SUBCLINICAL GASTROINTESTINAL PARASITOSES IN HORSES OF ANIMAL FAIRS IN RAJASTHAN

राजस्थान के पशु मेलों के अश्वों में उपशयनिक जठरान्त्रीय परजीवी संचार

PRAVEEN KUMAR PILANIA

THESIS

MASTER OF VETERINARY SCIENCE

(Veterinary Parasitology)

।।पशुधनं नित्यं सर्वलोकोपकारकम्।।

2010

Department of Veterinary Parasitology
College of Veterinary and Animal Science
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THESIS

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In partial fulfillment of the requirements for
the degree of

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(Veterinary Parasitology)

By
PRAVEEN KUMAR PILANIA

2010

Rajasthan University of Veterinary and Animal Sciences,
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CERTIFICATE - I

Date 08-09-2010

This is to certify that **Mr. Praveen Kumar Pilania** has successfully completed the **comprehensive examination** held on 07-08-2010 as required under the regulations for **Master of Veterinary Science** degree.

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This is to certify that this thesis entitled "**SUBCLINICAL GASTROINTESTINAL PARASITOSES IN HORSES OF ANIMAL FAIRS IN RAJASTHAN**" submitted for the degree of Master of Veterinary Science in the subject of Veterinary Parasitology embodies bonafide research work carried out by Mr. Praveen Kumar Pilania under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of the thesis was also approved by the advisory committee on 07-09-2010

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LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

INTRODUCTION

1. INTRODUCTION

The total global horse population is estimated at 58 millions, according to a report compiled by the Food and Agriculture Organization of the United Nations (FAOSTAT, 2007). Equines have a prominent position in the agricultural systems of many developing countries as they act as a mean of transport for men and material and provide livelihood to a number of rural and semi-urban population of India. India holds about 0.751 million horses and ponies (Census, 2003). The equine population is unevenly distributed all over the country. Total population of horses in Rajasthan is 24.74 thousand (Census, 2007). They do suffer from a number of diseases. Parasitic infestation is a major cause of illness. Documentation of parasitic infestations of equines in our country is lacking.

Monitoring equines numbers and habitat conditions as well as ascertaining parasitic disease surveillance become extremely important in maintaining adequate numbers of healthy equines. Scanty reports are available on the occurrence of parasitic infections in equines from plains of India (Chaudhri *et al.*, 1985; Sengupta and Yadav, 1997, 1998 and 2001). In Rajasthan there had been a few studies on endoparasites in horses. Also no attention has been paid to determine the potential losses in equines population. Thus, a need is felt to conduct a study regarding parasitic prevalence and its control which gives the suggestive guideline for vet-practitioner. Incidence of clinical and sub-clinical diseases of horses can be minimized through controlling the gastrointestinal parasites.

Parasitic infestations are the major veterinary problems in most of the developed and under-developed countries of the world. Some parasitic infestations even cause death when the control measures are neglected (Hayat *et al.*, 1987) and it is very important to take care of horses in investigating their parasitic diseases and to find the best

possible control measures, due to their inevitable role in daily life. These parasitic infestations are found at alarming and noxious level and have been considered highly responsible for substantial economic losses (Hourrigan, 1979)

Horses are said to have the largest collection of parasites of all domestic livestock. It is not unusual for a seemingly healthy horse to harbor over one-half million gastrointestinal nematode parasites. These parasites cause damage to the animals both during the infection phase when the invading larvae are undergoing early development in various tissues of the body and then again after these larval stages have emerged and developed fully to adult parasites living in their final or predilection sites laying eggs back into the environment (Bliss, 1999).

Overall, millions of dollars are spent every year for internal parasite control in horses; however, internal parasites remain one of the most important problems affecting the health and well-being of horses. The reason for this is that parasite control measures recommended and practiced over the past 25 years seem to have provided limited protection to the horse because they remove infections after these infections have already developed and the damage to the horse is already done with little or no effect on reducing environmental contamination.

Subclinical parasitism is hard to see and measure. Subclinically infected animals appear normal but this parasitism is responsible for reduced growth rates in foals, reduce reproductive rates in mares, reduced milk production for the young and a reduced ability of the infected animal's immune system to fight off other disease conditions. In performance horses, subclinical levels of parasitism and even slightly reduced performance can be very important.

Subclinical parasitism can be very costly because the owner is often unaware of the damage that is taking place since the parasites are not visible and the reduced performance can occur unknowingly.

The most important aspect of subclinical parasitism, however, is the ability of subclinically infected animals to shed worm eggs into the environment producing future infections. Subclinically infected animals, even with low worm egg counts, may be shedding thousands of eggs back in the horse's environment everyday. A horse with a parasite egg count of 2,000 eggs per gram of faeces, not an uncommon amount, could easily discharge 25 million eggs per day and, provide a ready source of infection for its pasture or pen mates (Stoltenow and Purdy, 2003).

In the livestock rich state of Rajasthan large number of animal fairs are held every year at different places. The animal fairs held at Nagaur, Merta city, Tilwara, Hanumangarh and Pushkar are important fairs of Rajasthan in which horses are brought in good numbers for business and sale. In these fairs horses are brought not only from Rajasthan but also from adjoining states. It was thought proper to carryout the faecal examination for recording subclinical gastrointestinal parasitoses of these horses which may represent whole of the state of Rajasthan with the following objectives:

1. To record the prevalence of subclinical gastrointestinal parasitoses in horses of animal fairs in Rajasthan by means of faecal examination.
2. To record intensity of gastrointestinal parasites of these horses.
3. To culture and identify the various infective larvae from strongyle eggs of these horses.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

The young animals and animal on poor diet tend to be more susceptible to parasitic infections. Animal suffering from current diseases are more likely to show the signs of parasitic disease. After parasitic infections some animals show severe signs or die whereas the rest of the herd demonstrates chronic, sub acute or subclinical manifestation of infection. Mere presence of the parasite will not produce the disease and severity of parasitic infections depends upon the host, parasite and environment, each of which in turn, includes many factors. In the host category the factors are age, sex, species resistance, nutritional status and ability to develop immunity to parasitic infection; while in the parasite category the factors are life cycle pattern, survival of larvae/egg on pasture and interaction between the host and environment which play an important role in causing parasitoses; and finally the environmental factors like climatic and seasonal variations in rain fall, temperature, humidity, amount of vegetation and micrometeorological conditions (presence of overgrazed areas or damp low lying terrain factors) have a profound effect on the transmission of most of the parasitic infestations (Shankariah, 1996).

2.1. Prevalence

Schoene (1938) studied incidence of strongyles by faecal examination in 200 military horses at Hanover and found strongyles (100%), ascarids (26%) and cestodes (4.5%).

De Jesus and Uichanco (1939) conducted faecal samples examination of 428 Philippine horses, aged few months to 12 years and found 95% of them infected with parasites such as *Strongylus spp.*

(93.2%), *Trichonema spp.* (29.6%), *Parascaris equorum* (16%), *Oxyuris equi* (8.2%) and *Anoplocephala perfoliata* (1.4%).

Hadley (1943) conducted faecal examination of 71 horses in a stud farm in Wiscosin and recorded strongyle (100%), *Parascaris equorum* (76%), *Anoplocephala spp.* (32%) and *Strongyloides westeri* (15.5%) infections.

Poynter (1970) examined 16103 faecal samples from 3227 horses and found *Parascaris equorum* (27.4%) and *Strongyloides westeri* (4.4%) infections.

Nebel (1976) examined samples of faeces from 100 horses in the German Federal Republic and found larvae of *Gasterophilus intestinalis* in one sample and *Eimeria leuckarti* in 4 samples.

Romano and Rubio (1977) examined faecal samples from 100 racehorses and also applied adhesive tapes to the perianal region for examining *Oxyuris equi* and revealed that Strongylidae infections were very common and *Parascaris equorum* and *Oxyuris equi* species occurred rarely.

Ambrosi and Piergili (1978) examined faecal samples of 126 horses from 18 farms and stables in Italy, of which 27 were positive for ascarids, 2 for *Strongyloides westeri*, 3 for anoplocephalids and 100 for strongyles.

Lopez and Mateus (1978) while conducting faecal examination found heavy infections of *Oxyuris equi* and strongyle in random faecal samples of 5 horses from the savanna region around Bogota, Colombia.

Mirck (1978) examined the faeces of 3791 horses and ponies in Utrecht, the Netherlands and revealed strongylids (57.3%), *Parascaris*

Fries (1982) examined 10871 faecal samples of horses in the Berlin area of Germany and found that strongyle eggs were present in 76.4%of the samples. Infections were higher among horses aged up to 4 years than in older groups and were higher in the summer than in the winter.

Schlichting and Stoye (1982) concluded that out of 100 foals, 81 exhibited patent *Strongyloides westeri* infection for up to 30 days after birth. Foals of nonpregnant mare showed higher and more protracted egg excretion than those mares which conceived again.

Fischer and Stoye (1983) reported that faecal examinations in 163 horses in five herds over a 12 month period in the lower Elbe area revealed *Fasciola hepatica* in two herds grazing water meadows and concluded that in one herd 38.5% of the horses were infected, and in the other 70.7%. Infection rates were higher in foals (43.3%) than in adults aged 3 years or more (20%).

Bauer and Stoye (1984) after faecal examination of 2314 horses reported infections of strongyles (63%), *Parascaris equorum* (6%), *Strongyloides westeri* (2%) and *Eimeria leuckarti* (1%).

Chaudhri *et al.* (1985) collected 2481 faecal samples of equines from wet (Karnal, Kurukshetra, Ambala, Jind, Sonepat and Rohtak districts) and dry (Hisar, Sirsa, Bhiwani, Gurgaon and Mohindergarh districts) regions of the state during 1975 to 1984 and found 51.14% animals infected with strongyles (45.3%), *Parascaris equorum* (3.5%) , *Strogyloides westeri* (9.3%) and paramphistomes (1.8%).

Islam (1986) examined 275 horses in Zambia, and revealed that 146 (53.09%) were infected with helminths parasites. Apart from strongyle, *Oxyuris equi* (13.45%), *Habronema megastoma* (12.72%), *H. muscae* (11.63%), *Parascaris equorum* (8.72%), *H. microstoma*

(6.54%), *Gastrodiscus aegyptiacus* (4.72%), *Strongyloides westeri* (3.63%), *Anoplocephala magna* (2.90%), *A. perfoliata* (1.81%) and *Dictyocaulus arnfieldi* (1.45%) were also recorded.

Jurasek (1986) while examining 292 faecal samples from horses in Mozambique, found *Strongylus spp.* (97%) and *Parascaris equorum* (1.7%).

Imrie and Jacobs (1987) collected and examined faecal samples of 80 horses from 20 stables and found *Anoplocephala perfoliata* in 22 horses (27.5%) from 12 stables.

Shalaby (1987) examined faecal samples of 140 diarrhoeic horses aged 5-7 years and found most of these infected with *Parascaris equorum, Strongyloides westeri, Strongylus spp.* and *Oxyuris equi.*

Silobad (1987) conducted faecal examination of 118 horses at the Zobnatica stud farm in Yugoslavia for gastrointestinal nematodes and found 83.3% foals (up to 1 year), 100% horses (1-2 years), 83.3% mares and 62.9% stallions infected. The infection of *Parascaris equorum* in these animals was 7.4, 75.0, 13.8 and 11.1% and that of strongyles was 74.1, 100, 80.5 and 62.9%, respectively.

Lyons *et al.* (1988) examined faecal samples from 164 foals on 13 farms in central Kentucky, USA and recorded oocysts of *Eimeria leuckarti* in 67 (41%) of the foals on 11 farms.

Dvorakova (1990) reported the results of faecal examination of horses for parasites sent to the Ceske Budejovice Veterinary Department from all parts of southern Czechoslovakia during 1984-1988 and reported the annual rates varying from 50 to 66% for Strongylidae and 0 to 25% for Trichonematidae and Ascarididae.

Nowosad *et al.* (1991) examined horses on 3 studs in Poland and 2 studs in Czechoslovakia during 1984-1986 for gastrointestinal nematodes and found strongyles and *Parascaris equorum* in Czech horses and *Oxyuris equi* in Polish horses. Prevalence rates varied from 87 to 100% for Czech horses and from 94 to 100% for Polish horses.

Virga *et al.* (1991) examined faecal samples of 153 horses and 11 mules slaughtered at Palermo abattoir in July-November, 1990 and showed infections of strongyles (93.3%), *Parascaris equorum* (26.8%), Anoplocephalidae (3.6%) and *Strongyloides westeri* (2.4%).

Santos *et al.* (1992) studied the occurrence of helminths in the faeces of horses (*Equus caballus*) in Bahia State, Brazil. A total of 102 faecal samples were examined among these 70 samples (68.6%) were infected with nematodes, such as *Strongylus spp.* (32-67%), *Strongyloides westeri* (13-27%), *Trichostrongylus axei* (0-12%) and *Parascaris equorum* (9-36%).

Epe *et al.* (1993) examined 9192 faecal samples of horses during 1984-1991 and detected strongylids (55.5%), Parascaris *equorum* (4%), anoplocephalids (2.2%), *Strongyloides westeri* (1.6%), *Oxyuris equi* (0.7%), *Eimeria leuckarti* (0.6%), *Fasciola hepatica* (0.2%) and *Dictyocaulus arnfieldi* (0.04%).

Itagaki *et al.* (1993) examined faecal samples from 123 horses on 11 farms in Japan during May-August, 1992 and showed that 122 (99.2%) were infected with strongyles and 25 (20.3%) with *Parascaris equorum.*

Lyons *et al.* (1993) examined faecal samples for *Strongyloides westeri* from 382 horse foals in central Kentucky, USA and revealed that it was present in 6% (22 of 382) of the foals on 7 of the 9 farms.

Ozer and Kucukerden (1993) while studying faecal samples from 225 equines in Elazg Province, Turkey found *Eimeria uniungulati* (2.2%), *E. solipedium* (0.9%), *Parascaris equorum* (2.7%), *Strongyloides westeri* (8.0%), *Strongylus spp.* (67.1%) and *Anoplocephala perfoliata* (0.4%).

Al-Alousi *et al.* (1994) conducted examination of faecal samples of 50 horses in Iraq and showed that parasitic infection rate was 66%. The most prevalent parasites were *Parascaris equorum* (28%) and *Strongylus spp.*

Battelli *et al.* (1995) conducted faecal examination of 51 horses (<3 years old) from studs in the province of Udine, Italy, 1993 and revealed coccidian oocysts of *Eimeria leuckarti* in 6 foals, 2 stallions and 1 mare.

Demir *et al.* (1995) while examining the faecal samples of 430 horses from Bursa, Turkey found 391 (90.9%) horses infected with the parasites namely *Dicrocoelium dendriticum* (1.1%), *Fasciola spp.* (1.6%), *Anoplocephala spp.* (1.3%), *Strongyloides westeri* (0.4%), Strongylidae (90.9%), *Parascaris equorum* (5.1%), *Oxyuris equi* (1.3%), *Trichuris spp.* (1.1%) and *Probstmayria vivipara* (0.4%).

Krecek *et al.* (1995) carried out a study on the parasites of 3 wild horses from the Namib Desert, Namibia and found all infected with *Habronema muscae*, *Oxyuris equi*, *Strongylus spp* and *Gasterophilus spp.*

Al-Khafaji and Al-Saad (1996) studied gastrointestinal parasites by faecal examination in 60 draught horses in Iraq and encountered *Parascaris equorum* (33.3%), *Strongylus spp.* (16.7%), *Gasterophilus spp.* (13.3%), *Anoplocephala spp.* (11.7%) and *Balantidium coli* (8.3%).

Sengupta and Yadav (1997) studied the seasonal prevalence of helminths in pony mares in the tarai area of Uttar Pradesh, India. Faecal samples were examined in March-June (summer), July-October (rainy season) and November-February (winter). Infection of *Strongylus spp.* was found in 40 of 62 ponies examined in the winter, in 18 of 51 examined in the rainy season and in 23 of 55 examined in the summer. Other helminths found were *Gastrodiscus aegyptiacus* (in 17 of 55 in the summer), *Trichonema spp.* (in 11 of 62 in the winter, 3 of 51 in the rainy season and 1 of 55 in the summer), *Trichostrongylus axei* (in 5 of 62 in the winter), *Strongyloides westeri* (in 2 of 62 in the winter), *Dictyocaulus arnfieldi* (in 1 of 62 in the winter), *Parascaris equorum* (in 8 of 55 in the summer) and *Oxyuris equi* (in 1 of 55 in the summer).

Sotiraki *et al.* (1997) investigated 300 faecal samples of equines (226 from horses and 37 from donkeys and mules) in Greece and found that prevalence of infection was 62.4% for horses, 75.7% for donkeys and 89.2% for mules. Besides Strongyles spp. which was predominant (large strongyles in horses (42.5%), donkeys(73.0%), and in mules (89.2%), respectively), (small strongyles in horses (45.6%), donkeys(37.8%), and in mules (89.2%), respectively) other species recorded were *Eimeria leuckarti* (2.6% in horses and 8.1% in donkeys), *Anoplocephala perfoliata* (0.4% in horses), *Parascaris equorum* (1.7% in horses), *Oxyuris equi* (4.1% in horses and 8.7% in mules), *Strongyloides westeri* (2.2% in horses, 5.4% in donkeys and 10.8% in mules), *Dictyocaulus arnfieldi* (0.9% in horses and 2.7% in donkeys) and *Setaria equina* (2.2% in horses and 2.7% in donkeys).

Epe *et al.* (1998) examined 3103 faecal sample of horses in Hannover, Germany and revealed Strongylids (48.46%), *Parascaris equorum* (1.66%), anoplocephalids (2.92%), *Strongyloides westeri* (0.77%), *Oxyuris equi* (0.5%), *Eimeria leuckarti* (0.35%) and *Fasciola hepatica* (0.17%).

Langrova (1998) studied prevalence of helminths by faecal examination in thoroughbred horses on a stud farm near Prague, Czech Republic and recorded Strongylidae (60.5%), Strongylinae (8.15%), *Parascaris equorum* (2.91%), *Strongyloides westeri* (1.88%) and *Habronema spp.* (0.73%).

Sengupta and Yadav (1998) found that the parasitic infection rate was higher in unorganized husbandry practices (128 equines: 13 horses, 17 donkeys, 98 mules) than in organized practices (141 equines: 84 horses, 54 donkeys, 3 mules) in Haryana. The *Strongylus spp.* was the major parasitic infection with prevalences of 57.81% in the unorganized sector and 14.18% in the organized sector. The other species recorded were *Trichonema spp.* (15.63%), *Paramphistomum spp.* (7.81%), *Trichostrongylus spp.* (6.25%), and *Oxyuris equi* (0.78%) in the unorganized sector, and *Anoplocephala spp.* (2.12%), *Parascaris equorum* (3.54%), *Oxyuris equi* (2.83%) and *Eimeria leuckarti* (1.41%) in the organized sector.

Perez (1999) recorded less than 50% prevalence of strongylid infection on farm 1, 80-100% on farm 2, 50-90% on farm 3 and 42-82% on farm 4 by faecal examination of 120 thoroughbred horses on 4 farms in the states of Aragua and Carabobo, Venezuela.

Piskin *et al.* (1999) examined faeces of 72 horses and found 30 horses infected with one or more helminth species. The species identified were Strongyle type in 22, *Strongyloides westeri* in 5 and *Parascaris equorum* in 1 horse. *Oxyuris equi* was detected in 2 out of 63 horses examined by the cellophane tape method.

Chaudhri and Singh (2000) observed that equines mainly suffered from cyathostomes, *Strongylus vulgaris, S. edentatus, S. equinus, Strongyloides westeri, Parascaris equorum,* and *Trichostrongylus axei* in Haryana.

Mundim *et al.* (2000) investigated 175 faecal samples of horses collected from Brazil and revealed that 163 samples (93.14%) were infected with helminth ova. The species identified were strongylids (92.57%), *Parascaris equorum* (9.71%), *Oxyuris equi* (4.0%) and *Strongyloides westeri* (5.14%).

Omar *et al.* (2000) examined 18 faecal samples from 18 miniature horses imported into Egypt from North Carolina, USA. Three species of helminths and three species of *Eimeria* were detected with an overall prevalence of 24% and 46.3%, respectively. The helminths recorded were *Parascaris equorum* (44.5%), small strongyles (16.7%) and *Dictyocaulus spp.* (11.1%).

Beelitz and Gothe (2001) tested four coprological methods for the detection of *Anoplocephala perfoliata* eggs in faeces and found that sedmentation/flotation methods was best for the detection of ova in 18 (47.4%) out of 38 parasitized horses.

Holland *et al.* (2001) recorded strongyle infections in 247 horses in 2 geographical areas, the Red River delta and the mountainous area of North Vietnam. The prevalence of *Strongylus spp.* was <7 per cent.

Konigova *et al.* (2001) counducted coprological examination of 913 horses from 46 stud farms and recorded the prevalence of equine gastrointestinal parasites in the Slovak Republic. The prevalence of strongyle type and *Parascaris equorum* eggs was 63.75 and 10.95%, respectively. *Strongyloides westeri*, *Dicrocoelium dendriticum* and *Anoplocephala spp.* were also detected in low numbers.

Lonc *et al.* (2001) examined faecal sample of domestic animals at farms of Silesia, Poland and found highest prevalence of parasites (52%) in horses. Ninty eight English blood-horses were mainly infected with *Parascaris equorum* and strongylids.

Sengupta and Yadav (2001) studied parasitic infections in 306 equines (93 horses, 198 donkeys and 15 mules), under organized (OHP) and unorganized husbandry practices (UHP), in the Bikaner area of Rajasthan. The range and quantum of infections were found higher in unorganized husbandry practices than in organized husbandry. *Strongylus spp.* infection was predominant in both organized (3.74%) and unorganized (15.59%) farms. The other species encountered in unorganized husbandry practices were *Trichonema spp.* (6.42%) and *Trichostrongylus spp.* (1.83%).

Banerjee *et al.* (2002) examined faecal samples of mules in Tarai region of Uttaranchal State and recorded strongyles, *Oxyuris equi*, *Parascaris equorum* and amphistomes.

Gawor (2002) recorded prevalence of intestinal parasites in riding horses and revealed strongyles (81%), ascarids (5.6%) and tapeworms (2.1%).

Konigova *et al.* (2002) investigated faecal samples of 913 horses from 46 stud farms in Slovakia and revealed family Strongylidae (63.8%) and *Parascaris equorum* (10.9%). Other parasite eggs were also detected in low numbers.

Montinaro *et al.* (2002) studied epidemiology of gastrointestinal nematode infections in horses in Sardinia. A total of 356 faecal samples were collected and examined for nematode eggs and prevalence of 63.5% and 12.9% was recorded for gastrointestinal strongyles and ascarids, respectively.

Rehbein *et al.* (2002) examined 2034 and 646 faecal samples of horses from Germany and Austria, respectively and the prevalence of *Strongylus spp.* (76.6 and 61.3%), *Parascaris equorum* (4.0 and 4.3%), *Oxyuris equi* (0.6 and 0.3%), *Strongyloides westeri* (0.1 and 0.3%),

Anoplocephala spp. (9.8 and 10.8%), and *Eimeria leuckarti* (0.1 and 0.9%) infections were recorded. *Habronema spp.* and *Paranoplocephala spp.* were observed in 0.05 and 0.5% of samples from Germany.

Singh *et al.* (2002) while conducting epidemiological study on gastrointestinal parasites in equines in Uttaranchal and Uttar Pradesh examined a total number of 600 faecal samples and found strongyles (86.65%), *Parascaris equorum* (25.33%) and amphistomes (12.94%) infections and few animals were also infected with *Oxyuris equi*, anoplocephalids, and Coccidia organisms.

Gul *et al.* (2003) examined faeces of 464 horses and 110 donkeys and showed that 327 of 464 (70.5%) horses and 85 of 110 (77.3%) donkeys were infected with helminth parasites. The species recorded in horses were Strongylidae (62.7%), *Strongyloides westeri* (5.8%), *Parascaris equorum* (3.2%), *Anoplocephala spp.* (2.4 %), *Fasciola hepatica* (0.9%), *Oxyuris equi* (0.6%), and *Paranoplocephala mamillana* (0.2%); and in donkeys; Strongylidae spp. (72.7%), *Strongyloides westeri* (13.6%), *Parascaris equorum* (2.7%), *Fasciola hepatica* (0.9%), *Oxyuris equi* (0.9%) and *Dicrocoelium dendriticum* (0.9%).

Oleaga *et al.* (2003) while examining faecal samples from different animals/birds in Salamanca recorded that 33.35% of 47 horses examined were infected by parasites.

