al. (2002) in Europe. An adult fluke has been recovered from the liver of one of the birds of emu and has been identified as *F. hepatica (*Vaughan et al. 1997*,* Soares et al. 2007).

Ectoparasites of ostrich and emu

Several species of ectoparasites affect ratites of all ages, both ratite specific and non-specific parasites species. Lice and mites can be found by examining the skin and feathers, especially around the vent, legs, wings and neck (Dingle and Shanawany 1999). Birds infested with ectoparasites generally exhibit irritation and react by scratching.

Ostriches and emus have been found to be infested with different types of lice, mites, ticks and flies. These types of infestation may lead to infectious diseases in ostriches Feather lice (*Struthiolipeurus struthionis*) do not suck blood but feeds on the feathers, resulting in skin damage, pruritius and excessive feathers preening and losses in ostriches. They are narrow bodied lice with large heads (Taylor et al. 2007). The lice and eggs can be seen in feathers closed to the skin (Van Heerden et al. 1983, Jefferey 1996, Hoover et al. 1998, Jurjda 2002, Cooper 2005, Yaman and Durgut 2005, Cooper and EI Doumani 2006, Taylor et al. 2007). *Struthiolipeurus* eggs were deposited on feathers barbs on both sides along the shaft (Van Heerden et al. 1983, Deeming 1999). Other different types of lice may also have been found in ostrich including *Struthiolipeurus nandu, S. rheae* (Ponce Gordo et al. 2002, Yaman and Durgut 2005, Taylor et al. 2007, Almeida et al. 2008), *Struthiolipeurus stresemanni* (Yaman and Durgut 2005, Taylor et al. 2007) while *Dahlemhoria asymmentrica* is an emu louse (Taylor et al. 2007).

A number of ticks of various species (*Hyalomma* sp., *Ambylomma* sp., *Rhipicephalus* sp.) have been reported in ostriches their main significance being disease vectors (Jeffery 1996, Deeming 1999). High infestation is associated with areas of high rainfall and dense vegetation (Dingle and Shanawany 1999, Cooper 2005). *Riphicephalus* sp. has been reported from ostriches in Portuguse farms (Cortes et al. 1999).

Different species of mites have been found in ostriches. Ostrich quill mites or shaft mites or feather mites (*Gabucinia bicaudata*) live in the vein in the ventral groove of the feather shaft

and feeds on blood and gelatinous contents of the feather sheath. They can be visualized as small, reddish, dust like elongated particles in the feather vein (Jefferey 1996, Deeming 1999, Jurjda 2002, Ponce Gordo et al. 2002, Cooper 2005, Cooper and EI Doumani 2006, Taylor et al. 2007). Other mites that have reported in ostriches were *Gabucinia sculpturata* (Taylor et al. 2007), *Gabucinia* sp. (Poudel 2012), *Dermoglyphus pachyenemis* (Ponce Gordo et al. 2002, Poudel 2012) and *Struthiopterolichus bicaudatus* (Almeida et al. 2008). *Gabucinia sculpturata* is a mite which has been found in emu (Taylor et al. 2007). The Hippoboscid fly (*Struthiobosca struthionis*) have been discovered in these birds (Ormerod 1900, Jurjda 2002). Mosquitoes and blackflies (*Simulim* spp.) regularly feed on ostriches and emus and in addition to causing irritation they can also transmit a number of infectious diseases (Craig 1993). Some species of family of Cullicoides acts as a vector of *Plasmodium struthionis* and *Leucocytozoon struthionis* and mechanical transmitters of fowl pox virus or filariosis in ostriches and emus (Craig 1993, Deeming 1999, Mushi et al. 1999). These arthropod infestations cause blood loss, irritation and stress and transmit other parasites (Craig 1993). Infestations by lice, flies, mites and ticks can be treated by regular and through spraying with synthetic pyrethrin or by dosing or injecting with Ivermectin (Jeffery 2001) which prevent both ectoparasites and endoparsites. Most scientific publications and articles all over the world are devoted to ostriches but very few materials are focused on aspects of emu (Nemejc and Lukesova 2012).

3. MATERIALS AND METHODS

3.1 Study Area

The study was carried out at Ostrich Nepal Pvt. Ltd. which lies Gongoliya-22, Tilottama municipality, Rupendehi district, Lumbini zone, Nepal. Gongoliya is situated three km. east

from Madhaulia, Siddhartha highway. It has tropical climate, summer with a warm and winter with cool, dry and humid. The average temperature ranges from 25°C to 37°C.

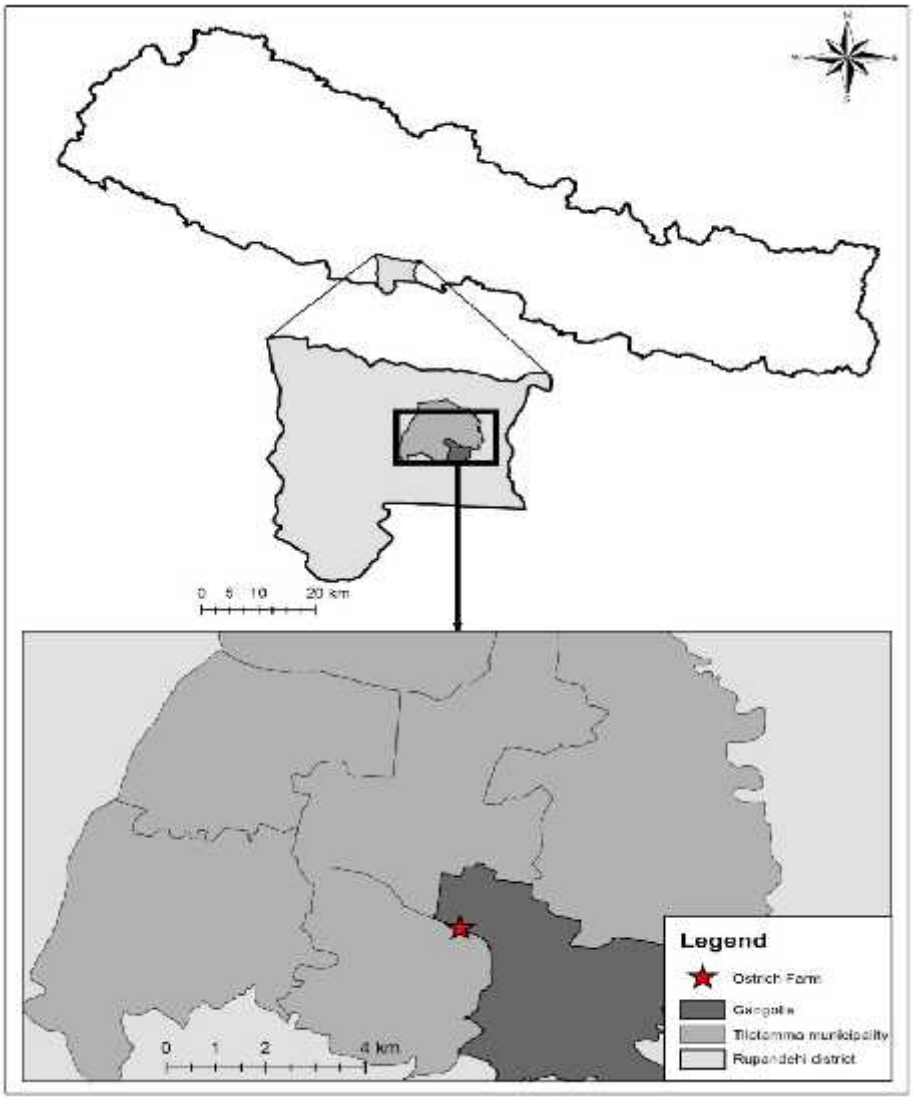

Fig:1 Map of Nepal including Gongoliya showing study area.

3.2 Materials

During the research the materials used have been listed below:

3.2.1 Materials for field

i. Sterile vial
ii Camera
iii. Polythen bag
iv. Globes

3.2.2 Materials for Laboratory

i. Beaker
ii. Gloves
iii. Volumetric flask
iv. Measuring cylinder
v. Centrifuge machine
vi. Cotton
vii. Stage micrometer
viii. Ocular micrometer
ix. Motor/Pestle
x. Slide
xi. Dropper
xii. Toothpick
xiii. Centrifuge tube
xiv. Electric microscope
xv. Mask
xvi. Glass rod
xvii. Cover slip
xviii. Tea strainer
xix. Niddle
xx. Electric balance
xxi. Refrigerator
xxii. Glass rod

3.3 Chemicals

Potassium dichromate ($K_2Cr_2O_7$)
Saturated Sodium chloride (NaCl) solution
Lugol's Iodine solution
Distilled water (D/W)
Methylene blue

3.4 Study Design

The present study was designed to assess the intestinal parasitic infection of ostrich and emu. The study was divided into following three phases to fulfill the objectives.

a. Faecal sample collection, preservation and examination for the identification of trophozoites and cysts of protozoa and eggs and larvae of helminthes parasites.
b. Questionnaire survey for assessment of the knowledge, attitude and practices (KAP) of labour working in the Ostrich Nepal Pvt. Ltd., Gongoliya, Rupendehi.
c. Questionnaire survey, observational study and secondary information collection to assess the management system of ostrich and emu farming in Ostrich Nepal Pvt. Ltd.

3.4.1 Faecal sample collection, preservation and examination.

Faecal sample collection

Fresh faecal samples were collected from ostrich and emu, using clean plastic bags by taking great care to collect only the fresh faeces of ground. All the faecal samples were collected during early morning in order to get good result and later transferred into clean, leak-proof sterile vials with 2.5% potassium dichromate. All the samples collected were labeled properly.

Preservation of samples

Collected faecal samples of ostrich and emu were preserved in 2.5% Potassium dichromate solution (5gm potassium dichromate powder dissolved in 200ml of distilled water) that help in maintaining the morphology of protozoan parasites, helminthic eggs and larvae.

Sample size

Altogether 200 sample were collected, 100 each from ostrich and emu. The samples were collected from Ostrich Nepal Pvt. Ltd., Gongoliya during months of May/July 2015. During the time period every 15 days interval, nearly 15-17 faecal samples each from ostrich and emu were collected.

These samples were transported to the laboratory of the Central Department of Zoology, Tribhuvan University, Kathmandu in preservatives and refrigerated and was conducted following techniques for the isolation and identification of eggs, cysts, trophozoites and oocysts present in faeces.

Microscopic Examination

The samples were examined at the laboratory of Central Department of Zoology, Tribhuwan University, Kirtipur by using concentration method (flotation and sedimentation) as follows:

Concentration method

Following floatation and sedimentation technique were applied for the detection of parasitic eggs, larvae, trophozoites and cysts (Poudel 2012, Teixeira 2013).

a. Differential Floatation Technique

Floatation involves suspending the specimen in a medium of greater density than that of the helminthes eggs and protozoans cysts. This technique ensures the egg float in the floatation liquid, which helps to identify the eggs (Poudel 2012).

Approximately 3 gm of faecal sample was taken in a beaker and added 20 ml of water then the sample was grinded lightly with the help of motor and pistle and filter the solution by tea strainer. The filtrate solution was poured into a centrifuge tube of 15 ml and centrifuged at 1000 rpm for 5 minutes. The tube's water was replaced with saturated sodium chloride solution and again centrifuged.

After centrifuge more saturated sodium chloride solution was added to develop convex surface at the top of the tube and one drop of methylene blue (to stained) where a cover slip can be placed for a few minutes and then cover slip was removed and placed on a slide and examined under microscope at 10X and 40X.

b. Differential Sedimentation Technique

Concentration of intestinal parasites by sedimentation techniques, using either gravity or centrifugation leads to a good recovery of cysts of protozoa and eggs of helminthes cysts (Poudel 2012).

Saturated salt solution was removed gently from the test tube after examined the flotation portion and poured the sediment content into the watch glass and stirred the content gently to mix it. One drop from the mixture was taken to prepare a second slide. The specimen was stained with iodine wet mounts solution.

In this way two slides were prepared from one sample (one from floation and one from sedimentation) were examined under 10X and 40X of microscope to detect eggs of helminthes and trophozoites or cyst of gastrointestinal protozoans.

c. Microphotography

The parasite, trophozoites eggs or cysts detected under microscope at 10X and 40X were photographed using microscopic camera for futher verification with published literature (Teixeira 2013).

3.4.2 Questionnaire survey to assess KAP towards ostrich and emu.

A questionnaire survey was conducted amongst 19 labours of Ostrich Nepal Pvt. Ltd. Details knowledge about the features of ostrich and emu, diseases prevalence in farm, veterinary facilities were included in the questionnaire. The questionnaire also contained about questions related to different attitude of labours and feeding, cleaning practices way of distribution eggs and cages.

3.4.3 Management system in the farm

Assessment of overall management system was carried out by using following methodology:

a. Questionnaire Survey

A pretested, semi structured questionnaire was used for data collection. A set of questionnaire survey was conducted amongst the major staffs and director of farm. The questionnaire includes about the management system of farm, hatchery facilities, uses of these bird and marketing condition.

b. Observational Study

Observational study was basically focused on:

i. Environmental conditions, hygiene and sanitation in an around the farm as well as waste management system.
ii. Feeding observation.
iii. Health management.

