PREVALENCE OF SOME PARASITES OF ONE – HUMPED CAMEL (*CAMELUS DROMEDARIUS*) AND EFFECTS OF EXPERIMENTAL *HAEMONCHUS* SPP. OF CAMEL ORIGIN INFECTION IN YANKASA SHEEP IN NIGERIA.

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AHMADU BELLO UNIVERSITY, ZARIA
NIGERIA

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DEPARTMENT OF VETERINARY PARASITOLOGY AND ENTOMOLOGY
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NIGERIA

February, 2008

DECLARATION

I declare that the work in this thesis entitled 'PREVALENCE OF SOME PARASITES OF ONE–HUMPED CAMEL (*CAMELUS DROMEDARIUS*) AND EFFECTS OF EXPERIMENTAL *HAEMONCHUS* SPP. OF CAMEL ORIGIN INFECTION IN YANKASA SHEEP IN NIGERIA.' was carried out by me in the Department of Veterinary Parasitology and Entomology under the supervision of Professors B.D.J. George, O.J. Ajanusi and M. Galadima.

The information derived from literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at any university.

Yahaya, Abdullahi Umaru		February, 2008
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Name of student	Signature	Date

CERTIFICATION

This thesis entitled "PREVALENCE OF SOME PARASITES OF ONE–HUMPED CAMEL (*CAMELUS DROMEDARIUS*) AND EFFECTS OF EXPERIMENTAL *HAEMONCHUS* SPP. OF CAMEL ORIGIN INFECTION IN YANKASA SHEEP IN NIGERIA." by Yahaya, Abdullahi Umaru meets the regulation governing the award of the degree of Doctor of Philosophy of Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to the memory of my late father Capt. Yahaya Biu (Rtd) who died in 1992. May God Almighty grant him *Aljanna Fiddausi*. Amin.

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I want to start by thanking Almighty God for sparing my life and also for giving me the opportunity to pursue a PhD programme. *Al Hamdu Lil Lah*.

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ABSTRACT

This study was conducted to assess the prevalence and distribution of ecto and endo-parasites in camels in Kano, Katsina and Zamfara States, Nigeria. It was also aimed at studying the pathology of *Haemonchus longistipes* and *H. placei* of Camel and Cattle origin respectively in experimentally infected Yankasa sheep. Out of the 558 gastrointestinal tracts collected from camels slaughtered in all the three States, 157 (28.14%) were found to harbour helminths. Among the nematodes encountered, *H. longistipes* had the highest overall prevalence of 54.12% followed by *Trichuris globulosa* (46.59%) and *Oesophagostomum venulosum* (13.62%). *Moniezia benedeni* and *Stilezia vittata* were the two cestodes encountered with prevalences of 14.87% and 12.07% respectively. Infections by nematodes were more during the wet season than during the dry season in the three States surveyed. However, male and female camels showed no significant difference ($P>0.05$) in rate of infection with helminths although males were found to harbour more. Among the protozoa encountered, *Trypanosoma evansi* infected 5.73% (32/558) of the camels whose blood were screened by thin, thick and buffy coat examination while *Eimeria dromedarii* had an overall prevalence of 4.30%. Another group of parasites of major significance encountered during the survey were ticks and mites. *Hyalomma dromedarii, Amblyomma variegatum* and *Rhipicephalus pravus* had overall prevalences of 58.06%, 31.36% and 21.33% respectively. 68.77% (425/618) of all tick infestations were recorded during the wet season while 31.23% (193/618) were in the dry season. Inaddition, 53.24% of the camels infested by ticks were males in contrast to 46.76% females. Peak prevalences of tick infestations by all the species occurred between May and October, although with slight variation from State to State depending on microclimate requirement of individual tick species. With regard to mite infestation, the

prevalence was very low (0.2%), the only detected case was in a female camel in Katsina. The species involved was *Demodex folliculorum var. cameli* which causes follicular mange. In the experimental infection to determine the pathology of *H. longistipes* and *H. placei*, it was found that Yankasa sheep given $5000L_3$ of *H. longistipes* (Group I) had reduced Weight, PCV and Hb values contrary to *H. placei* – infected (Group II) or control (Group III) sheep which had increase in these values during the 15weeks experimental period. However, lymphocyte counts in Groups I and II were significantly elevated during the experimental period ($P<0.05$). At necropsy, worms recovered in both groups were few and short in size. The percentage worm recovery recorded for Groups I and II were 0.71% and 1.2% respectively, while mean worm length for males and females in both groups were: Group I (M = 17.0 ± 0.78, F= 19.4 ± 1.99), Group II (M = 14.3 ± 0.77, F = 24.2 ± 0.58). Gross examination of the abomasum of sheep in Groups I and II revealed haemorrhagic lesions indicating point of attachments of the worms while histopathologic tissue sections revealed diffused infiltration of the abomasal mucosa and submucosa by inflammatory cells inaddition to epithelial necrosis. It was therefore concluded that, although the overall infection in camels by the various parasites was relatively low as compared to other reported cases elsewhere in the world, the parasites identified in these States could be a hinderance to camel production and also other livestock species considering the extent of common infestation/ infection (with ticks and some helminths) between camels and sheep. Government can partner with stakeholders in the camel industry to achieve a lower prevalence if not a total eradication of these parasites in the areas. This can be achieved through provision of dips and affordable veterinary services inaddition to awareness campaigns. Movements of camels and other livestock across the boarders should be properly monitored

by the appropriate agency to avoid importation of parasites and other diseases of livestock that could be of veterinary and public health significance.

TABLE OF CONTENTS

Title page ……..……..i

Declaration ……...……..ii

Certification ……..……iii

Dedication ……...……..iv

Acknowledgements …….....v

Abstract ……...…….....vii

Table of Contents …….....x

List of Tables ……...……...xvii

List of Figures ……...…….xix

List of Plates ……...……..xx

List of Appendices ……...……..xxii

Abbreviations ……...…….xxiii

Chapter One: Introduction ……..…….....1

Chapter Two: Literature Review

2.1 Overview of protozoans infecting Camels…..…….....8

2.1.1 *Trypanosoma evansi* ……..….....8

2.1.1.1 Transmission ……..….....9

2.1.1.2 Clinical signs ……...…….....9

2.1.1.3 Diagnosis ……..…….....10

2.1.1.4 Treatment ……..…….....14

2.1.2 Coccidia …….....15

2.1.2.1 Coccidia inhabiting the Gatro-intestinal Tract (GIT) …….....16

2.1.2.1.1 Diagnosis ……...……..17

2.1.2.1.2 Treatment ……...……..17

2.1.2.2 Cyst forming coccidia in tissues …….....17

2.1.3 *Theileria* species……...……..18

2.2 Overview of helminth parasites infecting Camels …….....18

2.2.1 Cestodes ……...……..21

2.2.1.1 Hydatid Cyst ……...…….21

2.2.1.1.1 Prevalence ……...…….21

2.2.1.1.2 Pathogenesis ……...……..23

2.2.1.1.3 Diagnosis ……..……...23

2.2.1.1.4 Treatment …….....23

2.2.1.2 *Coenurus cerebralis* ……...…..24

2.2.2 Nematodes ……...…...24

2.2.2.1 *Haemonchus* species….. ……..…24

2.2.2.1.1 Life Cycle of *H. longistipes* ……...…..27

2.2.2.1.2 Pathogenesis …….27

2.2.2.2 *Trichostrongylus* species……...……28

2.2.2.3 *Trichuris* species…….....28

2.2.2.4 *Camelostrongylus mentulatus* …….....29

2.2.2.5 *Onchocerca* species.……...……29

2.2.2.5.1 Prevalence ……...…….29

2.2.3 Other helminths occasionally infecting Camels……..30

2.2.3.1 *Moniezia* species.……...……...30

2.2.3.2 *Stilezia* species……...……...31

2.2.3.3 *Fasciola* species...……...…..31

2.2.3.4 *Oesophagostomum* species.…….…....31

2.2.4 Treatment and Control of Gastro-intestinal helminths of Camels …….....32

2.3 Overview of Ecto-parasitic Arthropods infesting Camels…….….....33

2.3.1 Ticks ……...……34

2.3.1.1 Prevalence ……...…….35

2.3.1.2 Life Cycle ……..……..38

2.3.1.3 Pathogenesis ……..…….....38

2.3.1.4 Control ……...……..39

2.3.2 Mite infestation ……...……..43

2.3.2.1 Prevalence ……...…….43

2.3.2.2 Life Cycle ……..…..44

2.3.2.3 Transmission ……...…….....45

2.3.2.4 Pathogenesis …….....45

2.3.2.5 Diagnosis ……...……..46

2.3.2.6 Control ……...…..46

2.3.3 Flies …….....47

2.3.3.1 Camel nasal bot fly (*Cephalopina titilator*) ..……..47

2.3.3.1.1 Prevalence …….....47

2.3.3.1.2 Life Cycle ……....48

2.3.3.1.3 Pathogenesis …….....48

2.3.3.1.4 Treatment / Control ……..49

2.3.3.2 Stable fly (*Stomoxys calcitrans*) ……..49

2.3.3.3 *Tabanus* species …….....50

2.3.3.4 *Simulium* species ……50

Chapter Three: Materials and Methods

3.1 Survey of Camels for parasites.....51

3.1.1 Study Sites ……..……51

3.1.1.1 Kano State..…….……...……51

3.1.1.2 Katsina State……..……52

3.1.1.3 Zamfara State……...……..53

3.1.2 Sample animals …….……...……...55

3.1.3 Sample collection …….……...……55

3.1.3.1 Collection of ticks……..……..……..55

3.1.3.2 Skin Scrapings for mites …..……...……....56

3.1.3.3 Collection of faecal samples for examination for coccidia.....56

3.1.3.4 Haematological techniques for blood parasites...……..…….57

3.1.3.4.1 Thin smear …….……...…….58

3.1.3.4.2 Thick smear ……...……59

3.1.3.5 Count of helminths in the gastrointestinal tract…….……....59

3.1.3.5.1 Differential parasite counts of nematode in the abomasum…...…59

3.1.3.5.2 Differential parasite counts of nematode in the small intestine.....61

3.1.3.5.3 Differential parasite counts of nematode in the large intestine.....61

3.1.3.5.4 Cestode identification and counting …….....62

3.2 Experimental infection of Yankasa sheep with *H. longistipes* and *H. placei* …….63

3.2.1 Experimental animals …….……..……..……63

3.2.2 Experimental groupings ……..……...….63

3.2.3 Collection of *H. longistipes* Adult worms from naturally infected Camels…….....…….....64

3.2.3.1 Culture of *H. longistipes* ……..……..….....64

3.2.4 Collection of *H. placei* Adult worms from naturally infected Cattle.....65

3.2.4.1 Culture of *H. placei* ……..…….....65

3.2.5 Enumeration of infective Larvae (L_3) of *H. longistipes* and

H. placei……..……..…….65

3.2.6 Infection of sheep ……..…….....66

3.2.7 Parasitological techniques …….……...……..66

3.2.7.1 Live weight measurement of sheep …..…….……....66

3.2.7.2 Faecal egg counts ...…..…….……...…….67

3.2.8 Haematological techniques …….……...….67

3.2.8.1 Blood collection ….……...……67

3.2.8.2 Determination of Packed Cell Volume (PCV). …….……...….67

3.2.8.3 Determination of Haemoglobin (Hb) level ……...…….68

3.2.8.4 Leukocyte (White Blood Cell) counts ……..……68

3.2.8.5 Differential leukocyte counts……...……..69

3.2.9 Necropsy……..……..70

3.2.9.1 Recovery and enumeration of adult worms …….…….....70

3.2.9.2 Recovery and enumeration of immature worms ….…….....71

3.2.9.3 Histopathology ..……..……..…….....72

3.3 Statistical techniques ……..…..72

Chapter Four: Results

4.1 Parasite survey…….…….73

4.1.1 *Trypanosoma evansi*…….……73

4.1.2 Gastro-intestinal helminths…..…….…….78

4.1.3 Coccidia…….……90

4.1.4 Tick infestations…….……...93

4.1.4.1 Distribution of *Amblyomma variegatum*……...101

4.1.4.2 Distribution of *Hyalomma dromedarii*……..…106

4.1.4.3 Distribution of *Rhipicephalus pravus*…..……..…111

4.1.5 Mite infestation…….....116

4.2 Experimental *H. longistipes* and *H. placei* infection in sheep….....118

4.2.1 Clinical findings……...….118

4.2.2 Live weight of sheep…….....121

4.2.3 Haematological indices…….125

4.2.4 Post mortem findings……...…….129

4.2.4.1 Parasitological findings…….……..129

4.2.4.2 Gross pathology……..…….....134

4.2.4.3 Histopathology……...…….134

Chapter Five: Discussion……...……...139

Chapter Six: Summary, Conclusion and Recommendations……...…….157

Reference……...…….....161

Appendix……...…….174

LIST OF TABLES

Table **Page**

4.1 Overall prevalence of *Trypanosoma evansi* infection in three Northern Nigerian States in relation to sex of camels……..……...…76

4.2 Monthly prevalence of *Trypanosoma evansi* in three States of Northern Nigeria ……..…….....77

4.3 Overall prevalence of gastro-intestinal helminths in camels in three States of Northern Nigeria.…….....83

.

4.4 Prevalence of gastro-intestinal helminth parasites in 558 slaughtered camels in three States of Northern Nigeria.…..……..…84

4.5 Seasonal prevalence of gastro-intestinal helminths in slaughtered camels in three Northern States of Nigeria…….....86

4.6 Prevalence of gastro-intestinal helminth parasites in three Northern Nigerian States in relation to sex of camels. ……...…….....88

4.7 Mean worm burden of the various helminths recovered from the GIT of slaughtered camels in three Northern Nigerian States surveyed during Wet and Dry seasons. ……..……..89

4.8 Prevalence of *Eimeria dromedarii* in camels in three States of Northern Nigeria. ……...…..…….……..…...92

4.9 Relative abundance of tick species on 558 camels in three States of Northern Nigeria……..……..…….....99

4.10 Overall monthly prevalence of different tick species on camels surveyed in Kano, Katsina and Zamfara States...……...…...……..100

4.11 Seasonal prevalence of *Amblyomma variegatum* in three States of Northern Nigerian……..……...…….104

4.12 Prevalence of *Amblyomma variegatum* in both sexes of camels in three

States of Northern Nigeria…….……...….105

4.13 Prevalence of *Hyalomma dromedarii* in both sexes of camels in three States of Northern Nigeria. …...…….....108

4.14 Seasonal prevalence of *Hyalomma dromedarii* in camels in three States of Northern Nigeria……...……110

4.15 Prevalence of *Rhipicephalus pravus* in both sexes of camels in three States of Northern Nigeria …….……..……113

4.16 Seasonal Prevalence of *Rhipicephalus pravus* in camels in three States of Northern Nigeria ……..……...…….....115

4.17 Mean Haematological values (Leukocytic series) in *Haemonchus longistipes*- infected sheep (Gr.I), *H. placei*-infected sheep (Gr. II) and Control (Gr. III)……...……..127

4.18 Worm recovery in experimentally *H. placei*-infected Yankasa sheep..131

4.19 Worm recovery in experimentally *H. longistipes*-infected Yankasa sheep ……..……132

4.20 Comparison between pre-infection and post-infection mean lengths of *H. longistipes* and *H. placei* recovered from experimentally infected Yankasa sheep. …….....133

LISTS OF FIGURES

Figure **Page**

3.1. Study sites…….…….…..…...…….54

4.2. Mean monthly adult tick burdens (a), overall monthly prevalence of nymph (b) and overall monthly prevalence of adult ticks (c) of *Amblyomma variegatum*……...…..……..…….....103

4.3. Mean monthly adult tick burdens (a), monthly prevalence of immature stages (b) and monthly prevalence of adult ticks (c) of *Hyalomma dromedarii*. ……..……107

4.4. Mean monthly adult tick burdens (a), overall prevalence of immature stages (b) and overall prevalence of adult ticks (c) of *Rhipicephalus pravus*.……..…….....112

4.5. Weight changes in *Haemonchus longistipes* (Gr. I) and *H. placei*-infected (Gr. II) and uninfected Yankasa sheep Gr. (III)…...……...….123

4.6. Mean Faecal Egg Counts (FEC) of *Haemonchus longistipes* and *H. placei* – infected Yankasa Sheep……..……..…124

4.7. Changes in mean Haemoglobin (Hb) levels (a); Changes in mean Packed Cell Volume (PCV) levels (b) of *Haemonchus longistipes* (Gr. I), *H. placei* (Gr. II) infected and uninfected Yankasa sheep (Gr. III)…….....128

LISTS OF PLATES

Plate **Page**

I. *Trypanosoma evansi* in blood of an infected camel …….....74

II. *Haemonchus longistipes* (anterior end) recovered from a camel ….....80

III. *Trichuris globulosa* (posterior end of male) recovered from a camel… ..……..…….80

IV. *Oesophagostomum venulosum* (anterior end) recovered from a Camel ……..….....81

V. *Moniezia benedeni* (scolex) recovered from a camel …….……..…..81

VI. *Stilezia vittata* (scolex) recovered from a camel .....……..….82

VII. *Eimeria dromedarii* recovered from a camel: (a) unsporulated oocyst; (b). sporulated oocyst…..……..……..91

VIII. *Amblyomma variegatum* recovered from a camel: (a). adult male; (b). flat female (c). engorged female and …..…….....95

IX. *Hyalomma dromedarii* recovered from a camel: (a). adult male; (b). flat female and (c). engorged female …….……..…96

X. *Rhipicephalus pravus* recovered from a camel: (a). adult male; (b). adult female……..……98

XI. Skin lesion of mite infested camel …….....117

XII. *Demodex folliculorum var. cameli* recovered from a camel ……..…117

XIII. Experimental sheep ……...……..119

XIV. Sheep showing sign of haemonchosis (swollen lower jaw) as a result of *H. longistipes* infection.....……..……. ……..119

XV. Aborted fetus of *H. longistipes* - infected sheep …….....120

XVI. Premature lamb delivered *by H. longistipes* - infected sheep…….....120

XVII. Normal Heart and lungs of *H. longistipes*-infected (a), *H. placei* – infected (b) and uninfected (c) sheep……..……...…135

XVIII. Abomasum of *H. longistipes* - infected sheep showing gross abomasal lesions……...…….…137

XIX. Abomasum of *H. placei* - infected sheep showing gross abomasal lesions …….…..……..137

XX. Section of *H. longistipes* worm in the mucosa surrounded by a zone of inflammatory cells…….…….....138

XXI. Parasitic tract of *H. placei* surrounded by zone of inflammatory cells…….....138

APPENDICES

Page

A Survey data collected from camels in abattoirs at Kano, Katsina and Zamfara States during the study period……..……..…...174

B Pre and Post infection data collected from sheep artificially infected with *Haemonchus longistipes* and *H. placei* during 15weeks study period…….……...…..……..210

C Solution / Fluid compositions……...…242

D Camel used as beast of burden in Zamfara State…….…….244

E Camel slaughtered for meat at Katsina abattoir …….……..244

F Ox-pecker birds in symbiosis with camels …….……245

G Camels feeding on *Azadiracta indica* (neem) at one of the study sites ……...…….245

H Camels grazing at one of the study sites..…….……....246

ABBREVIATIONS

ANOVA – anlysis of variance

cm – centimeters

dl - dalton

epg – egg per gram

FEC – faecal egg counts per gram of faeces

Hb - haemoglobin

GIT – gastrointestinal tract

g - gram

Kg – kilograms

L - litres

L_3 - third or infective stage of nematode larvae

L_4 – fourth stage of parasitic nematode larvae

LWM - live weight measurement

m - meters

ml - milliliter

min –minutes

NES – no egg seen

PCV – packed cell volume

RBC – red blood corpuscles

rpm – round per minute

sec – seconds

SD – standard deviation

SEM – standard error of the mean

μm – micromillimeter

WBC – white blood corpuscles

Wk – week

Wt – body weight

% - percentage

X^2 – chi - square

CHAPTER ONE

INTRODUCTION

The versatility and ability of the one – humped camel (*Camelus dromedarius*) to survive and perform in the harsh arid and semi-arid regions of the world has made it an integral part of the livestock and economy of many Saharan and sub-Saharan countries where many other livestock find it difficult to survive and perform optimally (Mukasa -Mugerwa, 1981; Musa *et al.*, 2004).

In most camel breeding countries, the role of the camel as a beast of burden is fast diminishing with emphasis shifting to breeding for milk and meat production (Mukasa -Mugerwa, 1981). Dada (1978) estimated that 3,410 camels were slaughtered between September and December at one abattoir in Kano. During the present survey, however, it was observed that the number of camels slaughtered at most of the abattoirs have multiplied ten fold probably due to increased human population and the demand for animal protein. The appearance, colour, texture and palatability of camel meat has been reported to be similar to beef and are therefore successfully marketed alongside that of cattle, sheep and goats in most markets in the North (Mukasa - Mugerwa, 1981). On the other hand camel milk is appreciated by consumers for its historic and medicinal properties. It is reputed to be anti-infectious, anti-

cancerous and anti-diabetic. The relatively large amount of vitamin C in camel milk is also believed to serve as supplement to fruit and vegetables which are usually scarce in arid and semi-arid areas (Gaukhar and Faye, 2004).

Nevertheless, in some remote areas, despite modern advances in science and technology, the camel is still used for several other purposes. The strength and docility of the camel are still being exploited for agricultural purposes, transportation, luggage, for riding and for police patrols. Camel products such as camel dung, hair and hides also play an important role in the economy of these communities (Higgins *et al.*, 1984).

Although overgrazing by livestock have generally been associated with desertification, available evidence from ecologist has shown that camel grazing has very little, if any, damaging effect on desert vegetation (Gaukhar and Faye, 2004). The flat pad-like feet have been suggested to be gentle on the soil surface, thereby making the camel an eco-friendly animal (Gaukhar and Faye, 2004).

However, despite the hostile environment in which the camel lives and which generally should not be conducive for the development and spread of disease - causing organisms, camels are reported to suffer from a diverse range of parasites and diseases (Steward, 1950; Higgins, 1983; Elbihari, 1985). Reports have shown that of all the numerous disease - causing organisms found

in camels, protozoa and helminth diseases are ranked as the second and third major causes of economic loss respectively (Boid *et al.,* 1985; Mukhwana and Mitema, 1995).

These parasites have been shown to impose considerable restrains to the productivity of camels in different parts of the world (Higgins *et al*, 1984). The diseases caused by these parasites normally manifest in form of general debility, reduced growth rates and milk yields, increased calving intervals, inappetance and anaemia (Tanwar, 2004); and, in some cases, these parasites result in death of the animal or play a significant role as a zoonotic agent (Acha and Szyfres, 1987).

Ecto-parasites on the other hand cause relatively little damage in camels compared to other livestock. However, these groups of parasites are responsible for heavy blood loss and tissue infections in camels (Wilson, 1998). Ticks and tick borne diseases are reported to be a major constraint to livestock production all over the world (Seifert, 1996). It has been estimated that 80% of the world livestock population are at risk of tick and tick borne diseases and over US$ 7 billion worth of losses are recorded annually (Perry *et al.,* 2002). Inaddition, ecto-parasites, particularly ticks, mites, and fleas may also cause direct damage such as reduction in quality of camel products like hide, milk, hair and wool, reduction in live weight gain, anaemia and in host's

resistance against other diseases, toxaemia, weakness and paralysis through their physical feeding habit (Yagil, 1982; Seifert, 1996).

Therefore, in formulating and implementing strategies for effective control of these parasites in order to achieve decrease in production costs, increased productivity, as well as a decrease in morbidity and mortality, adequate information is indispensable.

Background

Camel Stocks in Nigeria

Agriculture is the mainstay of the economy of Northern Nigeria. According to FAOSTAT (1999), there are over 20 million camels in the world with about 180,000 found in Nigeria. These camels are mostly found in the Sudan and Sahel Savanna areas of Sokoto, Katsina, Kano, Jigawa, Zamfara, Yobe, and Borno States (James-Rugu and Jidayi, 2004; Mohammed and Hoffmann, 2006).

In most of these areas, the camels are still being used as beasts of burden, as draught animals (Mohammed and Hoffmann, 2006), for meat inaddition to other purposes.

Constraint to Camel production in Nigeria

Like other livestock, several factors affect the productivity of camels. Although there are few published reports in Nigeria, grazing lands, water,

veterinary care/ drugs, bacteria, viruses and parasitic diseases are recognized as the major constraints to camel production in other parts of the world (Dolan *et al.,* 1983; Schwartz *et al.,* 1983). The importance of parasitic diseases as a constraint to the productivity and development of the camel industry in Nigeria is only recently being recognized by a few researchers (Falope, 1991; Egbe-Nwiyi, 1994; Baba *et al.,* 1994; Ogunsan *et al.,* 2000; James-Rugu and Jidayi, 2004; Kalla *et al.*, 2006; Lawal *et al.*, 2007; Biu and Abbagana, 2007).

Camel parasites

Parasites of camel, like those of other livestock, mainly belong to the phyla Protozoa, Platyhelminthes, Nemathelminthes and Arthropoda (Higgins, 1983; Elbihari, 1985; Boid *et al.*, 1985).

Protozoa: These are unicellular animals in which the various activities of metabolism, locomotion and so forth, are carried out by organelles of the cell. Majority of protozoa are free - living while few are serious parasites of man and his livestock (including wild animals) in different parts of the world. Many of the parasitic protozoa are found in the classes Mastigophora and Sporozoa with only a few in Sarcodina and Ciliata.

Platyhelminthes, which are otherwise referred to as flat worms have two classes of parasites: Trematoda (flukes) and the Cestoda (tapeworms). These parasites are flattened dorsor- ventrally and are hermaphroditic.

Nemathelminthes, in which the class Nematoda (round worms) is found. Many of the superfamilies of veterinary significance are found in this phylum.

Arthropoda, which are metamerically segmented animals possessing chitinous exoskeleton. Many species belonging to the class insecta and arachnida are important parasites/ vectors of medical and veterinary importance.

Justification

It was however observed that in spite of the large number of camels in Nigeria and the contribution of camel to the socio-economic development of the herdsmen and the country in general by contributing significantly to meat (and sometimes milk) production in meeting the shortfall created by fast rising human population, not much research has been conducted on camel parasites compared to other livestock. The few published reports are on bacterial and viral diseases (Addo, 1980; Ajayi *et al.*, 1984; Kwaga, 1985; Kwaga *et al.*, 1987).

However, for any livestock (camel) enterprise to be successful, priority must be given to health problems inaddition to providing good nutrition and clean drinking water among other factors. Good health, however, can only be achieved if adequate knowledge of the diseases affecting camels and the dominant parasites peculiar to a particular camel breeding area is known, inaddition to cross infectivity with these parasites among the different livestock

species kept with camels, especially with the changing livestock management from the traditional nomadic system commonly practiced in Nigeria to a system which will effectively utilize the available forage and incentives created, such as water spots, to maximize production.

Aims and Objectives

The research was aimed at achieving the following objectives:

* To determine the occurrence and prevalence of *Trypanosoma* species in camels in the North Western (Sudan Savanna) part of Nigeria in relation to sex of camel and season of the year.

* To study the prevalence, intensity and seasonal distribution of helminth parasites of camel in the study areas.

* To study the seasonal abundance of ticks and any other ecto-parasites that may be found associated with camels in the study areas.

* To study the pathogenecity of experimentally induced *H. longistipes* and *H. placei* infections in Yankasa sheep, an abnormal host.

Limitations of the Research:

The present research excludes tissue dwelling parasites (*Onchocerca* species. *Echinococcus granulosus, Coenurus cerebralis and Cephalopina titilator*), biting and nuisance flies that may be found associated with camels.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of protozoans infecting Camels.

A number of protozoan parasites have been reported to occur in camels although most, with the exception of *Trypanosoma* species, have little or no economic impact on the productivity of camels (Boid *et al.*, 1985). These probably explain the scanty work that has been done on the occurrence of most of these protozoan parasites and the diseases they cause in camels. In contrast to some of the protozoan diseases, there are several works on trypanosomosis in camels from different parts of the world (Higgins, 1983; Boid *et al.*, 1985; Aksoy, 2003). Protozon parasites commonly reported in camels include:

2.1.1 *Trypanosoma evansi* (Steel, 1885), Balbiani 1888.

Although *T. vivax*, *T. simiae* and *T. congolense* are often reported to infect camels, the major cause of Surra world wide is *T. evansi*. (Yagil, 1982; Higgins, 1983; Boid *et al.*, 1985; Stevens and Brisse, 2004). The parasites are mechanically transmitted by biting flies, chiefly tabanids. Surra, the disease caused by *T. evansi* is a wasting disease not only in camels but also in other livestock and wild life. It is responsible for great impairment in productivity of camels in several camel rearing areas (Wilson, 1998).

T. evansi in a mammalian host is typically monomorphic and occurs as long slender forms (trypomastigotes). It is between 15µm and 36µm in length (Stevens and Brisse, 2004).

2.1.1.1 Transmission

T. evansi is mechanically transmitted from animal to animal by biting fly vectors, including Tabanids, *Lyperosia* species and *Stomoxys* species, as well as vampire bats (Higgins, 1983; Boid *et al*, 1985; Taylor and Authie, 2004). This mode of transmission occurs when trypanosomes are transferred directly from the blood of an infected host to another host without undergoing development in the vector (Hall and Wall, 2004).

2.1.1.2 Clinical Signs

Surra in camels is characterized by intermittent fever, anaemia, emaciation, oedema, conjuctivitis and lacrymation, enlargement of the lymph node and spleen. There is also impaired motor function in affected camels and in some cases pregnant cows abort. Neurological signs may also be seen in the late stages of the infection (Tanwar, 2004; Taylor and Authie, 2004).

Mukasa- Mugerwa (1981) quoted Fazil (1977) as confirming camel trypanosomosis as a slow, wasting disease of camels. Animal becomes thin, weak, prostrate and eventually dies.

The first sign of Surra in camels may include a drop in milk production and loss of appetite leading to emaciation. Recovery of infected camels may occur in 20% of animals which are well fed, rested and managed. These animals subsequently become immune. The death of chronically affected animals is often triggered off by secondary infections such as bronchopneumonia (Mukasa – Mugerwa, 1981; Taylor and Authie, 2004).

2.1.1.3 Diagnosis

Some of the diagnostic methods routinely used in the laboratory or for practical application in the field for the diagnosis of trypanosomosis in camels are reviewed below.

Wet blood film

This is the easiest and cheapest diagnostic test for *T. evansi* in camels. It involves placing a drop of fresh blood between a slide and a cover slip, and then examining the blood by light microscopy at 400x amplification (Luquetti, 2004).

Thin Smear

This is performed by placing a drop of blood on a clean slide and quickly sliding a second glass slide at an angle of 30^0 to produce a thin smear which is then dried in air, fixed in methyl alcohol and finally stained with Giemsa.

Buffy Coat Layer

Due to the chronic nature of *T. evansi* infection, few parasites are usually present in the blood of infected animals. This has made detection of the trypomastigotes of *T. evansi* difficult (Dia, 2006). However, the use of Buffy coat layer instead of whole blood has been reported to increase diagnostic sensitivity ten fold (Luckins and Dwinger, 2004).

This method is an improvement of the microhaematocrit centrifugation technique. It involves centrifugation of microhaematocrit capillary tubes containing blood samples and expelling the buffy coat/ plasma interface on a microscope slide and then examining using dark-background or phase-contrast illumination. This method helps to increase the sensitivity by concentrating the parasites (Eisler *et al.,* 2004).

Serological assays

Many serological assays have been designed for used in the diagnosis of *T. evansi* in different parts of the world (Atarhouch *et al.*, 2003; Delafosse and Doutoum, 2004; Luckins and Dwinger, 2004). Some of these techniques include:-

Compliment fixation test

This test was said to have been used extensively in Philippines and China (Luckins and Dwinger, 2004). The test is in two stages. In the binding

stage, the antigen, test serum and compliment are mixed and incubated at 37^0C for 30minutes or at 6^0C for 16hours. In the haemolysis stage, red cells of sheep are sensitized by haemolytic serum and added to the mixture which is then kept for 15 – 30minutes at 37^0C. The reaction is positive when there is no haemolysis.

Due to complexity of this technique, among several other reasons, the use of this technique is mostly restricted to research Laboratories (Luquetti, 2004).

Card aggulutination test for trypanosomiasis (CATT)

This test is very common and uses standardized reagents which can be used under field conditions for detection of antibodies to *T. evansi* in a number of animal species. The technique is based on direct agglutination of specific antibodies in the blood of infected animal. Briefly, test serum is mixed with trypanosome antigen on a card and shaken for 5minutes. The result is then read by evaluating the presence of blue granules.

CATT sensitivity and specificity has been estimated at 84 –100% and 72 – 81% respectively (Delafosse and Doutoum, 2004).

Antibody detection ELISAs (Ab-ELISAs)

This technique utilizes crude sonicated antigens. Although antibody responses in individual animal vary, it is possible to detect antibodies 14- 21

days after infection in several different host species (Luckins and Dwinger, 2004).

It involves the use of particulate antigen bound to a flat- bottomed microplate, followed by incubation with sera and a second incubation with an anti- human IgG conjugated with an enzyme such as peroxidase. The intensity of the colour produced is then measured by a spectrophotometer.

However, the persistence of antibodies after treatment is considered to be a major impediment of this assay, since it is difficult to distinguish between active infections and past infections (Luckins and Dwinger, 2004).

Antigen detection ELISAs (Ag- ELISAs)

This test provides evidence of current infection by detecting circulating trypanosomal antigen. The technique is based on the double antibody-sandwich technique in which captured antibody is absorbed to a micro-titre plate and, after reacting with test sera, the same antibody conjugated with horseradish peroxidase is added as an indicator (Luckins and Dwinger, 2004).

Olaho-Mukani *et al.* (1993) in a comparison of the antibody and antigen detection enzyme immunoassays for the diagnosis of *T. evansi* infections in camels examined a total of 183 camels in Kenya for circulating trypanosomal antigens by four methods: monoclonal antigen-detection enzyme-linked immunosorbent assay (Ag-ELISA) and circulating anti-trypanosomal

antibodies, antibody-detection enzyme-linked immunosorbent Assay (Ab-ELISA), Buffy Coat Examination (BCE) and Mouse Sub-Inoculation. Thirty-Seven Camels (20%) were parasite positive by BCE and 60 camels (33%) were parasite positive by Mouse Inoculation (MI). Sixty three camels (34%) tested positive by Ag-ELISA, indicating the sensitivity of this test.

Use of Polymerase Chain Reaction (PCR)

Though not routinely used, this technique could offer a very precise method for detecting infection and discriminating between infected and non infected animals. Singh *et al.* (2004) reported higher (17.05%) sensitivity to *T. evansi* by PCR than Ag-ELISA (9.67%), thin Blood Smear (4.60%) or by Wet Blood Film (4.14%). Similarly, Njiru *et al.* (2004) also reported on the supremacy of the PCR over CATT/*T. evansi* test in detecting *T. evansi* infection. However, in developing countries, the use of DNA technologies is limited by several factors which include cost of reagents and equipments, training etc.

2.1.1.4 Treatment

Treatment and control of *T. evansi* relies on chemotherapy although there are isolated cases of drug resistance to most of the drugs in common use (Luckins and Dwinger, 2004). Some of the compounds used in camels include:

Suramin

This has been the mainstay of treatment for all host species infected by *T. evansi*. Suramin binds to serum proteins and can confer limited protection to treated animals. It is administered at a dose rate of 10mg/kg.

Diminazene aceturate

This drug is given at a dose rate of 3.5 mg/kg by an intramuscular injection.

Isometamidium chloride

The drug is found to be effective in suramin resistant *T. evansi* (Higgins, 1983). Isometamidium chloride is given slowly intravenously or at several injection sites at a dose of 1mg/kg body weight.

