A Survey of Gastrointestinal Helminths of Goats and Sheep of Rawalpindi-Islamabad Abbattoirs

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ALL PRAISES TO ALLAH, WHO
GUIDES US IN DARKNESS AND HELPS
US IN DIFFICULTIES

AND

ALL RESPECTS TO HIS HOLY PROPHET
(PEACE BE UPON HIM)
WHO ENABLES US TO RECOGNISE OUR
CREATOR

The whole of the experimental work described in thesis was carried out by myself in the parasitology laboratory, Department of Biological Sciences, Quaid-i-Azam University, Islamabad. The conclusions are my own reached after numerous discussions with Dr. Riaz Ahmed Pal. I have not presented any part of this work for any other degree.

Mazhar Qayyum

Date:_____

This thesis by Mazhar Qayyum is accepted in its present form by the Department of Biological Sciences as Satisfying the thesis requirements for the degree of Master of Philosophy in Parasitology.

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TO MY PARENTS

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LIST OF ABBREVIATIONS

rpm:	Revolution per minute.
epg:	Egg per gram
%:	percentage
NaCl:	Sodium chloride
mu:	Millimicron
ml:	millilitre
mg:	milligram
^{o}C:	centrigrade
mm:	millimeter
<:	more than
grm:	grams
HCl:	Hydrochloric acid
afa:	Formal Alcohol fixative
cc:	Cubic centrimeter

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Sheep and goats are important to the economy of Pakistan and are mostly reared by farmers as a subsidiary occupation, to augment their income through the sale of wool and surplus animals. Sheep and goats not only provide proteins in the form of milk and mutton, but also provide other human needs such as shoes, woolen carpets, leather wear met from the skin and wool of these animals. Presently, Pakistan has a goat population of 35.64 million heads, and sheep population of about 30.85 million heads (Agricultural Statistics of Pakistan, 1982); which together produce 400,000 metric tonnes of meat and 773,000 metric tonnes of milk, besides the sheep produce about 48,000 tonnes of wool per annum, (Economic Survey, 1989). Presently there is strong pressure on the livestock sector to increase its output, as demand for meat, milk and wool is rising rapidly.

The production of mutton, milk and wool has not kept pace with the phenomenal expansion, which has characterized the other sector of agricultural and industrial economy of Pakistan. The lag in production can be attributed to seasonal

fluctuations of both quantity and quality of the pastures, mainly as the result of climatic vagaries. The efficient conversion of pasture herbage by sheep and goats into products of agriculture value is matter of prime importance. One of the most important factor militating against efficient feed conversion is helminth infections.

The wide-spread prevalence of gastrointestinal helminths in tropical and subtropical areas has plagued the production potential of many livestock development programmes by causing countless deaths and insidious economic losses (Al-Quaisy *et al.*, 1987). Sheep and goats are rarely parasitized by only a single helminth species; helminthiasis in sheep and goats is usually the result of a combined assaults of numerous genera occurring in varing numbers, each contributing to the disease syndrome. Moderate numbers of parasites adversely affect growth and productivity; heavier worm burdens cause marked clinical symptoms or even death of the host. It is well known that helminth parasites has effects on the rate of growth of lambs and on milk and wool production in adult sheep. Recent reviews are available like (Barger, 1982; Steel and Symons, 1982; Sykes, 1982; Hayat *et al.*, 1984) on

different aspects i.e. reduction in appetite, loss of body weight, hypoproteinemia, impaired digestive efficiency and pathogenic effects. Though the reasons of these effects are obscure, they may be due to the possible secretion of toxins by the parasites which cause pathological condition. Removal of blood by blood-sucking parasites cause severe anaemia as in case of acute haemonchosis and the production of enzymes inhibitory substance which reduce digestive efficiency and induce malnutrition (Reveron and Topps, 1970). Outbreak of such diseases in domestic livestock is limited by an environment hostile to the development of the free-living stages of the parasites. When the environment becomes favourable in the absence of the controlling influence of anthelmintic treatment, parasitic disease will occur (Grant, 1981). Keeping in view the severity of the losses in the livestock sector different authors in different parts of the world have conducted survey studies for the assessment of parasitic population by applying various techniques and methods.

In attempts to establish the epizootiology, the seasonal incidence of parasites has been surveyed by the collection of

faecal samples at regular intervals and by doing differential worm egg counts (Crofton, 1957; Rossiter, 1964; Donald, 1968; Yazwinski and Featherstone, 1979; Roberts and Swan, 1982; Vercruysse, 1983). The following authors have determined that surveys of the epizootiology are best carried out by slaughtering members of flock at regular intervals, counting and identifying the worms and post-mortem on a more critical basis, (Barrow, 1964; Vilijoen, 1964; Grant, 1981; Hunter, 1984; Gupta *et al.*, 1987, 1988; Charles, 1989; Reinecke and Louw, 1989; Uriarte and Valderrabano, 1989).

In Pakistan, different workers have conducted such studies in its different parts, (Sarwar, 1962; Durrani and Hayat, 1964; Siddiqui and Ashraf, 1980; Shah *et* al., 1980;Mohiuddin *et al.*, 1984; Khan , 1988; Khan *et al.*, 1989; Marwat *et al.*, 1988) but these studies were based to study incidence, morphology and seasonal variation by applying post-mortem recovery technique only.

As far as upper Punjab (Pothwar Region) is concern no systematic survey has been undertaken except Sarwar, 1962 and Durrani *et al.*, 1981, but these studies were in the form of

reports only. Therefore, it has been decided to carry out a comprehensive survey in which the gastrointestinal tracts of autopsied sheep and goats were examined to identify pathogenic parasites prevalent in the area and to study their seasonal variations. Post-mortem determination of helminths population in sheep and goats are commonly based on an estimate of the number of worms recovered from the gastrointestinal tracts. A determination so made does not account for the specimens which may be embedded in the abomasal mucosa, as in the case of *Ostertagia ostertagi*, *Ostertagia circumcincta*, *Trichostrongylus axei*, *Haemonchus contortus* where large numbers may be missed. Therefore, enzymatic digestion method has been employed to recover these mature and immature worms embedded under abomasal muscosa.

The faecal egg counts technique, offers an ante-mortem aid to diagnosis. Egg counts were first attempted by using the technique developed by Whitlock and Gordon, (1939) for sheep strongyles. The rational behind this technique is based on the assumption that there is a definable relationship between the number of eggs per gram (epg) and the total strongyles worm burden. In the present investigation also it

has been tried to work out this assumption that whether such type of relationship between the number of eggs per gram and the total strongyles worm burden existed or not. Such type of studies will provide the basic information for the design of control measures that aim to reduce pasture infectivity and to plan the strategic dosing for helminths.

REVIEW OF LITERATURE

Gastrointestinal helminthiasis is a serious problem caused by helminth parasites to our livestock sector. The effects of gastrointestinal helminthiasis in sheep and goats vary widely, at one extreme, animals may die and represent a total economic loss and at the other, the effects may be so slight that they cannot be detected. Sheep and goats usually harbour mixed infections of gastrointestinal helminth parasites. The degree of damage inflicted by these infections is influenced to a large extent by the type and the numbers of parasites present. The helminths which occur only in the gastrointestinal tract are reviewed in this chapter.

I-TREMATODES

Mohajan (1942) reported that *Fasciola gigantica* was the most serious parasite of the sheep. Next in importance were the *Paramphistomum cervi*, *Schistosoma spindale* and *Schistosoma indicum* in the decreasing order of frequency.

Srivastava (1945) studied the incidence of helminth infection. He examined 191 guts of sheep and goats. Out of

and goats.

Anantaramams (1954) in efforts to prevent the occurence of helminthiasis in ruminants by scheduled treatment, based on seasonal conditions in Madras, (India) had found following trematodes. *Paramphistomum cervi, Cotylophoron cotylophorum, Fischoederius cobboldi, Gastrothylax crumenifer, Schistosoma spindale, Schistosoma indicum* and *Schistosoma nasalis.*

Thapar (1955) recovered the following species of trematodes from sheep and goats *Cotylophoron cotylophorum, Gastrothylax crumenifer, Paramphistomum cervi* and *Paramphistomum orthocoelium.*

Sircar (1956) recorded the incidence of intestinal amphistomes in sheep and goats at breeding farms of Patna and Gaya.

Varma (1957) described the seven species of amphistomes collected from different localities. *Gastrothylax crumenifer* found to be most prevalent in the gastrointestinal tracts of sheep and goats.

these 135 (71%) were found infected with helminths. The following helminths species were recovered, *Paramphistomum cervi*, *Cotylophoron cotylophorum* and *Gastrothylax crumenifer*. *Paramphistomum cervi* was found to be most prevalent.

Moghe (1945) reported the incidence of helminths in sheep, goats and cattle in Bihar (India). He recovered the following species of helminths. *Paramphistomum cervi*, *Cotylophoron cotylophorum*, *Cotylophoron ovatum*, *Gastrothylax crumenifer*, *Moniezia benedeni*, *Haemonchus contortus*, *Oesophagostomum columbianum*, *Ostertagia ostertagi* and *Trichostrongylus ovis*.

Alimar (1949) reviewed the occurrance of Amphistomiasis in ruminants, equines and elephants. He reported that the mature forms were mostly present in rumen but may occasionally be seen in the other forestomachs, liver and intestines. *Paramphistomum explanatum*, *Cotylophoron cotylophorum*, *Gastrothylax crumenifer*, *Fischoederius elongatus* and *Fischoederius cobboldi* were the amphistomes which were recorded in domestic animals like cattle, sheep

Shah and Pandit (1959) described the results of their survey conducted during 1956-1958. The commonest trematodes were *Fasciola gigantica, Cotylophoron cotylophorum* and *Gastrothylax crumenifer.*

Mukherjee and Deorani (1962) pointed out the heavy infection of trematodes in sheep. He recovered 32, 068 amphistomes from rumen. The incidence of various amphistomes were *Gastrothylax crumenifer* (86%), *Ceylonocotyle scoliocoelium* (14%).

Katiyar and Varshney (1963) reported the incidence of amphistomiasis in sheep and goats and found to be (41.54%) and (68.59%) respectively. The species recovered were *Gastrothylax crumenifer, Cotylophoron cotylophorum.*

Fitzsimmons (1964) worked out a check list of helminth parasites of domestic animal in Nyasaland. According to this list *Fasciola gigantica, Fasciola hepatica, Cotylophoron cotylophorum* and *Paramphistomum* (Species not worked out) were trematodes found in sheep.

Soulsby (1979) reported the following species of amphistomes in sheep and goats collected from different parts of the world. *Paramphistomum cervi, Paramphistomum explanatum, Cotylophoron cotylophorum, Cymbiforma indica, Gastrothylax crumenifer, Calcicophoron calcicophorum, Ceylonocotyle streptocoelium.*

Siddiqui and Ashraf (1980) studied the nineteen gastrointestinal tracts of goats slaughtered in Peshawar abattoirs and reported the following species of helminths. *Dicrocoelium dendriticum, Fasciola hepatica, Paramphistomum explanatum, Cotylophoron ovatum, Watsonius* sp., *Moniezia benedeni, Moniezia expansa, Avitellina centripunctata, Stilesia vittata, Haemonchus contortus, Bunostomum trigonocephalum, Oesophagostomum columbianum, Oesophagostomum venulosum, Chabertia ovina, Dictyocaulus filaria, Skrjabinema ovis, Globocephalus urosubulatus, Acanthoxynema lucknowense, Trichuris vondwei, Trichuris parvispiculum, Trichuris lani, Trichuris ovina, Trichuris infundibulum, Trichuris indica, Trichuris globulosa, Trichuris discolor.*

Gupta *et al.* (1984) studied the histology of the trematodes *paramphistomum cervi* collected throughout the year from rumen of sheep, revealed that the immature worms occurred from September to March, while mature were found during July and August, coincided with the availability of the intermediate host.

II. CESTODES

Annove (1944) reported the prevalence of *Moniezia expansa* in sheep and goats during rainy season. He correlate the incidence of *Moniezia expansa* of infection with the availability of intermediate host the oribatid mites.

Soliman (1961) reported cestodes from sheep in Egypt and the Sudanese Republic. The species were *Moniezia expansa*, *Avitellina centripunctata*, *Stilesia globipunctata*, *Helictometra giardi*, and *Echinococcus granulosus*.

Bjelica (1964) examined 139 guts of sheep for the presence of helminths. He recorded *Moniezia expansa* in (13%) *Ostertagia circumcincta* in (77%) and *Haemonchus contortus* in (9%).

Helle (1971) found that *Moniezia* infection was more prevalent on those pasture where intermediate host was available.

Amjadi (1971) reported the incidence of *Avitellina centripunctata* and only 9 animals found infected.

Jain and Kamalapur (1971) examined 100 guts of sheep. Of these, 6 were found to be infected with *Moniezia expansa*, 10 with *Moniezia benedeni*, 66 with *Stilesia globipunctata*, and 8 with *Avitellina centripunctata* and *Avitellina sudanea*.

Prokopic *et al.* (1976) described five cestodes species parasitizing the ruminants for the first time in Afghanistan. *Moniezia benedeni, Moniezia expansa, Avitellina centripunctata, Stilesia globipunctata,* and *Thysaniezia giardi*.

Ouhelli *et al.* (1981) conducted a survey of gastrointestinal tracts of sheep in Morocco. They collected *Moniezia benedeni* and *Moniezia expansa* from small intestine.

They also reported *Ostertagia ostertagi, Trichostrongylus axei* and *Haemonchus contortus* from abomasum.

Nicolas *et al.* (1985) reported the incidence of *Moniezia expansa* (10%) and nematodes (42%) in ewes.

Ismailov (1988) studied 5308 intestinal tracts of farms ruminants. (Sheep, goats and cattle). He recovered five species of Anophocephalidae. *Moniezia expansa, Moniezia benedeni, Moniezia autumnolia, Avitellina centripunctata* and *Thysaniezia giardi*.

III - NEMATODES

Crofton (1957) made studies on commercial flocks in South-West England in 1950. Samples of faeces were taken at weekly or fornightly intervals from lambs and ewes in these flocks. He recovered the following species of nematodes. *Haemonchus contortus, Ostertagia circumcincta, Trichostrongylus axei, Trichostrongylus vitrinus, Cooperia oncophora, Nematodirus filicollis, Nematodirus spathiger, Bunostomum trigonocephalum, Chabertia ovina, Oesophagostomum venulosum*.

Muller (1962) studied the parasites of adult ewes in winter rainfall region of South-Africa. He recorded 13 genera of nematodes parasites among these *Trichostrongylus* sp., *Ostertagia* sp. *Chabertia* sp. and *Oesophagostomun* sp. were the most prevalent.

Rossiter (1964) compared the critical slaughter results with egg count data and he also noted that *Haemonchus contortus* was prevalent from December to April, *Ostertagia* spp from October to December and *Trichostrongylus* spp. from July to August.

Durrani and Hayat (1964) studied the gastrointestinal parasites of sheep and goats in Lyallpur (Faisalabad) districts by examining 154 guts over a period of 12 months. They recorded the incidence of infection was (72.07%) with different types of parasites. The following percentage of different types of parasitic diseases was noted. Haemonchasis (32.40%), Oesophagostomiasis (29.87%), Trichuriasis(27.92%) Amphistomiasis(7.79%) and Tapeworm (46.10%). *Haemonchus contortus, Oesophagostomum venulosum,*

Oesophagostomum columbianum, *Trichuris ovis*, *Paramphistomum cervi*, *Paramphistomum explantum*, *Cotylophoron cotylophorum*, *Moniezia expansa*, *Moniezia bendeni*, *Avitellina* spp., *Stilesia* spp. and *Thysanizia* spp.

Thomas (1967) carried out a faecal worm egg counts on groups of lambs born over an extended period from February to May in the eastern Transvaal Highveld. The results indicated that the availability of infestation on pasture declined very markedly at the end of the summer rainfall season lambs born before this time showed 80-100% infestation rates and moderate egg counts.

Thomas (1968) described the pattern of worm egg counts in lambs in a summer rainfall area. Infestation with three major species, *Haemonchus contortus*, *Trichostrongylus colubriformis*, and *Oesophagostomum columbianum* appears to be strictly limited to the period of adequate rainfall, and pasture contamination dies out rapidly during the dry winter.

Viljoen (1969) studied the nematodes paratsites of sheep in Karoo and was found that the dominant parasites were

Trichostrongylus falculatus and *Nematodirus spathiger*. The incidence of these parasites increased during the winter and prevalence of *Haemonchus contortus* and *Oesophagostomum columbianum* decreased from the more humid region to the arid regions in Karoo.

Malczewski (1970) examined 144 gastrointestinal tracts of sheep in Poland. He recovered 3 Trematodes, 3 Cestodes and 25 Nematodes, including *Nematodirus abnormalis* (for the first time in Poland) along with other common helminths; *Haemonchus contortus*, *Ostertagia circumcincta*, and *Trichostrongylus axei*.

Taylor and Cawthorne (1972) examined 372 guts of sheep and goats from different abattoirs in Northern Ireland. The major species of nematode parasites found in the abomasum were *Ostertagia circumcincta*, *Ostertagia trifurcata*, *Ostertagia pinnata*, and *Trichostrongylus axie*, while *Nematodirus battus*, *Nematodirus filicollis*, *Trichostrongylus vitrinus* and *Cooperia curticei* were the most prevalent species in the small intestines.

Misra *et al.* (1974) examined 300 guts of sheep. They found that the most common parasites were *Haemonchus contortus, Oesophagostomum columbianum, Trichuris ovis, Stilesia globipunctata, Cotylophoron cotylophorum, Gastrothylax crumenifer,* and *Paramphistomum cervi.*

Cvetkovic and Lepojev (1975) reported the production of eggs by *Haemonchus contortus* under pasture condition. The studies were made 5-8 month old lambs and they became infected by *Haemonchus contortus* during the pasture season. For 10 day, all the faeces evacuated during 24 hours were collected and weighed, the number of eggs per gram was counted from this total number of egg produced per 24 hours by the parasites of each animal were estimated and it was found that each female *Haemonchus contortus* produced 1352-1730 eggs (minimum 140-430, maximum 2862-3610)/hours or 3.4 or 6.0/g.

Boag and Thomas (1975) carried out an investigation of sheep nematodes population between April 1970 and September 1971 by using the faecal egg counts. Samples were taken from both ewes and lambs at weekely intervals. From these results

absolute numbers of nematode eggs and infective larvae were estimated.

Boag and Thomas (1975) studied faecal the egg counts and pasture larval contamination of *Nematodirus* spp. in sheep and was found that *N. battus* takes short period in spring for hatching, while *N. filicollis* shows extended period of hatching begining in autumn and increasing steadly in winter and finally attain peak in winter resulted in slower annual rate of increase recorded for *N. filicollis*.

Southcott *et al.* (1976) described the seasonal pasture contamination and the availability of nematodes for grazing sheep and pointed out that *Haemonchus contortus* and *Trichostrongylus* spp follows the similar development pattern in summer, while *Ostertagia* spp., in autumn resulted in peak contamination in winter.

Balbo *et al.* (1977) studied the guts of 87 sheep and 12 goats in the alpine region of piemonta and valla d' Aosta in Italy for intestinal nematodes. *Nematodirus helvetianus, Ostertagia lyrata, Skrjabinema ovis* and *Trichuris skrjabini*

in sheep and *Nematodirus helventianus* and *Ostertagia ostertagi* in goats were recovered for the first time in Italy. *Ostertagia circumcincta* found to be more prevalent in both hosts (49.4 and 91.1% respectively).Next were *Nematodirus filicollis* (45.8%), *Haemonchus contortus, Trichostrongylus colubriformis* and *Bunostomum trigonocephalum* (34.4%) and in goats *Trichostrongylus colubriformis* (75%) *Ostertagia trifurcata* (85.3%) *Haemonchus contortus* (41.5%) *Bunostomum trigonocephalum, Nematodirus filicollis, Trichostrongylus axei* and *Trichostrongylus vitrinus* (all in 33.3%).

Eslami *et al.* (1979) examined 250 wild sheep (*Ovis orientalis*) from different national park and protected region of Iran for gastrointestinal nematodes. They found twenty-five species of nematodes. *Marshallagia marshalli, Ostertagia* spp., *Nematodirus* spp.,and *Skrjabinema ovis* were the most prevalent.

Sahai and Sinha (1979) studied gravid *Haemonchus* females collected from sheep and goats in a slaughter house in India and separated them into two types according to their

vulvular flaps and observed that *Haemonchus bisipinosus* had a Knob-like flap, while it was linguiform in the case of *Haemonchus contortus*. Eggs from each type were cultured separately and passed each into a separate kid. They were found to breed true. It was concluded that these are two different species.

Suh *et al.* (1980) recorded the incidence of gastrointestinal of sheep at an alpine breeding station in Korea. *Strongyloides papillosus* (32%), *Haemonchus contortus* (23%), *ostertagia ostertagi* (5.5%), *Bunostomum phlebotomum* (5.5%), *Trichostrongylus* spp. (36%), *Cooperia* spp. (1%) and *Oesophagostomum columbianum* (1%).

Shah *et al.* (1980) examined 375 guts of sheep and recovered the following species of nematodes with (75%) incidence *Haemonchus contortus*, *Oesophagostomum venulosum*, *Oesophagostomum columbianum*, *Ostertagia circumcincta*, *Skrjabinema ovis*, *Bunostomum trigonocephalum*, *Trichostrongylus axei*, *Trichostrongylus vitrinus*, and *Chabertia ovina*.

Grant, (1981) conducted a survey for gastrointestinal nematodes of sheep for a period of one year. *Haemonchus contortus* and *Oesophagostomum columbianum* were found to be of major importance. The incidence of *Haemonchus* rose to a peak and remained at a high level throughout the winter. The incidence of *Oesophagostomum columbianum* remained at a relatively high level from March until October. The other genera recovered were *Trichostrongylus* spp., *Cooperia* spp., *Strongyloides papillosus* and *Trichuris ovis*.

Soota and Deysarkar (1981) during a survey from December 1976 to January 1977, Himachel Pradesh, (India) and recovered 11 species of nematodes from nine genera and eight families. The new species recorded was *Rhabdochona bariliusi* from the intestine was characterized by its length (male 7.5 mm, female 11.9 to 13.5 mm), spicules (0.44 and 0.11 mm with bifurcated tips), caudal papillae (16 pair: 11 prencal, 6.6 postanal) and the size of the eggs (0.022 to 0.033 x 0.22 um). *Trichuris globulosa, Bunostomum trigonocephalum, Gaigeria pachyscelis* and *Oesophagostomum columbianum* and were recovered from the intestines of goats.

McKenna (1981) described the relationship between the strongyles egg counts and the total strongyles worm burden and the total pathogenic index of the worm burden in sheep of different age groups and found that there was a defineable relationship between the total worm burdens and the worm egg counts.

Gray and Kennedy (1981) studied the effects of gastrointestinal parasites on survival, wool growth and live weight gain of weaner sheep.

Horak (1981) determined the seasonal incidence of helminths infestation in sheep, cattle, impala and blesbok. The following nematodes were considered to be of major importance *Haemonchus* spp. and *Trichostrongylus* spp., in all 4 hosts, while *Ostertagia* spp., were most prevalent in sheep.

Georgiev *et al.* (1981) examined 100 sheep and 79 weaned lambs affected with strongylosis ovoscopic examination revealed that there were following 8 genera of nematodes *Ostertagia, Cooperia, Trichostrongylus, Nematodirus, Haemonchus, Bunostomum, Oesophagostomum* and *Chabertia.*

Ansari and Singh (1981) reported the incidence of *Gaigeria pachyscelis* in sheep (18.8%) and goats (9.4%) and found the average worm burden per host was 15.24 and 13.71, respectively. The incidence was minimum in the pre-monsoon months, moderate in the monsoon period and maximum in the post-monsoon and winter months. Effect of temperature and relative humidity on the development and hatching of egg *G. pachyscelis* was noted and found that temperature required for development ranged between 26°C-30°C, with the optimum temperature being 26°C-27°C , while 100% RH was required. Egg are susceptible to drying and increased temperature.

Beveridge and Ford (1982) reported the species of Trichostrongyloid nematodes present in 376 sheep from different agriculture regions of the South Australia. Parasites most commonly encountered in the abomasum were *Haemonchus contortus, Trichostrongylus axei, Trichostrongylus circumcincta,* was present in a small number of sheep only, mainly the Southern areas. In the small intestine *Trichostrongylus colubriformis, Nematodirus filicollis, Nematodirus spathiger* and *Nematodirus abnormalis* were

predominat species. *Cooperia* spp., were uncommon and species encountered were *Cooperia oncophora*, *Cooperia surnabada* and *Cooperia pectinata*.

Dhar *et al.* (1982) examined 62 gastrointestinal tracts of sheep at Handwarah (Kashmir) 85% sheep were found to be infected with *Haemonchus contortus*, *Trichostrongylus axei*, *Chabertia ovina*, *Bunostomum trigonocephalum*, *Nematodirus spathiger* and *Trichuris ovis*.

Tarazona *et al.* (1982) recorded the following species of genus *Trichostrongylus* from the different parts of the gastrointestinal tracts of sheep and goats. *Trichostrongylus axei*, *Trichostrongylus capricola*, *Trichostrongylus vitrinus* and *Trichostrngylus colubriformis*. They also reported that *Trichostrongylus capricola* found more in numbers in goats than in sheep.

Roberts and Swan (1982) described the quantitative studies of ovine haemonchosis level and the distribution of egg counts of *Haemonchus contortus* within extensively managed flock of merino sheep in South-east Queensland.

Coadwell and Ward (1982) Clun forest sheep, worm-free birth, were given a single dose of 20,000 infective larvae of *Haemonchus contortus*. The total number of eggs/day in the faeces was recorded for 21 infection and data on the population size, sex ratio and individual worm were collected from 76 sheep. The relation between increase in worm size and uteri egg content was linear. The number of eggs present in the uter was found to be an accurate measure of egg passed. It was shown that the daily egg output is related to total parasite weight and is not a measure of the number of individuals present.