Sengupta and Yadav (2003) recorded prevalence of gastrointestinal helminths in equines and found *Strongylus spp.* predominantly infecting 61.62% horses, 50.00% donkeys and 47.14% mules. Other parasites like *Dictyocaulus arnfieldi*, *Oxyuris equi*, *Strongyloides westeri*, *Anoplocephala spp.* and Paramphistomes spp., were also recorded in some hilly pockets of western Himalayas.

Aydenizoz (2004) processed 100 faecal samples of horses in Kirikkale, Turkey and found that 74% of the horses were infected with different helminth species. The helminth species found were Strongylidae (71%), *Parascaris equorum* (3%), *Anoplocephala perfoliata* (1%), and *Dicrocoelium dendriticum* (1%). Of these horses 72% were infected with only one helminth species, and only 2% of the horses were infected with two species.

Bakirci *et al.* (2004) conducted a survey to characterize the respiratory and gastrointestinal parasites in 85 horses of varying age, gender and breeds, Turkey. The faecal samples were examined by flotation, sedimentation and the Baermann-Wetzel method. The result showed that 64 horses (75.29%) were infected with atleast one (62.35%) or two (12.94%) parasites, respectively. The species encountered in the stud were Strongylidae (71.76%), *Parascaris equorum* (8.23%), *Dictyocaulus arnfieldi* (1.17%), *Oxyuris equi* (1.17%), Anoplocephalidae (1.17%) and *Eimeria leuckarti* (5.88%).

Cirak *et al.* (2004) studied daily faecal egg output of 6 thoroughbred Arabian horses for 3 days after anthelmintic treatment in Turkey, and observed *Anoplocephala magna* in 2 of 6 horses.

Epe *et al.* (2004) examined 4399 faecal samples in Germany during 1998 -2002 from horses and revealed strongylids (37.4%), anoplocephalids (1.4%), *Strongyloides westeri* (1.3%), *Parascaris equorum* (0.9%), *Oxyuris equi* (0.04%), *Eimeria spp.* (0.04%) and *Fasciola hepatica* (0.04%).

Gundach *et al.* (2004) analysed faeces of 899 horses of different breeds 1-16 years of age by floatation method in Lublin district and recorded *Eimeria leuckarti*, anoplocephalid, ascarid and strongylid infections.

Khajuria *et al.* (2004) recorded 77.75% incidence of helminth parasites in equines (265 horses and 162 mules) of Jammu region, India based on faecal examination. The samples were positive for strongyles (66.04%), *Strongyloides westeri* (16.39%), ascarids (4.68%), oxyurids (7.72%), amphistomes (3.74%) and mixed infections (20.84%). The faecal examination of equines from Katra town revealed higher infection rate (81.72%) as compared to Tehsil R.S. Pura (69.34%) of Jammu region. The incidence recorded from Katra revealed strongyles (72.06%), *Strongyloides westeri* (17.93%), ascarids (4.13%), oxyurids (8.27%), amphistomes (2.06%) and mixed infection (22.41%) whereas R.S. Pura showed corresponding figures as 53.28, 13.13, 5.83, 6.56, 7.29 and 17.51%, respectively. The prevalence of helminths in mules (82.71%) was higher than in horses (74.71%). The overall incidence of infection was 82.14%, 68.08%, 77.77% and 75.22% in summer, autumn, winter and spring, respectively.

Kornas *et al.* (2004a) recorded prevalence of *Parascaris equorum* during 2000-2002 in stallions, mares and young horses kept in different management systems in Western Poland by using Mc Master Method.

Kornas *et al.* (2004b) observed the current level of intestinal parasite infection in routinely treated, 752-975 stables, 94-132 stallion depots and 20-42 riding club horses from different types of environments in Poland. The parasites were found in 39.3-84%, 21.3-73.7% and 41.8-61.9%, in stables, riding club and stallion depots horses, respectively. A roundworm infection was found in 1.3-14.4% and 1.4-8.1% in horses kept in stables and stallion depots, respectively. Tapeworms were found only in two stables, and their prevalence was very low (6.2%).

Kornas *et al.* (2004) recorded the intestinal parasite infection of horses from riding clubs in Krakow, Poland and revealed that most common parasites were strongyles (Strongylidae). The seasonal mean prevalence of infection (April-October) in 2002 were higher in horses under pasture system (73.9%) than in horses on paddocks with grass (42.1%) and horses on paddocks without grass (19.2%).

Lyons and Tolliver (2004) examined oocysts in the faeces of 733 thoroughbred foals on 14 farms in central Kentucky, and recorded *Strongyloides westeri* (1.5%), *Parascaris equorum* (22.4%), strongyles (27.6%) and *Eimeria leuckarti* (41.6%) in feces of foals. The foals were infected with *S. westeri* on six farms (42.9%), with *P. equorum* on 12 farms (86%) and with strongyles and *E. leuckarti* on all 14 farms (100%).

Alcaino *et al.* (2005) analysed 666 faecal samples of thoroughbred racehorses in central zone of Chile and found that 6% of racehorses were positive for the presence of Fasciola hepatica eggs in the faecal sedimentation test.

Eslami *et al.* (2005) recorded *Parascaris equorum*, *Oxyuris equi*, and strongyle eggs in 13.8%, 17%, and 28.3% of tested faecal samples, respectively in 290 racehorses on 20 private horse farms in Iran.

Fikru *et al.* (2005) conducted coprological study (n=388) in western highlands of Oromia, Ethiopia and recorded overall prevalence of small and large strongyles (92.8%), *Parascaris equorum* (17.1%), *Dictyocaulus arnifieldi* (2.6%) and *Oxyuris equi* (2.1%).

Fioretti *et al.* (2005) collected 300 faecal samples of horses in Umbria and found that total prevalence of Cyathostominae and Anoplocephalidae were 65.93 and 25.6%, respectively.

Maddox *et al.* (2005) found 4% prevalence of *Anoplocephala perfoliata* in 5 regions of Denmark in 100 clinically healthy horses after their coprological examinations.

Gawor *et al.* (2006) studied parasitic infections in riding horses from one stud farm and 5 riding clubs. The species recorded in stud farm horses were strongyles (71.0%), *Parascaris equorum* (0.5%) and *Anoplocephala spp.* (6.7%). Strongyles (36.30-87.10%), *Parascaris equorum* (3.7-21%) and *Anoplocephala spp.* (0-1.8%) were recorded in club horses.

Katoch *et al.* (2006) analyzed 60 faecal samples in Spiti horses of Himachal Pradesh and observed that the overall incidence of strongyle, lungworms, *Parascaris equorum*, *Habronema spp.* and *Strongyloides westeri* were 75, 18.37, 10.2, 3.33 and 1.67%, respectively.

Kornas *et al.* (2006) recorded mean seasonal prevalence of tapeworm (*Anoplocephala spp.*) infection in two stud farms in Poland as 7.0 and 4.1%, respectively.

Kornas *et al.* (2006) examined 291 faecal samples of horses, kept under different management systems in two cycles of one year each. The prevalence of infection in the stable management system ranged from 16.7 to 79.3% in the first cycle and from 34.2 to 80% in the second cycle. Prevalence of infection in horses under the stable and pasture management system was higher (71.4-97.4% and 10.5-96.4%) repectively.

Roelfstra (2006) while studying the seasonal dynamics of gastrointestinal nematode egg production in horses observed high prevalence of *Anoplocephala spp.* infection on one breeding farm.

Slivinska (2006) studied prevalence of gastrointestinal parasites community of the Przewalski's and domestic horse and reveald Strongylid (100%), *Oxyuris equi* (81%), *Parascaris equorum* (19%) and Tapeworms (14.3%) infections; *Gasterophilus spp.* were also recorded in the Chernobyl exclusion zone.

Altas *et al.* (2007) examined faecal samples of 92 Arabian horses in Sanliurfa region of Turkey and found overall 76.08% prevalence of helminth infections. Besides *Strongylus spp.* (63.04%), which was predominant, other species recorded were *Dictyocaulus arnfieldi* (2.17%), *Oxyuris equi* (7.60%) and *Parascaris equorum* (22.82%).

Dorchies *et al.* (2007) carried out faecal examination in 1049 samples from the Equine Hospital of Toulouse Veterinary School or from equine practitioners and found that 55.7% of the samples were positive for digestive strongyles and the prevalence of *Anoplocephala spp.* was 2.2%.

Paudel (2007) found that the prevalence of gastrointestinal parasites was 80.48% (33/41) with *Strongylus spp.* (48.78%), *Trichostrongylus axei* (31.70%), *Parascaris equorum* (21.95%), *Trochonema spp.* (17.07%), *Gastrodiscus spp.* (7.31%), and *Habronema spp.* (4.87%) infections in horses of Sainik stud farm Chitwan.

Uslu and Guclu (2007) examined faecal samples from 111 horses and found the infections of Strongylidae (100%), *Parascaris equorum* (10.81%), *Strongyloides westeri* (7.2%), *Fasciola spp.* (3.6%), Anoplocephalidae (2.7%), *Oxyuris equi* (1.8%), *Trichuris spp.* (0.9%), *Dicrocoelium dendriticum* (0.9%), *Eimeria leuckarti* (4.5%) and *Eimeria spp.* (12.61%).

Benavides *et al.* (2008) reported (31.7%) prevalence of *Anoplocephala perfoliata* in 135 equids (105 horses, 2 mules and 28 asses) in the Northwest regions of Colombia by using methods of sedimentation / flotation.

Getachew *et al.* (2008) conducted coprological examination in 402 horses and donkeys in the regions of Ada, Akaki, Bereh and Boset in Ethiopia and recorded 16.2% prevalence of *Parascaris equorum.*

Kaur and Kaur (2008) studied the prevalence of gastrointestinal parasites in horses of Patiala and its adjoining areas and found that 76.47% of the horses were infected with parasites including *Parascaris equorum* (84.61%), *Strongyloides westeri* (76.92%) and *Trichostrongylus spp.* (38.46%).

Mahfooz *et al.* (2008) detected the prevalence and anthelmintic efficacy of Abamectin against gastrointestinal parasites under field conditions in100 horses from Faisalabad, Punjab, Pakistan. The overall prevalence of gastrointestinal parasites was 75%, including *Strongylus spp.* (50%), *Oxyuris equi* (12%), *Parascaris equorum* (8%) and mixed infections (5%).

Pandit *et al.* (2008) collected 935 faecal samples and examined by sedimentation and flotation techniques to determine the prevalence of gastrointestinal parasites in horses kept under unorganized husbandry in Kashmir valley of Jammu and Kashmir state, India. A total of 872 samples (93.26%) were found positive for various types of gastrointestinal parasites. The common parasites observed were *Strongylus spp.* (81.19%), *Dictyocaulus spp.* (14.10%), *Oxyuris equi* (9.40%), *Paranoplocephala spp.* (8.14%), *Strongyloides westeri* (6.19%), *Parascaris equorum* (4.01%), Amphistome spp. (0.91%) and *Eimeria spp.* (0.34%).

Veronesi *et al.* (2008) while performing faecal examinations on eighty three horses from 13 breeding farms in Tuscany and Lazio (Central Italy) found 86.74 and 14.45% prevalences for intestinal strongyles and cestode infections, respectively.

Papazahariadou *et al.* (2009) examined 223 fecal samples of stabled (150) and grazing (73) horses from various parts of central and northern Greece and found that 77 (34.5%) horses in the study were infected with one or more parasite species. In the stabled horses, the most common parasitic eggs were strongyles, *Strongyloides westeri*, *Anoplocephala spp.* and *Habronema spp.* and in the grazing horses *Parascaris equorum* and oocysts of *Eimeria spp.* and *Cryptosporidium spp.* were common.

Khan *et al.* (2010) examined 150 faecal samples of each of paddock horses, donkeys and mules of Mona Remount Depot, Sargodha, Pakistan to record the prevalence of *Parascaris equorum* and found this infection in 54 (36%) horses, 47 (31%) donkeys, and 42 (28%) mules.

2.2. Intensity

Schlichting and Stoye (1982) examined faecal samples of 100 foals in 23 studs, out of which 81 exhibited *S. westeri* infection and egg counts of over 30000 eggs/g of faeces with no clinical symptoms or change in faecal consistency.

Nowosad *et al.* (1991) observed that faecal egg counts for *P. equorum* were higher for younger horses (282epg) than older ones (108 epg) in Czechoslovakia.

Battelli *et al.* (1993) examined faecal samples from 38 trotter mares on a stud farm in Bologna, Italy. The mean monthly count was

183 epg (70-368) with minimum and maximum individual counts of 20 and 5240, respectively.

Mage (1996) studied the parasitic epidemiology of grazing draught mares and found that average number of excreted eggs was 300 epg during spring which increased during the grazing period between 650 and 950 epg.

Bray *et al.* (1998) investigated 16, 31 and 11 fresh faecal samples of the sedentary, nomadic and domestic groups of feral horses on public lands in Inyo National Forest in eastern California and western Nevada, USA. The median numbers of eggs/g for the sedentary, nomadic and domestic groups were 803, 69 and 321, respectively.

Theodoridis *et al.* (1999) while examining faeces of 91 horses at the 7 riding clubs in Thessaloniki, Greece, found epg of strongylids at 5 riding clubs between 2 and 94 eggs/g of faeces and horses of 2 riding clubs did not show any strongylids eggs.

Holland *et al.* (2001) recorded the mean faecal egg count of 2053 eggs/g of faeces in packhorses from mountainous areas and 732 eggs/g in carriage horses of the Red River delta.

Gawor (2002) while conducting faecal examination of 142 horses from 9 stables in Poland found 81% of the horses infected with cyathostomes with a mean epg of 460 (27.5% having less than 100 epg), and 19% negative.

Montinaro *et al.* (2002) studied epidemiology of gastrointestinal nematode infections in horses in Sardinia.and recorded the intensity of egg excretion as 252.1 - 502.2 and 11.5 - 53.5 epg for gastrointestinal strongyles and ascarids, respectively.

Singh *et al.* (2002) while conducting epidemiological study on gastrointestinal parasites in equines in Uttaranchal and Uttar Pradesh examined a total number of 600 faecal samples; they found that the epg of strongyle infection ranged 15-8050 in positive animals.

Dopfer *et al.* (2004) sampled faeces of 484 Dutch boarding horses and faecal eggs counts revealed that 267 (55.2%) horses had consistently low numbers of eggs per gram faeces (epg< 100, or=100), and 155 (32.0%) horses had consistently high epg (epg>100). Horses with consistently high epgs were more often mares. The female horses showed consistently high epgs as compared to male horses.

Kornas *et al.* (2004) examined the faecal samples of 752-975 horse from stables, 94-132 from stallion depots and 20-42 from riding clubs. Eggs per g faeces (epg) were evaluated which showed that maximum infection was of small strongyles and epg counts were 242-933, 87-504 and 119-347 epg in horses of stables, riding clubs and stallion depots, respectively.

Capewell *et al.* (2005) campared fecal egg counts of strongyle infections in stabled and pastured horses in 5 farms in central Vermont and found that there was no significant difference in fecal egg counts between stabled horses that had been treated 50 days earlier with fenbendazole and horses that grazed on pasture that had not been treated for parasites in more than 7 months.

Cirak *et al.* (2005) detected strongyle infection in 68% of the 320 horses from 9 farms in western Turkey and egg counts per gram of faeces (epg) were >950 in half of the animals.

Fikru *et al.* (2005) conducted a quantitative coprological study (egg count per gram of feces, epg) which indicated moderate infection

in 29.4%, 49.4% and 38.6%; and severe infection in 37.3%, 28.9% and 31.8% in donkeys, horses and mules, respectively.

Toguchi and Chinone (2005) conducted a helminthological survey based on faecal examination in 149 racehorses in Japan and recorded helminth eggs (94.0%), strongyle eggs (91.9%), tapeworm eggs (31.5%) and *Parascaris equorum* eggs (7.4%). Extremely high epg value (1001-4000) was observed in 15.3% of strongyle infected horses. The epg value tended to be higher in younger horses: 28.9% at 2 years of age, 13.3% at 3 years, 9.1% at 4 years and 5.0% at 5 years of age.

Gawor *et al.* (2006) recorded the egg counts of strongyles in one stud farm and 5 riding clubs which were 924 and 302-515, repectively.

Katoch *et al.* (2006) analyzed 60 faecal samples in Spiti horses of Himachal Pradesh and observed that the average strongyle egg per gram of faeces was 395-471.50.

Kornas *et al.* (2006) examined 291 faecal samples of horses kept under different management systems. The intensity of infection in the stable management system was 78-675 and 88-340 epg in first and second cycle while under the stable and pasture management system it was 138-969 and 90-649, respectively.

Kornas *et al.* (2008) studied seasonal dynamics of the occurrence of strongyles in horses in a stud and recorded 1,630 epg in 2004 and only 165 epg in 2006.

2.3. Coproculture and micrometry

Micrometry of infective larvae of various species of gastrointestinal nematodes of horse, cattle sheep and goat has been extensively studied and reported in literature; however a few reports

are on record for measurement of infective larvae of gastrointestinal nematodes of horse.

Dikmans and Andrews (1933) used size of sheath, total length, length of oesophagus and tail and number of intestinal cells for identification and differentiations of various third stage infective larvae.

Schoene (1938) performed faecal culture examination of 182 horses out of 200 and identified infective larvae of *Strongylus vulgaris* (16.22%), *S. edentatus* (5.75%), *S. equinus* (6.75%) and *Trichonema spp.* (71.30%).

Langenegger *et al.* (1967) conducted faecal examination of 149 saddle horses in eight municipalities in the state of Rio de Janerio and revealed *Strongylus vulgaris* in (74%), *S. edentatus* (78.5%), *S. equinus* (56%) and small strongyles (100%).

Poynter (1970) conducted faecal culture examination of 5288 samples from 1883 horses and identified infective larvae of *Trichonema spp.* (71.30%) *Strongylus vulgaris* (70%), *S. edentatus* (71.2%), *S. equinus* (1.04%), *Gyalocephalus spp.* (7.8%), *Triodontophorus spp.* (10.4%) and *Trichostrongylus axei* (23.9%).

Henriksen (1978) studied strongylosis in horses of Denmark and identified infective larvae in faecal samples and showed that *Trichonema spp.* account for more than 90% and *Strongylus vulgaris* for less than 5% of the infection.

Tolliver *et al.* (1987) based on faecal samples examinations from 513 horses aged from 4 months to 20 years in Kentucky, USA, during 1956 to 1983, reported infections of *Strongylus vulgaris* (84%), *S. edentatus* (79%), *S. equinus* (6%) and cyathostomes (100%).

Virga *et al.* (1991) performed faecal culture of 153 strongyle positive samples of 153 horses and 11 mules slaughtered at Palermo abattoir in July-November, 1990 and identified Cyathostoma (in 152), *Strongylus vulgaris* (128), *Strongylus edentatus* (123), *Poteriostomum spp.* (63), *Triodontophorus spp.* (24), *Strongylus equines* (21), *Gyalocephalus spp.* (20), *Oesophagodontus robustus* (17) and *Trichostrongylus axei* (7).

Battelli *et al.* (1993) examined faecal samples from 38 trotter mares on a stud farm in Bologna, Italy. The only larvae identified by faecal culture were *Strongylus vulgaris* and Cyathostominae.

Itagaki *et al.* (1993) conducted culture of faeces from 115 horses (10 farms) in Japan and identified *Strongylus vulgaris* in 22 (19.1%), *S. edentatus* 54 (47%), *S. equinus* 8 (7%), *Triodontophorus spp.* 34 (29.6%), *Gyalocephalus spp.*16 (13.9%), *Poteriostomum spp.* 22 (19.1%), and cyathostomes 113 (98.3%).

El *et al.* (1994) cultured the faecal samples collected from horses and gave the morphology of the 3rd stage larvae of equine strongyles and the general and differential characteristics of each type in detail.

Langrova (1998) found *Triodontophorus spp.* (5.17%), *Strongylus vulgaris* (2.49%), *S. equinus* (0.05%) and *S. edentatus* (1.88%) in faecal culture of thoroughbred horses on a stud farm near Prague, Czech Republic.

Sengupta and Yadav (1998) conducted coproculture of faecal sample in organized and unorganized equine practices in Haryana and identified *Strongylus equinus*, *S. edentatus*, *S. vulgaris*, *Triodontophorus spp.*, *Oesophagodontus spp.* and *Gyalocephalus spp.* larvae.

Theodoridis *et al.* (1999) conducted coproculture of 91 riding horses at the 7 riding clubs in Thessaloniki, Greece. The species encountered were *Triontophorus spp.* (42%), *Strongylus equinus* (29%), *S. edentatus* (21%), *S. vulgaris* (6%), *Trichostrongylus axei* (2%), *Cyathostomum spp.* (42%), *Cylicostephanus spp.* (24%), *Gyalocephalus spp.* (22%) and *Poteriostomum spp* (12%). *Triontophorus spp.*, *Gyalocephalus spp.*, *Poteriostomum spp.* and *Trichostrongylus axei* were noted for the first time in horses in Greece.

Konigova (2001) conducted coprological examination of 913 horses from 46 stud farms all over Slovakia and larval identification revealed *Gyalocephalus capitatus* (20%), *Poteriostomum spp.* and *Cylicostephanus spp.* (4%), *Strongylus vulgaris* (8%), *S. equinus*, *S. edentatus* and *Oesophagodontus spp.* (4%).

Sengupta and Yadav (2001) studied parasitic infections in 306 equines (93 horses, 198 donkeys and 15 mules), under organized (OHP) and unorganized husbandry practices (UHP), in the Bikaner area of Rajasthan. Coproculture revealed the presence of *Strongylus edentatus*, *S. equinus*, *Oesophagodontus spp.* and *Triodontophorus spp.* larvae.

Banerjee *et al.* (2002) examined faecal samples of mules in Tarai region of Uttaranchal State and recorded larvae of cyathostomes, *Strongylus vulgaris*, *S. edentatus*, *S. equinus*, and *Triodontophorus spp.* from coproculture.

Fuse *et al.* (2002) while conducting epidemiological study on helminths in Creole fillies observed Cyathostominae (85%), *Triodontophorus spp.* (8%), *Strongylus vulgaris* (2%), *S. edentatus* (2%) and *Trichostrongylus spp.* (3%).

Gawor (2002) identified cyathostomes (81%) and strongyles (3.5%) based on faecal culture and identification of infective larvae in riding horses.

Gherman *et al.* (2002) recorded strongyle population dynamics in horses from Northwestern Romania. Among the large strongyles, the following species were identified: *Strongylus equines* (40% in autumn, 10% in winter, 40% in spring, and 30% in summer), *Delafondia vulgaris* (50% in summer and autumn, 10% in winter, and 20% in spring), *Alfortia edentatus* (20% in autumn, 30% in winter, 40% in spring, and 30% in summer) and *Triodontophorus spp.* (30% in winter, 70% in spring, and 10% in summer). Small strongyles were represented by *Gyalocephalus capitatus* (30% in autumn, 10% in winter and summer); *Trichostrongylus axei* (50% in autumn and winter, decreasing to 30% in spring and to 20% in summer); *Oesophagostomum robustus* (10% in winter); and *Poteriostomum spp.* in winter and spring with a low incidence (40% and 70%, respectively).

Konigova *et al.* (2002) carried out larval identification of 913 horses from 46 stud farms in Slovakia and revealed Cyathostominae larvae as predominant in all larval coprocultures from all farms.

Singh *et al.* (2002) conducted epidemiological study on gastrointestinal parasites in equines in Uttaranchal and Uttar Pradesh by examining a total number of 600 faecal samples and revealed that out of 100 larvae identified in pooled culture of horses, mules, and donkeys, *Cyathostomum spp.* (73%) was the most predominant species followed by *Oesophagodontus spp.* (14%) and large strongyles (13%). *Strongylus vulgaris* (7-10%) and *S. equinus* (1-5%) were recorded in all the equine species whereas *S. edentatus* was recorded only in horses.

Cernea *et al.* (2003) conducted coproparasitological examination of 250 horses during October 2002 to May 2003 in Romania and found *Cyatostomum spp.* (81%), *Strongylus equines* (6%), *Oesophagodontus robustus* (6%), *Trichostrongylus axei* (4%), *S. vulgaris* (6%) and *S. edentatus* (3%).

Sengupta and Yadav (2003) recorded *Strongylus spp.* infection in horses (61.62%), donkeys (50.00%), and mules (47.14%) in hilly tracts of western Himalayas. The species identified by coproculture were *Strongylus equinus, S. edentatus, S. vulgaris, Trichonema spp., Trichostrongylus axei, Oesophagodontus spp., Triodontophorus spp., Gyalocephalus spp., Anoplocephala spp. and Paramphistomes spp.*

Aydenizoz (2004) recorded *Strongylus vulgaris* (40.8%), *S. edentatus* (23.94%), *Trichonema spp.* (71.83%), *Triodontophorus spp.* (22.53%), *Gyalocephalus spp.* (2.81%) and *Poteriostomum spp.* (12.67%) in the faecal cultures of infected horses from the Kirikkale province of Turkey.