Quinapyramine

This compound is found to be effective when given at 2 – 5mg/kg body weight by subcutaneous injection of infected animals.

2.1.2 Coccidia

Coccidiosis is a disease condition resulting from infection by either species of *Eimeria, Isospora* or *Sarcocystis*. It is contagious in many livestock including camels (Charray *et al.,* 1992; Wilson, 1998). Some species are gut - dwelling while others are tissue - dwelling (Boid *et al.,* 1985). In species

inhabiting the gastro-intestinal tract (GIT), the host is usually infected by ingesting coccidia excreted by sick animals (Charray *et al.,* 1992).

2.1.2.1 Coccidia inhabiting the gastro-intestinal tract (GIT*)*

A number of coccidia species inhabiting the GIT have been reported to occur in camels (Boid *et al.,* 1985). Some of these include: *Eimeria cameli, E. dromedarii, E. rajasthani, E. pellerdyi* and *E. bacteriani*.

Although coccidia are generally reported to be host-specific and infection does not pass readily from one animal species to another nor does cross immunity between species of coccidia occur (Radostits *et al.,* 1994), a species of *Isospor*a, (*I. orlovi*) believed to be of avian origin was reported in camels (Boid *et al.,* 1985).

However, in most livestock, coccidia infections may present as a sub clinical case or there is anaemia while the chronic form of the disease may be characterized by poor growth and low production (Charray *et al.,* 1992; Wilson, 1998).

Chineme (1980) documented a case of intestinal coccidiosis in a 5 - year old male camel from Nigeria caused by infection with *E. cameli*. Gross findings revealed pin – head sized whitish-grey foci which were more numerous in the distal portion of the jejunum. The mesenteric lymph nodes were enlarged and edematous. However, the most significant microscopic

changes observed during histopathology were confined to the jejunal mucosa where large, cyst-like structures and a few immature oocysts were seen in the lamina propria. Cellular reaction in the lamina propria of the jejunum was dominated by presence of lymphocytes and eosinophils, with a few macrophages.

2.1.2.1.1 Diagnosis

Diagnosis depends on the confirmation by laboratory examination of unsporulated oocyst in the faeces. However, where a post mortem examination is possible, scrapings of the small and large intestinal mucosae may be examined for the developmental stages (Soulsby, 1982).

2.1.2.1.2 Treatment

Coccidiosis in camels can be treated by the administration of sulphonamides in conjunction with antibiotics.

2.1.2.2 Cyst-forming Coccidia in tissue

Sarcocystis cameli is the only species of *Sarcocystis* reported to occur in camels (Boid *et al.,* 1985).

Camels serve as the intermediate host and become infected after ingestion of sporulated oocysts that are passed in the faeces of carnivores such as dogs. The sporozoa excyst in the gut of the camel, undergo a period of rapid division in the gut wall and eventually migrate to the striated muscles to form

cyst. The cycle is completed when the cyst (Sarcocyst) containing infective stages is ingested by the final host (Dog).

2.1.3 *Theileria* species

There seems to be some doubt as to the occurrence of the cameline species of *Theileria* in camels. Although there are recorded cases of camel infection by *Theileria camelensis* in Turkestan, former U.S.S.R, Egypt and Somalia, there are reservations as to the authenticity of the reports due to lack of satisfactory description of the schizont stages of the parasite (Elbihari, 1985). However, recent studies have shown the possibilities of camels becoming infected by *Theileria* species infecting other domestic livestock such as sheep. In an examination of slaughtered camels in Egypt, Mazyad and Khalaf (2002) recorded 18/190 (9.5%) prevalence of *Theileria ovis.* Inaddition, most of the ticks found attached to the camels had *T. ovis* in their gut and / or salivary gland as follows: *Rhipicephalus appendiculatus* (20%), *R. bursa* (16.7%), *R. turanicus* (10%), *Haemaphysalis parva* (10%), *H. a. excavaium* (30%), *H. dromedarii* (18%), and *H. a. anatolicum* (6.7%).

2.2 Overview of helminth parasites infecting Camels.

Despite the apparently unfavourable climatic conditions for the propagation of parasitic helminths as a consequence of the long dry season in

most camel breeding areas, the camel is reported to harbour a wide variety of gastrointestinal parasites and a few species of filarid worms (Higgins, 1983; Elbihari, 1985).

Altaif (1974) reported 100% prevalence of helminth infection in camels brought to a Baghdad abattoir between October 1971 and July 1972. Thirteen helminth species were recorded. *Trichostrongylus* species were the most common, while *Camelostrongylus mentulatus* and the hydatid larval cysts of *Echinococcus granulosus* were also found.

In Eastern Ethiopia, Bekele (2002) in an investigation of adult parasites in the gastrointestinal organs of dromedaries recorded 94% prevalence of *Haemonchus longistipes*, 75% for *Trichostrogylus columbriformis*, 25% for *T. probolurus*, 75% for *Trichuris* species, 63% for *impalaia tubaculata* and 20% for *Strongyloides papillosus.* Cestodes such as *Moniezia benedeni, Moniezia expansa, Avitellina* species and *Stilesia globipunctata* had prevalence rates of 31%, 13%, 25% and 19% respectively.

Faecal examination of 265 camels in Jordan showed that 96% of the animals were infected by gastrointestinal helminths. Nematodes represented 84% of all the gastrointestinal parasites with *Trichostrongylus probolurus, Camelostrongylus mentulatus, Trichuris ovis, Haemonchus longistipes, Cooperia oncophora* and *Nematodirus dromedarii* being the main nematodes.

Moniezia expansa, *Eurytrema pancreaticum* and *Fasciol*a *hepatica* were diagnosed with prevalence rates of 21%, 5% and 4% respectively (Sharrif *et al.,* 1998).

In Pakistan, the prevalence of gastrointestinal helminths was 69.1% of which 32.5% were mixed infections. The species of helminths recovered were: *Paramphistomum cervi* (1.6%), *Carmyerius spatiosus* (1.1%) *Gastrothylax crumenifer* (1.5%), *Moniezia expansa* (9.1%), *Moniezia benedeni* (7.8%), *Stilesia globipunctata* (5.5%), *Haemonchus contortus* (5.0%), *H. longistipes* (7.1%), *Trichostrongylus probollorus* (4.1%), *Camelostrongylus venulosum* (2.5%), *Cooperia oncophora* (2.5%), *Ostertagia cercumcincta* (3.3%) and *Chabertia ovina* (3.1%). Worm burden per camel ranged from 20 -330, 4 – 40 and 30 – 250 for trematodes, cestodes and nematodes respectively (Anwar and Khan, 1998).

In a faecal examination of 177 slaughtered camels in a metropolitan abattoir in Kano, Nigeria, Kalla *et al*. (2006) recorded an overall helminth infection rate of 78.5%. *Oesophagostomum radiatum*, *Haemonchus contortus* and *Strongylus* species were reported as being the most common.

In a related survey, Biu and Abbagana (2007) reported a prevalence rate of 29% for Paramphistomes in slaughtered camels examined in Maiduguri. Out of a total fluke burden of 308 recorded, *Paramphistomum cervi* had a fluke

burden of 105 (34.0%), *Euretrema pancreatum* 73 (27.3%), *Cotylophoron cotylophorum* 77 (25.0%) and *Gastrothylax crumenifer* 53 (17.2%). No significant difference was however observed with respect to sex of camels.

2.2.1 Cestodes

2.2.1.1 Hydatid cyst

The adult parasite, *Echinococcus granulosus*, is found in the small intestine of carnivores, particularly dogs, wolves and foxes while the hydatid cyst is found in a wide variety of domestic animals and man (Higgins, 1983; Sharrif *et al.*, 1998). Infection in camels occurs when eggs of *E. granulosus* are ingested.

2.2.1.1.1 Prevalence

Hydatidosis as a result of *E. granulosus* has been reported to be widespread in many camel- rearing areas of the world (Higgins, 1983).

In Jordan 44% of the slaughtered camels examined were found to be infected by hydatid cysts. Most of the cysts were lodged in the lungs (Al-Rawashdeh *et al.*, 2000).

In an earlier survey in Jordan, Sharrif *et al.* (1998) had reported on the distribution of hydatid cysts in organs of slaughtered camels. In the study, 62.5% of the camels had cysts in their lungs, 25% in their livers and 12.5% in other organs of the body.

However, relatively higher prevalence of hydatid cyst (77.5%) was recorded in camels slaughtered at Faisalabad abattoir in Pakistan in which 77.4% of the infections were in the lungs while 3.2% occurred in the livers (Anwar and Khan, 1998).

A recent survey of slaughtered camels in five different regions of Iran revealed 35.2% prevalence rate of hydatid cyst. Out of the 303 cysts recovered, 197 (65.0%) were fertile, 59 (19.5%) sterile and 47 (15.5%) calcified. The proportion of fertile cysts in the lungs was higher (69.7%) than in the liver (58.7%) or any other organ (Amadi, 2005).

In Nigeria, a rate of 57.2% was reported in 3410 slaughtered camels (Dada, 1978). The cysts were found in the lungs, liver and spleen of infected animals.

Similarly, an analysis of abattoir records of disease conditions in slaughtered camels in Yobe State in the North Eastern part of Nigeria showed that hydatidosis formed between 50% and 85% of the total disease conditions between 1986 and 1991 (Baba *et al.*, 1994).

A study on the situation of hydatidosis in Sokoto, a town in North Western Nigeria showed that out of the 1714 slaughtered camels examined only 26.2% were infected. This rate is relatively lower than that reported from any other part of the country (Ogunsan *et al.*, 2000). However, among the

affected batch of camels in the Sokoto survey, 88.8% of the cases were of pulmonary origin and 34.7% hepatic.

In a survey of hydatidosis in animals slaughtered in Kano abattoir, Nigeria, Luka (2006) recorded an overall prevalence rate of 32.6% antibody response to *Echinococcus granulosus* by ELISA. The higest prevalence rate of 38.9% was recorded in camels, followed by 36.2% in sheep, 31.2% in cattle and 23.8% in goats.

2.2.1.1.2 Pathogenesis

The harmful effect of hydatid cyst naturally depends on the organ in which it is situated and the severity of the infection. When cysts are lodged in the lung parenchyma, they may cause brocho-occlusion resulting in dyspnoea, or digestive disturbances and possibly ascitis when liver is infected (Soulsby, 1982).

2.2.1.1.3 Diagnosis

In animals, hydatid cyst in lungs or liver can be detected by percussion. However, in man different immunodiagnostic tests are widely used in the detection of hydatid cyst disease (Belding, 1965; Soulsby, 1982).

2.2.1.1.4 Treatment

Since adult worms are not found in camels, treatment of hydatid cyst is by surgical removal of cyst when possible.

2.2.1.2 *Coenurus cerebralis*

This is a cystic larval stage of the tapeworm *Taenia multiceps*. The adult parasite occurs in the small intestine of dogs while the intermediate stage may be found in cerebral hemisphere of affected camels (Higgins, 1983). Although it is not considered as a serious problem in camels, the larvae in the brain may cause a condition that is characterized by somnolence, loss of weight, visual disturbances and blind staggers in affected camels (Elbihari, 1985).

2.2.2 Nematodes.

2.2.2.1 *Haemonchus* species

Species of *Haemonchus* are voracious blood suckers commonly found in the abomasa of ruminants such as sheep, goats, cattle and camels (Soulsby, 1982). They are commonly reported from almost all parts of the world (Higgins, 1983; Elbihari, 1985; Jacquiet *et al.*, 1996).

Haemonchosis resulting from infection with *Haemonchus* species remains one of the major causes of economic loss to ruminant production in tropical Africa (Jacquiet *et al.*, 1998; Gatenby, 2002). Blood loss is about 0.05ml/ parasite and blood could be excreted in faeces 6 -12days post infection. Clinically, haemonchosis may present as either of these syndromes:

(a). Hyperacute haemonchosis.

This is uncommon, seen only in susceptible animals exposed to sudden massive infection and is characterized by rapidly developing severe anaemia, dark coloured faeces, sudden death from acute blood loss and severe haemorrhagic gastritis. Death may occur in the prepatent period of such heavy infections.

(b). Acute haemonchosis

Usually seen primarily in young susceptible animals heavily infected by ingesting infective stages of *Haemonchus spp*. Infection is accompanied by rapidly developing anaemia, expansion of the erythropoietic response of the bone marrow, hypoproteinaemia, oedema (bottle jaw) and death occurs. Egg counts are usually high, up to 100,000 epg. Carcas shows generalized oedema and anaemia, and 1000 – 10,000 parasites may be present in the abomasum.

(c). Chronic haemonchosis.

This is extremely common and is due to chronic infection with a fairly low number of parasites (100 – 1,000). Morbidity is 100%, but mortality is low. Animals appear weak, unthrifty and emaciated, with or without severe anaemia and hypoproteinaemia. Egg counts may be less than 200epg.

In West Africa, there are three common species of *Haemonchus* reported to infect ruminants: *H. contortus* in goats and sheep; *H. placei* in

cattle and *H. longistipes* in camels, although isolated cases of accidental cross infections are often reported (Elbihari, 1985).

In a study to experimentally check the host -parasite compatibility of different *Haemonchus* species in an unusual host, Jacquiet *et al*. (1998) reported poor establishment of *H. contortus* in zebu cattle with no worm recovery at post mortem, while only few worms were recovered in dromedaries. In contrast, sheep and goats were highly susceptible, with high levels of establishment and egg production / excretion. Similarly, sheep and goats seemed to present a high susceptibity to experimental *H. placei* infections while dromedaries developed only a slight infection with no egg excretion. However, no infection in zebu cattle was observed with *H. longistipes* although high establishment rates and high levels of egg excretion were observed in sheep and goats when infective dose exceeded 500 larvae.

In an earlier study, Arzoun *et al.* (1983) reported high susceptibility of goats to *H. longistipes*. Although unlike the age-dependency of camel haemonchosis, the severity of *H. longistipes* infection in experimental goats was reported to be dose - dependent and varies from mild to hyper - acute.

In another related study, an attempt to experimentally infect sheep with the camel stomach worm, *Haemonchus longistipes*, 28 out of 34 inoculated animals developed patent infection with the pre-patent infection lasting 3- 4

weeks in the majority of infected animals. Worm burdens were observed to be low and so was the total egg output. Inaddition most of the worms recovered at post mortem were reduced in size (Elbihari *et al.*, 1984).

2.2.2.1.1 Life cycle of *H. longistipes*

The life cycle of *H. longistipes* includes a free-living phase (from the egg to the infective larvae, with pre-infective stages being highly susceptible to harsh conditions) and a parasitic phase (from the infective larvae, ingested by the host, to the adults). During harsh dry season of most camel breeding areas, *H. longistipes* has been suggested to use arrested larval development (hypobiosis) as a survival strategy. Jacquiet *et al.* (1996) observed egg excretions, infective larvae derived from eggs as well as female prolificacy to show a marked seasonal pattern: high values in the rainy season and very low values in the dry season.

2.2.2.1.2 Pathogenesis

Infection with *Haemonchus longistipes* may result in anaemia, protein deficiency due to interference with digestibility and absorption of protein, calcium and phosphorus (Soulsby, 1982). In severe cases, oedema above eye, on the side of chest pad and the sub-mandibular region is common. Inappetance, progressive wasting and death may occur (Tanwar, 2004).

2.2.2.2 *Trichostrongylus* species

These are small, slender, pale reddish brown worms measuring 4 - 5.5mm long for males and 5 – 7mm for females. They are found in the anterior portion of the small intestine and sometimes also in the abomasum of sheep, goats, cattle, camels and several antelopes (Soulsby, 1982). Three species are commonly reported in camels. These are *Trichostrongylus probolurus*, *T. vitrinus* and *T. colubriformis* (Elbihari, 1985). The prevalence of these parasites nears or even exceeds that of *Haemonchus longistipes* in some localities (Altaif, 1974).

The harmful effect of *Trichostrongylus* species is noticed when worms penetrate into the mucosa underneath the epithelium, producing desquamation; infection may result in anaemia, emaciation and diarrhoea (Steward, 1950; Altaif, 1974; Soulsby, 1982).

2.2.2.3 *Trichuris* species

These are common parasites of camels, sheep, goats, cattle and many other ruminants. *Trichuris ovis*, *T. globulosa* and *T. cameli* have been frequently reported in camels (Elbihari, 1985).

Opinion about the pathogenecity of *Trichuris* species varies, but it has been suggested that they can produce an acute or chronic inflammation of the caecum in infected animals (Soulsby, 1982).

2.2.2.4 *Camelostrongylus mentulatus*

This is a common gastric parasite of camels. The parasite has also been found to infect domestic and wild ruminants such as sheep, gazelles and giraffe (Ruiz de Ybanez *et al.,* 2003).

C. mentulatus infection in camels is considered to be of little importance considering its low pathogenecity (Elbihari, 1985). However, Wisser *et al.* (2001) reported lethal abomasitis in dorcas gazelles as a result of infection by *Camelostrongylus mentulatus*.

2.2.2.5 *Onchocerca* species

These are elongated, filariform worms that occur in the connective tissues of their hosts. Three species: *Onchocerca fasciata, O. gutturosa* and *O. armillata* are frequently reported in camels (Elbihari, 1985). However, only *O. gutturosa* and *O. armillata* are suggested as accidental parasites and infections are always abortive.

2.2.2.5.1 Prevalence

The prevalence of *O. fasciata* in camels has been reported from different parts of the world (Steward, 1950; Ghandour *et al.*, 1991).

Cheema *et al.* (1984) reported on a prevalence of 26.2% out of 478 local and imported camels in Saudi Arabia. The prevalence rates in local and imported camels were 93/272 (34.2%) and 32/206 (15.5%) respectively.

Infected animals had microfilariae concentrated in the skin over the head and neck regions and often causing mild non - superative dermatitis.

Based on microfilariae in skin snips and nodules in the nuchal ligaments and subcutaneous tissues of the neck and shoulder, the overall prevalence rates of *O. fasciata* were 10.9% and 33.3% respectively. Most of the nodules (57.5%) were calcified while 42.5% were soft and viable (Ghandour *et al.*, 1991).

2.2.3 Other helminths occasionally infecting Camels

Inaddition to those helminths commonly reported to infect camels, several other helminths have been reported at one time or another. Some of these parasites are usually uncommon, sometimes rare and some of them might reflect accidental infections. Their relationship to clinical gastrointestinal parasitism in the camel is uncertain, so is their pathogenecity (Elbihari, 1985). A review of some of these helminths is given below.

2.2.3.1 *Moniezia* species

These worms (cestode) occur in the small intestine of sheep, goats, cattle and many ruminants. Animals become infected by ingesting cysticercoids in infected oribatid mites which serve as the intermediate hosts.

M. expansa and *M. benedeni* have been reported in camels in several parts of the world (Anwar and Khan, 1998; Sharrif *et al.*, 1998; Bekele, 2002).

Though no known pathogenic effect has been reported, it is suggested to cause gastric disturbance when they occur in large numbers (Soulsby, 1982).

2.2.3.2 *Stilezia* species.

Stilezia vittata, S. globipunctata and *S. hepatica* are commonly reported in Arabian camels. These parasites are known to parasitize sheep, goats, cattle and wild ruminants. They have been reported to be non pathogenic (Elbihari, 1985).

2.2.3.3 *Fasciola* species

Fasciola hepatica and *F. gigantica* frequently infect camels. Though these parasites are not considered to cause serious diseases in camels, they may result in thickening of the bile ducts.

2.2.3.4 *Oesophagostomum* species

O. venulosum occurs in the colon of sheep, goats, deer and camels. It is relatively harmless compared to other species in the genus, and infection seldom produces nodule formation. However, infection by *O. columbianum* and *O. radiatum* in young cattle is characterized by emaciation (due to continuous purging), prostration and often death (Soulby, 1982).

Other helminths of lesser importance and frequency in camels include: *Cooperia* species, *Bunostomum* species, *Strongyloides* species and *Ostertagia* species (Mukhwana and Mitema, 1995), *Avitellina* species and *Impalaia*

tuberculata (Bekele, 2002), *Physocephalus cristata* and *Nematodirus dromedarii* (Altaif, 1974), *Chabertia ovina* (Anwar and Khan, 1998), *Parabronema Skrjabini* (Higgins, 1983; Elbihari, 1985).

2.2.4 Treatment and Control of Gastrointestinal Helminths of Camels.

Most of the drugs used in the treatment of gastrointestinal helminths of camels are similar to those used in cattle and small ruminants. However, doses are usually extrapolations from experiences gathered from these animals (Elbihari, 1985). Some of these drugs include:

Benzimidazole Compounds

These drugs have excellent efficacy against all the major gastrointestinal nematodes of ruminants. Thiabendazole is efficacious against *Haemonchus*, *Trichostrongylus*, *Oesophagostomum* and *Strongyloides* among several other nematodes inaddition to inhibiting the production of eggs by these worms. Thiabendazole acts on nematodes by inhibiting the uptake of glucose thereby causing a depletion of the worm's glycogen reserves.

Substituted benzimidazoles such as Cambendazole, Fenbendazole, Mebendazole and Parbendazole are also reported to be effective against the adult and larval stages of most species of gastrointestinal nematodes. Like thiabendazole, the substituted benzimidazoles cause a depletion of the worm's

glycogen reserve necessary for the production of Adenosine Tri-Phosphate (ATP) required for survival (Roberson, 1977).

Phenothiazine

This drug possesses particularly good anthelmintic efficacy against the large abomasal worm (*Haemonchus*) and the nodular worm (*Oesophagostomum*) (Elbihari, 1985).

Organo-phosphorus compounds

These drugs are highly effective against abomasal and intestinal nematodes. The main effect of organo-phosphorus compounds on parasites is an inhibition of nematodal cholinesterase, leading to an interference with normal neuro-muscular transmission and consequent toxicity to the parasite (Roberson, 1977).

2.3 Overview of ecto-parasitic arthropods infesting Camels

Ecto-parasitic arthropods live on, puncture or burrow into the surface of their host's epidermis to feed or shelter. As a result, there may be direct damage to skin and other sub-cutaneous tissues. The presence of burrowing ecto-parasites and their salivary and faecal antigens can stimulate immune responses in some hosts leading to hypersensitivity (Arthur, 1970, 1973; Bordeau, 1982; Kemp *et al.*, 1982; George and Ben-Umar, 2002). Feeding may

also result in significant blood loss, secondary infestation, pruritis, alopecia, and in some cases, death. The behaviour of ecto-parasites may also cause irritation and worry particularly when present at high intensities. These cause disturbance, rubbing against hard objects leading to reduced time spent grazing and, in some cases, self injury. Some ecto-parasites also act as vectors of viruses, bacteria, protozoa, cestodes and nematodes (Hoogstraal, 1973, 1979). Although relatively few in number, the various species of arthropod ecto-parasites found to infest camels have a major effect on the husbandry, productivity and welfare of camels in several parts of the world through direct and indirect effects on their hosts (Higgins, 1983).

The common ecto-parasites reported to infest camels in different parts of the world include:

2.3.1 Ticks

Ticks are obligate, blood-feeding ecto-parasites of vertebrates, particularly mammals and birds (Colebrook and Wall, 2004). During heavy tick infestation, the host usually loses important nutrients resulting in anaemia, toxicosis, reduction in daily weight gain and milk production. There is also general body weakness and sometimes, death (Steward, 1950; Rutagwenda and Munyua, 1984). It has been reported that the amount of blood ingested by a soft tick during one feed is about 3 or 4 times its original body weight, whereas

in hard ticks this may be as high as 50 times or as low as 23 times (Arthur, 1962). Inaddition to the direct effects of tick bite on the host, they are known to transmit diseases of high economic significance in camels and other ruminants (Seifert, 1996; Anwar and Khan, 1998).

2.3.1.1 Prevalence

Although many ticks favour a particular host, they are usually not completely host-specific, and many parasitize a wide variety of animals (Radostits *et al.,* 1994). In camels, several species have been reported (Higgins, 1983; Wilson, 1998). These include *Hyalomma dromedarii*, *H. rufipes*, *H. truncatum*, *Rhipicephalus pulchellus*, *R. pravus* and *Amblyomma gemma* (Dolan *et al.,* 1983; Rutagwenda and Munyua, 1984).

In Jordan, the prevalence of tick infestation was 100%. *Hyalomma dromedarii* and *H. anatolicum* were the only ticks identified on camels surveyed (Al-Rawashdeh *et al.,* 2000).

Examination of animals for tick infestation in the Yemen Arab Republic indicated that *Hyalomma species* was the most abundant tick parasitizing Yemeni livestock with *Hyalomma dromedarii* forming 59% of the total adult ticks collected from camels. Nymphs of *H. dromedarii* also contributed significantly to the camel tick burden. *Amblyomma variegatum* and

Rhipicephalus simus were the most abundant representatives of their respective genera on the camels (Pegram, 1982).

In Pakistan, Anwar and Khan (1998) in a survey of parasitic fauna of the camel reported *Hyalomma dromedarii*, *H. anatolicum anatolicum*, *H. aegyptium* and *Haematopinus* species to constitute 38.8% of the 57% ecto-parasite burden recorded.

In Africa, studies conducted in Kenya on ticks infesting camels implicated 13 tick species with *Hyalomma* species being the most abundant (Dolan *et al.*, 1983). *Hyalomma dromedarii* was prominent in three of the four herds studied where it accounted for 48% of all ticks identified. Inaddition, the relative proportion of male and female ticks indicated more males than females in all the four herds.

In a related study to assess the prevalence of camel ticks in the Ngurunit area of Marsabit in Northern Kenya, *Hyalomma dromedarii* was reported to be the most common tick prevalent on camels in the area with a prevalence of 68.7%. Next was *Hyalomma rufipes* 21.7%, *H. truncatum* 5.6%, *Rhipicephalus pulchellus* 2.2 %, *Amblyomma gemma* 1.6% and the least was *Rhipicephalus pravus* with a prevalence of 0.2% (Rutagwenda and Munyua, 1984).

In Burkina Faso, camels surveyed had heavy tick infestations in all the three villages sampled. Like in most reports from countries in Africa,

Hyalomma dromedarii and *H. marginatum rufipes* were the species most commonly found. *H. impressum*, *H. truncatum* and *H. impellatum* were less frequent in all the three villages (Dia, 2006).

Thirteen species of ixodid ticks and two species of argasid ticks were collected from camels in 58 farms in Libya over a period of three years. During that period, 20391 animals were examined, 2020 (9.91%) had ticks with *Hyalomma dromedarii* particularly occurring frequently (Gabaj *et al.*, 1992b).

High prevalence of tick infestation was obtained in an investigation into ecto-parasites of livestock in Borno and Yobe States of Nigeria (James-Rugu and Jidayi, 2004). Tick species recorded on camels were *Hyalomma rufipes*, *Hyalomma drommedarii*, *Boophilus decoloratus* and *Hyalomma truncatum.*

Similarly, Lawal *et al.* (2007) in a survey of some ectoparasites of *Camelus dromedarius* in Sokoto, Nigeria, recorded tick species belonging to four (4) genera. *Hyalomma* species were the most common with a prevalence rate of 48.0%, followed by *Amblyomma* species with 16.79%, *Boophilus* species 14.91% and *Rhipicephalus* species 14.71%. Among the *Hyalomma* species, *H. dromedarii* was identified as the most prevalent with a rate of 46.9%. Others included *H. rufipes* 22.9%, *H. impeltatum* 18.5% and *H. truncatum* 11.7%.

2.3.1.2 Life cycle

The life cycles of ticks vary widely. Some species pass their entire life cycle on one host (one host ticks) while others pass different stages of their life cycle on successive hosts (two or three host ticks), and others are parasitic only at certain stages of their life cycle. Generally, the life cycle commences when eggs laid by engorged female tick develop into a six legged larva, then to an eight legged nymph and after renewed moulting to the imago.

2.3.1.3 Pathogenesis

The primary attachment lesion causes cytolysis following production of the hyaline sheath. There is itching accompanied by a tissue and humoral reaction of the host, with hyperaemia, eosinophil infiltration, and a local oedematous reaction (Arthur, 1970; Bordeau, 1982; Kemp *et al.*, 1982; Morel, 1989; George and Ben-Umar, 2002).

Depending on the attachment point, there can be immobilization of a limb or appearance of a different form of lameness due to the mechanical and painful effects of oedema. Apart from the mechanical cytolytic effects and blood loss, the host is affected by the presence of toxins in the saliva. These toxins may cause tick paralysis or sweating sickness in the host. In resistant hosts, there is sign of allergic reaction with increased blood level of histamine

which prevents tick attachment (Amin-Babjee and Riek, 1986; Adamson *et al.*, 1991).

2.3.1.4 Control

There are two basic approaches to tick control. These may be through the use of chemicals or through an integrated control method which may include biological, immunological, mechanical, genetic and also reasonable use of chemicals, while sanitary and surveillance procedures remain valuable (Uilenberg, 1996).

(a) Chemical Control

This involves the use of acaricides either as dip, pour-ons or sprays. Some of the common compounds in use for the control of ticks include:

(i). ***Arsenious Oxide***

These are used in dips. They are usually used in solutions with wetting agents and emulsifiers such as tar, soap, fat or gum. These emulsifiers and wetting agents increase the efficacy of the dips and also help to reduce the arsenic concentration.

(ii). ***Chlorinated Hydrocarbons***

These compounds are highly liposoluble thereby making them soluble in the lipids of the cuticle and body of insects. Chlorinated hydrocarbons lead to

nervous symptoms and are easily fixed in tissues. They are used as suspension or emulsions in dips.

(iii). ***Organophosphates***

These groups of acaricides are also highly liposoluble, inaddition to being water - soluble to an extent.

They have low stability in warm - blooded animals, and are therefore rapidly metabolized. Organophosphate compounds are administered orally, parenterally, and cutaneously. These compounds affect oogenesis and oviposition in ticks.

(b). Integrated control

For several decades, control of ticks and tick - borne diseases has mainly depended on the use of drugs and acaricides. The use of these acaricides on animals entails a certain degree of environmental pollution especially when they are used regularly and frequently.

Inaddition, residues from drugs and pesticides in animal products such as meat, milk, wool, etc, constitute a universal problem of major public health significance coupled with the high cost and the development of resistance to these compounds (Uilenberg, 1996).

Due to these and many other reasons, emphasis is shifting from chemical control of ticks and tick borne diseases to an integrated control. This approach

makes optimal use of all available methods of control in a way that is adapted to local circumstances and the economic reality of the day (Uilenberg, 1996; Perry *et al.*, 2002).

However, some of the methods reviewed here are presently being used to control ticks in some parts of the world while others are only potential possibilities (Uilenberg, 1996). Some of the techniques include:-

(i). ***Immunological control***

Although there are few practical results using these techniques, there is a report on the production of vaccines which cause allergic reactions in the skin of the host which can interrupt the metamorphosis of the tick on the host (Seifert, 1996). Another approach to tick control is that of selecting animals with an efficient immune response to ticks. This method was used successfully in the control of the one host tick, *Boophilus microplus*, in cattle (Seifert, 1996).

(ii). ***Biological Control***

These methods consist of using predators and diseases of ticks or parasites. Although the prospects of this approach for practical application is limited, promising experimental results have been obtained with a parasitoid against *Amblyomma variegatum* (Mwangi *et al.*, 1994), use of entomophagous nematodes against ticks (Samish and Glazer, 1992) and the potential use of

fungi against *Rhipicephalus appendiculatus* and *Amblyomma variegatum* (Kaaya *et al.,* 1996). Promising results have also been obtained with entomopathogenic fungi, *Metarhizium anisopliae* and *Beauveria bassiana*, strains of which are reported to be commercially available for control of some pests (Samish *et al.*, 2004).

(iii). ***Mechamical Control***

This method can be used to maintain the number of ticks and therefore disease prevalence to tolerable low levels. Ticks may be physically removed from the host or the host can be served as a live trap for ticks by using natural or synthetic pheromones and acaricides (Uilenberg, 1996).

(iv). ***Ecological control***

This method involves zero-grazing of animals in order to avoid contact with ticks, bush fires against ticks, pasture rotation to deprive larval ticks of their host among other strategies (Seifert, 1996).

(v). ***Sanitary control and surveillance***

These methods, combined with an appropriate legislation, can be helpful in tick control programme. Parasites such as mites and lice can be prevented by adequate quarantine measures while legislation can be formulated to prevent the spread or importation of parasite species or of pesticide- resistant strains.

2.3.2 Mite infestation

Scabies or Mange is the disease resulting from infestation by mites. Scabies was described as early as the sixteenth century, and the cause of the disease was established around 1835 (Belding, 1965).

The two most important causative agents of mange in camels are the astigmatid mites, *Sarcoptes scabiei*, and *Psoroptes ovis* (Colebrook and Wall, 2004). Although the only mange mite of clinical significance in the camel is *Sarcoptes scabiei* var. *cameli*, *Psoroptes* mites are sometimes reported to parasitize camels (Higgins, 1983; Colebrook and Wall, 2004).

S. scabiei var. *cameli* is an obligate, burrowing species that burrows into the skin of camels and man. The disease is highly contagious, obstinate and debilitating (Yagil, 1982). It is one of the most important health problems of camels all over the world where it causes huge economic loss (Wilson, 1998).

2.3.2.1 Prevalence

Sarcoptes scabiei var. *cameli* was diagnosed in 83% of the 32 camels examined for scabies in four Jordanian regions (Al-Rawashdeh *et al.*, 2000). Affected camels were reported to show alopecia, intense irritation, and anxiety.

Contrary to the high prevalence of mites recorded in Jordan, Anwar and Khan (1998) recorded a relatively low prevalence of 13.4% out of an overall

prevalence of 57% obtained for ecto-parasites in a survey of camel parasites in Pakistan.

In Burkina Faso, though no rate was given as the prevalence of mites in camels, Dia (2006) reported observing lesions suggesting mange to be widespread in the area.

Similarly, in another survey of mites on farm animals in Libya, 2287 farm animals suspected of carrying parasitic mites were examined at 58 farms. Though no rate was also given, the commonest parasite reported on camels and sheep were *Sarcoptes* and *Psoroptes* species (Gabaj *et al*., 1992a).

However, studies in Nigeria on the situation of ecto-parasites on some livestock from areas of Borno and Yobe States revealed the complete absence of mites on all the 1600 camels examined (James – Rugu and Jidayi, 2004). On the other hand, Lawal *et al*. (2007) reported low prevalence rate (3.54%) of *Sarcoptes scabiei var. cameli* in camels examined in a Sokoto abattoir livestock market.

2.3.2.2 Life cycle

Adult females burrow under the epidermis of the skin to create a permanent tunnel in which they feed and lay eggs. Tunnels created usually contain male and female mites. Eggs are laid in the burrows which hatch after

3-5 days into six legged larvae. The larvae moult to become eight - legged nymphs which later moult again to adult male or female mites.

2.3.2.3 Transmission

Mange mites are spread through close contact between infested camels, or by contaminated saddles, trees or formites (Yagil, 1982; Higgins, 1983).

2.3.2.4 Pathogenesis

The presence of mites in the tunnels and their feeding activities, inaddition to cutaneous hypersensitivity to mite faecal antigens, causes cutaneous inflammation and intense prurities, leading to excoriation, exudation and haemorrhage on the skin surface (Colebrook and Wall, 2004).

Clinical signs of mite infestations include marked irritation of the skin and itching. The connective tissue of the skin proliferates and keratinisation increases leading to thickened and wrinkle skin, often covered with a fine powdery coat. As a result of the feeding habit of the mites, hairs are deprived of blood and subsequently fall out creating bold patches. Inaddition, infested animals scratch against hard objects and trees resulting in self injury thereby creating an opportunity for secondary bacterial infection. The cumulative effect in infected camel is loss of weight, reduced milk production and eventual death (Yagil, 1982).