Cabaret (1983) examined the large intestines of 105 adult non-pregnant ewes for the period of three years at the abattoirs of Moulay-Bouazza (Morocco). The encountered nematodes species were *Oesophagostomum venulosum, Chabertia ovina, Trichuris ovis, Trichuris globulosa.*

Vercruysse (1983) conducted a survey of the gastrointestinal nematodes in domestic sheep and goats of the Sahelian zone of Senegal. At necoropsy of 30 animals during

the survey period. *Haemonchus contortus* and *Oesophagostomum columbianum* were the most important nematodes found.

Altaif and Issa (1983) studied the epidemiology of gastrointestinal nematodes of sheep at two different farms in the Baghdad area in 1979, revealed the two peaks of worm egg counts in ewes, one in spring and the other in autumn, the latter coincided with the lambing season. It was also observed that during hot and dry months, the helminth infection was at low level. Faecal culture of larvae and their identification indicated the predominance of *Haemonchus contortus* in ewes and that of *Ostertagia* spp. and *Trichostrongylus* spp. in lambs were found.

Mohiuddin *et al.* (1984) examined a total of 345 sheep and goats (306 goats and 89 sheep) and recorded *Cotylophoron cotylophorum, Gastrothylax crumenifer, Moniezia expansa, Moniezia benedeni, Avitellina centripunctata, Stilesia globipunctata, Thysaniezia giardi, Haemonchus contortus, Oesophagostomum venulosum, Gaigeria pachyscelis, Strongyloides papillosus, Skrjabinema ovis.* The incidence and seasonal variation was studied by monthly examination of the

host. *Skrjabinema ovis* has been recorded for the first time from the province of Sind. The incidence of infection was generaly higher in sheep than goats.

McCulloch *et al.* (1984) considered *Haemonchus, Trichostrongylus, Ostertagi* and *Nematodirus* worms population of Merino sheep based on differential egg counts with climatalogical and topographical data. Egg counts indicated that the estimated worm populations in animals of flat areas with low rainfall were as heavy as or heavier than in animals of steep hilly areas with a high rainfall.

Darmona (1984) reported the incidence of haemonchosis among the sheep slaughtered at Bogor (Indonesia) during March, 1981 to February, 1982. *Haemonchus contortus* was found in abomasum of 85% of the 142 slaughtered sheep, averaging 43±29 nematodes per head. The ratio of male to female nematodes was 2.2.

Jackson and Christie (1984) reported that increase in 10 fold infective larvae of *Ostertagia circumcincta* by lambs results in almost no increase in faecal egg counts. They also

described the relationship between larval intake and faecal egg out put.

Gruner and Cabarat (1985) described the different methods used to assess the parastic population like egg per gram, serum pepsinogen, and was found faecal egg counts and other relative methods are still of great use for assessment of parasitic population.

Vercruysse (1985) examined 1024 abomasa of sheep and (75%) were found to be infected with *Haemonchus contortus*.

Ahmed and Ansari (1987) examined the gastrointestinal tracts of 479 goats, and 392 sheep and recovered the following nematodes species. *Haemonchus contortus, Oesophogostomum columbianum, Bunostomum trigonocephalum* and *Trichuris ovis*. The prevalence of *Haemonchus contortus* infection was found to be highest from July to November, while the *Oesophagostomum columbianum* was the second highest and remained moderate throughout the year. Other shows no seasonal fluctuation. The goats were found to be infected more with *Trichuris ovis* while sheep with *Bunostomum*

trigonocephalum.

Ikeme *et al.* (1987) studied the seasonal changes in the prevalence of *Haemonchus* and *Trichostrongylus* hypobiotic larvae in tracer goats in Malaysia. Parasite free tracer goats were grazed with natually infected adults goats for one month and necropsied for worm count. No hypobiotic larvae of *Trichostrongylus* were recovered, while those of *Haemonchus* were recoverd only in small proportion in each month of the year.

Ansanji and Williams (1987) carried out an investigation for gastrointestinal parasite of sheep and goats and pointed out seasonal fluctuation, role of age and sex of hosts on both helminth load and species number per host. A higher number of old animals harboured less helminth species than young animals. All the helminths species showed a dry season rise from August to January, the highest and lowest relative densities being recorded in October and July respectively. Young animal harboured a significantly higher worm load than old animals. The most prevalent species was *Haemonchus contortus* followed by *Oesophagostomum columbianum* and

Oesophagostomum venulosum. Female hosts harboured a significantly higher worm load than male hosts.

b

Ansanji and Williams (1987) carried out a survey for a period of two years from 1973 to 1975, in which they examined 34,110 sheep and goats and recovered 24 identified helminths species. No single host carried all the recovered species of helminths, but there was a variation, each host harboured one-six species of helminths. The combined mean annual prevalence of infection for goats and sheep (70.0%), (64.6%) and (35.9%) for *Haemonchus contortus*, *Oesophagostomum columbianum* and *Oesophagostum venulosum*. Prevalence of nematodes and trematodes was more significant in goats, while cestodes prevalence was more significant in sheep.

Gupta *et al*. (1987) discussed the epidemiology of some gastrointestinal nematodes of sheep and goats in Karnal, Ambala and Rohtak districts of Haryana (India) revealed that *Haemonchus contortus* and *Trichostrongylus* spp. were responsible for parasitic gastroenteritis in these hosts. The adult parasites persisted in the host throughout the year and there was no indication of hypobiosis.

Guimaraes and Walter (1987) described the results of eighty three goats of undefined breed coming from different regions of the state of Minas Gerais, (Brazil). Post-mortem examination revealed the presence of following parasites *Haemonchus contortus* (82.01%), *Trichostrongylus colubriformis* (80%), *Trichostrongylus axei* (39%), *Trichostrongylus longispicularis* (2%), *Strongyloides papillosus* (36%), *Cooperia curticei* (30%), *Cooperia punctata* (6%), *Cooperia pectinata* (6%), *Bunostomum trigonocephalum* (7.0%), *Oesophagostomum columbianum* (42%), *Oesophagostomum radiatum* (2%), *Oesophagostomum asperum* (5%), *Trichuris ovis* (22%), *Moniezia expansa* (5%), *Eurytrema pancreaticum* (0.1%) and *Cysticercus tenuicollis* (.2%).

Njau (1987) conducted faecal examination on tracer lambs from July 1976 to Augest 1977, showed that the animals passed out small and large number of strongyles egg, respectively during dry (September-February) and wet seasons (March-August). The following nematode species were observed at necropsy. *Haemonchus contortus, Oesophagostomum columbianum, Trichostrongylus colubriformis* and *Trichuris*

ovis.

Jansen, (1987) investigated the trichostrongylid and strongylid egg out put in a group of ewes lambing in March compared with egg counts in groups of older ewes lambing in May-June and it was found that the groups lambing in March show rise in egg count is due to parturition, while in case of groups lambing in May-June is due to reinfection in summer resulted in the rise of egg counts.

Khan *et al*. (1988) studied sixty eight flocks of sheep in Kalat, Pishin, Loralai and Zhob districts of upland Baluchistan for internal parasites. Two most common breeds Baluchi and Harnai were included in the survey (79%) of the sheep in these areas were found to be infested with internal parasites. The incidence in different Districts was Kalat (94%); Zhob (80%); Loralai (71%) and Pishin (70%). The following internal parasites were recovered. *Nematodirus* spp. (54%), *Fasciola hepatica*, *Marshallagia marshalli* (25%), *Dictyocaulus filaria* (21%), *Strongyloides papillosus* (13%), *Trichostrongylus* spp. (13%) *Avitellina centripunctata* (13%), *Moniezia benedeni*, (12.5%) *Oesophagostomum* spp. (12%) and

Haemonchus contortus (11.75%).

Taylor and Hunt (1988) proposed the worm control strategies, on a commercial farm in South-East England, and monitored the contamination during the grazing season and observed the three peaks of larval infection in June, late August and late October in grazing ewes and lambs.

Gupta *et al.* (1988) they used tracer lambs to find out the pasture contamination with infective stages of helminth parasites during one year annual cycle in a subtropical climate. Post-mortem examination indicated that low infections with *Haemonchus contortus* occurred throughout the year except in June. *Trichostrongylus colubriformis* infection was detected throughout the year and 150 worm or more were per lamb were recorded during January to May and in August. Anoplocephalids were also recorded, but has no seasonal pattern, low infection with *Oesophgostostomum columbianum*, *Bunostomum trigonocephalum* and *Trichuris ovis* were observed. The faecal egg counts from permanent flock revealed heavy to mild worm burden throughout the year.

Pullman *et al.* (1988) Trichostrongyloid nematode infections of weaner sheep were investigated at the Tarretified (South Australia) over a three-year period (1982-1985). Acquisition of nematode larvae from pasture was occurred during the winter months, while Faecal egg counts were elevated during the summer, but declined to negligible levels during the winter months.

Khan *et al.* (1989) examined 500 guts, comprising 250 each from sheep and goats for gastrointestinal parasites. The prevalence of helminth, was (58.4%) and (54.0%) in sheep and goats, respectively. The relative prevalence of trematodes, cestodes and nematode was (20.8%), (14.4%) and (23.2%) in sheep and (19.6%), (13.2%) and (21.6%) in goats, respectively. The following species were recovered during the survey. *Paramphistomum cervi, Paramphistomum explanatum, Cotylophoron cotylophorum, Moniezia expansa, Moniezia benedeni*, and *Avitellina centripunctata* while in case of nematodes, *Haemonchus contortus, Oesophagostomum venulosum, Bunostomum trigonocephalum, Chabertia ovina, Cooperia cruticei, Trichuris ovis, Ostertagia circumcincta, Ostertagia ostertagi.*

Charles (1989) conducted a post-mortem examination of gastrointestinal nematodes to goats from April, 1979 to March, 1982 and he noted that each goat is parasitized by more than one species of nematode. *Haemonchus contortus*, *Strongyloides papillosus* and *Oesophagostomum columbianum* were the most prevalent nematodes found. The total worm burdens present in animal were highest during late rainy/early dry season (March-June) and lowest in mid-rainy season (January-February). The acquisition of nematodes by tracer goats occurred mainly from mid-rainy to early dry season (January-June).

Reinecke and Louw (1989) recovered the total differential worm counts in sheep during one year period May 1987-1988 slaughtered at Boontjieskraal Estate (South Africa) and was found that winter lambs infected with *Nematodirus spathiger* at 5 to 7 weeks of age. At weaning this species was superseded by *Teladorsagia circumcincta* and *Trichostrongylus rugatus*. Small number of *Trichuris skrjabini*, *Oesophagostomum venulosum* were also reported. Infective larvae aestivate in the faeces or in the soil of the lucerne pastures in the dry,

hot summer month and migrate on to the herbage during the cool, wet autumn.

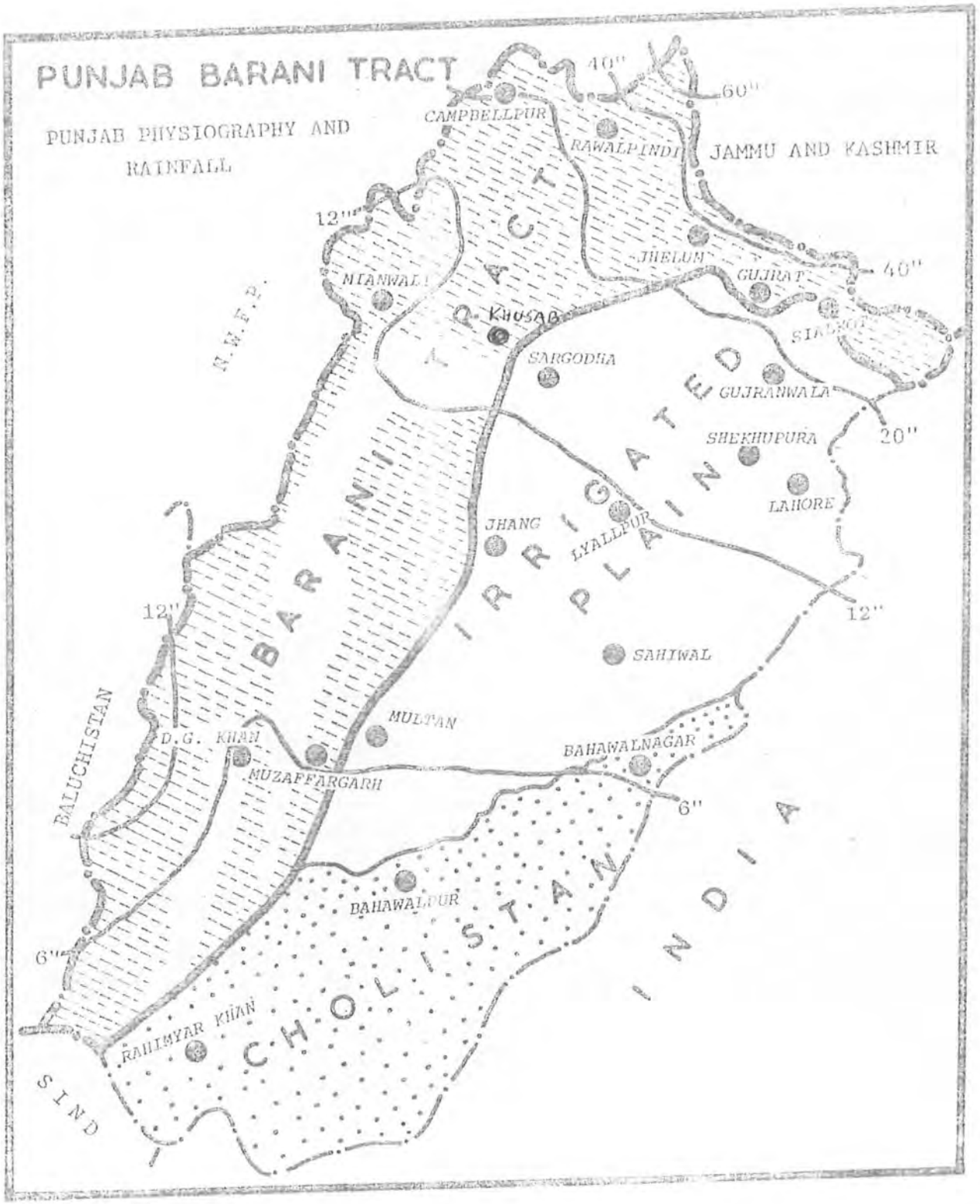
Uriarte and Valderrabano (1989) described the epidemiology of parasitic gastroenteritis under an intensive grazing system on irrigated land in northeast of Spain. Two type of parasites generations were identified in the study. One of them, derived from the eggs deposited in the previous autumn, gave rise to the first infection of the animals in March and April and were found responsible for the first parasitism in the lambs. *Ostertagia* spp., *Nematodirus* spp., and *Trichostrongylus* spp., were the parasites found in this population. The second generation, which appeared during May, was derived from the eggs of the previous generation and gave rise to an outbreak of parasitism in the lambs at the beginning of May and middle of June.*Haemonchus* spp. *Chabertia ovina* were present in this population.

The review of literature revealed that there was a need to conduct a comprehensive survey of gastrointestinal parasites of sheep and goats in Pothwar region.

MATERIALS AND METHODS

STUDY AREAS

The Barani or rainfed area comprises the districts of Attock, Jhelum, Rawalpindi, Islamabad, Mianwali, Gujrat, Gujranwala and Sialkot in the Punjab. The zone is spread over the salt range, Potwar plateau is generally open and undulating, developed mainly on sand stones. The land form in the salt range is eroded with well-developed scarps, and slopes intervening between hill ranges that narrow valleys are filled with silty and loamy material. Spring water is available for irrigated agriculture in some of these valleys. Climatically the zone is divided into two parts; A small narrow belt along the foot of the mountain is nearly humid with a hot summer and a cold winter having only a short dry season in summer. The Southwestern part of the zone is semi-arid and hot. The Southeastern part is humid with a mild summer and a cold winter without any pronounced dry season. Mean monthly maximum temperature range is 42^{o}C to 44^{o}C and mean monthly minimum temperature range is 0.5 to 3^{o}C while Mean monthly rainfall in Summer range is 200 mm to 236 mm and Mean monthly rainfall in winter range is 44 mm to 116 mm.


PUNJAB BARANI TRACT
PUNJAB PHYSIOGRAPHY AND RAINFALL
40"
60"
CAMPBELLPUR
RAWALPINDI
JAMMU AND KASHMIR
12"
JHELUM
GUJRAT
40"
MIANWALI
N.W.F.P.
KHUSAB
SARGODHA
SIALKOT
GUJRANWALA
SHEKHUPURA
20"
LAHORE
BARANI
IRRIGATED PLAIN
JHANG
LYALLPUR
12"
12"
SAHIWAL
BALUCHISTAN
D.G. KHAN
MULTAN
BAHAWALNAGAR
MUZAFFARGARH
6"
BAHAWALPUR
CHOLISTAN
INDIA
6"
RAHIMYAR KHAN
SIND

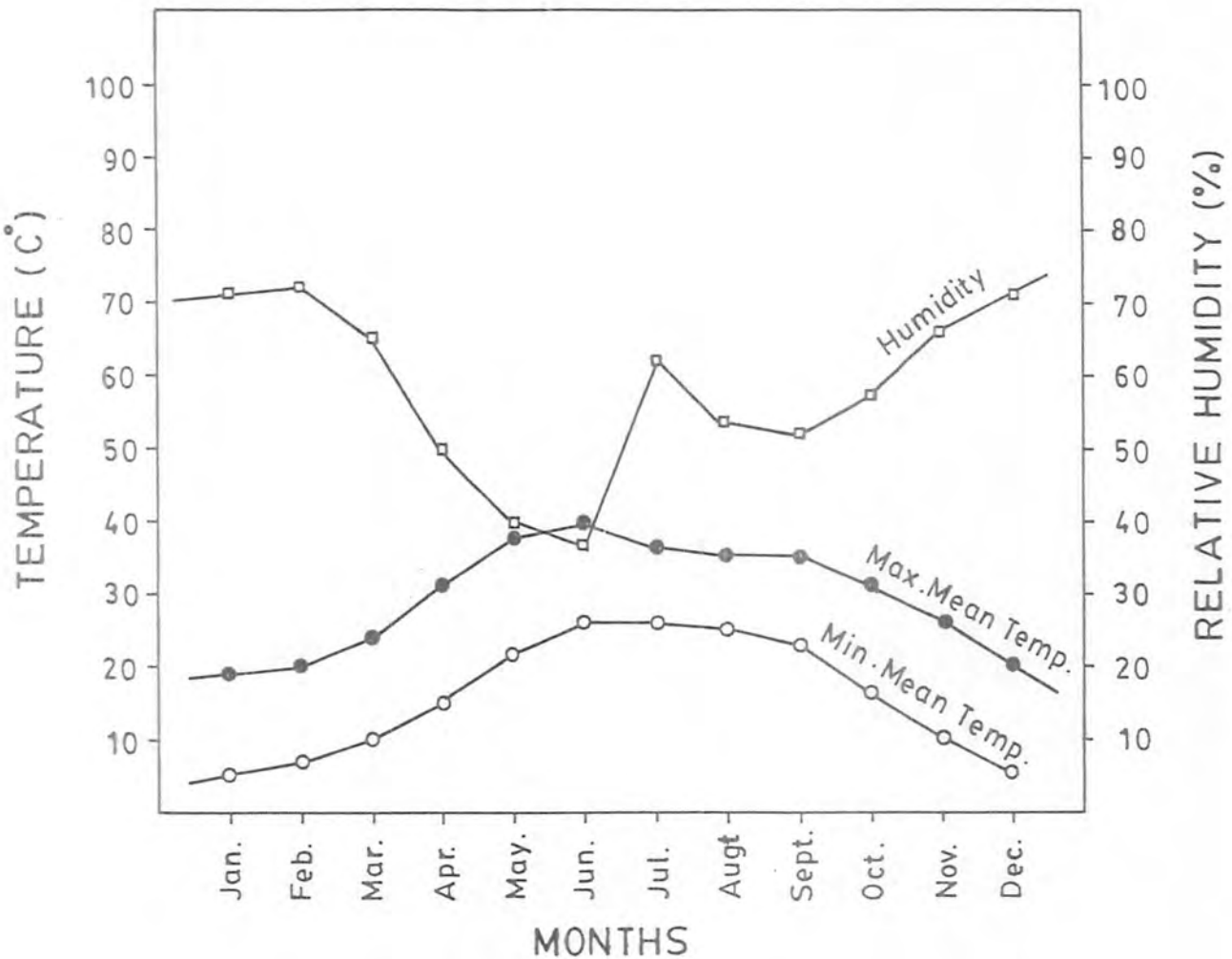


FIG.1: The monthly mean maximum and minimum temperature and mean monthly relative humidity at Barani areas during 1990-1991.

Barani areas has sub-tropical type of climate, which is of two types; the humid and the sub-humid. The lands are heavily grazed during summer growing season. The one year cycle is divided into three seasons winter (November - February), summer (March-June), Rainy (July - October). The native vegetation is a mixture of grasses and shrubs. *Heteropogon contortus, Chrysopogon anontanus, Bothriochloapertusa, Themeda anathera, Cymebopogon schoenanthus, Xanthium strumarium, Sageretia brandrethiana, Adhatoda vasica, Saccharum spontaneu, Eriophorum comosum, Eragrostis poaeoides, Artistida depressa, Cenchrus ciliaris, Calotropis procera, Sorghum halepense* are found here (Hasnain, 1985).

WEATHER DATA

The weather data for Barani areas were obtained, courtesy of the Director, Regional Meteorological Centre, Graveyard Road, Islamabad.

COLLECTION OF MATERIALS

This survey covers the period from Ist January, 1990 to

Ist January, 1991 during which the total 654 complete gastrointestinal tracts of each 311 sheep and 343 goats were obtained twice a week from the local abattoirs of Rawalpindi-Islamabad. At necropsy, gastrointestinal tracts were removed and transported to the laboratory for the examination immediately. The animals included in this study were brought from suburbs of Rawalpindi-Islamabad and its neighbouring districts viz: Rawalpindi-Islamabad, Chakwal, Attock, Jhelum, Gujrat, Khushab, Sargodha and Swat (NWFP). It has been found that 60% sheep were over 2 to 3 years of age, while 40% were less than 2 years of age. In case of goats, most of them (60-65%) were between 1 to 2 years of age, and very limited (30-35%) were more than 2 years of age. Random sampling was made in term of sex of host, but most of the sheep were ewes, while goats were both she and bucks. Breed of the animals were identified according to descriptions and figures given in (Hasnain, 1985). The breeds of sheep included in this study were viz: Latti, Lohi, Kajli, Kaghani, Bulkhi and Thalli while that of goats they were Teddy, Barbari, Desi (Jattal) and Kaghani.

PARASITOLOGICAL METHODS FOR THE RECOVERY OF HELMINTHS

a) Recovery of trematodes and cestodes:

Gastrointestinal trematodes and cestodes were recovered by applying the following methods. Adult gastrointestinal trematodes confined to rumen, reticulum, and omasum were removed easily by hand giving them a twist from the stomach wall. The immature amphistomes were detached from the mucosa with the help of a rubber coated forceps. While in the case of cestodes the intestine was placed in a bucket and sequeezing of the intestinal contents was done in the direction opposite to that of the peristaltic movement. This made the cestodes lodged in duodenum, ilieum, and jejunum and come out simply by the pressure of the rectal contents.

b). Nematodes parasitizing the abomasum, small and large intestines:

Sampling of nematodes from the abomasum, small and large intestines was carried out within 4 hours after the slaughter of animals. Abomasum, small and large intestines were ligated at omasal-abomasal, abomasal-duodenal and ileo-caecal junctions to prevent worms from spilling from one location to another. From abomasal, small and large

intestines samples of worms were collected and counted according to the technique described by Charles and Baker, 1988. In laboratory, each part of gastrointestinal tracts was opened separately and the mucosa was washed in water to remove all the parasites. Abomasal and small intestinal contents were washed through wire mesh of 71-um aperture, while those of the large intestines were washed through wire mesh of 500-um aperture. The material retained on the wire mesh was preserved in 10% formalin and were stored for later examination. The abomasal and small intestinal mucosae were soaked separately in saline at 37^{o}C for 1 hour. After soaking, the saline solution was set aside and the abomasal and small intestinal mucosae were washed separately with water, which then was passed through a wire mesh of 71-um aperture. The retained material was fixed in 10% formalin.

Total worm counts in aliquots of abomasal and small intestinal contents were estimated after washing on a 71-um aperture sieve. The matieral retained on the sieve was collected and was brought to a volume of 1 litre, with constant stirring, two 50 ml aliquots were taken and all nematodes in each aliguot were counted and identified. When

<100 worm were counted, additional aliquots were taken, until entire 1 litre was examined.Worms in the material obtainted from the soaking of the abomasal and small intestinal mucosae were counted in the same manner as those in the abomasal and small intestinal contents. Contents of the large intestine were emptied into a bucket. The entire contents were washed in small amount on a wire screen with the aperture 500-um . After all contents were washed the material that remained on the screen was fixed in 10% formalin. The entire contents were examined and worm were counted visually.

c) Enzyme digestion study of the abomasal mucosa for nematodes and their Larvae:

Worms inhabiting the lumen of the abomasum were isolated by the method described above. The conventional (sedimentation) procedure is not suitable for demonstrating larvae parasitizing the wall of the abomasum. First they have to be released from the tissues by enzyme digestion method. The method described in a British methodological publication (Ministry of Agriculture, Fisheries and food, 1979) was chosen for the purpose.

After careful removal of their contents by washing the abomasa were weighed to determine the volume of digestion solution required. Subsequently the entire abomasa were digested in a digestive solution pre-heated at 37°C. The composition of the digestive solution was as follows: 940 ml distilled water, 8 gm pepsin, 20 ml of concentrated HCl and 23 ml saturated NaCl solution. One litre of digestive solution was sufficient for the digestion of 500 gms of abomasum. The abomasa were digested at 37°C for 8 hours by mixing at a speed of 20-40 rpm in an incubator. Undigested tissues were removed and the solution containing the digested mucosa was filtered through two sieves.The pore size of the upper and lower wire mesh was 120-um and 75-um, respectively. The upper sieve retained undigested tissues, fat and sometime few mature worms, while on the lower sieve immature worms inhabiting the abomasal wall and colloidal fat were left over. The material retained by the lower sieve was washed with physiological saline, made volume upto 100 ml and preserved in 10% formaline. One tenth of the decanted and digested samples were examined.From the results the total worm and larval counts were estimated.

d) Faecal examination:

To determine the prevalence and intensity of infection, faecal samples were collected from the same autopsied animals. The faeces collected directly from the rectum, preserved in 10% formaline and stored at $4^{o}C$ were examined within 72 hours. The modified McMaster technique with saturated sodium chloride was used (Hatch and Larkin, 1988) A correction factor was used according to the consistency of faeces. X 1 for normal pellets, X 1.5 for soft formed faeces, 2 X for soft faeces and X 3 in case of diarrhaea (Skerman and Hillard, 1966).