3.5 Data Analysis

The collected data were analyzed and summarized in table and percentages. The collected data was analysed by using Microsoft Excel- 2007 and SPSS version 21.

Some Photo Plates

Photo 1: Questioning with labour of farm

Photo 2: Questioning with staff of farm.

Photo 3: Stool of ostrich

Photo 4: Stool of emu

Photo 5: Collection of stool of ostrich

Photo 6: Collection of Stool of emu.

Photo 7: Sample preservation of ostrich.

Photo 8: Sample preservation of emu.

Lab work Photos:

Photo 9: Running the centrifuge mechaine

Photo 10: Microscopic observation of slide

4. RESULTS

4.1 Gatro-intestinal parasites of ostrich and emu

A total of 200 faecal samples, 100 each from ostrich and emu were collected and microscopically examined using direct smear and concentration methods. Overall proportion of parasitic burden revealed 82% and 65% in ostrich and emu respectively which is statistically significant (X^2=7.419, p=0.006) (fig-2).

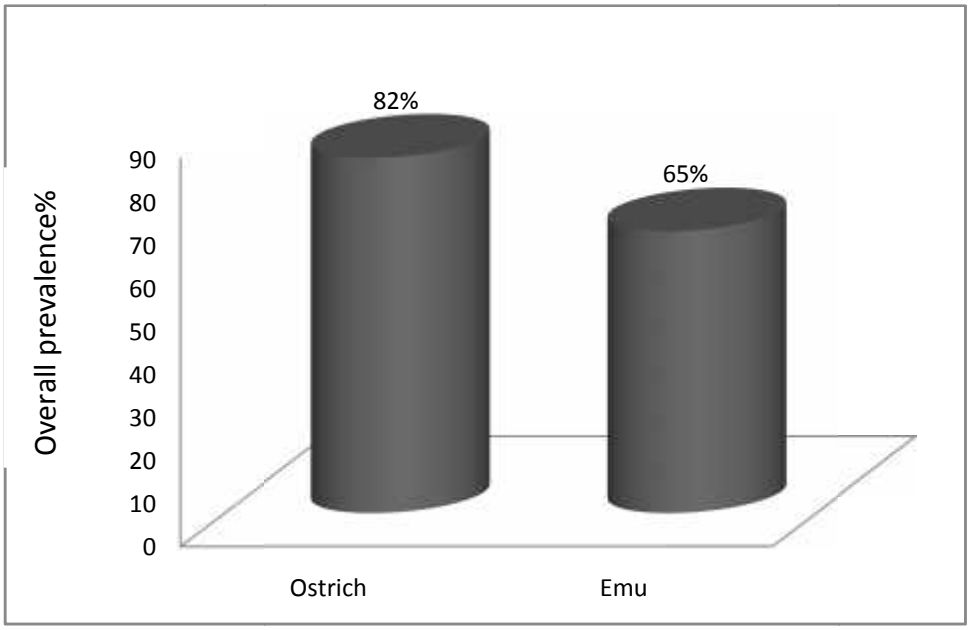

Fig: 2 Overall prevalence of gastro-intestinal parasites in ostrich and emu.

Comparasion of intestinal parasites of ostrich and emu revealed that, protozoan (65%) and nematode (54%) showed highest prevalence in ostrich as compared to emu. But cestode parasites showed comparatively higher prevalence rate in emu (14%) than in ostrich (10%). Association of protozoan (X^2=15.69, p=0.005) and nematode (X^2=13.98, p=0.005) parasites infection in ostrich and emu of Gongoliya ostrich farm show statistically significant association but association with cestode parasite is insignificant (fig-3).

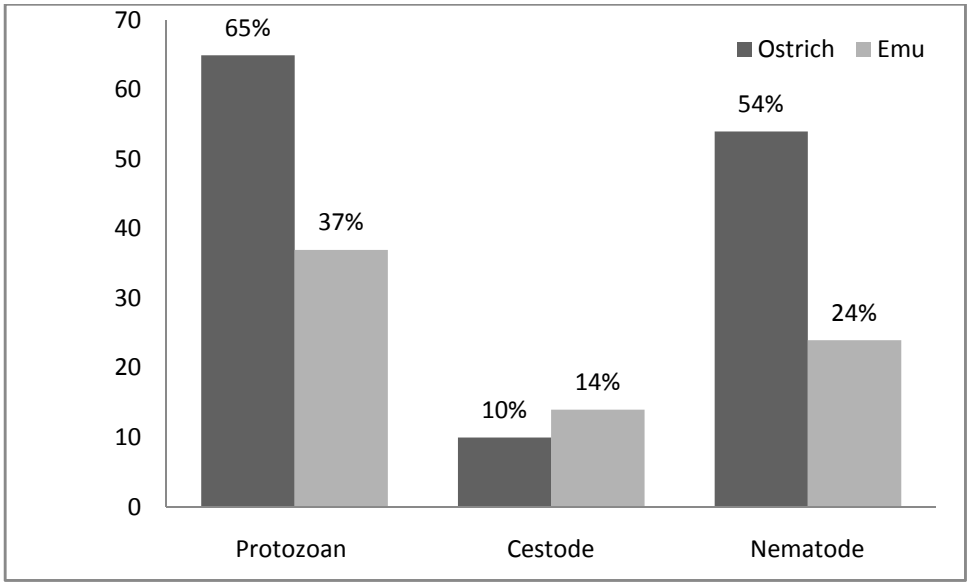

Fig: 3 Prevalence of intestional parasites in ostrich and emu.

Ostrich and emu were found to be infected with protozoan parasites particularly *Entamoeba* sp. as well as *Eimeria* sp. But the proportions of infection with these parasites were different. Ostrich were highly infected with *Entamoeba* sp. (X^2=35.066, p=0.000) while emu with *Eimeria* sp. (X^2=6.452, p=0.011) which is statistically significant. In addition ostrich were found to be infected with *Isospora* sp. as well as *Balantidium* sp. which were absent in case of emu.

Ostrich and emu were found to be infected with nematode parasites particularly *Ascaridia* sp. and *Heterakis* sp. But the proportion of infection with these parasites showed that ostrich were highly infected with both the parasites than emu. Species wise association showed that there is significant difference in proportion of *Ascaridia* (X^2=9.758, p=0.002). The host specific *Strongylus* sp. of ostrich *Libyostrongylus* sp. and emu specific *Dromaestrongylus* sp. was found almost equally infected. In addition, ostrich were found infected with *Codiostomum* sp. in the farm.

Similarly, both ostrich and emu were found infected with host specific cestode parasites. The result revealed, that 10% ostriches were found infected with Cestode i.e. *Houttuynia* sp. while emus where found infected with 9% and 5% of *Davainea* sp. and *Raillietina* sp. respectively (Table1).

During the faecal examintation some mite including *Gabucinia* sp. were also detected in ostrich and emu. The microphotograph of those mites were included in appendix (Appendix 2)

Table:1 Prevalence of gastrointestinal parasites in ostrich and emu.

1	Endoparasites	Prevalence in ostrich.	Prevalence in emu.	X^2-Value	P-Value
A.	**Protozoans**				
	a. Entamoeba sp.	48%	10%	35.066	0.000
	b. Eimeria sp.	15%	30%	6.452	0.011
	c. Isospora sp.	10%	0	10.526	0.001
	d. Balantidium sp.	4%	0	4.082	0.043
B.	**Cestodes**				
	a. Houttuynia sp.	10%	0		
	b. Davainea sp.	0	9%		
	c. Raillietina sp.	0	5%		
C.	**Nematodes**				
	a. Ascaridia sp.	34%	15%	9.758	0.002
	b. Libyostrongylus sp.	9%	0		
	c. Dromaestrongylus sp.	0	10%		
	d. Codiostomum sp.	11%	0	11.640	0.001
	e. Heterakis sp.	12%	5%	3.510	0.076

Single infection and double infection were almost similar in ostrich than multiple infection where as most of the samples were found of single infection in emu followed by double and multiple infection. While triple was only encountered in ostrich. More parasitic burden was observed in ostrich than in emu. The mixed infection in ostrich and emu is statistically significant (X^2=27.11, p=0.000) (fig-4).

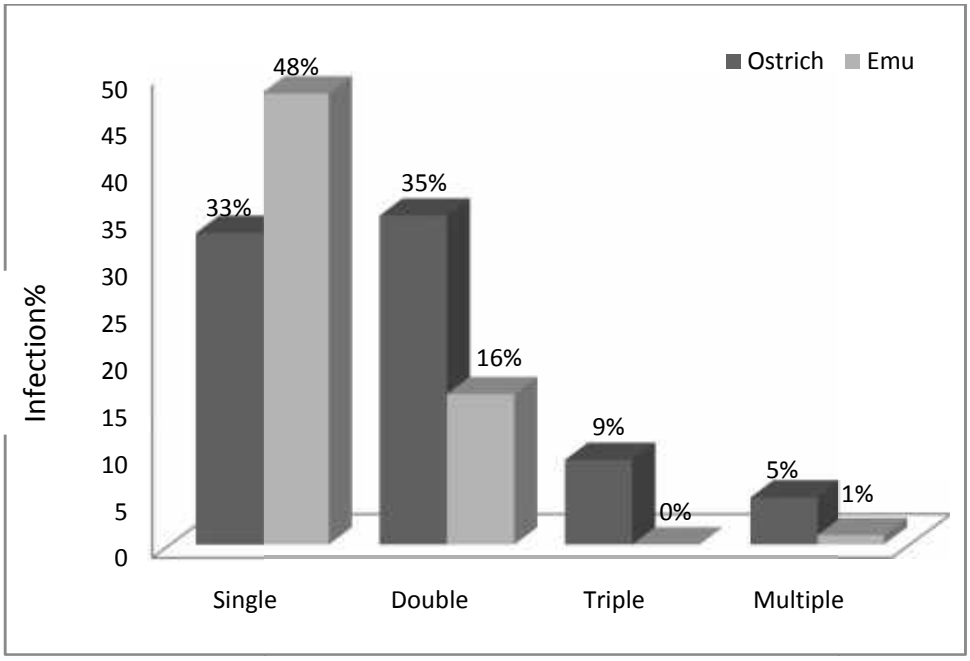

Fig: 4 Mixed Infections in ostrich and emu.

4.2 Assessment of knowledge, Attitude and Practice (KAP) of labour working in the Ostrich Nepal Pvt. Ltd. Gongoliya

The questionnaire survey was carried out among 19 labours working in the farm to assess their knowledge, attitude and practice using structured questionnaire.

Table: 2 Socio-demographic character of labour

Variables	**Characteristic (Range)**	**Proportion (N=19)**
Age group	Early adulthood(19-45 years old)	42.1%
	Midlife (46-60 years old)	52.6%
	Mature adulthood (60 above)	5.3%
Gender	Female	15.8%
	Male	84.2%
	Illitrate	5.3%
Education	Primary level (1-5 class)	26.3%
	Lower secondary level (1-8 class)	36.8%
	Secondary level (1-10 class)	31.6%
Work duration	2 and half years	63.2%
	4 and half years	5.3%
	Upto 7 years	31.6%

Among all the labours, majority (52.6%) belongs to Midlife followed by early adulthood (42.1%) and mature adulthood (5.3%). Gender wise distribution showed that (84.2%) of male were engaged in ostrich farm than female (15.8%). About, 5.3% labours were illiterate while rests all were literate. Maximum 63.2% labour were engaged from last two and half years followed by upto seven year (31.6%) and four and half years(5.3%) in overall care of the ostrich and emu.(Table2)

4.2.1 Knowledge of labour in relation to ostrich and emu farming

Most of the labours had knowledge about special features of ostrich and emu. Maximum (68.4%) of labours had knowledge about three features i.e. ostrich is largest and emu is second largest bird, ostrich has two toes while emu has three toes and both are flightless bird but 26.3% of labours had knowledge on more than three features thus added that they had small head, big eye, long neck and legs. Whereas, 5.3% had no knowledge about their features which was statistically insignificant with different age group and gender wise while significantly associated with level of education (X^2=24.596, p=0.005) and duration of work (X^2=12.23, p=0.016). Labours those who were literate and were working last two and half years had knowledge on special features of ostrich and emu (Table3).

Almost all labours 94.7% had knowledge on both similarity and dissimilarity between ostrich and emu. They put the view on similarity that both are flightless bird, both have small head, big eye, long neck and legs and in dissimilarity they said that ostrich has two toes while emu has three toes and ostrich is largest bird while emu is second largest bird in the world. The association was statistically insignificant with different age group and duration of work and was statistically significant with gender wise (X^2=5.630, p=0.018) and level of education (X^2=19.00, p=0.05). Mostly, male and those who are literate had knowledge about similarity and dissimilarity (Table3).

Most of labours had knowledge on their eggs. About 63.2% of labours have knowledge on two features thus, said that ostrich egg is white in colour and weight maximum 2.5kg and that of emu egg is green in colour and weight about 500gms. Likewise, 31.6% labour had more than two features. Futhermore, they said ostrich egg hatch within 42 days and emu egg hatch within 52 days. Also outer covering egg of both bird are used for decoration purpose. This association was found statistically significant with various level of education (X^2=19.724, p=0.003).