In an experimental infection of the one - humped camel (*Camelus dromedarius*) with *Sarcoptes scabiei* var. c*ameli* and *S. scabiei* var. *ovis,* lesions produced by both mites were reported to be progressive and similar in extent and severity (Nayel and Abu-Samra, 1986). Lesions produced by the mites spread mechanically through gnawing and scratching. Histopathological changes caused by *S. scabiei* var. *cameli* and *S. scabiei* var. *ovis* were also found to be similar. Lesions comprised thick scab and keratin with marked haemorrhages and severe degenerative and necrotic changes.

2.3.2.5 Diagnosis

Diagnosis of mange can be achieved by scraping the edge of the affected skin (until it bleeds) of a restrained camel. The scrapings are mixed with 20-30ml of 10% potassium hydroxide solution heated to dissolve the debris, and the mixture centrifuged. The supernatant is discarded and the sediment examined under low power of the microscope for the presence of the mites (Njanja, 1991).

2.3.2.6 Control

Control of mange in camels involves the use of acaricides which must be thoroughly applied to all parts of the skin. Buildings, beddings and other materials such as saddle should also be treated. However, ivermectin have been reported to be very effective in the treatment of Sarcoptic mange in camels and

other livestock (Higgins, 1983). Njanja (1991) and Radostits *et al.* (1994) recommended a single dose of 0.3mg/kg body weight given subcutaneously to camels to be very effective.

2.3.3 Flies

Several fly species are found associated with camels (Higgins, 1983). Although most of the flies are important as causing serious nuisance in camels, some of them are important as mechanical transmitters of diseases. Some of these flies include.

2.3.3.1 Camel Nasal bot fly *(Cephalopina titilator).*

These are fly maggots that live in the inside of the camel nose between turbinate bones. They are very common in camel herds (Wilson, 1998).

2.3.3.1.1 Prevalence

Steward (1950) reported the larvae of C*ephalopina titilator* to occur in large numbers attached to the nasopharyngeal mucosa of most of the camels examined at post mortem in Sudan.

In Jordan, 33% prevalence rate was recorded by Sharrif *et al.* (1998) in a study conducted on Jordanian camels.

In Somali State, Ethiopia, Bekele (2001) recorded high prevalence (71.7%) of *C. titilator* in 778 slaughtered camels at post mortem. The mean larval counts in infested camels were 26.7 ± 25.9 and 34.6 ± 30.8. Most of the infections

occurred in females (85%) while only 55% of the males were infested/ infected.

2.3.3.1.2 Life Cycle

Infection occurs when nasal botfly *Cephalopina titilator* adult female lays her larvae (maggot or bot) in the nostril of camels during flight. The larvae migrate into the head sinuses and nasal passages where they develop and feed on the nasal tissues. When mature they re-enter the nasal cavities, from where they are sneezed out.

2.3.3.1.3 Pathogenesis

Infestation by *C. titilator* causes a parasitic rhinitis which is characterized by a sticky, mucoid nasal discharge which many a times may be haemorrhagic. In Sudan, infection by *C. titilator* was found to cause oedema and inflammation of the pharynx inaddition to nasal discharge (Steward, 1950).

In most camels infested by *C. titilator*, animals generally show discomfort, sneezing, head shaking, allergic and inflammatory responses in the sinuses which may be followed by secondary bacterial infection that sometimes end with death (Higgins, 1983). Occasionally, the larvae of *C. titilato*r penetrate the olfactory mucosa and enter the brain causing ataxia and circling (Tanwar, 2004).

Bekele (2001) reported gross lesions in infested camels. The lesions showed congestion of the pharyngeal mucosa with profuse secretions, and haemorrhage in early cases. In some cases, he reported observing ulcer-like lesions and nodules which contain pus. At microscopy, there was infiltration of the lamina propria by eosinophils, lymphocytes and macrophages, hyperplasia of the stratified squamous epithelium, necrotic changes in the mixed glands and desquamation of epithelial cells.

2.3.3.1.4 Treatment/Control

Infection by camel nasal bot fly can be treated or prevented by the addition of trichlorfon to the drinking water at a dose of 0.03 – 0.05 % (Higgins, 1983; Tanwar, 2004).

2.3.3.2 Stable fly (*Stomoxys calcitrans)*

This is a blood feeding fly that appears similar to the house fly. Eggs of stable flies are laid in decaying vegetation or manure. Larval and pupal stages develop in the same environment, taking about three weeks to reach adult stage.

Both male and female flies feed on blood of man and animals. It is reported that *S. calcitrans*, inaddition to being a nuisance, can transmit *T. evansi* mechanically from an infected to susceptible camels (Luckins and Dwinger, 2004).

2.3.3.3 *Tabanus* species

Adult female of Tabanids are known to feed on blood and can remove up to 0.2ml of blood per feeding. Tabanids transmit several bacterial, viral and helminth diseases. They are associated with mechanical transmission of *T. evansi* in camels (Boid *et al.*, 1985).

2.3.3.4 *Simulium* species

The Simuliids occur in all parts of the world. They cause great annoyance and irritation to man and livestock. Several species of *Simulium* are vectors of several parasites. *Simulium* species are intermediate hosts of *Onchocerca fasciata* which is known to infect camels (Acha and Szyfres, 1987).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Survey of Camels for Parasites

3.1.1 Study Sites (Fig. 3.1).

3.1.1.1 Kano State

Location: Kano is located between latitude 12^0 40^I and 10^0 30^I and longitudes 7^0 40^I and 9^0 30^I.

Climate: The climate of Kano State is composed of two major seasons – the dry and wet seasons. The wet season starts in May when few episodes of rainfalls are recorded and ends in September or early October. Temperature ranges from 24^0 – 34^0C. Although rainfall is highly variable, annual rainfall ranges from about 780mm or less in the north to 1000mm in the extreme south. Dry season begins in late October and ends in April or early May. Mean temperatures during the dry season vary: 28^0 – 29^0C (warm and dry periods), 25^0 – 27^0C (cool and dry periods) and 28^0 – 39^0C (hot and dry periods) (Oboli and Harrison Church, 1969).

Vegetation: There are two main vegetation types in Kano State: the Guinea Savannah to the south and the Sudan Savannah to the north. The Northern Guinea Savannah is an open woodland or bush land with grasses shorter than

3m tall. The Sudan Savannah on the other hand has scattered trees, open grassland with grasses under 1-2m tall. In both vegetation types, plant species commonly found include: *Parkia clappertoniana, Khaya senegalensis, Balanites aegyptica, Acacia* species, *Tamarindus indica, Adansonia digitata,* and *Azadirachta indica* among several others.

3.1.1.2 Katsina State

Location: Katsina State covers an area of 23,938sq.km. It is located between latitudes 11^0 08^IN and 13^0 22^IN and longitudes 6^0 52^IE and 9^0 20^IE. The State is bounded by Niger Republic to the north, by Jigawa and Kano States to the east, by Kaduna State to the south and by Zamfara State to the west.

Climate: Annual rainfall figures range from 600 – 700mm in the extreme north. The climate of Katsina State is characterized by a cool dry (harmattan) season with minimum temperature of about 20^0C from December – February, a hot dry season with annual mean maximum temperature of about 34^0C from March – May; a warm wet season from June – September, a less marked season after rains during the months of October – November, characterized by decreased rainfall and a gradual lowering of temperature (Harrison Church, 1974).

Vegetation: Katsina State also has two main vegetation zones: The Guinea Savannah Zone in the southern part of the State and the Sudan Savannah Zone

in the north. Plant cover consists of tall tussocky grasses, and fine-leaved species of thorny trees among others.

3.1.1.3 Zamfara State

Location: Gusau is the capital of Zamfara State. The State covers a land area of 38,418sq.km. It is located between latitudes 10^0 50^IN and 13^0 38^IN, longitudes 4^0 16^IE and 7^0 13^IE. Zamfara State is bounded to the north by Sokoto State, Kebbi and Niger States to the south west, Kaduna to the south east and Katsina to the east.

Climate: Like Kano and Katsina, Zamfara State can be said to have 2 main seasons: the dry and wet seasons. Each of these seasons is characterized by a specific type of prevailing wind (Oboli and Harrison Church, 1969). Annual mean rainfall in 2003 was 749mm while annual mean minimum and maximum temperatures in the same period was 17.7^0C and 33.6^0C.

Vegetation: There are two vegetation zones in Zamfara State: Sudan Savannah in the north and the northern Guinea Savannah to the south. Vegetation consists of short grasses and scattered small thorny trees. In this vegetation zone are to be found *Azadiracta indica* (neem), *Adansonia digitata, Mangifera indica* and many others.

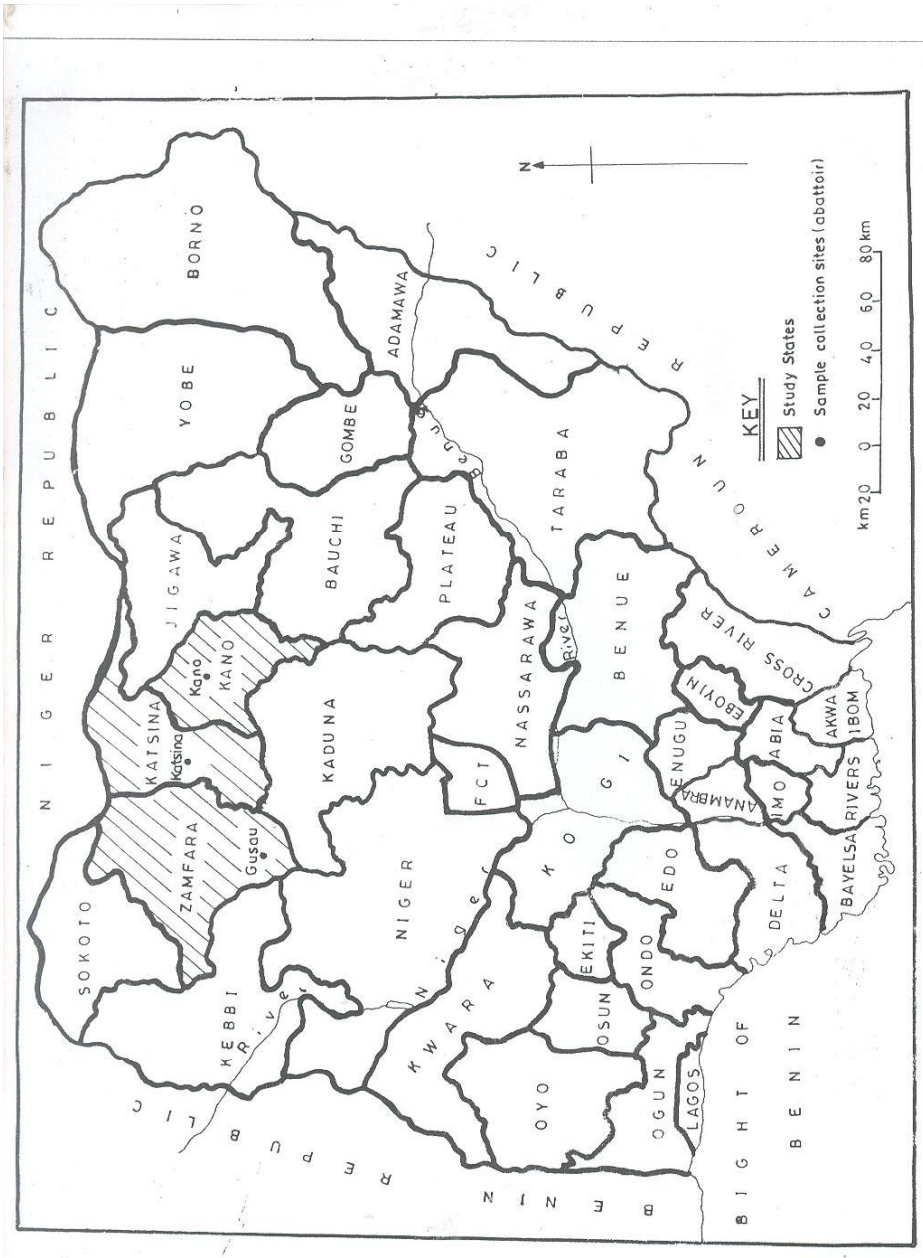


FIG. 1 : Map of Nigeria Showing The study sites Kano, Katsina and Zamfara (Gusau).
SOURCE: KEPA, Kaduna, 2006.

3.1.2 Sample animals

A total of five hundred and fifty eight (558) camels meant for slaughter in the main abattoirs of the capital towns of Kano, Katsina and Gusau were selected by simple sampling method and examined for parasites.

Though the histories of the camels were limited, most of the camels slaughtered in these States were from the rural camel markets in the States. However, these were often supplemented by imports from neigbouring Chad and Niger Republics. Camels of different ages and sexes were sampled monthly between January and December 2005. This was aimed at assessing the situation of parasitism in both rainy and dry seasons.

3.1.3 Sample collection

3.1.3.1 Collection of Ticks

Camels meant for slaughter were examined carefully for ticks with the help of the camel owners or their assistants. Predilection sites for ticks, such as the ear, head, dew lap, back, abdomen, anus, vulva, testes, tail and legs of the animals were carefully examined (Morel, 1989). Ticks of all sizes seen were picked by gently and firmly pulling them off from the host in the same direction as they were attached. All ticks collected were preserved in 70% alcohol (Morel, 1989) for identification later. Ticks were later identified in the Entomology Laboratory, Department of Veterinary Parasitology and

Entomology, Ahmadu Bello University, Zaria, with reference to Soulsby (1982) and preserved Museum specimens.

3.1.3.2 Skin scrapings for Mites

Skin scrapings were collected from suspected camels using a sharp scapel blade. Scraping was done at the margins of the suspected lesions and placed in a wide- mouth sample bottle containing 10ml of 1:1 mixture of glycerol and alcohol (Njanja, 1991). In the laboratory, the scrapings were mixed with 25ml of 10% potassium hydroxide solution and heated to dissolve the debris. The mixture was then centrifuged, the supernatant discarded and the sediment examined under X10 objective of the light microscope for the presence of the mites (Higgins, 1983).

3.1.3.3 Collection of faecal samples for examination for Coccidia

Before slaughter of the dromedaries, faecal samples were collected directly from the rectum of restrained animals into labeled polythene bags and preserved in ice box for transportation to the laboratory. In the laboratory, samples were processed by the Zinc Sulphate flotation method (Belding, 1965).

The flotation method involved putting approximately 1g of faeces into a test tube containing 5ml of Zinc Sulphate Flotation fluid. This was then mixed thoroughly with a stirring tongue. The resulting faecal suspension was poured into another test tube through a double layer of cotton gauze in a funnel. The test tube containing the filtrate was then placed in a test tube rack and gently

topped up to the brim with the flotation fluid. A glass cover slip was gently placed on top of the test tube and allowed to stand for 20 minutes. The cover slip was then lifted off the test tube carefully and immediately placed on a microscope glass slide. The slide was then examined under the light microscope at lower (X10) magnification.

Coccidia oocysts present were measured using a micrometer inside the eye piece tube of the microscope. Their sizes and other characteristics such as shape, wall layers; whether or not the micropyle is capped among other features were noted for identification (Boid *et al.*, 1985). Inaddition, positive faecal samples were processed by sedimentation method (Troncy, 1989), washed several times in distilled water to obtain oocysts which were then cultured in 2.5% potassium dichromate at room temperature for 7 days to obtain sporulated oocysts which were used for confirmatory identification.

3.1.3.4 Haematological techniques for blood parasites

Contact was made at each herd camp located close to the various abattoirs in the States the surveys were conducted for blood collection. Blood samples were collected in labeled EDTA vacutainer tubes in the morning between 7.30am and 10.30am from restrained camels meant for slaughter. The blood samples collected were shaken gently and placed in ice packed thermo box which was later transported to the laboratory. In the laboratory, about ¾ of blood was drown into a heparinized microhaematocrit tube and one end sealed

with a sealant. The microhaematocrit tube containing blood was placed in a microhaematocrit centrifuge with the sealed end away from the center and centrifuged at 12,000rpm for 4minutes. It was removed and placed in a PCV reader and the PCV recorded. The tube was then broken and the buffy coat/ plasma interface expelled on to a microscope glass slide and examined under X10 objective of the light microscope. *Trypanosome* species present were identified based on criteria for identification of mammalian trypanosomes by Itard (1989) and Stevens and Brisse (2004) after staining the Buffy coat layer with Giemsa stain.

Other blood parasites were examined by thin and thick smear preparations (Macinnis and Voge 1970). These involves:-

3.1.3.4.1 Thin Smear

This was prepared by placing a drop of blood near one end of a clean glass slide. A second glass slide held at an angle of 20^0 – 40^0 was used to spread the blood over the length of the smear slide with an even, smooth dragging motion. The blood film was allowed to dry thoroughly. This was then fixed in absolute methyl alcohol for one minute and allowed to dry again after which it was immersed in a solution of 1 part Giemsa stock to 20 parts of buffered water (pH 7.0 – 7.2) and allowed to stain for 20 minutes. The glass slide was then removed, dipped briefly in buffered water (pH 7.0 -7.2), drained

thoroughly and quickly air dried. The prepared slide was then examined for parasites under an oil immersion objective of the light microscope.

3.1.3.4.2 Thick Smear

This was prepared by placing two drops of blood on a clean glass slide. A small wire loop was used to spread the blood slightly with a circular stirring motion. The preparation was allowed to dry thoroughly in the air. The dried thick film was dipped in distilled water and air dried again, after which it was stained in 1 part of Giemsa stock to 20 parts of buffered water (pH 7.0 – 7.2) for 30 minutes. The slides were then washed in buffered water and air - dried thoroughly before examining under an oil immersion objective of the light microscope for the presence of blood parasites.

3.1.3.5 Count of helminths in the gastrointestinal tract

Parasitological techniques described by Ikeme (1989), Hansen and Perry (1994) were adopted for the differential helminth counts of the gastrointestinal tract (GIT).

3.1.3.5.1 Differential Parasite count of nematode in the abomasum

The GITs of slaughtered camels were removed and placed on a clean slab. The abomasum of each camel was then ligated with string to separate it from omasum and duodenum. Each abomasum was cut using a sharp knife and placed on a clean wide zinc sheet. With the aid of a sharp knife, it was opened

along the greater curvature and the content emptied into a 10litre calibrated rubber bucket. The evacuated abomasum was thoroughly washed several times with tap water paying particular attention to cleaning between the folds of mucous membrane. The washings were added to the contents in the 10litre calibrated rubber bucket and topped up to 5litres. Using a kitchen ladle of about 40ml capacity, the content in the bucket was vigorously stirred until all undigested food materials, mucus and water were thoroughly mixed.

A total of 200ml of the mixed content was transferred in five (5) steps of fourty (40) millilitres per step to a screw-lid wash jar (500ml capacity) using the ladle. Before each transfer, the mixture was stirred thoroughly. The wash jar containing the mixture was then filled with water and the lid screwed tightly. This was then inverted and shaken thoroughly for about 5 minutes. This process was repeated several times until the faecal matter were dislodged, after which the supernatant was then decanted. To the sediment in the jar, water was added to make the volume up to 50ml. This was poured into Petri-dishes in small volumes and a few drops of lugol's iodine solution added. The mixture was allowed to stand for 30minutes during which the worms picked up iodine stains.

Each worm species present in the sample was identified (Soulsby, 1982; Ikeme, 1989) and counted, and the process was repeated for each Petri-dish.

The species counts for all dishes were added and the total count multiplied by 20 to arrive at the total worm burden in the sampled camel.

3.1.3.5.2 Differential Parasite count of nematodes in the small intestine

Using a sharp knife, the small intestine was cut out free from the mesentery onto a zinc sheet. The freed intestine was then cut into manageable lengths. Each segment of the small intestine was washed thoroughly by pouring water into one end of the gut and flushing it out into a 10litre calibrated rubber bucket. Further washing was achieved by slitting open the various lengths and scraping the mucous membrane into the calibrated rubber bucket. Two hundred (200) millilitres of the washings were transferred to a wash jar using a 40ml kitchen ladle. This was washed thoroughly several times until all the faecal matter was removed. The supernatant was decanted and fresh water added to the sediment to make it up to 50ml. The mixture was stained with lugol's iodine and each species present was identified, counted and the total worm burden determined.

3.1.3.5.3 Differential Parasite count of nematodes in the large intestine

Similarly, the large intestine was uncoiled, cut into manageable lengths and placed on a clean zinc sheet. Each segment was washed by pouring water into one end and flushing it out into a 10litre calibrated rubber bucket. After

thorough washing, each segment was opened with a sharp knife and the mucous membrane scraped into the rubber bucket.

Sampling of the contents in the calibrated rubber bucket, washings using the wash jar, sub sampling, staining with lugol's iodine, identification and counting of worm species were performed as described for the abomasum and small intestine.

3.1.3.5.4 Cestode identification and counting

Tapeworms were picked out from the intestinal content with a pair of forceps, washed in tap-water and placed in 10% alcohol in a jar bottle. The worms were later relaxed by wrapping round a glass bottle and then carefully winding the strobila by rotating the bottle (Noble and Noble, 1962). The entire preparation was completely submerged in formol-alcohol-acetic (F.A.A.) and allowed to stand for 60 minutes. Worms were later unwound, washed in 50% alcohol and stored in 70% alcohol. Tapeworms were later identified in the Helminthology Laboratory, Veterinary Parasitology and Entomology, A.B.U Zaria using descriptions of Soulsby (1982).

3.2 Experimental Infection of Yankasa sheep with *Haemonchus longistipes* and *H. placei.*

3.2.1 Experimental animals

Fifteen (15) Yankasa sheep weighing between 15kg and 24kg were bought from Lamba and Maigana markets in Igabi and Soba Local Government Areas of Kaduna State, Nigeria. The sheep were transported to the Department of Veterinary Parastology and Entomology, Ahmadu Bello Univeristy Zaria. In the Department, the sheep were dewormed using albendazole ® 10mg/kg and deticked with novan ® 20ml/10ltr to make sure they were free of any helminth or tick infections and kept in pens which were cleaned out daily.

The sheep were kept for three (3) months during which they were monitored until they stabilized. Faecal samples were collected from all animals directly from the rectum and screened twice a week prior to experimental infection and 5 days after.

3.2.2 Experimental Groupings

The sheep were grouped randomly into 3 groups of five animals each. They were assigned identification numbers and kept in separate pens. Animals in each pen were maintained on dried groundnut leaves, maize shaft/bran and corn shaft, and also allowed salt lick and water *ad libitum* throughout the experimental period.

3.2.3 Collection of *Haemonchus longistipes* adult worms from naturally infected Camels

Adult *H. longistipes* were collected from the abomasum of naturally infected camels slaughtered at Kano abattoir. Worms collected were transported to the laboratory in cool boxes where they were picked, separated into sexes and identified based on the description of Jacquiet *et al.* (1996). The standard lengths of identified worms were noted in millimeters after which male worms were discarded while female worms were kept at 4^0C and later used for cultivation of the infective larval stage (L_3).

3.2.3.1 Culture of *H. longistipes*

Isolated adult female worms were crushed in a glass motar with a pestle, and mixed with sample of dry helminth - free cattle faeces that was sterilized at 100^0C for 30 minutes. Distilled water was added to the mixture to obtain the required consistency and moisture. Jam jars, two third filled with these mixtures were incubated at 26^0C in an atmosphere of 80 – 96% relative humidity, with the lids loosely covered. After 7 days incubation, the infective third stage larvae (L_3) were recovered as described by Taylor, (1967). The jars were taken out of the incubator and left on a bench for at least one hour in mild light in the laboratory with the lid of the jars screwed on tightly. The lid was taken off and the jar filled to the rim with tap water and put carefully up side down in a Petri-dish. A few millilitres of water was added to the Petri-dish.

Most of the active larvae were expected to have migrated into the water in the Petri-dish during the 3 hours the jars were left on the bench. The larvae were collected in a tube and examined microscopically to asses their viability.

3.2.4 Collection of *H. placei* adult worms from naturally infected Cattle

H. placei adult worms were collected from the abomasum of naturally infected cattle slaughtered at Zango abattoir in Zaria. The worms were transported in cool boxes to the laboratory where they were picked out, separated into sexes and identified based on the descriptions of Soulsby (1982) and Jacquiet *et al.* (1996). The standard lengths of the worms were measured in millimeters after which adult male worms were discarded and the females processed for the cultivation of the larval stages.

3.2.4.1 Culture of *H. placei*

The same procedure earlier described for the cultivation of *Haemonchus longistipes* to the infective larval stage was adopted.

3.2.5 Enumeration of infective third stage larvae (L_3) of *H. longistipes* and *H. placei*

The infective third stage larvae of *H. longistipes* and *H. placei* recovered from the modified Baermann apparatus (Taylor, 1967) were washed several times in distilled water and their number determined by dilution counting. The volumes were then adjusted so that 10ml contain 5,000 L_3 of each parasite to be used for artificial infection of sheep.

3.2.6 Infection of sheep

Group I of five (5) Yankasa sheep were infected with *H. longistipes*. Each sheep in the group was administered 5,000 infective larvae (L_3) by a stomach tube attached to a 10ml syringe. Sheep in Group II were given 5,000 infective larvae (L_3) of *H. placei* through the same process as above, while group III served as uninfected control.

Animals in the three groups were monitored for 15 weeks. Weight, PCV, Hb, WBC and differential blood counts were taken weekly. Pre- and post-infection screening of faeces of all sheep in the three groups was also carried out using Zinc Sulphate flotation method. The post infection screening was performed weekly to assess the presence or absence of helminth eggs.

3.2.7 Parasitological techniques

3.2.7.1 Live weight measurement of sheep

Animals in the three groups were each weighed a day before infection and weekly thereafter, for 4 months. The effects of the parasites on daily Live Weight (LWT) gain was determined for the 15weeks post infection period in groups I, II and III.

3.2.7.2 Faecal Egg Count (FEC)

Egg counts per gram of faeces in both *H. longistipes* and *H. placei* infected sheep were also performed weekly for 15weeks using the modified Mc-Master counting method (Hansen and Perry, 1994).

3.2.8 Haematological techniques

Blood collection and haematological analyses such as PCV, Hb, WBC and differential leukocyte counts were performed as described by King (1973), Davidsohn and Nelson (1974) and Charray *et al*. (1992).

3.2.8.1 Blood collection

Blood samples were collected from the jugular veins of sheep using a disposable 5ml syringe with 20 – gauge needle after the area had been thoroughly cleaned with 70% alcohol. Blood collected was then transferred into a tube containing EDTA and gently shaken. Each tube was properly labeled with the animal's identification number. Blood samples collected were taken to the laboratory for haematological analysis.

3.2.8.2 Determination of Packed Cell Volume (PCV)

The Pack Cell Volume (PCV) of each sheep in the three groups was monitored weekly during the course of the experiment. The PCV was determined by half filling an EDTA - impregnated microhaematocrit tube with venous blood sample from sheep. The empty end of the tube was sealed in a

flame from a bursen burner. The tubes were then placed in the radial grooves of a microhaematocrit centrifuge (Centirion, UK) head with the sealed end away from the centre. The centrifuge was then set at 2000g for 5 minutes after which the PCV was read with the aid of a PCV reader (Hawsley, England).

3.2.8.3 Determination of Haemoglobin (Hb) level

5ml of Drabkin's solution was transferred into two matched cuvettes, using an accurate volumetric transfer pipette. Venous blood from each sheep taken weekly was thoroughly mixed by gently tipping the tubes end over end several times before a sub - sample was taken. 0.02ml of whole blood taken from each sheep was transferred into one of the two cuvettes containing Drabkin's solution. This was then mixed by swirling the cuvette which was thereafter left standing for 10 minutes. The second cuvette containing only Drabkin's solution served as blank. The wavelength scale of the spectrophotometer (Ce 202 ultraviolet, Cambridge England) was adjusted to 540nm and the haemoglobin values read from a haemoglobin standard table.

3.2.8.4 Leukocyte (White Blood Cell) counts

The White Blood cell (WBC) counts of all the sheep in the three groups were performed weekly during the period of study. 0.5ml of blood collected from each sheep was drawn using a Thoma white –blood cell diluting pipette

(Weber Scientific International, England) and then the white blood cell diluting fluid added to the 11 mark on the pipette. Excess blood adhering to the pipette was wiped off with cotton wool. The blood and the diluting fluid were mixed gently for 3minutes by shaking end over end. The first 3 – 4 drops of cell - free fluid in the pipette were discarded while the remaining fluid was discharged onto a counting chamber by gently running the fluid under the cover slip of an improved Neubauer haemocytometer (Weber Scientific International, England).

The leukocytes were then counted under an X10 objective lens of a partially closed condenser diaphragm of a light microscope. Leukocytes in each of the four (4) large corner squares of the improved Neubauer haemocytometer were counted and the total multiplied by a factor (200) to give the number of leukocytes in mm^3 of blood.

3.2.8.5 Differential leukocyte counts

This was also performed weekly on all blood samples collected from the sheep in all groups. This was achieved by placing a drop of blood on a clean and dust-free glass slide ¾ inch from an end of the slide. The slide was then placed on a flat table surface. Holding a spreader glass slide with the thumb and fore-finger against the surface of the first slide at an angle of $30^0 – 40^0$, the spreader slide was drawn back until contact was established with the drop of

blood on the first slide. The spreader slide was then pushed at moderate speed forward spreading the blood evenly on the first slide.

The glass slide was rapidly air - dried. Prepared slides were then labeled and stained in Wright stain. The stain was floated off with a stream of distilled water to remove excess stain. Excess water was also drained off by tilting the slide. The film was air - dried and carefully examined with an oil immersion objective. Each leukocyte seen was classified and the percentage of each cell type seen was calculated.

3.2.9 Necropsy

Experimental sheep in all the three groups (groups I, II and III) were humanely sacrificed fifteen (15) weeks post infection. Each sheep was opened up and subjected to post mortem examination by a pathologist. The heart, liver, lungs, kidneys and the abomasum were grossly examined and tissues taken and preserved in 10% formaldehyde for histopathological analysis.

3.2.9.1 Recovery and enumeration of adult worms

The abomasum was ligated to separate it from the rest of the GIT. The whole GIT was removed from the carcass, and using a sharp knife, the abomasum was separated from the GIT and flushed with the aid of a rubber hose attached to a running tap and the content collected in a 2L rubber bucket. The abomasum was then slit open lengthwise with the aid of a pair of scissors

and washed thoroughly into the rubber bucket, after which the mucosa was scraped gently with a scapel into a separate containers for the recovery of any immature adult worm.

The washing in the rubber bucket was sieved, little quantity at a time, using a 100 mesh sieve. This was done by directing water into the sieve through a rubber tubing attached to a tap until all matter escaped through the sieve. The sieve was emptied into a container and worms were picked and counted, and their lengths were measured in millimeters.

3.2.9.2 Recovery and enumeration of immature worms

The recovery of immature stages of *H. longistipes* and *H. placei* from the mucosa of the abomasa of the sheep in groups I and II was performed, using the Digestion Technique (Ikeme, 1989).

The abomasal mucosa scrapings collected from sheep in groups I and II in separate containers were processed by pepsin digestion. About 100g of the scraping from the mucosa of each sheep was added to 200ml of pepsin digestion fluid in a beaker and incubated overnight at 37^0C (Ikeme, 1989). This was sieved through a 100 mesh using hot water to remove fat. Larvae recovered were estimated by dilution technique using a dissection microscope.

3.2.9.3 Histopathology

Tissues collected and preserved in 10% formaldehyde at necropsy were embedded in paraffin wax. Tissue sections (4µm thick) were made and stained with haematoxylin and eosin (H & E) (Mahoney, 1966).

3.3 Statistical technique

Data collected were analysed by ANOVA, Student's t – test and Chi – Square (X^2) test respectively using Statistical Package for Social Science (SPSS) version 13. Tables and graphs were, however, plotted using either Microsoft word (MS) and / or MS Excel.

CHAPTER FOUR

RESULTS

4.1 Parasite survey in camels

4.1.1 *Trypanosoma evansi*

Overall Prevalence

A total of 558 blood samples from camels, made up of 301 males and 257 females meant for slaughter at Kano, Katsina and Gusau abattoirs were collected and examined for trypanosome infection. *T. evansi* was the only trypanosome species found infecting camels in the three States surveyed (Plate I).

The overall prevalence of *T. evansi* recorded was 5.73%. Out of 301 blood samples collected from the male camels, 20 (6.64%) were positive for *T. evansi* while only 12 (4.67%) of the female camels had the infection (Table 4.1). Out of 320 camels examined between April and October 26 (8.13%) had *T. evansi*, while out of the 238 camels examined between November and March 6 (2.52%) were found to be infected by the parasite (Table 4.2).

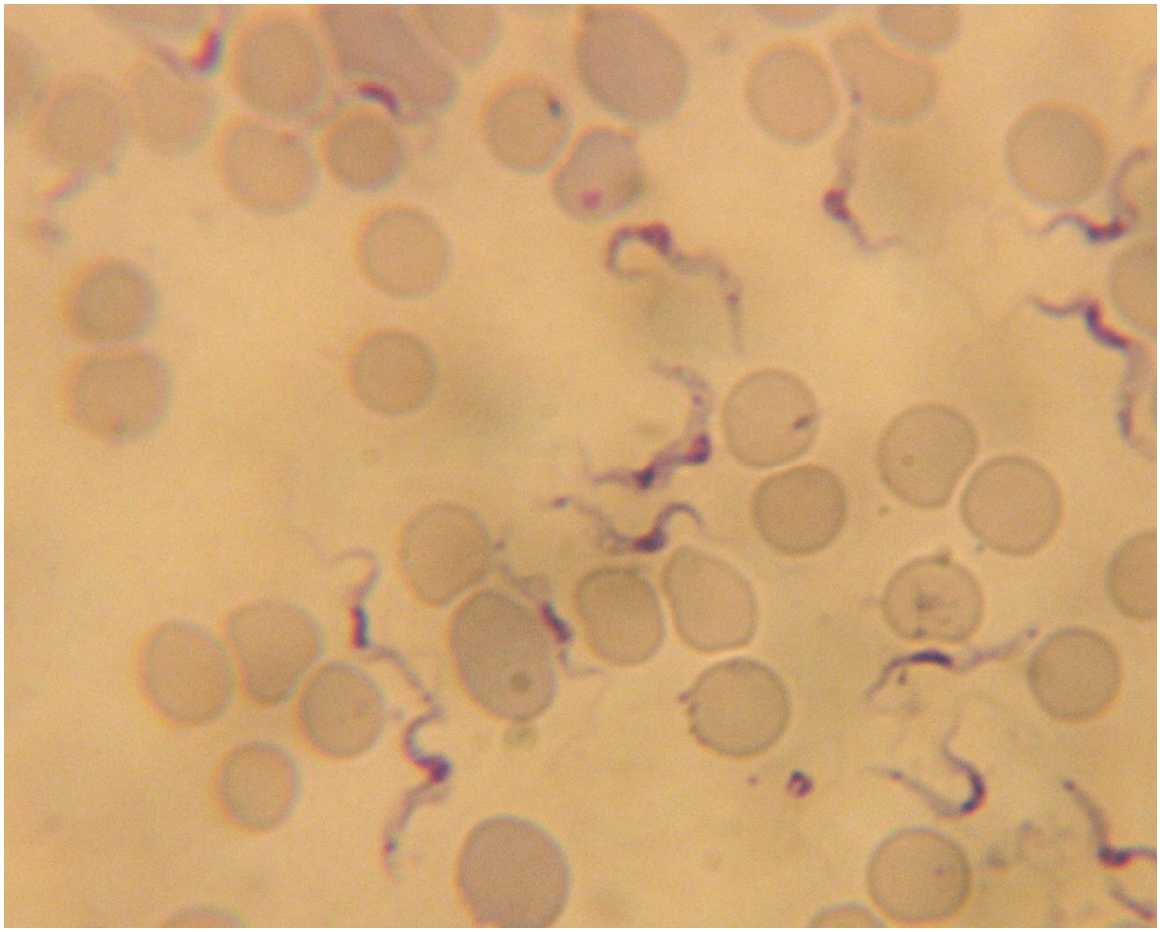


Plate I. *Trypanosoma evansi* in blood of an infected camel. (X1000)

Prevalence by State

The prevalence of *T. evansi* was highest (9.22%) in Kano followed by Katsina with 3.95% and the least occurred in Zamfara with 3.43% (Table 4.1). The monthly prevalence of *T. evansi* in camels in the three States is presented in Table 4.2. In all the States, infections were more recorded between early April and late June. Although the peak prevalence of *T. evansi* varied from State to State, in Kano *T. evansi* appeared to be present between March and November with peak infections in May and June. In Katsina and Zamfara States, infections were common between the months of February and May. High infections occurred in both States during the commencement of rains in late May and disappeared completely between June / July and January.