Bakirci *et al.* (2004) incubated faecal samples that contained strongylid eggs, for larval differentiation of 85 horses in Turkey and the larvae obtained were identified as Cyathostominae (98%) and *Triodontophorus spp.* (2%). No larvae of the *Strongylus spp.* were detected.

Slivinska (2006) studied gastrointestinal parasites community of the Przewalski's and domestic horse and reported *Cylicostephanus minutus, C. longibursatus, C. bidentatus, Cyathostomum catinatum, Cylicocyclus nassatus, C. calicatus* and *C. asworthi* (more than 90%), *Coronocyclus coronatus, Cylicostephanus goldi*, and *Cylicocyclus leptostomus* (70-81%) and 17 species of Strongylidae (fewer than 50%).

Altas *et al.* (2007) examined faecal samples of 92 Arabian horses in Sanliurfa region of Turkey and found that the common species were *Strongylus spp.* (63.04%) and *Cyathostoma spp.* (55.17%). The most prevalent species of *Strongylus* was *S. vulgaris* (36.20%) followed by *S. edentatus* (24.13%) and *Triodontophorus spp.* (15.51%).

Bentounsi and Maatallah (2008) identified *Strongylus vulgaris*, *S. edentatus*, *S. equines*, *Oesophagodontus spp.*, *Triodontophorus spp.* and *Trichostrongylus axei* in faecal larval cultures of horses in sub-humid zone of Algeria.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The study was undertaken to know the prevalence of sub clinical gastrointestinal parasitoses and to record the intensity of gastrointestinal parasites in horses of different age groups and of different regions brought to the animal fairs held at Pushkar (Ajmer), Nagaur, Merta City (Nagaur), Hanumangarh, and Tilwara (Barmer). The coproculture were also set to identify the infective strongyle larvae.

3.1. Animals and their management

The animals for the study were horses, brought at the animal fairs of Pushkar (Ajmer), Nagaur (Plate 1), Merta City (Nagaur), Hanumangarh (Plate 2), and Tilwara (Barmer) during the year 2009-10 mainly from different geoclimatic regions of Rajasthan and some from nearby states of Punjab, Haryana, Gujarat, Uttar Pradesh, Bihar and Madhya Pradesh. These horses were generally reared in open stable and close stable system in groups irrespective of their age and sex, they were offered dry / green fodder and concentrate and provided tube well / well / pond / canal water ad lib.

3.2. Collection of faecal samples

A total 719 faecal samples of horses (153 from Pushkar, 153 from Nagaur, 107 from Merta City, 156 from Hanumangarh and 150 from Tilwara) were collected randomly from the fairs. Shri Kartic Pashu Mela, Pushkar (Ajmer) was held from 26 October to 4 November, 2009, Shri Ramdev Pashu Mela, Nagaur from 15 to 23 January, 2010, Bhatner Ashva Mela, Hanumangarh from 15 to 21 February, 2010, Shri Mallinath Pashu Mela, Tilwara (Barmer) from 11 to 26 March, 2010 and Shri Baldev Pashu Mela Merta City, (Nagaur) was held from 16 to 23 March, 2010. The samples were mostly collected during the middle days of the fairs. The faecal sample of individual animal was collected

Plate 1: Horse at Nagaur fair.

Plate 2: Horse at Hanumangarh fair.

directly from the rectum and during whole of the study period the samples were collected, as far as possible, during morning hours and kept in individually marked polythene bags. The relevant informations regarding age, sex, breed, feed, water, deworming history and region etc. were also noted.

3.3. Faecal examination

To know the prevalence and intensity of parasitic infections of horses, the collected faecal samples were processed and examined as follows:

3.3.1. Qualitative faecal examintion

Qualitative examination was conducted to record the sub clinical gastrointestinal parasitoses in horses on the basis of presence/absence of eggs/oocyts in the fasces of animals. The samples were qualitatively examined by direct smear, flotation and sedimentation methods.

3.3.1.1. Direct smear method

A small amount of faeces was placed on a clean microglass slide and emulsified in 3-4 drops of water with the help of an applicator stick, then a micro coverslip was put over it and was examined under low power objective (10X) of the microscope.

3.3.1.2. Floatation method

1-5 g of faecal sample was mixed with 15-20 ml of ordinary water and triturated by pestle and mortar. It was strained and taken in 15 ml centrifuge tube and centrifuged for 1-2 min. at 1000-1500 r.p.m. The supernatant was removed and after emulsifying the decant centrifugation was repeated one or more times till the colour of faeces

was cleared. After last washing in water, the faecal decant at the bottom of the tube was mixed with Zinc sulphate solution (32.5%), filling the tube to its brim, covered with a clean coverslip and centrifuged similarly. The tube was placed in vertical position in the tube stand for 2 minutes. The coverslip was then picked up gently and put over a slide for examination under low power objective (10X).

3.3.1.3. Sedimentation method

1-5 g of faecal sample was mixed with 15-20 ml of ordinary water and triturated by pestle and mortar. It was strained and taken in 15 ml centrifuge tube and centrifuged for 1-2 min. at 1000-1500 r.p.m.. The supernatant was removed and after emulsifying the decant centrifugation was repeated one or more times till the colour of faeces was cleared. After last washing in water, the faecal decant at the bottom of the tube was mixed, placed on a clean microglass slide, a micro coverslip was put over it and was examined under low power objective (10X) of the microscope.

The prevalence was recorded if parasitic infection was shown by any or all of these methods i.e., direct, sedimentation and floatation methods.

3.3.2. Quantitative faecal examination

To obtain accurate information with regard to the severity of infection, eggs/oocysts counting (quantitative faecal examination) methods were used to determine the number of eggs/oocysts per gram of faeces. It was done by modified McMaster counting technique as described by Coles *et al.* (1992).

Three grams of faeces were taken in a mortar and soaked in 42 ml water for few minutes and then emulsified by using pestle. The emulsion was poured through a sieve and after stirring,15 ml of

emulsion was centrifuged at 1500 rpm for 5 minutes. The supernatant was gently poured off. The tube was agitated to loosen sediment and saturated salt solution was added to make the final volume up to 15 ml. The tube was inverted five to six times and immediately sample/emulsion was withdrawn and both the chambers of the McMaster slide were charged by using pasture pipette. Eggs/oocysts were counted under low power objectives in two ruled squares containing 0.3 ml of total volume of emulsion. The number of eggs/oocysts counted in both these squares was multiplied by 50 to get eggs/oocysts per gram of faeces in the samples.

3.3.3. Coproculture and larval identification

Coproculture were set to identify the various Strongyle larvae on the basis of gut cells number and morphological peculiarities of third stage infective larvae of Strongyles.

Faecal cultures provide an environment suitable for the hatching of strongylid eggs and for their development to the infective third stage larvae. Different eggs require different conditions but the general method given below was suitable for the culture of strongylid eggs in horse faeces.

For this purpose strongyle nematode egg positive faecal samples of horses were pooled in 5 sets and cultured following the method of Roberts and Sullivan (1950).

About 30-40 grams of faeces were broken up finely, using a large pestle and mortar along with spatula. If the lump remained harder a small quantity of water was added to make it desirably soft and if the faeces were too soft in consistency animal charcoal was added to get the required consistency. A large lump of faeces of desirable consistency was taken in a small Petri dish and spread evenly and this

dish was placed in another larger Petri dish having a small quantity of water in it. The larger Petri dish was then covered with another Petri dish to minimize evaporative losses and incubated at 25-27°C in BOD incubator for 7 days (Plate 3). The water in larger Petri dish contained larvae which migrated from the faecal mass in small Petri dish after hatching out from the eggs. Many of the larvae reached the infective third stage by that time facilitating specific diagnosis.

The infective larvae migrating to water in outer Petri dish were pipetted out and centrifuged at 1500 rpm for 3 minutes. The supernatant was discarded and the sediment was warmed over the spirit lamp for few seconds to kill and stretch the infective larvae. A drop of sediment was taken on the slide, and mixed with a drop of lugol's iodine and the stained larvae were examined under microscope.

The micrometries of larvae were performed for total length and extension of tail sheath beyond tip of larvae. The larvae were identified on the basis of key provided by Dikmans and Andrews (1933), Keith (1953), Whitlock (1956), Soulsby (1965), Levine (1968), Anonymous (1971) and Ivashkin (1978). For estimating the strongyle larval composition 100 larvae of strongyle from strongyle egg positive pooled samples from animals of each fair were counted and classified on the basis of anatomical peculiarities. The measurements were expressed in micron (µm) and composition in percentage (%).

3.4. Analysis of observations

The data obtained from faecal examination were classified according to fair, age, sex, district groups and type of infection and were statistically analysed by "F" test (Variance ratio test) and significant means were compared with DNMRT (Dunken New Multiple Range Test).

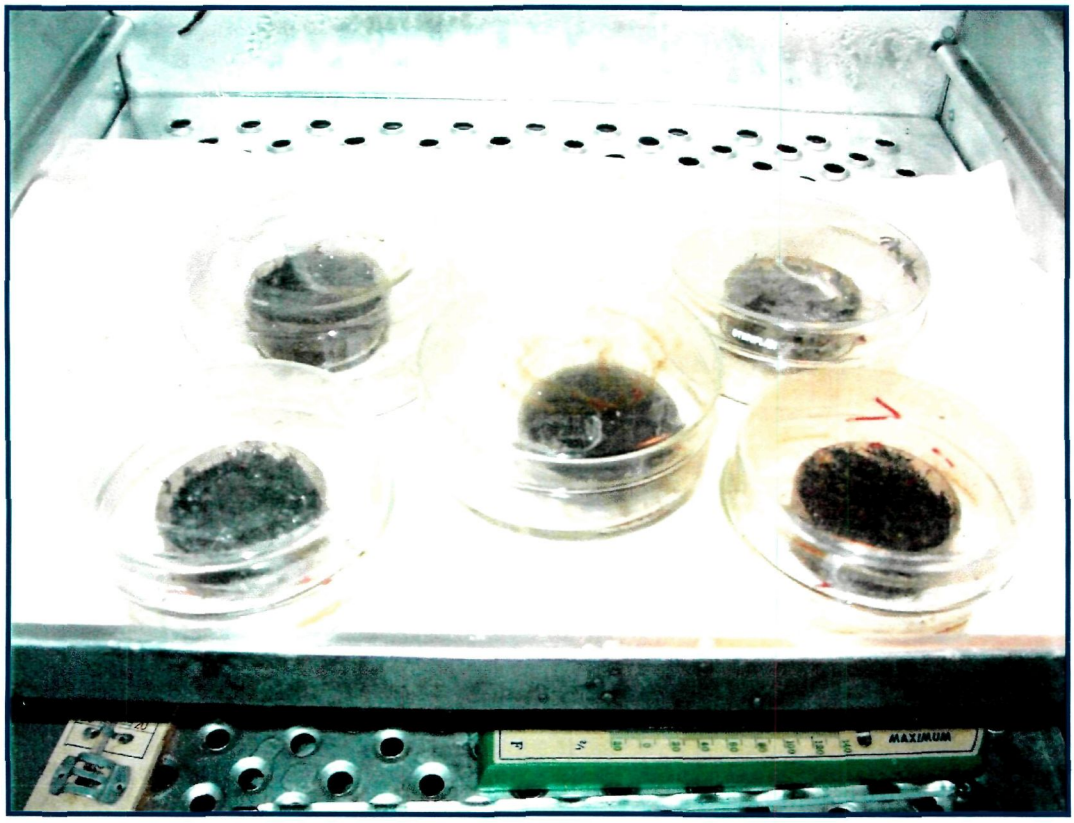


Plate 3: Photograph showing coproculture sets in BOD incubator for larval culture.

RESULTS

4. RESULTS

A total of 719 faecal samples were collected from the animal fairs held at Pushkar, Nagaur, Merta City, Hanumangarh and Tilwara during the year 2009-10. These faecal samples were examined for the presence of parasitic eggs/oocysts employing different parasitological techniques for detection of subclinical gastrointestinal parasitoses in horses. Out of 719, 179 samples were from male and 540 from female horses.

4.1. Prevalence of gastrointestinal parasites in horses

A total of 719 faecal samples of horses were examined by direct, flotation and sedimentation methods and the prevalence was recorded if parasitic egg/oocyst was shown by any or all of these methods. The results are presented in Table 1 and Figures 1, 2, 3 and 4 and Plates 4, 5, 6, 7, 8, 9, 10, 11 and 12.

4.1.1. Overall prevalence

Out of 719 faecal samples of horses examined, 239 (33.24%) showed gastrointestinal parasites (helminths and protozoa). Among helminths, prevalence of *Habronema* (14.04%), strongyle (10.01%), *Parascaris equorum* (7.09%), *Strongyloides westeri* (4.86%), *Draschia* (0.27%), *Schistosoma* (0.13%), *Oxyuris equi* (0.13%) and *Anoplocephala* (0.13%) was recorded.

Among protozoa, prevalence of *Eimeria leuckarti* (0.27%) was recorded.

4.1.2. Fairwise prevalence

Gastrointestinal parasites showed maximum prevalence (46.66%) at Tilwara fair and minimum (13.72%) at Pushkar fair.

Table 1. Prevalence of gastrointestinal parasites in horses of animal fairs in Rajasthan

Criteria	Faeal samples examined (numbers)	Faecal samples positive for (numbers)									
		Gastrointestinal parasites	Helminths (species)								Protozoa
			Strongyle type	*Strongyloides westeri*	*Parascaris equorum*	*Habronema*	*Draschia*	*Schistosoma*	*Anoplocephala*	*Oxyuris equi*	*Eimeria leuckarti*
1.FAIR											
Pushkar	153	21(13.72)	15(9.80)	9(5.88)	2(1.30)	-	-	-	-	1(0.65)	-
Nagaur	153	41(26.79)	19(12.41)	10(6.53)	11(7.18)	3(1.96)	-	-	-	-	2(1.30)
Hanumangarh	156	69(44.23)	12(7.69)	5(3.20)	16(10.25)	39(25.00)	1(0.64)	-	-	-	-
Tilwara	150	70(46.66)	16(10.66)	8(5.33)	13(8.66)	40(26.66)	1(0.66)	1(0.66)	1(0.66)	-	-
Merta City	107	38(35.00)	10(9.34)	3(2.80)	9(8.41)	19(17.75)	-	-	-	-	-
2.AGE											
Below 3 Years	397	131(32.99)	41(10.32)	23(5.79)	34(8.56)	44(11.08)	-	-	-	-	01(0.25)
3-5 Years	181	65(35.91)	17(9.39)	7(3.86)	11(6.07)	38(20.99)	2(1.10)	1(0.55)	1(0.55)	-	1(0.55)
Above 5 Years	141	43(30.49)	14(9.92)	5(3.54)	6(4.25)	19(13.47)	-	-	-	1(0.70)	-
3. SEX											
Male	179	69(38.54)	26(14.52)	10(5.58)	15(8.37)	31(17.31)	-	-	-	-	-
Female	540	170(31.48)	46(8.51)	25(4.62)	36(6.66)	70(12.96)	2(0.37)	1(0.18)	1(0.18)	1(0.18)	2(0.37)
OVERALL	719	239(33.24)	72(10.01)	35(4.86)	51(7.09)	101(14.04)	2(0.27)	1(0.13)	1(0.13)	1(0.13)	2(0.27)

Note: Figures In the parentheses indicate per cent.

Fig. 1. Overall prevalence of gastrointestinal parasites in horses of animal fairs in Rajasthan

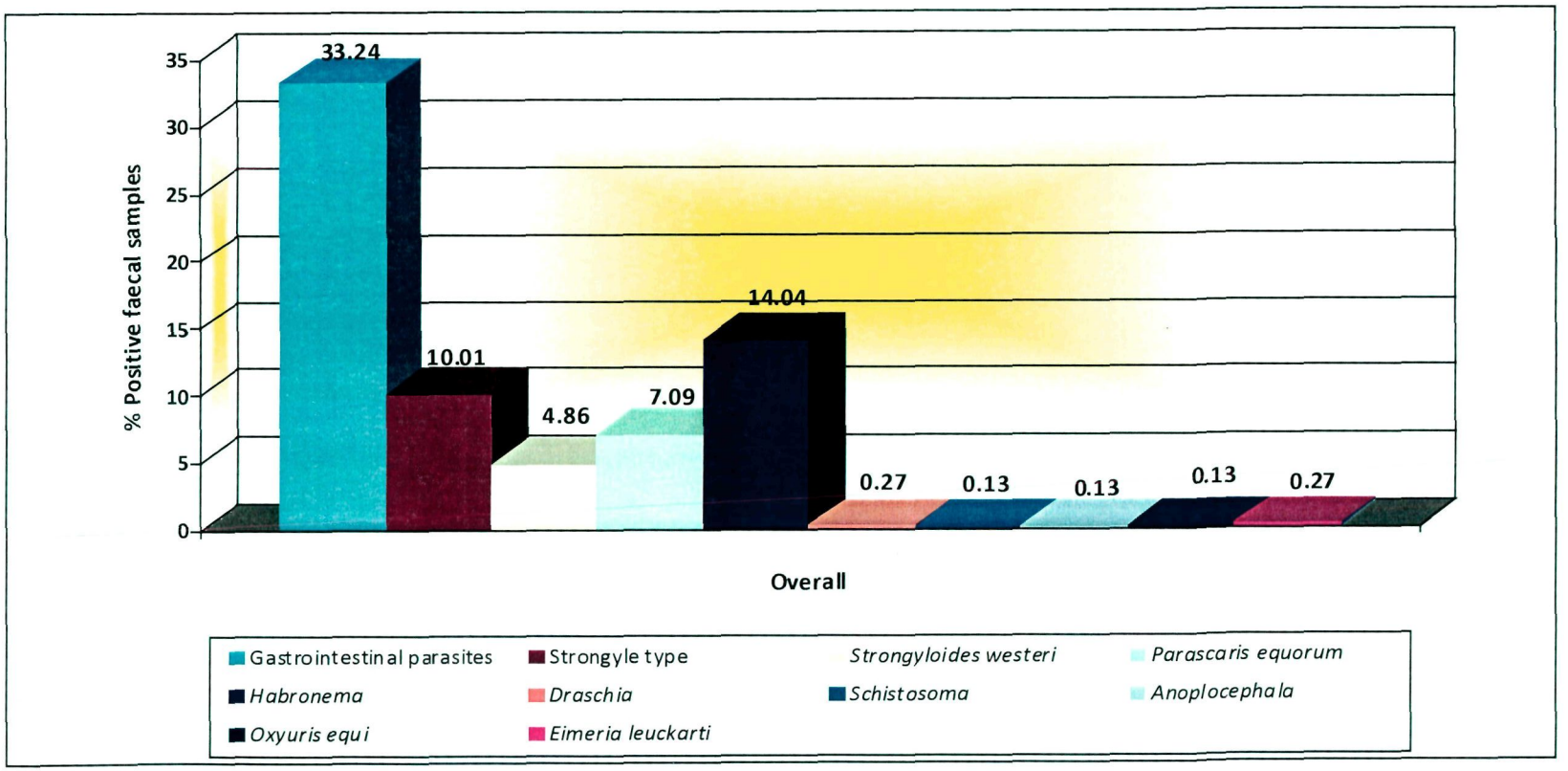


Fig. 2. Fairwise prevalence of gastrointestinal parasites in horses of animal fairs in Rajasthan

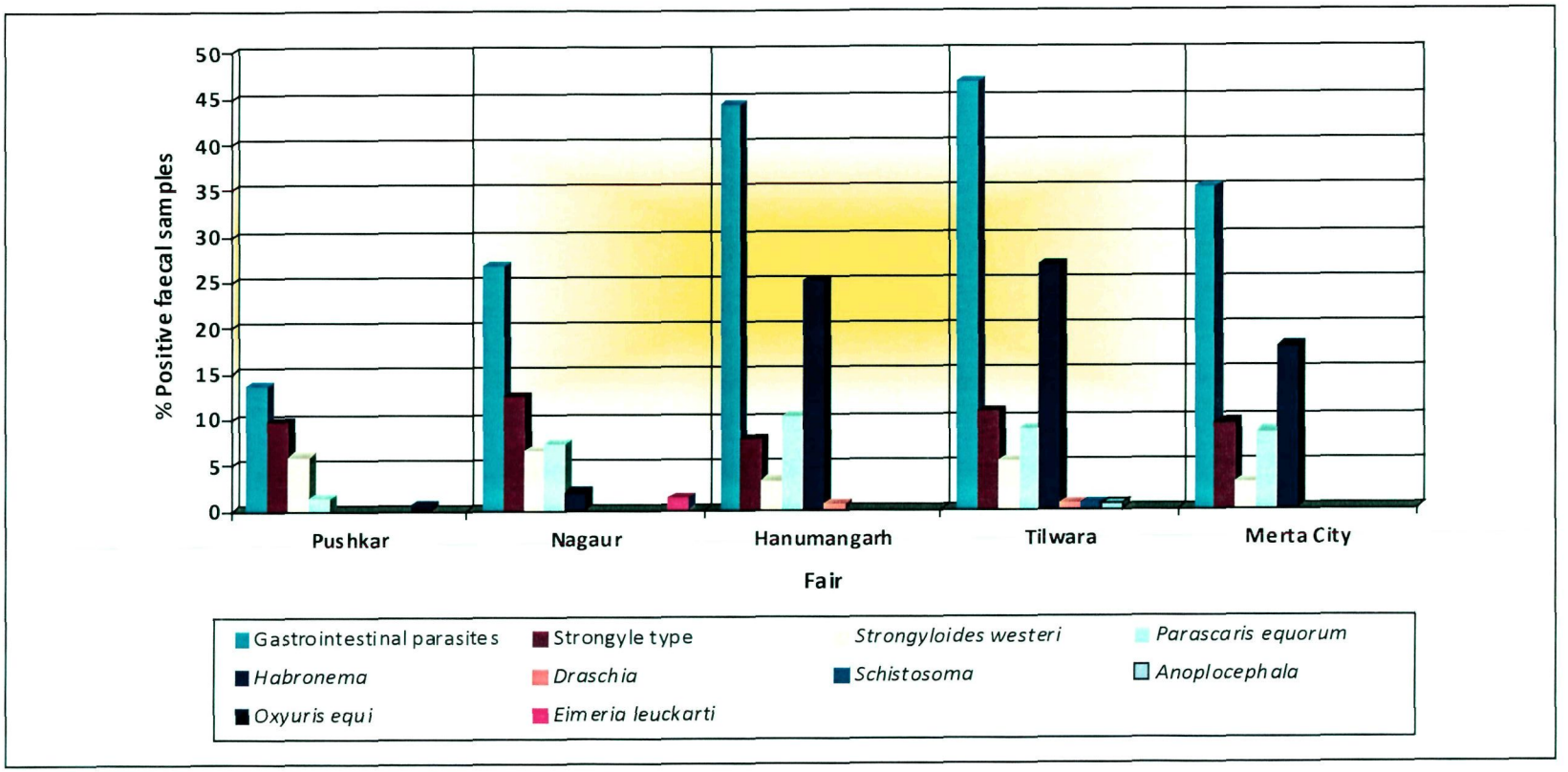


Fig. 3. Agewise prevalence of gastrointestinal parasites in horses of animal fairs in Rajasthan