Ostrich farm of Gongoliya was found to be prevalence with diseases like Mycotoxicosis, Constipation, Diarrhoea and Colistodium. But only 11(57.9%) of labours had known few of these diseases. In the reasons of weight loss of these bird, 42.1% of labour thought is due to diseases where as 36.8% of labours told due to imbalance diet but 10.5% put their view on both the reasons and rest 10.5% where totally unknown about it(Table3).

Majority of labours, 73.7% told about the veterinary facilities given to the bird. According to them use of drugs, regular checkup are main facilities with a residential veterinarian.

Table 3 Knowledge of labour in relation to ostrich and emu farming

Knowledge related parameters	**Proportion (N=19)**	**Age P-value**	**Gender P-value**	**Education P-value**	**Work duration P-value**
Special features of ostrich and emu.					
a. Three features	68.4%				
b. More than three features	26.3%	0.520	0.43	**0.000**	**0.016**
c. Don't know	5.3%				
Similarity and dissimilarity.					
a. Having knowledge on both	94.7%	0.484	**0.018**	**0.000**	0.735
b. Don't know	5.3%				
Knowledge about their egg.					
a. Two features	63.2%				
b. More than two features		0.682	0.054	**0.003**	0.574
c. Don't know	31.6%				
	5.3%				
Diseases prevalence in farm.					
a. Two diseases	57.9%	0.622	0.348	0.081	0.195
b. Don't know	42.1%				
Reasons of weight loss.					
a. Diseases	42.1%				
b. Imbalance diet	36.8%				
c. Both	10.5%	0.68	0.530	0.103	0.067
d. Don't know	10.5%				
Veterinary facilities.					
a. Two facilities	73.7%				
c. Don't know	26.3%	0.096	0.084	0.360	0.771

4.2.2 Attitude of labour in relation to ostrich and emu farming.

Almost all the labours agreed that ostrich and emu can grow in different parts of Nepal. Most of labours thought that people will start consuming ostrich meat against chicken and other meat in the coming days. Some of them told ostrich meat is of cholesterol free, good for heart diseases patients and pregnant women. The association is statistically significant with gender (X^2=4.460, p=0.035). Maximum 73.7% of labours thought that ostrich and emu die in the farm were due to diseases while rests all were disagreed. About 36.8% of labours agreed that visitors carry various diseases dreadful to them. About, 26.3% of labours agreed that feed prepared for ostrich and emu might be contaminated with pathogenic sources (Table4).

Table: 4 Attitude of labour in relation to ostrich and emu farming.

Attitude related parameters	**Proportion (N=19)**	**Age P-value**	**Gender P-value**	**Education P-value**	**Work duration P-value**
Ostrich and emu can grow in different part of Nepal. a. Agree b. Disagree	100%				
People will start consuming ostrich meat against chicken and other meat. a. Agree b. Disagree	78.9% 21.1%	0.316	0.035	0.260	0.799
Ostrich and emu died in the farm were due to diseases. a. Agree b. Disagree	73.7% 26.3%	0.222	0.764	0.252	0.622
Visitors can carry various diseases dreadful to ostrich and emu. a. Agree b. Disagree	36.8% 63.2%	0.731	0.149	0.626	0.405
Feed prepared for ostrich and emu are decontaminated. a. Agree b. Disagree	73.7% 26.3%	0.161	0.764	0.889	0.774

4.2.3 Practice of labour in relation to ostrich and emu farming

Among 19 labours, those who were involved in feed preparation were found not wearing Apron, Gloves or Masks but in the slaughter house, labours were wearing Apron, mask, Cap and Gloves. It was noticed that, as the adult ostrich are dangerous so, the prepared food were taken in tracter and dropped in the yard for feeding. While for the emus since, food were carried in hand and dropped on ground as they loves ground picking. The farms provide single sources of water. Each water buckets were kept in the sides of cages so that water can be filled with pipes from outsides whenever necessary. In the breeding seasons ostrich start laying eggs from March to April while Emu start from December to January. Labours collect eggs laid by these birds. Then the eggs are separated. Well and full developed eggs are taken to hatchery room for hatching while those eggs whose weight is less than 12gm. and scratched eggs are sold. They told that full egg cost Rs.2000 and empty egg for decoration cost Rs.1000.

Occasionally, the bird dies in the farm in that case, maximum labours told that birds used to buried but some of them added that mature and fresh dead bird were buried only after skinning. After working in the farm labour found washing hand with soap and water.

Usually, the birds are shifted in different cages according to different criteria. In the farm there are total seven cages for ostrich and five cages for emu. Among these cages, in one cage Parent bird lying eggs of ostrich were kept but two cages for parent emu. Likewise, those ostriches which were ready for slaughters were kept in two cages while, for emu kept in only one cage. Those ostriches of Age group between one to five monthes were kept in three cages. Also emu of one to four monthes were arranged in two cages, while injured and sick birds of both ostrich and emu were also isolated from herd and kept in single cage.

4.3 Management practices of ostrich and emu farming in Gongoliya, Rupendehi

The questionnaire survey was carried out among staffs involved in management system similarly; observation was made in and around ostrich farm regarding management practice in ostrich and emu farming.

According to the management team, it was known that at present there are about 3500 ostriches and 1500 emus. Ostrich and emu have been managed at 22 bighas (around 13.54

hectares) area of land in seven cages of ostriches (each cage contain 200-300 ostriches) and five cages of emus (each cage contain 200-300) including farm office and housing. Height of each cage was managed above five feet. Ostriches and emus in the farm were kept for commericial purposes but it is not highly commercialized yet. Both ostriches and emus were provided with premix based compounded foods once a day in morning. Woven wires and poles were used as fencing materials. Colony configuration of breeding was practiced in the farm as a means of Reproductive practices. At present, near about 500 visitors comes to visit this farm in a day. The visitors in the farm were first sprayed with virgon before entering in the farm as decontaminants. Feeding and teasing for the birds are strictly prohibited in the farm by visitors. Besides, ostirch and emu farming, Kangaooes as well as fish farming have also been pacticed these days.

There is hatchery facility of these birds within the farm. Before, transporting eggs to hatchery ward, all the selected eggs were first cleaned by virgon with water of 42°C temperature. Then, was stored in AC room at 16 °C - 18 °C temperature for one week with 75-80% relative humidity (RH). After that eggs are transfer to incubator and incubate at 36 degree centgrate with 28-34% RH. After 15 days, eggs are scanned to see wheather it is fertilized or not if not then they are sold otherwise go on futher procedure. Once again within 35 days it was scanned to see development of chicks. It takes about 42 and 52 days for hatching ostrich and emu eggs respectively. Hatched chicks are then, transfor to next room with specific feed prepared for them.

In the farm, ivermectin antihelminthes drugs is given every interval of six months for deworming. No any diagnosed have been made for the treatment of disease. It was also found that no faecal examination was done till date for the diagnosed and treatment of parasitic diseases.

According to the staffs, hygiene and sanitation of ostrich and emu were mentioned by removing dropping regularly for chicks while in case of large birds dropping generally not removed. This might enhance the infection for disease transmission among birds. But according to them, eggs of these birds were not found infected with any disease. Ostrich were rared for their meat, skin leather, feather and eggs for decoration purpose. Likewise, emu were mainly rared for their meat, fat and egg for decoration purpose. There was high demand of their meat in the market. It has been known that ostrich meat with bone cost Rs.1000, without bone Rs.1700 and of emu meat cost Rs.990. It is being exported in Kathmandu,

Pokhara, Narayanghat and Butwal but was not able to fulfill the demand in the western part of country. Also not exported in international context.

4.3.1 Feeds supplement for ostriches and emus:

In wild state, ostriches mainly feed on seeds, grains, shrubs, grass, fruits and flowers; occasionally they also feed on insects such as locusts, worms, rodents, frog, lizards and field mice available in their harsh habitat. While emu eat fruits, seeds, growing shoots of plants, insects, other small animals and animal droppings but in wild condition they don't eat dry grasses or mature leaves even if they are available. In the captive state they were provided with premix based compounded foods which include grasses, wheat, maize, soyameals, vitamins and minerals and others (Table-5). But grasses are not given for emu as a food (Table-6).

Table: 5 Composition of feeds given to ostriches in the farm.

Composition of feeds	**Percentage**
Grass	50%
Wheat	12%
Maize	18%
Soyameal	17%
Vitamins and minerals	1%
Others (oil, NaCl, refined sugarcane juice)	2%

Table: 6 Composition of feeds given to emus in the farm.

Composition of feeds	**Percentage**
Wheat	32%
Maize	38%
Soyameal	27%
Vitamins and minerals	1%
Others (oil, NaCl, refined sugarcane juice)	2%

Extra vitamins and minerals were provided to Ostriches and Emus along with the foods. A deficiency of vitamin E and/or selenium causes the degeneration of the muscles, also reffered to as 'white muscles diseases'. The lack of calcium or phosphorus in the ration can lead to the development of soft bones leading to frequent and multiple fractures. Ostriches and emus fed on grain rations without vitamin supplement can develop vitamins B deficiencies, mainly affecting the skin of head. So, in the farm vitamins and minerals were added in the feed according to the schedule prepared by Pro Bio-Tech Industries Pvt. Ltd. in order to overcome the nutrients deficiencies in ostriches and emus and table included in appendix (Appendix 2).

Photos of Parasites of ostrich.

Cysts, Oocysts and Trohozoite of Protozoan Parasites:

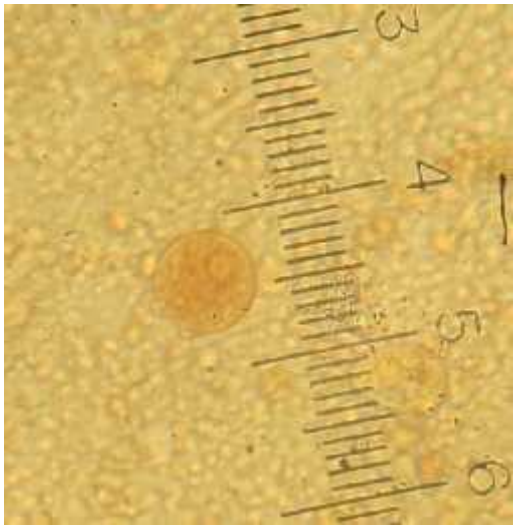

Photo 11: *Entamoeba* sp. *(40X)*

Photo 12:*Eimeria* sp. (40X)

Photo 13: *Isospora* sp. (40X)

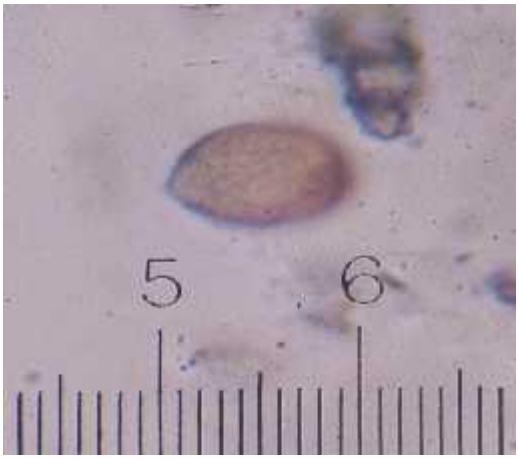

Photo 14: *Balantidium* sp. (40X)

Cestode Parasites:

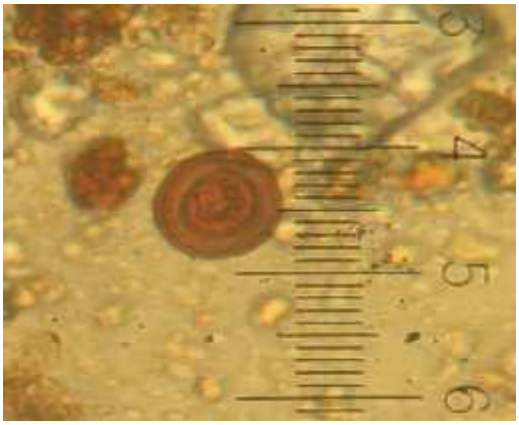

Photo 15: *Houttuynia* sp. *(40X)*

Nematode Parasites:

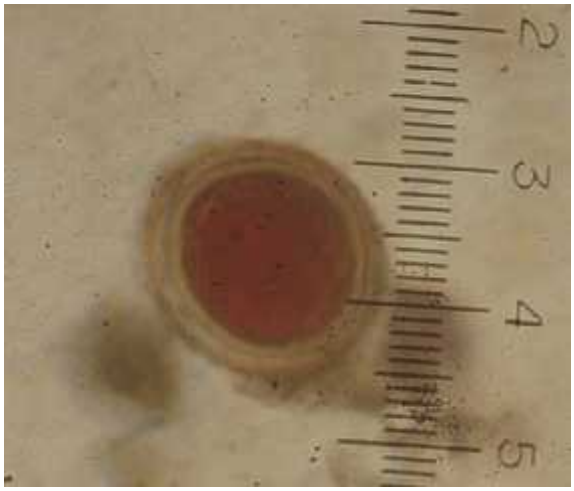

Photo 16: *Ascaridia* sp. (40X)

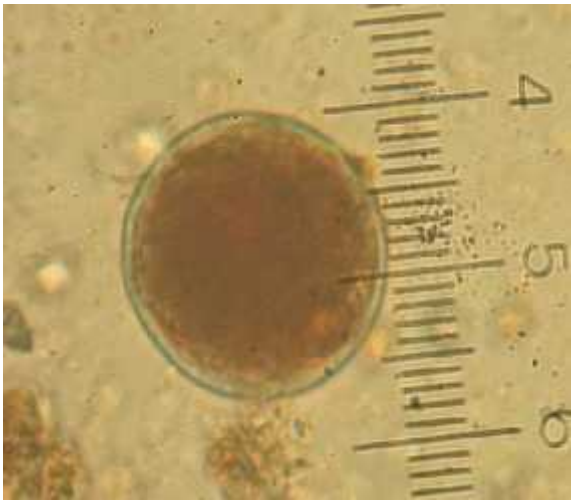

Photo 17: *Codiostomum* sp. (40X)

Photo 18: *Libyostrongylus* sp. *(40X)*

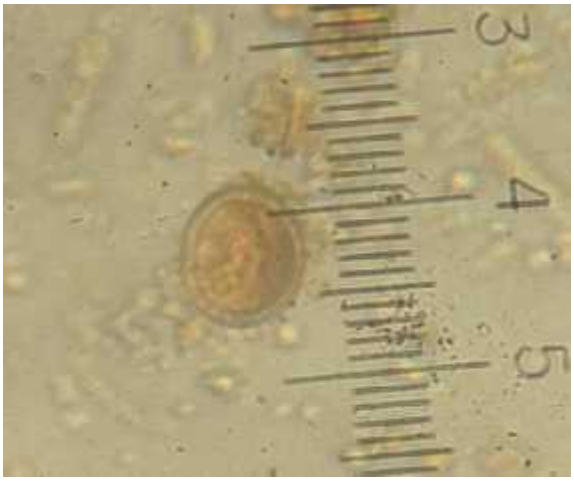

Photo 19: *Heterakis* sp. (40X)

Photos of Parasites of emu.