Table 4.1 also shows that out of the total male population examined from each State, 10.53%, 5.26% and 3.26% were found to be infected by *T. evansi* at Kano, Katsina and Zamfara States respectively. Lower prevalences were, however, recorded in the female camels during the same period. The difference in prevalence was, however, not statistically significant ($P>0.05$).

Table 4.1. Overall Prevalence of *T. evansi* infection in three Northern Nigerian States in relation to sex of Camels.

State	Sex	No. of camels Examined	No. of camels Infected	% Infected	X^2 – value
Kano	Male	114	12	10.53	
	Female	92	7	7.61	0.528
	Sub-Total	206	19	9.22	
Katsina	Male	95	5	5.26	
	Female	82	2	2.44	0.863
	Sub- Total	177	7	3.95	
Zamfara	Male	92	3	3.26	
	Female	83	3	3.61	0.028
	Sub- Total	175	6	3.43	
Total		558	32	5.73%	

Table 4.2. Monthly prevalence of *Trypanosoma evansi* in three States of Northern Nigeria.

		State							
		Kano		Katsina		Zamfara		All States	
Months	No. Exam.	No. inf.	%	No. inf.	%	No. inf.	%	No. inf.	Inf. Rate %
January	48	0	0	0	0	0	0	0	0
February	48	0	0	1	6.25	1	7.69	2	4.17
March	47	1	5.88	1	5.88	1	7.69	3	6.38
April	42	3	20.00	1	7.14	1	7.69	5	11.91
May	48	4	21.05	3	21.43	3	20.00	10	20.83
June	46	4	23.53	1	6.67	0	0	5	10.87
July	45	2	12.50	0	0	0	0	2	4.44
August	46	1	5.88	0	0	0	0	1	2.17
September	46	2	12.50	0	0	0	0	2	4.35
October	47	1	5.88	0	0	0	0	1	2.13
November	46	1	5.88	0	0	0	0	1	2.17
December	49	0	0	0	0	0	0	0	0
Total	558	19	9.22	7	3.95	6	3.43	32	5.73

4.1.2 Gastro-intestinal helminths

Out of the 558 gastrointestinal tracts of camels examined, 157(28.14%) were found to harbour helminths. Three species of nematodes and two of cestodes were encountered. These were *Haemonchus longistipes*, *Trichuris globulosa*, *Oesophagostomum venulosum*, *Moniezia benedeni* and *Stilezia vittata* (Plates II - VI). In most cases, two, three or more of these parasites were found to be present in the same host concurrently.

H. longistipes had the highest overall prevalence of 53.76% among the nematodes, followed by *T. globulosa* (46.77%) and *O. venulosum* (13.62%). Among the cestodes, *M. benedeni* had a prevalence of 14.87% while *Stilezia vittata* was least, infected 12.01% of the animals (Table 4.3).

Prevalence with respect to State

Kano had the highest prevalence of gastrointestinal helminths with 59.14% followed by Katsina 45.34% and Zamfara with 36.74%. In each of the three States nematodes were more prevalent than cestodes. The prevalences for nematodes were 51.79%, 33.15% and 39.39% in Kano, Katsina and Zamfara respectively. For the cestodes, the prevalences were 7.35%, 12.19% and 7.35% for Kano, Katsina and Zamfara respectively (Table 4.4). In all the three states, *H. longistipes* was the most prevalent with prevalences ranging between 53.71% – 53.88%. *T. globulosa* was highest (50.28%) in Katsina and least

(40.00%) in Zamfara while *O. venulosum* (36.89%) was encountered only in Kano (Table 4.3).

The prevalence of *M. benedeni* and *S. vittata*, the two recorded cestodes in this study, were relatively low compared to nematodes. The prevalence rates for *M. benedeni* in the three States were 13.11%, 8.48% and 23.43% in Kano, Katsina and Zamfara camels respectively. *S. vittata* was not encountered in the Zamfara camels, but it occurred in Kano and Katsina camels with prevalence rates of 6.80% and 29.94% respectively.



Plate II: *Haemonchus longistipes* (anterior end) recovered from a camel. (mag: x400)

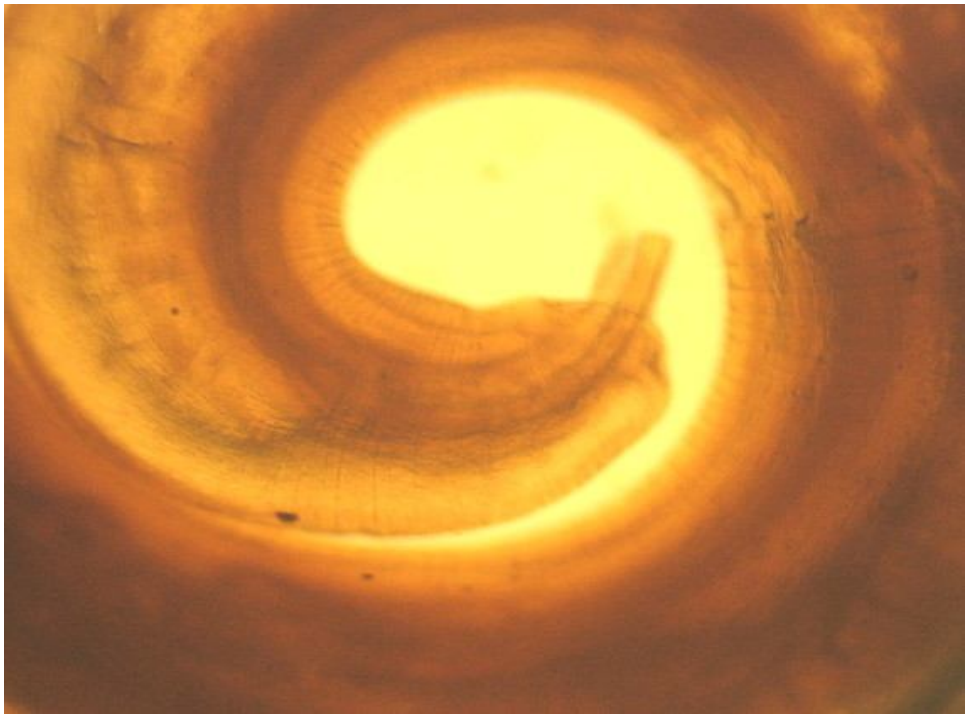


Plate III: *Trichuris globulosa* (posterior end of adult male) recovered from a camel. (mag: x400)



Plate IV: *Oesophagostomum venulosum* (anterior end) recovered from a camel. (mag: x400)



Plate V: *Moniezia benedeni* (scolex) recovered from a camel. (mag: x400)



Plate VI. *Stilezia vittata* (scolex) recovered from a camel.
(mag: x400)

Table 4.3. Overall Prevalence of Gastro-intestinal helminths in Camels in three States of Northern Nigeria

Parasites	State							
	Kano (n= 206)		Katsina (n= 177)		Zamfara (n= 175)		All States (n = 558)	
	No. inf.	%	No. inf.	%	No. inf.	%	No. inf.	%
Cestodes:								
M. benedeni	27	13.11	15	8.48	41	23.43	83	14.87
S. vittata	14	6.80	53	29.94	0	0.00	67	12.01
Nematodes:								
H. longistipes	111	53.88	95	53.77	94	53.71	300	53.76
T. globulosa	102	49.03	89	50.28	70	40.00	261	46.77
O. venulosum	76	36.89	0	0.00	0	0.00	76	13.62

Table 4.4. Prevalence of Gastro-intestinal parasites in 558 slaughtered Camels in three States of Northern Nigeria.

Parasite Group	State					
	Kano		Katsina		Zamfara	
	No. infected	%	No. infected	%	No. infected	%
Cestodes	41	7.35	68	12.19	41	7.35
Nematodes	289	51.79	165	33.15	164	39.39
Total	330	59.14	253	45.34	205	36.74

Prevalence in relation to Season

Table 4.5 shows the prevalence of various helminth parasites of the GIT of camels encountered during the dry and wet seasons in Kano, Katsina and Zamfara States. Infections by nematodes were more during the wet season than during the dry season in the States surveyed. More than 58% of the camels examined during the wet season in the three States were found to harbour *H. longistipes*. Similarly, between 15.94% and 50% of the camels examined during the same season had either *T. globulosa* or *O. venulosum* or both overall.

Prevalence rates of 15.38%, 9.09% and 25.49% were also recorded for *M. benedeni* during the wet season at Kano, Katsina and Zamfara respectively. These prevalence rates far exceeded those recorded for the dry season for the same parasite in the same States. However, higher prevalence (10.11%) of *S. vittata* was recorded in the GIT of slaughtered camels during the dry season than in rainy season at Kano.

Table 4.5. Seasonal Prevalence of Gastro-intestinal helminths in slaughtered Camels in three Northern States of Nigeria.

Season	State	No. of Camels examined	Helminths				
			M. benedeni	*S. vittata*	*H. longistipes*	*T. globulosa*	*O. venulosum*
			No. inf. (%)	No. inf. (%)	No. inf. (%)	No. inf. (%)	No. inf. (%)
WET							
	Kano	117	18 (15.38)	5 (4.27)	67 (57.26)	60 (51.28)	51(43.59)
	Katsina	101	10 (9.09)	35 (34.65)	59 (58.42)	56 (55.45)	0 (0.00)
	Zamfara	102	26 (25.49)	0 (0.00)	60 (58.62)	44 (43.14)	0 (0.00)
Wet Season Total		320	54 (16.88)	40 (12.50)	186 (58.16)	160 (50.00)	51 (15.94)
DRY							
	Kano	89	9 (10.11)	9 (10.11)	44 (49.44)	42 (47.19)	25 (28.09)
	Katsina	76	5 (6.58)	18 (23.68)	36 (47.37)	33 (43.42)	0 (0.00)
	Zamfara	73	15 (20.55)	0 (0.00)	34 (46.58)	26 (35.62)	0 (0.00)
Dry Season Total		238	29 (12.18)	27 (11.34)	114 (47.90)	101 (42.44)	25 (10.50)
All Season Total		558	83 (14.87)	67 (12.01)	300 (53.76)	261 (46.77)	76 (13.62)

Prevalence in relation to sex of Camels

The prevalence of the various helminth parasites was generally higher in male than in female camels slaughtered in the three States. *H. longistipes*, *M. benedeni* and *S. vittata* were observed to have relatively higher prevalence in male camels in two of the States (Table 4.6). *T. globulosa* on the other hand had a higher prevalence in female camels from Kano and Zamfara, although these differences were not statistically significant (P>0.05).

Intensity of worm infection

The intensity of worm infection by the various helminths as reflected by mean worm burden of helminth recovered from the GIT of slaughtered camels during the dry and wet seasons is presented in Table VII. In all the abattoirs, the average worm collection per camel during the wet season was higher than dry season for all the nematodes. The minimum and maximum range for mean worm burden ± Standard Error (SE) for the three States were 1,579 ±161.1 – 2,079 ± 182.9; 200 ± 15.7 – 928 ± 96.4 and 0 ± 0.0 - 124 ± 9.4 during the wet season, 159 ± 49.9 – 1,474 ± 175.9; 61 ± 10.1 – 360 ± 66.4 and 0 ± 0.0 - 99 ± 13.2 during the dry season for *H. longistipes*, *T. globulosa* and *O. venulosum* respectively. However, there were no differences in intensity of infections by *M. benedeni* or *S. vittata* in the two seasons during the study period.

Table 4.6. Prevalence of Gastro-intestinal helminth parasites in three Northern Nigerian States in relation to sex of Camels.

State	Sex of Camels	Number Examined	Helminths				
			M. benedeni	*S. vittata*	*H. longistipes*	*T. globulosa*	*O. venulosum*
			No. inf. (%)	No. inf. (%)	No. inf. (%)	No. inf. (%)	No. inf. (%)
Kano	Male	114	14 (12.28)	9 (7.89)	62 (54.39)	54 (47.37)	39 (34.21)
	Female	92	13 (14.13)	5 (5.43)	49 (53.26)	48 (52.17)	37 (40.22)
Katsina	Male	95	9 (9.47)	30 (31.58)	47 (49.47)	52 (54.74)	0 (0.00)
	Female	82	6 (7.32)	23 (28.05)	48 (58.54)	37 (45.12)	0 (0.00)
Zamfara	Male	92	23 (25.00)	0 (0.00)	51 (55.43)	36 (39.13)	0 (0.00)
	Female	83	18 (21.69)	0 (0.00)	43 (51.81)	34 (40.96)	0 (0.00)
Total		558	83 (14.87)	67 (12.01)	300 (53.76)	261 (46.77)	76 (13.62)

Table 4.7. Mean worm burden of the various helminths recovered from the GIT of slaughtered Camels in three Northern Nigerian States Surveyed during Wet and Dry seasons.

State	Season	Helminth									
		M. benedeni		*S. vittata*		*H. longistipes*		*T. globulosa*		*O. venulosum*	
		Total	mean (SE)*	Total	mean (SE)	Total	mean (SE)	Total	mean (SE)	Total	mean (SE)
Kano	Wet	19	1 (0.1)	5	1 (0.0)	282,680	2,079 (182.9)	24,530	200 (15.7)	12,460	124 (9.4)
	Dry	9	1 (0.0)	10	1 (0.0)	129,710	1,474 (175.9)	10,590	126 (12.3)	4,940	99 (13.2)
Katsina	Wet	10	1 (0.0)	37	1 (0.0)	220,930	1,841 (108.9)	103,980	928 (96.4)	0	0
	Dry	6	1 (0.0)	19	1 (0.1)	31,100	432 (60.1)	24,060	360 (66.4)	0	0
Zamfara	Wet	27	1 (0.0)	0	0	189,440	1,579 (161.1)	18,940	215 (30.8)	0	0
	Dry	17	1 (0.1)	0	0	10,800	159 (49.9)	3,480	61 (10.1)	0	0

* Standard Error

4.1.3 Coccidia

A total of 558 faecal samples were collected from 301 male and 257 female camels in Kano, Katsina and Zamfara States. Out of this number, 24 (4.30%) were found to harbour *Eimeria dromedarii* [mean size: 31.86µm x 21.42µm] (Plate 4.7). The camels found to be infected by this protozoan were all from Katsina State thereby accounting for 13.56% of the 177 faecal samples collected from the State. No positive cases of coccidia were encountered in the faecal samples from Kano and Zamfara States (Table 4.8).

Most of the infections recorded were light. Infection rates in male and female camels were not significantly different ($P>0.05$), although females were more infected.

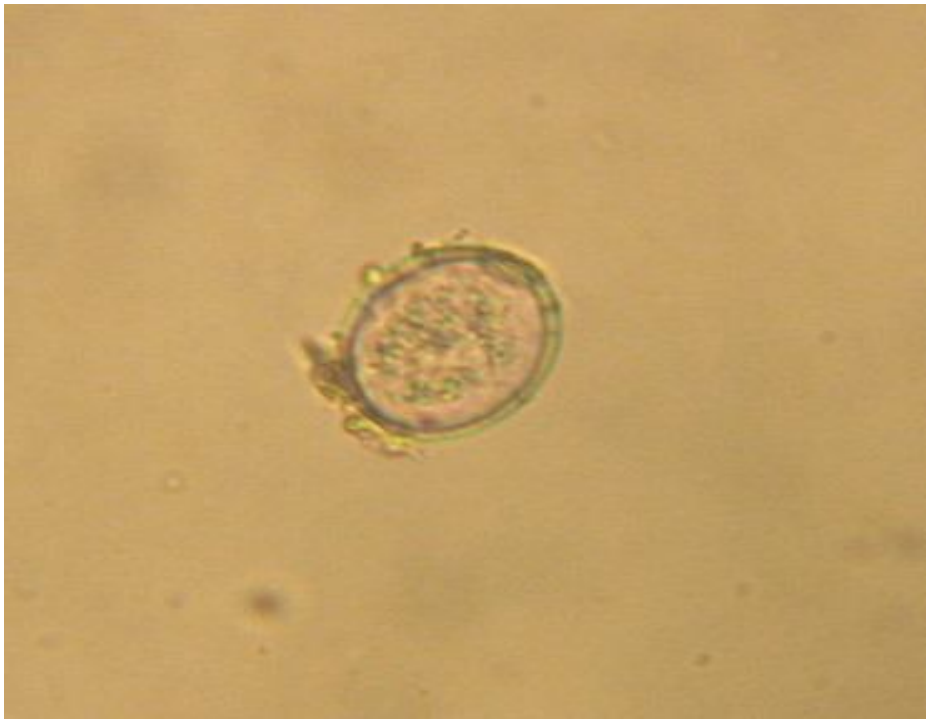


Plate VII: (a). Unsporulated oocyst of *E. dromedarii* recovered from a camel. (mag: x400)



Plate VII: (b). Sporulated oocyst of *E. dromedarii* recovered from a camel. (mag: x400)

Table 4.8. Prevalence of *Eimeria dromedarii* in Camels in three States of Northern Nigeria.

State	Male Camels		Female Camels		All Camels	
	No. Exam.	No. inf. (%)	No. Exam.	No. inf. (%)	No. Exam.	No. inf. (%)
Kano	114	0 (0.00)	92	0 (0.00)	206	0 (0.00)
Katsina	95	13 (13.68)	82	11 (17.74)	177	24 (13.56)
Zamfara	92	0 (0.00)	83	0 (0.00)	175	0 (0.00)
Total	301	13 (4.32)	257	11 (4.38)	558	24 (4.30)

4.1.4 Tick infestation

Overall distribution

Three tick species belonging to three genera were found on camels in the three States surveyed. These were *Amblyomma variegatum*, *Hyalomma dromedarii* and *Rhipicephalus pravus* (Plates VIII -X). *H. dromedarii* had the highest prevalence of 58.06% (324/558), forming 10226 (70.19%) of the 14,569 ticks collected. This was followed by *A. variegatum* with a rate of 31.36% (175/558) and *R. pravus* with 21.33% (119/558) forming 2890 (19.84%) and 1453 (9.97%) respectively of the total (14,569) ticks collected during the survey (Table 4.9). It was also observed that 8886 (60.99%) of all the ticks collected from camels in all the States put together were males.

Table 4.10 shows the overall monthly prevalence of the different tick species in the States surveyed. Although all the three tick species were observed to infest camels in all the three states all year round, peak prevalences for *A. variegatum* and *R. pravus* occurred in October while *H. dromedarii* peaked in July. Peak prevalences for *A. variegatum*, *R. pravus* and *H. dromedarii* were 53.19%, 40.43% and 77.78% respectively. 425 (68.77%) of all tick infestations were recorded during the wet season while 193 (31.23%) were in the dry season. Peak infestations with all three species were recorded between the months of June and October in the three States.

The overall sex-related prevalence shows that 329 (53.24%) of the male camels were infested by *A. variegatum*, *H. dromedarii* and *R. pravus* during the survey compared to female camels 289 (46.76%).



Plate VIII: (a). *Amblyomma variegatum* (adult male) recovered from a camel.



Plate VIII: (b). *A. variegatum* (Flat female) recovered from a camel.



Plate VIII: (c). *A. variegatum* (Engorged female) recovered from a camel.



Plate IX: (a). *Hyalomma dromedarii* (adult male) recovered from a camel.



Plate IX: (b). *H. dromedarii* (Flat female) recovered from a camel.



Plate IX: (c). *H. dromedarii* (Engorged female) recovered from a camel.



Plate X: (a). *Rhipicephalus pravus* (adult male) recovered from a camel.



Plate X: (b). *R. pravus* (adult female) recovered from a camel.

Table 4.9. Relative abundance of Tick species on 558 Camels in three States of Northern Nigeria.

Tick species	No. of Camels Infested (%)	No. of Ticks Collected (% of Total)	Distribution of Tick Population					
			Kano		Katsina		Zamfara	
			M	F	M	F	M	F
Amblyomma. variegatum	175 (31.36)	2,890 (19.84)	924	523	396	265	395	337
Hyalomma. dromedarii	324 (58.06)	10,226 (70.19)	2044	1299	2283	1551	1953	1096
Rhipicephalus pravus	119 (21.33)	1,453 (9.97)	263	186	495	293	133	83
	Total	14,569 (100.00)	3,231	2,058	3,174	2,109	2,481	1,516

Table 4.10. Overall monthly prevalence of different Tick species on Camels surveyed in Kano, Katsina and Zamfara States.

Months	No. of Camels Examined	Tick species					
		A. variegatum		*H. dromedarii*		*R. pravus*	
		No. infested	Infestation rate (%)	No. infested.	Infestation rate (%)	No. infested.	Infestation rate (%)
January	48	11	22.92	19	39.58	6	12.50
February	48	7	14.58	18	37.50	7	14.58
March	47	9	19.15	17	36.17	1	2.13
April	42	9	21.43	18	42.86	6	14.29
May	48	13	27.08	25	52.08	6	12.50
June	46	15	32.61	33	71.74	13	28.26
July	45	20	46.67	35	77.78	14	31.11
August	46	20	43.48	35	76.09	13	28.26
September	46	21	45.65	33	71.74	16	34.78
October	47	25	53.19	36	76.60	19	40.43
November	46	14	30.43	28	60.87	10	21.74
December	49	11	22.45	27	55.10	8	16.33
Total	558	175	31.36	324	58.06	119	21.33

4.1.4.1 Distribution of *Amblyomma variegatum*

Figure 4.2 (a-c) presents the mean monthly tick burden, prevalence of nymphs and adult ticks of *A. variegatum* on camels in the three States. Prevalence of adult ticks was higher at Kano than in either Katsina or Zamfara States. Peak prevalence was recorded in Kano between June and July while *A. variegatum* peaked between September and October in Katsina and Zamfara States.

However, immature stages of *A. variegatum* were not found on camels at Kano, while at Zamfara they were completely absent between January and April but resurfaced around May and peaked by June. At Katsina, although relatively high prevalence of the immature stages was recorded in April, the highest prevalence was recorded in October.

Fig 4.2 (a) shows the intensity of tick infestation on camels. Highest mean adult tick burden on camels occurred between May and October in the three States.

Analysis of data on the seasonal prevalence of *A. variegatum* on camels in the States showed a significant difference between wet (38.44%) and dry (21.85%) seasons ($P<0.05$) (Table 4.11). *A. variegatum* infestations showed an increase of 10.95% – 20.09% during the wet season of the year over the dry season.

Similarly, Table 4.12 shows the prevalence of *A. variegatum* in relation to the sex of camels. The male camels in Katsina and Zamfara were more infested than the female camels in the two States, the female camels in Kano were more infested than the males in the State. However, there was no significant difference in the overall infestation rates between the male and female camels ($P>0.05$).

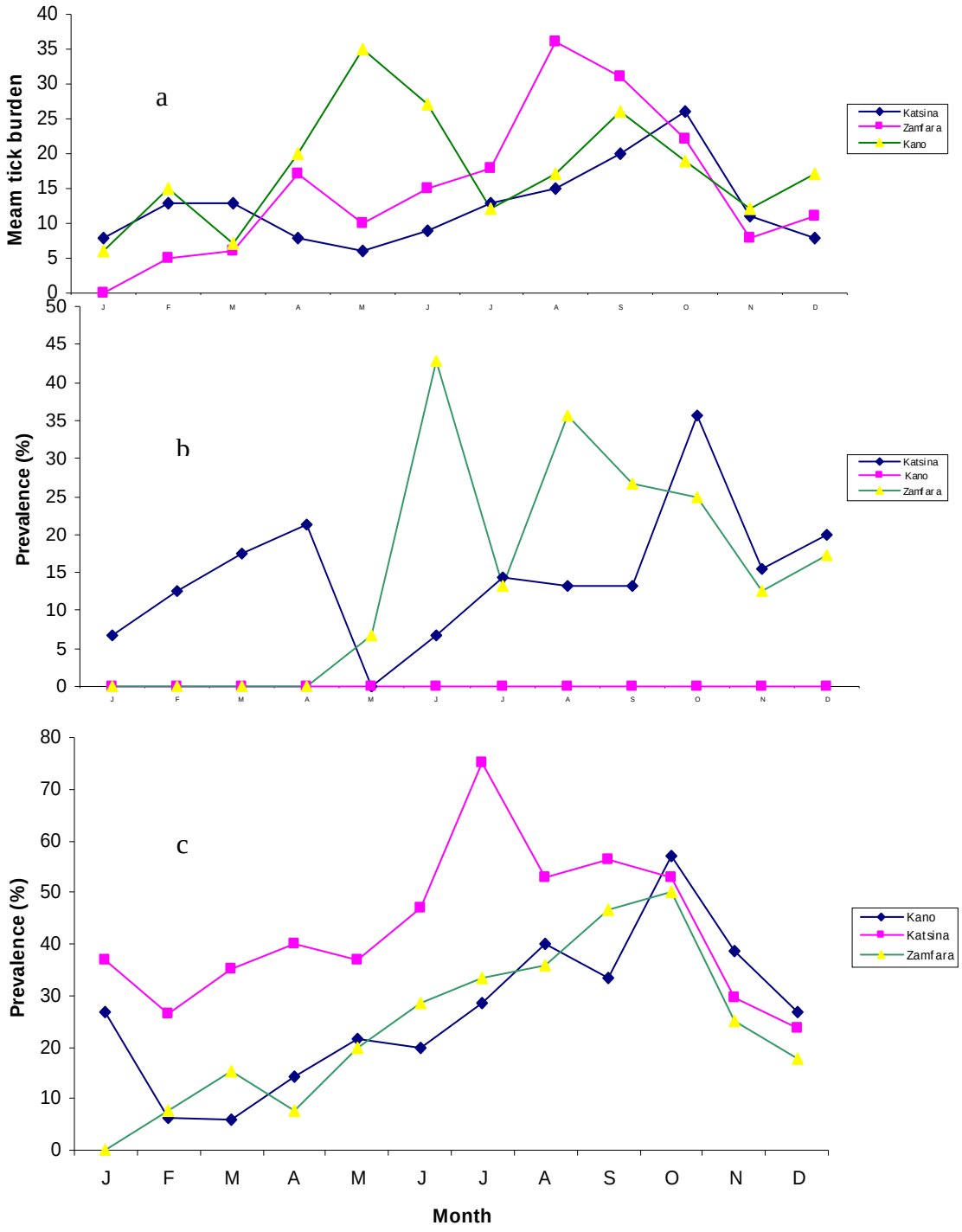


Figure 4.2. Mean monthly adult tick burden (a), Overall monthly prevalence of nymph (b) and Overall monthly prevalence of adult ticks (c) of *A. variegatum*.

Table 4.11. Seasonal prevalence of *Amblyomma variegatum* in three States of Northern Nigeria.

Season	State	Number of Camels Examined	Number infested	Infestation rate (%)
WET				
	Kano	117	59	50.43
	Katsina	101	31	30.69
	Zamfara	102	33	32.35
Wet Season Total		320	123	38.44
DRY				
	Kano	89	27	30.34
	Katsina	76	15	19.74
	Zamfara	73	10	13.70
Dry Season Total		238	52	21.85
All Season Total		558	178	31.90

Table 4.12. Prevalence of *Amblyomma variegatum* in both sexes of Camels in three States of Northern Nigeria.

Sex of Camels	States	Number of Camels Examined	Number of Camels Infested	Infestation rate (%)
MALE				
	Kano	114	41	35.96
	Katsina	95	25	26.32
	Zamfara	92	28	30.43
Total for Male		301	94	31.23
FEMALE				
	Kano	92	45	48.91
	Katsina	82	21	25.61
	Zamfara	83	15	18.07
Total for Female		257	81	31.52
Total for Male and Female		558	175	31.36

4.1.4.2 Distribution of *Hyalomma dromedarii*

The prevalence of *H. dromedarii* on camels in the three States, unlike *A. variegatum*, was generally high (Fig. 4.3). In the three States, the prevalence of adult ticks was above 60% between the months of June and October. Lower prevalences were, however, recorded between January and April.

Nymphal stages of *H. dromedarii* were more prevalent on camels in Katsina and Zamfara between April and December with peak prevalence in June and September respectively. Like in *A. variegatum*, nymphal stages of *H. dromedarii* were not encountered in Kano. However, highest mean tick burden of *H. dromedarii* coincided with periods of highest tick proliferation in May and October.

Both male and female camels were found to be infested by *H. dromedarii*. Prevalence was not significantly different ($P>0.05$) in male and female camels in the three States (Table 4.13). In Katsina and Zamfara States 60 – 61.96% of male camels examined were found to be infested by *H. dromedarii* while only 52.44 -56.63% of the female camels in the same States were infested. In Kano, the female camels were about 9% more infested by *H. dromedarii* than were the male camels.

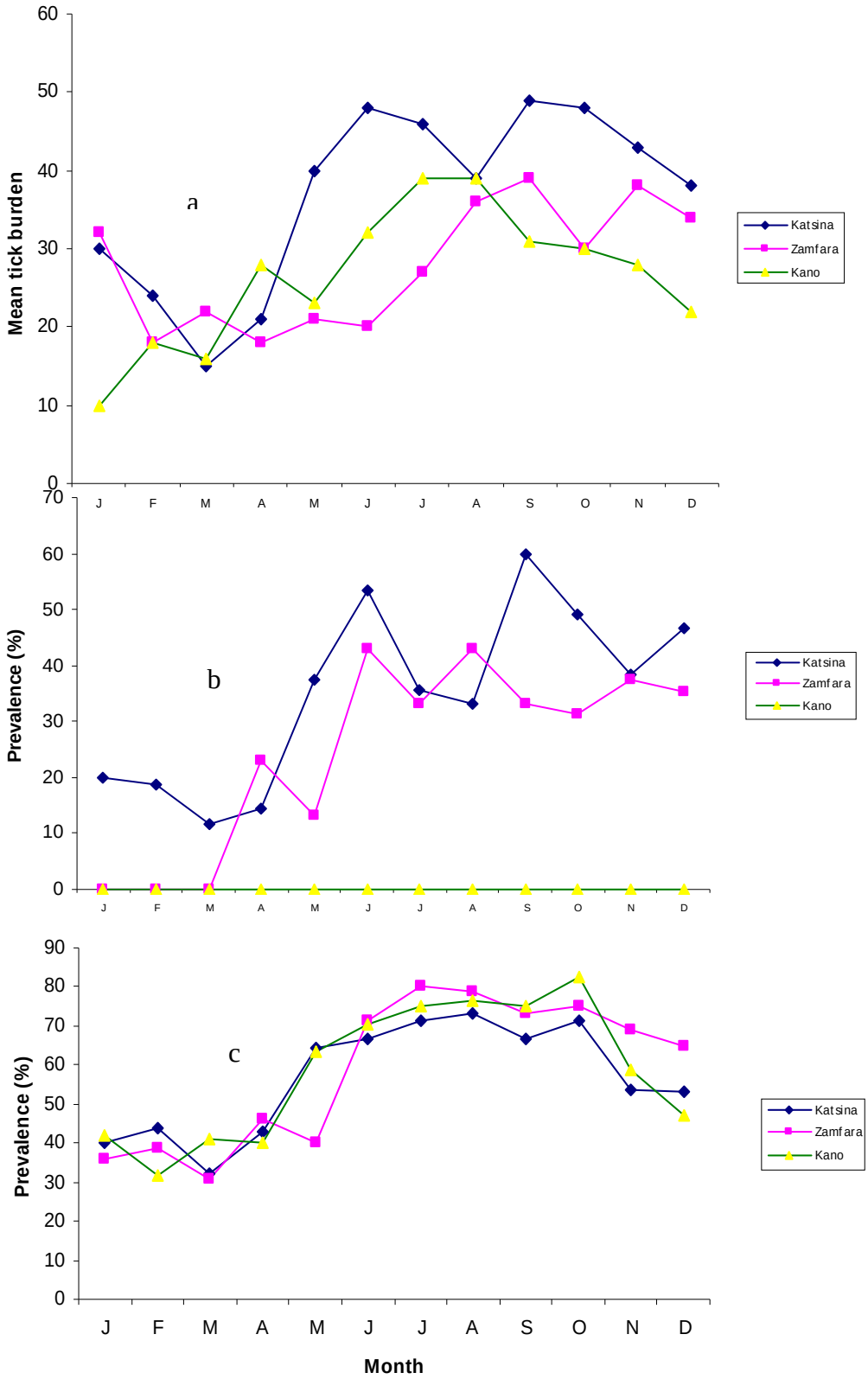


Figure 4.3. Mean monthly adult tick burden (a), Monthly prevalence of immature stages (b) and Monthly prevalence of adult ticks (c) of *H. dromedarii*.

Table 4.13. Prevalence of *Hyalomma dromedarii* in both sexes of Camels in three States of Northern Nigeria.

Sex of Camels	States	Number of Camels Examined	Number of Camels Infested	Infestation rate (%)
MALE				
	Kano	114	62	54.39
	Katsina	95	57	60.00
	Zamfara	92	57	61.96
Total for Male		301	176	58.47
FEMALE				
	Kano	92	58	63.04
	Katsina	82	43	52.44
	Zamfara	83	47	56.63
Total for Female		257	148	57.59
Total for both Sexes		558	324	58.06

The seasonal distribution of *H. dromedarii* on camels in Kano, Katsina and Zamfara is shown in Table 4.14. Between 65.35% and 69.23% of the 320 camels examined in the wet season were found to be infested in contrast to between 43.82% and 49.32% infestation in animals examined during the dry season. Inaddition analysis of the data shows a significant difference in *H. dromedarii* infestation between the two seasons ($P<0.05$).

Table 4.14. Seasonal Prevalence of *Hyalomma dromedarii* in Camels in three States of Northern Nigeria.

Season	States	Number of Camels Examined	Number of Camels Infested	Infestation rate (%)
WET				
	Kano	117	81	69.23
	Katsina	101	66	65.35
	Zamfara	102	68	66.67
Total for Wet Season		320	215	67.19
DRY				
	Kano	89	39	43.82
	Katsina	76	34	44.74
	Zamfara	73	36	49.32
Total for Dry Season		238	109	45.80
Total for two Seasons		558	324	58.06

4.1.4.3 Distribution of *Rhipicephalus pravus.*

Although the prevalence of *R. pravus* was relatively low compared to *A. variegatum* and *H. dromedarii* in all the three States, high prevalence rates were recorded for adult ticks between June and October (Fig. 4.4).

In Kano, peak prevalence of *R. pravus* was in June while in Katsina and Zamfara States, prevalences above 20% were recorded between June and October.

Larvae and nymphs of *R. pravus* were found to infest camels from March to April in Katsina and Zamfara States and peaked between July and October. No larval or nymphal stages of *R. pravus* were found to infest camels in Kano during the study period. However, mean adult tick burden on camels in Kano and Zamfara States were found to remain relatively constant from June through December. On the contrary, the mean tick burden on camels in Katsina State increased from June to reach a peak around October with an average of 37 adult ticks per infested camel.

In Kano and Katsina, female camels were 6.83% - 8.30% more infested by *R. pravus* than male camels (Table 4.15). In Zamfara, infestation was more on male than on female camels, although the difference was not significant ($P>0.05$).