McMASTER TECHNIQUE FOR EGG PER GRAM (E.P.G.)

1. 3 gms of faeces weighed out and put in the bottle and add 42 ml of distilled water.
2. The faeces were homogenized with the help of homogenizer.
3. The mixture was poured through a wire mesh screen with an aperture of 0.15 mm and the strained solution caught in a bowl. The debris left on the Screen was discarded.
4. The strained fluid was stirred and a sample of it was poured into a centrifuge tube to within 1 cm of the

top. The tube was centrifuged for 2 minutes at 1500 rpm and the supernatant was poured off and discarded.

5. The tube was agitated until the sediment was loosened and formed a homogeneous sludge at the bottom of the tube. The tube was filled with saturated salt solution to the same level as before.

6. The contents of the tube were thoroughly mixed by inverting it five or six times with the thumb over the end and sufficient of the fluid was immediately withdrawn with a pasteur pipette and carefully allowed to run into one chamber of the counting slide. After further mixing a second and third sample was withdrawn and run into the other chambers.

7. Bringing the lines on the counting chamber into sharp focus under the low power of the microscope using subdued light, count each type of egg in three chambers and multiply each sum by 50 to give the results in eggs per gram. Main interest was centred on strongyle eggs, but other worm eggs were also differentiated and counted.

PRESERVATION AND STAINING OF HELMINTHS

A. TREMATODES

i) PRESERVATION

After the removal of trematodes from stomach, they were carefully washed in physiological saline in order to remove any mucus and detritus from their surfaces. They were then flatten between slides and hot AFA solution was run under by the means of a pipette so that they got their internal organs in fixed state. The worms were remained in the fixative overnight after which they were placed in 70% alcohol.

ii) PROCEDURE OF STAINING

a- Passed the pressed specimens through 30% and 50% alcohol for 20 minutes in each concentration and then in 70% alcohol.

b-Dehydrated the specimens with 50% and 30% alcohol for 25 minutes in each case and then wash with distilled water for few minutes.

c- Treated with Gower's carmine stain 5-8 hours and again wash with distilled water.

d- Worms were decolourized in acid alcohol until the deep red colour changed to light pink.

e- Dehydrated by treating the specimens successively with 30%,50%, 70% 80%, 90% and absolute alcohol for 25 minute in each case.

f- Worms were then cleared with equal volume of xylene and absolute alcohol for two times.

g- Worms were cleared in xylene.

h- Worms were then mounted in Canada Balsam and the edges of the cover slip were sealed with nail polish.

i- The slides were placed in an oven at 60^{o}C until they become dry.

B. CESTODES

PRESERVATION AND STAINING

The cestodes were given 2-3 changes in distilled water. Scolex along with neck, mature and gravid segments were cut with a sharp blade. The specimens were pressed between two slides gently and cotton thread was placed between two slides to avoid crushing of the specimen.

a- Passed the pressed specimens through 30% and 50% alcohol for 10 minutes in each concentration and then in 70% alcohol for overnight.

b- Dehydrated the specimens with 50% and 30% alcohol and then with distilled water for 10 minute in each case.

c- Treated with Gower's carmine stain 10-20 minutes and again wash with distilled water.

d- Dehydrated with 30%, 50% and 70% alcohol, destained with acid alcohol for 3-5 minutes.

e- Dehydrated with 70% and 90% alcohol for 10 minutes in each case. Placed in absolute alcohol for half an hour.

f- Treated with equal quantities of xylene and absolute alcohol for 10 minutes.

g- Cleared in pure xylene for two times.

h- Put in clove oil and then were mounted in canada balsam and the edges of the cover slip were sealed with nail polish.

C. NEMATODES

i) PRESERVATION

The nematodes were recovered and washed in

physiological saline and were fixed in 70% alcohol for 24 hours.

ii) PREPARATION OF WHOLE MOUNT

After treatment with 70% alcohol, the nematodes were transferred to a vial containing a hot mixture of ethyl alcohol (70%)-50 parts and glycerol (chemically pure)-50 parts. The worms were kept in this vial partly covered until all the ethyl alcohol was evaporated and worms left in pure glycerol. The worms were cleared in lactophenol and then placed on microscope slide and mounted in pure glycerol. Excess of glycerol was removed with the help of filter paper and the edges of the cover slip were sealed with nail polish.

IDENTIFICATION AND MEASUREMENTS OF HELMINTHS

Majority of the parasites were identified by the use of low power of microscope and identified according to the keys and morphological characteristics discussed by Soulsby, (1982); Yamaguti, (1958,1959, 1961); Ministry of Agriculture, Fisheries and Food, (1979). Drawing were made with the help of camera lucida. Measurements of helminths were taken on

stained specimens except the total length which were taken on fresh but relaxed specimens. Measurements of the internal organs of helminths were taken after preparation of permanent mount of the specimens and were taken on a calibrated microscope and were presented in millimeters (mm).

PREPARATIONS OF STAINS AND SOLUTIONS

i) Gower's Carmine:

10 gms of carmine (Merck) boiled in 100 cc of 45% glacial acetic acid; cooled and filtered. Filterate discarded. Precipitate dried and dissolved in 5% potash alum to make 1/2% solution of stain. A crystol of thymol was added to prevent any growth of mould.

ii) Lactophenol was prepared according to procedure described by (Morgan and Hawkins, 1960).

Phenol	1 part
Glycerol (Chemically pure)	2 parts
Distilled water	1 part
Lactic acid	1 part

iii) Formal-Alcohol Fixative (a.f.a) was also prepared according to procedure described by (Morgan and Hawkins, 1960).

Formaline Commercial	10 parts
Glacial acetic acid	2 parts
Ethyl alcohol (95%)	50 parts
Distilled water	40 parts

iv. Physiological Saline was prepared by dissolving 0.9 gm of sodium chloride in 100 ml of distilled water.

v. Acid-alcohol was prepared by adding 1 ml of concentrated HCl to 100 ml of 70% ethyl alcohol.

vi. Saturated Salt Solution was prepared according to procedure described by (Hatch and Larkin, 1988).i.e, by dissolving 360 gms of sodium chloride in 1 litre of distilled water.

GENERAL DISCRIPTION

A detailed study of the species of helminths was made and the observations were recorded. The morphometric studies showed that the measurements lie within the range described for these species.

A. TREMATODES (Amphistomes):

Family: Paramphistomidae, Fischoeder, 1901

Subfamily: Paramphistominae, Fischoeder, 1901

Genus: *Paramphistomum*, Fischoeder, 1901

i. *Paramphistomum cervi* Zeder, 1790

(Fig. 19 Table 7)

The colour of live adult specimens was light red and pear-shaped, slightly concave ventrally and converse dorsally, with a large posterior subterminal sucker. The testes were slightly lobed and tandem, anterior to the ovary. The vitellaria were in compact groups between the pharynx and the posterior sucker.

ii. *Gastrothylax crumenifer* Creplin, 1847

(Fig. 20 Table 8)

It was red when fresh, elongated, circular in shape.

These worm have a very large ventral pouch, opening anteriorly and extending over the whole ventral surface up to the posterior sucker, which was large and terminal and had a raised border. The terminal oval sucker was small. The genital pore opened into the pouch, half-way between the pharynx and intestinal bifurcation. The intestinal caeca end at about the level of the anterior border of the testes, which were lobed and horizontal, with the ovary behind them. The uterus crosses from right to left at about the middle of the body.

iii. *Cotylophoron cotylophorum* Fischoeder,1901

(Fig. 21 Table 9)

The *C. cotylophoron* in its living state was easily dinguishable from others by its purple colour. The

genital pore near the intestinal fork was surrounded by a sucker. Testes were lobed and situated one behind the other. Laurer's canal opened posterior to excretory pore vitellaria extended throughout caecal zone.

iv. *Cotylophoron ovatum* Harshey, 1934

(Fig. 22 Table 10)

The colour of this trematode was light red and was characterized by having curled shaped caeca, giving Zig-Zag appearance and end slightly before the ventral sucker. The testes were lobed shape and situated one behind the other. The ovary was posterior to the testes. The vitellaria glands were dispersed throughout the caecal zone and were dot-like in appearance.

B. CESTODES (Anoplocephalids)

Family: Anoplocephalidae Blanchard, 1891

Subfamily: Anoplocephalinae Blanchard, 1891

Genus: *Moniezia* Blanchard, 1891

i. *Moniezia expansa* Rudolphi, 1801

(Fig. 23 Table 11)

The scolex possessed four prominent suckers. The segments were wider than long and each segment contained two sets of genital organs. Interproglottidol glands extended across the posterior border of the segment. The ovaries formed a horse shoe shaped structure on each side of the

segment.

ii. *Moniezia benedeni* Moniez, 1879

(Fig. 24 Table 12)

The scolex also provided with four suckers The distinguishing feature was that the interproglottid glands arranged in a short continuous row close to the mid-line of the segment.

Family: Thysanosomidae Fuhrmann, 1907

Genus: *Avitellina* Gough, 1911

iii. *Avitellina centripunctata* Rivolta, 1874

(Fig. 25 Table 13)

The segments were cylinderical and proglottids were short. Each segment contained a single set of genitalia. The utertus lies transversely in the middle portion of the proglottid.

Genus: *Stilesia* Railliet, 1893

iv. *Stilesia vittata* Railliet, 1896

(Fig. 26 Table 14)

The scolex provided with prominent suckers and there was a broad neck. The proglottids were short. The genital organs were single and the genital pores alternate irregularly. The testes were arranged in the groups 5 to 6 in numbers in each segment.

C. NEMATODES

Family: Trichostongylidae Leiper, 1912

Genus: *Haemonchus* Cobbold, 1898

i. *Haemonchus contortus* Rudolphi, 1803

(Fig. 27 Table 15)

Male: The lateral lobes of the bursa were long. The dorsal lobe was positioned asymmetrically. Spicules were long and taper towards the posterior end which was rounded and each had a barb near the posterior end.

Female: Vulva opened towards the posterior end. It was covered with a large linguiform process, other small

processes were present near the vulval opening. The ovaries were spirally twisted.

Family: Cyathostomidae Yamaguti, 1961

Subfamily: Oesophagostominae Railliet, 1916

Genus: *Oesophagostomum* Molin, 1861

vi. *Oesophagostomum columbianum* Curtice, 1890

(Fig. 28 Table 16)

Male: The lateral cervical alae were present in this case. Cervical papillae were situated in the oesophageal region. Bursa was well developed.

Female: Anterior end of female is similar like that of male.

vii. *Oesophagostonum venulosum* Rudolphi, 1809

(Fig. 29 Table 17)

Male: There were no lateral cervical alae cervical groove was present. Cervical papillae was situated behind the oesophagus. Bursa was well developed.

Female: Anterior end of female is similar to like that of

male.

Genus: *Ostertagia* Ransom, 1907

ii. *Ostertagia ostertagi* Stiles, 1892

(Fig. 30 Table 18)

Male: Bursa was small. The accessory bursal membrane was supported by two divergent rays. The gubernaculum was oval in shape with a posterior extension.

Female: The vulva opened as a transverse slit. It was usually covered by a cuticular flap.

iii. *Ostertagia circumcincta* Stadelmann, 1894

(Fig. 31 Table. 19)

Male: The lateral lobes of the bursa was well developed but the dorsal lobe was small. The accessory bursal membrane was small.

Female: The vulva was covered with a large linguiform process, but reduced in size. The ovaries were spirally twisted.

Genus: *Trichostrongylus* Looss, 1905

iv. *Trichostrongylus axei* Cobbold, 1879

(Fig.32 Table 20)

Male: The lateral lobes of the bursa was large. The dorsal lobe was small. The spicule were short, twisted and unequal. The gubernaculum was some what spindle shaped.

Female: The vulva was opened in a longitudinal slit from the cone-shaped tail end.

v. *Trichostrongylus colubriformis* Giles, 1892

(Fig. 33 Table 21)

Male: The lateral lobes of the bursa was large. The dorsal lobe was small. The spicules were unequal in length with a some what triangular projection at the posterior end. The gubernaculum was spindle shaped.

Female: The vulva was opened as a longitudinal slit.

Genus: *Bunostomum* Railliet, 1902

Bunostomum trigonocephalum Rudolphi, 1808

(Fig. 34 Table 22)

Male: The anteriaor end was bent in a dorsal direction.

Buccal capsule opened anterodorsal and it was relatively large and beared at it ventral margin, a pair of chitinous plates. The Bursa was well developed and had an asymmetrial doral ray. Spicules were slander and alated.

Family: Trichuridae Railliet, 1915

Subfamily: Trichurinae Ransom, 1911

Genus: *Trichuris* Roederer, 1761

Trichuris ovis Abildgaard, 1795

(Fig. 35, Table 23)

Male: The narow anterior end constitutes three quarter, of the length. There was no bursa. The spicule sheeth was covered with a minute spines.

Female: The narrow end constituted just over two-thirds of the body.

Trichuris globulosa Linstow, 1901

(Fig. 36, Table 24)

Male: In male the spicular sheath beared a terminal spherical expansion on which the spines were larger than on the remaining portion.

Female: The narow end constituted just two-thirds of the

body.

Trichuris lani Arkiukh, 1948

(Fig. 37, Table 25)

Male: The spicular sheath was long and slenderical in shape and provided with spines on its surface.

Female: The narow end constituted just over two-thirds of the body.

Family: Oxyuridae Cobbold, 1864

Subfamily: Syphaciinae Railliet, 1916

Genus: *Skrjabinema* Werestchajin, 1926

Skrjabinema ovis Skrjabin, 1915

(Fig. 38, Table 26)

Female: The oesophagus was cylinderical and terminated in a large spherical bulb. They had three large, complicated lips and three small intermediated lips.

No male was recorded during the study period.

RESULTS

In this investigation, 20 different species of helminths from 13 different genera were recovered from a total of 654 necropsies. Three hundred and eleven gastrointestinal tracts were obtained from sheep and 343 from goats. In sheep 275 (88.42%) and in goats 291 (84.83%) gastrointestinal tracts were found positive for mixed parasitic infection throughout the areas surveyed for the year 1990-1991. In sheep higher incidence of infection was found as compared to goats. There were few exceptions like *Paramphistomum cervi*, *Moniezia expansa*, *Ostertagia ostertagi*, *O. circumcincta*, *Trichuris globulosa* and *Trichostrongylus axei* that showed high incidence of infection in goats as compared to sheep. Majority of the sheep and goats examined were infected with more than one species of helminth, having the minimum two and maximum seven species of helminth parasites in each host. Their overall prevalences, range, host sites and the mean worm burdens are summarized in the tables 1 and 2. The following species of helminths were identified in both sheep and goats.

Paramphistomum cervi (Zeder, 1790), *Cotylophoron cotylophorum* (Fischoeder, 1901), *Cotylophoron ovatum*

(Harshey, 1934), *Gastrothylax crumenifer* (Creplin, 1847), *Moniezia expansa* (Rudolphi, 1810), *Moniezia benedeni* (Moniez, 1879), *Avitellina centripunctata* (Rivolta, 1874), *Stilesia vittata* (Railliet, 1896) *Haemonchus contortus* (Rudolphi, 1803), *Oesophagostomum columbianum* (Curtice, 1890), *Oesophagostomum venulosum* (Rudolphi, 1809), *Ostertagia ostertagi* (Stiles, 1892), *Ostertagia circumcincta* (Stadelmann, 1894), *Trichostrongylus axei* (Cobbold, 1879), *Trichostrongylus colubriformis* (Giles, 1892), *Trichuris ovis* (Abildgaard, 1795), *Trichuris globulosa* (Linstow, 1901), *Trichuris lani* (Arkiukh, 1948), *Bunostomum trigonocephalum* (Rudolphi, 1808) and *Skrjabinema ovis* (Skrajbin, 1915).

A-TREMATODES

INCIDENCE:- The overall incidence of trematodes in sheep and goats was recorded to be 30.54% and 25.65% respectively (Table 3,4). *Cotylophoron cotylophorum* was the predominant trematodes of sheep and goats encountered in this survey. The incidence of this parasite was found to be 18.00% in sheep and 12.53% in goats. *Paramphistomum cervi* was the second in predominance encountered in the present investigation. The percentage of infection in sheep and goats

was noted to be 14.14% and 14.57% respectively. *Cotylophoron ovatum* was recorded in small numbers during this study period. Its incidence was recorded to be 5.78% in sheep and 1.16% in goats. *Gastrothylax crumenifer* was found to be 12.86% in sheep and 8.74% in goats.

SEASONAL VARIATIONS:- The lowest incidence of trematodes was recorded during the months of April, May and June, while the highest incidence was noted during July, August, September and October (Appendix tables 27-34) in both sheep and goats.

The seasonal incidence of different trematodes in both sheep and goats is illustrated graphically in the Figs. 2 and 3 respectively.

In case of *Paramphistomum cervi* a downward trend starting in January and terminating in June in the case of sheep and in May-June in case of goats was observed. From July the incidence then rose fairly rapidly to culminate in a major peak in September in the case of sheep and in September-October in goats, after which the incidence fell

progressively to a low level in the remaining period of the investigation. In *Gastrothylax crumenifer* there was a decrease in the incidence from January to February and from January to April in sheep and goats respectively. In sheep this species was entirely absent in March-April, while in goats it was entirely absent from April to June. In sheep the incidence then rose gradually to a peak in September, while in goats similiar increase was observed to a peak in August after which a gradual decline was noted in both the cases. In *Cotylophoron cotylophorum* a slightly increase in the incidence was observed from January to March then declined to a very low level in June. As far as goats were concerned a major peak was recorded in February which then declined to a low level in June. In sheep the incidence rose again to a major peak in July after which it declined progressively to a minor peak in October. In goats a minor peak was noted in August then steadily declined to a low level in rest of the study period. *Cotylophoron ovatum* was entirely absent during the first six months of the study period. In sheep the incidence then rose rapidly to a peak in July after which it declined to a low level with minor fluctuations in rest of the study period. In goats its incidence was low, erratic and

did not show any seasonal pattern. Numerically *C. catylophorum* dominated the *C. ovatum* during this study.

B-CESTODES

INCIDENCE:- The overall incidence of cestodes infection was recorded to be 40.19% in sheep and 39.65% in goats (Table 1 and 2).

Moniezia expansa was found to be the most prevalent cestodes of sheep and goats followed by *Avitellina centripunctata*. The percentage of infection with *Moniezia expansa* was found to be 28.29% in sheep and 30.61% in goats. In case of *Moniezia benedeni* the incidence was noted to be 11.25% in sheep and 8.74% in goats while the infection with *Avitellina centripunctata* was recorded to be 32.79% and 29.15% in sheep and goats respectively. *Stilesia vittata* was recovered in a very small numbers during the present investigation and the incidence was noted to be 3.21% in sheep and 1.16% in goats.

SEASONAL VARIATIONS:- The seasonal distributions of cestodes in both sheep and goats are illustrated graphically

in Figs. 4 and 5.

In *Moniezia expansa*, from January to June, the incidence first declined and then rose gradually to a major peak in August in case of sheep. In goats the incidence of this parasite rose to a minor peak in April and then declined to a low level in June it then rose again to a major peak in August and from this period onwards the incidence declined gradually with some fluctuations. In case of *Moniezia benedeni* low infection was observed consistently with minor fluctuations in different months in sheep while in goats a similar trend was followed except in June when it was entirely absent. Numerically *Moniezia expansa* dominated the *M. benedeni* throughout the survey period. *Avitellina centripunctata* was a dominant species after *M. expansa* and was consistently present throughout the study period in sheep and goats where it almost followed a similar seasonal pattern. From January to March low infection was recorded after which the incidence rose steadily to a peak in July as in case of sheep and in July-August in case of goats.

Stilesia vittata occurred in both sheep and go[illegible] in

insignificant numbers intermittently throughout the study period. In sheep the incidence rose sharply in the month of September while in goats low infection rate was noted in March and September. In both the hosts it was entirely absent for rest of the observation period.

C- NEMATODES

INCIDENCE:- The overall prevalence of nematodes infection was recorded to be 72.34% in sheep and 70.84% in goats (Table 3 and 4).

It was observed that *Haemonchus contortus, Ostertagia ostertagi, Trichostronylus axei, Trichostrongylus colubriformis* and *Oesophagostomum columbianum* were the major nematodes, while *Trichuris* spp. *Bunostomum trigonocephalum, Ostertagia circumcincta* and *Skrjabinema ovis* were the minor nematodes recorded during the present investigation.

Haemonchus contortus was by far the predominant parasite of both sheep and goats encountered during this investigation. The percentage of infection was noted to be 67.84% in sheep and 61.22% in goats. *Oesophagostomum*

columbianum was the second in predominance in both sheep and goats and was recorded throughout the study period. In sheep and goats the incidence was recorded to be 63.02% and 59.76% respectively. *Ostertagia ostertagi* was recovered in fairly large numbers in the present investigation. The incidence was found to be 50.01% and 50.14% in sheep and goats respectively. No mixed infection was recorded with *O. circumcincta*. *Trichostrongylus axei* was mainly abomasal parasite. The incidence was recorded to be 51.44% in sheep and 55.39% in goats. *Trichostrongylus colubriformis* was the most prevalent parasite of small intestine found in the present investigation. The incidence was noted to be 33.76% in sheep and 27.69% in goats. *Ostertagia circumcincta* percentage of infection was recorded to be 5.46% in sheep and 7.58% in goats. Three species of *Trichuris* were recorded during this study period. Of which all the three species *Trichuris ovis, Trichuris globulosa* and *Trichuris lani* were found in sheep while two species *T. ovis* and *T. globulosa* were recovered from goats. The percentage of infection with *T. ovis* was recorded to be 34.08% in sheep and 22.74% in goats, while that of *T. globulosa* the incidence was noted to be 2.57% and 6.41% in sheep and goats respectively. The

incidence of *T. lani* was recorded to be 0.96% in sheep. No mixed infection among these species were recorded throughout the study period. *Bunostomum trigonocephalum* and *Skrjabinema ovis* were the parasites of small and large intestine respectively and were recoverded from goats only. *Bunostomum trigonocephalum* and *Skrjabinema ovis* were recovered irregularly and did not show any seasonal pattern. The percentage of infection was recorded to be 2.04% and 1.45% respectively.

SEASONAL VARIATIONS:- The seasonal distributions of nematodes are illustrated graphically in Figs. 6 and 7 regarding sheep and goats respectively.

The incidence of *Haemonchus contortus* in goats rose to a minor peak in May, then fell to a low level in June. It then rose again in July to a major peak in August-September after which it showed decline in the pr eceding months, while in case of sheep the incidence rose progressively from January to a major peak in September after which it was declined to a low level in the remaining period of observation.

The incidence of *Oesophagostomum* spp. was recorded throughout the year with minor fluctuations in different months in both sheep and goats. In sheep a major peak was recorded in March and then from June to September a minor depression in the incidence was noted, it then rose again to a minor peak in November while in goats moderate infection was observed throughout the study period. The incidence rose rapidly to a peak in May, after which it declined in the preceding months with some fluctuations. In both sheep and goats *Ostertagia* species showed a simil ar seasonal pattern. The incidence of infection inclined steadily to a major peak in August and then fell progressively to a low level in December in both the cases. Numerically *O. ostertagi* dominated the *O. circumcincta* during this investigation. No mixed infection among these two species were recorded during this study period.

Trichostrongylus spp. were recovered fairly in large numbers in both sheep and goats with almost similar seasonal pattern from January to July which then rose gradually to a peak in August and then declined progressively to a low level

in the preceding months. Numerically *T. axei* dominated the *T. colubriformis* throughout the year. The mixed infection with these two species was observed during the study period.

In sheep a downward trend in the case of *Trichuris* spp. was observed from January to March and from April to October relatively small numbers of these species were recovered. After which the incidence inclined rapidly to a major peak in November. In case of goats where from January to April a moderate infection was recorded which then showed a minor depression from May to July and then inclined to a peak in August-September. The incidence declined to a low level in the remaining period of the investigation.

IMMATURE AND ADULT WORM COUNTS:- The incidence of immature worms in both sheep and goats are illustrated in Fig. 8. In the majority of necropsies immature worm of the species *Trichostrongylus axei* and *Haemonchus contortus* were recorded under the mucosa of abomasum. A moderate number of *T. axei* immature worm were recovered from January to August with minor downward fluctuations which then incline to a major peak in October after which it fell to a low level in

the preceding months. Immature worm of *Haemonchus contorus* were not recorded during the first six months of the survey period. The incidence rose progressively from June with minor fluctuations to a peak in October after which the incidence fell to low level in the remaining period of investigation. Significant numbers of adult *T. axei* worms were also recovered during the artificial digestion of the abomasal wall. It was also observed during February-March that above 40% of the large intestines of both sheep and goats has nodules on their surfaces.

EGG PER GRAM (e.p.g):- The seasonal pattern of the prevalences and the egg output is presented in table 6.

The highest prevalence and the highest overall mean EPG counts were recorded in October in both sheep and goats. The mean EPG counts during the first six months was low. It then rose gradually from July to a peak in October. It was also observed that EPG counts was higher during rainy summer season (July-September) in both the hosts. The overall mean EPG during January to June was found to be 366, while the overall EPG in rainy season was recorded to be 2316 in case

of sheep, while in goats the overall mean EPG from January to June was 316 while in rainy season it was recorded to be 1933. The eggs of *Trichuris* spp. and *Moniezia* spp. were also observed and separately counted.

A COMPARISON BETWEEN AVERAGE EGG COUNTS AND AVERAGE WORM BURDENS:- The results of comparison betwen average egg counts and average worm burdens are illustrated graphically in Figs. 9 and 10 in sheep and goats respectively. In sheep a close relationship was observed between the average egg counts and the average strongyle worm burdens. It was found that the worm burdens rose progressively from January to a peak in September which also caused a corresponding increase in egg counts. The worm burdens during this period was contributed by *Oesophagostomum* spp., *Ostertagia* spp., *Trichostrongylus* spp. and *Haemonchus contortus*. From July to October the worm burdens were mainly due to highest prevalence of *Haemonchus contortus* resulting increase in the egg out put.