Protozoan Parasites:

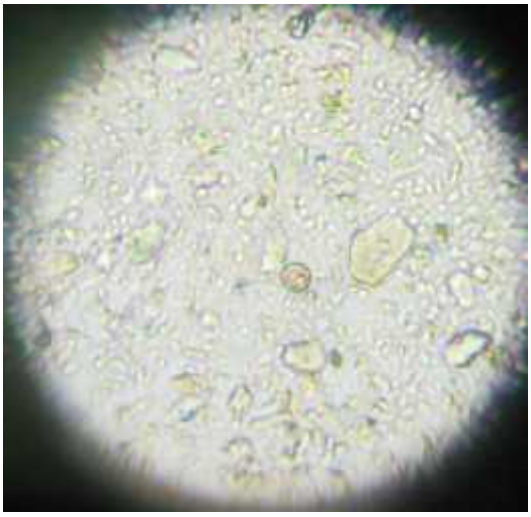

Photo 20: *Entamoeba* sp. (10X)

Photo 21: *Eimeria* sp. (10X)

Eggs of Cestode Parasites:

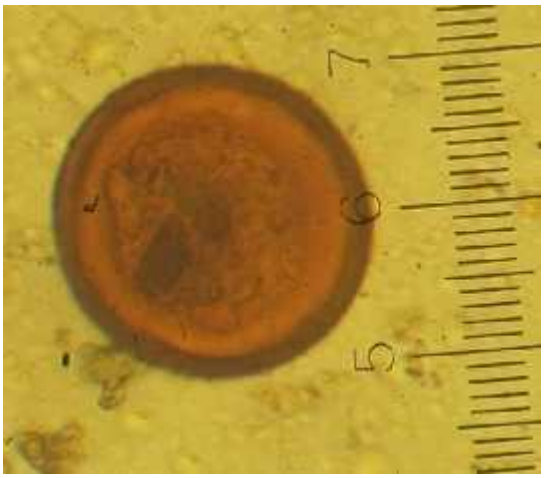

Photo 22: *Davainea* sp. (40X)

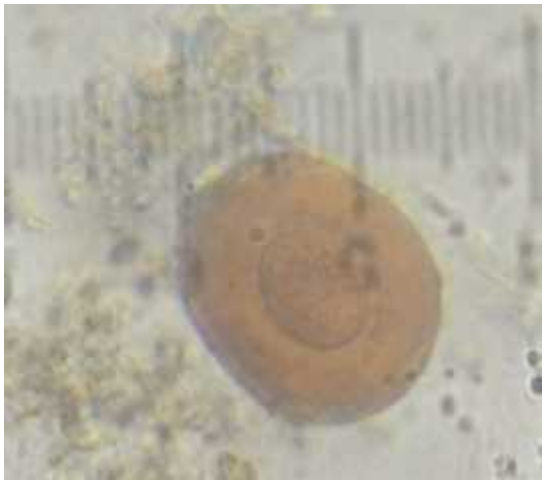

Photo 23: *Raillietina* sp. (40X)

Eggs of Nematode Parasites:

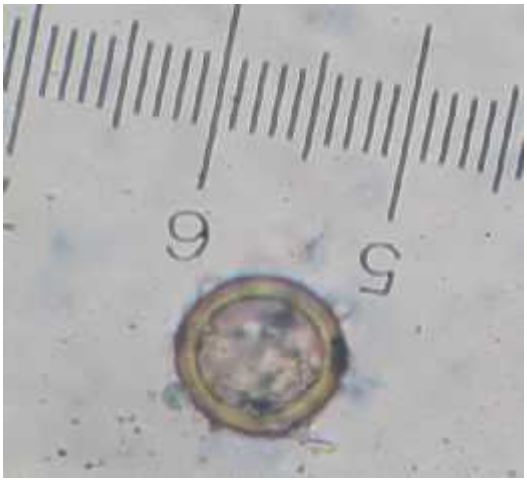

Photo 24: *Ascridia* sp. (40X)

Photo 25: *Dromeostrongylus* sp. (40X)

Photo 26: *Heterakis* sp. (40X)

5. DISCUSSION

The present study revealed the high prevalence of gastrointestinal parasites in ostrich and emu. The samples of both ostrich and emu were found to be positive either for protozoan or helminths. The overall prevalence of endoparasites of ostriches and emus were 82% and 65% respectively which was lowered as compared to the prevalence rates of 100%, 92.85% and 88% obtained by the previous studies Bonadiman et al. (2006), Fagundes et al. (2012) and Ibirahm et al. (2006) respectively. But in case of ostrich in present study was higher than 78.8% obtained by Sotiraki et al. (2001) and lowered than 86.96% obtained by Poudel (2012) in Nepal. The prevalence of gastrointestinal parasites is high in places where the condition of life and basic sanitation are unsatisfactory (Teixeira 2013). Both protozoa and helminthes parasites are transmitted by mainly contaminated water or food while other helminthes genus *strongyloides* are transmitted by larvae present in the soil through skin penetration (Neves 2005).

Cryptosporidium sp. has been reported in ostrich from Canada (Gajadhar 1993), Greece (Sotiraki et al. 2001), Spain, Protugal, Netherland, Belgium, Britain, France (Ponce Gordo et al. 2002). Two species of *Cryptosporidium* sp. have been reported from ostriches (Sotiraki et al. 2001, Santos et al. 2005, Nemejc and Lukesova 2012). Both ostrich and emu in Ostrich Nepal Pvt. Ltd. at Gongoliya, Rupendehi were negative for this parasite. *Isospora struthionis* is only one species of *Isospora* sp. described from an ostrich at a Russian Zoo (Yakimoff 1940). *Isospora* sp. have been reported from ostrich (Jansson and Christensson 2000, Ponce Gordo et al. 2002, Mattos et al. 2011) and oocyst of *Eimeria* sp. have also been reported in ostrich from Negeria (Ibrahim et al. 2006; Mshelia et al. 2010), Iran (Eslami et al. 2007), Czech Republic (Nemejc and Lukesova 2012), Botswana (Mushi et al. 2003), North America (Wade 1992) in different state of Europe (Ponce Gordo et al. 2002). Likewise, both *Isospora* sp. and *Eimeria* sp. have been reported in emu (Papini et al. 2011, Teixeira 2013). In the present study, 15% of *Eimeria* sp. and 10% of *Isospora* sp. from ostrich and 30% of *Eimeria* sp. from emu were isolated from faecal examintation. The prevalence rate of present study of *Eimeria* sp. was less than the prevalence rate (43.8%) as obtained by Mshelia et al. (2010). But the prevalence of both *Eimeria* sp. and *Isospora* sp. of ostrich and *Eimeria* sp. of emu were higher than the prevalence rate of *Eimeria* sp. (7.61%) and *Isospora* sp. (3.26%) as obtained by Poudel (2012).

Histomonas sp. has been reported in ostrich (Deeming 1999, Ponce Gordo et al. 2002). Ratites have been found susceptible with *Giardia* sp. (Ponce Gordo et al. 2002, Foreyt 2005). There are many reports of trophozoits and cysts of *Giardia* sp. in ostrich (Wade 1992, Greinger and Gitchie 1994, Stewart 1994, Huchzermeyer 1999) and in emu (Teixeira 2013). In Nepal, 1.09% *Histomonas* sp. was reported by Poudel (2012) but these parasite were negative in present study.

The prevalence rate (80%) obtained by Ponce Gordo et al. 2002 was much higher than the present study (4%). This prevalence rate was also less than the prevalence rate 60% and 5.43% as obtained by Ederli and Oliveira (2008) and Poudel (2012) respectively. *Entamoeba* sp. have been reported from ostrich in Spain, Portugal, Belgium, France, Great Britain, Netherlands (Ponce Gordo et al. 2002), Greece (Sotiraki et al. 2001), Scotland (Pennycott and Patterson 2001), Sweden (Jansson and Christensson 2000) and cysts and trophozoites of *Entamoeba* sp. have also been discovered in emu (Teixeira 2013). The prevalence rate of *Entamoeba* sp. (48%) in ostrich and 10% in emu at present study of Gongoliya was less than the prevalence rate (50.6%) at same place obtained by Poudel (2012). The present study was also less than the prevalence rate (90%) obtained by Ponce Gordo et al. (2002). Other types of amoeba *Endolimex* and *Iodamoeba* have also been found in ostrich (Sotiraki et al. 2001, Ponce Gordo et al. 2002).

The present study was positive for both *Houttuynia* sp. and *Davainea* sp.parasites. The prevalence rate 10% of *Houttuynia struthionis* from ostrich was higher than the prevalence rate (4.35%) as obtained by the unidentified cestode cysts by Poudel (2012). Prevalence rate (9%) of *Davainea* sp. was isolated from emu in this study. Different types of *Raillietina* sp. i. e. *Raillietina beveridgei, R. chiltoni, R. dromaius* and *R. mitchelli* have been discovered earlier (O'Calleghan et al. 2003). The prevalence rate (5%) of *Raillietina* sp. was discovered from emu in the present study.

Libyostrongylus sp. with prevalence rate 9% was isolated in the present study but no adult worms were recovered. The prevalence of *Libyostrobgylus* sp. in the present study was less than the prevalence rate of previous studies obtained by Sotirako et al. (2001) (43.45%), Ponce Gordo et al. (2002) (20%), Eslami et al. (2005) (40%), Ibhrahim et al. (2006) (100%), De Andra et al. (2011) (61-97%) and Poudel (2012) (14.13%). Egg and larva of *Strongyloide* have been diagnosed in emu (Teixeira 2013). *Dromaestrongylus* sp. with prevalence rate (10%) was isolated in present study in emu but no adult worms and larvae were recovered.

Codiostomum struthionis nematode parasites have been found in ostrich which is slightly large roundworm that inhabits in the large intestine and caeca of ostriches (Huchzermeyer 1994, Deeming 1999, Dingle and Shanawany 1999, Juarjda 2002, Blood et al. 2007, Ederli et al. 2008). It is relatively harmless (Huchzermeyer 1994) but heavy infections are likely to be dangerous (Jurajda 2002, Blood et al. 2007). This parasite has been isolated from Spain and Great Britian (Ponce Gordo et al. 2002), Sweden (Jansson and Christensson 2000), Greece (Sotiraki et al. 2001), Rio Grande do Sul (Mattos et al. 2011), Brazil (Oliveria et al. 2009, Fagundes et al. 2012), Czech Republica (Nemejc and Lukesova 2012). The prevalence rate of *Codiostomum* sp. in the present study was found to be 11% which was higher than as obtained by Ponce Gordo et al. (2002) (less than one) and Poudel (2012) (6.52%) but less than as obtained by Fagundes et al. (2012) (56%). This parasite was negative for emu in present study.

Another nematode *Capillaria* sp. have been recorded in faecal sample of ostrich in North East Nigeria (Ibrahim et al. 2006), different states of Europe (Ponce Gordo et al. 2002) and Rio Grande do Sul (Mattos et al. 2011) and Jansson and Christensson (2000) found Capillaria spp. in emu faecal sample. This parasite was negative for both the faecal sample of ostrich and emu in present study.