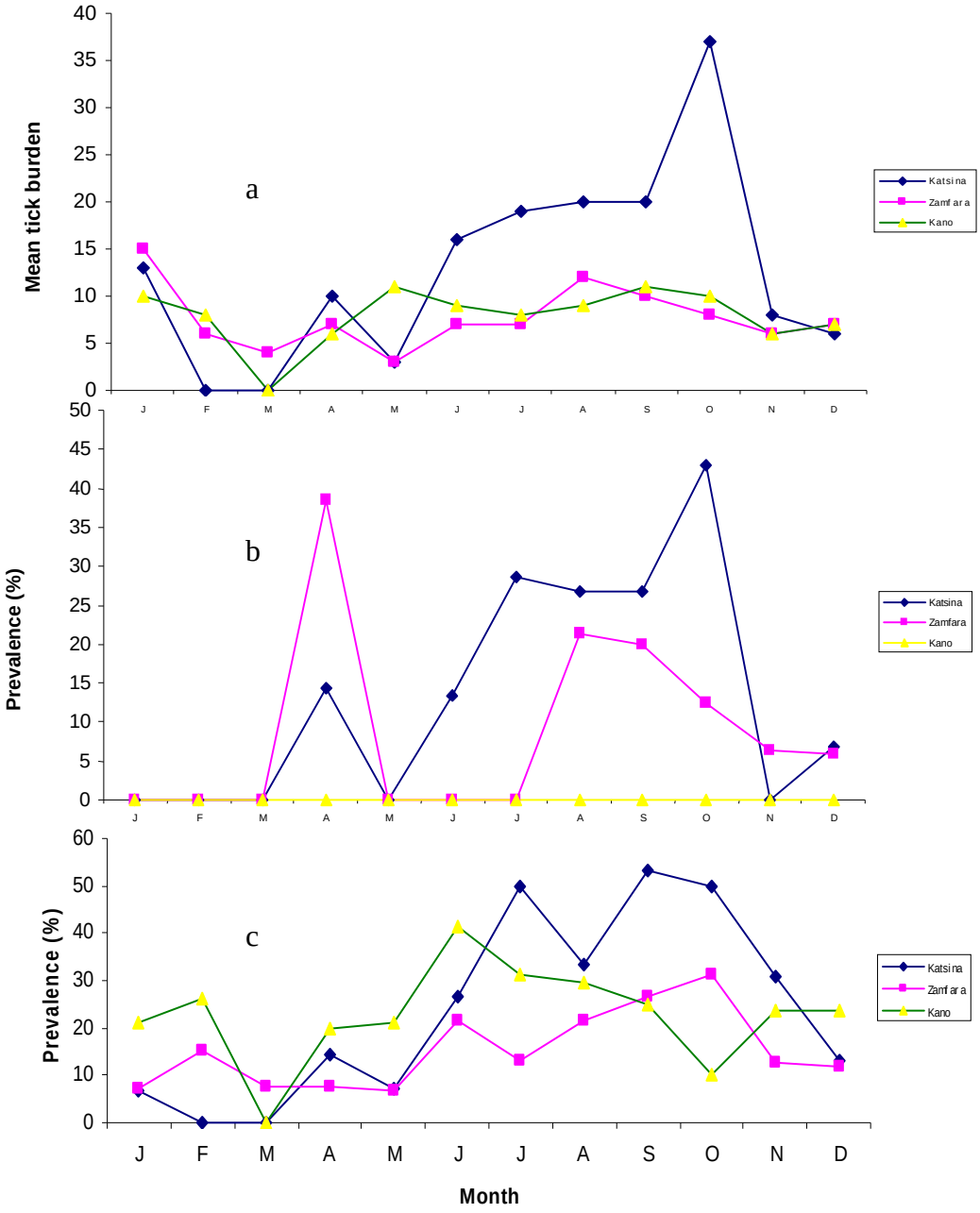


Figure 4.4. Mean monthly adult tick burden (a), Overall prevalence of immature stages (b) and Overall monthly prevalence of adult ticks (c) of *R. pravus*.

Table 4.15. Prevalence of *Rhipicephalus pravus* in both sexes of Camels in three States of Northern Nigeria.

Sex of Camels	States	No. of Camels Examined	No. of Camels Infested	Infestation rate (%)
MALE				
	Kano	114	24	21.05
	Katsina	95	19	20.00
	Zamfara	92	16	17.39
Total for Male		301	59	19.60
FEMALE				
	Kano	92	27	29.35
	Katsina	82	22	26.83
	Zamfara	83	11	13.25
Total for Female		257	60	23.35
Total for both Sexes		558	119	21.33

Data on the seasonal prevalence of *R. pravus* showed higher infestation of camels during the wet season than during the dry season in the three States. In Katsina, Kano and Zamfara States, 33.66%, 29.06% and 18.63% respectively of the camels examined in the wet season were found to be infested by *R. pravus* while 9.21% - 19.10% of the camels examined during the dry season of the same year in the three States were found to be infested (Table 4.16). Further analysis revealed a significant difference between infestations by *R. pravus* in the two seasons ($P<0.05$).

Table 4.16. Seasonal Prevalence of *Rhipicephalus pravus* in Camels in three States of Northern Nigeria.

Seasons	States	Number of Camels Examined	Number of Camels Infested	Infestation rate (%)
WET				
	Kano	117	34	29.06
	Katsina	101	34	33.66
	Zamfara	102	19	18.63
Total for Wet Season		320	87	27.19
DRY				
	Kano	89	17	19.10
	Katsina	76	7	9.21
	Zamfara	73	8	10.96
Total for Dry Season		238	32	13.45
Total for two Seasons		558	119	21.33

4.1.5 Mite infestation

Although cases of clinical mite infestation were not very common during the present survey, a suspected case was recorded in a female camel at Katsina abattoir in late February, 2005. The camel was presented with thickened, scaly and reddened skin; there was alopecia in the affected area (Plate XI) and the animal appeared restless.

Skin scrapings of lesion from the suspected camel, when processed and examined, yielded *Demodex folliculorum var. cameli* (Plate XII). The infestation appeared to be very low in the sampled areas.

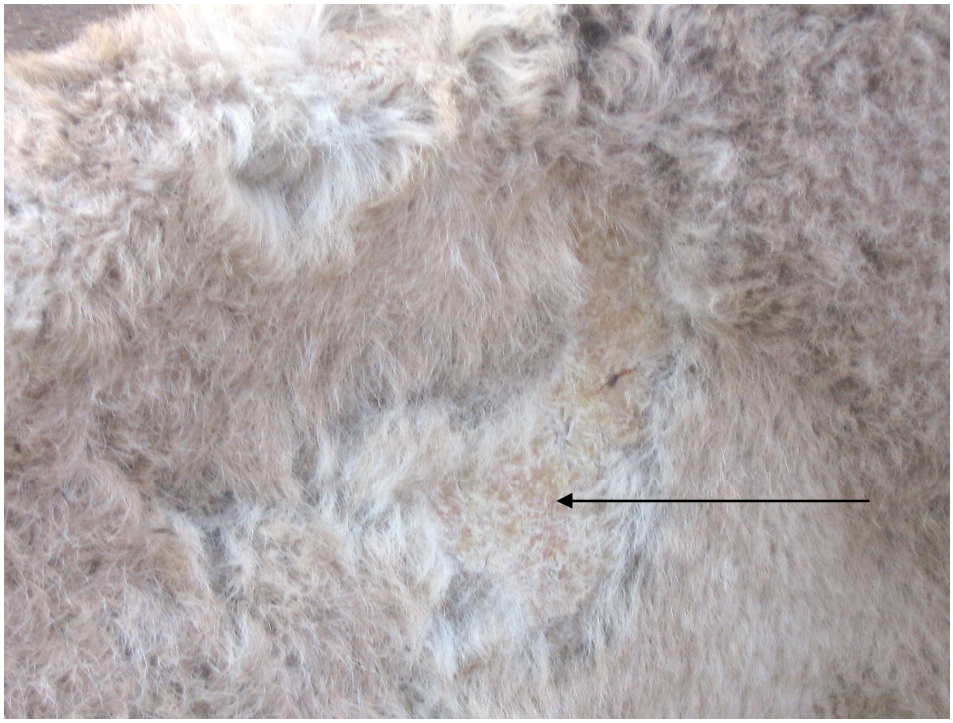


Plate XI. Skin lesion of mite infested camel.



Plate XII: *Demodex folliculorum var. cameli* recovered from a camel.

(mag: x160)

4.2 Experimental *H. longistipes* and *H. placei* infection in sheep.

4.2.1 Clinical findings

Sheep in groups I (5), II (5) and III (control) passed faeces of normal consistency and appeared normal throughout the experimental period (Plate XIII). However, two sheep in group I (id.no. 2 and 5) appeared to react to the challenge during the first three to four weeks post infection as one of the sheep lost weight, looked emaciated and had dull coat (Plate XIV). Close and careful examination revealed both sheep were carrying early pregnancy. One of the two sheep later aborted the pregnancy by the fourth week post infection. The second sheep gave birth to a premature lamb in the 12 week post infection (Plates XV - XVI).

None of the animals in all the three groups died during the duration of the experiment.



Plate XIII: Experimental sheep.

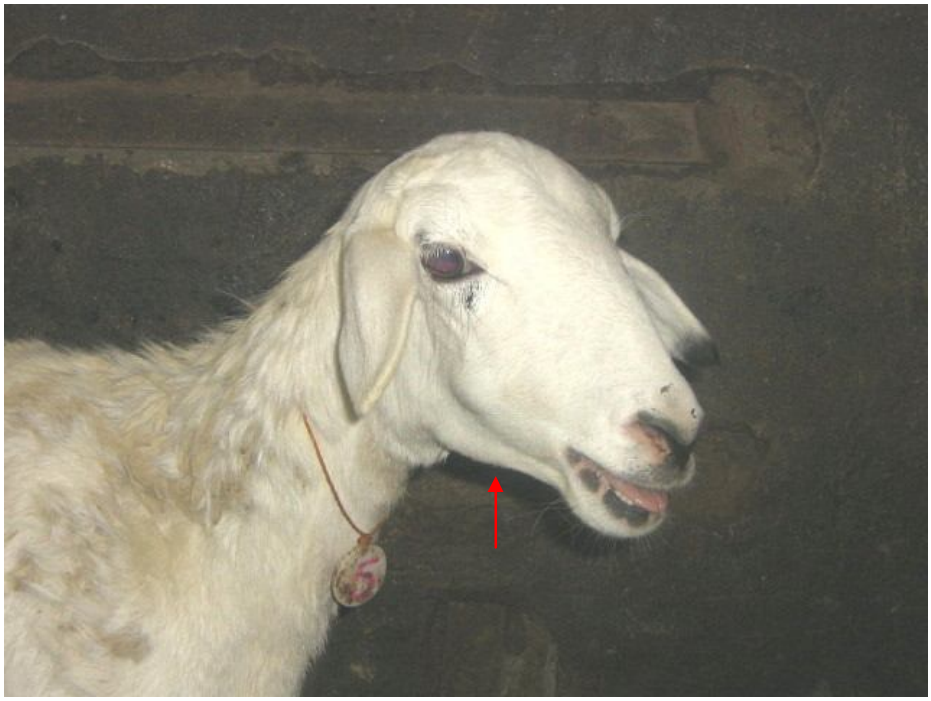


Plate XIV: Sheep showing sign of haemonchosis (swollen lower jaw) as a result of *H. longistipes* infection.



Plate XV: Aborted fetus of *H. longistipes* - infected sheep.



Plate XVI: Premature lamb delivered by one of the *H. longistipes* – infected sheep.

4.2.2 Live weight of sheep

The sheep in Group III serving as control gained weight of between 0.2kg and 5.5kg from week one extending through the duration of the experiment, while the sheep in Group I infected with *H. longistipes* lost weight of between 0.4kg and 2.2kg from the second week through to the fifteenth week though with intermittent slight increase in weight of about 0.4kg – 1.8kg. However the sheep in Group II infected with *H. placei* generally showed an increase in weight of between 0.1kg and 3.0kg. Slight weight loss was, however, observed on five, seven, eight and eleventh week post infection (Fig. 4.5).

Figure 4.6 shows the mean faecal egg counts of *H. longistipes* and *H. placei* - infected Yankasa sheep during the fifteen weeks experimental period. *H. longistipes* eggs was first detected in faeces of infected sheep of Group I during the fifth week post infection with a mean egg count (± SD) of 44 ± 26.5 epg. The highest mean faecal egg count of 532 ± 341.7 epg was recorded during the twelfth week post infection while the least (8 ± 16 epg) was during the fourteenth week post infection.

However, eggs of *H. placei* were first detected in the faeces of the sheep in Group II during the third week post infection. The mean faecal egg counts rose steadily from 56 ± 59.9 epg (during the prepatent period) to reach its peak

(4,588 ± 5444.9 epg) by the sixth week post infection, after which egg output dropped and remained low (48 ± 69.9 epg) until the experiment was terminated by the fifteenth week.

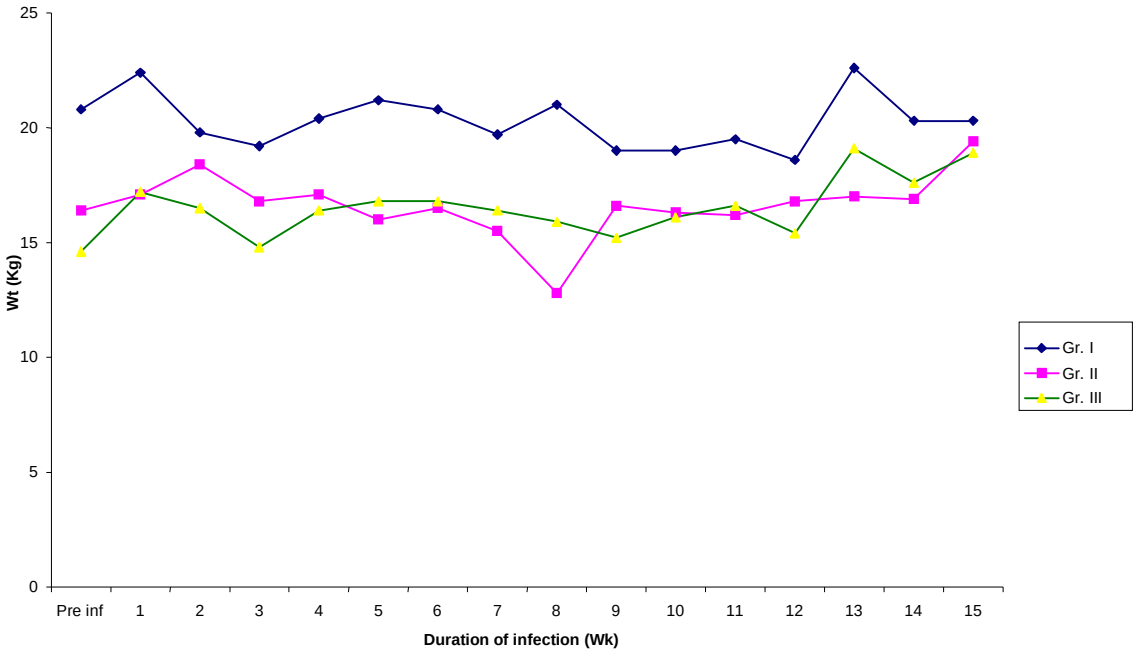


Figure 4.5. Weight changes in *H. longistipes* (Gr. I) and *H. placei* infected (Gr. II) and uninfected sheep (Gr. IIII).

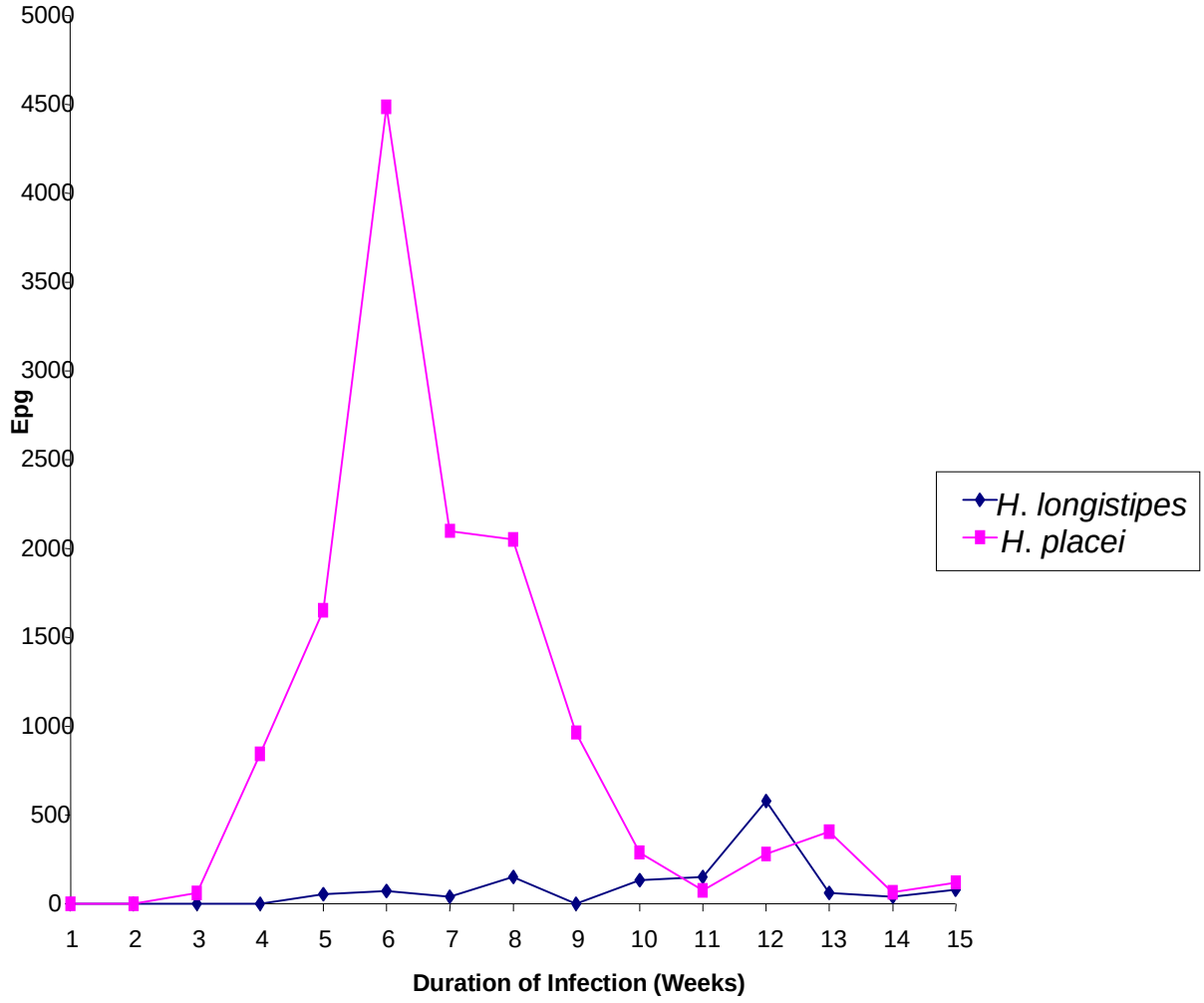


Figure 4.6. Mean FEC of *H. longistipes* and *H. placei* infected Yankasa sheep

4.2.3 Haematological indices

The various haematological indices (PCV, Hb, WBC, Lymphocytes and Neutrophils) in the present study showed a normal limit (Pagot and Wilding, 1992) in the sheep in Group III when the pre-infection and post infection values were compared. The PCV and Hb levels increased slightly in this group while mean WBC counts was relatively constant throughout the duration of the experiment.

Fig. 4.7 shows the mean PCV and Hb levels in sheep in Groups I, II and III. With the exception of weeks four, five, seven, nine and fourteenth in which lower mean PCV values (27.0% – 30.8%) were recorded, there was generally an increase (31.6% – 35.8%) in the mean levels in sheep in Group II relative to the pre-infection value (31.4%) in the remaining weeks the experiment lasted. The mean PCV values in sheep in Group I, however, was generally lower (25.8% - 28.4%) compared to the pre-infection value (28.6%). A slight increase (0.2% – 0.4%) though not significant ($P>0.05$) was observed in PCV levels of sheep in this group in weeks three, five, six, eight and thirteen post infection.

Similarly, higher (10.6dl – 12.2dl) values of Hb were recorded in the sheep in Group II compared to the pre-infection level (10.4dl) during the same period as in PCV, while the sheep in Group I had lower (8.6dl – 9.4dl) mean

Hb levels from week one through week fifteen relative to pre-infection value (9.5dl) except in weeks three, five, six, eight and fourteen in which higher values (9.6dl – 9.7dl) were recorded.

However, mean WBC counts in both Groups I and II tended to fluctuate below the pre-infection levels (Table 4.17). The lowest (9.9 $x10^9$/L) mean WBC counts in Group I was recorded in week three post infection while the highest count (16.0 $x10^9$/L) was in weeks seven and fifteen post infection. Similarly, values of mean WBC counts in sheep in Group II dropped from the second week and stayed low till the fifteenth week though with minor fluctuations below the pre-infection levels of the WBC (Table 4.17). A significantly lower level (10.1 $x10^9$/L) of WBC count was, however, recorded in sheep in Group II in week six post infection ($P<0.05$).

The mean haematologial values (Leukocytic series) in *H. longistipes*, *H. placei* and Control group are presented in Table 4.17. The differential leukocyte counts showed that both the lymphocytes and neutrophil counts recorded at post infection differed from the pre-infection counts significantly ($P<0.05$). There was an appreciable increase in lymphocyte counts from week one to week fifteen post infection in sheep of Groups I and II while neutrophil counts in both groups decreased.

Table 4.17. Mean Haematological values (Leukocytic series) in *H. longistipes* - infected sheep (G I), *H. placei* – infected sheep (G II) and Control (G III).

Duration Infection	WBC x 10^9 per l			Lymphocytes per cent			Neutrophils per cent			Eosinophils per cent		
(Wks)	G I	G II	G III	G I	G II	G III	G I	G II	G III	G I	G II	G III
0*	18.6	14.9	10.0	48.0	63.6	46.0	51.6	36.2	54.0	0.0	1.0	0
1	11.1	15.4	5.5	51.4	81.6	47.0	47.2	16.8	53.0	3.5	2.0	0
2	11.9	13.6	13.3	48.4	81.8	49.0	49.2	17.0	51.0	0.0	1.0	0
3	9.9	13.7	10.5	48.0	64.6	53.0	52.0	34.0	47.0	0.0	1.3	0
4	11.1**	14.0	8.9	58.4	72.6	43.5	39.6	26.0	43.5	0.0	1.3	0
5	14.5	14.2	12.8	50.4	71.4	45.5	49.6	27.2	54.5	0.0	1.7	0
6	13.3	10.1	10.6	46.0	84.2	44.5	54.0	15.0	55.5	0.0	1.0	0
7	16.0	11.6	13.2	51.0	64.6	44.5	49.0	39.5	55.5	0.0	1.3	0
8	11.8	12.2	8.1	60.4	64.6	40.0	39.6	34.8	60.0	0.0	0.0	0
9	10.6	13.9	9.8	61.8	82.0	44.0	35.8	18.0	56.0	0.0	1.0	0
10	14.9	14.5	8.5	45.0	77.8	30.5	55.0	20.8	69.5	0.0	1.5	0
11	11.1	14.4	10.7	39.6	78.2	39.5	60.4	20.8	59.5	0.0	1.3	0
12	15.0***	14.4	8.0	46.6	74.2	44.0	53.4	25.0	56.0	0.0	2.0	0
13	13.8	11.1	9.0	55.0	72.0	49.5	45.0	27.8	50.5	0.0	1.0	0
14	12.1	11.9	11.6	69.2	52.0	69.5	29.6	47.8	29.0	1.5	1.0	0
15	16.0	11.7	11.9	80.6	56.8	74.8	18.6	42.2	18.5	2.0	1.5	0

* Mean of pre-infected readings; ** one of the sheep in the group aborted; *** one of the sheep gave birth to a premature lamb.

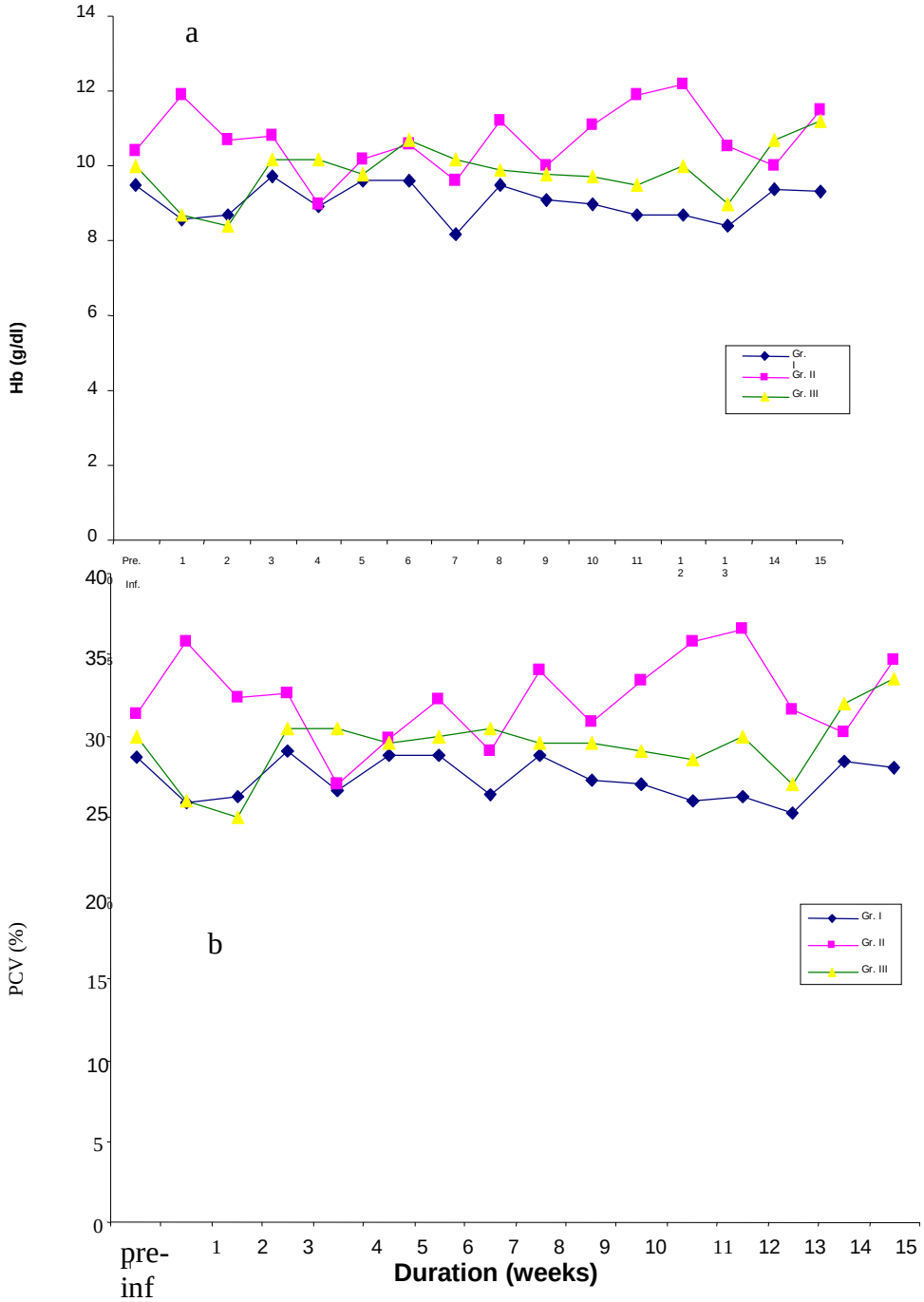


Figure 4.7: (a). Changes in mean Hb levels; (b).Changes in mean PCV levels of *H. longitipes* (Gr. I), *H. placei* (Gr. II) infected and uninfected Yankasa sheep (Gr. III).

4.2.4 Post mortem findings

4.2.4.1 Parasitological findings

An average of two immature and sixty adult worms were recovered from the abomasa of the sheep in Group II at necropsy. Out of the total adult worms recovered, 80 (26.67%) were identified to be males (Table 4.18).

Relatively lower number (36) of adult worms (on the average) was recovered from the abomasum of sheep in Group I at post mortem. 126 (70.00%) of the worms recovered were males. Few immature worms (larval stages) were seen after pepsin digestion of the abomasal scrapings (Table 4.19).

Table 4.20 shows a comparison between pre-infection and post – infection mean lengths of adult *H. longistipes* and *H. placei* recovered from infected Yankasa sheep. Post-infection mean lengths of both male and female *H. longistipes* were shorter than the pre-infection mean lengths. Male *H. longistipes* were shorter in length from a mean length of 23.8mm ± 0.18mm to 17.0mm ± 0.78mm, while in females, the pre-infection mean length was 34.7mm ± 0.41mm while the post-infection mean length was 19.4mm ± 1.99mm, indicating a highly significant difference between the mean lengths ($P<0.001$).

Similarly, for *H. placei* males, there was a significant difference between the pre-infection mean length of 16.5mm ± 0.34mm and the post-infection mean lenght of 14.3mm ± 0.77mm at the end, at fifteen weeks ($P<0.05$). This however, was not the case with female *H. placei*, as the pre-infection mean lengths (24.8mm ± 0.25mm) of worms was not significantly different from the post infection mean lengths (24.2mm ± 0.58mm) ($P>0.05$).

Table 4.18. Worm recovery in experimentally *H. placei* – infected Yankasa sheep.

	----------Larvae----------			----------Adult----------			
Sheep Id.	Infective dose (L_3)	No. recovered*	% recovery	No. recovered* ♂	No. recovered* ♀	Total	% recovery
8	5000	3	0.06	4	11	15	0.30
9	5000	2	0.04	4	12	16	0.32
10	5000	1	0.02	6	15	21	0.42
11	5000	0	0.00	63	175	238	4.76
12	5000	4	0.08	3	07	10	0.20

* At Post mortem

Table 4.19. Worm recovery in experimentally *H. longistipes* – infected Yankasa sheep.

	----------Larvae----------			----------Adult----------			
Sheep Id.	Infective dose (L_3)	No. recovered*	% recovery	No. recovered* ♂	No. recovered* ♀	Total	% recovery
1	5000	10	0.20	3	0	3	0.06
2	5000	3	0.06	10	5	15	0.03
3	5000	0	0.00	32	14	46	0.92
4	5000	5	0.10	5	3	8	0.16
5	5000	0	0.00	76	32	108	2.16

*At Post mortem

Table 4.20. Comparison between pre-infection and post - infection mean lengths of *H. longistipes* and *H. placei* recovered from experimentally infected Yankasa sheep.

Parasite	Sex	Period (Pre-i and Pi)*	mean length (mm) ± SEM	Range	P-value
H. longistipes	M	Pre-i	23.8 ± 0.18	19 -28	
		Pi	17.0 ± 0.78	14 -20	0.0001
	F	Pre-i	34.7 ± 0.41	25 -43	
		Pi	19.4 ± 1.99	12 -30	0.0001
H. placei	M	Pre-i	16.5 ± 0.34	13 -19	
		Pi	14.3 ± 0.77	12 -18	0.0042
	F	Pre-i	24.8 ± 0.25	23 -27	
		Pi	24.2 ± 0.58	21 -30	0.3492

* Pre-i =Pre –infection, Pi =Post- infection.

4.2.4.2 Gross pathology

At necropsy in the fifteenth week post infection, the heart, liver, spleen, kidneys, lungs and mesenteric lymph nodes of the sheep in all the three groups appeared normal grossly (Plates XVII a - c). However, the abomasa of the sheep in Groups I and II had numerous red pin head size lesions which might have been the attachment points of the worms (Plates XVIII -XIX).

4.2.4.3 Histopathology

No histopathological changes were observed in tissue sections made from the heart, liver, spleen, kidneys and mesenteric lymph nodes of the sheep in all the three groups. However, significant lesions were seen in tissue sections made from abomasae of the sheep in Groups I and II. Main lesions observed in the sheep of both groups included cellular infiltration of the mucosa and sub - mucosa by inflammatory cells inaddition to epithelial necrosis (Plates XX – XXI).

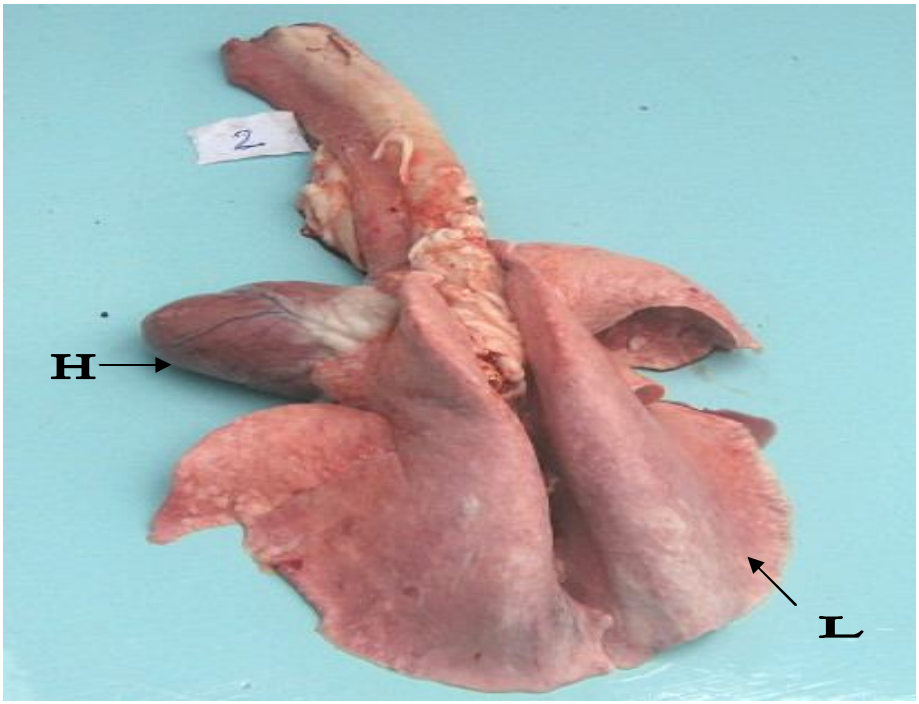


Plate XVII: (a). Normal Heart and lungs of *H. longistipes* infected sheep.

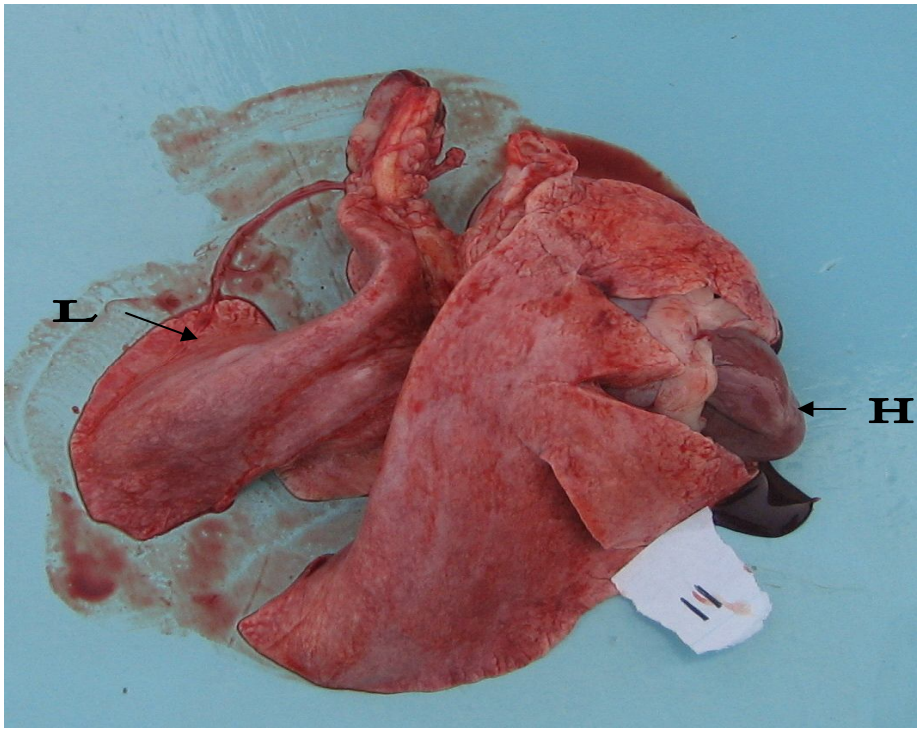


Plate XVII: (b). Normal Heart and lungs of *H. placei* infected sheep.