In case of goat fairly close relationship was observed between the average egg counts and the average worm burdens. The average worm counts rose gradually from January to May

which then fell to a low level in June. The worm counts rose again in September to a major peak in October while, in case of egg counts similar increase with a major peak in October was recorded. The overall mean worm burdens were low in goats as compared to sheep. In goats the main worm burden contributor were the same as that were found in sheep.

HOST AGE-WISE DISTRIBUTION OF PARASITES:- Sheep and goats having two age groups and their percentage of infection with different helminth parasites is presented in tables 3 and 4.

Sheep examined during this survey period were divided into two age groups. One those having less than 2 years of age. and the other 2 to 3 years of age. It was found that the sheep having 2-3 years of age were more infected with trematodes infection as compared to sheep having less than 2 years of age. As far as cestodes and nematodes were concerned it was noted that the sheep having less than 2 years of age were highly infected while that of 2-3 years of age were relatively found less infected. Similarly goats were also divided into two categories according to their age: one

having the 1-2 years of age other having the more than 2 years of age.. It was also found that goats having more than 2 years of age were found more prone to trematodes infection as compared to other one. Similarly the goats having 1-2 years of age were found highly infected with cestodes and nematodes infection as compared to goat having more than 2 years of age.

SEX-WISE DISTRIBUTION OF PARASITES:- A total of 343 goats were examined during this investigation. Out of which 189 were female while rest of 154 were male. It was observed that the percentage rate of infection in female and male goats was 89.94% and 78.57% respectively. It was therefore, observed that females goats had more infection of helminths than the males. In case of sheep 87% sheep were ewes while rest were males. Therefore, no such relationship was worked out in sheep.

BREED-WISE DISTRIBUTION OF PARASITES:- Six breeds of sheep: Lohi, Latti, Thalli, Kajli, Balkhi, Kaghani and four breed of goats Desi (Jattal), Teddy, Kaghani and Barbari were included during this study period. It was observed that

Kaghani breed of both sheep and goats were found to be highly infected with different helminth parasites. A marked feature was observed that the only three Kaghani sheep were examined and all of them found positive for parasitic infection. Slight increase in incidence rate was also observed in Balkhi sheep.No significant breed differences was noted in the rest of breeds of sheep and goats (Figs. 17 and 18).

AREA-WISE DISTRIBUTION OF PARASITES:- The incidence of helminthic infection was found to be highest in Swat region, where 96.42% sheep and goats were infected with different helminth species. During the whole study period only three sheep belong to Swat region were examined and all of them were found positive. This was followed by Rawalpindi-Islamabad where 93.6% sheep and goats were positive for helminthic infection. Other levels of infection were in the following order: Gujrat, 93.02%; Jhelum, 91.86%; Attock, 91.56%; Sargodha, 90.62%; Chakwal, 88%; Khushab, 85.56% (Table 5).

In the case of trematodes *Paramphistomum cervi*, *Gastrothylax crumenifer*, *Cotylophoron cotylophorum* and

Cotylophoron ovatum were the most prevalent in the Sargodha, Khushab and Gujrat districts in both sheep and goats. Low level of infection with these parasites were recorded in Jhelum, Attock and Rawalpindi-Islamabad districts. While no trematodes infection were noted in Chakwal and Swat regions. The goats from Jhelum districts did not show any trematodes infection (Figs. 11 and 12). The infection with different genera of cestodes were also varied in different districts. *Moniezia expansa* was the most prevalent cestodes of sheep and goats in Sargodha, Attock and Jhelum which was followed by *Avitellina centripunctata* while moderate infection was recorded in the rest of the districts. The sheep from Jhelum, Chakwal and Swat were found highly infected with *Avitellina centripunctata* while moderate infected with this parasite was noted in rest of the districts surveyed.

Low infection of *Stilesia vitatta* was recorded from goats brought from Khushab and Attock districts. Sheep of Khushab district were found positive for this parasite. While it was absent from rest of the area under study (Figs. 13 and 14).

As far as nematodes were concerned *Haemonchus contortus* was the most prevalent nematode in all districts under surveyed in both sheep and goats except in Swat region where lowest infection was recorded (Figs. 15 and 16). Infection with *Oesophagostumum* spp. was also very high in both sheep and goats in Attock, Jhelum and Chakwal districts, while fairly large numbers of animal were found positive in Sargodha, Rawalpindi-Islamabad, Attock and Khushab districts. Very low infection of this parasite was noted in Swat region. *Ostertagia* spp. were the most prevalent nematode in sheep and goats of Swat region. While fairly large numbers of animals were found infected with this parasite in rest of the districts under study except Chakwal where small numbers of goats were found positive. *Trichostrongylus* spp. were also the most prevalent in sheep and goats of Swat region, this was followed by Rawalpindi-Islamabad and rest of the districts under survey except Chakwal where low level of infection was found in both sheep and goats. *Trichuris* spp. were present in fairly large numbers in both sheep and goats of Rawalpindi-Islamabad, Sargodha, Khushab, Gujrat, and Attock district, while relatively low infection was noted in rest of the districts under investigation. *Skrjabinema ovis*

and *Bunostomum trigonocephalum* were recovered from the goats of Attock district only.

Table 1 : Species, prevalence and range of gastrointestinal helminths found in 311 sheep slaughtered at Rawalpindi-Islamabad abattoirs

Class	Organ	Species	Prevalence (%)	Range	Mean worm burdens
I. TREMATODES	Rumen & Reticulum	Paramphistomum cervi	14.14	1 - 115	31
		Gastrothylax crumenifer	12.86	6 - 130	27
		Cotylophoron cotylophorum	18.00	1 - 75	15
		Cotylophorm ovatum	5.78	2 - 24	9
II. CESTODES	Small intestine	Moniezia expansa	28.29	1 - 11	4
		Moniezia benedeni	11.25	1 - 10	4
		Avitellina centripunctata	32.79	1 - 25	7
		Stilesia vitatta	3.21	2 - 14	8
III. NEMATODES	Abomasum	Haemonchus contortus	67.84	1 - 1360	263
		Ostertagia ostertagi	50.01	1 - 765	146
		Ostertagia circumcincta	5.46	3 - 34	14
		Trichostrongylus axei	51.44	5 - 779	141
	Small intestine	Trichostrongylus colubriformis	33.76	1 - 319	53
	Large intestine	Oesophagostomum columbianum	63.02	1 - 239	29
		Oesophagostomum venulosum	9.96	1 - 24	11
		Trichuris ovis	34.08	2 - 102	21
		Trichuris lani	0.96	4 - 11	11
		Trichuris globulosa	2.57	5 - 23	13

Table : 2 Species, prevalence and range of gastrointestinal helminths found in 343 goats slaughtered at Rawalpindi-Islamabad abattoirs.

Class	Organ	Species	Prevalence (%)	Range	Mean worm burdens
I. TREMATODES	Rumen & Reticulum	Paramphistomum cervi	14.57	2 - 56	12
		Gastrothylax crumenifer	8.74	2 - 37	14
		Cotylophoron cotylophorum	12.53	1 - 48	11
		Cotylophoron ovatum	1.16	1 - 3	2
II. CESTODES	Small intestine	Moniezia expansa	30.61	1 - 13	4
		Moniezia benedeni	8.74	1 - 10	5
		Avitellina centripunctata	29.15	1 - 44	6
		Stilesia vitatta	2.62	2 - 13	7
III. NEMATODES	Abomasum	Haemonchus contortus	61.22	1 - 739	101
		Ostertagia ostertagi	50.14	1 - 270	87
		Ostertagia circumcincta	7.58	2 - 89	20
		Trichostrongylus axei	55.39	1 - 301	43
	Small intestine	Trichostrongylus colubriformis	27.69	1 - 171	29
		Bunostomum trigonocephalum	2.04	1 - 6	2
	Large intestine	Oesophagostomum columbianum	59.76	1 - 287	44
		Oesophagostomum venulosum	4.08	2 - 12	10
		Trichuris ovis	22.74	3 - 161	39
		Trichuris globulosa	6.41	3 - 68	10
		Skrjabinema ovis	1.45	25 - 714	190

Table : 3 The helminthic infection found in 311 sheep of two different age groups

Helminths	No. of sheep examined less than 2 years of age = 151	No. of sheep examined of 2--3 years of age = 160	Overall helminthic infection
Percentage infection of trematodes.	29.83%	36.25%	30.54%
Percentage infection of cestodes.	52.41%	37.5%	40.19%
Percentage infection of nematodes.	89.51%	71.25%	72.34%

Table : 4 The helminthic infection found in 343 goats of two different age groups

Helminths	No. of goats examined of 1--2 years of age = 228	No. of goats examined more than 2 years of age = 115	Overall helminthic infection
Percentage infection of trematodes.	16.66%	43.47%	25.65%
Percentage infection of cestodes.	41.22%	35.65%	39.65%
Percentage infection of nematodes.	67.90%	67.82%	70.84%

Table : 5 Percentage of helminithic infection in sheep and goats in Swat and different districts of the Punjab

Name of city	Percentage of infection (%)
Rawalpindi/Islamabad	93.6
Khushab	85.56
Sargodha	90.62
Gujrat	93.02
Attock	91.56
Jhelum	91.86
Chakwal	88.00
Swat	96.42

Table : 6 Monthly Prevalence and EPG of gastrointestinal in sheep and goats

Months	SHEEP			GOATS		
	Strongyle			Strongyle		
	No. examined	EPG mean	EPG range	No. Examined	EPG mean	EPG range
January	20	500	150-550	20	250	150-350
February	23	200	100-350	25	100	50-200
March	25	150	50-300	31	150	100-250
April	24	350	200-500	24	400	200-550
May	28	350	250-450	30	300	250-600
June	28	650	350-600	22	700	650-800
July	27	1250	850-1350	29	1300	1050-1500
August	29	1750	950-2100	31	1250	950-1450
September	28	2100	1300-2700	30	1800	1500-2100
October	29	3100	1850-4100	33	2750	1900-3150
November	21	2650	1700-2950	37	1750	1450-2300
December	29	950	650-1250	31	800	400-1050

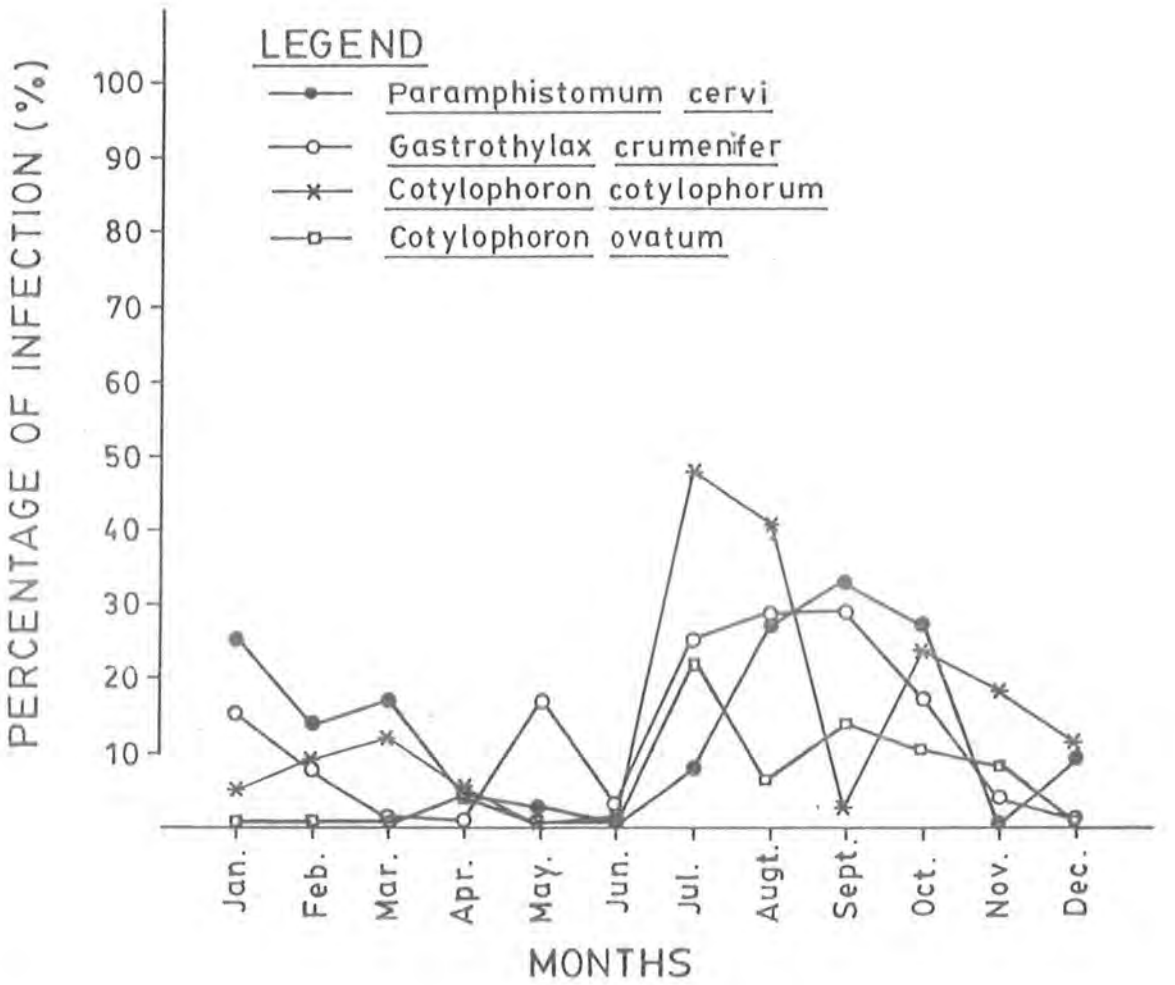


FIG.2: The seasonal variations of trematodes in sheep slaughtered at Rawalpindi-Islamabad abattoirs.

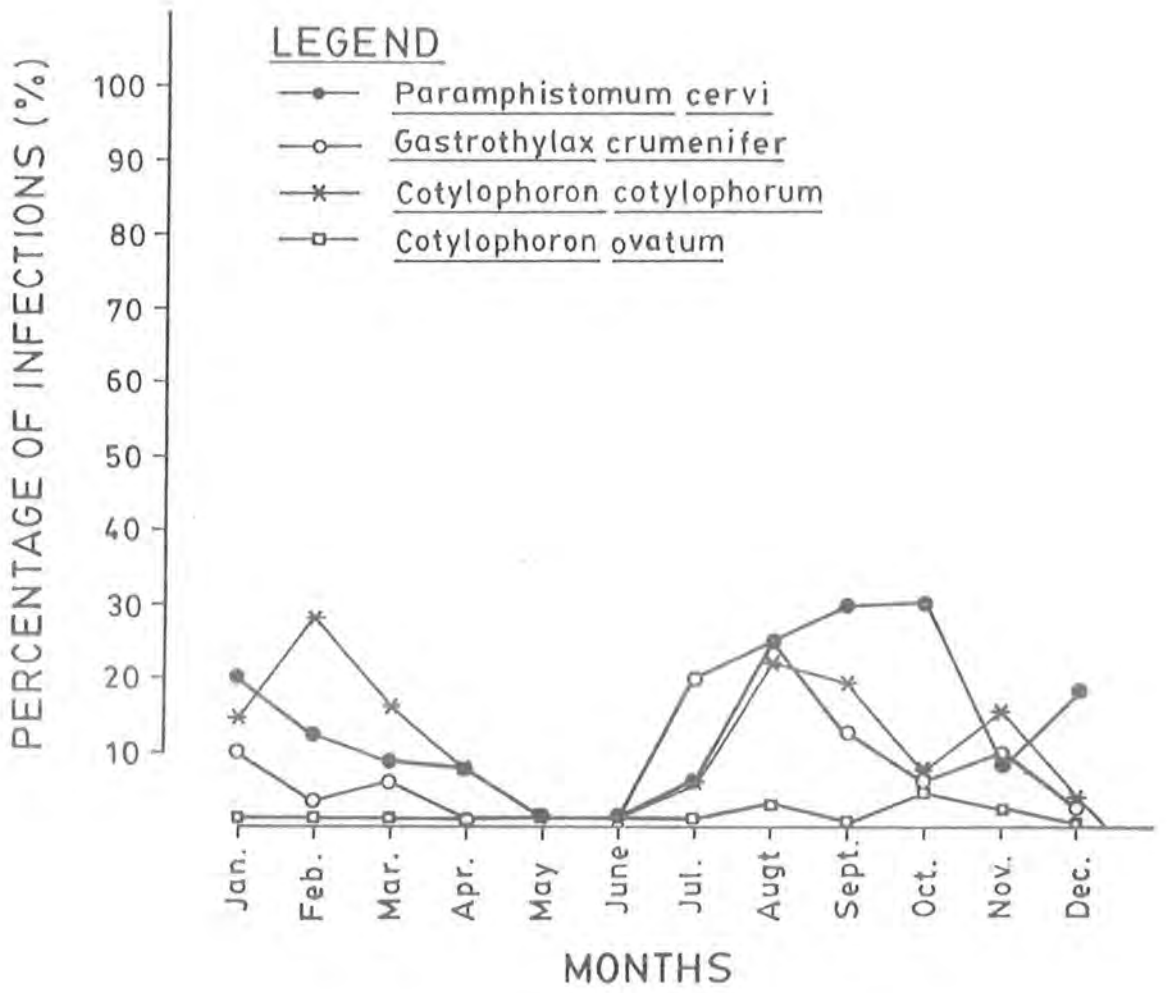


FIG. 3: The seasonal variations of trematodes in goats slaughtered at Rawalpindi-Islamabad abattoirs.

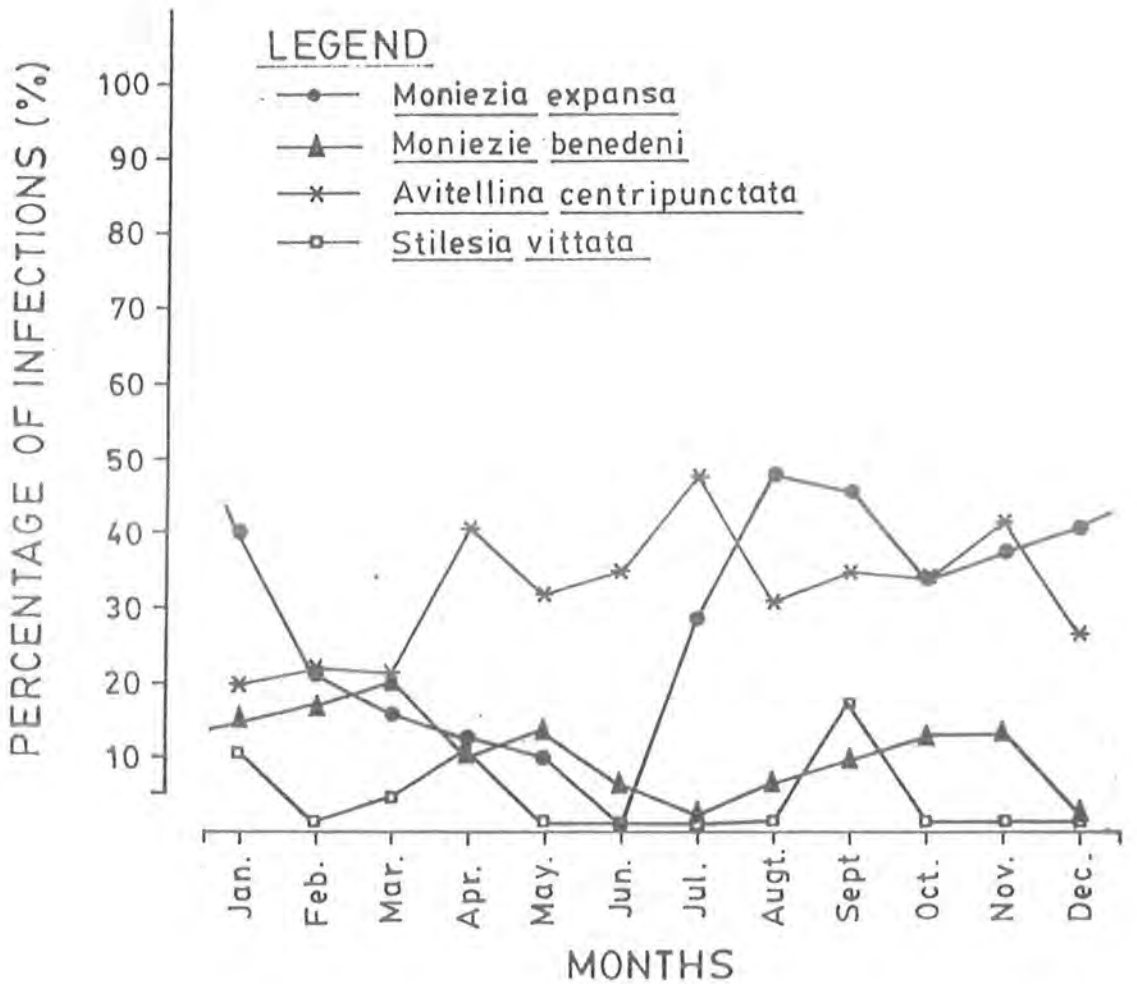


FIG. 4: The seasonal variations of cestodes in sheep slaughtered at Rawalpindi-Islamabad abattoirs.

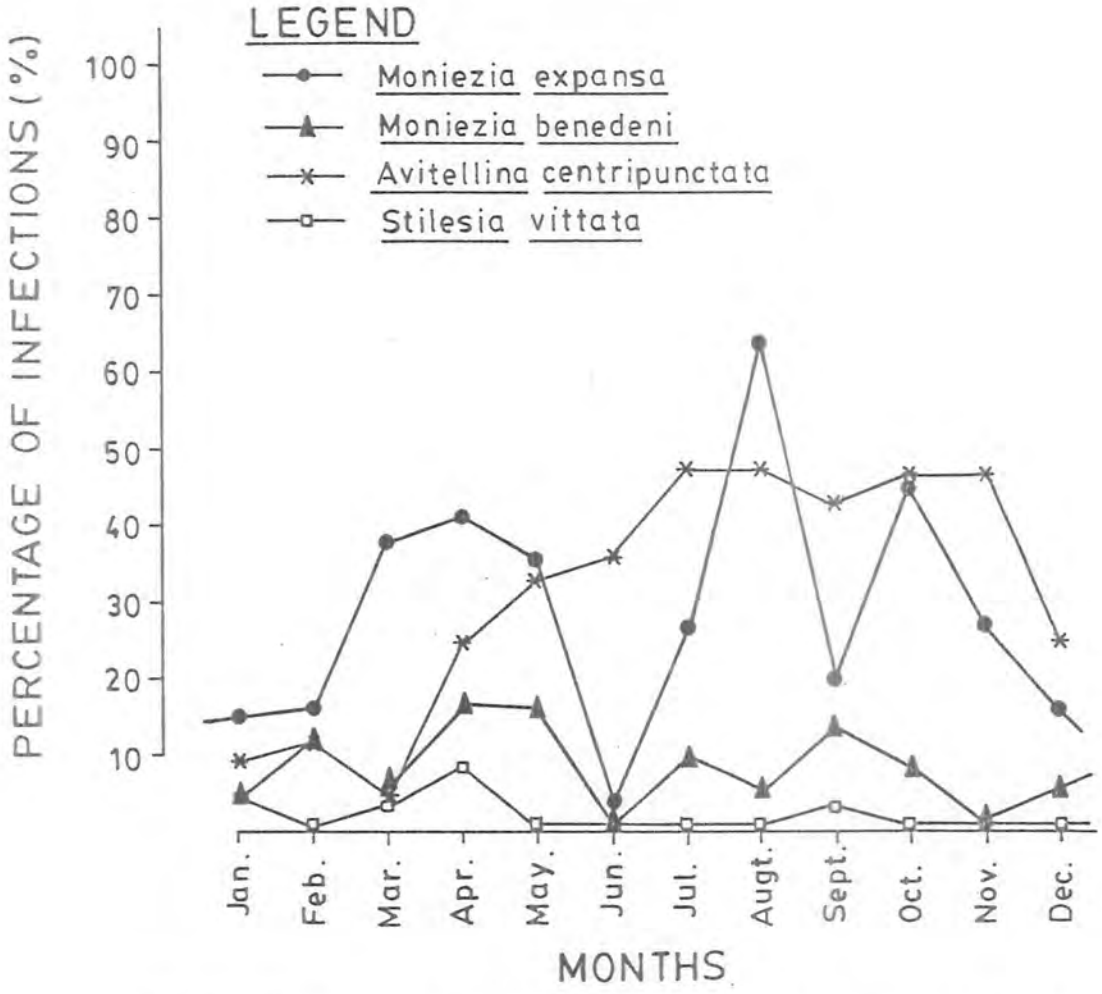


FIG.5 : The seasonal variations of cestodes in goats slaughtered at Rawalpindi-Islamabad abattoirs.