Likewise, nematode *Ascaridia struthionis* has been reported from ostrich in Italy (Yamaguti 1961), *Ascaridia* sp. in North East Nigeria (Ibrahim et al. 2006), different states of Europe (Ponce Gordo et al. 2002) and Rio Grande do Sul (Mattos et al. 2011) and in Nepal (Poudel 2012) and from emu (Teixeira 2013). The prevalence rate in present study was found to be 34% in ostrich and 15% in emu. The prevalence rate of both ostrich and emu was higher as compared to previous finding (Ibrahim et al. 2006 and Ponce Gordo et al. 2002) whose prevalence rate was less than one. But present study was seems to be less prevalence with the prevalence rate (43.48%) of Poudel (2012). *Serratospiculum* egg like nematode has been isolated by Poudel (2012), which was negative in present study. *Heterakis dispar* is nematode common in poultry has also recorded from ostrich in Iran (Eslami et al. 2007) and Rio Grande do Sul (Mattos et al. 2011). This species was absent in the study of Poudel (2012) but prevalence rates with 12% and 15%was positive in ostrich and emu respectively. This might be due to contact with the wild birds. It is quite similar with *Ascaridia* sp.

The only trematode *Philophthalmus gralli* has been described from ostrich, which was found in the nictitating membrane of ostrich in Florida (Greve and Harrison 1980). An unidentified

trematode spp. has been found by Ponce Gordo et al. (2002). This parasite was not found in the present study. An adult fluke of *Fasciola hepatica* has been recovered from emu (Vaughan et al. 1997, Soares et al. 2007). But in the present study none of them harbour trematode parasites.

The mites found during faecal examination were probably due to contamination of feather mites and quill mites during defecation. Feather mites and quill mites are discovered in ostrich (Jurjda 2002, Cooper and EI Doumani 2006, Taylor et al. 2007and some in emu (Taylor et al. 2007).

As compared to the previous study carried out in same place ostrich Nepal Pvt. Ltd. Gongoliya in 2012 (Poudel 2012), the parasitic prevalence showed not much remarakable difference. Prevalance of coccidian parasite showed almost 2-3 fold increase. Similarly Codiostomum nematode parasite also showed 2 fold increases. While rest of the common parasitic prevalence showed almost similar. The reason behind the highly prevalence of these parasites could be due to poor management system of the birds and also could be the ineffective use of anthelminthic. During the study it was found that ivermectin drug has been used as antihelmintic mixing in their feed in every interval of six months. The drug could be ineffective against the coccidian parasites.

This crossectional study was conducted to determine KAP of labours working in the Gongoliya ostrich and emu farm. Among all the labours, about half of labours were from midlife and most of them were male. From the survey study, it was found that most of the labours were literate and more than half of them were engaged from two and half years.

More than half of the labours have knowledge about three features of ostrich and emu. There is statistically, significant association with various level of education and duration of work ($P<0.005$) compared to age and sex group of labours. Those who were literate and were working last two and half years had knowledge on special features of ostrich and emu. Likewise, most of them had knowledge on both similarity and dissimilarity between ostrich and emu which is statistically significant between gender wise and different level of education ($P<0.005$). Similarly, about the knowledge of their eggs, most of them had idea on it which showed statistically significant with various level of education ($P<0.005$). Almost half of labours have idea about common diseases of ostriches and emus in the farm of Gongoliya. Since, ostrich and emu can grow in various climatic conditions (Warale et al.

2014). Such types of climatic conditions can be found in Nepal. So, all the labours were agreed that these birds can grow in Nepal.

Fatiregun and Saani (2008) in Neigeria reported that wearing of personal protective equipment was not a routine practices among the workers of poultry farm. According to Fatiregun and Saani (2008) only 11.4% always used face masks, gloves (10.7%) and boots (16.7%). The result concluded that, 100% of labours were not found wearing Apron, Gloves and masks while in slaughter house 100% of labours were using apron, gloves, cap and masks. The food prepared for ostrich were taken in tracter and dropped in yard and for emu taken in hand dropped on ground in the morning. Water is provided whenever necessary. Many author reported that higher consumption of feed was found during the early hours of day or in morning (Sambraus 1994, Mckeegan and Deeming 1997). They drank water more in afternoon (Ahmed and Salih 2012). The study conducted by Sultana et al. (2012) showed that much less of workers told that dead poultry were buried under the soil while all the labours of Gongoliya put their view that all the dead birds were buried.

Ostrich and emu production in Nepal is still in its nascent stage, but development process is going on day by day. Various scientific researches are needed on the management system of ratite in order to enrich the farming system and overall economy of country.

In 2012 there have been found 890 ostriches and 200 emus managed in 20 bighas but in 2015 there were 3500 ostriches and 1500 emus managed in seven cages for ostriches and five cages for emus within 22 bighas land areas. In between there years it was noticed that number of ostrich and emu have been increased drastically. It could be possible because at the first they have imported eggs and chicks of both birds from Australia but now they have been producing eggs and introduced hatching facilities in the farm. Thus, able to produced large number of birds. Recently, along with ostrich and emu they have been keeping some kangaroos and fish farming as a extra livestocks in the farm of Gongoliya. Even though practiced of keeping ostrich with other animals favours the predeposition of the birds to cross transmission of diseases (Moreki et al. 2011).

In Neigeria, 29% of farm used Ivermectin and Fenbendazole as anthelmintic drugs (Meshelia et al. 2011). The present result showed that the Ivermectin drug has been used to treat for both ecto and endoparasites. Currently, they have been producing bird upto the age of slaughtering and exporting meat to different part of Nepal. It has known that the ostrich meat

with bone and without bone cost Rs. 1000 and Rs. 1700 respectively and of emu cost Rs. 990. The farm in Gongoliya has provided premix based compound food with sole grass and cereal bran for ostrich and only premix based compound food with cereal bran for emu. Extra vitamins and minerals have also supplied along with the feeds in order to overcome the nutrients deficiencies in both Ostrich and Emu. Calcium and Phosphorus are important minerals in bone formation as well as egg shell formation (Moreki et al. 2012).

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The overall prevalence of gastrointestional parasites of ostrich and emu were found to be 83% and 65% respectively. Protozoan (65%) and nematode (54%) showed high prevalence in ostrich than emu while cestode prevalence was found high in emu (14%) than in ostrich (10%). Four genera of protozoan parasites were identified infecting ostrich among them *Entamoeba* sp. (48%) showed the highest prevalence followed by *Eimeria* sp. (15%), *Isospora* sp. (10%) and *Balantidium* sp. (4%) and two genera were encountered in emu in which *Eimeria* sp. (30%) was highly prevalence than *Entamoeba* sp. (10%). In case of helminthes parasites cestode and nematode parasites where encountered. Among cestode, ostrich and emu were infected with their own host specific parasites. Ostrich was infected with *Houttyunia* sp. (10%). and emu were found infected with *Davainea* sp. (9%) and *Raillietina* sp. (5%). Four different genera of nematode were observed in ostrich in which Ascaridia (34%) was highly prevalent followed by *Heterakis* sp. (12%), *Codiostomum* sp. (11%) and *Libyostrongylus* sp. (9%). In emu three genera of nematode were revealed. *Ascaridia* sp. (15%) showed higher prevalence followed by *Dromaestrongylus* sp. (10%) and *Heterakis* sp. (5%). Single (33%) and double (35%) infections were almost similar in ostrich than multiple (5%) infection where as most of the samples were found of single (4%) infection in emu followed by double (16%) and multiple (1%) infection while triple (9%) was only encountered in ostrich. More parasitic burden was observed in ostrich than in emu. Parasitic wise association between ostrich and emu was found to be significant for *Entamoeba* sp., *Eimeria* sp. and *Ascaridia* sp.

A questionnaire surveys with 19 labours were conducted to assess their knowledge, attitude and practice. Majority of them had knowedge on feather, similarity and dissimilarity and idea about their eggs of ostrich and emu. They were found wearing protective equipment during slaughtering birds but not during making feeds for them and 100% were agreed that farm can grow in Nepal. The health practices, hygiene and sanitation adopted in Ostrich farming were not much satisfactory. This can lead to the high prevalence of endoparasites. Therefore, effective antihelminthes medication and management strategy should be conducted in order to upgrade the health status and hence to maximize the benefit from Ostrich farming.

6.2 Recommendations

On the basis of conclusion following recommendations have been made to reduce the risk of gastrointestinal parasites in the farm and to enrich the economy.

a. Overcrowing of birds should be checked in different cages and sick and injured ostrich and emu also must kept in their own separate cages.
b. Dropping must be removed from the cages regularly and Deworming must be done in regular interval for theeffective control of endoparasites.
c. Faecal examination must be done to determine actual parasitic infections in birds.
d. Labours should encourage wearing personal protective equipments.

7. REFRENCES

AAFC. 1999. Snapshot of the Canadian Ostrich, Emu and Rhea Industries. Agriculture and Agri-Food Canada, Ottawa, Ontario.

Adams, J. and Revell, B.J. 2011. Ostrich Farming:- A Review and Feasibility study of opportunities in the Eu. http://www.macaulay.ac.uk. accessed on 11 January 2016.

Ahmed, F.A.M. and Salih, R.R.M. 2012. Some behavioral Traits of Red Neck Ostrich Under Captive Conditions. Veterinary Science and Techonology **3**(2): 117.

Aichinger, A., Martins, N.R., Souza, J.D., Resende, J.S., Muniz, R., Ferreira, W.M. 2007. O avestruz no Brasil e no mundo. Rev Vet Zootec Minas **27**(1): 36-39.

Akoha, A. 1980. An outbreak of Pasteurellosis in Akano zoo. Journal of Wildlife Diseases **16**: 3-5.

Alden, P.A., Estes, R.D., Schlitter, D. and Mc Bride, B. 1996. African Birds. In Collins Guide to African Wild Life, Harper Collins Publisher, London: 638-663.

Alison. 2012. Autrucherie Du Pont D'Amour Ostrich farm, Dinant Belgium. http://www.cheeseweb.eu. accessed on18 December, 2015.

Allwright, D.M., Burger, W.P., Gayer, A. and Wessels, J. 1994. Avian pox in ostriches. Journal of the South African Veterinary Association **65**: 23-25

Almeida, M.A., Duarte, L.F., Rocha, J.S., Silva, M.S., Guimaraes, J.E. and Ayres, M.C. 2008. Occurrence of Ectoparasites in Ostriches (*Struthio camelus*) reared in Semiarid region of Bahia. Revista Brasileira Veterinary Parasitology **17**(3): 155-157.

Amnon I., Shkoda I., Lapin E., Raibstein I., Rosenbluth E., Neggi S. et al. 2011. Isolation and Identification of Highly pathogenic Avain influenza Virus Subtypes H5N1 from Emus from the Ein Gedi Oasis by the Dead sea. Avian Diseases **55**(3): 499-502.

Animal Corner 2013. Ostrich at animal corner. http://www.animalcorner.co.uk. accessed on 15 November 2015.

APL 1997. National Residue Survey (Ratite Slaughter). Australian Parliamentary Library Bills Digest **154**: 1996–1997.

Arne, P., Thierry, S., Wang, D., Deville, M., Le Loch, G., Desoutter, A., et al. 2011. Aspergillus Fumigatus in Poultry. International Journal of Microbiology **2011**(2011): 1-14. Doi: 10.1155/2011/746356.

Araghi, M., Ghaniei, A. and Heidari, T. 2014. Aspergillosis Outbreaks in Ostrich Flocks of Eastern Iran during 2010-2012. Bulgarian Journal of Veterinary Medicine **17**(4): 325-330.

Ayers, J.R., Lester, T.L. and Angulo, A.B. 1994. An epizootic attributable to Western Equine Encephalitis virus infection in emus in Texas. American veterinary medical Association **205**: 600-601.

Barton, N.J. and Seward, D.A. 1993. Detection of *libyosttrongylus douglassii* in Ostriches in Australia. Australia Veterinary Journal **70**: 31-32.

Bennett, G.F., Huchzermeyer, F.W., Burger, W.P. and Earle, R.A. 1992. The Leucocytozoidae of South African birds. Redescription of *Leucocytozoon struthionis* Walder, 1912. Ostrich **63**: 83-85.

Bertram, B.C.R. 1992. The Ostrich Communal Nesting System. Princeton University Press, Princeton, New Jersey.

Birdlife International 2012a. *Struthio camelus*. IUCN Red List of Threatened Species. Version 2013.2. International Union for Conservation of Nature. accessed 17 November 2015.

Birdlife International 2012b. *Dromaius novaehollandiae*. IUCN Red List of Threatened Species. Version 2013.2. International Union for Conservation of Nature. accessed on 17 November 2015.

Blood, D.C., Studdert, V.P. and Gay, C.C. 2007. Saunders Comprehensive Veterinary Dictionary 3rd ed. Saunders Ltd., Philadelphia, 2172 p.

Bodger, J. and Goulding, B. 2003. Distribution of meat products from prospective Australian animal industries: Crocodiles, emus, game birds, rabbits, hares and snails, RIRDC Publication, Rural Industries Research and Development Corporation, Canberra.

Bonadiman, S.F., Ederli, N.B., Soares, A.K.P., de Moraes Neto, A.H.A., Santos, C.P. and Da Matta, R.A. 2006. Occurrence of *Libyostrongylus* sp. (Nematode) in Ostriches (*Struthio camelus* Linnaeus, 1758) from the North Region of the Rio de Janeiro, Brazil. Veterinary Parasitology **137**(1-2): 175-179.