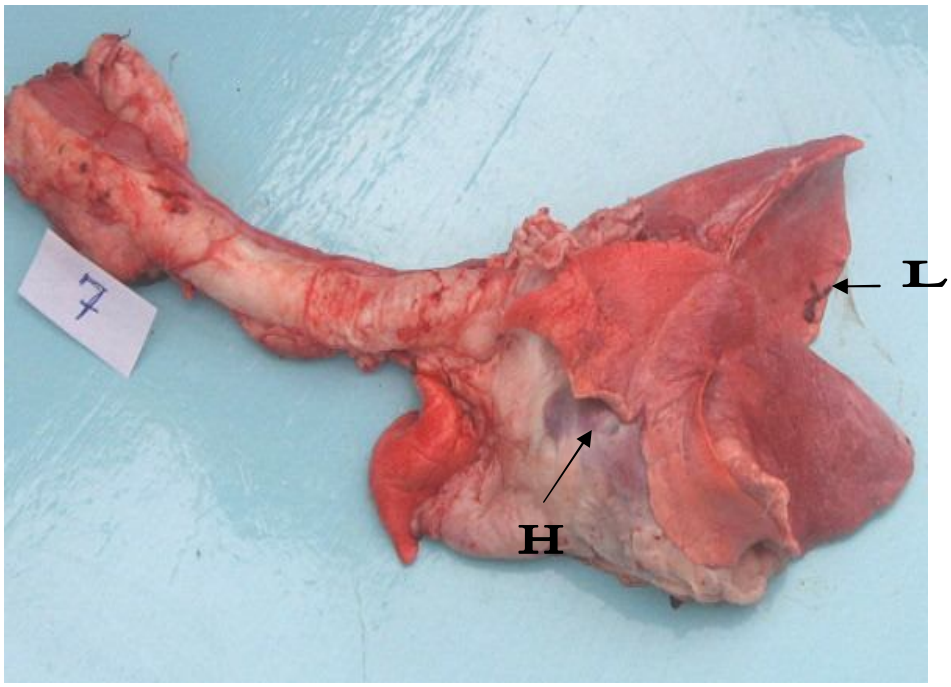


Plate XVII: (c). Normal Heart and lungs of uninfected sheep (Control).



Plate XVIII: Abomasum of *H. longistipes* - infected sheep showing gross abomasal lesions.

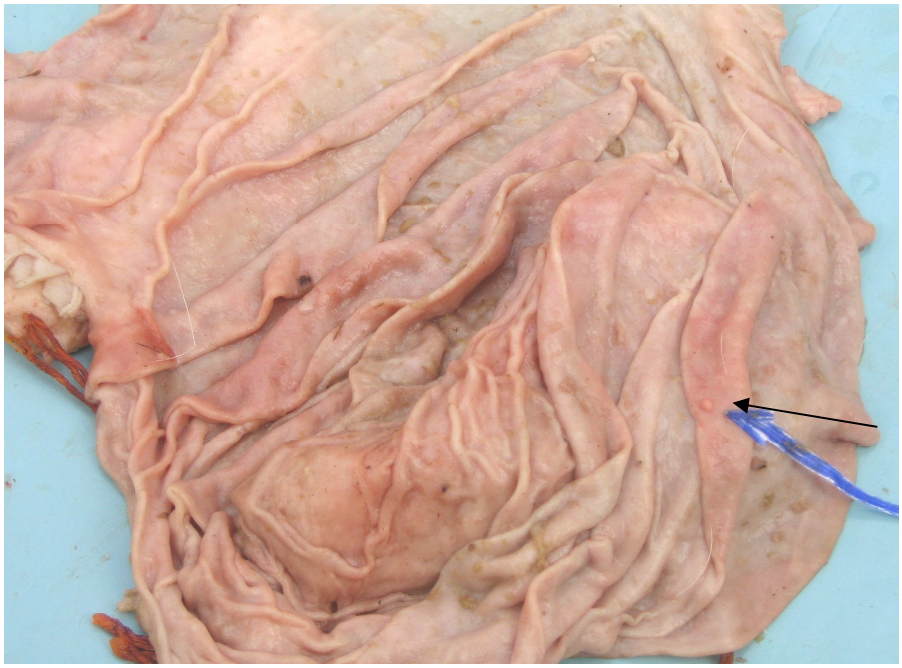


Plate XIX: Abomasum of *H. placei* - infected sheep showing gross abomasal lesions.

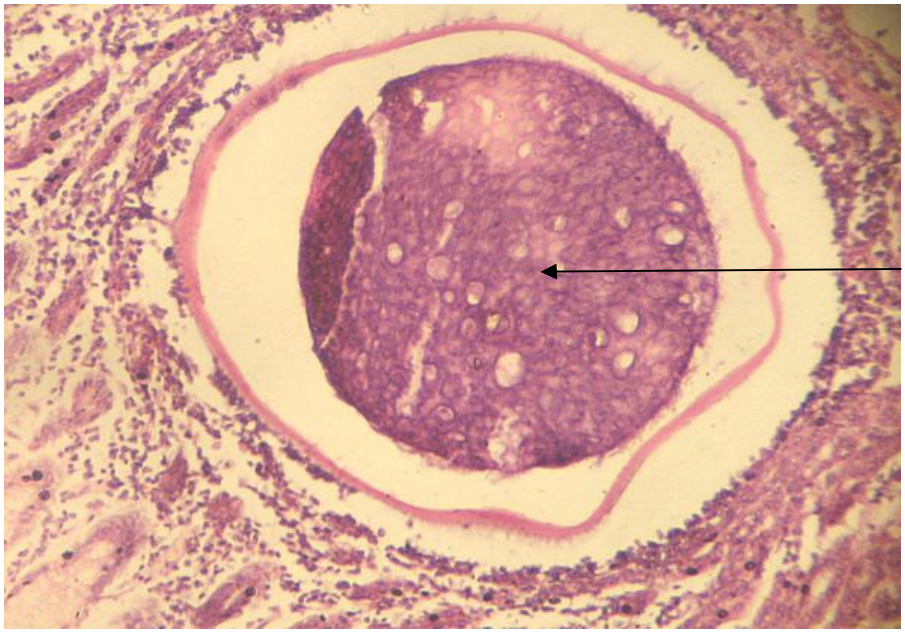


Plate XX: Section of *H. longistipes* worm in the mucosa surrounded by a zone of inflammatory cells. (mag: x1000)

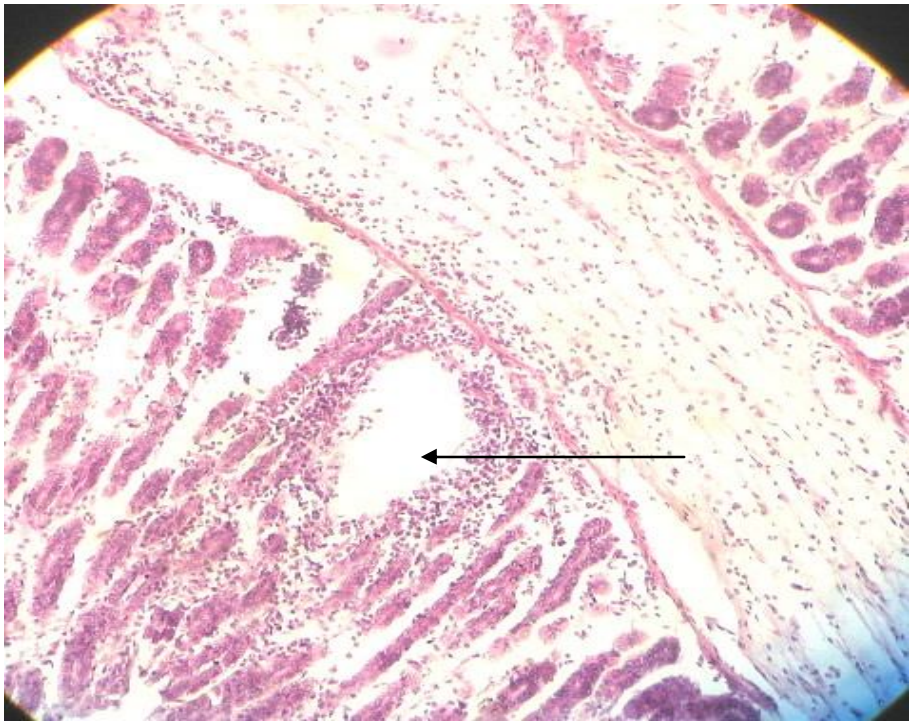


Plate XXI: Parasitic tract of *H. placei* surrounded by zone of inflammatory cells. (mag. x1000)

CHAPTER FIVE

DISCUSSION

Out of the 558 GITs of camels examined at Kano, Katsina and Zamfara State abattoirs, 28.14% were found to harbour helminths. The helminths recorded were: *H. longistipes* (54.12%), *T. globulosa* (46.59%), *O. venulosum* (13.62%), *M. benedeni* (14.87%) and least were *S. vittata* (12.07%). Several nematodes (*Trichostrongylus* spp. *Impalaia tuberculata*, *Strongyloides* spp., *Camelostrongylus mentulatus*, C*ooperia* spp., *Ostertagia* spp., *Chabertia ovina*, *Nematodirus* spp. and *Bunostomum* spp.) and cestode (*Avitellina* spp. and *Moniezia expansa*) recorded in camels in Kenya by Mukhwana and Mitema (1995), in Pakistan by Anwar and Khan (1998), in Jordan by Sharrif *et al.* (1998), and in Ethiopia by Bekele (2002) were not encountered in the present study. Inaddition, the overall prevalence (28.14%) of the helminths recorded in the present study is relatively lower than those (69.10% - 75.00%) reported by these authors. This present observation is not surprising considering the fact that the epidemiology of gastrointestinal helminths varies in different localities, depending on the local climate, season and management practices (Hansen and Perry, 1994).

Animals such as insects, birds and mammals use plant parts with secondary compounds to improve their comfort and health (Krief e*t al.,* 2005). Some of these plant species have actual or putative bioactivities likely to offer anti-parasitic benefits. Huffman *et al.* (1996) reported the expulsion of live adult worms of *Oesophagostomum* species by chimpanzees after a diet of rough leaves of *Aspilia* species. However, the feeding habits of camels are remarkable. Camels are reported to feed on a variety of plant species (Finlayson, 1952; Schwartz *et al.,* 1983; Mohammed and Hoffmann, 2006). Some of these plants have significant anthelmintic and anti-protozoal properties and are used by local practitioners in the treatment of such diseases in humans and in animals (ITDG and IIRR, 1996; Githiori, 2004).

For instance, the neem plant (*Azadirachta indica*) which is intolerably bitter is well devoured by camels, and it is well known for its anthelmintic, antiprotozoal and antipyretic properties.

In an experiment to determine the efficacy of neem (*A. indica*) for the control of GIT helminths in small ruminants in Malaysia, Nor Fasihah *et al.* (2002) reported 65% and 85% reduction in faecal egg counts (FEC) and total number of worms recovered at post mortem respectively in neem - treated sheep. Similarly, Chandrawathani *et al.* (2000) and Chandrawathani *et al.*

(2002) reported significantly lower FEC and adult worm recovery in nematode infected sheep after having been fed on neem plant for a month.

The absence in this present study, of many helminth species that had been reported in other countries could therefore be attributed to differences in the diversity of the local vegetation which serve as source of food and also therapeutic to these camels. Neem plants are grown in the arid and semi-arid parts of Nigeria to serve as wind break. These plants, among many others serve as feed to the animals.

With the exception of *O. venulosum* which seemed to be common in camels from Kano only, all the worms recorded were well represented in all the three States surveyed. *H. longistipes* and *T. globulosa* occurred in large numbers during the rainy season although their prevalence persisted throughout the year. Inaddition, the average worm burden per camel was significantly lower in the dry season ($P<0.05$). The significant seasonal disparities in population of *H. longistipes* in camels have been associated with hypobiosis exhibited by *Haemonchus* species as a survival strategy during harsh and unfavourable weather conditions (Bekele, 2002).

The major factors, however, that play a role in increasing the prevalence and worm burden of helminths in camels generally during the wet season is a favourable climatic condition which allows the development of the larval

stages in the external environment, and which also facilitates resumption of arrested development of the larvae within the host.

The low prevalence of helminths observed in the dry season could not also be unconnected to the lower moisture level characteristic of the dry season which generally is not favourable for larval development, thus reducing the infection rate.

The difference in prevalence rates of helminths in male and female camels in all the three States were not significantly different ($P>0.05$), although male camels were more infected. Bekele (2002) found a significantly higher helminth infection in female camels than in males and associated the discrepancy to the effect of age and stress of lactation and pregnancy which might have relaxed the immunity in the adult female.

However, the relatively high prevalence of helminths in male camels in this study could be due to increased subceptibility resulting from physiological stress and underfeeding caused by long working hours especially during periods of land preparation for agriculture.

Even though the prevalence rates of the helminths recorded in the three States did not vary significantly ($P>0.05$), there was a significant difference with regard to the average worm burden of nematode per infected camel in the States. This variation could be attributed to difference in local management

practices that may include wider use of anthelmintics, provision of food and clean drinking water and diseases. These management practices may vary from State to State, inaddition to other factors that may tend to favour the bionomics of these parasites. However, the prevalence and worm burden of cestodes in all the three States were generally low, irrespective of season and sex of camel. These parasites might not be a serious threat to camel production in these areas since the pathogenecity of *M. benedeni* and *S. vittata* is said to be minimal, although in heavy infestations may cause reduced weight gain and intestinal obstruction (Soulsby, 1982).

The survey of ecto-parasites on camels in the areas covered shows that ticks were the most common of all the ecto-parasites known to infest camels. Ticks identified (*Hyalomma dromedarii, Amblyomma variegatum* and *Rhipicephalus pravus*) were those commonly reported to occur on camels all over the world (Al-Rawashdeh *et al.,* 2000). However, *Hyalomma rufipes, Boophilus decoloratus* and *Hyalomma truncatum*, species reported to infest camels in Borno and Yobe States (James-Rugu and Jidayi, 2004) in North Eastern part of the country were not encountered in the present study.

Among the tick species identified, *H. dromedarii* was the most prevalent and most abundant in all the three States, accounting for 70.19% of the total number of adult ticks collected. This finding confirms the results of earlier

investigations (Rutagwenda and Munyua, 1984; Dia, 2006). *H. dromedarii* is known to be camel – specific, but it may attach to cattle or sheep as alternative host in the absence of camels. Although ticks do not play a major role in disease transmission in camels, *H. dromedarii* has been associated with out breaks of pasteurellosis (Wilson, 1998).

A. variegatum, a tick commonly found to infest cattle, sheep and goats was the next most prevalent tick on camels in the study area. The prevalence of *A. variegatum* on camels was higher in Kano than in Katsina or in Zamfara States. This could be as a result of mixed grazing of livestock, rotational grazing between sheep, goats, cattle and camels which favours transmission of larval stages. Inaddition, transportation of different livestock in the same truck could be a pre-disposing factor for the exchange of ticks.

R. pravus, the third tick species identified on camels in the zone is less prevalent than the two genera of *Amblyomma* and *Hyalomma*. In all the three States, the prevalence of these ticks was generally low irrespective of the season of the year. However, prevalence of all the tick species recorded on camels was highest during the rainy season. Osman *et al*. (1982) observed a marked seasonal variation in nine species of ticks infesting cattle, sheep, goats and camels in the ecological zone of Kordofan region of the Sudan. Similarly, Kaiser *et al*. (1991) reported a strong seasonal incidence of *R. appendiculatus*

and *A. variegatum* on camels in northern Uganda, an area of monomodal rainfall with a definite hot dry season.

The high prevalences of *H. dromedarii, A. variegatum* and *R. pravus* observed during the wet season, relative to the dry season in the three States was probably due to the high relative humidity and optimum temperature that occurred during the season. Wet seasons in Nigeria are periods of abundant vegetation, moisture and moderate temperature which usually favour the survival of the larval stages of ticks and also enhance easy attachment of the larval stages to the host. These, however, contrast the dry season especially in the semi-arid and arid parts of the country where the study was conducted. The dry seasons are characterized by unfavourable weather such as extremely high temperatures, low humidity, harsh and dry environment which do not allow larval survival. Other factors that could also be responsible for the low prevalence of the various species include hand picking by herdsmen since they are less busy during the dry season, increased activities of predatory birds (ox-pecker, cattle egrets) due to the fact that insects which serve as alternative food source are less abundant during the dry season. These factors no doubt could significantly reduce tick population during the dry season.

Although the main influences over tick proliferation have been identified as level of relative humidity of the atmosphere and air temperature, different

tick species have peculiar micro-climate requirements which tend to result in varied peaking periods for different tick species (Hunter, 1994). *H. dromedarii* and *A. variegatum* peaked during periods of high rainfall while *R. pravus* had peak prevalence between September and October which coincides with end of rainy season in the area studied.

The relative proportions of male and female ticks of all the species identified in the present study revealed that adults of *H. dromedarii*, *A. variegatum* and *R. pravus* had a surplus of male than female ticks. Similar observations were reported by Rutagwenda and Munyua (1984) in northern Kenya. The disparity in population between male and female ticks could be due to the fact that male ticks stay much longer than female ticks on the host since female ticks drop off after engorgement to lay eggs and die in order to continue the life cycle (Wilson, 1998).

Immature stages (larvae and nymphs) of *H. dromedarii, A. variegatum* and *R. pravus* on the other hand were absent on camels in Kano but were observed in Katsina and Zamfara States. Peak prevalence of the immature stages tends to coincide with wet season in all the States they occur on camels. This period happens to be a period of high tick proliferation and infestation. The presence of the immature stages on camels in Katsina and Zamfara States may also present a serious problem to camel production. The various stages of

these ticks are reported to remove large amount of blood (depending on species) from their host thereby causing anaemia (Soulsby, 1982).

Similarly, highest mean tick load of the various tick species reflects the peak infestation periods of the various ticks identified which occur in the rainy season. These heavy tick loads which occur during the wet season will significantly affect camel production in the areas and, to some extent, other livestock species. This is because conventional methods of tick control with the host dipped or sprayed with water borne acaricide will obviously be difficult with camels, considering the level of awareness of the herdsmen and the extent to which other livestock species serve as alternative hosts to these ticks.

Another ecto-parasite found to infest camel population in one of the study areas was mite. Mite infestation is one of the most important camel diseases after trypanosomosis (Surra) (Mukasa-Mugerwa, 1981). The disease is highly contagious, affecting animals of all ages and sexes. It can also be spread easily to herdsmen and others associated with infected animals (Mukasa-Mugerwa, 1981).

The economic impact of mite infestation results from the intense anxiety associated with pruritis, causing poor weight or weight loss and reduced ability to work (Al-Rawashdeh *et al,* 2000).

There are two genera known to cause mange in camels. These are *Sarcoptes* (Mukasa-Mugerwa, 1981; Wilson, 1998), and *Psoroptes* (Bates, 1999 cited by Colebrook and Wall, 2004). However, the mite detected in the present study and for the first time infesting camels in Nigeria was *Demodex folliculorum var. cameli*. These parasites are specialized group of parasitic mites which live in hair follicles and sebaceous glands of their host, causing follicular mange (Soulsby, 1982).

Like in sarcoptic mange, follicular mange results in loss of hair, thickening and wrinkling of the skin, which becomes scaly and itchy.

Although the life cycle of *Demodex folliculorum var. cameli* is not known (Soulsby, 1982), the parasite may be of public health significance considering the fact that it can be transmitted to man.

Of major significance is the presence of protozoan parasites in the camels surveyed. One of the protozoan parasites identified in the study areas was *Trypanosoma evansi*, the main cause of trypanosomosis (Surra) in camels. Surra is a disease condition of major importance in camel production in different parts of the world, especially in Africa and Asia (Radostits *et al.*, 1994). The trypanosomes are inoculated into the host from the contaminated mouth parts of biting flies or the saliva of vampire bats. They multiply in the blood and body fluid causing anaemia.

The prevalence of *T. evansi* recorded in camels at Kano (9.22%), Katsina (3.95%) and Zamfara (3.43%) were not very different from that recorded by Falope (1991) in Kaduna. However, the relatively low prevalence not withstanding, the presence of *T. evansi* in the present study is of major concern and gives a reason for the need to study the situation of the disease in the areas considering the fact that other animals such as horses and wild animals are susceptable and can therefore serve as reservoir hosts. Inaddition, the prevalence might be an under estimation of the true situation in the areas considering the low parasitaemia associated with *T. evansi* which makes it difficult for any parasitological technique (including the one used in the present study) to be totally effective in identifying all infected animals (Luckins and Dwinger, 2004; Singh *et al.*, 2004). Serology, which is said to be very sensitive, has its own impediments as it is difficult to distinguish between active infections and past infections. Nevertheless, the data obtained from the present investigation is of signifinance as it provides considerable evidence for the presence of camel trypanosomosis in the study areas.

Delafosse and Doutoum (2004) observed that the longitude of pasture in the dry season was a major risk factor in *T. evansi* infection. This is because the favourable sites for transmission of *T. evansi* are those that facilitate high

concentrations of both animals and vectors such as the presence of water and pasture.

In all the three States, camels are bought from local camel markets in villages or in some cases imported from neghbouring countries in large numbers. They are kept close to the abattoirs or in homes as beast of burden, and are usually taken out daily for grazing in order to save the cost of up – keep. This practice of extensive management among several other factors could have been responsible for the pockets of infections observed during the drier months of the year when water tend to be scarce resulting in the tendency of animals to aggregate at the few available watering spots after grazing for the day. However, peak prevalence of *T. evansi* recorded in Kano (23.53%), Katsina (21.43%) and Zamfara (20.00%) is in agreement with those reported by many authors who identified period of peak prevalences during or immediately after the rainy season when there is increase in population of biting flies (Radostits *et al*., 1994).

In the three States, the prevalence of *T. evansi* in male and female camels were not significantly different ($P>0.05$). This is in conformity with results of Dia *et al.* (1997) and Njiru *et al.* (2004).

Other protozoa detected in one of the study areas and which are of economic significance to camel production were Coccidia.

Coccidiosis is more debilitating in young calves and the severity of the disease depends on the level of infection (Hunter, 1994). Chineme (1980) reported gross and histopathologic lesions in a 5-year old male camel in Nigeria. Histologically, giant schizonts in various stages of development were seen in the lamina propria of the jejunum.

The light infection observed in the present study could be due to the age of the camels as most of them were adults. According to Soulsby (1982), coccidia infections are self - limiting and sexual reproduction does not continue indefinitely. In repeated infection, the host may develop immunity, one of the effects of which is reduced biotic potential of the coccidium. Whereas an initial infection may produce a large number of oocysts, as immunity supervenes, the life cycle is progressively inhibited, so that only a few oocysts may be produced as seen in the present study.

Although the infection recorded was light, the camels could serve as reservoir of coccidia and possibly serve as source of environmental contamination, the overall effect of which will be felt when young and old animals congregate in yards after grazing during rainy season or at watering spots during dry seasons, thus culminating in an out break of clinical coccidiosis among herds.

The experimental infection of Yankasa sheep with *H. longistipes* and *H. placei* gave an insight to some features of *Haemonchus* infection. It has been noted that the most prominent characteristics of chronic haemonchosis are progressive anaemia and weight loss (Radostits *et al.*, 1994). Anaemia results with the commencement of the fourth stage larvae (L_4) which are voracious blood suckers (Soulsby, 1982). The decrease in PCV and Hb levels relative to pre-infection levels in Group I is an indication of the continuous blood letting activity of the larval and adult stages of *H. longistipes* and the loss of iron required for Hb formation.

Repression of growth and development of larval stages, and the inhibition of egg production by adult female worms as seen in *H. longistipes* in the present study have been considered as some of the responses of the host against intestinal helminth infections (Wakelin, 1994). The observed low egg output, worm burden and reduced size of worms recovered at post mortem in sheep of Group I infected with *H. longistipes* confirm earlier reports of Elbihari *et al*. (1984). Similarly, the successful establishment of *H. placei* in sheep is in line with findings of Jacquiet *et al*. (1998).

However, the continuous decrease in weight observed in sheep of Group I could be due to interference with abomasal functions of *H. longistipes* - infected sheep which ultimately affect assimilation of nutrients. Singh *et al.*

(1993) observed loss of body weight in goats experimentally infected with *H. longistipes*.

Of significance, however, was the observation in the present study of the continuous increase in weight, PCV and Hb levels relative to pre-infection levels in sheep in Group II infected with *H. placei* 2 weeks after the prepatent period on day 15. This could be that, the population of sheep used for the study had previous exposure to *H. placei* under natural conditions and therefore have developed premunity, resulting in only mild or subclinical infection; or probably the loss of blood which usually correlates roughly to the intensity of the worm burden was compensated for with adequate intake of iron, minerals and protein in the diet. These could also explain the increase in weight observed in sheep of this group in spite of the infection.

Schalm (1965) cited Grunsell (1955) as observing a significant association between lower erythrocyte counts and a rise in worm burden during the late winter and early spring when nutrients are scarce contrary to a period of nutritional abundance, suggesting that a high level of nutrient may partly offset the effect of worm burden. Similarly, Giltner (1907) cited by Schalm (1965) reported low haemoglobin levels and red cell counts in parasite - infected sheep, and asserted that effects of parasitism were partially overcome by providing a more generous and easily digestable ration.

The high values of lymphocytes recorded in the infected groups are to be expected. In helminth infections in man and animals, a complex set of specific immune mechanisms are usually initiated which include elements of cell-mediated and antibody - dependent immunity against the worms and their products (Pritchard, 1987; Smyth, 1994). Antibodies, in particular local IgA, IgE and to a lesser extent IgG, have been reported to play a significant role in *H. contortus* - infected sheep (Schallig, 2000).

The essential process in the manufacture of these antibodies is the mitotic proliferation of a particular family (clone) of lymphocytes with the inherited capability to respond to a particular antigen by both proliferating and synthesizing the specific antibody reacting with that antigen. These antibodies – forming clones make up the B-lymphocytes and they act in the presence of a second population of lymphocyte cells (T-lymphocytes) which generally are regarded as helper cells.

It is therefore not surprising that the lymphocyte levels in sheep in both Groups I and II rose significantly during the experimental period considering their role in antibody - dependent immunity in parasitic infections. Arzoun *et al.* (1983) also reported an elevated level of lymphocytes in goats experimentally infected with *H. longistipes*.

Another important feature observed in the study was the degree of damage caused in infected sheep of Groups I and II. Although the sheep in Group II did not show much clinical signs of the infection, gross and histologic tissue sections revealed some level of damage. This however confirms that infection with intestinal worms may cause a variety of pathologic changes in the mucosa, some of which may reflect physical and chemical damage to tissues; others may result from immunopathologic responses.

Gross pathologic lesions observed on the abomasum of the sheep in Groups I and II were as a result of physical attachment points of the adult worms. Inaddition, the histologic tissue sections revealed diffused infiltration of the mucosa and submucosa by inflammatory cells with some degree of epithelial necrosis. Inflammation in animals involves the application of the vascular and cellular response to the presence of an irritant with the aim of destroying and removing it, thus preventing additional injury and spread of the irritant to other parts of the body, and also to repair the damage created by the irritant and restore the body to normalcy (Runnells *et al.,* 1965).

Wakelin (1994) observed in both sheep and guinea pigs a correlation between levels of genetically determined resistance to infection with *H. contortus* and *T. columbriformis*, and the infiltration of the mucosa by inflammatory cells. He concluded that immune – mediated inflammatory

mechanisms have some role to play in *H. contortus* and *T. columbriformis* infections.

It is therefore possible that the host's responses (presence of inflammatory cells) observed in the sheep in Groups I and II could be as a result of the pressure exerted on the tissue by the presence of the worm or probably as a result of the Secretory-Excretory antigens of the worms which might have evoked immunologic response in the host as suggested by Lightowlers and Rickard (1988).

CHAPTER SIX

Summary

Five hundred and fifty eight (558) gastro-intestinal tracts were collected from slaughtered camels at Kano, Katsina and Gusau (Zamfara State) abattoirs. Out of this number, 28.14% were found to be infected by one or more helminth parasites. *H. longistipes* had the highest prevalence of 54.12%, followed by *T. globulosa* (46.59%) and *O. venulosum* (13.62%). Others were *M. benedeni* (14.87%) and *S. vittata* (12.07%). Highest prevalence of these helminths was recorded during the rainy season. No significant difference was, however, observed in the rate of infection by the various helminths with respect to sex of camel (P>0.05).

In addition, ticks encountered were *H. dromedarii*, *A. variegatum* and *R. pravus* with prevalences of 58.06%, 31.36% and 21.33% respectively. *H. dromedarii* accounted for 70.19% of total ticks collected in all the three States studied. Highest rate (68.77%) of infestation by all three species of ticks was recorded during the wet season while only 31.23% occurred in the dry season. Infestation in male and female camels was not found to be significantly different (P>0.05). However, male ticks were found to be more on the camels than female ticks.

T. evansi and *E. dromedarii* were the only two protozoan parasites detected in camels in the areas of study with 5.73% (32/558) of the total blood samples examined from camels at Kano, Katsina and Zamfara States found to be infected while the oocysts of *E. dromedarii* were detected in 4.30% (24/558) of the faecal samples examined.

An analysis of haematological data of sheep in Groups I and II experimentally infected with *H. longistipes* and *H. placei* indicated decreased weight, PCV and Hb levels in sheep in Group I while these indices had increased values in the sheep in Groups II and III. However, an elevated lymphocyte level was observed in the sheep in Groups I and II. These indices were relatively stable in the uninfected control group.

At post mortem, worms recovered were few. Inaddition the post-infective mean length of worms was relatively shorter than the pre-infective mean length.

Conclusion

This study on parasites of camels in Kano, Katsina and Zamfara States all in the Sudan Savannah Zone of Nigeria has shown that:

T. evansi could be of major importance in the study areas as a limiting factor to successful production of camels.

Gastrointestinal parasites and tick infestation are major problems of camels in the areas of study.

Yankasa sheep are partially susceptible to both *H. longistipes* and *H. placei* infection. Inaddition, *H. longistipes* seems to cause more pathologic damage than *H. placei* in infected sheep.

Sheep may serve as reservoir hosts for *H. longistipes* and *H. placei* since camels are often herded with sheep.

Recommendations

The following are recommended:

- The provision of trypanocides, acaricides and anthelmintics would seem a prerequisite for improving milk and meat production as well as improving the draught and baggage performance of camels. Government can achieve this through the provision of veterinary services in strategic areas where camels are kept and also awareness campaigns.
- Movement of camels and other livestock across boarders should be properly monitored by the appropriate agency backed by legislation to avoid importation of parasites and other diseases from neighbouring countries that might be of veterinary and public health significance.

- A study of ox-pecker birds as a possible mechanical transmitter of *T. evansi* could be useful in the development of a strategy for management of camel trypanosomosis in the camel breeding areas of Nigeria considering the feeding habit of these birds.

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APPENDIX A: Survey data collected from Camels in abattoirs at Kano, Katsina and Zamfara States.