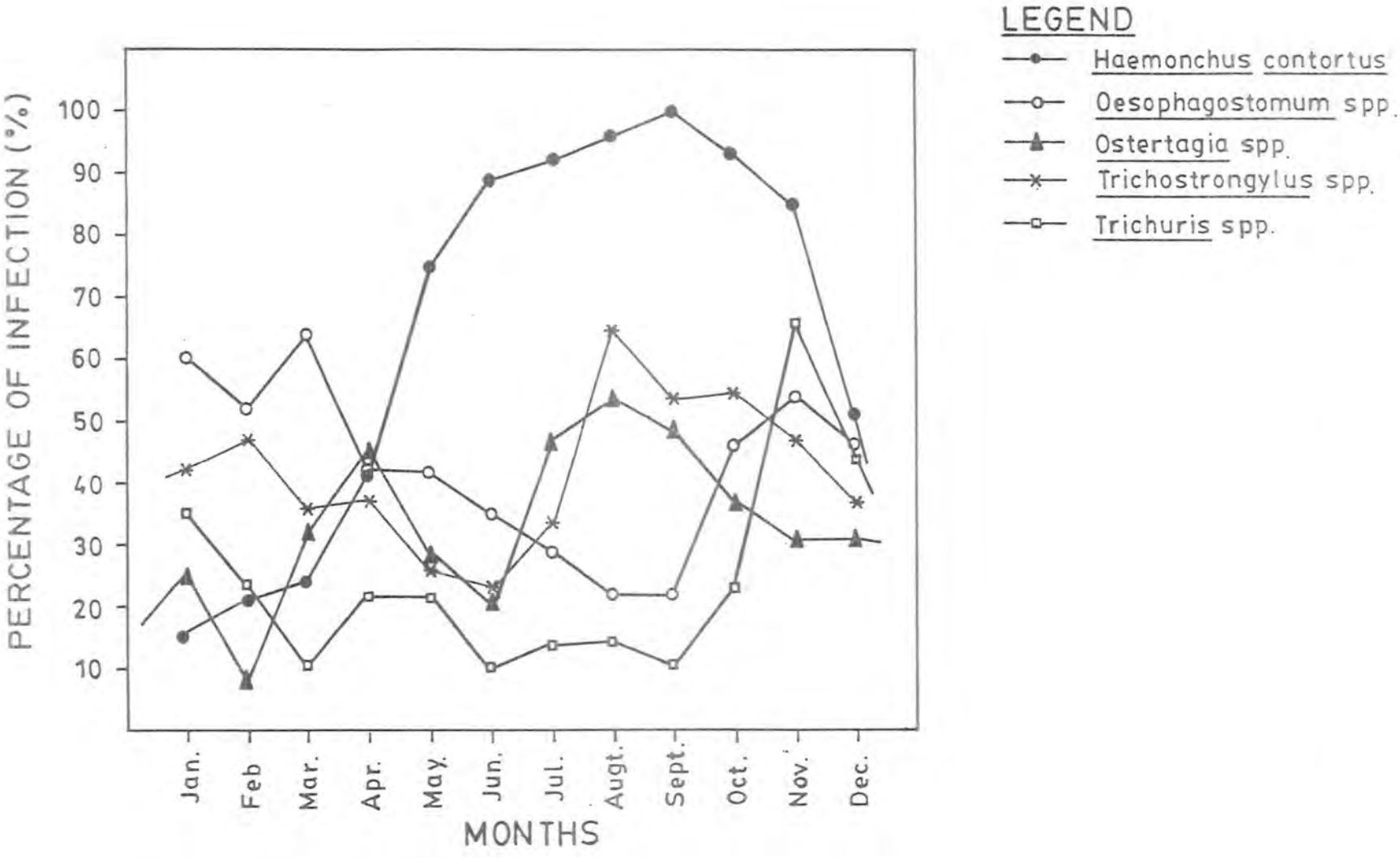


FIG.6 : The seasonal variations of nematodes in sheep slaughtered at Rawalpindi-Islamabad abattoirs.

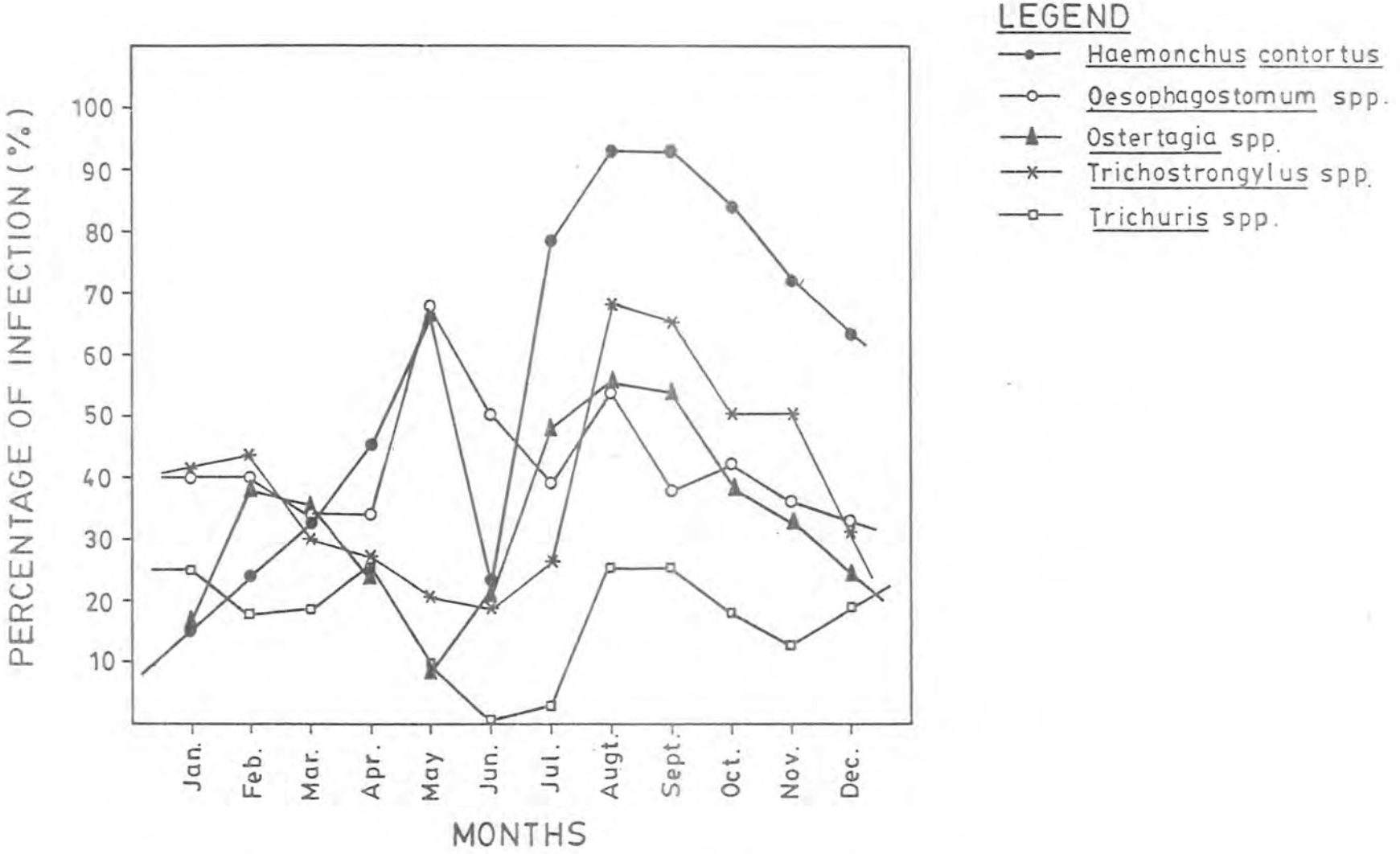


FIG.7 : The seasonal variations of nematodes in goats slaughtered at Rawalpindi-Islamabad abattoirs.

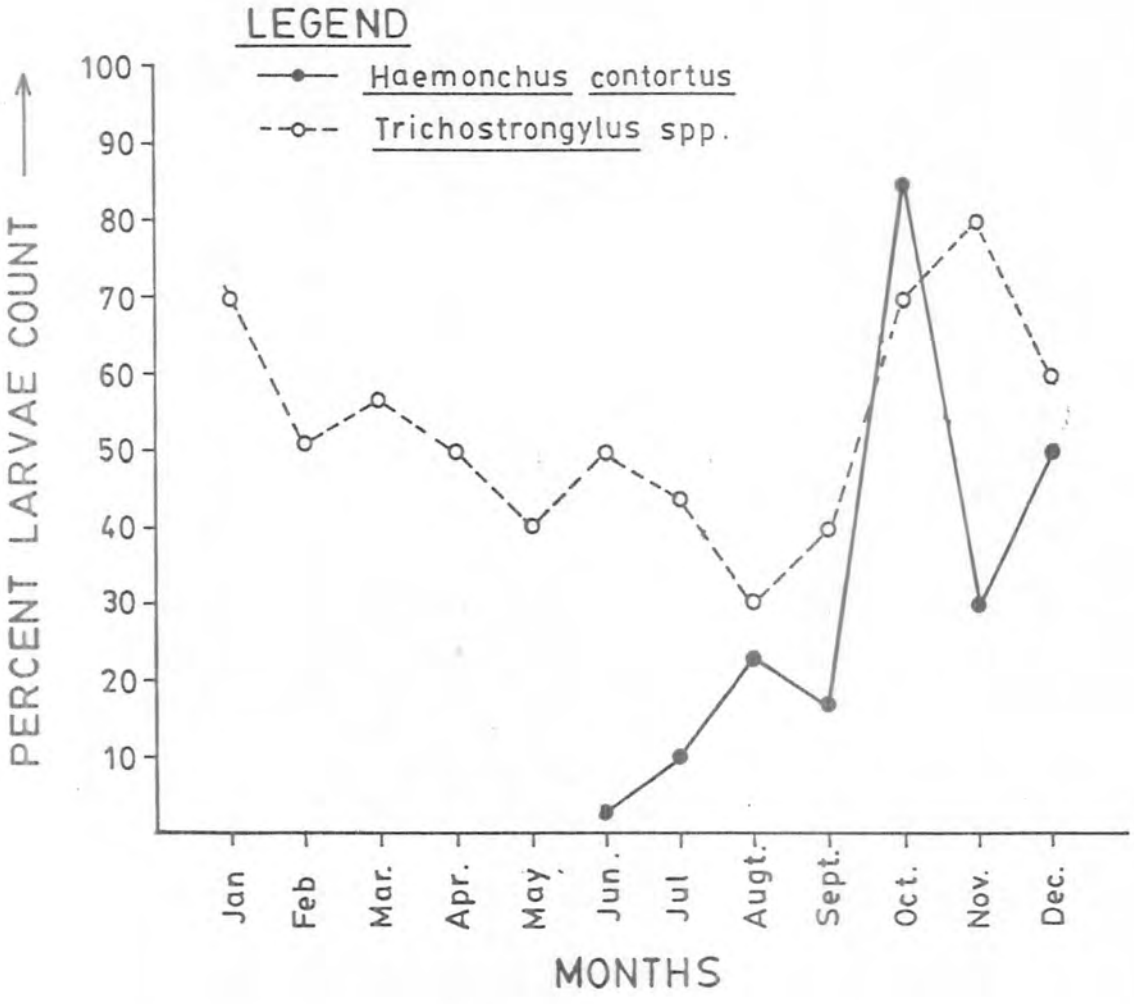


FIG.8 : Percent larvae counts of major nematodes of abomasum in sheep and goats slaughtered at Rawalpindi-Islamabad abattoirs.

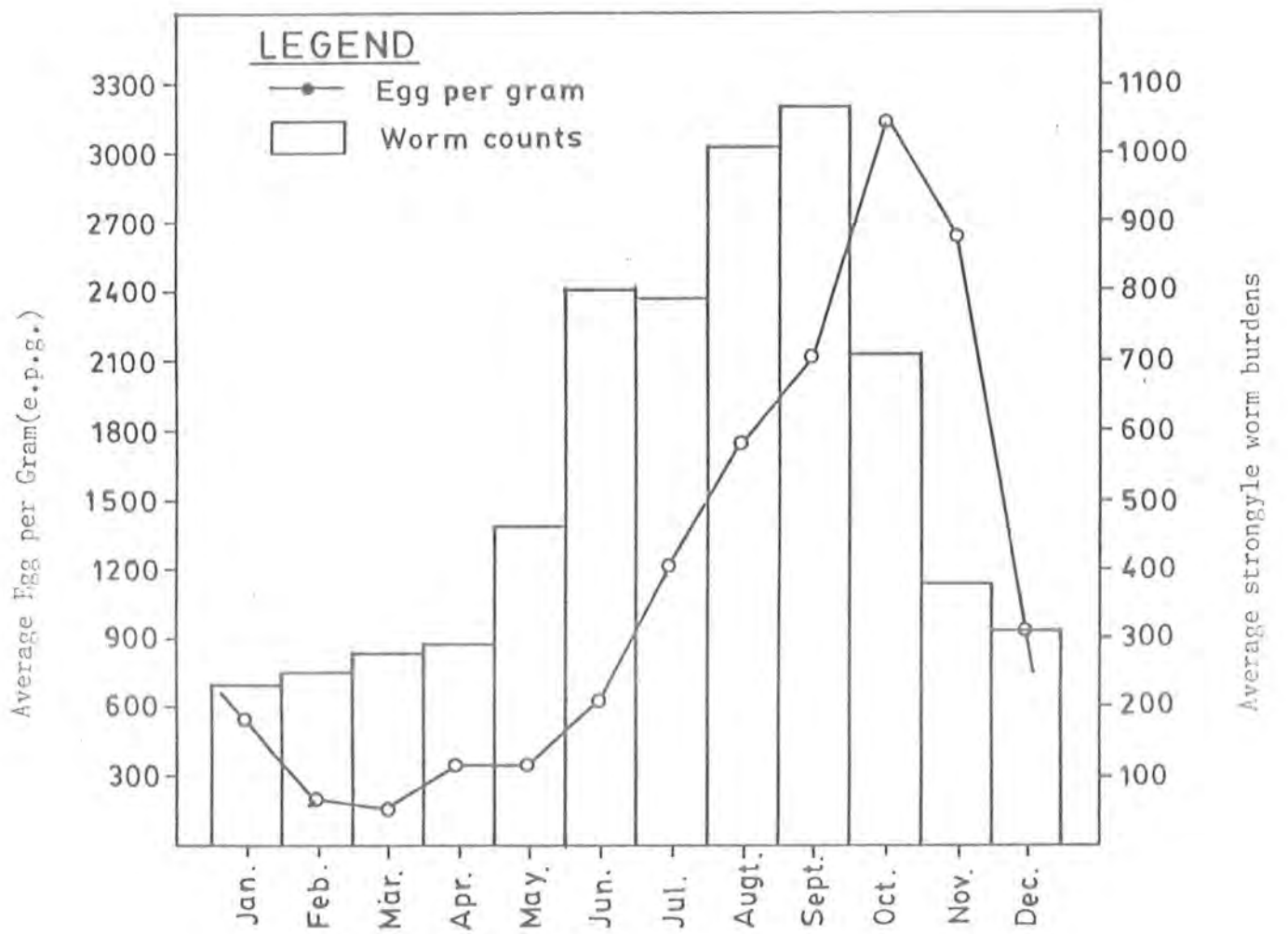


FIG.9 : The comparison between the average egg counts and the average strongyle worm burdens in sheep slaughtered at Rawalpindi-Islamabad abattoirs.

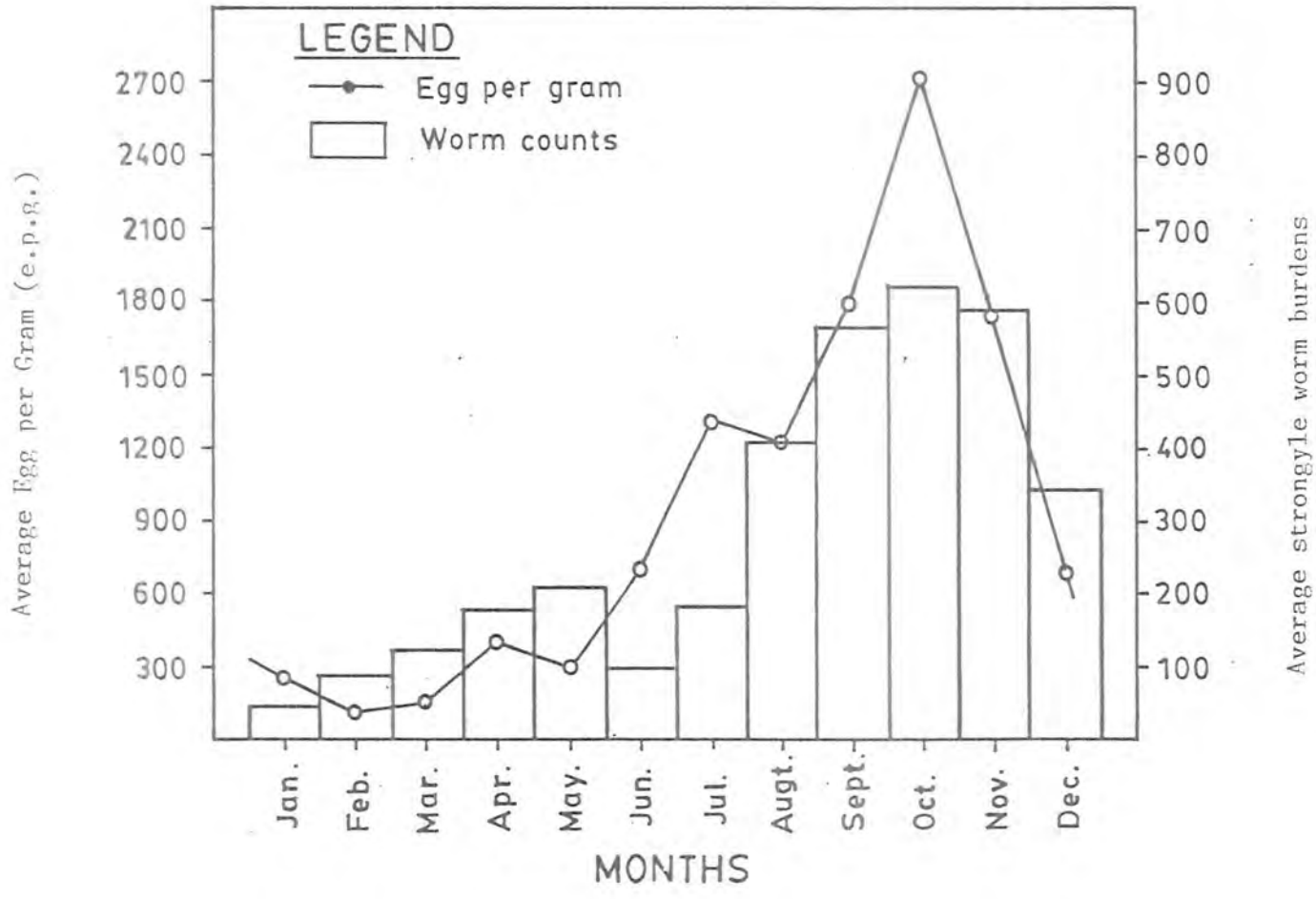


FIG. 10 : The comparison between the average egg counts and the average strongyle worm burdens in goats slaughtered at Rawalpindi-Islamabad abattoirs.

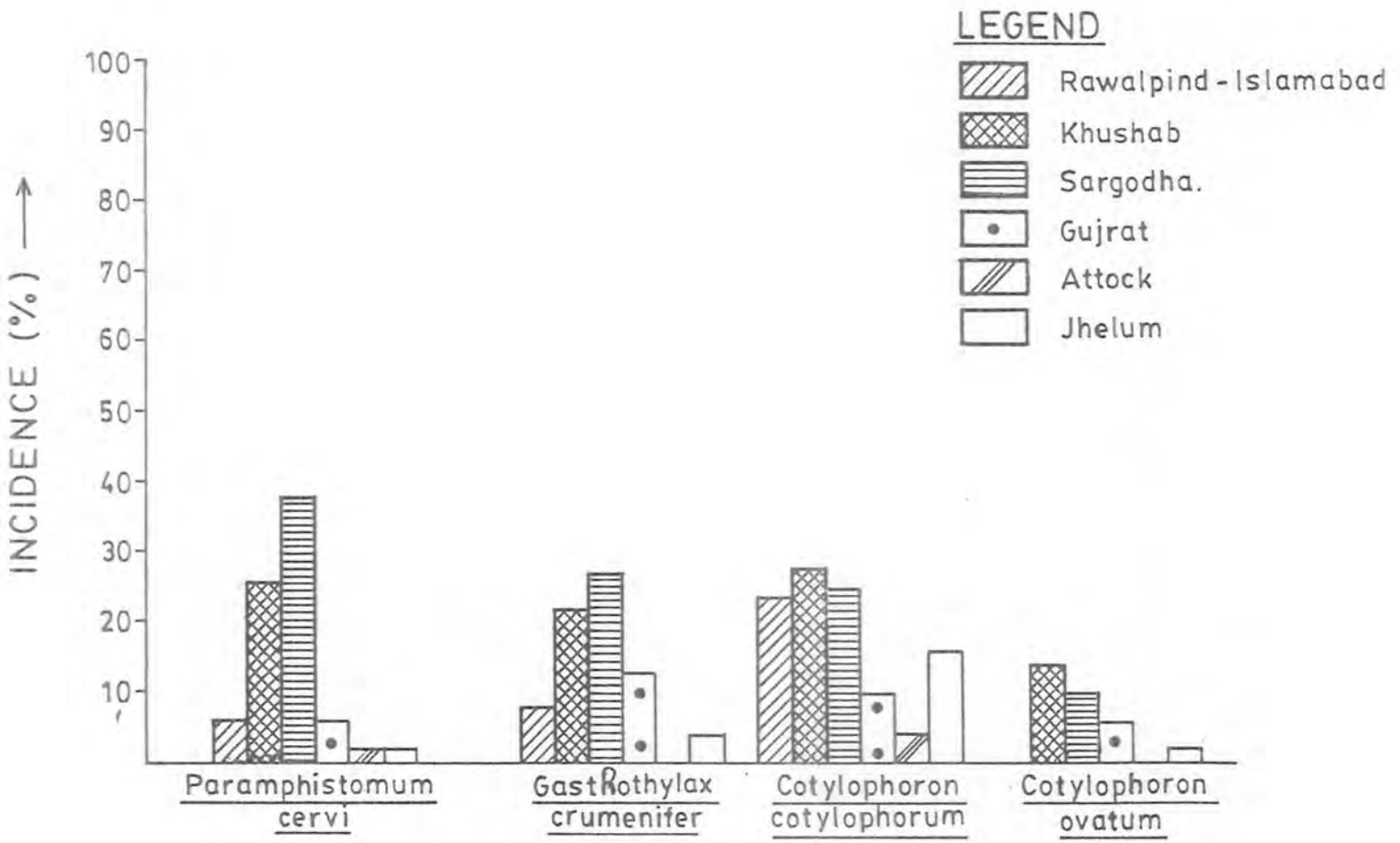


FIG.11 : The incidence of trematodes of sheep in Swat and different districts of the Punjab.

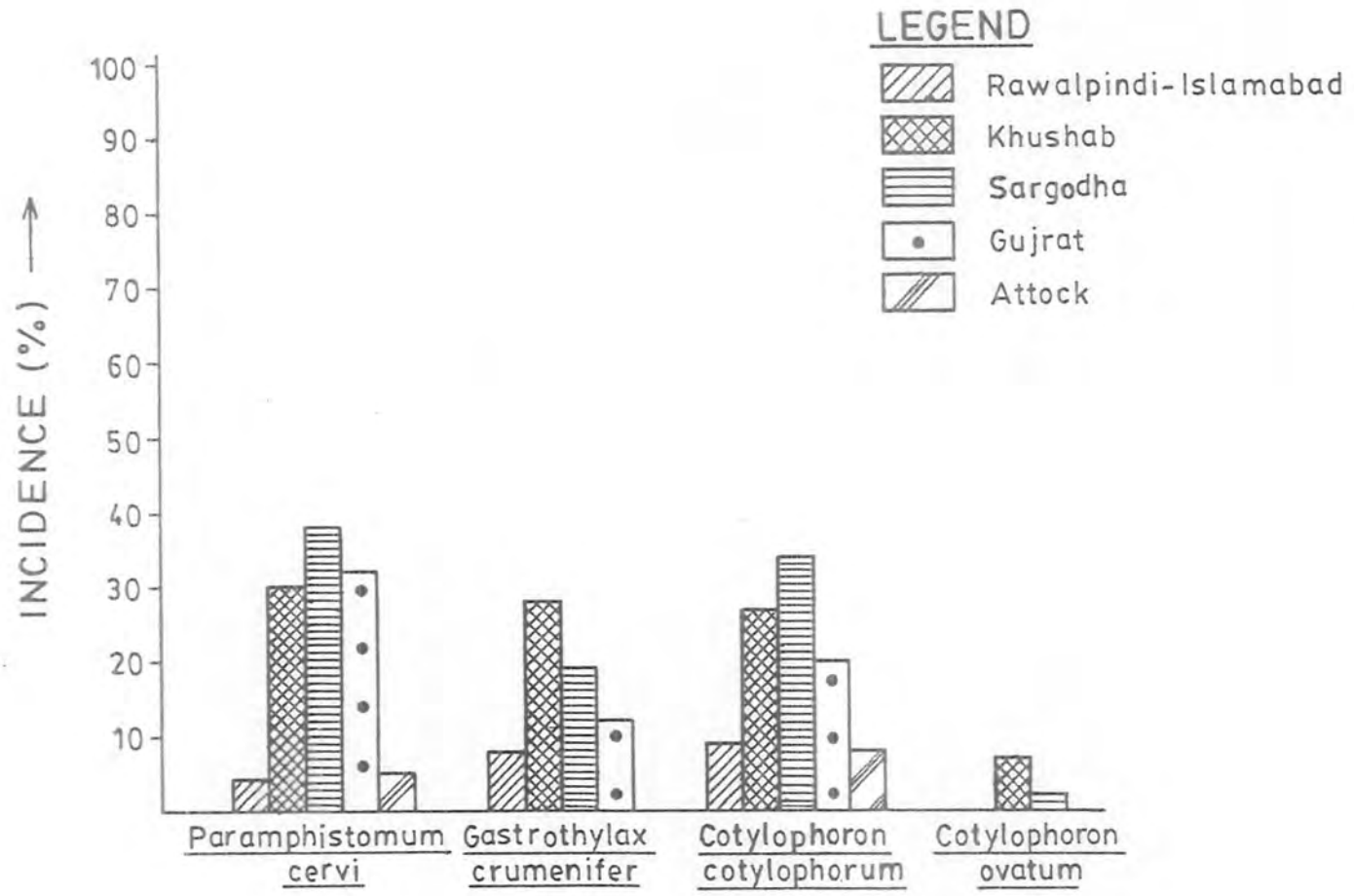


FIG.12 : The incidence of trematodes of goats in Swat and different districts of the Punjab.