Brown, T., Jordan, F.T. and Wood, A.M. 2008. Fungal diseases. In: Poultry Diseases. 6th ed. Saunders Elsevier, p. 428.

Capau, I., Gough, R.E., Scaramozzino, P., Lelli, R. and Gatti, A. 1994. Isolation of an adenovirus from an Ostrich (*Struthio camelus*) causing pancreatitis in experimentally infected guinea fowl (*Numida meleagris).* Avian Diseases **38**(3): 642-646.

Capua, I., Mutinelli, F., Bozza, M.A., Terrogino, C., Cactali, G. 2000. Highly pathogenic avian influenza (H7N1) in Ostriches (*Struthio camelus*). Avian Pathology **29**: 643–646. Doi: 10.1080/03079450020016913.

Carbajo, E. 2006. Ostrich Production to Mature. World Poultry **22**(8): 24-26.

Chakravarty, I. 1976. A case history of mycotic infection (aspergillosis) in an emu (*Dromaius novaehollandae*) in Delhi zoo. Indian. Veterinary Journal **53**: 881-882.

Chang Reissig, E., Olaechea, F. and Robles, C.A. 2001. Parasitological findings of Lesser Rhea (*Pterocnemia pennata*) in Faeces from Northern Patagonia, Argentina. Archivos de Medicine Veterinaria **33**: 247-251.

Chin, R.P. and Woolcock, P. 1994. Identification of Birnavirus-like particles from the intestines of 8-week-old ostriches. In Proceeding Western Poultry Disease Conference. Sacramento, California, 27 February-1 March. Western Poultry Disease Conference, Divis, California, 110 p.

Clavijo, A., Riva, J., Copps, J., Robinson, Y. and Zhou, E.M. 2001. Assessment of the pathogenicity of an emu-origin influenza A H5 virus in ostriches (*Struthio camelus*). Avian Pathology **30**: 83-89.

Clavijo, A., Riva, J. and Pasick, J. 2003. Pathogenicity of a Ratite. Origin Influenza A H5 Virus in Ostriches (*Struthio camelus*). Avian Diseases **47**(3): 1203-1207.

Cooper, R.G. 2005. Bacterial, Fungal and Parasitic Infections in the Ostrich (*Struthio camelus domesticus*). Animal Science Journal, **76**: 97-106.

Cooper, R.G., Horbanczuk, J.O. and Fujihera, N. 2004. Viral disease of the Ostrich (*Struthio camelus domesticus*). Animal Science Journal **75**(2): 89-95.

Cooper, R.G. and EI Doumani, H.A.A. 2006. The Presence of quill mites (*Ganucinia bicaudata*) and lice (*Struthiolipeurus struthionis*) in Ostrich wing feathers. Journal of South African Veterinary Association **77**(1): 9-11.

Cooper, R.G., Mahrose, K.M., EI-Shafei, M. and Marai, I.F. 2008. Ostrich (*Struthio camelus*) production in Egypt. Tropical Animal Health and Production **40**(5): 349-355.

Cortes, H., Caeiro, V. and Vila-Vicosa, M. 1999. Ectoparasites encontrados na avestruz (*Struthio camelus* Linnaeus 1766) em Portugal. *In* Hernandez, S., Martinez, A., Martinez, M.S., Moreno, T., Becerra, C., Acosta, I. et al. (eds.). IV Congreso Iberico de Parasitologia, Graficas Minerva de Cordoba, S.I., Cordoba, 16 p.

Craig, T. 1993. Natural parasites of ratites. In Proceeding Annual Ratire Conference. Collage Station, Texas, 9-10 September. College of Veterinary Medicine, Texas A and M. University.

Craig, T.M. and Diamond, P.L. 1996. Parasites of Ratites. *In* Tully, T.N. and Shane, S.M. (eds). Ratite management. Medicine and Surgery. Krieger Publishing Company, Malabar, FL. p. 115-126.

Davies, K. 1993. Emus and Ostriches: Nowhere to hide. Poultry Press 3(4): 1.

Davies, S.J.J.F. 2002. Species accounts, in Ratites and Tinamous partII- Bird Families of the World, C.M. Perrins, W.J. Bock, and J. Kikkawa, (eds)., Oxford University Press, New York NY, USA. p. 211-227.

Davies, S.J.J.E. 2003. Birds I Tinamous and Ratites to Hoatzirs. In Hutchins Mich ael. Grzimek's Animal Life Encyclopedia 2th ed. Farmington Hills, MI: Gale Group. 99p.

Day, J.F. and Stark, L.M. 1996. Eastern equine encephalitis transmission to emus (*Dromaius novaehollandiae*) in Volusia Country, Florida: 1992 through 1994. Journal of the American Mosquito Control Association, **12**(3part1): 429-436.

De Andra de, J.G., Lelis, R.T., Lelis, R.T. Damatta, R.A. and Santos, C. de P. 2011. Occurrence of nematodes and anthelmintic management of Ostrich farms from different Brazilian states: *Libyostrongylus douglassii* dominates mixed infections. Veterinary Parasitology **178**(1-2): 129-133.

Deeming, D.C. 1999. The Ostrich: Biology, Production and Health 1st ed. CABI Publishing, London, 358 p.

Deeming, D.C. and Angel C.R. 1996. Introduction to the ratites and farming operations around the world. In Deeming, D.C. (eds.). Improving our understanding of ratites in a farming Environment. Ratite Conference. Oxfordsshire, UK, p. 1-4.

Deeming, D.C., Ayers, L. and Ayers, F.J. 1993. Observations on the commercial production of ostrich (*Struthio camelus*) in the United Kingdom: incubation. Veterinary Record **132**: 602-607.

Diego, S. 2012. Zoo's Animal Bytes: Ostrich. http//www.sandiegozoo.org. Assessed on 17 December 2015.

Dingle, J. and Shanawany, M.M. 1999. Ostrich production systems. FAO Animal Production and Health Paper 144 1st ed. FAO, Rome, 256 p.

Dzoma, B.M. and Motshegwa, K. 2009. A retrospective study of egg production, fertility and hatchability of farmed ostriches in Botswana. International Journal of Poultry Science **8**(7): 660 – 664.

Ederli, N.B. and Oliviera, F.C.R. 2008. *Balantidium* sp. in Ostriches (*Struthio camelus* L., 1758) in the state of Rio De Jeneiro, Brazil. Revista Brasileira de Parasitologia Veterinaria **17**: 327-330.

Ederli, N.B. Oliviera, F.C.R., and De Azevedo Rpdriguez, M.L. 2008. Futher study of *Codiostomum struthionis* (Nematoda, Strongylidae) Parasite of Ostriches (*Struthio Camelus*). Veterinary Parasitology **157**: 257-283.

Ederli B. N. and de Oliveira F. C. R. 2014. Comparative morphology of the species of *Libyostrongylus* and *Codiostomum*, parasites from Ostrich (*Struthio camelus),* with identification key to the species. Brazil Journal Veterinary Parasitology Jaboticabal **23**(3):291-300.

Ederli, N. B. and Oliveira, F.C.R. 2015. Gastrointestinal nematodes in Ostriches, *Struthio camelus,* in different region of the state of Rio de Janeiro, Brazil. Veterinary Parasitology **24**(2): 168-173.

Eslami, A., Rahmat, H., Meshgi, B. and Ranjbar-Bahadori, S. 2007. Gastrointestinal Parasites of Ostrich (*Struthio camelus domesticus*) raised in Iran. Iranian Journal of Veterinary Research **8**: 80-82.

Fagundes, T.F., Soleiro, C.A. and Menezes, A.A. 2012. The occurance of *codiostomum struthionis* in Ostriches (*Struthio camelus*) of different ages and during the dry and rainy seasons at two farms in the State of Rio de Janeiro, Brazil. Veterinary Parasitology, **183**(3-4): 269-273.

Fantham, H.B. and Porter, A. 1943. *Plasmodium struthionis*, sp. n., from Canadian Speckled Trout (*Salvelinus Fontinalis*), together with a record of Sarcocystis in the Eel Pout (*Zoarces angularis*). Proceedings of the Zoological Society, London **113**: 25-30.

Fatiregun, A.A. and Saani, M.M. 2008. Knowledge, Attitudes and Compliance of Poultry workers with preventive measures for avian influenza in Lagelu Oyo State Neigeria. Journal Infection Developing Countries **2**(2): 130-134.

Foggin, C.M. 1992. Veterinary Problems of Ostriches. *In* Hallam, M.G. (eds.). The Tropaz introduction to Practical Ostriches farming p. 61-96.

Foreyt, W.J., 2005. Parasites of ratites. Parasitology Veterinaryn –Reference Manual 5th ed. Roca: São Paulo, p. 181-184.

Gajadhar, A.A. 1993. *Cryptosporidium* species in imported Ostriches and Consideration of possible implications for birds in Canada. Canadian Veterinary Journal **34**: 115-116.

Gillespie, J and Flanders, F. 2009. Modern Livestock and Poultry Production. Cengage Learning. 908 p.

Gotch, A.F. 1995a. Ostrich. Latin Names Explained. A Guide to the Scientific classifications of Reptiles, Birds and Mammals. London: Facts of File, 176 p.

Gotch, A.F. 1995b. Emu. Latin Names Explained. A Guide to the Scientific classifications of Reptiles, Birds and Mammals. London: Facts of File, 179 p.

Greiner, E.C. and Ritchie, B.W.1994. Parasites. *In*: Ritchie, B.W., Harrison, G.L., Harrison, L.R. (eds), Avian Medicine: Principles and Application. Lake Worht, FL, Wingers Publishing, p. 1014-1019.

Greve, J.H. and Harrison, G.J. 1980. Conjunctivitis caused by Eye flukes in captive-reared Ostriches. Journal of American Veterinary Medicine Association **177**: 909-910.

Griffiths, G. and Buller, N. 1991. *Erysipelothrix rhusiopathiae* infection in semiintensively farmed emu. Australian veterinary Journal **68**: 121-122.

Grompone. M.A., and Irigaray, G.M. 2005. Composition and thermal properties of Rhea oil and its fractions. European Journal of Lipid Science and Technology **107***:* 762–6.

Hegner, R. 1934. Specificity of the genus *Balantidium* based on size and shape of body and macronucleus with description of six new species. American Journal of Hygiene **19**: 38-67.

Hines, M.E., Styer, E.L., Baldwin, C.A. and Cole, J.R. 1995. Combined adenovirus and rotavirus enteritis with *Escheichia coli* Septicemia in an emu chick (*Dromaius novaehollandiae*). Avian Diseases **39**(3): 646-651.

Hoberg, E.P., Lloyd, S. and Omar, H. 1995. *Libyostrongylus dentatus* n. sp. (Nematoda: Trichostrongylidae) from Ostriches in North America, with Comments on the genera *Libyostrongylus* and *Paralibyostrongylus*. Journal of Parasitology **81**: 85-93.

Hoover, J.P., Lochner, F. K. and Mullins, S.B. 1998. Quill mites in an Ostrich with rhinitis, sinusitis and air sacculitis. Companion Animal Practical **2**: 23-26.

Huchzermeyer, F.W. 1994. Ostrich Disaeses. Agricultural Research Council, Pretoria, South Africa.

Huchzermeyer, F.W. 1997. Animal health risks associated with Ostrich products. Revista Science and Technology **16**(1): 111-116.

Huchzemeyer, F.W., 1999. Veterinary Problems in the Ostrich: Biology, Production and Health, CAB International, p. 303–305.

Huchzermeyer, F.W. 2002. Diseases of farmed Crocodiles and ostriches. Revista Science and Technology **21**: 265-276.

Hyde K. 2004. Zoology: An Inside view of Animal 3rd ed. Dubuque, IA: Kendall Hunt Publishing.

Ibrahim, U.I., Mbaya, A.W., Geidam, Y.A. and Geidam, A.M. 2006. Endoparasites and Association Worm Burden of Captive and free living ostriches (*Struthio camelus*) in the

Semi-Arid Region of North Eastern Neigeria. International Journal of Poultry Science **5**(2): 1128-1132.

Jansson, D.S. and Christensson, D. 2000. Gastrointestionala parasite hos Strutsfaglar I Sverige. Svensk Veterinar tidning **52**: 621-626.

Jeffery, J.S. 1996. Husbandary and Medical Management of Ostriches. Wildlife and Exotic Animal Teleconsultants, College station, Texas p. 9-110.

Jeffery, J.S. 2001. Ostrich production. Texas Agricultural Extension Services Bulletin. Texal A and M University, Texas: p. 1-4.

Jones, L.D. 2007. O, Those Ostriches. My Florida Story. Adventures with history and Culture in the Sunshine State. http://www.myfloridahistory.blogspot.com. accessed on 30 December 2015.

Jurajda, V. 2002. Chov a nemoci pstrosv 1st ed. Veterinarni a Farmaceuticka Univerzita Bron, Brno, 92p.

Kang, W., Pang, W., Hao, J. and Zhao D. 2006. Isolation of avian influenza virus (H9N2) from emu in China. Veterinary Journal **59**(3): 148-152.

Karunakaran, S., Krishnan N.G., Divakaran N.N. and Mini M. 2010. Systemic Aspergillosis in Emu Chicks in an organized farm in Kerala. Veterinary World **3**(10): 453-455.