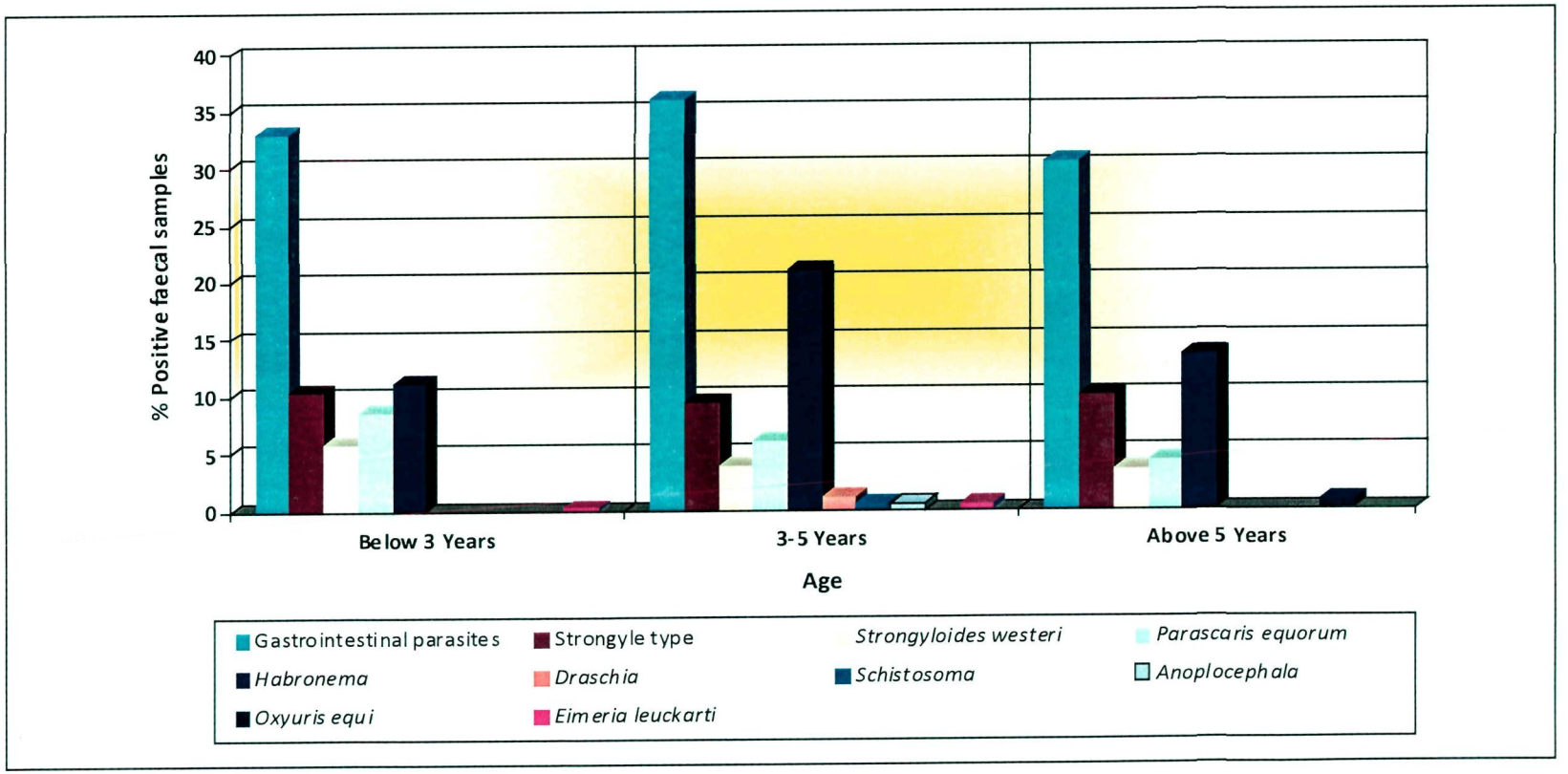
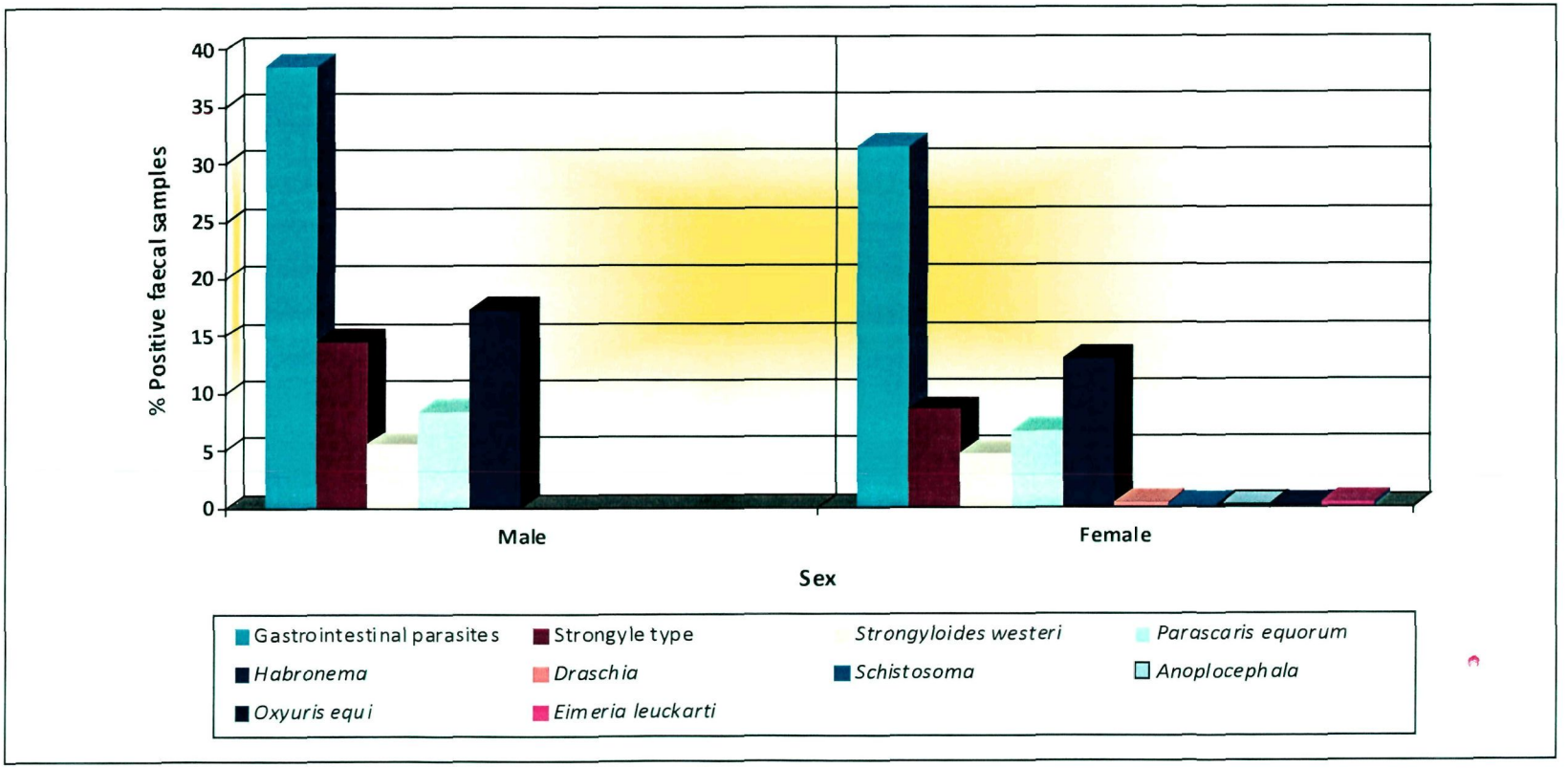


Fig. 4. Sexwise prevalence of gastrointestinal parasites in horses of animal fairs in Rajasthan



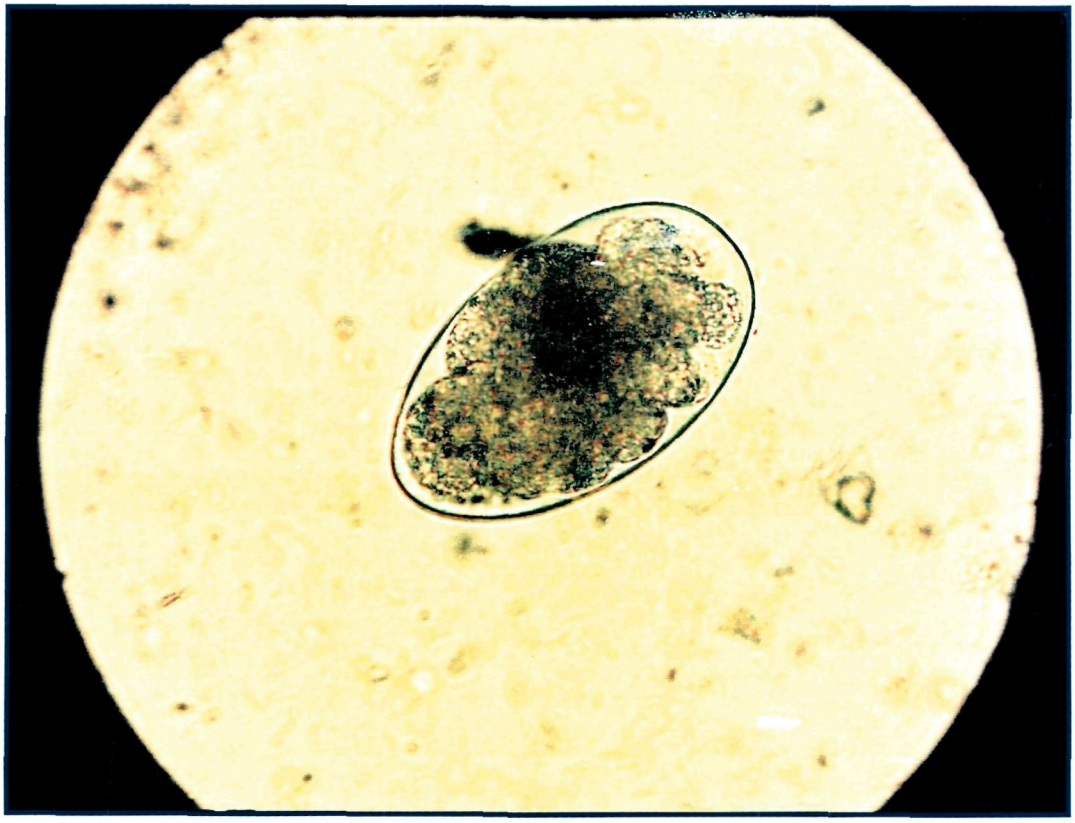


Plate 4: Microphotograph of strongyle type egg (X400).

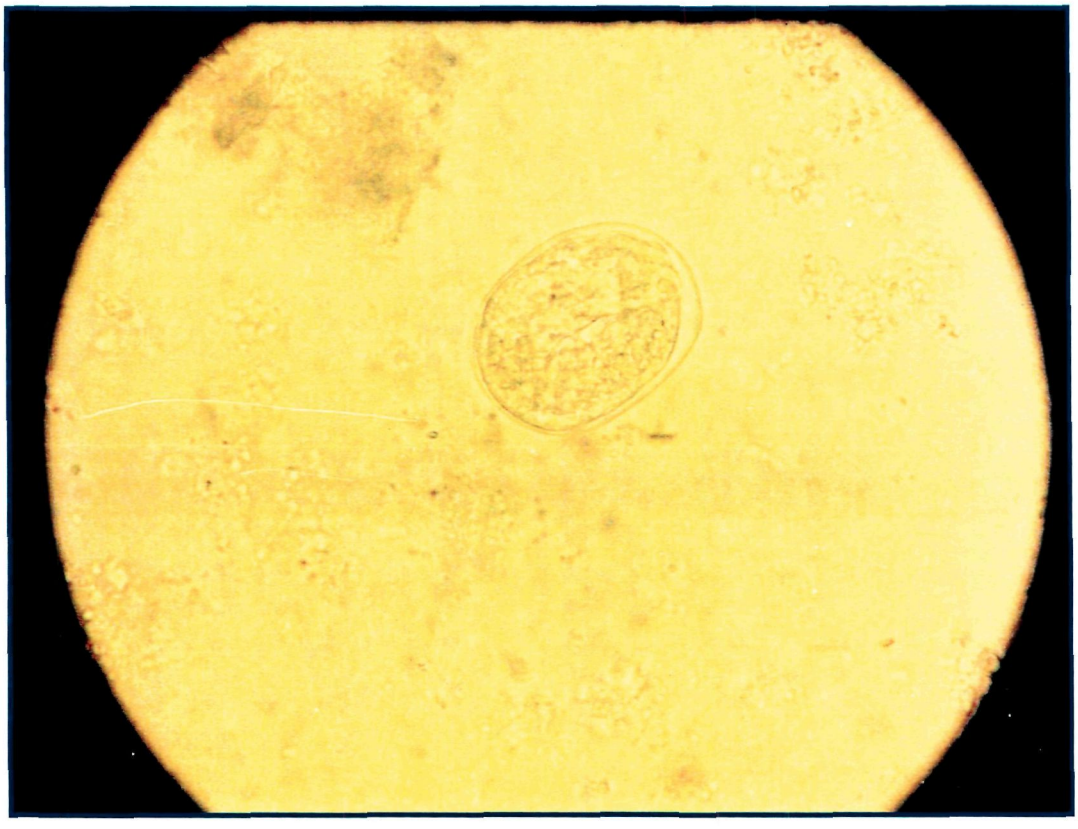


Plate 5: Microphotograph of *Strongyloides westeri* egg (X400).

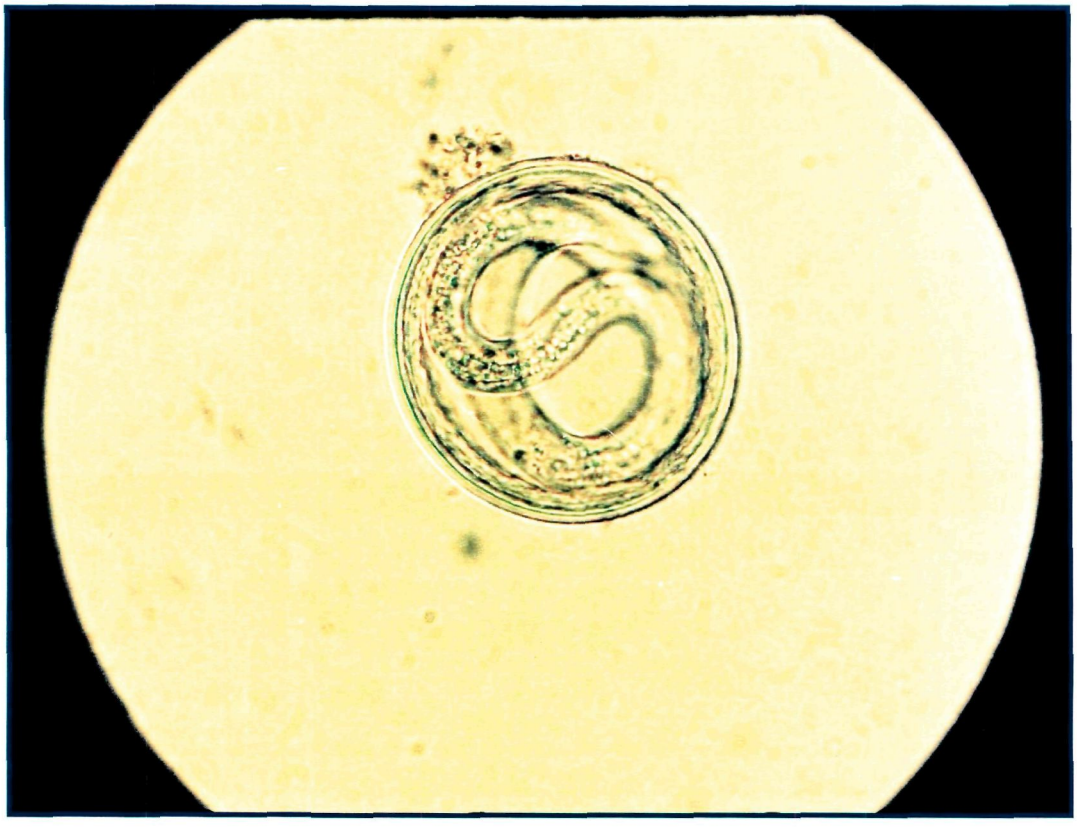


Plate 6: Microphotograph of *Parascaris equorum* egg (X400).

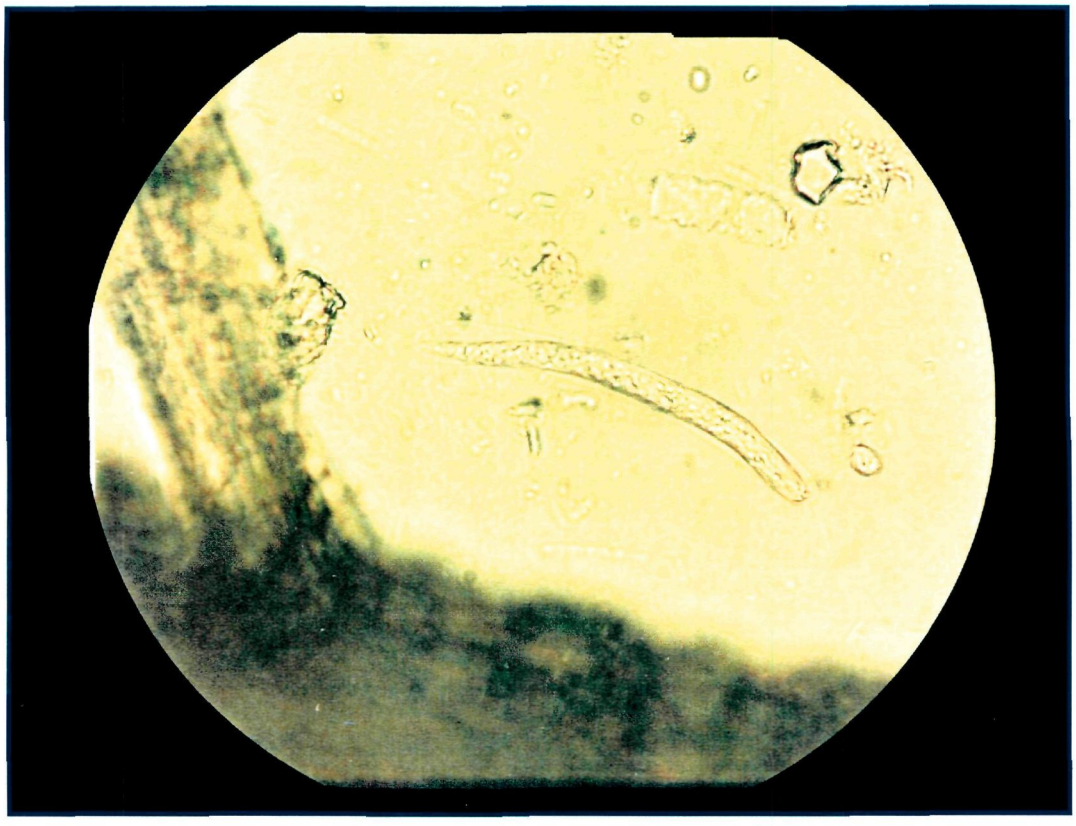


Plate 7: Microphotograph of *Habronema* egg (X400).

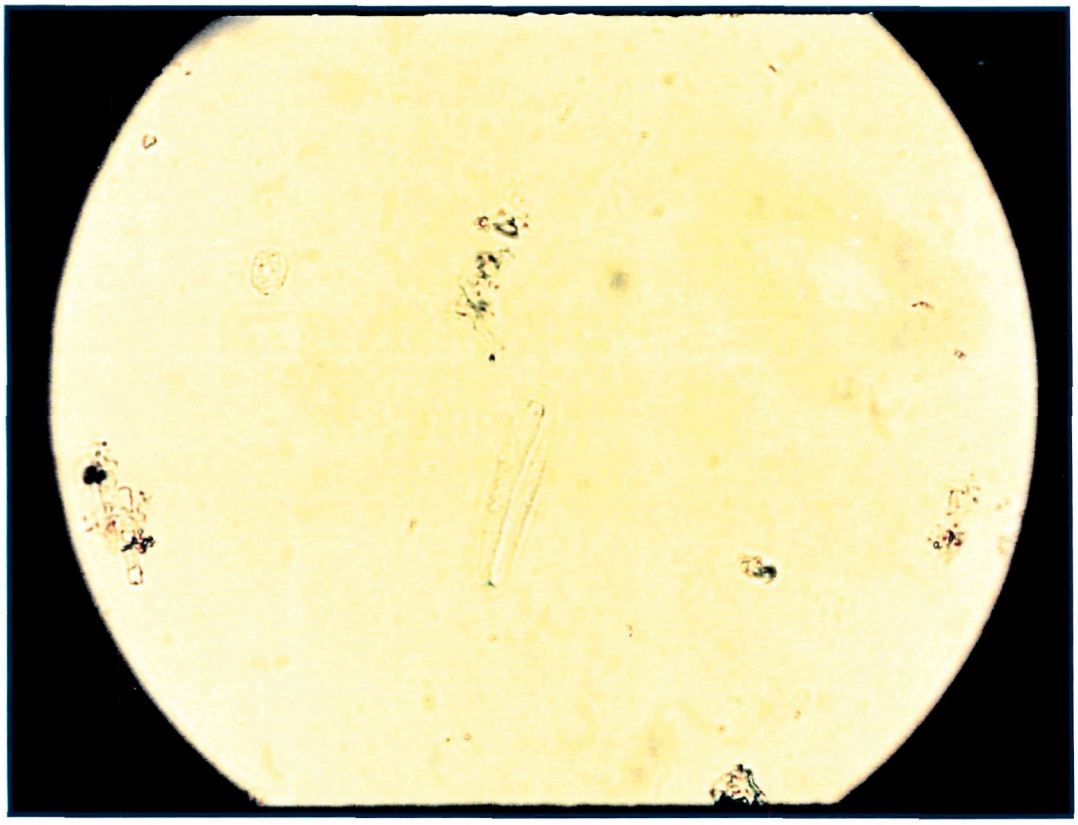


Plate 8: Microphotograph of *Draschia* egg (X400).

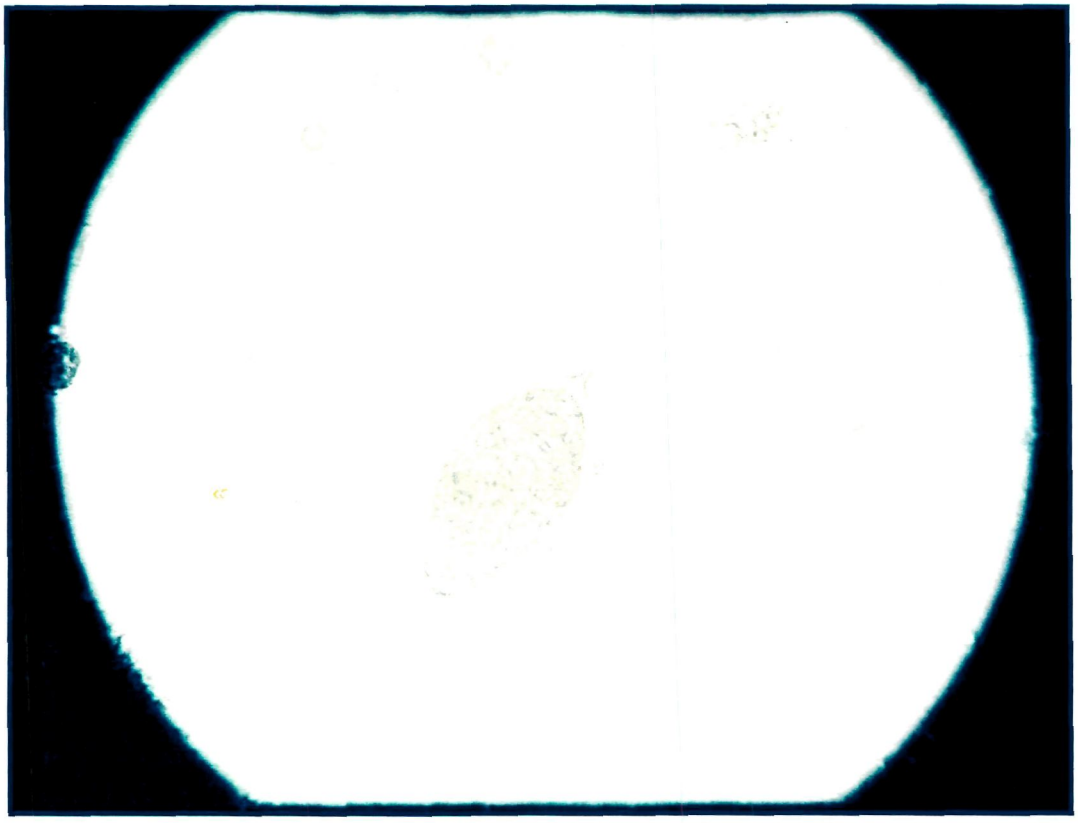


Plate 9: Microphotograph of *Schistosoma* egg (X200).