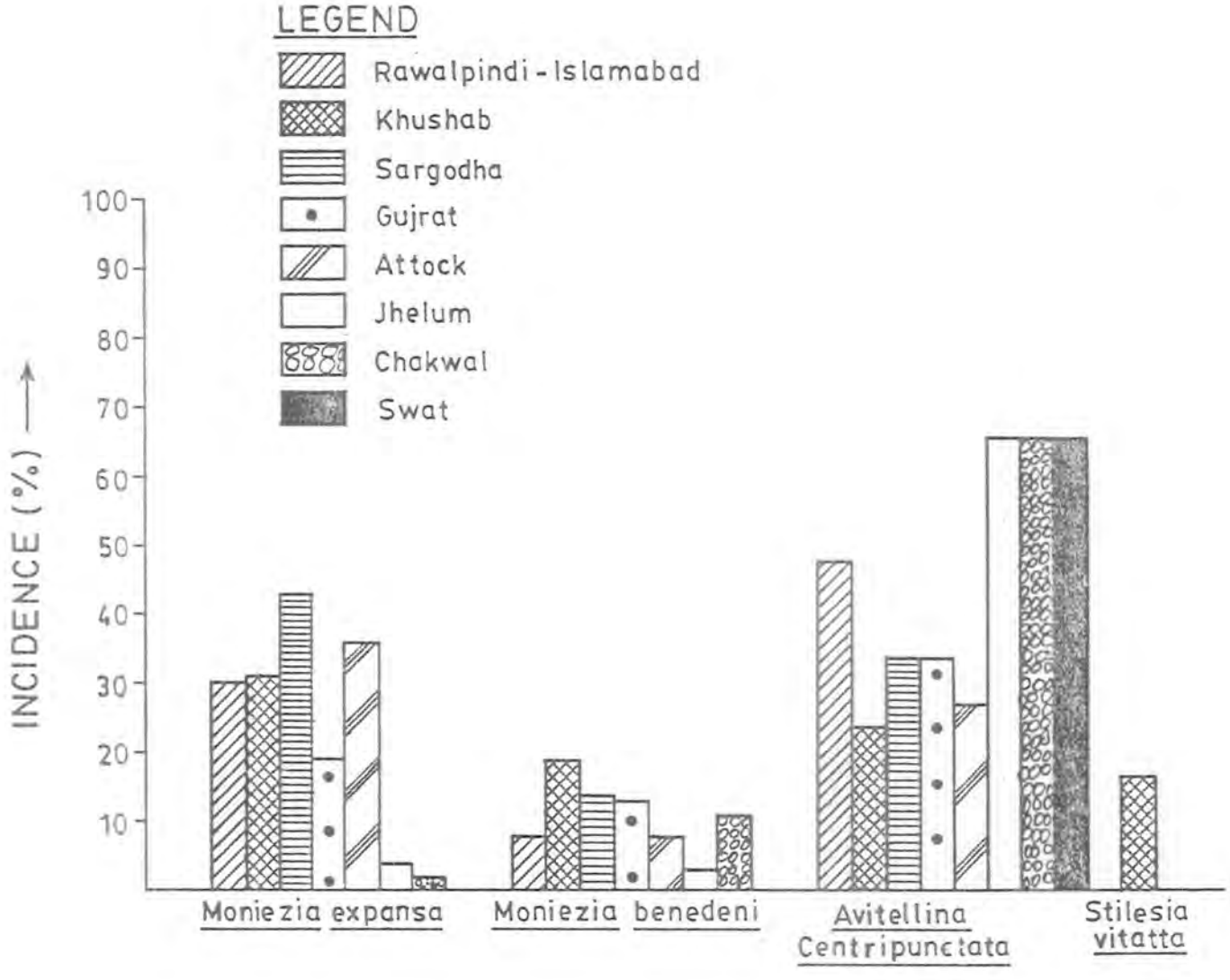


FIG.13 : The incidence of cestodes of sheep in Swat and different districts of the Punjab.

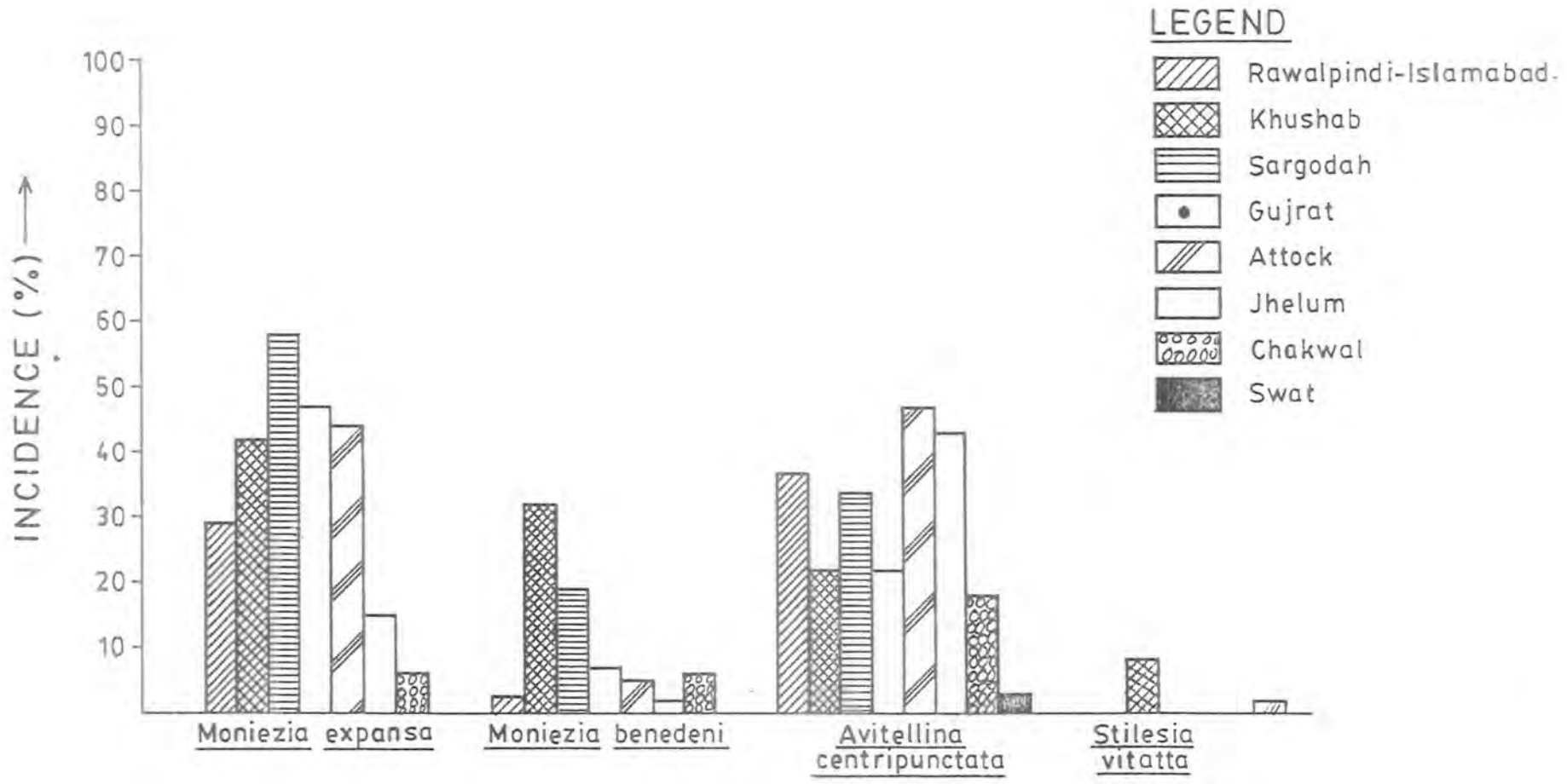


FIG.14 : The incidence of cestodes of goats in Swat and different districts of the Punjab.

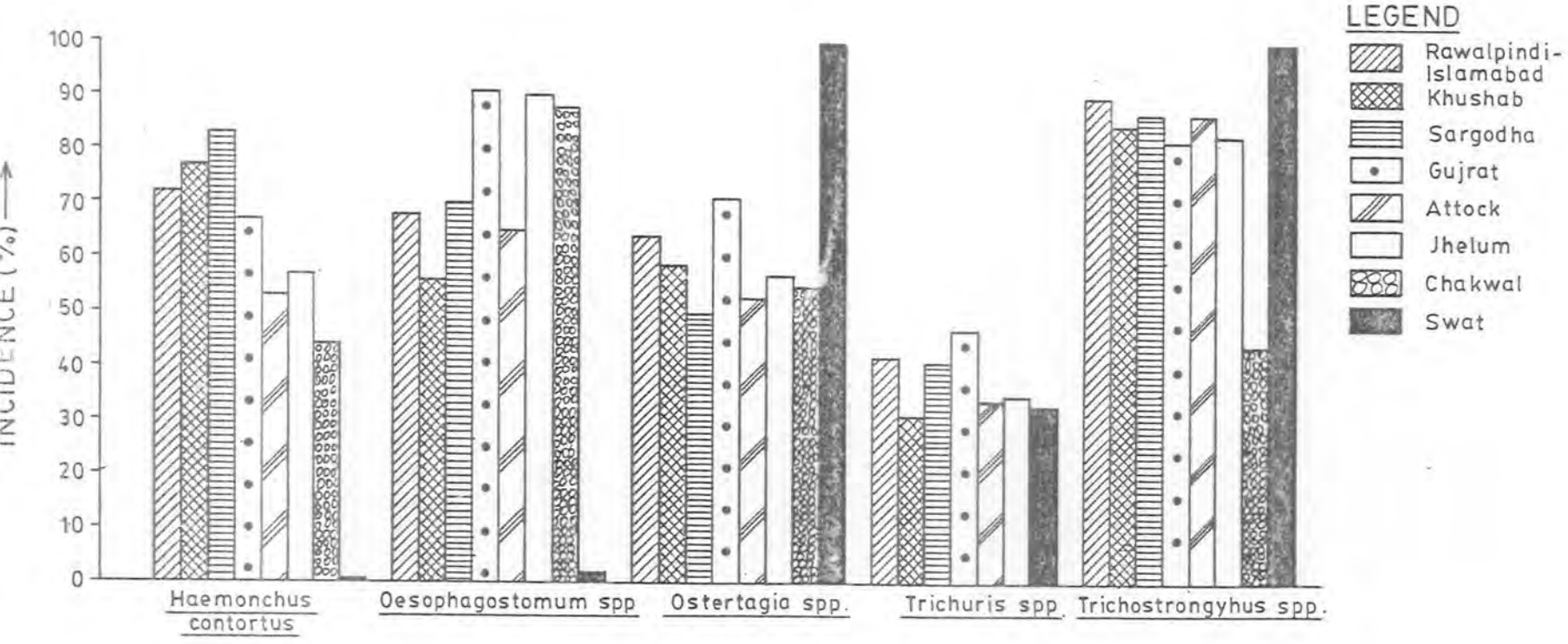


FIG.15 : The incidence of nematodes of sheep in Swat and different districts of the Punjab.

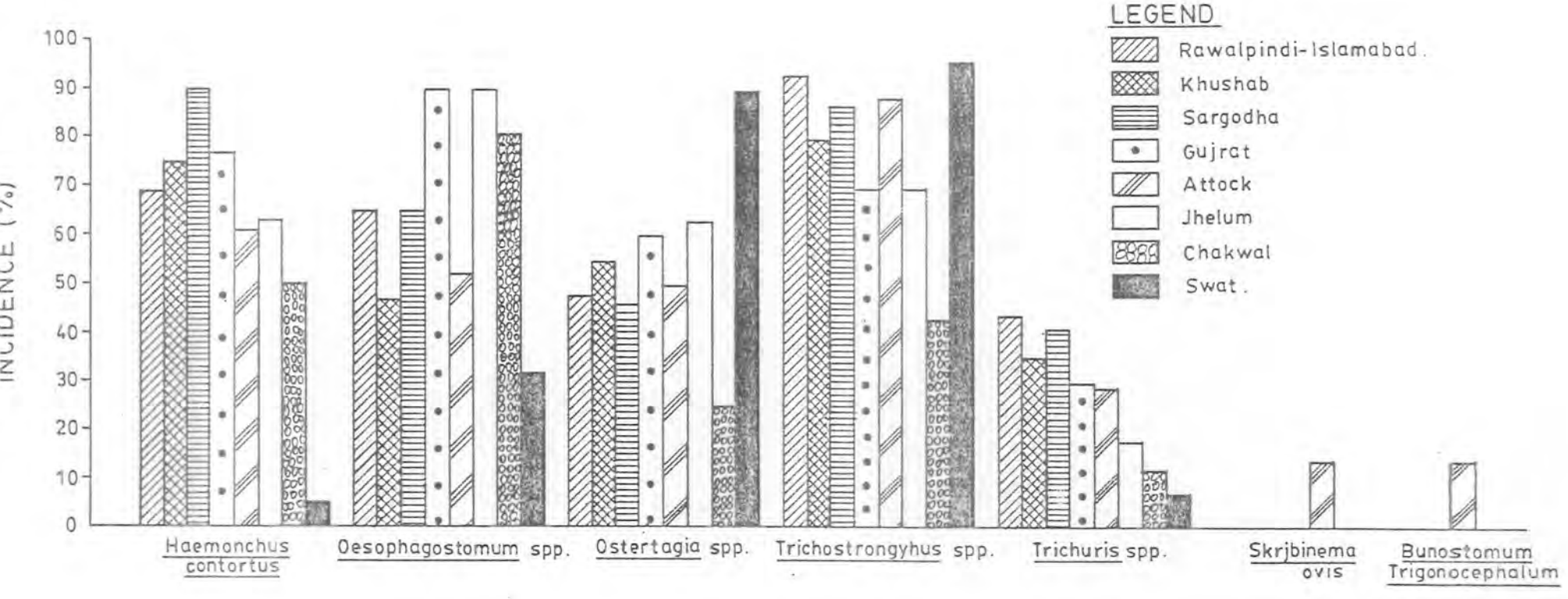


FIG.16 : The incidence of nematodes of goats in Swat and different districts of the punjab.

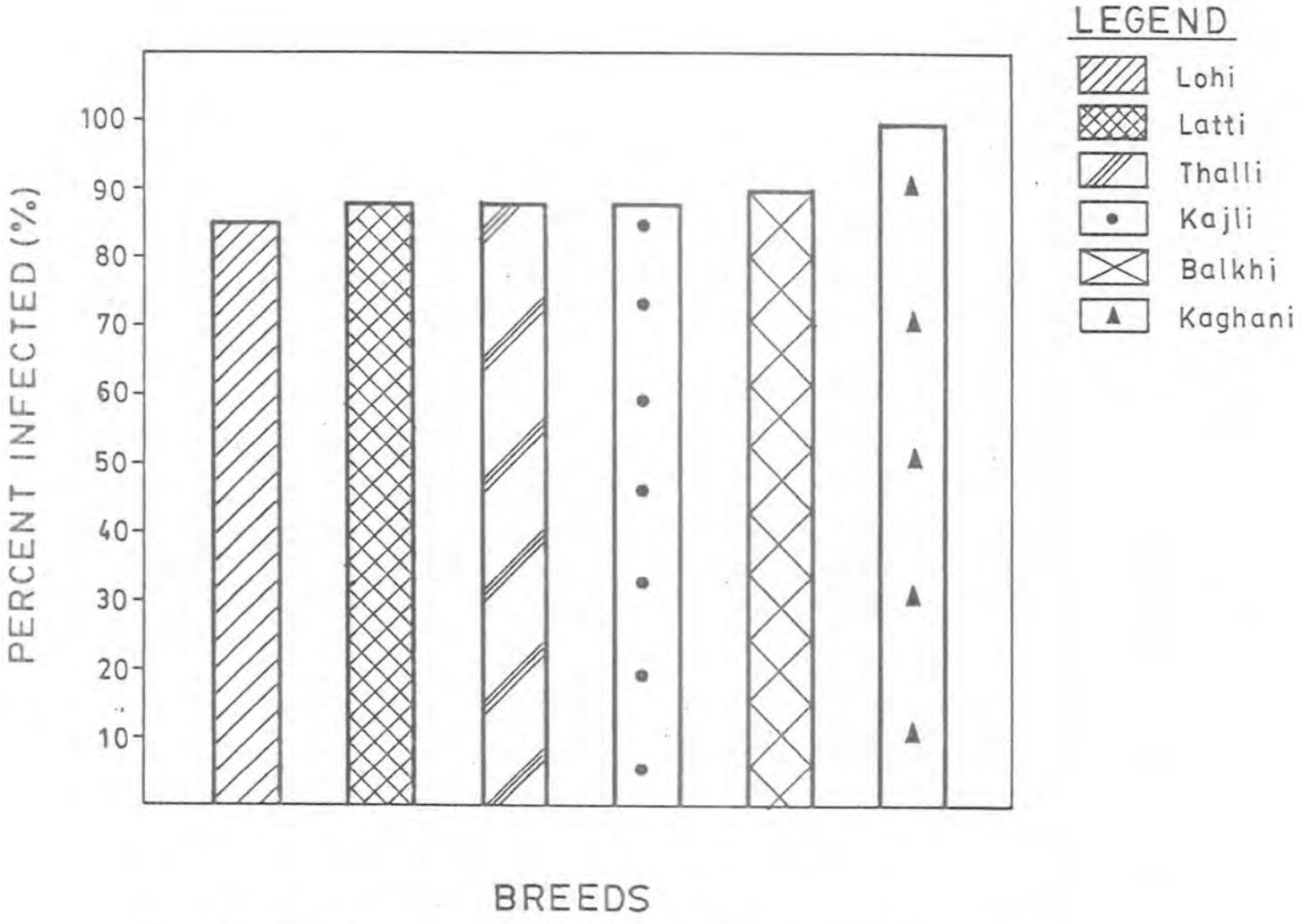


FIG.17 : Breed variations in the incidence of helminth parasites of sheep slaughtered at Rawalpindi-Islamabad abattoirs.

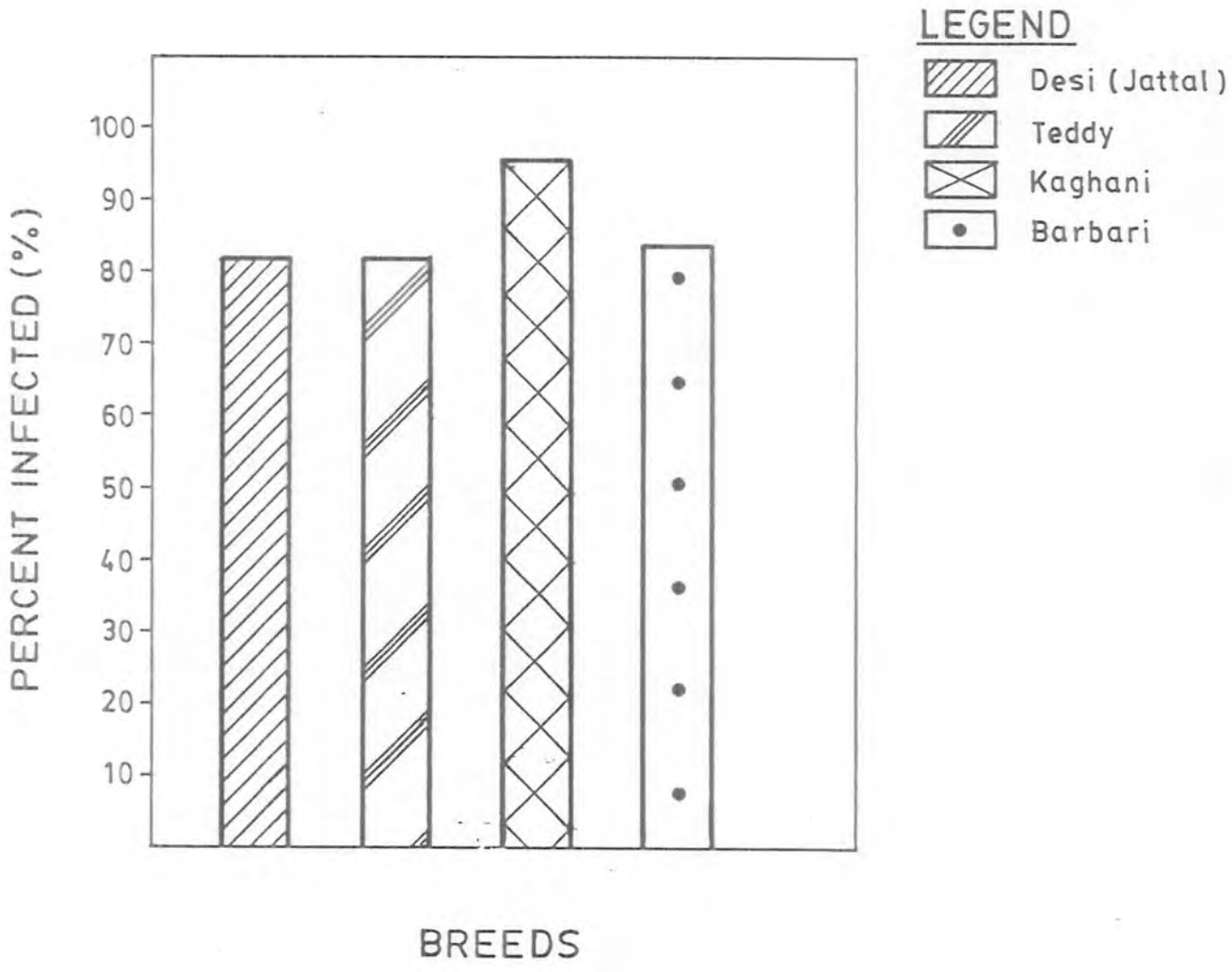
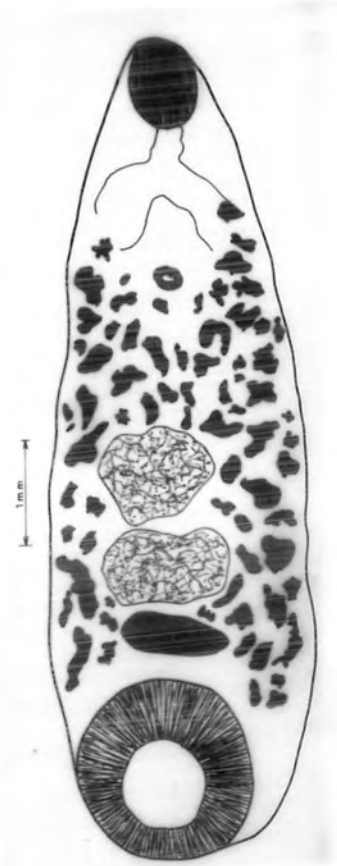
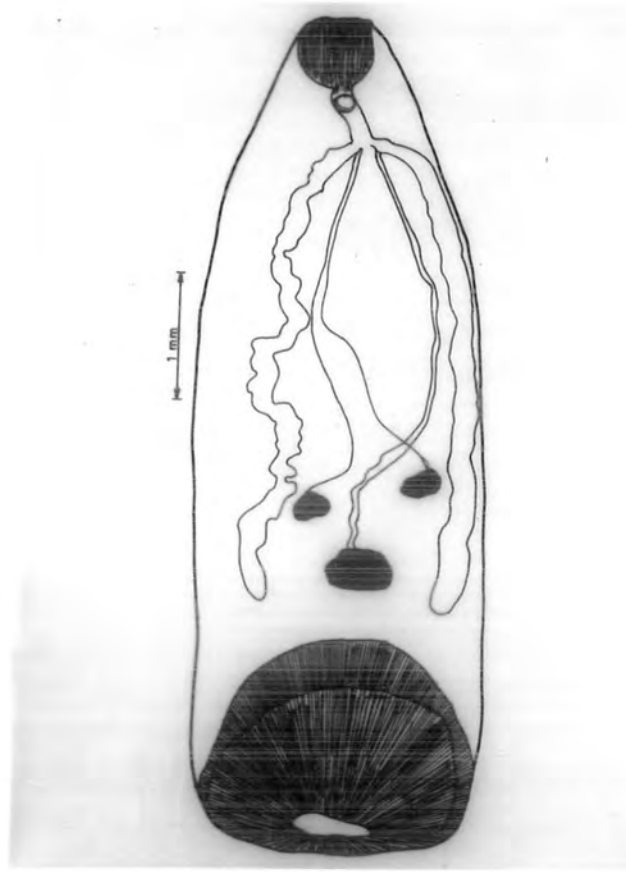


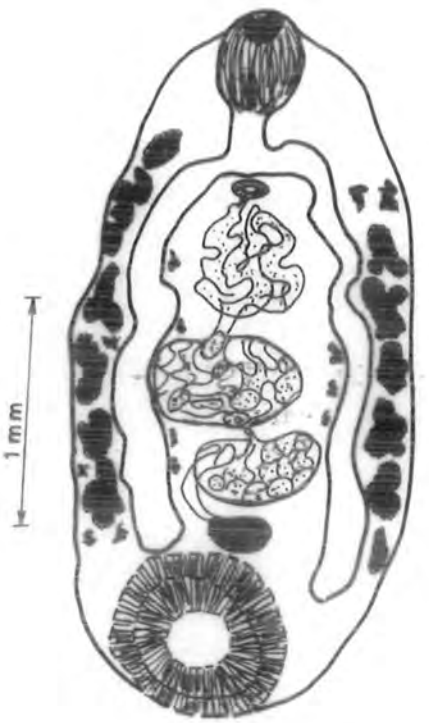
FIG.18 : Breed variations in the incidence of helminth parasites of goats slaughtered at Rawalpindi-Islamabad abattoirs.