Month: January State: Kano

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii.*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	30	-ve	-	-	-	07	04	-	-	-	-	950	1800	400	300	-	-	-	-
2.	F	28	“	04	03	-	05	04	-	03	07	-	1000	2100	100	100	120	130	1	1
3.	M	32	“	03	02	-	09	03	-	-	-	-	740	220	300	200	-	-	-	-
4.	F	34	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	M	29	“	04	02	-	05	03	-	04	08	-	1500	3900	200	100	100	60	-	-
6.	M	30	“	04	03	-	06	04	-	03	04	-	1100	3000	-	-	200	180	-	-
7.	M	30	“	02	04	-	07	05	-	-	-	-	-	-	50	80	-	-	-	-
8.	F	27	“	01	03	-	07	04	-	02	07	-	1400	2900	200	150	130	110	-	1
9.	M	36	“	-	-	-	-	-	-	-	-	-	-	-	-	-	70	50	-	-
10.	M	35	-ve	-	-	-	-	-	-	-	-	-	-	-	500	300	100	100	-	-
11.	F	35	“	-	-	-	-	-	-	-	-	-	600	1600	180	130	-	-	-	-
12.	M	37	“	02	02	-	04	02	-	-	-	-	-	-	-	-	-	-	-	-
13.	M	38	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14.	M	40	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15.	F	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16.	F	38	“	-	-	-	-	-	-	-	-	-	10	30	-	-	-	-	-	-
17.	M	41	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18.	F	40	“	-	-	-	-	-	-	-	-	-	-	-	-	-	20	10	-	-
19.	M	35	-ve	-	-	-	-	-	-	-	-	-	50	120	10	30	30	20	-	-

Month: February State: Kano

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	33	-ve	-	-	-	-	-	-	-	-	-	500	900	30	10	-	-	-	-
2.	M	35	“	-	-	-	-	-	-	-	-	-	50	100	-	-	-	-	-	-
3.	M	40	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.	F	42	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	F	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6.	M	32	“	-	-	-	-	-	-	-	-	-	100	300	40	20	-	-	1	-
7.	F	37	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.	M	41	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	M	36	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10.	M	30	-ve	04	03	-	09	04	-	-	-	-	70	150	20	10	25	20	-	-
11.	F	42	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12.	F	36	“	-	-	-	-	-		04	08	-	-	-	-	-	-	-	-	-
13.	F	29	“	05	09	-	12	07	-	02	04	-	400	500	-	-	40	10	-	-
14.	M	33	“	-	-	-	07	06	-	05	03	-	60	170	-	-	-	-	-	-
15.	M	38	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16.	M	29	“	09	15	-	11	07	-	04	02	-	1000	1400	120	90	30	05	-	1
17.	F	30	“	07	06	-	12	06	-	04	03	-	700	900	80	50	-	-	-	-
18.	M	28	“	08	07	-	15	10	-	-	-	-	900	1800	50	80	20	12	-	1
19.	F	38	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Month: March State: Kano

S/no.	Sex	Pcv	T. *evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	30	-ve	04	01	-	08	04	-	-	-	-	90	120	40	300	-	-	-	1
2.	M	31	“	02	03	-	07	05	-	-	-	-	50	140	25	150	-	-	-	-
3.	F	15	“	08	07	-	15	05	-	-	-	-	1200	3000	20	40	50	40	1	2
4.	M	40	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	F	46	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6.	M	36	“	-	-	-	-	-	-	-	-	-	40	150	20	60	-	-	-	-
7.	M	30	-ve	04	03	-	10	07	-	-	-	-	30	470	40	100	-	-	-	-
8.	M	40	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	F	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10.	F	29	“	02	03	-	10	06	-	-	-	-	60	120	30	80	100	80	1	-
11.	F	33	“	-	-	-	08	05	-	-	-	-	-	-	50	90	-	-	-	-
12.	M	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13.	M	25	+ve	05	03	-	10	08	-	-	-	-	100	250	20	60	-	-	-	1
14.	M	30	“	-	-	-	-	-	-	-	-	-	-	-	-	-	30	20	-	-
15.	M	31	“	-	-	-	-	-	-	-	-	-	70	120	30	40	-	-	-	-
16.	F	34	“	-	-	-	-	-	-	-	-	-	-	-	10	20	-	-	-	-
17.	M	35	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Month: April State: Kano

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	45	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.	F	30	+ve	09	05	-	22	08	-	02	04	-	50	300	70	130	50	100	-	1
3.	M	39	-ve	-	-	-	-	-	-	-	-	-	20	140	10	40	-	-	-	-
4.	F	42	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	M	36	“	-	-	-	-	-	-	-	-	-	-	-	04	12	-	-	-	-
6.	M	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.	M	40	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.	F	37	“	-	-	-	-	-	-	-	-	-	10	60	30	80	20	30	-	-
9.	F	36	“	05	03	-	13	07	-	-	-	-	60	200	60	150	-	-	-	-
10.	M	34	+ve	-	-	-	08	04	-	05	03	-	90	140	20	40	30	40	-	-
11.	F	32	-ve	13	09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
12.	F	33	“	18	13	-	20	16	-	-	-	-	20	50	30	60	-	-	-	-
13.	F	34	“	-	-	-	-	-	-	-	-	-	50	130	-	-	30	20	-	-
14.	M	32	“	15	12	-	16	10	-	01	02	-	-	-	-	-	-	-	-	-
15.	F	30	+ve	10	08	-	20	18	-	-	-	-	40	120	40	160	20	60	1	-

Month: May State: Kano

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	32	+ve	13	08	-	18	15	-	-	-	-	80	950	180	200	100	160	-	-
2.	F	35	-ve	-	-	-	25	20	-	-	-	-	50	650	80	180	60	30	-	-
3.	M	37	“	-	-	-	-	-	-	08	05	-	-	-	-	-	-	-	-	-
4.	M	33	+ve	15	06	-	18	15	-	-	-	-	70	300	90	120	70	130	-	1
5.	F	34	“	18	10	-	15	08	-	-	-	-	100	500	40	90	20	10	-	-
6.	M	38	“	-	-	-	11	10	-	-	-	-	-	-	-	-	-	-	-	-
7.	M	37	+ve	07	05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.	M	32	-ve	-	-	-	04	05	-	-	-	-	90	250	70	130	50	120	1	-
9.	M	34	“	14	09	-	08	10	-	-	-	-	-	-	-	-	-	-	-	-
10.	F	38	“	-	-	-	-	-	-	10	08	-	-	-	-	-	-	-	-	-
11.	M	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12.	F	40	“	20	18	-	15	10	-	-	-	-	30	100	40	90	-	-	-	-
13.	F	41	“	18	12	-	-	-	-	05	02	-	-	-	-	-	-	-	-	-
14.	M	39	“	-	-	-	10	06	-	-	-	-	-	-	-	-	-	-	-	-
15.	F	37	-ve	-	-	-	17	09	-	-	-	-	-	-	-	-	-	-	-	-
16.	M	40	“	-	-	-	-	-	-	04	01	-	-	-	-	-	-	-	-	-
17.	M	42	“	-	-	-	13	10	-	-	-	-	20	40	-	-	10	20	-	-
18.	M	31	+ve	-	-	-	06	02	-	-	-	-	100	200	50	30	20	10	-	1
19.	M	36	-ve	-	-	-	-	-	-	-	-	-	120	300	80	50	40	30	-	-

Month: June State: Kano

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	30	-ve	-	-	-	25	20	-	05	04	-	90	1800	500	300	70	50	-	-
2.	M	35	“	20	05	-	18	15	-	-	-	-	-	-	100	200	-	-	-	-
3.	M	28	“	19	10	-	22	18	-	-	-	-	120	560	-	-	50	30	1	-
4.	F	36	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	M	39	“	-	-	-	-	-	-	08	03	-	-	-	-	-	-	-	-	-
6.	F	37	+ve	12	05	-	19	10	-	-	-	-	-	-	-	-	-	-	-	-
7.	F	35	-ve	-	-	-	08	05	-	06	05	-	50	120	-	-	-	-	-	-
8.	F	33	“	10	06	-	-	-	-	04	03	-	-	-	140	100	-	-	-	-
9.	M	32	+ve	-	-	-	22	10	-	-	-	-	90	450	600	350	150	70	-	-
10.	M	33	-ve	-	-	-	25	15	-	-	-	-	70	200	100	80	-	-	-	-
11.	M	35	“	22	12	-	18	10	-	-	-	-	-	-	-	-	-	-	-	-
12.	F	29	“	25	13	-	09	05	-	06	04	-	100	1200	800	500	30	20	1	-
13.	F	27	+ve	17	10	-	15	09	-	-	-	-	110	230	700	350	50	40	2	-
14.	F	39	-ve	-	-	-	-	-	-	06	03	-	-	-	-	-	-	-	-	-
15.	M	40	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16.	M	31	+ve	-	-	-	27	22	-	-	-	-	90	1300	1000	600	-	-	-	-
17.	F	32	-ve	16	10	-	21	12	-	05	02	-	80	300	650	400	100	80	-	-

Month: July State: Kano

S/no.	Sex	Pcv	T. *evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata.*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	25	+ve	08	05	-	17	05	-	05	02	-	80	1500	300	150	100	120	1	-
2.	M	27	-ve	06	03	-	30	22	-	-	-	-	70	1200	200	250	90	100	1	-
3.	M	30	“	07	04	-	25	15	-	-	-	-	60	750	250	200	50	80	-	-
4.	F	35	“	10	07	-	16	10	-	07	05	-	140	500	70	140	-	-	-	-
5.	F	30	+ve	08	04	-	17	12	-	04	03	-	120	2000	150	210	-	-	-	-
6.	M	40	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.	F	32	“	10	05	-	22	16	-	-	-	-	110	1400	180	270	80	160	-	-
8.	F	38	“	04	02	-	32	20	-	-	-	-	-	-	-	-	-	-	-	-
9.	F	40	“	05	03	-	26	18	-	-	-	-	-	-	60	180	120	200	-	-
10.	M	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11.	M	37	“	07	03	-	22	16	-	02	01	-	30	600	30	90	40	100	-	-
12.	M	33	“	09	05	-	15	10	-	-	-	-	50	800	70	220	70	130	-	-
13.	M	39	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14.	F	34	“	04	02	-	29	22	-	05	04	-	80	1200	90	60	20	50	-	-
15.	M	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16.	F	32	“	06	12	-	30	20	-	-	-	-	100	2000	100	50	60	200	1	-

Month: August State: Kano

S/no.	Sex	Pcv	T. *evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	38	-ve	15	10	-	20	18	-	-	-	-	2600	4500	500	200	-	-	-	-
2.	M	42	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.	F	40	“	10	08	-	-	-	-	09	05	-	-	-	-	-	150	130	-	-
4.	F	37	“	16	11	-	26	15	-	-	-	-	-	-	-	-	-	-	-	-
5.	M	35	“	-	-	-	29	20	-	05	03	-	1800	3500	360	220	100	50	-	-
6.	F	33	“	14	07	-	22	11	-	-	-	-	2900	5600	300	140	200	100	1	-
7.	M	38	“	13	06	-	24	17	-	-	-	-	-	-	-	-	-	-	-	-
8.	M	29	+ve	10	05	-	20	16	-	-	-	-	3800	7000	200	100	-	-	1	-
9.	F	34	-ve	-	-	-	18	10	-	06	02	-	3000	6500	400	250	210	150	-	-
10.	F	36	“	-	-	-	25	13	-	-	-	-	1800	3100	-	-	-	-	-	-
11.	M	30	“	-	-	-	36	18	-	-	-	-	3400	6100	230	110	270	180	1	-
12.	F	38	“	07	04	-	19	14	-	-	-	-	-	-	-	-	-	-	-	-
13.	F	39	“	-	-	-	20	09	-	10	06	-	-	-	-	-	-	-	-	-
14.	M	37	“	09	04	-	-	-	-	-	-	-	300	800	40	30	50	20	-	-
15.	M	41	“	04	03	-	-	-	-	02	01	-	-	-	-	-	-	-	-	-
16.	F	36	“	-	-	-	24	13	-	-	-	-	2000	4200	100	70	-	-	-	-
17.	F	31	-ve	-	-	-	23	15	-	-	-	-	3600	6500	300	150	200	120	1	-

Month: September State: Kano

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	34	-ve	10	02	-	20	14	-	-	-	-	4600	6200	200	90	-	-	-	-
2.	F	38	“	15	08	-	15	08	-	-	-	-	-	-	-	-	-	-	-	-
3.	F	41	“	-	-	-	-	-	-	08	05	-	-	-	-	-	-	-	-	-
4.	M	37	“	16	05	-	16	10	-	-	-	-	1000	3000	-	-	30	20	-	-
5.	M	33	“	25	22	-	15	12	-	-	-	-	4100	6500	-	-	-	-	-	-
6.	F	29	+ve	15	09	-	20	10	-	-	-	-	3500	5800	350	120	300	250	1	-
7.	M	32	“	-	-	-	-	-	-	10	06	-	4200	5200	100	50	-	-	-	-
8.	M	28	+ve	20	10	-	22	15	-	-	-	-	3900	6100	300	140	350	300	1	-
9.	F	35	-ve	-	-	-	17	08	-	-	-	-	-	-	-	-	-	-	-	-
10.	F	31	“	18	07	-	16	13	-	-	-	-	3300	5000	320	150	310	290	1	-
11.	M	39	“	-	-	-	20	12	-	-	-	-	-	-	-	-	-	-	-	-
13.	M	35	“	15	06	-	26	16	-	03	01	-	4000	5100	-	-	-	-	-	-
14.	F	40	“	-	-	-	-	-	-	-	-	-	-	-	-	-	280	200	-	-
15.	F	35	“	-	-	-	21	17	-	07	04	-	2700	3400	500	300	-	-	-	-
16.	M	34	“	-	-	-	-	-	-	-	-	-	1800	3600	-	-	-	-	-	-
17.	M	33	-ve	23	15	-	25	13	-	-	-	-	3700	4900	210	140	190	100	-	-

Month: October State: Kano

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	34	-ve	10	05	-	25	18	-	-	-	-	2900	5400	300	210	200	210	-	-
2.	F	37	“	15	07	-	24	11	-	-	-	-	-	-	-	-	100	70	-	-
3.	M	36	“	10	06	-	18	12	-	05	02	-	3000	4000	-	-	-	-	1	-
4.	M	33	“	-	-	-	21	14	-	07	04	-	3500	4900	-	-	-	-	-	-
5.	F	35	“	-	-	-	17	09	-	10	07	-	2700	5800	-	-	300	150	-	-
6.	M	32	+ve	-	-	-	20	12	-	-	-	-	3700	6000	290	250	350	270	-	1
7.	F	40	-ve	18	10	-	22	09	-	-	-	-	-	-	-	-	-	-	-	-
8.	F	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	M	31	“	-	-	-	20	15	-	02	01	-	3600	5700	270	200	310	230	1	-
10.	M	34	“	-	-	-	-	-	-	-	-	-	2200	4600	-	-	150	100	-	-
11.	M	36	“	07	04	-	16	06	-	-	-	-	-	-	-	-	-	-	-	-
12.	F	37	-ve	13	11	-	15	08	-	-	-	-	-	-	-	-	-	-	-	-
13.	M	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14.	M	30	“	09	05	-	18	13	-	01	-	-	4200	5900	310	270	280	190	1	-
15.	F	33	“	12	07	-	16	10	-	-	-	-	3800	5100	270	200	350	220	-	-
16.	M	32	“	-	-	-	19	07	-	10	04	-	3400	5200	250	150	300	200	-	-
17.	F	35	-ve	11	08	-	18	14	-	08	05	-	2500	4800	400	260	190	100	-	-

Month: November State: Kano

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	30	-ve	04	06	-	10	09	-	-	-	-	3800	5700	200	150	-	-	1	-
2.	M	35	“	-	-	-	12	06	-	-	-	-	2400	3800	-	-	-	-	-	-
3.	M	27	+ve	07	04	-	16	08	-	-	-	-	-	-	80	30	-	-	1	1
4.	M	36	-ve	-	-	-	-	-	-	02	01	-	4200	7000	-	-	380	300	-	-
5.	F	37	“	-	-	-	-	-	-	-	-	-	-	-	290	120	-	-	-	-
6.	F	33	“	-	-	-	25	19	-	-	-	-	3200	4100	500	300	-	-	-	-
7.	M	38	“	-	-	-	-	-	-	-	-	-	1500	2400	100	50	100	40	-	-
8.	F	34	“	13	05	-	18	11	-	-	-	-	-	-	-	-	-	-	-	-
9.	M	37	“	-	-	-	20	14	-	-	-	-	2400	3700	300	200	-	-	-	-
10.	F	36	“	-	-	-	16	09	-	05	03	-	-	-	-	-	420	200	-	-
11.	F	35	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12.	F	29	-ve	-	-	-	23	17	-	03	02	-	3500	6900	280	250	300	150	1	-
13.	M	31	“	-	-	-	18	13	-	-	-	-	3000	6300	240	200	200	100	-	-
14.	M	35	“	-	-	-	-	-	-	-	-	-	-	-	310	210	180	130	-	-
15.	M	38	“	06	02	-	10	06	-	-	-	-	-	-	-	-	-	-	-	-
16.	M	32	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17.	F	31	-ve	12	04	-	-	-	-	05	03	-	400	1200	-	-	-	-	-	-

Month: December State: Kano

S/no.	Sex	Pcv	T. *evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	35	-ve	-	-	-	18	15	-	-	-	-	-	-	-	-	-	-	-	-
2.	F	33	“	07	05	-	15	10	-	02	01	-	100	500	120	80	30	20	-	-
3.	M	36	“	-	-	-	09	05	-	-	-	-	-	-	-	-	-	-	-	-
4.	M	37	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	F	30	“	-	-	-	12	07	-	-	-	-	200	750	100	180	150	80	1	-
6.	F	32	“	-	-	-	-	-	-	05	03	-	1900	3900	300	250	-	-	-	-
7.	F	33	“	12	06	-	18	07	-	-	-	-	600	2000	40	30	100	50	-	-
8.	F	35	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	M	32	“	-	-	-	15	06	-	03	02	-	-	-	-	-	-	-	1	-
10.	M	38	“	-	-	-	-	-	-	-	-	-	80	350	60	120	-	-	-	-
11.	F	36	-ve	10	04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12.	M	38	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13.	M	35	“	-	-	-	-	-	-	-	-	-	1300	2000	-	-	-	-	-	-
14.	F	33	“	-	-	-	13	05	-	-	-	-	700	1800	60	40	-	-	-	-
15.	M	32	“	-	-	-	-	-	-	06	05	-	1200	3600	100	70	-	-	-	-
16.	M	30	“	15	09	-	-	-	-	-	-	-	1000	3200	50	30	60	40	-	1
17.	M	34	-ve	-	-	-	15	08	-	-	-	-	-	-	-	-	-	-	-	-

Month: January State: Katsina

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	37	-ve	-	-	-	-	-	-	-	-	-	-	-	20	80	-	-	-	-
2.	F	34	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.	M	30	“	-	-	-	08	04	01	-	-	-	-	-	50	100	-	-	-	-
4.	M	29	“	-	-	-	15	07	02	-	-	-	30	50	-	-	-	-	-	1
5.	M	31	“	-	-	-	-	-	-	-	-	-	100	200	100	300	-	-	-	-
6.	F	32	“	05	03	-	05	02	01	-	-	-	150	290	-	-	-	-	-	-
7.	M	35	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.	M	33	“	-	-	-	-	-	-	-	-	-	20	40	-	-	-	-	-	-
9.	M	32	“	08	05	01	-	-	-	08	05	-	-	-	110	900	-	-	-	1
10.	M	36	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11.	M	35	-ve	-	-	-	-	-	-	-	-	-	200	300	-	-	-	-	-	-
12.	M	34	“	-	-	-	-	-	-	-	-	-	-	-	60	450	-	-	-	-
13.	F	32	“	04	02	-	33	10	03	-	-	-	-	-	-	-	-	-	-	-
14.	F	33	“	-	-	-	29	14	07	-	-	-	-	-	-	-	-	-	-	-
15.	F	31	-ve	03	02	-	35	16	-	-	-	-	50	150	-	-	-	-	-	1

Month: February State: Katsina

S/no.	Sex	Pcv	T. *evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	31	-ve	-	-	-	18	10	-	-	-	-	80	150	40	70	-	-	1	1
2.	M	33	“	-	-	-	10	07	03	-	-	-	-	-	-	-	-	-	-	-
3.	F	34	“	-	-	-	-	-	-	-	-	-	110	200	-	-	-	-	-	-
4.	F	37	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	M	30	+ve	-	-	-	14	08	03	-	-	-	60	300	100	800	-	-	-	1
6.	M	32	-ve	-	-	-	10	07	05	-	-	-	-	-	20	100	-	-	-	-
7.	F	38	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.	F	39	“	-	-	-	-	-	-	-	-	-	60	250	-	-	-	-	-	-
9.	F	36	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10.	M	35	“	-	-	-	13	09	04	-	-	-	-	-	60	300	-	-	-	-
11.	M	34	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12.	M	33	“	-	-	-	-	-	-	-	-	-	10	20	30	80	-	-	-	-
13.	M	31	“	-	-	-	35	12	03	-	-	-	-	-	50	170	-	-	-	1
14.	F	36	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15.	F	32	“	08	05	02	09	05	02	-	-	-	40	120	100	1000	-	-	-	-
16.	M	35	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Month: March State: Katsina

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	39	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.	M	35	“	-	-	-	08	05	01	-	-	-	-	-	-	-	-	-	-	-
3.	F	41	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.	M	33	“	-	-	-	-	-	-	-	-	-	20	30	15	20	-	-	-	-
5.	M	36	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6.	F	32	“	-	-	-	-	-	-	-	-	-	25	40	60	100	-	-	1	-
7.	F	30	“	-	-	-	-	-	-	-	-	-	50	100	40	180	-	-	-	1
8.	F	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	M	34	“	-	-	-	10	07	02	-	-	-	-	-	-	-	-	-	-	-
10.	M	31	“	07	06	03	07	03	01	-	-	-	10	20	30	90	-	-	-	1
11.	M	33	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12.	F	37	“	-	-	-	-	-	-	-	-	-	40	110	-	-	-	-	-	-
13.	M	38	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14.	F	35	“	-	-	-	10	07	-	-	-	-	30	70	20	60	-	-	-	-
15.	F	36	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16.	F	29	+ve	-	-	-	15	10	04	-	-	-	100	500	-	-	-	-	-	2
17.	M	32	-ve	-	-	-	06	05	03	-	-	-	70	140	50	130	-	-	1	-

Month: April State: Katsina

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	31	+ve	-	-	-	15	07	-	-	-	-	230	650	190	500	-	-	-	1
2.	M	37	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.	M	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.	F	33	“	-	-	-	-	-	-	-	-	-	170	210	60	390	-	-	-	-
5.	F	32	“	-	-	-	-	-	-	-	-	-	300	800	55	300	-	-	-	-
6.	F	36	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.	M	35	“	-	-	-	12	05	02	-	-	-	-	-	30	180	-	-	-	-
8.	M	32	“	-	-	-	15	08	03	-	-	-	140	450	150	550	-	-	1	-
9.	M	31	-ve	-	-	-	14	05	02	05	03	01	250	700	100	600	-	-	-	1
10.	M	35	“	-	-	-	-	-	-	-	-	-	-	-	20	150	-	-	-	-
11.	F	37	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12.	F	34	“	05	04	03	09	06	02	-	-	-	100	400	160	590	-	-	-	-
13.	M	34	“	-	-	-	-	-	-	-	-	-	180	500	70	210	-	-	-	-
14.	F	38	-ve	05	02	-	07	04	-	06	05	03	50	80	-	-	-	-	-	-

Month: May State: Katsina

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	33	-ve	-	-	-	28	15	06	01	02	-	500	700	-	-	-	-	-	-
2.	M	37	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.	M	31	+ve	-	-	-	25	18	04	-	-	-	300	650	30	140	-	-	1	1
4.	F	30	-ve	03	01	-	20	10	-	-	-	-	200	350	250	1400	-	-	-	2
5.	M	33	“	-	-	-	24	12	07	-	-	-	1100	2400	180	300	-	-	-	-
6.	F	35	“	05	03	-	29	07	01	-	-	-	-	-	-	-	-	-	-	-
7.	M	36	“	-	-	-	-	-	-	-	-	-	-	-	160	210	-	-	-	-
8.	M	32	+ve	-	-	-	32	17	05	-	-	-	2000	3100	-	-	-	-	-	-
9.	M	37	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10.	F	35	“	-	-	-	29	11	07	-	-	-	400	600	-	-	-	-	-	-
11.	F	37	“	-	-	-	-	-	-	-	-	-	-	-	200	400	-	-	-	-
12.	M	34	“	04	02	-	20	09	04	-	-	-	1450	2900	-	-	-	-	-	-
13.	M	31	+ve	-	-	-	33	20	09	-	-	-	1960	3172	200	1800	-	-	-	1
14.	F	35	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Month: June State: Katsina

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	35	-ve	-	-	-	33	11	09	-	-	-	850	1440	-	-	-	-	-	1
2.	F	37	“	-	-	-	-	-	-	-	-	-	-	-	200	1000	-	-	-	-
3.	M	33	“	-	-	-	29	10	05	12	07	-	1900	2600	-	-	-	-	1	1
4.	M	34	“	-	-	-	32	19	10	-	-	-	2900	4100	150	1100	-	-	-	1
5.	M	32	“	06	03	-	-	-	-	09	05	-	-	-	-	-	-	-	1	1
6.	F	38	“	-	-	-	23	17	06	-	-	-	-	-	-	-	-	-	-	-
7.	F	35	“	-	-	-	30	20	11	-	-	-	1450	2850	410	1300	-	-	-	-
8.	M	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	F	31	-ve	05	04	-	35	13	-	11	05	-	2150	4500	400	1350	-	-	-	1
10.	M	35	“	-	-	-	42	17	09	-	-	-	1400	3200	510	1000	-	-	-	-
11.	F	37	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
12.	M	36	“	-	-	-	31	13	10	-	-	-	-	-	200	650	-	-	-	-
13.	M	38	+ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14.	F	34	-ve	-	-	-	38	11	06	-	-	-	1800	3950	-	-	-	-	-	-
15.	M	32	“	07	03	01	33	14	02	10	03	02	2600	5000	300	900	-	-	-	1

.

Month: July State: Katsina

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	40	-ve	-	-	-	12	30	-	-	-	-	-	-	-	-	-	-	-	-
2.	F	33	“	07	03	01	17	10	03	12	05	01	1800	3700	390	2200	-	-	1	1
3.	F	36	“	-	-	-	-	-	-	-	-	-	-	-	600	3000	-	-	-	1
4.	M	38	“	-	-	-	15	29	-	-	-	-	300	1260	-	-	-	-	-	-
5.	M	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6.	F	35	“	-	-	-	20	39	-	10	07	03	1500	3100	250	1400	-	-	-	1
7.	M	33	“	10	05	03	16	27	02	11	03	-	1740	3200	300	1920	-	-	-	1
8.	M	32	-ve	-	-	-	25	24	10	-	-	-	2100	3800	340	2100	-	-	1	1
9.	F	37	“	-	-	-	-	-	-	22	16	09	-	-	-	-	-	-	-	-
10.	F	31	“	08	04	02	15	35	04	13	08	01	1900	3750	400	2100	-	-	-	1
11.	F	30	“	10	05	-	13	33	07	08	05	-	2000	3900	280	2250	-	-	-	1
12.	M	36	“	-	-	-	19	33	05	-	-	-	-	-	-	-	-	-	-	-
13.	F	35	“	-	-	-	-	-	-	-	-	-	1000	2300	460	2180	-	-	-	-
14.	M	34	-ve	-	-	-	17	30	06	09	04	0	1700	2400	500	3500	-	-	-	1

Month: August State: Katsina

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	36	-ve	09	05	-	13	17	-	14	09	04	-	-	50	650	-	-	-	-
2.	M	33	“	-	-	-	18	20	03	-	-	-	1900	3000	90	1500	-	-	-	1
3.	F	38	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.	M	35	“	-	-	-	12	29	09	-	-	-	1600	4500	-	-	-	-	-	1
5.	F	32	“	12	04	02	-	-	-	17	06	07	1130	3100	180	1900	-	-	-	1
6.	F	31	“	-	-	-	17	28	05	13	05	-	1810	3200	450	780	-	-	-	1
7.	M	35	“	15	06	-	31	10	08	-	-	-	-	-	-	-	-	-	1	-
8.	F	37	-ve	-	-	-	-	-	-	-	-	-	600	1000	-	-	-	-	-	-
9.	F	34	“	08	06	-	20	11	-	15	08	02	1350	4100	-	-	-	-	-	-
10.	M	33	“	-	-	-	32	15	02	-	-	-	2100	3400	300	700	-	-	-	1
11.	M	35	“	09	05	-	27	16	01	-	-	-	-	-	-	-	-	-	-	-
12.	F	37	“	-	-	-	-	-	-	-	-	-	1700	2800	390	980	-	-	-	-
13.	M	33	“	07	03	01	25	09	05	12	03	01	1400	3400	-	-	-	-	-	1
14.	F	34	“	-	-	-	33	11	03	-	-	-	1200	3300	-	-	-	-	-	-
15.	M	36	-ve	-	-	-	26	14	05	-	-	-	-	-	360	1400	-	-	-	-

Month: September State: Katsina

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	35	-ve	13	09	02	-	-	-	19	08	-	1200	2400	210	1400	-	-	-	-
2.	F	37	“	11	06	01	39	16	08	-	-	-	-	-	-	-	-	-	-	-
3.	M	35	“	12	06	-	30	09	12	06	03	-	-	-	460	2800	-	-	-	-
4.	M	28	“	-	-	-	36	20	-	-	-	-	1950	4100	500	3900	-	-	-	2
5.	F	39	“	-	-	-	35	15	07	-	-	-	-	-	-	-	-	-	-	-
6.	M	29	“	13	08	-	28	17	-	13	06	08	1210	2000	600	4000	-	-	-	1
7.	F	38	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.	F	31	-ve	-	-	-	32	13	10	05	08	01	1600	3500	300	870	-	-	1	1
9.	F	33	“	-	-	-	35	20	14	13	04	-	1400	3100	40	180	-	-	-	-
10.	M	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11.	M	36	“	-	-	-	33	18	06	-	-	-	-	-	390	3000	-	-	-	-
12.	F	33	“	14	07	04	-	-	-	17	09	05	1500	2900	420	3750	-	-	-	1
13.	M	32	“	-	-	-	26	15	04	20	06	02	1300	3200	390	2600	-	-	1	-
14.	F	35	“	-	-	-	-	-	-	-	-	-	1100	2100	490	950	-	-	-	-
15.	F	34	-ve	-	-	-	33	19	09	15	05	06	-	-	570	4100	-	-	-	-

Month: October State: Katsina

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	37	-ve	-	-	-	-	-	-	25	20	10	-	-	200	1100	-	-	-	-
2.	M	35	“	07	18	06	28	07	06	-	-	-	600	1800	-	-	-	-	-	-
3.	F	30	“	08	12	04	15	20	10	-	-	-	1200	2700	600	2100	-	-	-	1
4.	F	39	“	-	-	-	-	-	-	29	23	09	-	-	-	-	-	-	-	-
5.	M	40	“	-	-	-	-	-	-	-	-	-	-	-	700	1900	-	-	-	-
6.	F	31	“	20	18	07	20	32	08	-	-	-	1100	2900	-	-	-	-	-	1
7.	F	33	“	-	-	-	18	37	04	24	10	05	700	2200	-	-	-	-	1	-
8.	F	34	“	-	-	-	23	31	08	21	22	09	1000	2500	500	1600	-	-	-	-
9.	M	35	-ve	18	15	09	27	39	05	-	-	-	500	1300	400	950	-	-	-	1
10.	M	37	“	15	08	02	-	-	-	30	18	01	850	1600	-	-	-	-	-	-
11.	M	36	“	-	-	-	35	14	02	-	-	-	-	-	800	4120	-	-	-	-
12.	M	30	“	13	10	05	24	15	05	18	12	03	1400	3100	-	-	-	-	-	1
13.	F	34	“	09	10	01	35	19	06	05	02	-	-	-	950	3200	-	-	-	-
14.	M	33	-ve	21	07	03	21	17	04	-	-	-	900	2300	-	-	-	-	-	1

Month: November State: Katsina

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	40	-ve	05	02	-	-	-	-	02	04	-	-	-	-	-	-	-	-	-
2.	M	31	“	-	-	-	33	20	03	-	-	-	1000	2300	110	900	-	-	-	1
3.	F	37	“	06	05	02	15	12	01	-	-	-	300	1200	-	-	-	-	-	-
4.	M	33	“	-	-	-	29	22	05	-	-	-	650	1900	150	1200	-	-	-	1
5.	M	38	“	10	08	04	-	-	-	05	07	-	100	400	220	1000	-	-	-	-
6.	M	39	“	07	04	-	-	-	-	-	-	-	-	-	100	1100	-	-	-	-
7.	F	33	“	-	-	-	33	20	08	-	-	-	700	1500	-	-	-	-	-	1
8.	F	35	-ve	03	08	01	24	11	10	-	-	-	400	1800	200	800	-	-	-	-
9.	M	34	“	-	-	-	27	20	05	-	-	-	60	100	-	-	-	-	-	-
10.	M	32	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
11.	F	31	“	-	-	-	-	-	-	04	03	-	-	-	500	2400	-	-	-	1
12.	M	37	“	-	-	-	18	15	02	03	02	-	200	600	300	750	-	-	-	-
13.	F	38	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Month: December State: Katsina

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O.venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	38	-ve	05	03	01	-	-	-	-	-	-	-	-	130	400	-	-	-	-
2.	M	31	“	-	-	-	32	20	07	-	-	-	750	1190	-	-	-	-	-	1
3.	F	35	“	-	-	-	28	12	05	-	-	-	-	-	100	2500	-	-	-	-
4.	M	36	“	-	-	-	-	-	-	-	-	-	-	-	200	2100	-	-	-	-
5.	F	33	“	-	-	-	21	13	10	-	-	-	1620	1900	-	-	-	-	1	-
6.	M	37	“	-	-	-	10	09	03	-	-	-	-	-	50	300	-	-	-	-
7.	M	38	“	08	05	03	-	-	-	01	03	-	900	700	-	-	-	-	-	-
8.	F	32	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
9.	F	34	“	-	-	-	-	-	-	-	-	-	800	1200	160	500	-	-	-	-
10.	F	32	“	-	-	-	30	20	08	-	-	-	300	1350	-	-	-	-	-	1
11.	M	30	“	-	-	-	25	23	06	-	-	-	50	200	70	130	-	-	-	1
12.	M	31	“	03	02	04	19	14	12	-	-	-	100	1000	-	-	-	-	1	-
13.	F	37	“	-	-	-	-	-	-	02	04	01	-	-	120	1500	-	-	-	-
14.	M	38	“	05	03	02	-	-	-	-	-	-	-	-	40	200	-	-	-	-
15.	F	35	-ve	-	-	-	15	10	03	-	-	-	400	1100	-	-	-	-	-	-

Month: January State: Zamfara

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	28	-ve	-	-	-	10	07	-	-	-	-	30	50	10	20	-	-	1	-
2.	M	37	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.	F	40	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.	M	41	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	F	30	“	-	-	-	15	10	-	-	-	-	15	30	-	-	-	-	-	-
6.	F	33	“	-	-	-	-	-	-	-	-	-	18	35	-	-	-	-	-	-
7.	M	31	“	-	-	-	23	12	-	-	-	-	-	-	20	30	-	-	1	-
8.	F	35	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	M	34	“	-	-	-	-	-	-	09	06	-	-	-	-	-	-	-	-	-
10.	M	33	-ve	-	-	-	27	11	-	-	-	-	10	20	11	15	-	-	-	-
11.	F	32	“	-	-	-	29	14	-	-	-	-	25	70	-	-	-	-	-	-
12.	F	36	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13.	M	37	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14.	M	39	-ve	-	-	-	-	-	-	-	-	-	-	-	12	19	-	-	-	-

Month: February State: Zamfara

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	32	-ve	-	-	-	-	-	-	-	-	-	29	40	-	-	-	-	-	-
2.	F	36	“	-	-	-	-	-	-	-	-	-	-	-	20	50	-	-	-	-
3.	M	28	+ve	-	-	-	16	10	-	-	-	-	100	3000	-	-	-	-	1	-
4.	F	37	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	M	40	“	-	-	-	-	-	-	03	02	-	-	-	-	-	-	-	-	-
6.	M	31	“	-	-	-	07	03	-	-	-	-	40	145	18	22	-	-	1	-
7.	M	35	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.	F	34	-ve	-	-	-	-	-	-	-	-	-	-	-	23	40	-	-	-	-
9.	M	33	“	-	-	-	-	-	-	-	-	-	50	300	-	-	-	-	-	-
10.	F	36	“	03	02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11.	M	32	“	-	-	-	10	07	-	-	-	-	30	90	30	70	-	-	-	-
12.	F	33	“	-	-	-	09	06	-	05	03	-	-	-	60	200	-	-	-	-
13.	F	30	-ve	-	-	-	13	10	-	-	-	-	70	400	80	350	-	-	1	-

Month: March State: Zamfara

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	35	-ve	-	-	-	19	08	-	-	-	-	-	-	06	30	-	-	-	-
2.	F	37	“	01	02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.	M	32	“	-	-	-	-	-	-	-	-	-	110	130	-	-	-	-	-	-
4.	M	31	“	-	-	-	-	-	-	-	-	-	100	170	-	-	-	-	1	-
5.	F	39	“	-	-	-	-	-	-	03	01	-	-	-	-	-	-	-	-	-
6.	M	40	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.	M	33	“	-	-	-	-	-	-	-	-	-	-	-	150	250	-	-	-	-
8.	F	30	+ve	-	-	-	18	07	-	-	-	-	20	30	-	-	-	-	1	-
9.	F	32	-ve	-	-	-	06	05	-	-	-	-	40	90	-	-	-	-	1	-
10.	M	31	“	-	-	-	15	08	-	-	-	-	130	210	-	-	-	-	-	-
11.	F	35	“	02	05	-	-	-	-	-	-	-	-	-	70	150	-	-	-	-
12.	M	36	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13.	F	34	-ve	-	-	-	-	-	-	-	-	-	70	150	100	400	-	-	-	-

Month: April State: Zamfara

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	36	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.	F	32	“	-	-	-	10	06	-	-	-	-	280	850	-	-	-	-	1	-
3.	M	34	“	-	-	-	07	04	02	-	-	-	-	-	270	360	-	-	-	-
4.	F	32	“	-	-	-	11	07	04	-	-	-	120	300	130	240	-	-	-	-
5.	M	35	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6.	M	31	“	-	-	-	13	10	-	-	-	-	30	40	300	1500	-	-	-	-
7.	M	30	-ve	-	-	-	16	09	03	-	-	-	200	3000	-	-	-	-	1	-
8.	F	37	“	12	05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	F	31	+ve	-	-	-	-	-	-	05	02	05	300	5000	-	-	-	-	-	-
10.	M	33	-ve	-	-	-	11	04	-	-	-	-	20	30	50	200	-	-	-	-
11.	F	38	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12.	F	37	“	-	-	-	-	-	-	-	-	-	-	-	20	50	-	-	-	-
13.	F	35	-ve	-	-	-	-	-	-	-	-	-	80	470	-	-	-	-	-	-