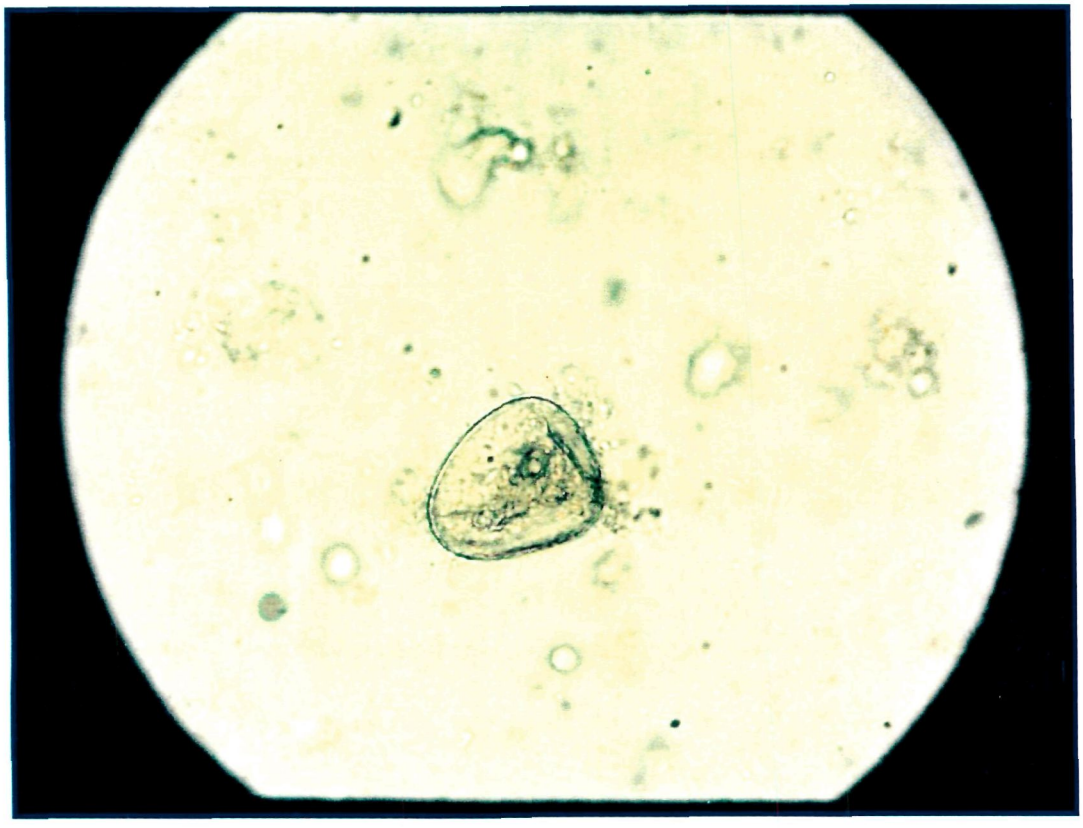


Plate10: Microphotograph of *Anoplocephala* egg (X200).

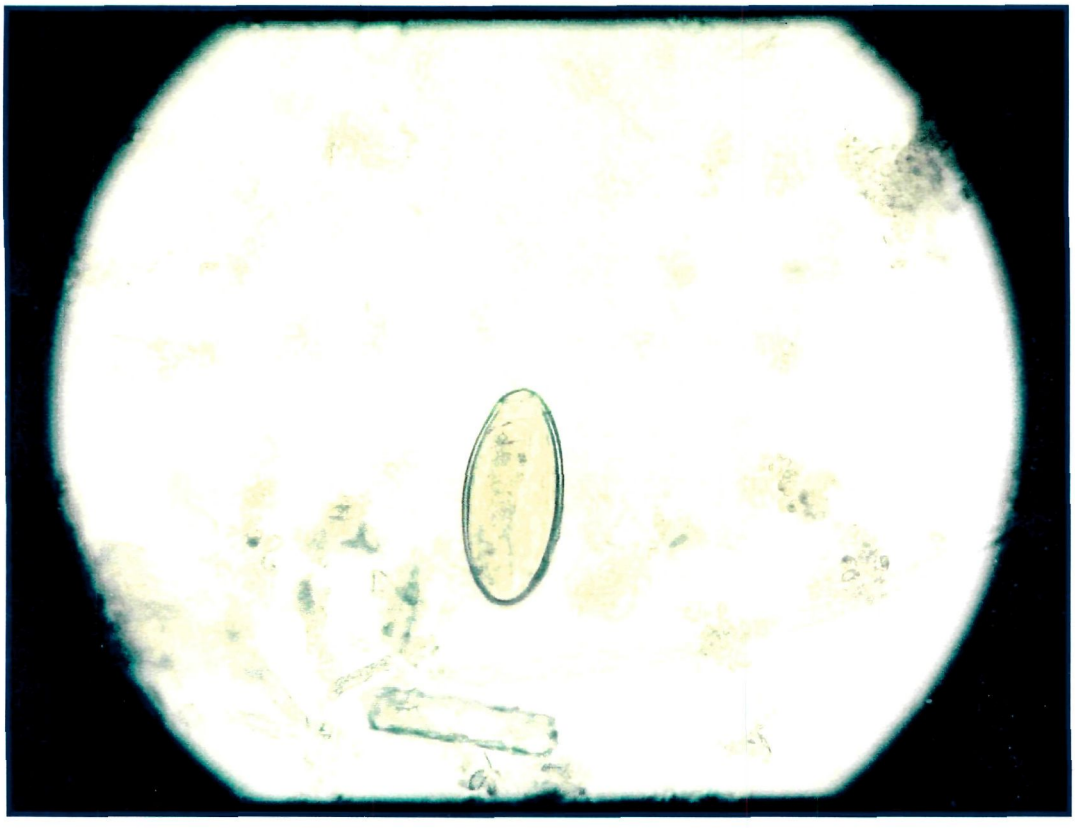


Plate 11: Microphotograph of *Oxyuris equi* egg (X200).

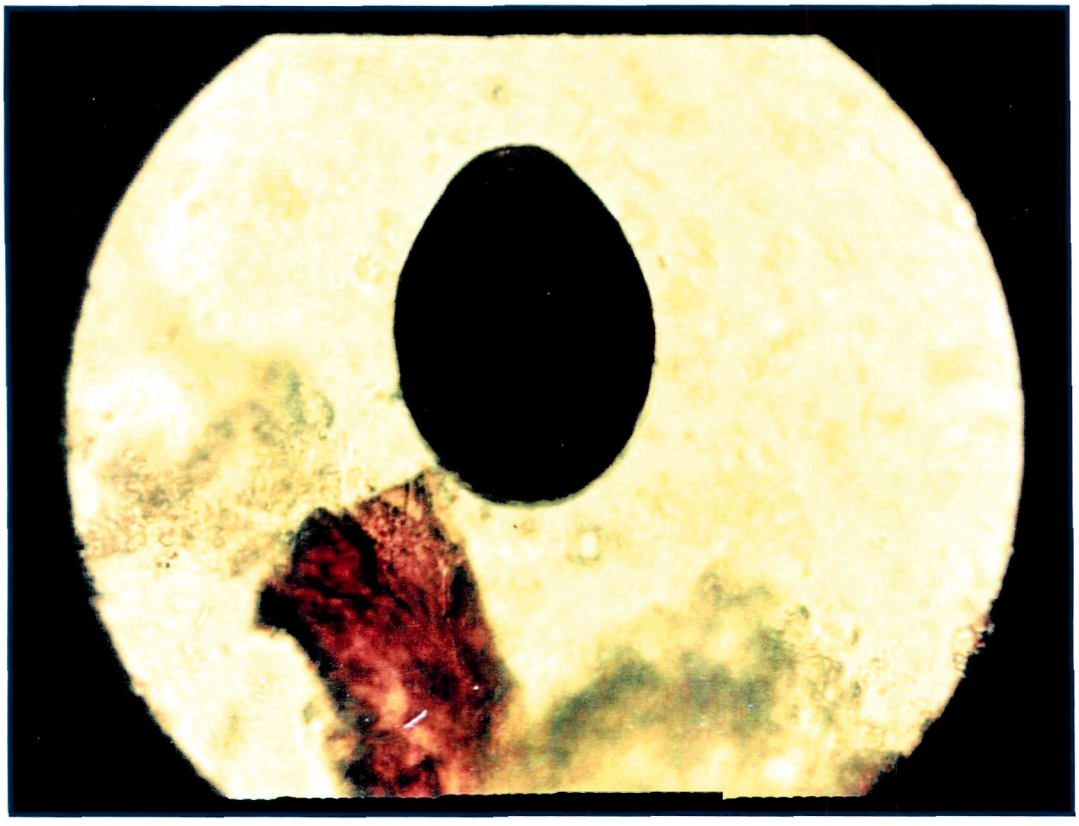


Plate 12: Microphotograph of *Eimeria leuckarti* oocyst (X400).

Among the helminths, *Habronema* infection was most prevalent in animals of Tilwara (26.66%), Hanumangarh (25%) and Merta city (17.75%) fairs.

Only one horse each could show *Schistosoma* (at Tilawara), *Anoplocephala* (at Tilawara) and *Oxyuris equi* (at Pushkar) infections in animals examined at all the fairs. *Draschia* infection was recorded in two horses only (one each at Hanumangarh and Tilwara) among the animals examined at all the fairs.

Among protozoa, only *Eimeria leuckarti* infection was recorded in two horses of Nagaur fair only out of all 719 horses examined in all the fairs.

4.1.3. Agewise prevalence

Gastrointestinal parasites showed higher prevalence (35.91%) in horses of 3-5 years followed by horses below 3 years (32.99%) and above 5 years (30.49%) of age.

Among helminths, *Habronema* infections predominated followed by strongyles, *Parascaris equorum* and *Strongyloides westeri* in all the three age groups studied. *Draschia* (two horses), *Schistosoma* (one horse) and *Anoplocephala* (one horse) infection were detected in 3-5 years age groups only. *Oxyuris equi* could be detected only in one horse of above five years of age.

Among protozoa, only *Eimeria leuckarti* infection was recorded only in one horse below 3 years and one in 3-5 years age groups.

4.1.4. Sexwise prevalence

Gastrointestinal parasites showed comparatively higher prevalence (38.54%) in male than female (33.24%) horses.

Among helminths, *Habronema* predominated in both the sexes followed by strongyle, *Parascaris equorum* and *Strongyloides westeri* infections. *Habronema*, strongyle, *Parascaris equorum* and *Strongyloides westeri* showed comparatively higher prevalence (17.31, 14.52, 8.37 and 5.58%, respectively) in male than female (12.96, 8.51, 6.66 and 4.62%, respectively) horses. *Draschia* (0.37%), *Oxyuris equi* (0.18%), *Schistosoma* (0.18%) and *Anoplocephala* (0.18%) were recorded only from female horses.

Among protozoa, *Eimeria leuckarti* (0.37%) was recorded only in females.

4.1.5. Districtwise prevalence

The results are presented in Table 2.

The horses from which faecal samples were collected at theses five fairs belonged to a total of forty three districts out of which twenty three were from Rajasthan and twenty from nearby states.

Animals of 33 out of 43 districts, brought to animal fairs showed the prevalence of gastrointestinal parasites.

Among helminths, strongyle infection was detected in examined animals of maximum (24) districts followed by *Habronema* (22) and *Strongyloides westeri* and *Parascaris equorum* (16 each). *Draschia* was detected only in the animals of two districts (Hanumangarh and Jaipur). *Schistosoma* (Muktsar), *Oxyuris equi* (Bharatpur) and *Anoplocephala* (Nagaur) infection were observed in the animals of one district each.

Among protozoa only *Eimeria leuckarti* was observed in the animal of Nagaur district only.

Table 2. Districtwise prevalence of gastrointestinal parasites in horses of animal fairs in Rajasthan

District	Faecal samples examined (numbers)	Faecal samples positive for (numbers)									
		Gastrointestinal parasites	Helminths (species)								Protozoa
			Strongyle type	*Strongyloides westeri*	*Parascaris equorum*	*Habronema*	*Draschia*	*Schistosoma*	*Anoplocephala*	*Oxyuris equi*	*Eimeria leuckarti*
Agra	1	-	-	-	-	-	-	-	-	-	-
Ajmer	33	12(36.36)	1(3.03)	1(3.03)	1(3.03)	9(27.27)	-	-	-	-	-
Alwar	3	2(66.66)	1(33.33)	1(33.33)	1(33.33)	-	-	-	-	-	-
Badanyou	1	-	-	-	-	-	-	-	-	-	-
Balia	3	2(66.66)	2(66.66)	-	-	1(33.33)	-	-	-	-	-
Banaskatha	2	1(50.00)	-	-	-	1(50.00)	-	-	-	-	-
Barelly	3	2(66.66)	1(33.33)	-	-	1(33.33)	-	-	-	-	-
Barmer	54	18(33.33)	5(9.25)	2(3.70)	3(5.55)	10(18.51)	-	-	-	-	-
Bharatpur	4	2(50.00)	1(25.00)	-	-	-	-	-	-	1(25.00)	-
Bhatinda	2	1(50.00)	-	-	-	1(50.00)	-	-	-	-	-
Bhilwara	4	1(25.00)	-	1(25.00)	-	-	-	-	-	-	-
Bikaner	3	-	-	-	-	-	-	-	-	-	-
Bundi	1	1(100.00)	1(100.00)	-	-	-	-	-	-	-	-
Chittor	5	2(40.00)	2(40.00)	1(20.00)	-	-	-	-	-	-	-
Churu	12	2(16.66)	-	2(16.66)	-	-	-	-	-	-	-
Dausa	3	-	-	-	-	-	-	-	-	-	-
Faizabad	2	-	-	-	-	-	-	-	-	-	-
Firozpur	4	2(50.00)	-	-	1(25.00)	1(25.00)	-	-	-	-	-
Ganganagar	26	17(65.38)	2(7.69)	-	6(23.07)	10(38.46)	-	-	-	-	-
Hanumangarh	111	42(37.83)	9(8.10)	5(4.50)	7(6.30)	23(20.72)	1(0.90)	-	-	-	-
Haridwar	2	-	-	-	-	-	-	-	-	-	-

Continued...

District	Faecal samples examined (numbers)	Faecal samples positive for (numbers)									
		Gastrointestinal parasites	Helminths (species)								Protozoa
			Strongyle type	*Strongyloides westeri*	*Parascaris equorum*	*Habronema*	*Draschia*	*Schistosoma*	*Anoplocephala*	*Oxyuris equi*	*Eimeria leuckarti*
Hisar	3	-	-	-	-	-	-	-	-	-	-
Jaipur	12	6(50.00)	-	-	1(8.33)	5(41.66)	1(8.33)	-	-	-	-
Jaisalmer	7	3(42.85)	-	1(14.28)	1(14.28)	1(14.28)	-	-	-	-	-
Jalore	6	4(66.66)	1(16.66)	-	1(16.66)	2(33.33)	-	-	-	-	-
Jodhpur	55	20(36.36)	5(9.09)	1(1.81)	8(14.54)	8(14.54)	-	-	-	-	-
Karauli	2	-	-	-	-	-	-	-	-	-	-
Mahu	1	1(100.00)	1(100.00)	-	1(100.00)	-	-	-	-	-	-
Mandsor	1	1(100.00)	1(100.00)	-	-	-	-	-	-	-	-
Mathura	7	5(71.42)	2(28.57)	1(14.28)	-	1(14.28)	-	-	-	-	-
Mujjfarnagar	1	1(100.00)	1(100.00)	1(100.00)	-	-	-	-	-	-	-
Muktsar	5	2(40.00)	-	-	1(20.00)	1(20.00)	-	1(20.00)	-	-	-
Nagaur	263	60(22.81)	24(9.12)	13(4.94)	15(5.70)	15(5.70)	-	-	1(0.38)	-	2(0.76)
Pali	16	8(50.00)	3(18.75)	2(12.50)	-	3(18.75)	-	-	-	-	-
Patan	2	-	-	-	-	-	-	-	-	-	-
Patna	3	2(66.66)	1(33.33)	1(33.33)	1(33.33)	1(33.33)	-	-	-	-	-
Rajkot	1	-	-	-	-	-	-	-	-	-	-
Sikar	14	5(35.71)	2(14.28)	1(7.14)	1(7.14)	1(7.14)	-	-	-	-	-
Sirohi	4	1(25.00)	-	1(25.00)	-	-	-	-	-	-	-
Sirsa	12	7(58.33)	2(16.66)	-	2(16.66)	3(25.00)	-	-	-	-	-
Surendra Nagar	3	1(33.33)	1(33.33)	-	-	1(33.33)	-	-	-	-	-
Tonk	11	1(9.09)	1(9.09)	-	-	-	-	-	-	-	-
Udaipur	11	4(36.36)	2(18.18)	-	-	2(18.18)	-	-	-	-	-
Overall	719	239(33.24)	72(10.01)	35(4.86)	51(7.09)	101(14.04)	2(0.27)	1(0.13)	1(0.13)	1(0.13)	2(0.27)

Note: Figures in parentheses indicate per cent.

4.2. Comparision of direct smear, flotation and sedimentation methods of faecal examination for detection of gastrointestinal parasites

The results are presented in Table 3 and Figure 5.

By comparing all these methods it was observed that flotation method could detect more gastrointestinal parasitic infections (31.84%) than sedimentation (30.18%) and direct smear methods (15.02%).

Among helminths, sedimentation method detected more *Habronema* (13.35%) infection than flotation (12.93%) and direct smear (3.75%) methods.

Flotation method detected more strongyle (9.73%), *Strongyloides westeri* (4.45%) and *Parascaris equorum* (6.95%) infections than sedimentation (8.34%, 3.61% and 6.39%, respectively) and direct smear (5.56%, 1.94% and 4.72%, respectively) methods.

Among protozoa, sedimentation method detected more (0.27%) *Eimeria leuckarti* infection than direct smear (0.13%) method.

4.3. Intensity of gastrointestinal parasites

For having an idea of intensity/severity of gastrointestinal parasitic infections, counts of egg per gram of faeces (epg) for helminths and oocyst per gram of faeces (opg) for *Eimaria*, for all the positive faecal samples were made and least square means calculated (egg count data of infections reported only in one or two animals were excluded from statistical analysis). The results are presented in Tables 4 and 5 and Figures 6, 7, 8 and 9.

Table 3. Comparison of direct smear, flotation and sedimentation methods of faecal examination for detection of gastrointestinal parasites in horses

Fair	Faecal samples examined (numbers)	Direct smear method										Flotation method										Sedimentation method										Total positive for G.I. parasites
		Helminths (species)								Pro.	G.I. Parasites	Helminths (species)								Pro.	G.I. Parasites	Helminths (species)								Pro.	G.I. Parasites	
		Strongyle type	*Strongyloides westeri*	*Parascaris equorum*	*Habronema*	*Draschia*	*Schistosoma*	*Anoplocephala*	*Oxyuris equi*	*Eiimeria leuckarti*		Strongyle type	*Strongyloides westeri*	*Parascaris equorum*	*Habronema*	*Draschia*	*Schistosoma*	*Anoplocephala*	*Oxyuris equi*	*Eiimeria leuckarti*		Strongyle type	*Strongyloides westeri*	*Parascaris equorum*	*Habronema*	*Draschia*	*Schistosoma*	*Anoplocephala*	*Oxyuris equi*	*Eiimeria leuckarti*		
Pushkar	153	10 (6.53)	5 (3.26)	2 (1.30)	-	-	-	-	-	-	14 (9.15)	14 (9.15)	8 (5.22)	2 (1.30)	-	-	-	-	1 (0.65)	-	20 (13.07)	11 (7.18)	6 (3.92)	2 (1.30)	-	-	-	-	1 (0.65)	-	17 (11.11)	21 (13.72)
Nagaur	153	11 (7.18)	3 (1.96)	7 (4.57)	1 (o.65)	-	-	-	-	1 (0.65)	22 (14.37)	19 (12.41)	9 (5.88)	10 (6.53)	3 (1.96)	-	-	-	-	-	38 (24.83)	16 (10.45)	7 (4.57)	10 (12.41)	1 (0.65)	-	-	-	-	2 (1.30)	34 (22.22)	41 (26.79)
Hanumangarh	156	7 (4.48)	2 (1.28)	13 (8.33)	11 (7.05)	-	-	-	-	-	32 (20.51)	12 (7.69)	4 (2.56)	16 (10.25)	34 (21.79)	1 (0.64)	-	-	-	-	65 (41.66)	11 (7.05)	3 (1.92)	16 (10.25)	37 (23.71)	1 (0.64)	-	-	-	-	64 (41.02)	69 (44.23)
Tilwara	150	8 (5.33)	3 (2.00)	8 (5.33)	9 (6.00)	-	-	-	-	-	25 (16.66)	16 (10.66)	8 (5.33)	13 (8.66)	38 (25.33)	1 (0.66)	-	1 (0.66)	-	-	69 (46.00)	14 (9.33))	7 (4.66)	10 (6.66)	39 (26.00)	1 (0.66)	1 (0.66)	1 (0.66)	-	-	66 (44.00)	70 (46.66)
Merta City	107	4 (3.73)	1 (0.93)	4 (3.73)	6 (5.60)	-	-	-	-	-	15 (14.01)	9 (8.41)	3 (2.80)	9 (8.41)	18 (16.82)	-	-	-	-	-	37 (37.57)	8 (7.47)	3 (2.80)	8 (7.47)	19 (17.75)	-	-	-	-	-	36 (33.64)	38 (35.00)
Total	719	40 (5.56)	14 (1.94)	34 (4.72)	27 (3.75)	-	-	-	-	1 (0.13)	108 (15.02)	70 (9.73)	32 (4.45)	50 (6.95)	93 (12.93)	2 (0.27)	-	1 (0.13)	1 (0.13)	-	229 (31.84)	60 (8.34)	26 (3.61)	46 (6.39)	96 (13.35)	2 (0.27)	1 (0.13)	1 (0.13)	1 (0.13)	2 (0.27)	217 (30.18)	239 (33.24)

Note: 1. Figures in parentheses indicate per cent.
2. Pro. : Protozoa
3. G.I. : Gastrointestinal

Fig. 5. Comparison of direct smear, flotation and sedimentation methods of faecal examination for gastrointestinal parasites in horses

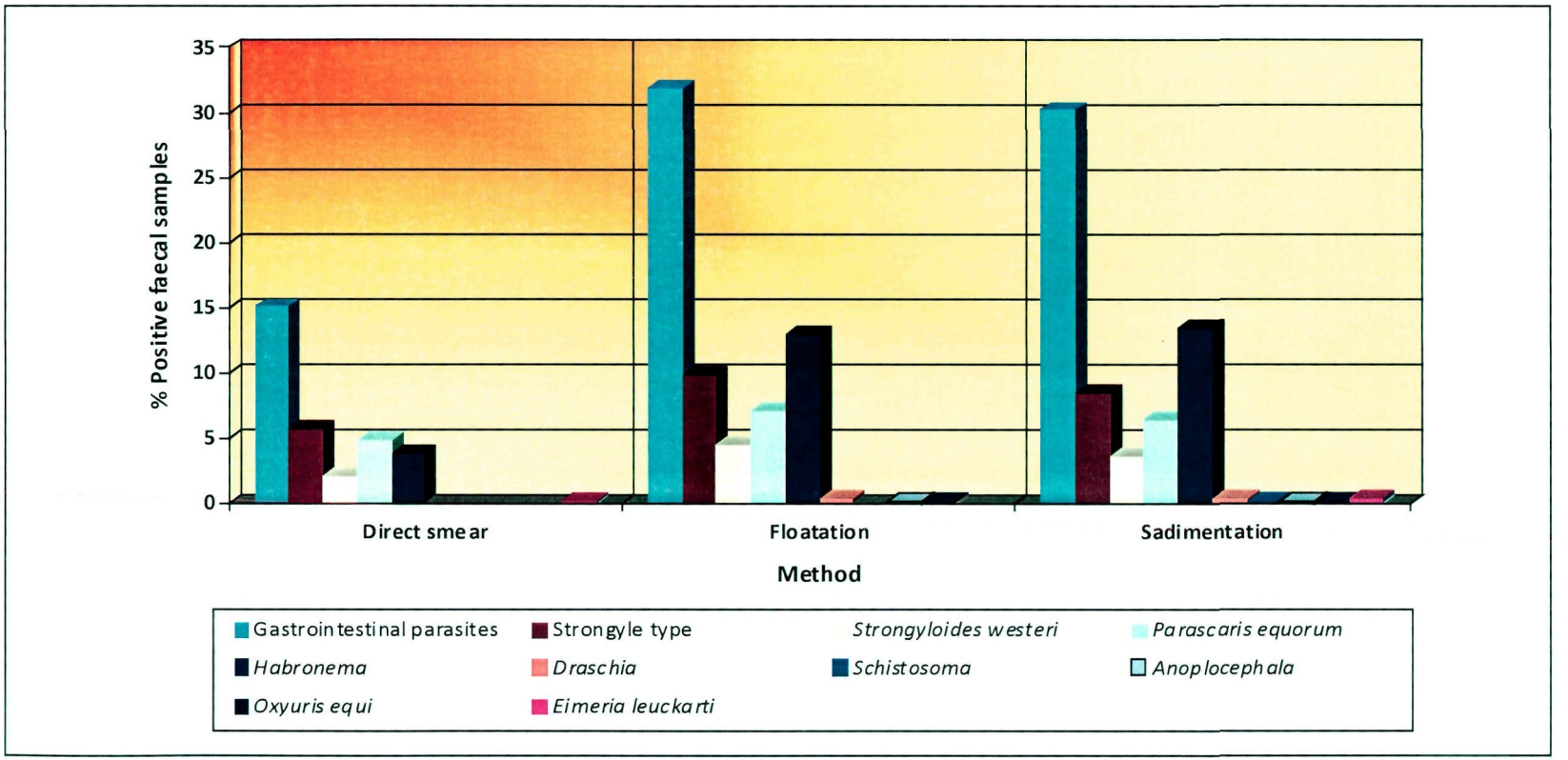


Table 4. Intensity (Eggs per gram of faeces) of gastrointestinal helminth parasites in horses of animal fairs in Rajasthan (Least square mean ±S.E.)