1mm

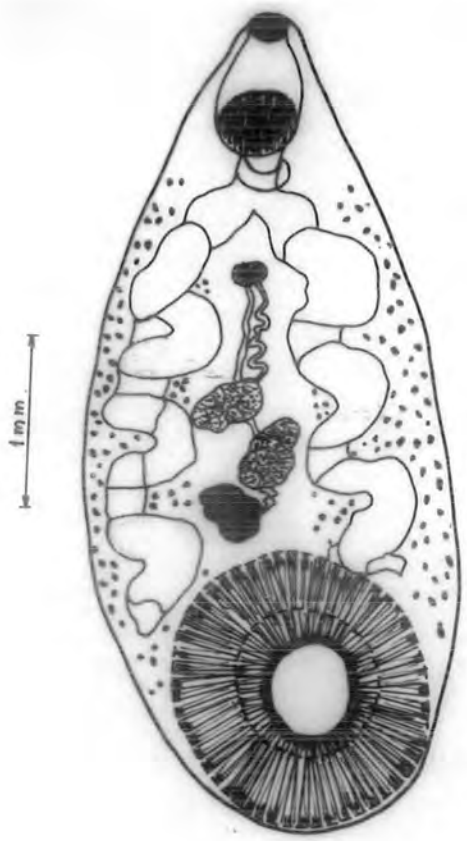
Gastrotylax crumenifer (Creplin, 18-
(entire)


1 mm

Cotyloblastoma cotyloplorum (Diesing, 1850)
(entire)


1 mm

Cotylophoron ovatum (Harsley,
(entire)


1 mm

Moniezia expansa (Rudolphi, 1810)

A. Scolex.
B. mature proglottid.
C. gravid proglottid.
D. egg.

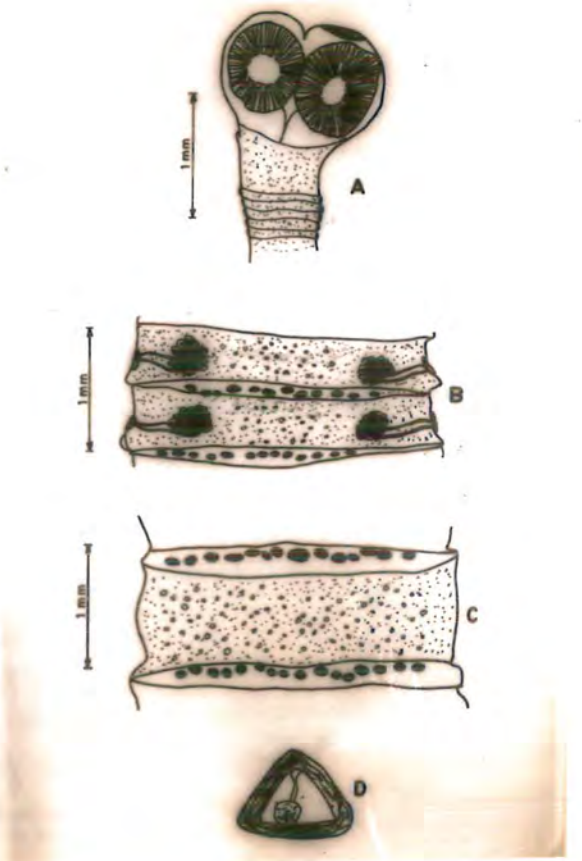
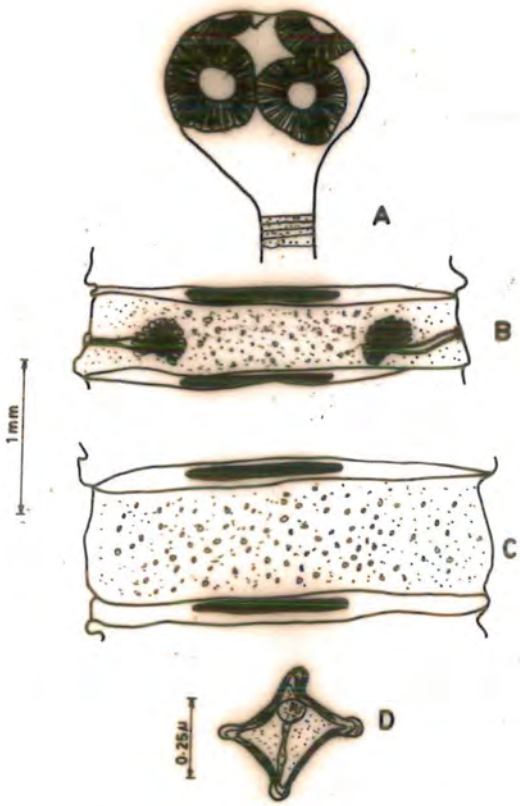

1 mm
A
1 mm
B
1 mm
C
D

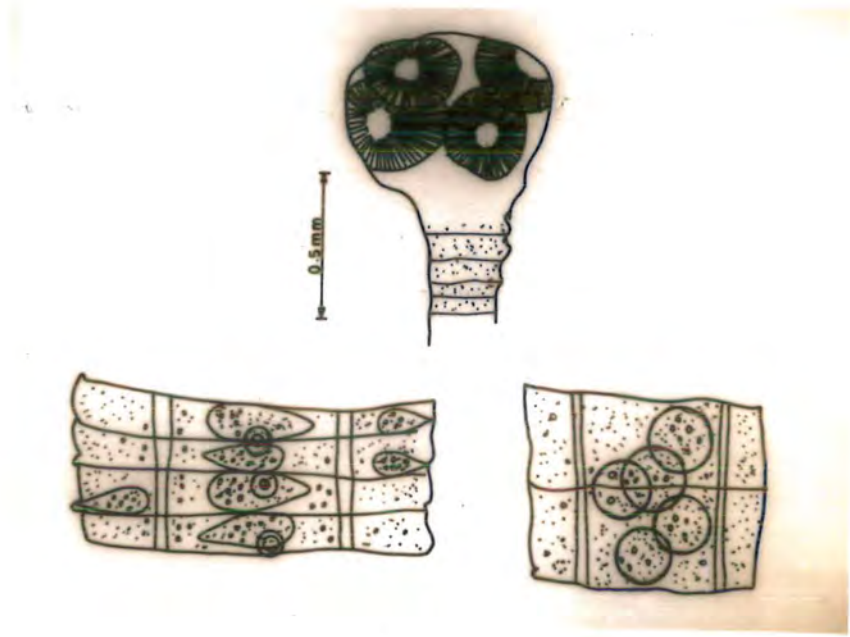
Fig. 24. *Moniezia benedeni* (Moniez, 1879)

A. Scolex.
B. mature proglottid.
C. gravid proglottid.
D. egg.


A
B
C
D
1 mm
0·25μ

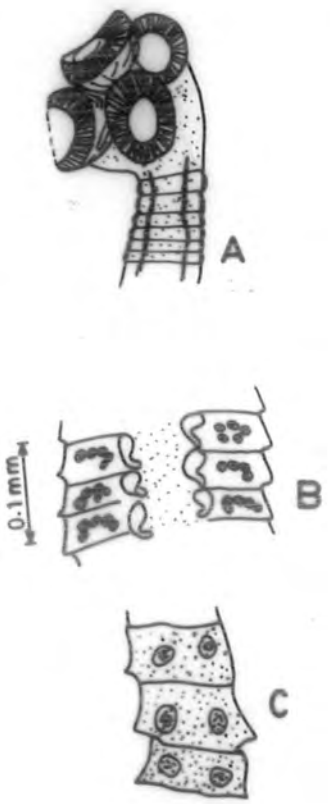
Avitellina centripunctata (Rivolta, 1874)

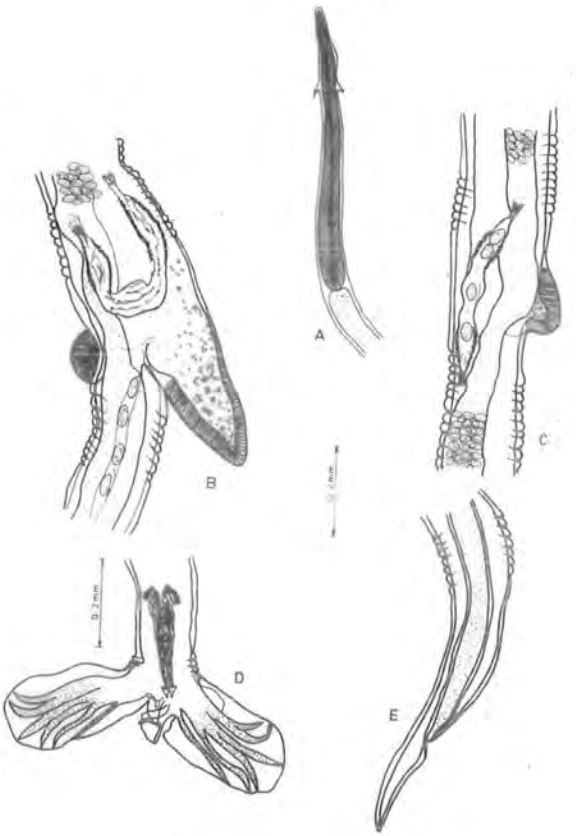
A. Scolex.
B. mature proglottid.
C. gravid proglottid.
D. egg.

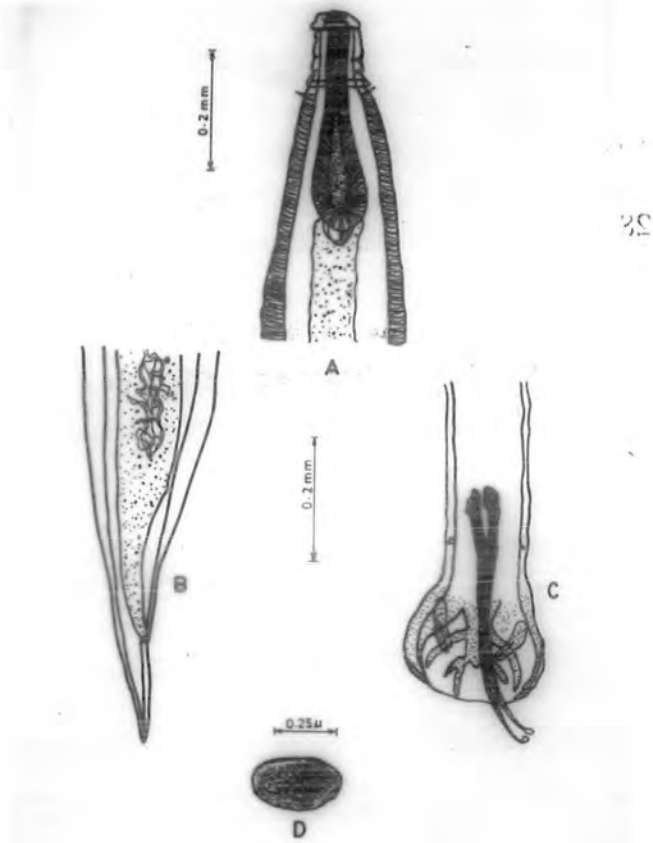

0.5mm

Stilesia Vittata (Railliet, 1909)

A. Scolex.
B. mature proglottid.
C. gravid proglottid.

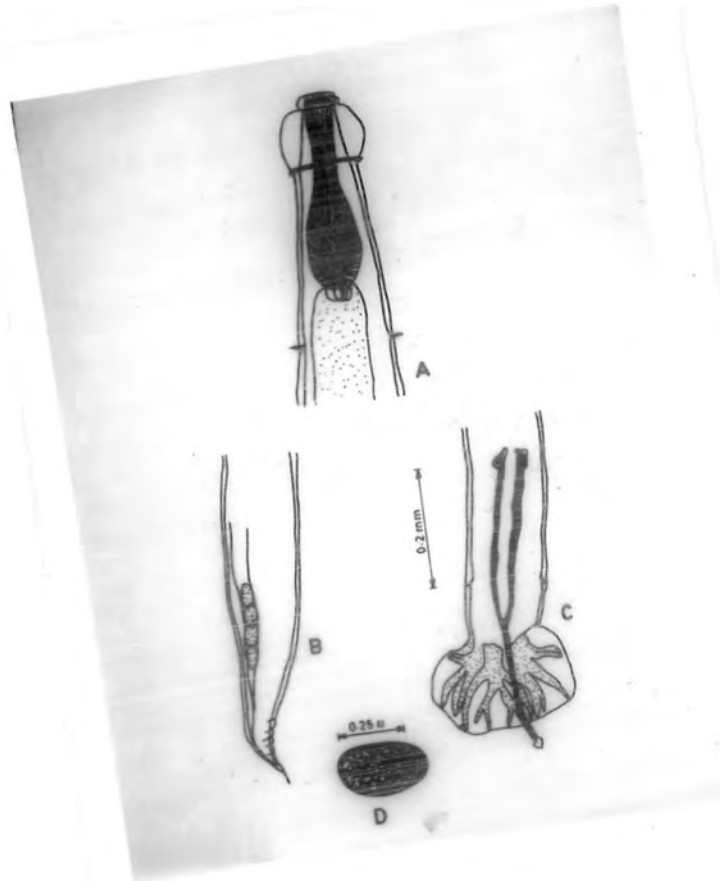

A
0.1mm
B
C


A
B
C
D
E
0.1 mm
0.1 mm


0.2 mm
A
B
0.2 mm
C
0.25μ
D

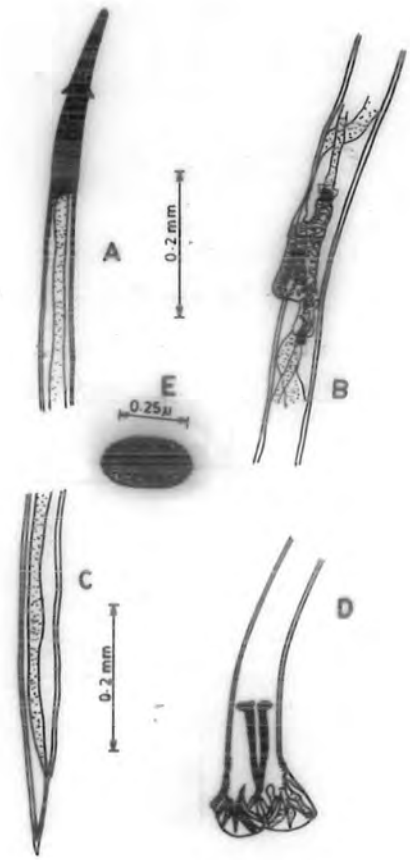
Oesophagostomum ven

A. anterior end.
B. posterior end of female.
C. posterior end of male.
D. egg.


A
B
C
D
0.2 mm
0.25 µ

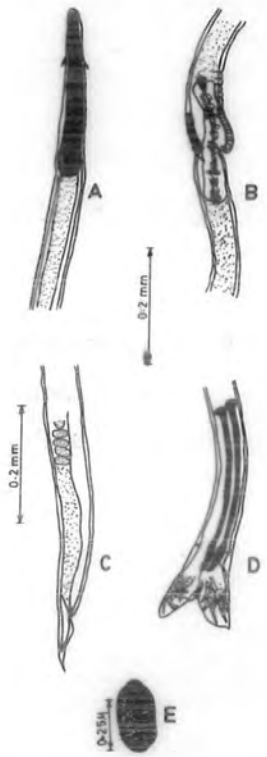
Osterhagia osterhagi (Stiles,

A. anterior end.
B. part of female showing vulvar
C. posterior end of female.
D. posterior end of male.
E. egg


A
0·2 mm
B
E
0·25 μ
C
0·2 mm
D

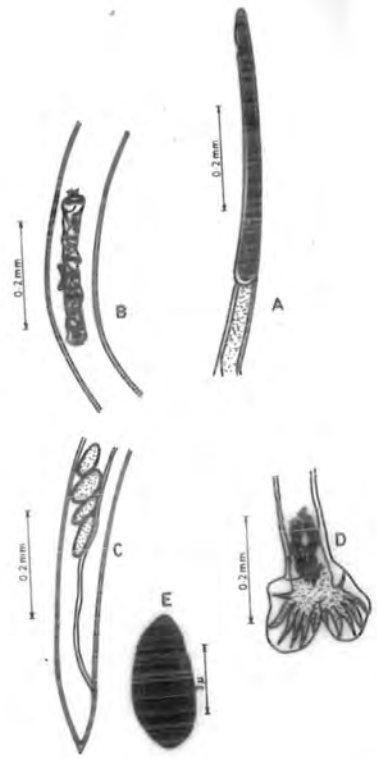
Osteocyte

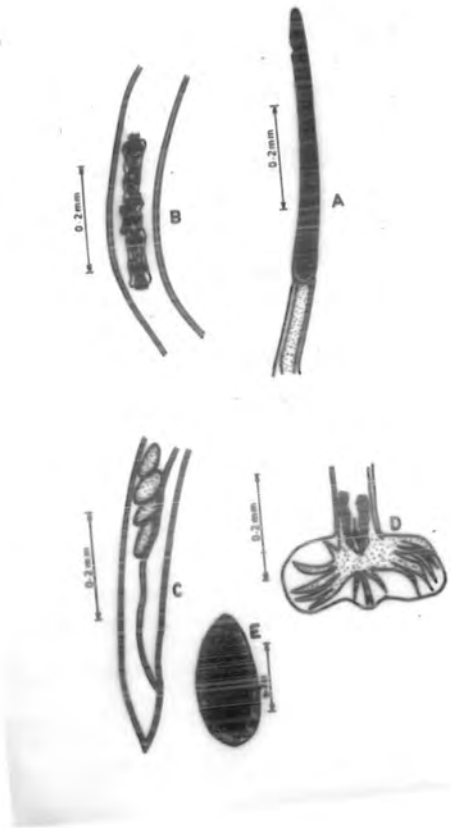
A. anterior end.
B. part of female showing the vulva
C. posterior end of
D. posterior end of
E. egg.


A
B
0·2 mm
0·2 mm
C
D
0·25 M
E

Trichostrongylus axei (

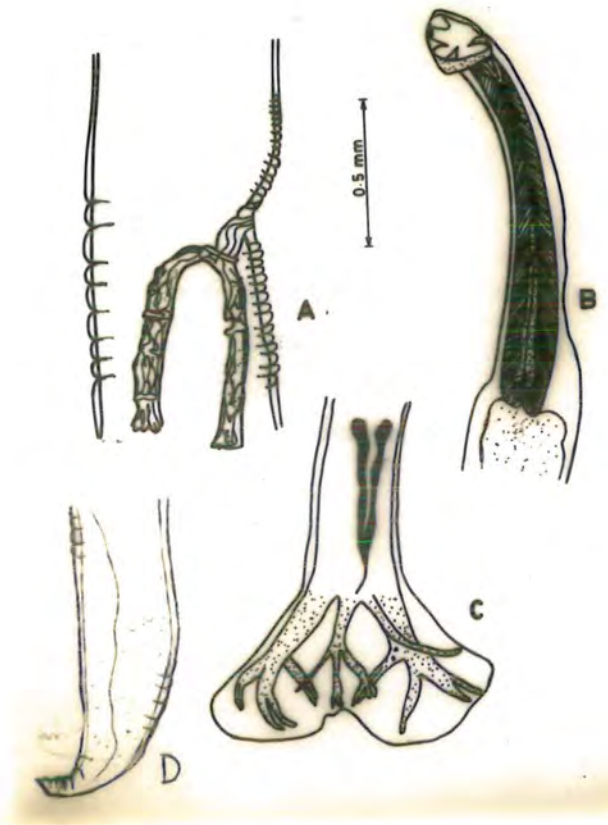
A. anterior end.
B. part of female showing the
C. posterior end of female.
D. posterior end of male.
E. egg.

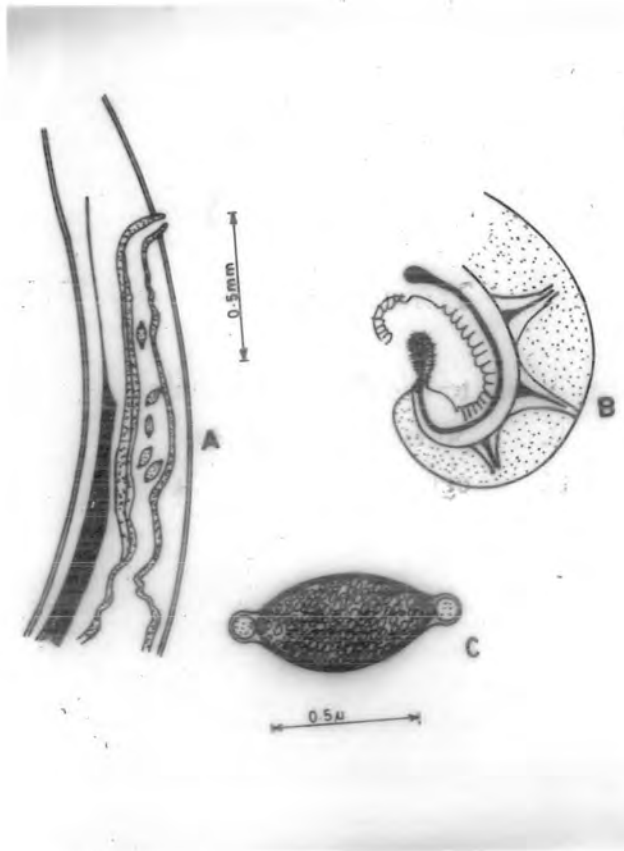

0.2mm
A
0.2mm
B
0.2mm
C
0.2mm
D
E

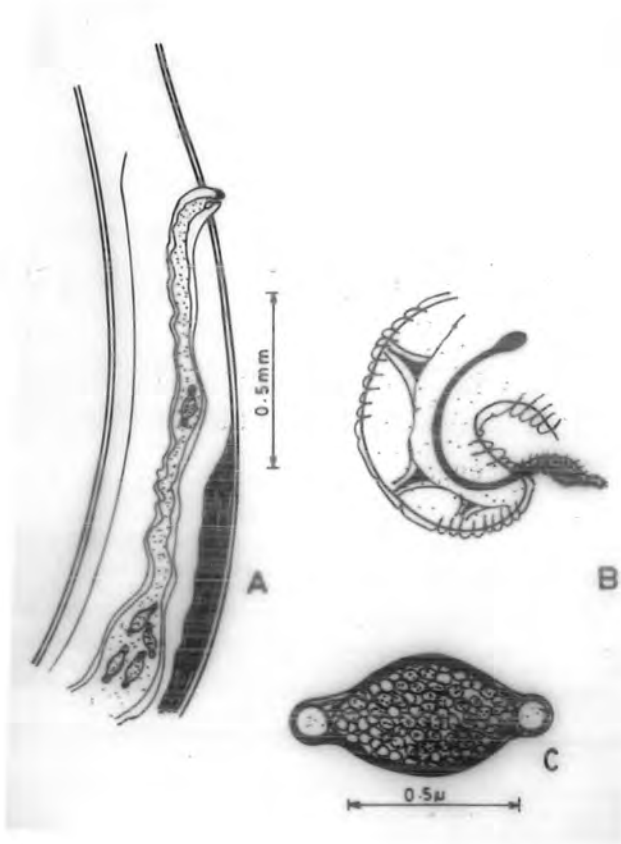

0.2mm
B
0.2mm
A
0.2mm
C
0.2mm
D
E

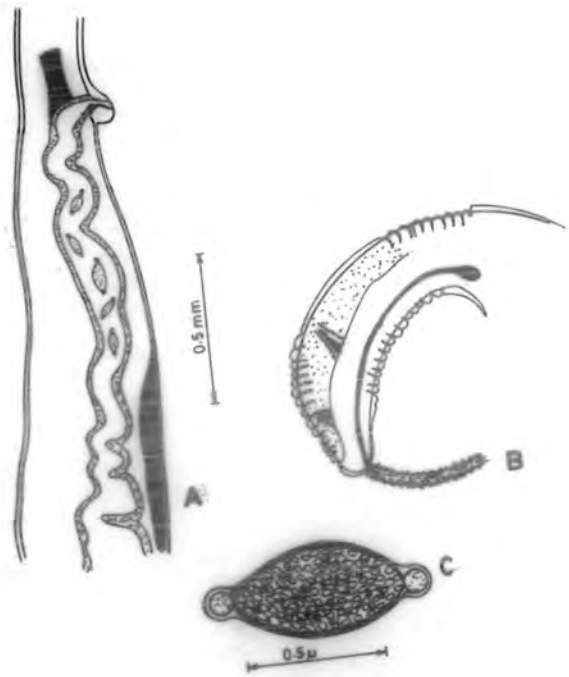
Bursectomy (bursectomies)

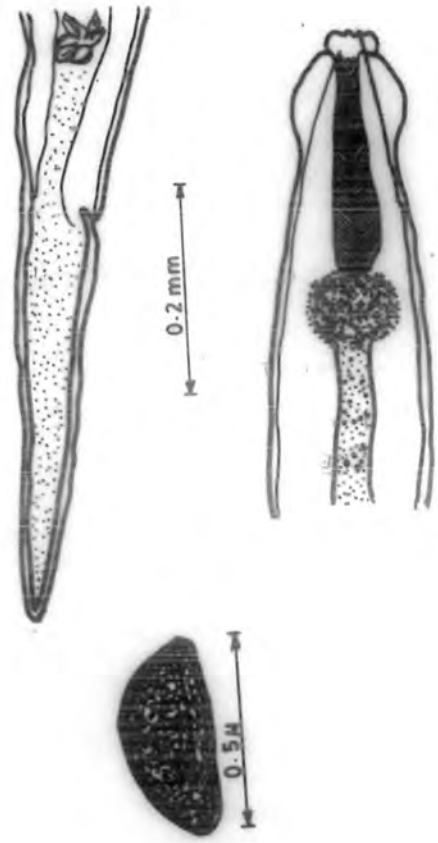
A. part of female showing the vu
B. anterior part
C. posterior part of male
D. posterior part of fema


0.5 mm
A
B
C
D


0.5mm
A
B
C
0.5μ


0.5mm
A
B
C
0.5μ


0.5 mm
A
B
C
0.5μ


0·2 mm
0·5H

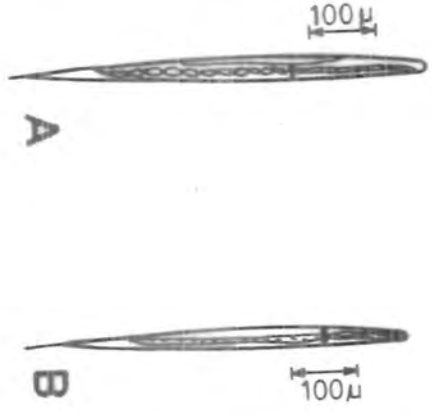

100μ
A
B
100μ

Table - 7 : Measurements of Paramphistomum cervi (in mm)