Kazacos, K.R., Winterfield, R.W., Thacker, H.L. 1982. Etiology andepidemiology of verminous encephalitis in an emu. Avian Diseases **26**: 389-391.

Kazacos, K.R., Fitzgerald, S.D., Reed, W.M. 1991. *Baylisascaris procyonis* as a cause of cerebrospinal nematodiasis in ratites. Journal of Zoological Wildlife Medicine **22**: 460-465.

Kocan, A.A. and Crawford, J.A. 2007. The Oklahoma state Ostrich Book (online). http://instruction.cvhs.okstate.edu/kocan/ostrich. accessed on 10 November 2015.

Khosravi, A.R., Shokri, H., Ziglari, T., Naeini, A.R., Mousavi, Z. and Hashemi, H. 2008. Outbreak of severe disseminated aspergillosis in a flock of ostrich (*Struthio camelus*). Mycoses **51**: 557-559.

Khyalia, M.K., Pandey, V.S. and Prajapati, K.S. 2014. Study on Seroprevalence of various diseases in Emu in Gujarat. International Journal of Advanced Multidisciplinary Research **1**(4): 24-27.

Kwon, Y.K., Lee, Y.J. and Mo, J.P. 2004. An Outbreak of necrotic enteritis in the Ostrich farm in Korea. Journal Veterinary Medical Science **66**(12): 1613-1615.

Kyoung, O.H. 2001. Aspergillosis in an ostrich (*Struthio camelus*). Journal of Veterinary Clinics **18**: 174-177.

Leavy, A., Perelman, B., Grevenbroek, M.V., Creveld, C.V., Agbaria, R. & Yagil, R. 1990. Effect of water restriction on renal function in ostriches (*Struthio camelus*). Avian Pathology **19**: 385-393.

Levine, N.D. 1985. Veterinary Protozoology. Iowa State University Press, Ames, IA, 414 p.

Lordman, W.J. and Bronneberg, R.G. 2004. *Libyostrongylus douglassii* in Ostriches (*Struthio camelus*) in the Netherlands. Veterinary Parasitology **92**: 173-179.

Lublin, A., Mechanis, Horowitz, H.I. and Weisman, Y. 1993. A paralytic- like disease of the ostrich (*Struthio camelus masaicus*) associated with *Clostridium chauvoei* infection. Veterinary. Record **132**: 273-275.

Maloney, S.K. 2008. Thermoregulation in ratites. Australian Journal of Experimental Agriculture **48**(0): 2193-1301.

Manvell, R.J., Jørgensen, P.H., Nielsen. O.L. and Alexander. D.J. 1998. Experimental assessment of the pathogenicity of two avian influenza A H5 viruses in ostrich chicks (*Struthio camelus*) and chickens. Avian Pathology **27**: 400-404.

Manvell, R.J., English, C., Jørgense, P.H. and Brown, L.H. 2003. Pathogenesis of H7 influenza A viruses isolated from ostriches in the homologous host infected experimentally. Avian Diseases **47**:1150-1153.

Marks, S.L., Stauber, E.H. and Ernstrom, S.B. 1994. Aspergillosis in an ostrich. Journal of the American Veterinary Medical Association **204**: 784-785.

Marshall, A.J. 1960. Biology and Comparative Physiology of Birds, Academic Press, 446 p.

Martinez Diaz, R., Herrera, S., Castro, A. and Ponce, F. 2000. *Entamoeba* sp. (Sarcomastigophora: Endamoebidae) from Ostriches (*Struthio camelus*). Veterinary Parasitology **92**: 173-179

Mattos, M.J.T., Ribeiro, V.S.and Marques, S.M.T. 2011. Gastrointestinal Parasitism and aspects of the management of Ostriches (*Struthio camelus*) of small properties of Rio Grande do Sul, Brazil. Veterinary in Focus Canoes **8**(2): 143-151.

Mckeegan , D.E.F. and Deeming, D.C. 1997. Effects of gender and group size on the time-activity budgets of adult breeding ostriches (*Struthio camelus*) in a farming environment. Applied Animal Behaviorial Science **51**: 159-177.

Mckenna, P.B. 2005. *Libyostrongylus* infections in Ostriches- a brief review with particular reference to their detection in New Zealand. New Zealand Veterinary Journal **53**: 267-270.

Menon, D.G., Bennett, D.C. and Cheng, K.M. 2014. Understanding the Behavior of Domestic Emu: A means to Improve Their Managements and Welfare-Major Behaviors and Activity Time Budgets of Adult Emus. Journal of Animals **2014**: 1-8.

Mertin, J.W. and Schlater, J.L. 1991. Exotic ectoparasites of Ostriches recently imported into the United States. Journal of Wildlife Diseases **27**: 180-182.

Mohan, R. 1993. Mycoplasma in ratites. In Proceeding Association of Avian Veterinarians (AAV). Nashville, Tennessee, 31 August-4 September. AAV Publications, Orlando, Florida, p. 294-296.

Moreki, J.C., Kebonye, N.M. and Tiroesele, B. 2012. Commerical Ostrich Farming in Botswana: A case study of Dibete Ostrich Multiplication unit. Life Science Biomedicine **2**(5): 192-195.

Moreki J.C. and Koloka O.A. 2010. A critical review of Botswana's ostrich industry. http://www.world-ostrich.org/pastnewsletters/news90.htm. accessed on 12 November 2015.

Mshelia WP, Abdu PA, Abdussamad AM, and Wakawa AM (2010). Prevalence of endoparasites in Ostriches (*Struthio camelus*) raised in selected states of Northern Nigeria. Conference on International Research on Food Security, Natural Resource Management and Rural Development. Tropentag, September 14-16, Zurich. 2010.

Mshelia, W.P., Abdu, P.A., Abdussamad, A.M., Wakawa, A.M. and Malumfashi, A.I. 2011. Ostrich management practices in three states of Norhtern Negeria. Veterinary World, **4**(2): 64-67.

Mushi, E.Z., Binta, M.G., Chabo, R.G., Isa, J.F.W. and Phuti, M.S. 1999. Limb Deformities of Farmed ostrich (Struthio camelus) Chicks in Botswana. Tropical Animal Health and Production **31**: 397-404.

Mushi, E.Z., Binta, M.G., Chabo, R.G. and Toto, P.A.S. 2003. A note on Endoparasites of Wild Ostriches (*Struthio camelus*) in the Mokolodi Nature Reserve, Gaborone, Botswana. Journal of the South African Ratite Association **74**(1): 22-23.

Mustapha, P. 2003. How to raise and market Ostriches 1st ed. Acacis Publisher, Nairobi, p. 1-49.

Nel, C.J. 1980. Dosing of Ostriches for internal parasites. Elsenburg Journal **4**: 31-33.

Nemejc K. 2007. Ostrich Farm Management and its Perspectives in Conditions of the Czech Republic, B. Sc. Thesis, Institute of Tropics and Subtropics, Czech University of Life Science Prague, The Czech Republic.

Nemejc, K. and Lukesova, D. 2012. Parasitic Fauna of Ostriches, Emus and Rheas. Agricultura Tropica ET Subtropica **45**(1): 45-50.

Neves, D.P. 2005. Human parasitology. 11th ed. São Paulo, Atheneu, 494 p.

O'Callaghan, M.G., Davies, M. and Andrews, R.H. 2000. Species of *Raillientina* Fuhrmann 1920 (Cestoda: Davaineidae) from the emu (*Dromaius novaehollandiae*). Transactions of the Royal Society of South Australia Incorporated **124**(2): 105-116.

O'Callaghan, M.G., Davies, M. and Andrews, R.H. 2003. Cysticercoids of five species of *Raillientina* Fuhrmann, 1920 (Cestoda: Davaineidae) in ants, Pheidole species from emu farms in Australia. Systematic Parasitology **55**(1): 19-24.

Oliveira, F.C.R., Ederli, N.B., Ederli, B.B., Albuquerque, M.C. and Santos, M.D. 2008. Ocorrencia de oocistos de *Cryptosporidium* spp. (Apicomplexa, Cryptosporidiidae) em avestruzes, *Struthio camelus* L., 1758 (Aves,Struthionidae) criadas nas regioes norte e baixada litorânea do Estadodo Ride Janeiro. Brasil Revista Brasileira de Parasitologia Veterinaria **17**(1): 322-325.

Oliveira, F.C., Ederli, N.B., Lopes, C.W. and Rodrigues, M. de L. 2009. Pathological finding in the Caeca of naturally infected Ostriches (*Struthio camelus* Linnaeus 1758) (Aves, Struthionidae) Parasitized by *Codiostomum struthionis* (Horst 1885) Railliet and Henry 1911 (Nematode, strongylidae). Veterinary Parasitology **165**(1-2): 175-178.

O'Malley, P 1997. A handbook for farmer: emu farming, RIRDC, <http://www.rirdc.gov.au/pub/handbook/emu.html>, updated December 1997 and accessed on 14 April 2015.

Ormerod 1900. Ostrich fly: *Hippobosca struthionis* n. sp. Agricultural Journal, Department of Agriculture, Cape Colony **2**: 293-294.

Orumbayev A. 2015. A study on Breeding Proportions of Emu. International Journal of Poultry Science **14**(2): 89-91.

Patodkar, V.R., Rahane, S.D., Shejal, M.A. and Belhekar, D. R. 2009. Behavior of emu bird (*Dromaius novaehollandiae*). Veterinary World **2**(11): 439-440.

Panjgarphy, B., Senne, D.A. and Pearson, J. E. 1995. Presence of avian influenza virus (AIV) subtypes H5N2 and H7N1 in emus (*Dromaius novaehollandiae*) and rheas (Rhea Americana) Virus isolation and Serologic finding. Avian Diseases **39**(1): 64-67.

Papini, R., Girivetto, M., Marangi, M., Mancianti, F. and Giangaspero, A. 2011. Endoparasite Infections in Pet and Zoo Birds in Italy. The Scientific World Journal, p. 1-9.

Paula A.A., Francisco, Paulo and Costa da R. 2009. Prevalence of Toxoplasm gondii antibodies in Ostriches (*Struthio camelus*) from commercial breeding facilities in the states of Sao Paulo Brazil. Brazilian Journal of Veterinary Research and Animal Science **46**(3): 175-180.

Pennycott, T. and Patterson, T. 2001. Gastrointestinal Parasites in Ostriches (*Struthio camelus*). Veterinary Record **148**: 155-156.

Perelman, B. and Kuttin, E.S. 1992. Aspergillosis in Ostriches. Avian Pathology **21**: 159-163.

Perkins, L.E. and Swayne, D.E. 2002. Pathogenicity of a Hong Kong –Origin H5N1highly pathogenic Avian influenza virus for emus, geese, ducks and pigeons. Avian Diseases: **46**(1): 53-63.

Ponce Gordo, F., Herrera, S., Castro, A.T., Garcia Duran, B. and Martinez Diaz, R. A. 2002. Parasites from Farmed Ostriches (*Struthio camelus*) and Rheas (*Rhea americaba*) in Europe. Veterinary Parasitology **107**: 137-160.

Poudel, Y. 2012. Parasitic Impediments of Ostrich farming in Gongoliya, Rupendehi. M.Sc. Thesis. Central Department of Zoology, Tribhuwan, University, Kathmandu, Nepal.

Rickard, L.G., Steinohrt, L.A. and Black, S.S. 1997. Subclinical cyathostomiasis and unidientified helminthiasis in a Juvenile emu (*Dromaius novaehollandiae*). Avian Diseases, **41**: 993-996.

Samberg, Y., Hadesh, D., Perelman, B. and Meroz, M. 1989. Newcastle disease in ostrich (*Struthio camelus*): field case and experimental infection. Avian Pathology **18**: 221-226.

Sambraus, H.H. 1994. The circadian rhythm in the Behaviour of Ostriches (*Struthio camelus*) kept in pens. Berliner and Muenchener Tieraerztliche Wochenschrift **107**: 339-341.

Sancak, A.A. and Paracikoulu, J. 2005. Aspergillosis and Gastric impaction in an ostrich. Turkish Journal of Veterinary and Animal Sciences **29**: 933-935.

Santos, M.M., Peiro, J.R. and Meireles, M.V. 2005. Cryptosporidium infection in Ostriches (*Struthio camelus*) in Brazil: Clinical and Molecular Studies. Revista Brasileira de Cienica Avicota **7**: 113-117.

Sasani, F., Khosravi, A.R.., Dordari, M., Moghadam, Rajabi and Hajibabaie, A. 2003. Pulmonary aspergillosis in ostrich. Archives of Razi Institute **55**: 117-120.

Saxton-shaw, K. D., Ledermann, J. P., Kenney, J. L., Berl, E., Graham A. C., Russo J.M. et al. 2011. The First Outbreak of Eastern Encephalitis in Vermont: Outbreak Description and Phylogenetic Relation ships of the Virus Isolate. Plos One **10**(6): e 0128712.

Selleck, P.W., Arzey, G., Kirkland, P.D., Reece, R.L., Gould, A.R., Daniels, P.W. et al. 2003. An Outbreak of Highly Pathogenic Avian Influenza in Australia in 1997 Caused by and H7N4 Virus. Avian Diseases **47**(3): 806-811.

Shanawany, M.M. 1994. The Importance of Light for ostriches. Ostrich Update **3**: 52-54.