Effects	Strongyle type (epg)	*Strongyloides westeri* (epg)	*Parascaris equorum* (epg)	*Habronema* (epg)	Gastrointestinal helminth parasites (epg)
1.FAIR					
Pushkar	206.12±23.47	174.58±35.87^{a}	343.00±85.62^{b}	-	221.15±21.95^{b}
Nagaur	192.78±23.01	157.90±35.61^{a}	247.64±46.26^{a}	92.93±23.17	220.93±17.07^{b}
Hanumangarh	197.45±27.60	140.68±48.56^{a}	299.12±36.36^{b}	91.96±7.07	170.83±13.19^{a}
Tilwara	193.09±23.39	219.11±36.32^{b}	259.20±38.56^{a}	82.77±6.48	155.84±12.75^{a}
Merta City	216.62±29.20	171.94±59.03^{a}	247.89±42.62^{a}	89.14±6.48	167.07±17.48^{a}
2.AGE					
Below 3 Years	237.12±15.23^{b}	194.07±20.13^{b}	336.37±23.65^{b}	95.33±7.26	207.77±8.99^{b}
3-5 Years	187.08±23.07^{a}	146.00±38.11^{a}	213.62±43.62^{a}	78.40±9.61	132.83±13.36^{a}
Above 5 Years	179.41±24.20^{a}	178.46±52.31^{b}	288.13±63.41^{b}	93.87±10.87	153.40±16.49^{a}
3.SEX					
Male	203.65±19.40	143.34±36.71	276.27±40.76	89.39±9.88	180.48±12.62
Female	198.75±14.30	202.35±25.99	282.47±28.54	92.01±7.08	178.53±8.59
OVERALL	201.20±12.28	172.84±24.80	279.37±29.65	89.20±7.19	187.16±7.52

Note: 1. Comparison between different means were made with in effect groups.
2. Figures with different superscript letters differ significantly at ($P<0.05$).

Table 5. Least squares analysis of variance

Source of variation	d.f.	Mean Squares			
		Strongyle type	*Strongyloides westeri*	*Parascaris equorum*	*Habronema*
Fair	4	1134.73^{NS}	5111.78^{NS}	8591.12^{NS}	538.56^{NS}
Age	2	23811.00*	5858.42^{NS}	52404.96*	2753.53^{NS}
Sex	1	341.23^{NS}	19048.73^{NS}	350.13^{NS}	532.48^{NS}
Remainder	-	7949.57	8672.82	13076.02	1491.66
d.f. of Remainder	-	64	27	43	94

Note: 1. NS : Non Significant (P>0.05).
2. * : Significant at (P<0.05).
3. d.f. : Degree of freedom.

Fig. 6. Overall intensity of gastrointestinal parasites in horses of animal fairs in Rajasthan

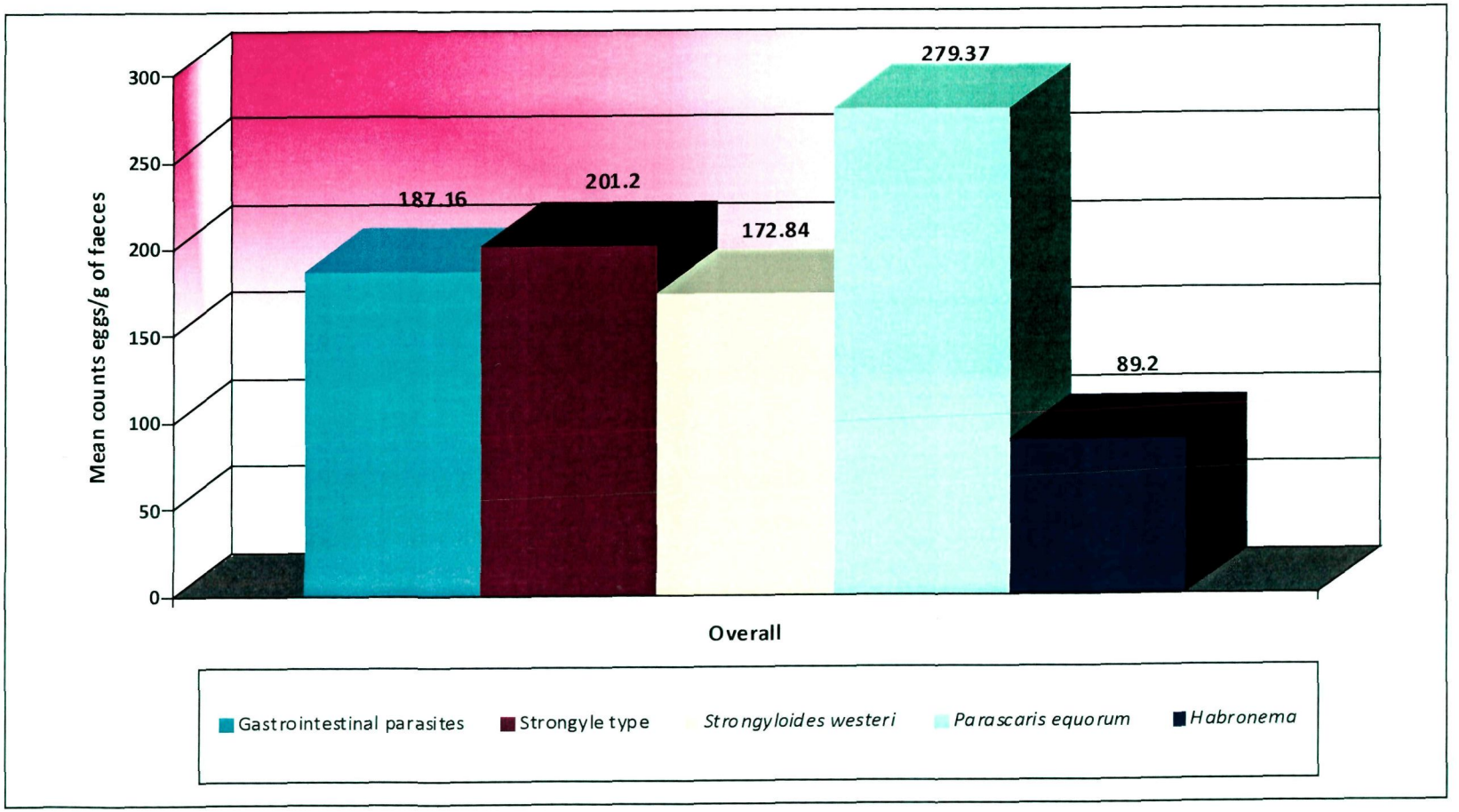


Fig. 7. Fairwise intensity of gastrointestinal parasites in horses of animal fairs in Rajasthan

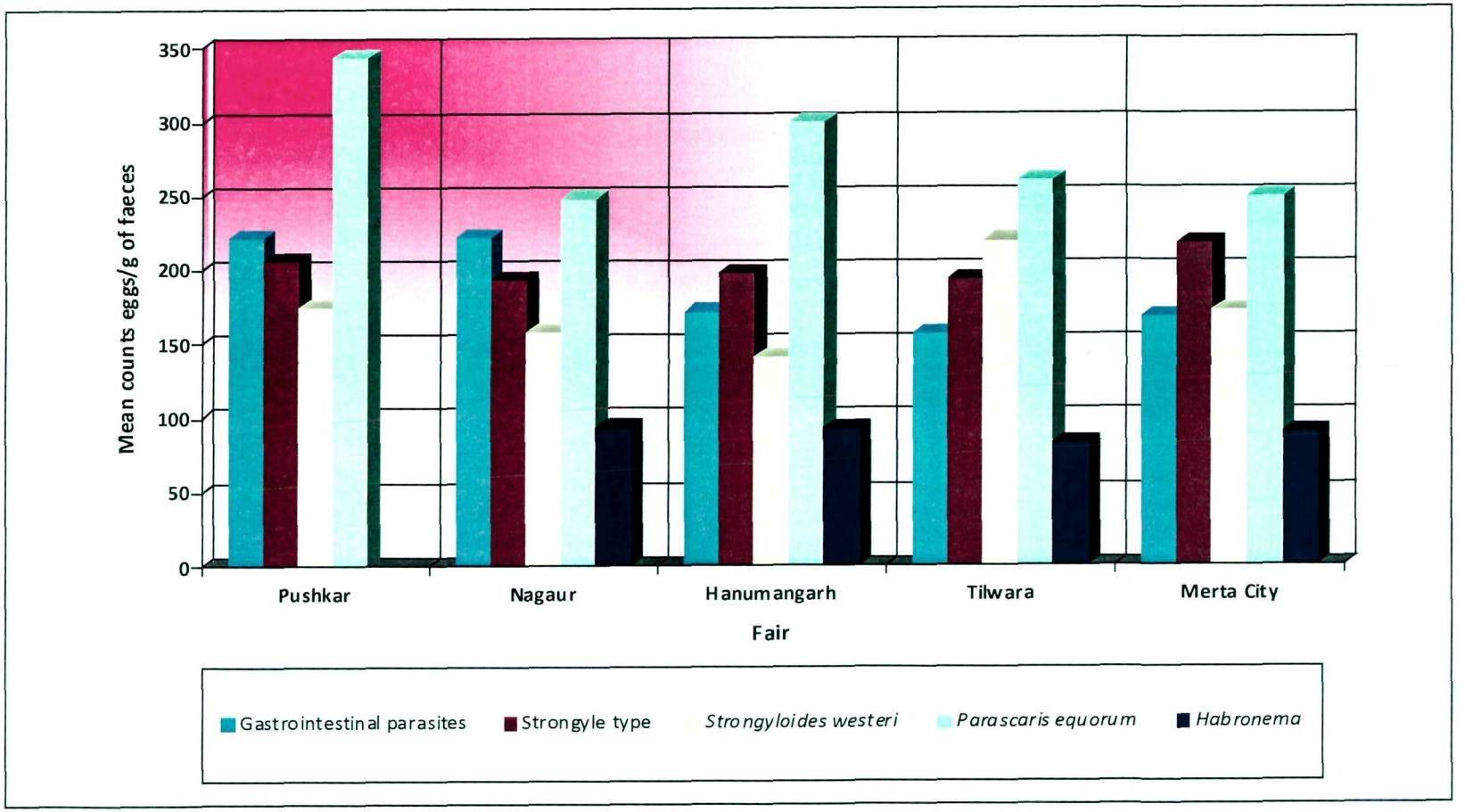


Fig. 8. Agewise intensity of gastrointestinal parasites in horses of animal fairs in Rajasthan

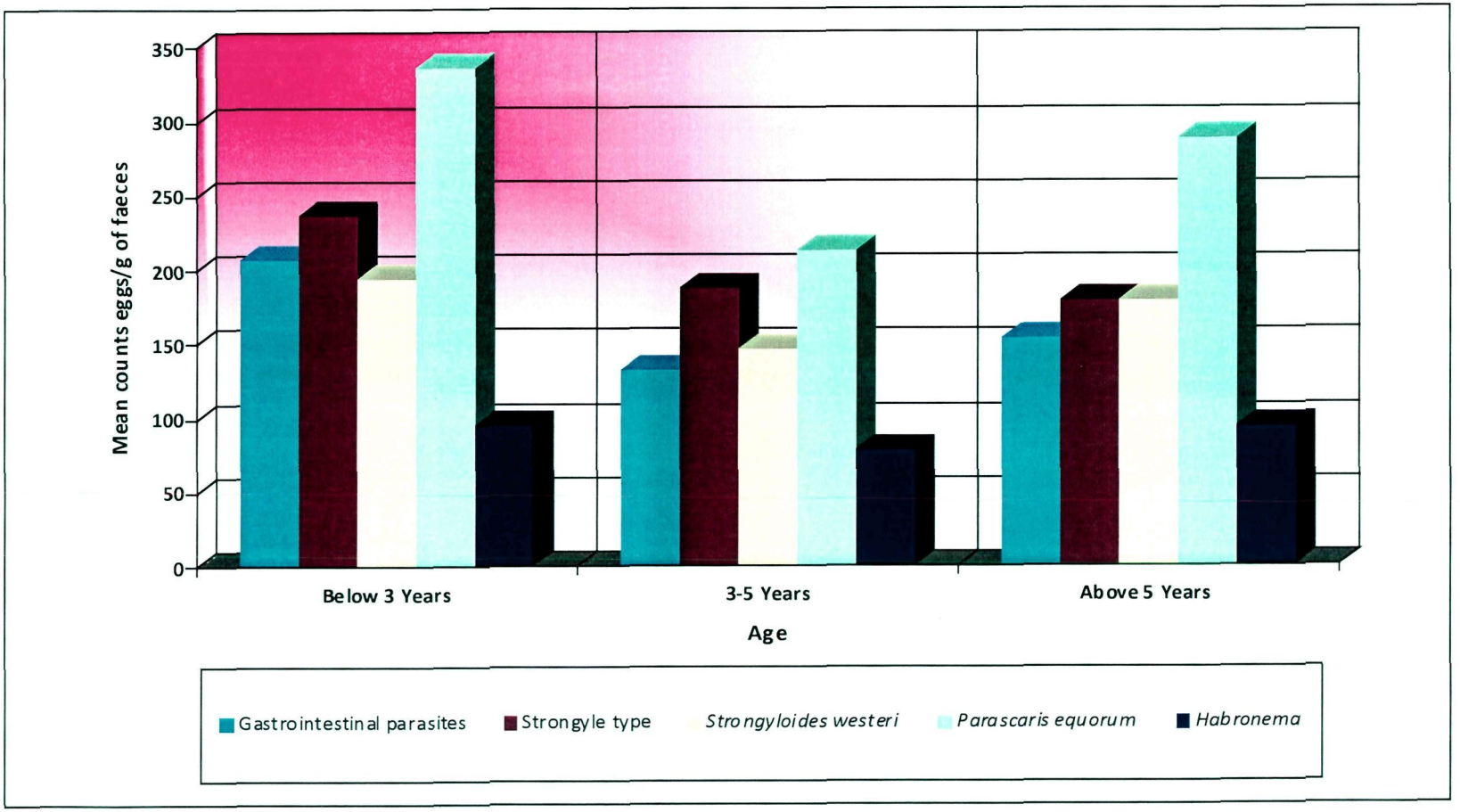
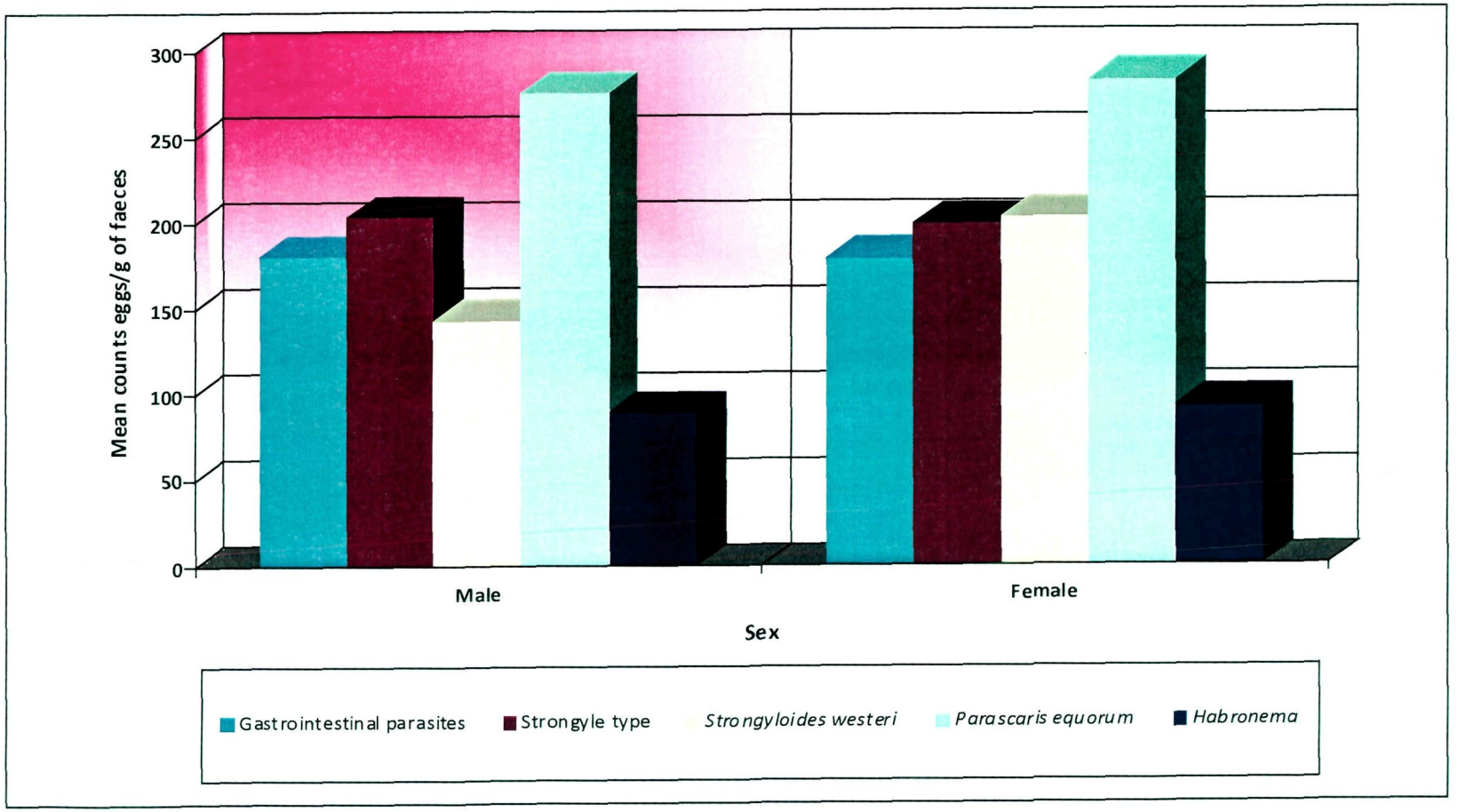


Fig. 9. Sexwise intensity of gastrointestinal parasites in horses of animal fairs in Rajasthan



4.3.1. Overall intensity

In the horses of animal fairs positives faecal samples showed overall mean counts of 187.16±7.52 epg for gastrointestinal helminth parasites.

The maximum overall mean counts of 279.37±29.65 epg was recorded for *Parascaris equorum* followed by 201.20±12.28 epg for strongyle, 172.84±24.80 epg for *Strongyloides westeri* and 89.20±7.19 epg for *Habronema*.

The egg counts/mean egg/oocyst counts were 75 for *Draschia*, 100 each for *Oxyuris equi* and *Schistosoma*, 250 for *Anoplocephala* and 75 for *Eimeria leuckarti* based on only two positive samples for *Draschia* and *Eimeria* and only one positive sample for others. Being positive in one or two samples these data of counts were not included in statistical analysis.

4.3.2. Fairwise intensity

The horses of Pushkar and Nagaur fairs showed significantly higher intensity of gastrointestinal helminth parasites (221.15±21.95 and 220.93±17.07 epg, respectively) than Hanumangarh (170.83±13019 epg), Merta City (167.07±17.48 epg) and Tilwara (155.84±12.75 epg) fairs.

The horses of Pushkar and Hanumangarh fairs had significantly higher intensity of *Parascaris equorum* infection (343.00±85.62 and 299.12±36.36 epg, respectively) than Tilwara (259.20±38.56 epg), Merta City (247.89±42.62 epg) and Nagaur (247.64±42.26) fairs. The horses of Tilwara showed a significantly higher intensity of *Strongyloides westeri* (219.11±36.32 epg) than Pushkar (174.58±35.87 epg), Merta City (171.94±59.03 epg), Nagaur (157.90±35.61 epg) and Hanumangarh (197.45±27.60 epg) fairs. The horses of all the animal fairs studied showed no significant difference in the intensity of strongyle and *Habronema*.

Only one horse each positive for *Schistosoma*, *Anoplocephala* and *Draschia* showed epg of 100, 250 and 100 respectively at Tilwara fair. Only one horse positive for *Draschia* at Hanumangarh had an epg of 50. Only one horse positive for *Oxyuris equi* at Pushkar only had epg of 100. Only two horses positive for *Eimeria leuckartia* at Nagaur fair only showed an average opg of 75.

4.3.3. Agewise intensity

The horses below 3 years of age showed a significantly higher intensity (207.77±8.99 epg) of gastrointestinal helminth parasites than 3-5 years (132.83±13.36 epg) and above 5 years (153.40±16.49 epg) of age groups.

The horses below 3 years of age and above 5 years of age had significantly higher intensity of *Parascaris equorum* (336.37±23.65 and 288.13±63.41) and *Strongyloides westeri* (194.07±20.13 and 178.46±52.31) than horses of 3-5 years (213.62±43.62 and 146.00±38.11) of age group. Horses below 3 years of age showed a significantly higher intensity (237.12±15.23) of strongyle infection than horses of 3-5 years (187.08±23.07) and above 5 years (179.41±24.20) of age groups.

4.3.4. Sexwise intensity

Sex had no significant effect on the intensity of any parasitic infection detected.

During the present investigation none of the horses was showing any apparent clinical symptoms, all the animals were normal and healthy. The present results revealed that the animals were suffering from subclinical parasitism.

4.4. Coproculture and identification of third stage strongyle larvae of horses

The third stage infective strongyle nematodes larvae recorded from faecal culture in present investigation were identified on the basis of measurements of their total length and extention of tail sheath beyond tip of the larvae (µm) and some morphological characters.

4.4.1. Mean measurements and other morphological characters

The mean biometrical observation and morphological identification are presented in Table 6.

Strongylus vulgaris

Total length of larvae ranged from 959.00-1164.50 µm with an average of 1047.46±9.86 µm. The tail sheath varied from 191.80-287.70 µm with an average of 228-98±5.34 µm. The sheath was long and pointed and intestinal cells numbering 28-32 were short, triangular in shape (Plate 13).

Strongylus edentatus

Total length of larvae ranged from 698.70-876.80 µm with an average of 780.90±3.90 µm. The tail sheath varied from 123.30-178.10 µm with an average of 147.65±1.49 µm. The tail sheath was blunt and 20 indistinct intestinal cells were seen (Plate 14).

Strongylus equinus

Total length of larvae ranged from 776.20-890.50 µm with an average of 822.91±3.66 µm. The tail sheath varied from 191.80-274.00 µm with an average of 225.59±2.52 µm and small trilobed process on larval tail was seen (Plate 15).

Trichostrongylus axei

Total length of larvae ranged from 589.10-657.60 µm with an average of 626.36±4.36 µm. The tail sheath varied from 82.20-123.30 µm with an average of 103.57±2.96 µm. Tail sheath was short and conical.

Gyalocephalus capitatus

Total length of larvae ranged from 506.90-602.80 µm with an average of 554.39±5.40 µm. The tail sheath varied from 137.00-178.10 µm with an average of 163.94±2.41 µm. The tail sheath was long and intestinal cells numbering 12 were triangular in shape.

Oesophagodonts spp.

Total length of larvae ranged from 917.90-1000.10 µm with an average of 960.21±3.55 µm. The tail sheath varied from 205.50-274.00 µm with an average of 242.03±2.92 µm. The tail sheath was long and filamentous and intestinal cells numbering more than 16 were defined triangular in shape (Plate 16).

Strongyloides westeri

Total length of larvae ranged from 438.40-561.70 µm with an average of 488.98±4.90 µm. The larvae were having bifid tail without tail sheath. Oesophagus was more than one third of the body length (Plate 17).

Table 6. Mean measurements (µm) of third stage larvae of strongylid nematodes of horses (Mean ±S.E.)