Month: May State: Zamfara

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	32	+ve	-	-	-	13	06	-	-	-	-	190	1750	-	-	-	-	1	-
2.	M	36	-ve	08	06	-	-	-	-	02	01	-	-	-	30	40	-	-	-	-
3.	F	34	“	-	-	-	-	-	-	-	-	-	-	-	20	50	-	-	-	-
4.	M	33	“	-	-	-	-	-	-	-	-	-	150	1600	40	90	-	-	-	-
5.	F	31	“	-	-	-	16	08	-	-	-	-	100	1200	-	-	-	-	1	-
6.	F	29	+ve	03	02	-	19	12	01	-	-	-	200	2200	-	-	-	-	1	-
7.	M	30	-ve	-	-	-	13	05	03	-	-	-	180	1100	-	-	-	-	-	-
8.	M	38	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	F	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10.	F	40	“	-	-	-	-	-	-	-	-	-	-	-	70	150	-	-	-	-
11.	F	33	“	-	-	-	11	04	-	-	-	-	50	1200	-	-	-	-	-	-
12.	M	32	+ve	06	03	01	-	-	-	-	-	-	100	750	-	-	-	-	-	-
13.	M	34	-ve	-	-	-	09	04	-	-	-	-	170	1900	-	-	-	-	-	-
14.	M	36	“	-	-	-	-	-	-	-	-	-	-	-	30	120	-	-	-	-
15.	F	35	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Month: June State: Zamfara

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	36	-ve	-	-	-	-	-	-	-	-	-	-	-	30	50	-	-	-	-
2.	M	33	“	-	-	-	18	06	-	-	-	-	2000	3500	-	-	-	-	-	-
3.	M	38	“	05	09	-	-	-	-	03	02	-	-	-	-	-	-	-	-	-
4.	F	32	“	-	-	-	33	07	02	-	-	-	500	1500	-	-	-	-	1	-
5.	F	33	“	-	-	-	12	08	04	-	-	-	2000	4600	70	120	-	-	-	-
6.	M	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.	M	41	-ve	06	08	-	01	03	-	-	-	-	-	-	-	-	-	-	-	-
8.	F	36	“	-	-	-	17	06	09	-	-	-	1000	3000	-	-	-	-	-	-
9.	M	33	“	03	11	-	06	02	-	04	01	-	2100	5100	100	300	-	-	-	-
10.	F	31	“	-	-	-	11	05	-	-	-	-	-	-	50	70	-	-	1	-
11.	F	30	“	-	-	-	21	10	05	-	-	-	4100	7000	-	-	-	-	1	-
12.	M	28	“	-	-	-	19	06	10	-	-	-	5100	10000	-	-	-	-	1	-
13.	M	34	“	13	04	06	02	05	-	-	-	-	-	-	140	600	-	-	-	-
14.	F	35	-ve	-	-	-	-	-	-	07	04	-	250	1500	-	-	-	-	-	-

Month: July State: Zamfara

S/no.	Sex		*Pcv T. evansi*	*A. variegatum*			*H. dromedarii*			*R.* pravus			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	37	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.	M	31	“	12	04	-	22	07	-	-	-	-	1900	4950	-	-	-	-	1	-
3.	F	33	“	-	-	-	13	05	-	05	03	-	1300	3800	30	70	-	-	-	-
4.	M	36	“	13	08	03	18	09	02	-	-	-	-	-	-	-	-	-	-	-
5.	F	34	“	-	-	-	27	13	05	-	-	-	500	2500	100	200	-	-	-	-
6.	F	32	“	-	-	-	15	07	-	-	-	-	900	1250	40	60	-	-	1	-
7.	F	35	“	09	04	01	06	08	03	03	03	-	700	2000	35	150	-	-	-	-
8.	M	38	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	M	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10.	M	31	“	15	07	-	21	07	-	-	-	-	1100	6100	20	40	-	-	1	-
11.	F	35	“	-	-	-	13	05	06	-	-	-	-	-	50	380	-	-	-	-
12.	M	30	“	11	06	-	25	14	08	-	-	-	2000	7500	-	-	-	-	-	-
13.	F	30	“	-	-	-	29	16	10	-	-	-	1500	5900	-	-	-	-	1	-
14.	F	34	“	-	-	-	11	08	02	-	-	-	-	-	30	1000	-	-	-	-
15.	M	32	-ve	-	-	-	17	13	-	-	-	-	950	3600	-	-	-	-	-	-

Month: August State: Zamfara

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	29	-ve	-	-	-	35	19	-	-	-	-	2000	3500	30	50	-	-	2	-
2.	M	36	“	-	-	-	23	10	-	-	-	-	910	1700	-	-	-	-	-	-
3.	F	38	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.	F	33	“	-	-	-	26	17	06	-	-	-	1900	2300	380	600	-	-	-	-
5.	M	37	“	24	17	09	-	-	-	05	04	-	-	-	-	-	-	-	-	-
6.	M	30	“	-	-	-	19	11	03	-	-	-	1500	3200	450	800	-	-	1	-
7.	F	33	“	-	-	-	21	16	07	-	-	-	1000	2500	400	750	-	-	-	-
8.	M	35	-ve	23	12	02	13	08	04	-	-	-	-	-	50	90	-	-	-	-
9.	F	31	“	-	-	-	27	13	09	-	-	-	1300	2900	300	500	-	-	1	-
10.	F	38	“	22	06	01	18	10	-	06	05	01	-	-	-	-	-	-	-	-
11.	M	39	“	-	-	-	23	16	02	-	-	-	-	-	-	-	-	-	-	-
12.	M	32	“	-	-	-	25	15	11	-	-	-	1700	2200	140	260	-	-	-	-
13.	M	35	“	21	15	06	-	-	-	10	05	04	2100	2800	-	-	-	-	-	-
14.	F	32	-ve	27	14	09	20	09	04	-	-	-	1100	1950	-	-	-	-	1	-

Month: September State: Zamfara

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	33	-ve	15	09	03	22	11	01	-	-	-	1200	3000	160	500	-	-	-	-
2.	M	37	“	19	10	06	-	-	-	04	05	-	-	-	-	-	-	-	-	-
3.	F	31	“	-	-	-	30	20	05	-	-	-	700	1200	140	900	-	-	1	-
4.	M	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	F	33	“	26	17	02	27	18	02	-	-	-	250	550	80	180	-	-	-	-
6.	F	34	“	-	-	-	22	18	07	-	-	-	300	400	-	-	-	-	-	-
7.	M	36	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.	M	30	-ve	24	15	01	21	09	-	06	03	-	500	1100	110	250	-	-	1	-
9.	F	35	“	-	-	-	32	13	09	-	-	-	-	-	-	-	-	-	-	-
10.	F	31	“	17	12	06	31	13	07	-	-	-	650	1000	80	200	-	-	1	-
11.	F	32	“	-	-	-	27	15	03	-	-	-	390	820	-	-	-	-	-	-
12.	M	35	“	-	-	-	17	10	-	-	-	-	-	-	120	500	-	-	-	-
13.	M	34	“	22	16	09	23	07	-	05	01	-	250	500	100	350	-	-	-	-
14.	F	36	“	-	-	-	-	-	-	10	05	03	-	-	-	-	-	-	-	-
15.	M	32	-ve	10	04	02	31	13	06	-	-	-	480	950	200	1600	-	-	1	-

Month: October State: Zamfara

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	F	31	-ve	-	-	-	28	13	07	-	-	-	210	3800	40	240	-	-	1	-
2.	F	36	"	-	-	-	22	06	03	-	-	-	-	-	-	-	-	-	-	-
3.	M	38	"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.	M	33	"	15	07	02	13	08	05	05	03	-	280	3200	-	-	-	-	-	-
5.	F	36	"	-	-	-	17	10	-	-	-	-	-	-	50	300	-	-	-	-
6.	M	30	"	10	09	-	21	10	04	-	-	-	250	1900	-	-	-	-	1	-
7.	M	35	"	19	12	05	18	09	-	06	04	01	30	190	20	40	-	-	-	-
8.	M	31	"	06	04	-	08	05	-	03	02	-	350	1500	-	-	-	-	-	-
9.	F	32	-ve	14	09	03	22	17	10	07	05	-	40	160	20	30	-	-	-	-
10.	F	38	"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11.	M	31	"	-	-	-	27	18	06	-	-	-	120	290	30	40	-	-	1	-
12.	F	39	"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13.	M	33	"	16	17	07	19	12	03	-	-	-	50	180	20	50	-	-	1	-
14.	M	40	"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15.	M	32	"	11	06	01	10	08	04	05	03	03	100	200	130	170	-	-	1	-
16.	F	31	-ve	13	11	04	20	10	06	-	-	-	160	370	-	-	-	-	-	-

Month: November State: Zamfara

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T.globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	35	-ve	-	-	-	20	17	03	-	-	-	30	70	-	-	-	-	-	-
2.	F	39	"	03	02	-	-	-	-	04	05	01	-	-	-	-	-	-	-	-
3.	M	33	"	-	-	-	33	20	10	-	-	-	50	90	40	100	-	-	-	-
4.	M	36	"	-	-	-	13	07	-	-	-	-	-	-	-	-	-	-	-	-
5.	F	31	"	-	-	-	25	15	06	-	-	-	40	110	20	40	-	-	1	-
6.	F	33	"	-	-	-	29	15	03	-	-	-	60	120	20	80	-	-	-	-
7.	M	35	"	06	05	01	19	13	07	-	-	-	30	70	-	-	-	-	-	-
8.	M	32	-ve	-	-	-	21	19	-	-	-	-	-	-	-	-	-	-	2	-
9.	M	37	"	03	04	-	-	-	-	02	01	-	-	-	-	-	-	-	-	-
10.	F	39	"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11.	F	31	"	-	-	-	25	20	10	-	-	-	50	130	30	70	-	-	-	-
12.	M	36	"	-	-	-	20	10	05	-	-	-	-	-	10	30	-	-	-	-
13.	M	30	"	-	-	-	17	14	03	-	-	-	70	180	40	90	-	-	1	-
14.	F	38	"	06	02	02	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15.	M	39	"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16.	F	33	-ve	-	-	-	26	12	10	-	-	-	30	80	50	120	-	-	-	-

Month: December State: Zamfara

S/no.	Sex	Pcv	*T. evansi*	*A. variegatum*			*H. dromedarii*			*R. pravus*			*H. longistipes*		*T. globulosa*		*O. venulosum*		*Moniezia benedeni*	*Stellizia vittata*
				M	F	N	M	F	N	M	F	N	M	F	M	F	M	F		
1.	M	37	-ve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.	M	31	“	-	-	-	23	20	10	-	-	-	30	150	10	20	-	-	1	-
3.	F	40	“	-	-	-	08	03	-	-	-	-	-	-	-	-	-	-	-	-
4.	M	32	“	-	-	-	20	17	07	-	-	-	50	100	20	50	-	-	-	-
5.	F	37	“	02	03	-	-	-	-	03	-	-	-	-	-	-	-	-	-	-
6.	F	34	“	-	-	-	16	11	03	-	-	-	-	-	-	-	-	-	-	-
7.	M	31	“	10	09	05	11	06	-	03	04	01	40	120	-	-	-	-	1	-
8.	M	38	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	M	33	“	-	-	-	20	13	06	-	-	-	30	110	30	90	-	-	-	-
10.	F	31	-ve	-	-	-	25	15	10	-	-	-	40	130	20	100	-	-	-	-
11.	F	39	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12.	M	30	“	-	-	-	29	16	05	-	-	-	500	1800	-	-	-	-	1	-
13.	F	40	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14.	M	29	“	-	-	-	25	18	08	-	-	-	90	200	-	-	-	-	2	-
15.	M	32	“	-	-	-	27	13	04	-	-	-	30	90	-	-	-	-	-	-
16.	F	36	“	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17.	M	31	-ve	06	04	01	20	18	03	-	-	-	60	180	30	120	-	-	-	-

APPENDIX B: Pre and Post infection data collected from sheep artificially infected with *Haemonchus spp*. during 15 weeks study period.

Pre-Infection Values Date: 14 – 07 – 06

Group 1 (*H. longistipes* infected Sheep)

S/no	Wt (Kg)	Egg/gram (Epg)	Floatation Technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes	Remarks
1	21	00	NES[a]	23	07.7	22.6	22	78	-	-	
2	21	00	NES	25	08.3	19.2	31	69	-	-	
3	24	00	NES	25	08.3	24.8	68	30	-	-	
4	19	00	NES	40	13.3	10.1	51	49	-	-	
5	19	00	NES	30	10.0	16.3	68	32	-	-	
6[*]	18	00	NES	27	09.0	09.1	39	61	-	-	
7[*]	13	00	NES	33	11.0	10.8	53	47	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Post-Infection Values Week 1

Group 1 (*H. longistipes* infected Sheep).

S/no	WT (Kg)	Egg/gram (Epg)	Floatation Technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes	Remarks
1	24	00	NES	24	08.0	13.1	50	49	01	-	
2	22	00	NES	21	07.0	09.4	41	59	-	-	
3	25	00	NES	26	08.7	12.1	70	24	06	-	
4	21	00	NES	32	10.7	06.8	36	64	-	-	
5	20	00	NES	26	08.7	14.1	60	40	-	-	
6*	19	00	NES	25	08.3	04.2	43	57	-	-	
7*	17	00	NES	27	09.0	06.9	51	49	-	-	

[a] No egg seen

[b] Strongyle ova

* Non infected control

Group 1.(*H. longistipes* infected Sheep) Week 2.

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocutes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes	Remarks
1	19	00	NES	28	09.3	11.8	32	68	-	-	
2	20	00	NES	16	5.3	10.7	62	28	-	-	
3	22	00	NES	25	8.3	11.5	53	47	-	-	
4	19	00	NES	32	10.7	10.3	35	63	-	-	
5	19	00	NES	30	10.0	15.1	60	40	-	-	
6*	17	00	NES	24	08.0	10.2	52	48	-	-	
7*	15	00	NES	26	8.7	16.3	46	54	-	-	

[a] No egg seen

[b] Strongyle ova

* Non infected control

Group 1. (*H. longistipes* infected Sheep). Week 3

S/no.	Wt (Kg)	Egg/gram (Epg)	Flotation technique	Pcv (%)	HB (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes	Remarks
1	18	00	NES	31	10.3	09.2	52	48	-	-	
2	19	00	NES	21	07.0	10.9	40	60	-	-	
3	22	00	NES	22	07.3	12.0	80	20	-	-	
4	19	00	NES	36	12.0	08.3	39	61	-	-	
5	18	00	NES	35	11.7	09.0	29	71	-	-	
6*	18	00	NES	28	09.3	12.0	67	33	-	-	
7*	14	00	NES	33	11.0	09.0	39	61	-	-	

[a] No egg seen

[b] Strongyle ova.

* Non infected control

Group 1 (*H. longistipes* infected Sheep) Week 4

S/no.	Wt (KG)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocutes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes	Remarks
1	19	00	NES	29	09.7	12.3	53	47	-	-	
2	20	00	NES	19	06.3	13.0	66	24	-	-	
3	24	00	NES	25	08.3	15.0	80	20	-	-	
4	20	00	NES	36	12.0	08.4	42	58	-	-	
5	19	00	NES	24	08.0	07.0	51	49	-	-	
6*	20	00	NES	30	10.0	06.7	30	54	10	-	
7*	16	00	NES	31	10.3	11.1	57	33	10	-	

[a] No egg seen

[b] Strongyle ova.

* Non infected control

Group 1 (*H. longistipes* infected Sheep). Week 5

S/no.	Wt (Kg)	Egg/gram (Epg)	Flotation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes	Remarks
1	19.5	40	+[b]	30	10.0	19.0	46	54	-	-	
2	19	80	++	22	07.3	14.2	43	57	-	-	
3	26	40	+	26	08.7	13.8	72	28	-	-	
4	20	60	+	36	12.0	11.8	31	69	-	-	
5	21.5	00	NES[a]	30	10.0	13.6	60	40	-	-	
6[*]	20	00	NES	29	09.6	10.4	29	71	-	-	
7[*]	17	00	NES	30	10.0	15.2	62	38	-	-	

[a] No egg seen

[b] Strongyle ova.

[*] Non infected control

Group1 (*H. longistipes* infected Sheep). Week 6

S/no.	Wt (Kg)	Egg/gram (Epg)	Flotation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes	Remarks
1	19	00	NES[a]	27	09.0	08.2	40	60	-	-	
2	19	00	NES	24	08.0	13.5	31	69	-	-	
3	25	100	++[b]	26	08.6	16.8	66	34	-	-	
4	21	00	NES	37	12.3	07.3	42	58	-	-	
5	20	40	++[b]	30	10.0	10.9	51	49	-	-	
6	19[*]	00	NES	31	10.3	09.4	59	41	-	-	
7	17[*]	00	NES	33	11.0	11.7	30	70	-	-	

[a] No egg seen

[b] Strongyle ova.

[*] Non infected control

Group 1 (*H. longistipes* infected Sheep). Week 7

S/no.	Wt (Kg)	Egg/gram (Epg)	Flotation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes	Remarks
1	17.5	00	NES[a]	26	08.7	22.0	60	40	-	-	
2	17.5	00	NES	20	06.7	15.2	69	31	-	-	
3	25.5	00	NES	26	08.7	21.6	43	57	-	-	
4	19.5	40	+[b]	33	11.0	13.1	32	68	-	-	
5	18.5	40	+	27	09.0	08.3	51	49	-	-	
6*	18.5	00	NES	28	09.3	14.2	29	71	-	-	
7*	16.5	00	NES	33	11.0	12.2	60	40	-	-	

[a] No egg seen

[b] Strongyle ova.

* Non infected control

Group 1 (*H. longistipes* infected Sheep). Week 8

S/no.	Wt (Kg)	Egg/gram (Epg)	Flotation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils	Monocytes	Remarks
1	19.5	00	NES[a]	27	09.0	13.6	64	36	-	-	
2	19.5	40	++[b]	26	08.7	13.2	70	30	-	-	
3	24.5	60	++	28	09.3	14.6	60	40	-	-	
4	20.5	00	NES	35	11.7	07.6	52	48	-	-	
5	21.0	360	++	28	09.0	10.1	56	44	-	-	
6[*]	19.5	00	NES	29	09.7	08.6	43	57	-	-	
7[*]	16.5	00	NES	30	10.0	07.5	37	63	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group 1 (*H. longistipes* infected Sheep). Week 9

S/no.	Wt (Kg)	Egg/gram (Epg)	Flotation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils	Monocytes	Remarks
1	17.0	00	NES[a]	23	07.7	12.4	58	40	-	-	
2	17.0	00	NES	23	07.7	09.6	61	31	-	-	
3	24.0	00	+[b]	25	08.3	10.0	48	50	-	-	
4	18.0	00	+	35	11.7	08.2	70	30	-	-	
5	19.0	00	+	30	10.0	12.6	72	28	-	-	
6[*]	18.0	00	NES	28	09.3	08.6	52	48	-	-	
7[*]	15.0	00	NES	31	10.3	08.0	36	64	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group 1 (*H. longistipes* infected Sheep. Week 10

S/no.	Wt (Kg)	Egg/gram (Epg)	Flotation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils	Monocytes	Remarks
1	17.0	00	NES[a]	25	08.3	14.6	66	34	-	-	
2	17.5	00	NES	22	07.3	11.6	49	51	-	-	
3	23.0	60	++[b]	25	08.3	18.5	22	78	-	-	
4	18.0	40	+	34	11.3	11.8	60	40	-	-	
5	19.5	300	++	29	09.6	18.0	28	72	-	-	
6[*]	19.0	00	NES	27	09.0	08.0	31	69	-	-	
7[*]	16.5	00	NES	31	10.3	09.0	30	70	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group 1 (*H. longistipes* infected Sheep. Week 11

S/no.	Wt (Kg)	Egg/gram (Epg)	Flotation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils	Monocytes	Remarks
1	17.5	00	NES[a]	26	08.6	10.4	32	68	-	-	
2	18.0	100	+[b]	20	06.7	07.0	53	47	-	-	
3	23.0	140	+	24	08.0	12.1	42	58	-	-	
4	20.0	00	NES	31	10.3	10.6	49	51	-	-	
5	19.0	220	+	29	09.7	15.2	22	78	-	-	
6[*]	20.0	00	NES	28	09.3	08.6	30	68	02	-	
7[*]	17.0	00	NES	29	09.7	12.8	49	51	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group 1 (*H. longistipes* infected Sheep. Week 12

S/no.	Wt (Kg)	Egg/gram (Epg)	Flotation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils	Monocytes	Remarks
1	15.5	00	NES	25	08.3	11.0	53	47	-	-	
2	21.5	00	NES	20	06.7	17.0	51	49	-	-	
3	24.0	280	++[b]	24	08.0	16.0	37	63	-	-	
4	17.0	00	NES	32	10.7	10.0	52	48	-	-	
5	15.0	880	+++	30	10.0	21.0	40	60	-	-	
6[*]	17.5	00	NES	30	10.0	06.0	37	63	-	-	
7[*]	16.0	00	NES	30	10.0	10.0	51	49	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group 1 (*H. longistipes* infected Sheep. Week 13

S/no.	Wt (Kg)	Egg/gram (Epg)	Flotation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils	Monocytes	Remarks
1	21.0	00	NES	23	07.7	17.1	62	38	-	-	
2	21.0	00	NES	20	06.7	14.6	53	47	-	-	
3	27.5	60	+[b]	25	08.3	16.7	40	60	-	-	
4	23.0	00	NES	30	10.0	08.8	52	48	-	-	
5	20.5	60	++	28	09.3	11.6	68	32	-	-	
6[*]	22.5	00	NES	26	08.6	07.2	46	54	-	-	
7[*]	20.5	00	NES	28	09.3	12.4	53	47	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group 1 (*H. longistipes* infected Sheep. Week 14

S/no.	Wt (Kg)	Egg/gram (Epg)	Flotation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils	Monocytes	Remarks
1	18.5	00	NES	28	09.3	14.5	70	29	-	01	
2	19.5	40	+[b]	24	08.0	10.8	63	37	-	-	
3	24.5	00	NES	29	09.6	12.0	88	12	-	-	
4	21.5	00	NES	29	09.6	11.0	63	34	01	-	
5	17.5	00	NES	32	10.6	12.4	62	36	02	-	
6[*]	19.5	00	NES	30	10.0	08.0	70	28	01	01	
7[*]	19.0	00	NES	34	11.3	15.1	69	30	-	01	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group 1 (*H. longistipes* infected Sheep. Week 15

S/no.	Wt (Kg)	Egg/gram (Epg)	Flotation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils	Monocytes	Remarks
1	19.0	00	NES	25	08.3	11.6	81	19	-	-	
2	19.5	00	NES	24	08.0	20.4	73	24	02	01	
3	25.0	40	+[b]	29	09.6	16.0	86	14	-	-	
4	21.0	00	NES	32	10.6	15.5	79	20	-	01	
5	17.0	120	++	30	10.0	16.6	84	16	-	-	
6[*]	21.5	00	NES	34	11.3	10.9	76	22	01	01	
7[*]	19.5	00	NES	33	11.0	12.8	84	15	-	01	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Pre- infected Values 11 – 08 - 06

Group II (*H. placei* infected Sheep)

S/no	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	19	00	NES[a]	29	09.6	15.I	76	24	-	-	
9	16	00	NES	26	08.6	13.9	80	20	-	-	
10	17	00	NES	30	10.0	14.0	61	38	01	-	
11	12	00	NES	43	14.3	15.9	41	59	-	-	
12	18	00	NES	29	09.6	15.4	60	40	-	-	
13[*]	16	00	NES	49	16.3	11.0	69	30	-	-	
14[*]	14	00	NES	34	11.3	11.8	56	44	-	-	
15[*]	12	00	NES	32	10.6	09.8	50	50	-	-	

[a] No egg seen.

[b] Strongyle ova

[*] Non infected control

Post infection Values.

Group II (*H. placei* infected Sheep) Week 1

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	18.5	00	+[b]	42	14.0	15.3	80	18	01	01	
9	16.5	00	NES[a]	24	08.0	14.6	83	16	-	01	
10	17.5	00	+	33	11.0	14.8	84	12	03	01	
11	13.5	00	+	47	15.6	16.4	78	22	-	-	
12	19.5	00	NES	33	11.0	15.8	83	16	-	01	
13[*]	16	00	NES	27	09.0	11.2	79	20	02	-	
14[*]	18	00	NES	28	09.3	07.9	54	46	-	-	
15[*]	16	00	NES	26	08.6	05.9	48	52	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

.Group II (*H. placei* infected Sheep) Week 2

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	21.0	00	+[b]	31	10.3	14.5	73	26	01	-	
9	17.5	00	NES[a]	32	10.6	10.6	86	13	01	-	
10	19.0	00	+	31	10.3	13.0	83	15	01	01	
11	15.0	320	++	32	10.6	17.1	80	18	01	01	
12	19.5	00	NES	36	12.0	12.8	87	13	-	-	
13*	20.5	00	NES	35	12.6	11.7	80	20	-	-	
14*	16	00	NES	27	09.0	17.3	49	51	-	-	
15*	14	00	NES	25	08.3	15.3	43	57	-	-	

[a] No egg seen

[b] Strongyle ova

* Non infected control

Group II (*H. placei* infected Sheep) Week 3

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	19.0	40	+[b]	35	11.6	15.3	68	32	-	-	
9	16.5	00	NES[a]	30	10.0	13.0	62	36	01	01	
10	16.5	80	++	32	10.6	11.8	66	33	01	-	
11	13.0	160	++	33	11.0	15.5	65	34	-	01	
12	19.0	00	NES	33	11.0	12.7	62	35	02	01	
13[*]	14.0	00	NES	35	11.6	10.4	60	40	-	-	
14[*]	15.0	00	NES	34	11.3	10.0	42	58	-	-	
15[*]	13.0	00	NES	32	10.6	08.0	36	64	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group II (*H. placei* infected Sheep) Week 4

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	20.5	180	+[b]	31	10.3	15.0	82	17	01	00	
9	16.5	380	+	20	06.6	12.8	61	36	02	01	
10	16.5	380	++	30	10.0	14.3	67	31	01	01	
11	13.0	3,120	+++	25	08.3	16.1	75	25	-	-	
12	19.0	160	++	29	09.7	11.7	78	21	01	-	
13[*]	14.0	00	NES[a]	28	09.3	14.0	75	24	-	01	
14[*]	17	00	NES	32	10.6	12.1	60	40	-	-	
15[*]	15	00	NES	30	10.0	10.1	54	46	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group II (*H. placei* infected Sheep) Week 5

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	19	240	++[b]	32	10.6	17.0	76	22	01	01	
9	15	520	++	31	10.3	14.2	70	27	02	01	
10	16	320	++	32	10.6	12.8	68	32	-	-	
11	12	7,100	+++	25	08.3	14.1	60	38	02	-	
12	18	80	++	29	11.3	16.0	83	17	-	-	
13[*]	13	00	NES	31	10.3	14.8	68	30	01	01	
14[*]	18	00	NES	31	10.3	16.2	65	35	-	-	
15[*]	16	00	NES	29	09.6	14.2	59	41	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group II (*H. placei* infected Sheep) Week 6

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	19.5	1,200	++[b]	36	12.0	12.5	81	18	01	-	
9	15.0	1,100	++	33	11.0	06.8	91	08	01	-	
10	15.0	1,200	++	32	10.6	10.9	80	20	-	-	
11	14.0	14,440	+++	25	08.3	12.1	77	22	-	01	
12	19.0	00	NES	35	11.3	08.0	92	07	-	01	
13[*]	14.0	00	NES	31	10.3	10.4	82	18	-	-	
14[*]	18.0	00	NES	34	11.3	12.7	33	67	-	-	
15[*]	16.0	00	NES	32	10.6	09.7	27	73	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group II (*H. placei* infected Sheep) Week 7

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	19.0	80	++[b]	33	11.0	12.9	90	10	-	-	
9	15.0	40	++	29	09.6	11.7	86	1`2	01	01	
10	16.0	30	++	26	08.6	09.6	64	34	02	-	
11	12.0	10,280	+++	21	07.0	13.1	48	50	01	01	
12	15.5	60	++	36	12.0	10.5	35	64	-	01	
13[*]	14.0	00	NES	29	09.6	16.0	84	15	-	01	
14[*]	17.0	00	NES	34	11.3	13.4	63	37	-	-	
15[*]	16.0	00	NES	30	10.0	10.0	57	43	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group II (*H. placei* infected Sheep) Week 8

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	16.5	160	++[b]	32	10.4	13.6	66	33	-	01	
9	13.0	00	NES	35	11.6	10.9	68	31	-	01	
10	13.0	00	+	33	11.0	11.8	61	38	-	01	
11	09.0	3,940	+++	32	10.4	12.5	82	18	-	-	
12	12.5	00	NES	38	12.6	12.4	46	54	-	-	
13*	10.5	00	NES	30	10.3	12.0	53	47	-	-	
14*	17.0	00	NES	31	10.3	09.0	40	60	-	-	
15*	16.0	00	NES	29	09.6	06.0	34	66	-	-	

[a] No egg seen

[b] Strongyle ova

* Non infected control

Group II (*H. placei* infected Sheep) Week 9

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	20.5	160	++[b]	28	09.3	15.1	86	14	-	-	
9	16.0	380	++	32	10.6	14.8	88	12	-	-	
10	16.5	420	++	29	09.6	12.5	84	16	-	-	
11	14.0	3,600	+++	33	11.0	13.0	80	20	-	-	
12	16.0	260	++	32	09.6	14.2	72	28	-	-	
13*	13.0	00	NES	27	09.0	11.9	63	35	01	01	
14*	16.0	00	NES	32	10.6	09.0	39	61	-	-	
15*	14.0	00	NES	30	10.0	07.0	33	67	-	-	

[a] No egg seen

[b] Strongyle ova

* Non infected control

Group II (*H. placei* infected Sheep) Week 10

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	20.0	220	++[b]	41	13.6	14.5	84	16	-	-	
9	17.0	340	++	31	10.3	13.8	76	22	02	-	
10	16.5	220	++	30	10.0	14.7	79	19	01	01	
11	13.0	40	++	33	11.0	15.0	82	17	01	-	
12	15.0	620	++	32	10.6	14.3	68	30	02	-	
13[*]	12.5	00	NES	27	09.0	16.0	65	35	-	-	
14[*]	17.0	00	NES	32	10.6	10.0	33	67	-	-	
15[*]	15.5	00	NES	28	09.3	08.0	27	73	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group II (*H. placei* infected Sheep) Week 11

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	19.5	160	++[b]	34	11.3	12.7	72	27	01	-	
9	16.0	40	+	40	13.0	13.0	76	24	-	-	
10	16.0	00	NES	33	11.0	15.3	76	21	02	01	
11	12.5	40	+	42	14.0	14.5	82	18	-	-	
12	17.0	60	+	30	10.0	16.3	85	14	01	-	
13*	12.0	00	NES	33	11.0	15.0	88	12	-	-	
14*	18.0	00	NES	30	10.0	14.6	52	48	-	-	
15*	16.0	00	NES	28	09.3	11.0	46	54	-	-	

[a] No egg seen

[b] Strongyle ova

* Non infected control

Group II (*H. placei* infected Sheep) Week 12

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	21.0	320	++[b]	38	12.6	14.0	69	31	-	-	
9	16.0	200	++	33	11.0	10.1	67	33	-	-	
10	16.0	340	+	36	12.0	14.4	81	16	02	01	
11	14.0	260	++	43	14.3	18.2	74	25	-	01	
12	17.0	00	NES	33	11.0	15.4	80	20	-	-	
13[*]	11.0	00	NES	35	11.6	13.3	75	25	-	-	
14[*]	16.5	00	NES	31	10.3	11.0	54	46	-	-	
15[*]	16.0	00	NES	29	09.3	09.0	48	52	-	-	

[a] No egg seen

[b] Strongyle ova

[*] Non infected control

Group II (*H. placei* infected Sheep) Week 13

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	22.0	140	++[b]	33	11.0	10.3	62	38	-	-	
9	17.0	140	+	29	09.5	12.0	63	36	01	-	
10	16.0	1,000	+++	33	11.0	14.7	81	19	-	-	
11	14.0	300	++	34	11.3	10.6	80	20	-	-	
12	16.0	440	++	29	09.6	07.8	74	26	-	-	
13*	12.0	00	NES	28	09.3	14.5	43	57	-	-	
14*	21.0	00	NES	30	10.0	13.0	57	43	-	-	
15*	19.5	00	NES	27	09.0	11.8	49	51	-	-	

[a] No egg seen

[b] Strongyle ova

* Non infected control

Group II (*H. placei* infected Sheep) Week 14

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	21.0	40	++ [b]	32	10.6	11.9	47	53	-	-	
9	16.0	80	++	29	09.6	08.6	51	48	01	-	
10	16.5	100	++	31	10.3	12.5	53	47	-	-	
11	14.0	00	NES	29	09.6	13.8	55	45	-	-	
12	17.0	40	++	30	10.0	12.9	54	46	-	-	
13*	12.0	00	NES	26	08.6	11.6	34	66	-	-	
14*	20.0	00	NES	36	12.0	16.0	72	27	-	01	
15*	17.5	00	NES	30	10.0	14.2	66	44	-	-	

[a] No egg seen

[b] Strongyle ova

* Non infected control

Group II (*H. placei* infected Sheep) Week 15

S/no.	Wt (Kg)	Egg/gram (Epg)	Floatation technique	Pcv (%)	Hb (g/dl)	WBC	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	Remarks
8	24.0	00	NES	35	11.6	11.4	51	49	-	-	
9	19.0	00	NES	35	11.6	11.2	58	42	-	-	
10	19.0	00	NES	32	10.6	10.4	60	40	-	-	
11	16.0	180	++ [b]	37	12.3	12.3	58	39	02	01	
12	19.0	60	+	34	11.3	13.4	57	41	01	01	
13*	15.0	00	NES	27	09.0	11.8	40	60	-	-	
14*	20.0	00	NES	35	11.6	13.8	87	13	-	-	
15*	18.5	00	NES	31	10.3	11.9	80	19	-	01	

[a] No egg seen

[b] Strongyle ova

* Non infected control

APPENDIX C: Solutions / Fluid

Buffer

PH	Na_2HPO_4 (9.5g/L) (anhydrous)	$NaH_2PO_4.H_2O$ (9.2g/L) or KH_2PO_4 (9.07g/L)	Distilled water
7.0	61.1ml	38.9ml	900 ml
7.2	72.0ml	28.0ml	900 ml

Digestive Fluid

Distilled Water (Warmed)	1 L
Powdered Pepsin	5 g
Hydrochloric acid	7 ml

Drabkin's Diluent

Sodiium bicarbonate ($NaHCO_3$)	1 g
Potassium Cyanide (KCN)	0.05 g
Potassium ferricyanide ($K_3Fe(CN)_6$)	0.20 g
Distilled water	1000 ml

Formalin (10%)

Commercial formalin	10 ml
Distilled water	90 ml

F.A.A. (formol – alcohol – acetic)

Formalin	10 parts

Alcohol, ethyl 85%	85 parts
Acetic acid, glacial	05 parts

Giemsa stain

Thin smear

Stock Giemsa solution	1 pt
Phosphate buffer	10 pts

Thick smear

Stock Giemsa solution	1 pt
Phosphate buffer	50 pts

Floatation medium (Specific gravity 1.180)

Zinc Sulphate	380 g
Tap water	1000 ml
Thymol	1 crystal

Normal saline (Physiological solution)

Sodium Chloride	9 g
Distilled water	1000 ml

WBC Diluting fluid

1% Gentian Violet	0.5 ml
Conc. Glacial acetic acid	10 ml
Distilled water	50 ml

APPENDIX D – H:



Plate D: Camel used as beast of burden in Zamfara State.



Plate E: Camel slaughtered for meat at Katsina abattoir.



Plate F: Ox-pecker birds in symbiosis with camels.



Plate G: Camels feeding on *Azadiracta indica* (neem) at one of the study sites.



Plate H: Camels grazing at one of the study sites.