Shane, S.M., Camus, A.C., Strain, M.G., Thoen, C.O. and Tully, T.N. 1993. Tuberculosis in commercial emus (*Dromaius novaehollandiae*). Avian Diseases **37**: 1172-1176.

Shathele, M.S., Fadlelmula, F.A. Al-Hizab, F.A. and Zaki, M.M. 2009. Fatal aspergillosis in an ostrich (*Struthio camelus*) predisposed by pulmonary haemangioma in the Kingdom of South Arabia. International Journal of Zoological Research **5**: 80-85.

Shinde, P.V., Koratkar, S.S., Pawar, Kale, S.D., Rawankar, A.S. and Mishra, A.C. 2012. Serologic evidence of avian influenza H9N2 and Paramyxovirus type 1 infection in emus (Dromaius novaehollandiae) in India. Avian Diseases **56**(1): 257-260.

Silvanose, C.D., Samour, J.H., Naldo, J.L., and Bailey, T.D. 1998. Oro-pharyngeal protozoa in captive bustard: clinical and pathological consideration. Avain Pathology **27**(526-530).

Smit, D.J. 1963. Ostrich Farming in the Iittle Karoo. Department of Agricultural Technical Services, Pretoria, South Africa, Bulletin no. 358.

Snoeyenbos, G.H. 1965. In: *Anthrax*, Biester, H.E. and Schwarte, L.H. eds. In Diseases of poultry, 5th ed. Iowa State University Press, Arnes, Iowa, p. 432-435.

Soares, M.P., Da Silva, S.S., Nizoli, L.Q., Felix, S.R.and Schild, A.L. 2007. Chronic Fascioliasis in Farmed and Wild Greater Rheas (*Rhea Americana*). Veterinary Parasitology **145**: 168-171.

Sotiraki, S.T., Georgiades, G., Antoniadon-Sotiriadou, K. and Himonas, C.A. 2001. Gastrointestinal Parasites in Ostriches (*Struthio camelus*). Veterinary Record **148**: 84-86.

Stewart, J.S. 1994. Ratites. In: Ritchie B.W., Harrison, L.R. eds. Avian medicine: Principles and application. Wingers Publishing ,Florda. USA.

Sultana, R., Rimi N.A., Azad, S., Islam, M.S., Khan, M.S., Gurley, E.S., et al. 2012. Bangladesh backyard Poultry raisers Perceptions and practices related to zoonotic transmission of avian Influenza. Journal of Infection in Developing Countries **6**(2): 156-165.

Sunday Standard 2012. Ostrich farmers association praying EU grants abattoir license. http://www.sundaystandard.info/article.php?NewsID=14621and GroupID=3. accessed on 16

Taylor, M.A. Coop, R.L. and Wall, R.L. 2007. Veterinary Parasitology 3rd ed. Blackwell Publishing, UK, 874 p.

Teixeira, D.S.T. 2013. Enteroparasites attacking observed in faeces of Emu, *Dromaius novaehollendiae* Latham, 1790. (Birds: Struthioniforms). M.Sc. Thesis. Center of the non-

Agricultural Science and Techonology of the Universidade Esta dual de Norte Fluminanse Darcy Ribeiro.

Terzich, M. and Vangooser, S. 1993. Postmortem findings of ostriches submitted to the Oklahoma Animal Disease Diagnostic Laboratory. Avian Diseases **37**: 1136-1141.

Thompson, R.S. 1997. Raising emus and ostriches. Farming Systems Information Center, http://afsic.nal.usda.gov/. accessed on 15 December 2015

Tisljar, M., Beck, R., Copper, R.G., Marinculic, A., Tudja, M., Lukoc-Novak, I. et al. 2007. First finding of Libyostrongylosis in farmed-reared Ostriches (*Struthio camelus*) in Croatia: Unusual histopathological finding in the brain of two Ostriches, naturally infected with *Libyostrongylus douglasi*. Veterinary Parasitology **147**: 118-124.

Tully, T.N., Shane, S.M., Poston, R.P., England, J.J., Vice, C.A., Cho, D.Y. et al. 1992. Viscerotropic Eastern Encephalitis in a flock of emus (*Dromaius novaehollandiae*). Avian Disease **36**: 808-819.

Tully, T.N. and Shane , S.M. 1996. Husbandary Practices as related to infectious and Parasitic Diseases of farmed raratie. Revue Scientificque Technque International Office of Epizootics **15**: 73-89.

Van Heerden, J., Hayes, S.C. and Williams, M.C. 1983. Suspected vitamins e- Selenium deficiency in two Ostriches. Journal of the South African Veterinary Association **54**: 53-54.

Vaughan, J.L., Charles, J.A., and Boray, J.C. 1997. Fasciola hepatica infection in farmed emus (*Dromaius novaehollandiae*). Australian Veterinary Journal **75**(11): 811-813.

Veazey, R.S., Vice, D.Y., Tully, T.N. and Shane, S.M. 1994. Pathology of Eastern Equine Encephalitis in Emus (*Dromaius novaehollandiae*). Veterinary pathology **31**: 109-111.

Vyver, A. van der 1992. Viewpoint: The world ostrich industry will South Africa maintain its domination. Agrekon **31**: 47-49.

Wade, J.R. 1992. Ratite pediatric medicine and surgery. Association of Avian Veterinarians: 340-353.

Warale, R.H., Chaughan, H.D., Parmar, D., Kulkarni, R.C., Srivastava, A.K., Makwana, R.B., et al. 2014. Emu farming: An alternative to Indian Poultry. Trends in veterinary and Animal Science **1**: 9-14.

Warmser, M.F. 1930. Ostrich industry in South Africa. M.Sc. Thelsis. University of South Africa, Pretoria.

Weisman, Y., Malkinson, M., Pearl, S., Ashash, S., Meir, R., Nir, A. et al. 1994. Borna disease in ostriche (Abs). In Proceedings Western Poultry Disease Conference. Sacramento, California, 27 February-1 March. Western Poultry Disease Conference, Davis, California: 22 p.

Wikepedia 2015. Emu. https://en.wikipedia.org/wiki/Emu. (accessed on 11 March 2016)

Wikepedia 2015. Ostrich. https://en.wikipedia.org/wiki/Ostrich. (accessed on 11 March 2016)

Woolcock, P.R., Shivaprasad, H.L. and Rosa, M.D. 2000. Isolation of avian influenza virus (H1N7) from an Emu (*Dromaius novaehollandiae*) with conjunctivitis and respiratory diseases. Avian diseases **44**: 737-744.

Yakimoff, W.L. 1940. *Isospora struthionis* n. sp., Coccidie de 1' autruche africaine. Annales de la Societe Belge de Medicine Tropicale **20**: 137-138.

Yokota, T.T., Shibahara, Y., Wada, R., Hiraki, Y., Ishikawa and Kadota, K. 2004. *Aspergillus fumigatus* infection in an ostrich (*Struthio camelus*). Journal of Veterinary Medical Science **66**: 201-204.

Yamaguti, S. 1961. Systema Helminthum. Vol. III. The Nematodes of Vertebrates Pt. II and I Interscience Publishers, New York and London, 1261 p.

Yaman, M. and Durgut, R. 2005. Parasitic Infestations in Ostriches and Therapy. Turkiye Parazitology Dergisi **29**: 103-109.

APPENDIX 1

Demographic information

Name: **Farm:**

Age: **No. of Ostriches:**

Sex: **No. of Emus:**

Education: **Responsibility:**

Duration of work:

A. Knowledge related information:

1. Do you know some special features of Ostrich and Emu?
2. Can you tell me similarity and dissimilarity in between Ostrich and Emu?
3. What do you want to tell about the egg of these bird?
4. Mostly from which diseases they are suffering?
5. If they are suffering then was there problem of weight loss in Ostrich and Emu?
6. What are the veterinary facilities given to them?

B. Attitude related information:

1. Do you agree Ostrich and Emu can grow in different parts of Nepal?
2. Do you think people will start consuming Ostrich meat against chicken and other meat?
3. Is Ostrich and Emu died in the farm were due to diseases?
4. Do you agree visitors can carry various diseases dreadful to Ostrich and Emu?
5. Do you think feed prepared for Ostrich and Emu are decontaminated?

C. <u>Practice related information:</u>

1. How many cages of which height are made here for raring of Ostriches and Emus?

2. At what time do you provide food for them?

3. At which time do you provide water for them?

4. What is the sources of water?

5. What are the feeding practices adopted in these farm?

APPENDIX 2

2.1 Ectoparasites of ostrich and emu encountered during faecal examination

Different types of ectoparasites infect the ostrich and emu. Generally ectoparasites infect external part of body. In present study different types of mites were recovered during faecal examination as shown in (Photo 27-32).

Ectoparasites of ostrich

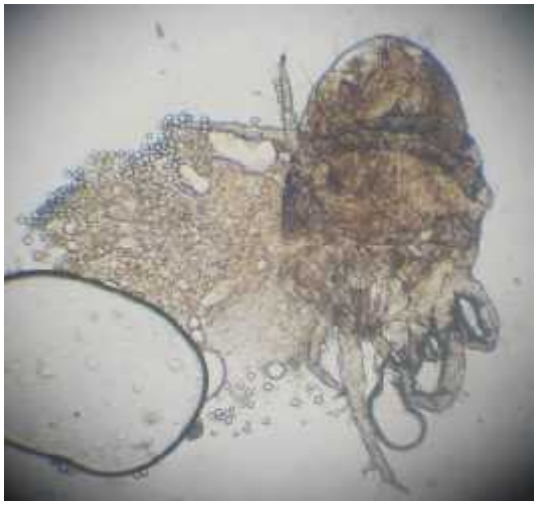

Photo 27: Unidentified sp. Mite (40X)

Photo 28: *Gubicinia* sp. (10X)

Ectoparasites (Unidentified mite) of emu

Photo 29: Unidentified sp. mite (40X)

Photo 30 : Unidentified sp. of mite (40X)

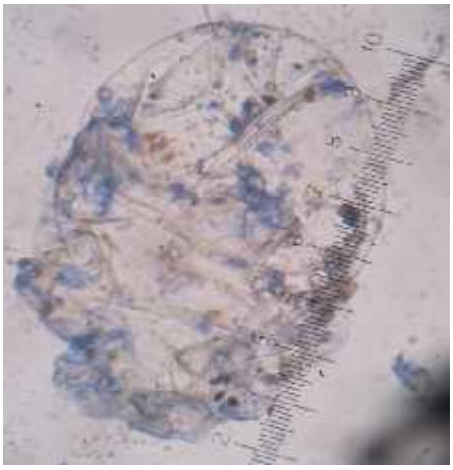

Photo 31: unidentified sp. mite (10X)

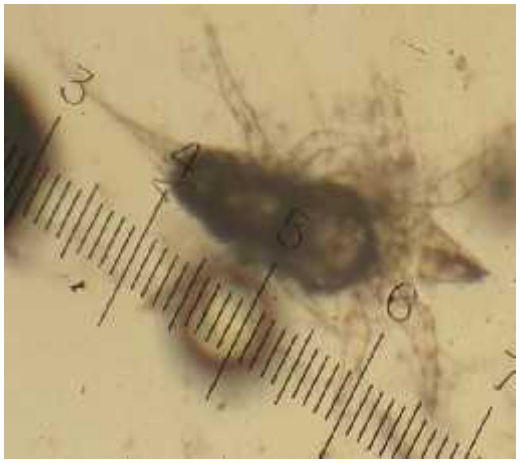

Photo 32: unidentified sp. mite (40X)

2.2 Extra vitamins and minerals supplement for ostriches and emus along with feeds

The schedule provide by Pro Bio-Tech Industries Pvt. Ltd. of extra vitamins and minerals supplement for ostriches and emus along with feeds is shown in table (Table 7).

Table: 7 Extra vitamins and minerals supplied along with the feeds.

Each 1.5kg contains:

Vitamin A(miu)	Vitamin A 1000	12
Vitamin D3(miu)	Vitamin D3 500	3.6
Vitamin E (g)	Vitamin E-50 (50%)	150
Thiamine (B1) (g)	Thaimine Mononitrate (98%)	1.8
Riboflavin (B2) (g)	Riboflavin (80%)	4.8
Niacin (B3) (g)	Niacin (99.5%)	12
Panthothenic Acid (B5)	D-CALPAN (98%)	4.2
Pyridoxine (B6)	Pyridoxine HCL (99%)	1.2
Folic Acid (B9)	Folic Acid 100 (97%)	0.9
Cyanoc (B12)	Vitamin B12 10000 (1%)	0.01
Biotin (H2)	Biotin HP (10%)	0.12
Menodione (k)	Menodione (31.2%)	0.18
Cobalt	Cobalt Sulphat 21%	0.06
Iodine	Potassium Iodide 68%	0.21
Iron	Ferrous Sulphate 30%	7
Manganese	Manganese Oxide 52%	24
Copper	Copper Sulphate 25%	1.2
Zinc	Zinc Sulphate Mono 35%	18
Magnesium	Magnesium Oxide 56%	12
Choline Choride	Choline Chloride 60%	100
Lysine	Lysine Mono HCL	300
Methionine	DL Methionine	225
Anti-Oxidant	Eurotiox-32	25
Vitamin C		100gms

Source: Pro Bio-Tech Industries Pvt. Ltd.