Nematodes	Total length (Range)	Extension of tail sheath beyond tail (Range)	Remarks
Strongylus vulgaris	1047.46±9.86 (959.00-1164.50)	228.98±5.34 (191.80-287.70)	Tail sheath long and pointed, 28-32 intestinal cells triangular in shape.
Strongylus edentatus	780.90±3.90 (698.70-876.80)	147.65±1.49 (123.30-178.10)	Tail sheath blunt, 20 indistinct intestinal cells
Strongylus equinus	822.91±3.66 (776.20-890.50)	225.59±2.52 (191.80-274.00)	Small trilobed process on larval tail, long thin larvae
Trichostrongylus axei	626.36±4.36 (589.10-657.60)	103.57±2.96 (82.20-123.30)	Tail sheath short and conical, more than 16 intestinal cells
Gyalocephalus capitatus	554.39±5.40 (506.90-602.80)	163.94±2.41 (137-178.10)	Tail sheath long, 12 intestinal cells triangular in shape
Oesophogodontus spp.	960.21±3.55 (917.90-1000.10)	242.03±2.92 (205.50-274.00)	Tail sheath long and filamentous. More than 16 intestinal cells triangular in shape
Strongyloides westeri	488.98±4.90 (438.40-561.70)	-	No sheath, tail bifid, oesophagus long

Note: Figures in parentheses indicate range of lengths.

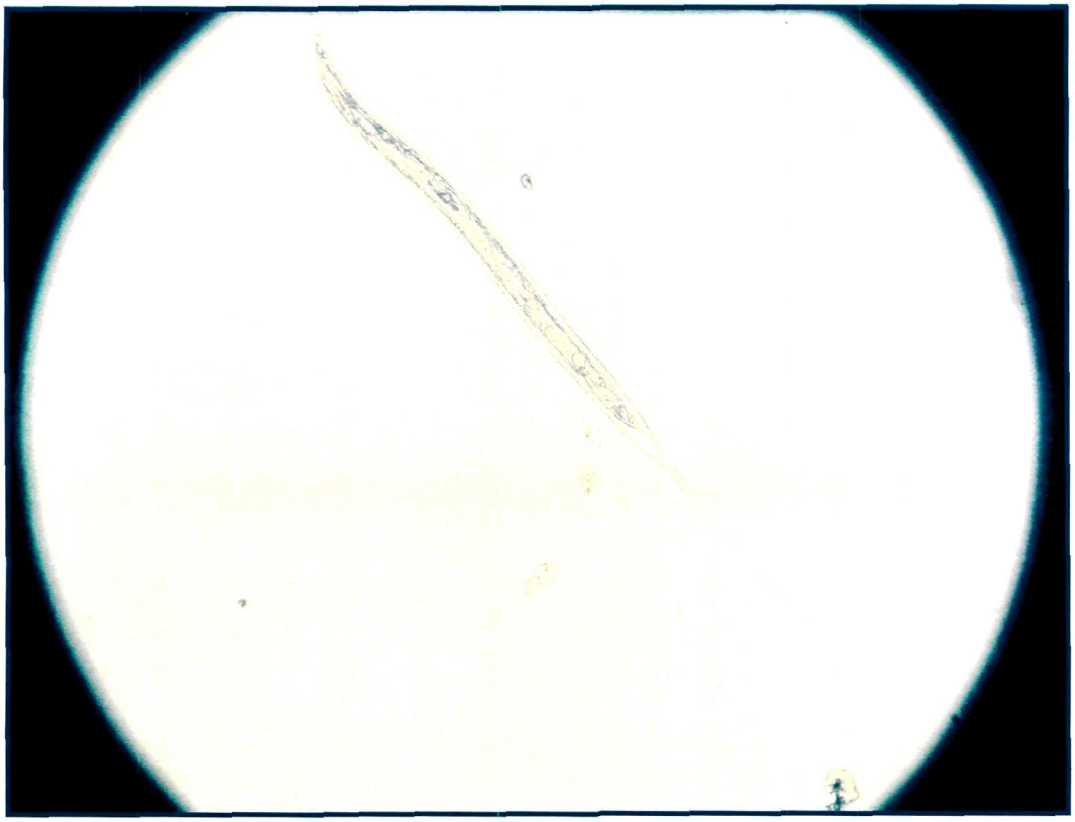


Plate 13: Microphotograph of larva of *Strongylus vulgaris* (X100).

Plate 14: Microphotograph of larva of *Strongylus edentatus* (X100).

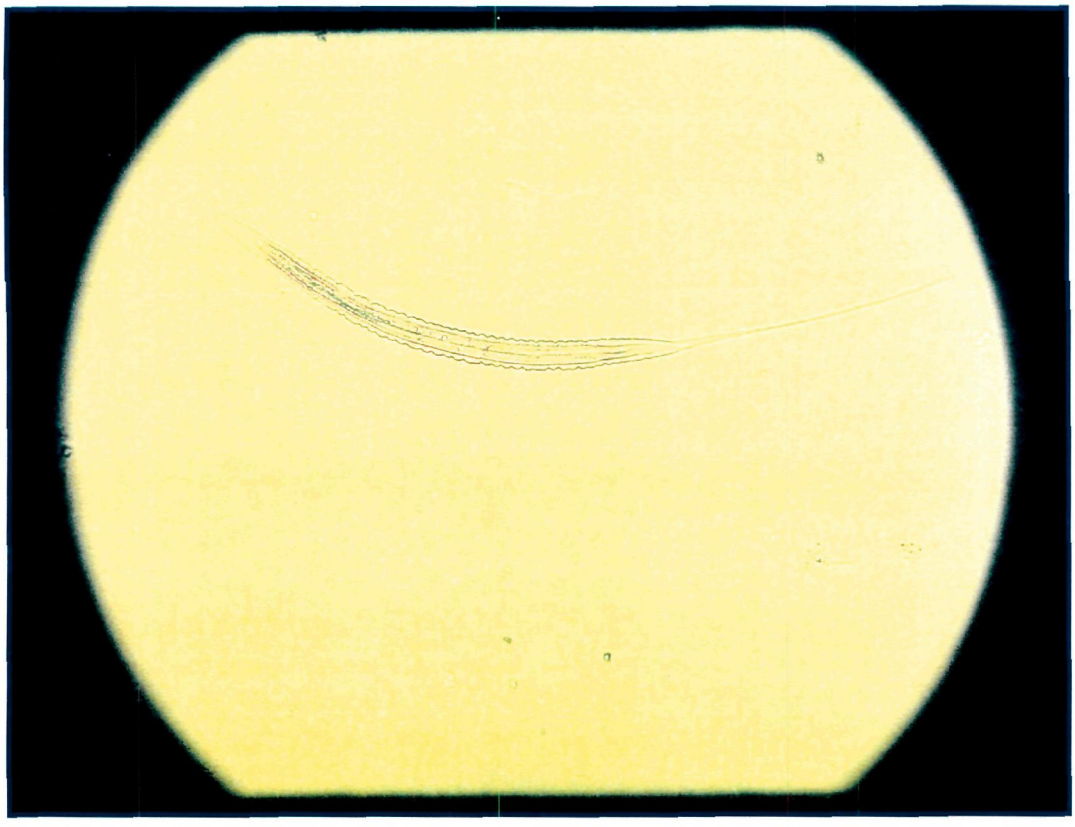


Plate 15: Microphotograph of larva of *Strongylus equinus* (X100).

Plate 16: Microphotograph of larva of *Oesophagodontus spp.* (X100).

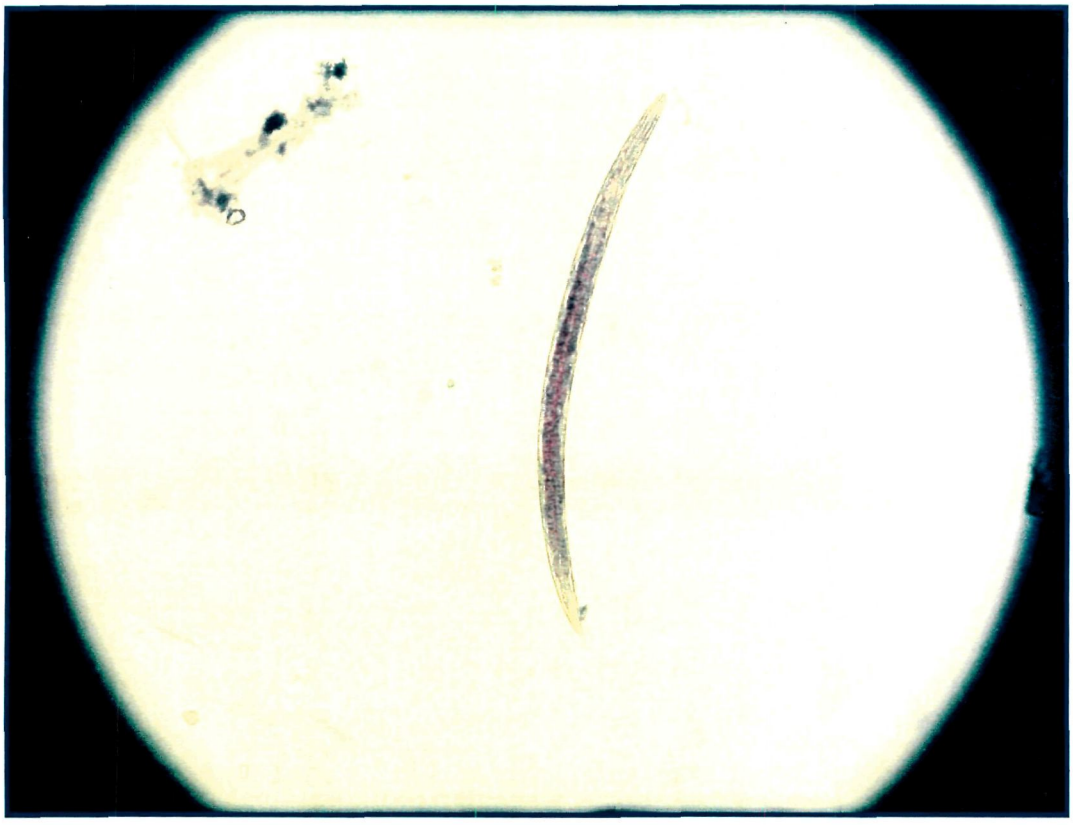


Plate 17: Microphotograph of larva of *Strongyloides westeri* (X100).

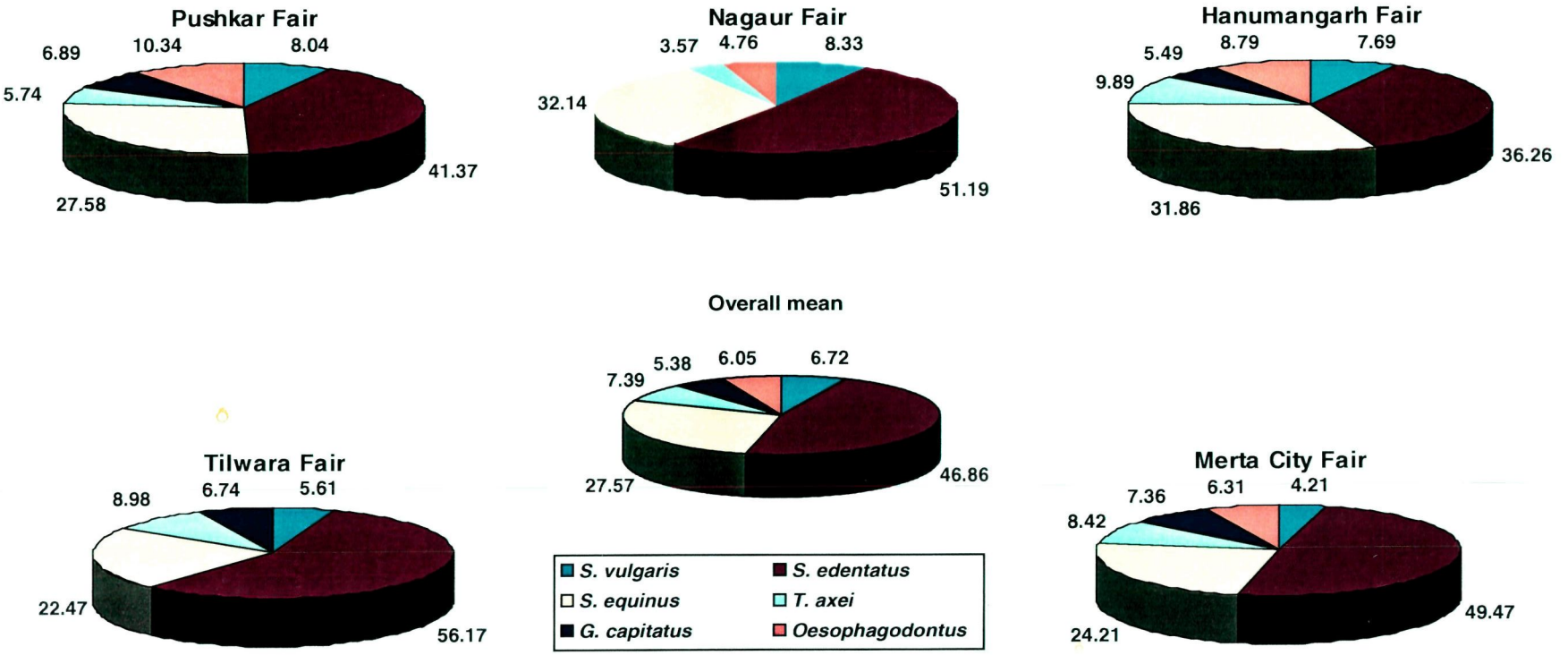
4.4.2. Proportion of strongyle larvae on coproculture

The proportion (per cent) of different third stage strongyle larvae in coproculture were determined (Table 7 and Figure 10) and results indicated that *Strongylus edentatus* was major contributor to the strongyle worm population (46.86%) and highest proporation (56.17%) was recovered at Tilwara fair followed by Nagaur (51.19%), Merta City (49.47%), Pushkar (41.37%) and Hanumangarh (36.26%) fairs. The percent contribution of *Strongylus equinus* was (27.57%) with peak recovery at Nagaur (32.14%) and lowest at Tilwara (22.47%) fairs. *Trichostrongylus axei* contributed (7.39%) of the larval recovery with peak (9.89%) at Hanumangarh and lowest (3.57%) at Nagaur fairs. *Strongylus vulgaris* contributed (6.72%) of the larval recovery with peak (8.33%) at Nagaur and lowest (4.21%) at Merta City fairs. *Oesophagodontus spp.* contributed (6.05%) of the larval recovery with peak (10.34%) at Pushkar and lowest (4.76%) at Nagaur fairs. *Gyalocephalus capitatus* contributed (5.38%) of the larval recovery with peak (7.36%) at Merta Citya and lowest (5.49%) at Hanumangarh fairs.

Table 7. Proportion of strongyle larvae of horses on coproculture (%)

Fair	Pushkar	Nagaur	Hanumangarh	Tilwara	Merta City	Overall
Strongylus vulgaris	8.04	8.33	7.69	5.61	4.21	6.72
Strongylus edentatus	41.37	51.19	36.26	56.17	49.47	46.86
Strongylus equinus	27.58	32.14	31.86	22.47	24.21	27.57
Trichostrongylus axei	5.74	3.57	9.89	8.98	8.42	7.39
Gyalocephalus capitatus	6.89	-	5.49	6.74	7.36	5.38
Oesophogodontus spp.	10.34	4.76	8.79	-	6.31	6.05

Fig. 10. Proprtion of Strongyle larvae of horse on coproculture



DISCUSSION

5. DISCUSSION

During the present investigation, it was found that 33.24% of horses of five different fairs were suffering from subclinical gastrointestinal parasitism. The prevalence of gastrointestinal parasites in horses has been recorded earlier by many workers in different parts of world. It has been reported that 76.40% horses in Berlin, Germany (Fries, 1982), 66.00% in Iraq (Al-Alousi *et al.*, 1994), 62.40% in Greece (Sotiraki *et al.*, 1997), 93.14% in Brazil (Mundim *et al.*, 2000), 77.75% in Jammu and Kashmir, India (Khajuria *et al.*, 2004), 75% in Faisalabad, Pakistan (Mahfooz *et al.*, 2008) and 76.47% in Patiala, Punjab, India (Kaur and Kaur, 2008) were infected with gastrointestinal parasites.

Maximum prevalence (46.66%) of gastrointestinal parasires was recorded in the horses of Tilwara fair. Being the largest fair of Rajasthan, horses are brought at Tilwara from different geographical areas of Rajasthan as well as from adjoining states which might be responsible for the higher prevalence in comparison to Hanumangarh (44.23%), Nagaur (26.79%), Merta City (35.00%) and Pushkar (13.72) fairs where horses were mainly brought from adjoining districts of fair.

Prevalence of gastrointestinal parasites in the horses has been reported from India and abroad earlier by many workers (Silobed, 1987; Epe *et al.*, 1993; Chaudhri and Singh, 2000; Sengupta and Yadav, 2001 and Mahfooz *et al.*, 2008). However, such study on horses of animal fairs could not be detected in the literature. In a similar study in animals (camels) of animal fairs Kumar *et al.* (1993) observed that 90.16% animals of Gogameri fair were suffering from subclinical gastrointestinal parasitism.

Season and climatic conditions like humidity, temperature, availability of vectors for parasites having indirect life cycle before and during the time of fair may also play an important role in the prevalence

of parasires (Gundach *et al.*, 2004). The effect of dry and wet climate on the prevalence of parasires has been reported by Chaudhri *et al.* (1985) who recorded prevalence of gastrointestinal parasitic infections in the horses of wet and dry districts of Haryana. In wet areas, might be due to the high humidity, probably the free living stages of parasites survive for sufficient length of time and continuous cycle of infection is maintained between the host and pasture. In dry areas, summer and autumn seasons are suitable for the development of infections in equines.

The rate of infection varied from place to place in a district and season to season with in the same region (Chaudhri *et al.*, 1985; Sengupta and Yadav, 1998).

During the present research horses were also suffering from mixed infection of different gastrointestinal parasites. The mixed infections of gastrointestinal parasites in horses have been reported earlier also (Piskin *et al.*, 1999; Aydenizoz, 2004; Khajuria *et al.,* 2004 and Altas *et al.*, 2007).

In the present study, slightly higher prevalence (35.91%) of gastrointestinal parasites was found in the horses of 3-5 years of age group and below 3 years (32.99%) than above 5 years (30.49%) of age groups which might be due to higher susceptibility of these animals than older animals to parasitic infections (Fries, 1982; Fischer and Stoye, 1983 and Silobad, 1987). Chaudhri *et al.* (1985) recorded influence of age on the prevalence of gastrointestinal nematodes. They observed high infection in young foals than adults. Fries (1982) also observed that infections were higher among horses aged up to 4 years than in older groups. Fischer and Stoye (1983) recorded higher infection rates in foals as compared to that of adults. Silobad (1987) recorded higher prevalence of gastrointestinal parasites in foals of below 1 year than the horses 1-2 years and adults.

In the present study the prevalence of gastrointestinal parasites was found to be higher (38.54%) in males in comparison to females (31.48%). Kornas *et al.* (2006a) also reported 12% tapeworm infection in geldings and stallions and 5.2% in mares while conducting a study in horses from stud farms and individual breeding systems in Poland. However, no significant difference in the prevalence of parasites with regard to sex has also been reported (Perez, 1999; Singh *et al.*, 2002; Alcaino *et al.*, 2005 and Eslami *et al.*, 2005).

In the present investigation, among helminths, subclinical infection of *Habronema* was maximum (14.04%) followed by strongyle (10.01%), *Parascaris equorum* (7.09%), *Strongyloides westeri* (4.86%), *Draschia* (0.26%), *Schistosoma* (0.13%), *Anoplocephala* (0.13%) and *Oxyuris equi* (0.13%). The prevalence of similar helminths were also recorded earlier by many workers (Mirck, 1978; Silobad, 1981; Islam, 1986; Demir *et al.*, 1995; Banerjee *et al.*, 2002; Pandit *et al.*, 2008 and Khan *et al.*, 2010). The higher prevalence of *Habronema* observed in present study is in conformity with the findings of Islam (1986) who also observed a higher prevalence of *Habronema* while conducting a study in Zambia. Pandey *et al.* (1981) also reported a very high prevalence of *Habronema* infection while conducting a study on stomach worm of horses in Morocco.

Next to *Habronema*, strongyle infection was observed to be very common in horses in this study. The strongyle infection has been reported to be predominant in horses in similar studies conducted by many workers (Hadley, 1943; Mirck, 1978; Bauer and Stoye, 1984; Langrova, 1998; Epe *et al.*, 2004 and Uslu and Guclu, 2007). Moreover, *Habronema* eggs are not very easy to detect in faecal examination owing to their thin and transparent nature of egg shell.

Among the strongyle infection, *Strongylus edentatus* was main contributor (46.86%) followed by *S.equinus* (27.57%), *Trichostrongylus axei* (7.39%), *S. vulgaris* (6.72%), *Oesophagodontus spp.* (6.05%) and

Gyalocephalus capitatus (5.38%). Holland *et al.* (2001) showed that moderate to high strongyle infection were common in horses from North Vietnam as no anthelmintic treatment was given. Similar studies have also been conducted by other workers (Chaudhri *et al.*, 1985; Itagaki *et al.*, 1993; Sengupta and Yadav, 1998 and Sengupta and Yadav, 2003). Among strongyes, *Strongylus edentatus* has been reported to be main contributor by other workers also (Langenegger *et al.*, 1967; Poynter, 1970 and Itagaki *et al.*, 1993). However, *S. equinus* (Theodoridis *et al.*, 1999) and S. *vulgaris* has also been reported to be predominant among strongyles (Tolliver *et al.*, 1987; Aydenizoz, 2004 and Altas *et al.*, 2007).

In the present study average total length and tail sheath length of recovered infective third stage larvae of *Strongylus vulgaris* were (1047.46±9.86 and 228.98±5.34 µm), *S. edentatus* (780.90±3.90 and 147.65±1.49 µm), *S. equinus* (822.91 ±3.66 and 225.59±2.52 µm), *Trichostrongylus axei* (626.36±4.36 and 103.57±2.96 µm) *Gyalocephalus capitatus* (554.39±5.40 and 163.94±2.41 µm) and *Oesophagodontus spp.* (960.21±3.55 and 242.03±2.92 µm). Keith (1953), Soulsby (1965), and Levine (1968) also gave the measurement of total length and tail sheath length of the infective third stage larvae.

Among protozoa, a low (0.27%) overall prevalence of *Eimeria leuckarti* only was reported in present study. Variations in protozoal infections have been earlier reported by various workers from different places. Epe *et al.* (1993) reported 0.6% prevalence of *E. leuckarti* infection. Sotiraki *et al.* (1997) recorded 2.6% positive cases for *E. leuckarti* in Greece. Rehbein *et al.* (2002) also recorded 0.1% and 0.3% incidence of *E. leuckarti* infection in Germany and Austria, respectively. Bakirci *et al.* (2004) recorded 5.88% prevalence of *E. leuckarti* infection in Turkey. Pandit *et al.* (2008) also recorded 0.34% incidence of *Eimeria spp.* infection in Kashmir valley of Jammu and Kashmir state.

Animals of 33 out of 43 districts, brought to animal fairs showed the prevalence of gastrointestinal parasites. Among helminths, strongyle infection was detected in examined animals of maximum (24) districts followed by *Habronema* (22) and *Strongyloides westeri* and *Parascaris equorum* (16 each). *Draschia* was detected only in the animals of two districts (Hanumangarh and Jaipur). *Schistosoma* (Muktsar), *Oxyuris equi* (Bharatpur) and *Anoplocephala* (Nagaur) infection were observed in the animals of one district each. Districtwise finding of gastrointestinal parasitic infection in equines have also been reported by Chaudhri *et al.* (1985) in Haryana. Sengupta and Yadav (2001) detected the high prevalence of strongyle infection in Bikaner area of Rajasthan. Khajuria *et al.* (2004) recorded high incidence (77.75%) of helminth parasites in equines of Jammu region. Pandit *et al.* (2008) also reported high prevalence (93.26%) of gastrointestinal parasites in Kashmir valley of Jammu and Kashmir state.

Present study revealed that flotation and sedimentation methods were better as compared to direct smear method as these could detect more parasitic infections (31.84 and 30.18%) than direct smear (15.02%) method. Flotation and sedimentation methods have been found better than direct smear method by earlier studies also for parasite detection (Beelitz and Gothe, 2001 and Rehbein *et al.*, 2002). It was also observed that direct method usually failed to detect the mild infection having epg below 150 (Kayam *et al.*, 1992). These results also showed that flotation method was better to detect strongyle, *Parascaris equorum*, *Strongyloides westeri*, *Anoplocephala* and *Oxyuris equi* whereas the sedimentation method was found better for detection of *Habronema* and *Eimeria leuckarti* infections. *Habronema* egg floats easily but cannot be seen easily might be due to thin and transparent nature of egg shell. *Eimeria leuckarti* oocysts did not float probably because of their heavy weight and shape.

The least square mean epg±SE in all the five animal fairs were also calculated. The horses of all these five fairs were apparently healthy and showed no clinical symptoms. They appeared to be normal and healthy. The recorded infections were of low grade as the horses did not show any abnormal symptoms or in other words horses were subclinically infected with gastrointestinal parasites.

The present investigation revealed that the overall intensity of gastrointestinal parasites in the horses of animal fairs was 187.16 ±7.52epg. Battelli *et al.* (1993) recorded mean monthly count of strongyles as 183 epg in Italy with minimum and maximum individual counts of 20 and 5240 epg, respectively. Sengupta and Yadav (1998) recorded the average epg in the infected (555.00) and entire group (86.71) from organized and unorganized equid farm of Haryana.

In the present investigation highest overall intensity of *Parascaris equorum* (279.37±29.65) was recorded which was followed by strongyle (201.20 ±12.28), *Strongyloides westeri* (172.84±24.80) and *Habronema* (89.20±7.19) infections. Chaudhri *et al.* (1985) recorded egg counts of *Parascaris equorum* less than 500 throughout the survey period except April, August and September and they found that the mean epg counts of *Strongyloides westeri* was more than 2000 in subclinical form in equines. Nowosad *et al.* (1991) recorded high intensity of *Parascaris equorum* in Czech horses. Comparatively high intensity of gastrointestinal parasitic infection was also recorded by Singh *et al.* (2002). They recorded high intensity (585.85 ±832.17, mean epg ±S.D.) in Uttaranchal and Uttar Pradesh.

In the present study low intensity of subclinical parasitism in the horses of animal fairs was probably due to different geographical condition of Rajasthan and awareness of horse's keepers about the worm infestation as most of the owners usually dewormed their animals before bringing to the animals in these fair for sale to get a higher price. Holland *et al.* (2001) recorded high incidence of

gastrointestinal parasites among horses which were not given anthelmintic treatment.

During the present investigation, it was found that horses of Pushkar (221.15±21.95) and Nagaur (220.93±17.07) fairs exhibited higher intensity of gastrointestinal parasites as compared to those of Hanumangarh (170.83±13.19), Merta City (167.07±17.48) and Tilwara (155.84 ±12.75) fairs. Intensity was higher in Pushkar fair probably, because this fair comes just after monsoon, considered to be conducive climatically for breeding of parasites as well as their vectors. On the other hand during other fairs environmental conditions were extreme in the semiarid and arid regions of Rajasthan. Chaudhri *et al.* (1985) also observed seasonal variation in intensity of gastrointestinal parasitic infection of equine in dry and wet regions of Haryana.

The prevalence and intensity of different species of gastrointestinal nematodes varied from season to season, place to place with the age of horses. This variation in prevalence and intensity of various species of nematodes could be attributed to the difference in the temperature, humidity and rainfall in these regions which affects the development of free living stages of the parasites on the pasture and even to the hypobiotic larvae on the host. Fikru *et al.* (2005) revealed no significant variations in prevalence rate and epg across districts, equine species and sex of horses whereas significant difference was recorded in different seasons and with age of equines.

Horses of Hanumangarh and Pushkar fairs showed significantly higher intensity of *Parascaris equorum* than Tilwara, Merta City and Nagaur fairs because in these fairs horses of comparatively more irrigated districts like Ganganagar, Hisar, Sirsa and Udaipur, Chittor, Ajmer were brought, respestively. Higher intensity of *Parascaris equorum* might be due to different agro climatic conditions of these districts of arid and irrigated zone of Rajasthan which provide favorable conditions for the development of infection. Kornas *et al.* (2004a)

recorded higher intensity of *Parascaris equorum* in horses housed in different management systems. They found that young horses displayed a distinct increase in the number of parasite egg output in the faeces during January up to 1863 epg. Kornas *et al.* (2004b) also recorded that intensity of round worm infection in horses kept in stable was 39-1130 epg and from stallion depots was 100-312 epg.

Significantly higher intensity of gastrointestinal parasites was found in the horses below 3 years of age than 3-5 years and above 5 years of age groups. Nowosad *et al.* (1991) recorded that higher intensity of gastrointestinal parasitic infection in younger horses might be due to more susceptibility of young to parasitic infections. Toguchi and Chinone (2005) also recorded epg value which tended to be higher in younger horses i.e. 28.90% at 2 years of age, 13.30% at 3 years, 9.10% at 4 years and 5.00% at 5 years of age. During the investigation it was also found that age had no significant effect on the intensity of *Habronema*. It was also observed that female had slightly higher intensity of gastrointestinal parasitic infections as compared to that of males. Dopfer *et al.* (2004) also observed higher intensity of gastrointestinal parasitic infections in females than males.

The prevalence of gastrointestinal parasites present and their intensities depended upon hosts, natural resistance or immunity, grazing habit, climate, character of the soil, nature and amount of the vegetation, stocking rate, species and number of other domestic and wild ruminants grazing on the same land (Lodha, 1977).

On the basis of present investigation it could be summarized that horses of animal fairs harbour subclinical infection of gastrointestinal parasites. The prevalence and intensity of infection varied from fair to fair, district to district and age to age with in the same fair. Slight variation was also observed due to sex.

SUMMARY

6. SUMMARY

The thesis embodies information about the overall, fairwise, agewise and sexwise prevalence and intensity of natural gastrointestinal parasitoses based on faecal sample examination in horses of animal fairs held at Pushkar, Nagaur, Merta City, Hanumangarh and Tilwara during the year 2009-10. The study also includes coproculture and identification of infective third stage strongyle larvae.

The overall prevalence of gastrointestinal parasites in horses from all the five fairs was 33.24%.

Among helminths, prevalence of *Habronema* (14.04%), strongyle (10.01%), *Parascaris equorum* (7.09%), *Strongyloides westeri* (4.86%), *Draschia* (0.27%), *Schistosoma* (0.13%), *Oxyuris equi* (0.13%) and *Anoplocephala* (0.13%) and among protozoa, prevalence of *Eimeria leuckarti* (0.27%) was recorded.

Gastrointestinal parasites showed maximum prevalence (46.66%) at Tilwara fair and minimum (13.72%) at Pushkar fair.

Among the helminths, *Habronema* infection was most prevalent in animals of Tilwara (26.66%), Hanumangarh (25%) and Merta city (17.75%) fairs. Only one horse each could show *Schistosoma* (at Tilawara), *Anoplocephala* (at Tilawara) and *Oxyuris equi* (at Pushkar) infections in animals examined at all the fairs. *Draschia* infection was recorded in two horses only, (one each at Hanumangarh and Tilwara) among the animals examined at all the fairs.

Among protozoa only *Eimeria leuckarti* infection was recorded in two horses of Nagaur fair only out of all 719 faecal samples examined in all the fairs.

Gastrointestinal parasites showed higher prevalence (35.91%) in horses of 3-5 years followed by horses below 3 years (32.99%) and above 5 years (30.49%) of age.

Among helminths, *Habronema* infection predominated followed by strongyle, *Parascaris equorum* and *Strongyloides westeri* in all the three age groups studied. *Draschia* (two horses), *Schistosoma* (one horse) and *Anoplocephala* (one horse) infection were detected in 3-5 years age groups only. *Oxyuris equi* could be detected only in one horse of above five years of age.

Among protozoa, only *Eimeria leuckarti* infection was recorded only in one horse below 3 years and one in 3-5 years age group.

Gastrointestinal parasites showed comparatively higher prevalence (38.54%) in male than female (33.24%) horses.

Among helminths, *Habronema* predominated in both the sexes followed by strongyle, *Parascaris equorum* and *Strongyloides westeri* infections. *Habronema*, strongyle, *Parascaris equorum* and *Strongyloides westeri* showed comparatively higher prevalence (17.31, 14.52, 8.37 and 5.58%, respectively) in male than female (12.96, 8.51, 6.66 and 4.62%, respectively) horses. *Draschia* (0.37%), *Oxyuris equi* (0.18%), *Schistosoma* (0.18%) and *Anoplocephala* (0.18%) were recorded only from female horses.

Among protozoa, *Eimeria leuckarti* (0.37%) was recorded only in two female horses.

Animals of 33 out of 43 districts, brought to animal fairs showed the prevalence of gastrointestinal parasites.

Among helminths strongyle infection was detected in examined animals of maximum (24) districts followed by *Habronema* (22) and

Strongyloides westeri and *Parascaris equorum* (16 each). *Draschia* was detected only in the animals of two districts (Hanumangarh and Jaipur). *Schistosoma* (Muktsar), *Oxyuris equi* (Bharatpur) and *Anoplocephala* (Nagaur) infection were observed in the animals of one district each.

Among protozoa only *Eimeria leuckarti* was observed in the animal of Nagaur district only.

By comparing all these methods it was observed that flotation method could detect more gastrointestinal parasitic infections (31.84%) than sedimentation (30.18%) and direct smear methods (15.02%).

Among helminths, sedimentation method detected more *Habronema* (13.35%) infection than flotation (12.93%) and direct smear (3.75%) methods.

Flotation method detected more strongyle (9.73%), *Strongyloides westeri* (4.45%) and *Parascaris equorum* (6.95%) infections than sedimentation (8.34%, 3.61% and 6.39%, respectively) and direct smear (5.56%, 1.94% and 4.72%, respectively) methods.

Among protozoa, sedimentation method detected more (0.27%) *Eimeria leuckarti* infection than direct smear (0.13%) method.

In the horses of animal fairs positives faecal samples showed overall mean counts of 187.16±7.52 epg for gastrointestinal helminth parasites.

The maximum overall mean counts of 279.37±29.65 epg was recorded for *Parascaris equorum* followed by 201.20±12.28 epg for strongyle, 172.84±24.80 epg for *Strongyloides westeri* and 89.20±7.19 epg for *Habronema*.

The egg counts/mean egg/oocyst counts were 75 for *Draschia*, 100 each for *Oxyuris equi* and *Schistosoma,* 250 for *Anoplocephala* and 75 for *Eimeria leuckarti* based only two positive samples for *Draschia* and *Eimeria* and only one positive sample for others. Being positive in one or two samples these data of counts were not included in statistical analysis.

The horses of Pushkar and Nagaur fairs showed significantly higher intensity of gastrointestinal helminth parasites (221.15±21.95 and 220.93±17.07 epg, respectively) than Hanumangarh (170.83±13019 epg), Merta City (167.07±17.48 epg) and Tilwara (155.84±12.75 epg) fairs.

The horses of Pushkar and Hanumangarh fairs had significantly higher intensity of *Parascaris equorum* infection (343.00±85.62 and 299.12±36.36 epg, respectively) than Tilwara (259.20±38.56 epg), Merta City (247.89±42.62 epg) and Nagaur (247.64±42.26) fairs. The horses of Tilwara showed a significantly higher intensity of *Strongyloides westeri* (219.11±36.32 epg) than Pushkar (174.58±35.87 epg), Merta City (171.94±59.03 epg), Nagaur (157.90±35.61 epg) and Hanumangarh (197.45±27.60 epg) fairs. The horses of all the animal fairs studied showed no significant difference in the intensity of strongyle and *Habronema*.

Only one horse each positive for *Schistosoma, Anoplocephala* and *Draschia* showed epg of 100, 250 and 100 respectively at Tilwara fair. Only one horse positive for *Draschia* at Hanumangarh had an epg of 50. Only one horse positive for *Oxyuris equi* at Pushkar only had epg of 100. Only two horses positive for *Eimeria leuckartia* at Nagaur fair only showed an average opg of 75.

The horses below 3 years of age showed a significantly higher intensity (207.77±8.99 epg) of gastrointestinal helminth parasites than

3-5 years (132.83±13.36 epg) and above 5 years (153.40±16.49 epg) age groups.

The horses below 3 years of age and above 5 years of age had significantly higher intensity of *Parascaris equorum* (336.37±23.65 and 288.13±63.41) and *Strongyloides westeri* (194.07±20.13 and 178.46±52.31) than horses of 3-5 years (213.62±43.62 and 146.00±38.11) of age group. Horses below 3 years of age showed a significantly higher intensity (237.12±15.23) of strongyle infection than horses of 3-5 years (187.08±23.07) and above 5 years (179.41±24.20) of age groups.

Sex had no significant effect on the intensity of any parasitic infection detected.

The average total length and tail sheath length of recovered infective third stage larvae of *Strongylus vulgaris* were (1047.46±9.86 and 228.98±5.34 µm), *S. edentatus* (780.90±3.90 and 147.65±1.49 µm), *S. equinus* (822.91±3.66 and 225.59±2.52 µm), *Trichostrongylus axei* (626.36±4.36 and 103.57±2.96 µm) *Gyalocephalus capitatus* (554.39±5.40 and 163.94±2.41 µm) and *Oesophagodontus spp.* (960.21±3.55 and 242.03±2.92 µm).

Coproculture showed that *Strongylus edentatus* was major contributor to the strongyle worm population (46.86%) and highest proportion (56.17%) was recovered at Tilwara fair followed by Nagaur (51.19%), Merta City (49.47%), Pushkar (41.37%) and Hanumangarh (36.26%) fairs. The percent contribution of *Strongylus equinus* was (27.57%) with peak recovery at Nagaur (32.14%) and lowest at Tilwara (22.47%) fairs. *Trichostrongylus axei* contributed (7.39%) of the larval recovery with peak (9.89%) at Hanumangarh and lowest (3.57%) at Nagaur fairs. *Strongylus vulgaris* contributed (6.72%) of the larval recovery with peak (8.33%) at Nagaur and lowest (4.21%) at Merta City

fairs. *Oesophagodontus spp.* contributed (6.05%) of the larval recovery with peak (10.34%) at Pushkar and lowest (4.76%) at Nagaur fairs. *Gyalocephalus capitatus* contributed (5.38%) of the larval recovery with peak (7.36%) at Merta Citya and lowest (5.49%) at Hanumangarh fairs.

On the basis of present investigation it could be summarized that horses of animal fairs harboured subclinical infection of gastrointestinal parasites. The prevalence and intensity of infection varied from fair to fair, district to district and age to age with in the same fair. Slight variation was also observed due to sex.

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ABSTRACT
(English and Hindi)

SUBCLINICAL GASTROIANTESTINAL PARASITOSES IN HORSES OF ANIMAL FAIRS IN RAJSTHAN

M.V.Sc. Thesis

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ABSTRACT

A total of 719 faecal samples were collected from the horses of five animal fairs, out of which 156 were from Hanumangarh, 153 from Pushkar, 153 from Nagaur, 150 from Tilwara and 107 from Merta City fairs. The faecal samples were examined by direct smear, flotation and sedimendation methods for detection of any of parasitic infection based on the presence of parasitic egg/oocyst by any or all of these methods. Egg counting for intensity of parasites and coproculture for identification of strongyle larvae were also carried out.

The overall prevalence of gastrointestinal parasites in horses from all the five fairs was 33.24%. *Habronema* showed maximum prevalence followed by strongyle, *Parascaris equorum*, *Strongyloides westeri*, *Draschia*, *Eimeria leuckarti*, *Oxyuris equi*, *Anoplocephala* and *Schistosoma*.

Gastrointestinal parasites showed maximum prevalence at Tilwara fair. *Habronema* infection was most prevalent in Tilwara, Hanumangarh and Merta City fairs. Strongyle infection was predominated in Pushkar and Nagaur fairs. *Draschia* was recorded only in Hanumangarh and Tilwara fairs. *Schistosoma* and *Anoplocephala* were recorded only in Tilwara fair. *Oxyuris equi* was recorded only in Pushkar fair. *Eimeria leuckarti* was recorded only in Nagaur fair.

Habronema predominated followed by strongyle, *Parascaris equorum* and *Strogyloides westeri* infections in all the three age groups

i.e. below 3 years, 3-5 years and above 5 years. *Eimeria leuckarti* was recorded in horse below 3 years and 3-5 years of age.

Animals of 33 out of 43 districts, brought to animal fairs showed the prevalence of gastrointestinal parasites.

Among helminths strongyle infection was detected in examined animals of maximum (24) districts followed by *Habronema* (22) and *Strongyloides westeri* and *Parascaris equorum* (16 each). *Draschia* was detected only in the animals of two districts. *Schistosoma* (Muktsar), *Oxyuris equi* (Bharatpur) and *Anoplocephala* (Nagaur) infection were observed in the animals of one district each. Among protozoa only *Eimeria leuckarti* was observed in the animals of Nagaur district only.

Flotation method of faecal examination could detect more gastrointestinal parasites, strongyle, *Parascaris equorum* and *Strongyloides westeri*. Sedimentation method detected more *Habronema* and *Eimeria leuckarti*.

The horses of Pushkar and Nagaur fairs showed significantly higher intensity of gastrointestinal helminths than Hanumangarh, Tilwara and Merta City fairs. The horses of Pushkar and Hanumangarh fairs showed a significantly higher intensity of *Parascaris equorum* than Nagaur, Tilwara and Merta City fairs. The horses of Tilwara fairs showed a significantly higher intensity of *Strogylodies westeri* than Pushkar, Nagaur, Hanumangarh and Merta City fairs.

The horses below 3 years of age showed a significantly higher intensity of gastrointestinal helmiths than 3-5 years and above 5 years of age groups. The horses below 3 years and above 5 years of age groups showed significantly higher intensity of *Strogylodies westeri* and *Parascaris equorum* infections than 3-5 years of age group. The horses below 3 year of age group showed significantly higher intensity of strongyle infection than 3-5 years and above 5 years of age groups.

On coproculture 6 types of strongyle larvae i.e. *Strongylus valgaris, Strongylus edentatus, Strongylus equinus, Trichostrongylus axei, Gyalocephalus capitatus* and *Oesophagodontus spp.* were encountered. Coproculrure showed that *Strongylus edentatus* was the main contributor of strongyle worm population. Highest population of *Strongylus edentatus* was recorded at Tilwara fair.

राजस्थान के पशु मेलों के अश्वों में उपशयनिक जठरान्त्रीय परजीवी संचार

स्नातकोत्तर शोध ग्रंथ,
पशु परजीवी विज्ञान विभाग,
पशु चिकित्सा एवं पशु विज्ञान महाविद्यालय,
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प्रस्तुतकर्त्ता- **प्रवीण कुमार पिलानियां**
मुख्य उपादेष्टा- **डॉ. जी. एस. मनोहर**

अनुक्षेपण

पांच पशु मेलों के अश्वों से कुल 719 मल के नमूने एकत्रित किए गए जिनमें से 156 हनुमानगढ़, 153 पुष्कर, 153 नागौर, 150 तिलवाड़ा तथा 107 मेड़ता शहर मेले से लिए गए। मल की जांच परजीवी संक्रमण का पता लगाने हेतु उसमें स्थित परजीवियों के अंडों/ पुटियों के आधार पर क्रमशः अव्यवहित आलेप, प्लवन तथा तलछट का जमाव विधियों द्वारा की गई। अण्ड गणना परजीवी संक्रमण की तीव्रता मापने के लिए व मल संवर्धन क्रमशः स्ट्रोंगाइल लार्वा की पहचान के लिए किए गए।

पाचों मेलों के अश्वों में जठरान्त्रीय सूत्रकृमियों का सर्वछादी प्रायोर्भाव 33.24 प्रतिशत था। हेब्रोनीमा का प्रायोर्भाव स्र्वाधिक, तत्पश्चात स्ट्रोंगाइल, पारऐस्केरिस इक्वोरम, स्ट्रोंगाइलोइडिस वेस्टेराइ, ड्राश्चिया, आइमेरिया ल्युकारटी, ओक्सियूरिस इक्वाई, अनोप्लोसिफेला तथा सिस्टोसोमा का क्रमानुसार पाया गया।

जठरान्त्रीय सूत्रकृमियों का सर्वाधिक प्रायोर्भाव तिलवाड़ा मेले से रहा। हेब्रोनीमा संक्रमण का प्रायोर्भाव क्रमशः तिलवाड़ा, हनुमानगढ़ तथा मेड़ता शहर मेलों में अधिक रहा। स्ट्रोंगाइल संक्रमण क्रमशः पुष्कर व नागौर मेलों में प्रभावशाली रहा। ड्राश्चिया केवल हनुमानगढ़ तथा तिलवाड़ा मेलों में ही पाया गया। सिस्टोसोमा तथा अनोप्लोसिफेला केवल तिलवाड़ा मेले में पाया गया। ओक्सियूरिस इक्वाई केवल पुष्कर मेले में पाया गया जबकि आइमेरिया ल्युकारटी केवल नागौर मेले में ही पाया गया।

तीनों आयुवर्गों (3 वर्ष से कम, 3 से 5 वर्ष तथा 5 वर्ष से अधिक आयुवर्ग) में हेब्रोनीमा संक्रमण सबसे अधिक प्रभावशाली रहा, तत्पश्चात स्ट्रोंगाइल, पारऐस्केरिस इक्वोरम व स्ट्रोंगाइलोइडिस वेस्टेराइ क्रमानुसार रहे। आइमेरिया ल्युकारटी 3 वर्ष से कम व 3 से 5 वर्ष आयु वर्ग में ही पाया गया।

परिक्षण किए गए 43 जिलों के अश्वों में से 33 जिलों के अश्वों में जठरान्त्रीय सूत्रकृमीयों पायें गये। सभी सूत्रकृमियों में स्ट्रोंगाइल सर्वाधिक 24 जिलों में, हेब्रोनीमा 22 जिलों में जबकि स्ट्रोंगाइलोइडिस वेस्टेराइ व पारऐस्केरिस इक्वोरम दोनों, 16 जिलों में पाये गयें। ड्राश्चिया 2 जिलों (जयपुर व हनुमानगढ़) में पाया गया जबकि सिस्टोसोमा (मुक्तसर), ओक्सियूरिस इक्वाई (भरतपुर) तथा अनोप्लोसिफेला (नागौर) का

संक्रमण केवल एक ही जिले में पाया गया। आइमेरिया ल्युकारटी का संक्रमण केवल नागौर जिले में ही पाया गया।

मल परिक्षण की प्लवन विधि से ज्यादा संख्या में जठरान्त्रीय परजीवियों (स्ट्रोंगाइल, पारऐस्कोरिस इक्वोरम व स्ट्रोंगाइलोइडिस वेस्टेराइ) का पता लगाया गया जबकि तलछट जमाव विधि द्वारा हेब्रोनीमा व आइमेरिया ल्युकारटी अधिक पाए गए।

पुष्कर तथा नागौर मेलों के अश्वों में जठरान्त्रीय सूत्रकृमियों की तीव्रता हनुमानगढ़, तिलवाड़ा व मेड़ता शहर मेले के अश्वों की तुलना में चिन्हिकृत रूप से अधिक पाई गई। पुष्कर व हनुमानगढ़ मेले के अश्वों में पारऐस्केरिस इक्वोरम की तीव्रता चिन्हिकृत रूप से नागौर, तिलवाड़ा व मेड़ता शहर के मेलों के अश्वों से अधिक पाई गई। तिलवाड़ा मेले के अश्वों में स्ट्रोंगाइलोइडिस वेस्टेराइ की तीव्रता चिन्हिकृत रूप से पुष्कर, नागौर हनुमानगढ़ व मेड़ता शहर के मेलों के अश्वों से अधिक पाई गई।

तीन वर्ष से कम आयु वर्ग के अश्वो मे जठरान्त्रीय सूत्रकृमियों की तीव्रता चिन्हिकृत रूप में 3 से 5 वर्ष तथा 5 वर्ष से अधिक आयु वर्ग के अश्वों से अधिक पाई गईं। तीन वर्ष से कम व 5 वर्ष से अधिक आयु वर्ग के अश्वों में स्ट्रोंगाइलोइडिस वेस्टेराइ व पारऐस्केरिस इक्वोरम के संक्रमण की तीव्रता 3 से 5 वर्ष आयु वर्ग के अश्वों की तुलना में चिन्हिकृत रूप से अधिक पाई गई। तीन वर्ष से कम आयु वर्ग के अश्वों में स्ट्रोंगाइल संक्रमण की तीव्रता चिन्हिकृत रूप में 3 से 5 वर्ष व 5 वर्ष से अधिक आयु वर्ग के अश्वों से अधिक पाई गई।

मल संवर्धन से 6 प्रकार के स्ट्रोंगाइल लार्वा क्रमशः स्ट्रोंगाइलस वल्गेरिस, स्ट्रोंगाइलस ईडेनटेटस, स्ट्रोंगाइलस ईक्विनस, ट्राइकोंस्ट्रोंगाइलस एक्सीआई गाइलोसिफेलस केपिटेटस तथा ईसोफेगोडोन्टस प्रजाति प्राप्त हुए। मल संवर्धन में स्ट्रोंगाइल लार्वा के अन्तर्गत स्ट्रोंगाइलस ईडेनटेटस प्रजाति की प्रमुखता रही व स्ट्रोंगाइलस ईडेनटेटस का सर्वाधिक प्रभाव तिलवाड़ा मेले में पाया गया।