	1	2	3	4	5	Average
Length of Worm	4.00	3.30	5.00	4.40	4.00	4.1
Width of Worm	1.41	1.21	1.61	1.46	1.50	1.43
Diameter of oral sucker	0.28 x 0.42	0.21 x 0.16	0.35 x 0.40	0.28 x 0.42	0.25 x 0.35	0.27 x 0.35
Size of anterior tests	0.75 x 0.70	0.60 x 0.64	0.90 x 0.75	0.85 x 0.85	0.81 x 0.82	0.78 x 0.75
Size of posterior tests	0.90 x 0.78	0.75 x 0.70	0.85 x 0.75	0.90 x 0.85	0.81 x 0.75	0.84 x 0.76
Size of ventral sucker	1.10 x 0.95	0.95 x 0.85	1.15 x 9.00	1.05 x 0.85	1.00 x 0.95	1.05 x 0.92

Table - 8 : Measurements of Gastrothylax crumenifer (in mm)

	1	2	3	4	5	Average
Length of Worm	4.18	3.10	2.90	4.40	3.15	3.54
Width of Worm	1.70	1.65	1.50	1.80	1.60	1.65
Diameter of oral sucker	0.60 x 0.29	0.50 x 0.25	0.30 x 0.26	0.42 x 0.37	0.26x0.30	0.41x0.29
Size of left tests	0.34 x 0.34	0.30 x 0.25	0.89 x 0.58	0.61 x 0.55	0.50x0.37	0.52x0.41
Size of right tests	0.51 x 0.26	0.25 x 0.20	0.70 x 0.55	0.58 x 0.50	0.47x0.35	0.50x0.37
Size of ventral sucker	1.46 x 1.65	0.99 x 1.12	1.21 x 1.25	1.25 x 1.32	0.91x1.35	1.16x1.33

Table - 9 : Measurements of Cotylophoron cotylophorum (in mm)

	1	2	3	4	5	Average
Length of Worm	3.00	3.50	3.00	4.00	3.00	3.30
Width of Worm	1.10	1.21	1.05	1.20	1.15	1.14
Diameter of oral sucker	0.21 x 0.23	0.27 x 0.31	0.25 x 0.21	0.30 x 0.25	0.25 x 0.21	0.25 x 0.24
Size of anterior testes	0.45 x 0.42	0.35 x 0.31	0.25 x 0.23	0.30 x 0.26	0.41 x 0.31	0.35 x 0.30
Size of posterior testes	0.50 x 0.45	0.40 x 0.38	0.27 x 0.21	0.31 x 0.25	0.37 x 0.41	0.37 x 0.34
Size of ventral sucker	0.90 x 0.85	0.85 x 0.82	0.85 x 0.80	0.95 x 0.90	0.90 x 0.87	0.89 x 0.84

Table - 10 : Measurements of Cotylophoron ovatum (in mm)

	1	2	3	4	5	Average
Length of Worm	3.00	4.00	3.80	4.50	4.00	3.86
Width of Worm	1.12	1.26	1.21	1.30	1.25	1.22
Diameter of oral sucker	0.25 x 0.28	0.30 x 0.37	0.25 x 0.27	0.30 x 0.35	0.35 x 0.32	0.29 x 0.31
Size of anterior testes	0.22 x 0.24	0.27 x 0.21	0.31 x 0.25	0.31 x 0.24	0.31 x 0.27	0.28 x 0.24
Size of posterior testes	0.25 x 0.27	0.26 x 0.27	0.21 x 0.18	0.27 x 0.21	0.30 x 0.25	0.25 x 0.23
Size of ventral sucker	1.05 x 0.99	0.99 x 0.98	0.85 x 0.76	1.10 x 1.00	1.02 x 0.97	1.00 x 0.54

Table - 11 : Measurements of Moniezia expansa (in mm)

	1	2	3	4	5	Average
Length of Worm	245	301	165	150	95	191
Size of Scolex (length and width)	0.47 x 0.55	0.40 x 0.57	0.11 x 0.16	0.90 x 0.11	0.80 x 0.60	0.53x0.39
Diameter of sucker	0.21 x 0.22	0.25 x 0.24	0.18 x 0.17	0.20 x 0.20	0.40 x 0.30	0.24x0.22
Length of mature proglottid	2.57	2.14	2.01	1.92	1.25	1.97
Width of mature proglottid	0.28	0.34	0.28	0.19	0.14	0.24
Length and width gravid proglottid	0.71 x 3.00	0.50 x 3.19	0.70 x 2.61	0.35 x 2.16	0.56 x 1.96	0.56x2.58
Length and width of tests	0.04 x 0.03	0.03 x 0.02	0.03 x 0.03	0.02 x 0.02	0.03 x 0.03	0.03x0.02
Size of ovary	0.07 x 0.06	0.06 x 0.06	0.07 x 0.08	0.07 x 0.08	0.07 x 0.06	0.06x0.06

Table - 12 : Measurements of Moniezia benedeni (in mm)

	1	2	3	4	5	Average
Length of Worm	300	316	265	400	519	360
Size of Scolex (length and width)	0.47 x 0.73	0.49 x 0.79	0.52 x 0.91	0.42 x 0.81	0.37 x 0.72	0.45 x 0.79
Diameter of Sucker	0.34 x 0.28	0.24 x 0.27	0.29 x 0.27	0.28 x 0.26	0.34 x 0.32	0.29 x 0.33
Length of mature proglottid	0.62	0.57	0.61	0.51	0.71	0.60
Width of mature proglottid	2.36	2.20	2.05	2.96	3.16	2.54
Length and width gravid proglottid.	1.00 x 4.66	0.92 x 4.78	0.85 x 3.24	0.85 x 3.21	1.00 x 4.78	0.92 x 4.13
Length and width of testes	0.04 x 0.04	0.03 x 0.02	0.04 x 0.04	0.05 x 0.04	0.05 x 0.05	0.04 x 0.03
Size of ovary	0.11 x 0.17	0.12 x 0.14	0.13 x 0.15	0.19 x 0.17	0.17 x 0.20	0.14 x 0.16

Table - 13 : Measurements of Avitellina centripunctata (in mm)

	1	2	3	4	5	Average
Length of Worm	91	85	115	67	45	80
Size of Scolex (length and width)	1.08 x 1.63	0.55 x 0.99	0.90 x 0.95	0.75 x 0.83	0.57 x 0.71	0.76 x 1.02
Size of sucker	0.75 x 0.71	0.55 x 0.55	0.81 x 0.80	0.65 x 0.65	0.41 x 0.38	0.63 x 0.61
Length of mature proglottid	0.21	0.25	0.28	0.14	0.12	0.20
Width of mature proglottid	1.20	0.99	1.36	0.91	0.78	1.04
Length and width gravid proglottid	0.20 x 0.80	0.29 x 0.61	0.31 x 0.71	0.19 x 0.46	0.13 x 0.35	0.22 x 0.58
Length and width of tests	0.05 x 0.05	0.04 x 0.04	0.04 x 0.04	0.03 x 0.03	0.03 x 0.03	0.038x0.038
Size of ovary	0.05 x 0.05	0.03 x 0.03	0.04 x 0.04	0.03 x 0.03	0.03 x 0.03	0.036x0.036

Table - 14 : Measurements of *Stilesia vittata* (in mm)

	1	2	3	4	5	Average
Length of Worm	25	16	40	10	45	27
Size of Scolex (length and width)	0.43 x 0.75	0.23 x 0.35	0.23 x 0.35	0.31 x 0.40	0.41 x 0.50	0.32 x 0.47
Size of Sucker	0.25 x 0.25	0.18 x 0.19	0.13 x 0.12	0.015 x 0.09	0.19 x 0.17	0.18 x 0.16
Length of mature proglottid	0.16	0.16	0.18	0.10	0.22	0.16
Width of mature proglottid	0.99	0.91	1.00	0.85	1.05	0.96
Length and width gravid proglottid	0.13 x 0.40	0.11 x 0.25	0.12 x 0.23	0.10 x 0.25	0.14 x 0.30	0.12 x 0.28
Length and width of testes	0.02 x 0.02	0.03 x 0.02	0.03 x 0.03	0.04 x 0.03	0.04 x 0.04	0.03 x 0.02
Size of ovary	0.02 x 0.02	0.03 x 0.03	0.02 x 0.03	0.03 x 0.02	0.03 x 0.03	0.02 x 0.02

Table - 15 : Measurements of Haemonchus contortus (in mm)

	1	2	3	4	5	Average
Length of Oesophagus	1.27	1.37	1.41	1.46	1.48	1.39
Diameter of Oesophagus	0.05 x 0.40	0.11 x 0.37	0.08 x 0.28	0.09 x 0.31	0.11 x 0.34	0.08 x 0.34
Length of male body	11	11	9	13	14	11
Width of male body	0.26	0.29	0.21	0.30	0.31	0.27
Length of female body	15	16	18	22	17	17
Length of tail	0.45	0.39	0.41	0.44	0.45	0.38
Width of female body	0.42	0.39	0.36	0.40	0.32	0.37
Length of vulvar flap	0.12	0.31	0.22	0.22	0.31	0.23
Width of vulvar flap	0.11	0.23	0.23	0.17	0.17	0.27
Length of spicules	0.34	0.43	0.45	0.40	0.36	0.39

Table - 16 : Measurements of Oesophagostomum columbianum (in mm)

	1	2	3	4	5	Average
Diameter of head	0.04 x 0.13	0.04 x 0.12	0.03 x 0.90	0.04 x 0.13	0.05 x 0.12	0.04
Length of Oesophagus	0.89	0.90	0.99	0.89	0.87	0.90
Diameter of Oesophagus	0.18	0.17	0.15	0.20	0.22	0.18
Distance of cervical papillae from head	1.30	1.23	1.29	1.36	1.45	1.32
Length of male body	13	16	13	14	17	14
Width of male body	0.37	0.34	0.36	0.26	0.45	0.34
Length of female body	21	25	26	30	21	24
Length of tail	0.17	0.19	0.20	0.22	0.21	0.19

Table - 17 : Measurements of Oesophagostomum venulosum (in mm)

	1	2	3	4	5	Average
Diameter of head	0.05 x 0.15	0.05 x 0.13	0.04 x 0.14	0.05 x 0.15	0.06 x 0.15	0.05 x 0.14
Length of Oesophagus	0.87	0.99	0.85	0.80	0.80	0.86
Diameter of Oesophagus	0.19	0.17	0.18	0.20	0.21	0.19
Distance of cervical papillae from head	1.19	1.10	1.35	1.19	1.42	1.25
Length of male body	13	15	15	12	14	13
Width of male body	0.33	0.36	0.30	0.36	0.28	0.32
Length of female body	21	21	22	18	20	20
Length of tail	0.16	0.19	0.20	0.17	0.21	0.18

Table - 18 : Measurements of *Ostertagia ostertagi* (in mm)

	1	2	3	4	5	Average
Length of male body	7	5	6	5	4	5
Width of male body	0.14	0.10	0.9	0.16	0.12	0.28
Length of female body	12	8	9	10	7	9
Length of tail	0.14	0.11	0.10	0.16	0.13	0.12
Distance of vulva from tail	1.2	1.1	1.0	1.2	1.4	1.18

Table - 19 : Measurements of Ostertagia circumcincta (in mm)

	1	2	3	4	5	Average
Length of male body	9	8	12	7	6	8
Width of male body	0.17	0.16	0.15	0.17	0.14	0.15
Length of female body	14	16	17	13	11	14
Width of female body	0.17	0.19	0.20	0.22	0.16	0.18
Distance of vulva from tail	2.3	1.6	2.0	2.1	2.0	2

Table - 20 : Measurements of Trichostrongylus axei (in mm)

	1	2	3	4	5	Average
Length of male body	3	3	4	2.5	3	3.1
Width of male body	0.05	0.04	0.07	0.06	0.05	0.05
Length of female body	4	5	6	4	3	4.4
Width of female body	0.5	0.7	0.7	0.6	0.5	0.6
Distance of vulva from tail	0.75	0.85	0.91	0.76	0.61	0.77

Table - 21 : Measurements of Trichostrongylus colubriformis (in mm)

	1	2	3	4	5	Average
Length of male body	4	3	2	4	3	3.2
Width of male body	0.5	0.6	0.3	0.8	0.4	0.52
Length of female body	5	5	4	6	5	5
Length of tail	0.07	0.03	0.02	0.04	0.03	0.03
Spicules length	0.061	0.070	0.069	0.071	0.071	0.068

Table - 22 : Measurements of Bunostomum trigonocephalum (in mm)

	1	2	3	4	5	Average
Length of Oesophagus	0.61	0.56	0.50	0.41	0.30	0.47
Length of male body	14	16	13	14	15	14
Width of male body	0.31	0.32	0.31	0.42	0.41	0.35
Length of female body	19	20	18	17	22	19
Length of tail	0.6	0.51	0.42	0.36	0.29	0.43
Width of female body	0.46	0.51	0.36	0.37	0.47	0.43
Length of spicules	0.56	0.60	0.50	0.61	0.52	0.55

Table - 23 : Measurements of Trichuris ovis (in mm)

		1	2	3	4	Average
Length of female body	ant.	31	37	45	50	40
	post.	12	10	17	18	11
Width of female body	ant.	0.17	0.14	0.11	0.10	0.13
	post	0.70	0.65	0.61	0.58	0.63
Length of spicular sheath		0.21	0.19	0.18	0.19	0.19
Diameter of spicular sheath		0.02	0.07	0.08	0.7	0.21
Length of male body	ant.	39	32	30	41	35
	post.	17	13	11	14	13
Width of male body	ant.	0.15	0.11	0.10	0.14	0.12
	post.	0.56	0.47	0.39	0.63	0.51

Table - 24 : Measurements of Trichuris globulosa (in mm)

		1	2	3	4	Average
Length of male body	ant.	0.45	0.38	0.40	0.41	0.41
	post.	0.15	0.12	0.11	0.12	0.12
Width of male body	ant.	0.17	0.15	0.11	0.13	0.14
	post.	0.63	0.70	0.56	0.60	0.62
Length of spicular sheath		1.01	1.16	1.13	1.01	1.07
Length of spicule		4.00	5.10	4.13	4.23	4.36
Width of female body	ant.	29	30	21	17	24
	post.	0.68	0.77	0.71	0.72	0.72

Table - 25 : Measurements of Trichuris lani (in mm)

		1	2	3	4	Average
Length of female body	ant.	12	11	12	12	11
	post.	35	30	33	45	35
Width of female body	ant.	0.17	0.11	0.19	0.13	0.15
	post.	0.66	0.61	0.71	0.62	0.65
Length of spicular sheath		0.41	0.32	0.39	0.23	0.33
Diameter of spicular sheath		0.04	0.02	0.03	0.04	0.03
Length of male body	ant.	36	32	31	41	35
	post.	11	10	14	15	12
Width of male body	ant.	0.17	0.13	0.12	0.13	0.13
	post.	0.57	0.43	0.51	0.61	0.53

Table - 26 : Measurements of Skrjabinema ovis (in mm)

	1	2	3	4	5	Average
Size of head	0.031 x 0.069	0.028x0.061	0.030x0.063	0.034x0.071	0.028x0.056	0.030x0.064
Length of Oesophagus	0.76	0.71	0.65	0.61	0.85	0.71
Diameter of Oesophageal bulb	0.14	0.16	0.15	0.13	0.17	0.15
Length of female body	9	10	7	6	7	7
Length of tail	0.41	0.39	0.44	0.43	0.36	0.40
Width of female body	0.45	0.42	0.40	0.41	0.34	0.40

DISCUSSION

The aim of this study is to determine the intensity of gastrointestinal infection in sheep and goats that were slaughtered in Rawalpindi-Islamabad abattoirs. The animals which are included in this survey belong to Rawalpindi-Islamabad, Jhelum, Attock, Chakwal, Gujrat, Sargodha, Khushab and Swat (NWFP). The results of this investigation of above mentioned districts have revealed that the helminthic infection is a major health hazard by which the growth and the development of the sheep and goats may be seriously retarded. In this chapter various parameters that we included in this study are discussed in detail.

A-TREMATODES

In this study, four species of gastrointestinal trematodes(amphistomes) of sheep and goats are recorded viz; *Paramphistomum cervi* (Zeder, 1790), *Cotylophoron cotylophorum* (Fischoeder, 1901), *Gastrothylax crumenifer* (Creplin, 1847) and *Cotylophoron ovatum* (Harshey, 1934). These trematodes species except *C. ovatum* had already been reported by

Srivasatava (1945), Anantaramam (1954) and Thapar (1955), while the species *C. ovatum* was previously reported by Mogle (1945) and Siddiqi and Ashraf (1980). The trematodes like *Gastrothylax crumenifer*, *Paramphistomum cervi*, *Cotylophoron cotylophorum* are encountered most frequently in comparison to the data presented by Marwat *et al.* (1989). The important reason could be the relative abundance of the snails which serve as a intermediate hosts of these trematodes species. During this investigation the *Cotylophoron cotylophorum* is the most prevalent species encountered in this survey. This finding is in agreement with the reports of Mogle (1945), Varma (1957) and Durrrani *et al.* (1981). They had previously reported that *C. cotylophorum* was the most common gastrointestinal trematodes of sheep. In this investigation, high incidence rate of trematodes infection is recorded from July to November. This period corresponds to the summer rainy season thus there could be a reason that maximum number of intermediate hosts are available during this rainy season that result in the higher incidence of trematodes infection. Low incidence in winter months could be attributed to the fact that the intermediate host, hibernate during winter (Dutt and Bali, 1981). Moreover the knowledge

about the ecology of these snails could be helpful to analyse the seasonal incidence of trematodes in a better way.

Age-wise result reveals that the higher infection rate is recorded in old age animals as compared to the young one. The similar results had already been reported by Mohiuddin *et al.* (1982). The reason could be that the old age animals has got the maximum period of time to coincide with the availability of intermediate hosts to a slow build up of infection as compared to young animals, which are slaughtered much earlier before they get the infection.

It is observed that the higher incidence rate of infection is recorded in Sargodha, Gujrat, Jhelum and Khushab districts. These results have confirmed the findings of Sarwar (1963) who observed that "Amphistomiasis" was the most prevalent malady of sheep and goats in the alluvial plains of the Punjab. The higher incidence of infection in these districts could be attributed to the fact that the grazing grounds for sheep and goats are only available in these alluvial plain, having the extensive irrigation channels system. Thus sheep and goats drank daily from these open

channels which are used to irrigate various crops.These channels are usually heavily populated with various species of snails which serve as intermediate hosts of different trematodes species. According to Blood *et al.* (1983) the snails prefer to live in low lying swampy areas with slow moving water. The verges of these channels have a permanent grass cover which the livestock graze upon regularly, and clearly this is a potential source of trematodes infection. The low incidence rate in rest of the districts surveyed could be explained that rainfall is low and channel system for irrigation purposes is also lacking in these areas thus reducing the survival chances of intermediate hosts involved for the transmission of infection.

B-CESTODES

Four species of Anoplocephalids are recorded during this investigation viz; *Moniezia expansa* (Rudolphi, 1810) *Moniezia benedeni* (Moniez, 1879), *Avitellina centripunctata* (Rivolta, 1874), *Stilesia vittata* (Railliet, 1896). First three cestodes had previously been reported by Thapar (1955), Prokopic (1976), Siddiqi and Ashraf (1980), Durrani *et al.*

(1981), Mohiuddin *et al.* (1984), Marwat *et al.* (1988) and Khan *et al.* (1989), while the *S. vittata* species was reported by Siddiqi and Ashraf (1980) and Marwat *et al.* (1988). The incidence of *M. expansa* and *M.* benedeni is in conformity with that reported by Khan *et al.* (1989), while that of *A. centripunctata* is almost consistent with that recorded by Durrani *et al.* (1981). During this study the *Moniezia expansa* and *Avitellina centripunctata* are the most prevalent cestodes of sheep and goats and it could be attributed to the fact that there may be relative abundance of oribatid mites, which serve as their intermediate hosts for these Anoplocephalids. Schuster (1988) reported the fauna of oribatid mites that serve as a carrier of cestodes infection. These are *Scheloribates laevigatus, S. latipes, S. pallidus, Eupelope occultus, Trichooribates novus, Achipteria coleoptrata, Punctoribatus* spp., and *Techtoecpheus velatus.* The seasonal distribution of *Moniezia expansa, M. benedeni,* and *Avitellina centripunctata* reveals that they are almost present throughout the year showing different peaks in different months. It is observed that their incidence is high during the spring and summer rainy season, while the low incidence is recorded in winter. In winter the vegetation is

scarce thus reducing the chances of oribatid mites availability to the grazing sheep and goats. The higher incidence in spring and summer rainy seasons could be reasoned that the vegetation in these seasons is well flourished thus increasing the chances of oribatid mites ingestion to the grazing sheep and goats. According to Chandler and Read (1961) these oribatid mites creep out of the soil when the dew is on the grass and are devoured by herbivores along with the vegetation.

The area-wise distribution of Anoplocephalids shows that they are prevalent in almost all the areas surveyed so far except Swat where *A. centripunctata* and *M. expansa* have been reported only. This could be attributed to the fact the vegetation and climatic conditions of these areas are well suitable for the survival and migration of oribatid mites. The incidence of these Anoplocephalids however differ in different districts, which may be due to the distribution of oribatid mites per acre area. Moreover it may not be necessary that all the mites may be carrier of Anoplocephalids infection. The knowledge about the infection risks of areas can be assessed if the density of intermediate

host, and their infection is known. In addition to this it is observed that the young animals are more prone to Anoplocephalids infection as compared to old one. The reason could be the host resistance which may be well established in old age animals. According to Urquhert *et al.* (1962) the immunocompatence is not achieved until the six months of age. Moreover it is found that the incidence is slightly higher in sheep as compared to goats this may be due to grazing behaviour of sheep which rely to graze on ground pastures.

C-NEMATODES

Twelve species of nematodes are recorded during this study viz; *Haemonchus contortus* (Rudolphi, 1803), *Oesophagostomum columbianum* (Curtice, 1890), *Oesophagostomum venulosum* (Rudolphi, 1809), *Ostertagia ostertagi* (Stiles, 1892), *Ostertagia circumcincta* (Stadelmann, 1894), *Trichostrongylus axei* (Cobbold, 1879), *Trichostrongylus colubriformis* (Giles, 1892), *Bunostomum trigonocephalum* (Rudolphi, 1808), *Skrjabinema ovis* (Skrajbin, 1915), *Trichuris ovis* (Abildgaard, 1795), *Trichuris lani* (Arkiukh, 1948), *Trichuris globulosa* (Linstow, 1901). These parasites

have been previously reported by Sarwar (1962), Durrani and Hayat (1964), Siddiqi and Ashraf (1980) Shah *et al.* (1980), Mohiudin *et al.* (1984), Ahmed and Ansari (1987), Gupta *et al.* (1988), Marwat *et al.* (1988) and Khan *et al.* (1989). In addition to these species the following species are also reported viz; *Nematodirus spathiger* by Sarwar, (1962) at Lahore and Marwat *et al.* (1988) at Peshawar. *Chabertia ovina* by Siddiqi and Ashraf (1980) and Shah *et al.* (1980) at Peshawar and Lahore respectively. *Gaigeria pachyscelis* by Mohuddin *et al.* (1984) at Hyderabad (Sind). *Marshallagia marshalli* by Khan *et al.* (1988) at Quetta (Baluchistan). These nematodes which are not recovered during this study could be due to the fact that different nematodes species have different geographical distribution, having the different climatic conditions that favours the development of pre-parasitic stages of these nematodes species. The most prevalent nematode encountered in this study is *Haemonchus contortus* particulary from July-October. This is in agreement with the findings of Bali and Singh (1977), Grant (1981), Vercruysse (1983), Ahmed and Ansari (1987) and Gupta *et al.* (1987). They also observed that *Haemonchus contortus* was the most prevalent nematode in sheep and goat during the

summer rainy season (July-September). The higher prevalence of this species could be due to the fact that this nematodes has a relatively short generation interval and its ability to take the advantage of favourable environmental conditions (Grant, 1981). During this season the prevailing climatic condition are extremely favourable for the development of *Haemonchus contortus*. According to Gordon's (1953) criteria mean monthly maximum temperatures of 18.3^{o}C or above and total monthly rainfalls of 50 mm or more are conducive for translation and transmission of *H. contortus*. These conditions are found satisfied in most of the areas surveyed between July-November, because usual monsoon rainy season which approaches from late June and moderate temperature during this period facilitates the development of free-living stages of *H. contortus*. In this study low infection with *H. contortus* was recorded from January to June in both sheep and goats This seems contrary to the work of Grant (1981), Vercruysse (1983) and Ahmed and Ansari (1987). It could be due to the low temperature that retards the development of free-living stages and even at 9^{o}C no development takes place (Soulsby, 1982). Besides weather conditions self cure phenomena (Stewart, 1953; Dineen, 1966) may also be the

reason for the decrease of the incidence from January to June.

The incidence of *Oesophagostomum* spp. is in agreement with the reports of Patnaik *et al.* (1973), Sinha and Sahai (1977) and Ahmed and Ansari (1987). Moderate infection of *Oesophagostomum* spp. may be due to the fact that the warm, moist summer experienced in these areas is well suited to the development and survival of the free-living stages of this parasite. Moreover they show little resistance to desiccation and would be unable to survive the long dry winter (Kates 1950; Crofton, 1963). This, however is of little consequence because this species can have a long prepatent period in which the larvae,cause the formation of nodular lesions on the intestinal and caecal wall in which they can successfully hibernate within the host (Grant, 1981). During this study it is also observed that during February-March above 40% intestines of sheep and goats have the nodules on their surface which also confirms the above statement. The incidence of *Oesophagastomum* spp., however is not in conformity with the reports of Misra and Ruprah (1968); Khan *et al.* (1988) and Gupta *et al.* (1988). They reported that low

incidence of this parasite in different geographical regions. Low infection could due to be the adverse semi-arid climatic conditions in these areas because of the low resistance of the pre-parasitic stages of this parasites to weather conditions (Kates, 1950).

The results shows that *Trichostrongylus* spp. is recorded throughout this study period with relatively higher prevalence during August-October, which is almost consistent with that described by Gupta *et al.* (1987). The prevalence of *Trichostrongylus* spp. is influenced by ambient temperatures. The reason that prevalences is correlated with autumn, winter, spring and not summer temperatures may be that seasons are generally suitable for the development and survival of the free-living stages. *T. colubriformis* is adopted to climates with higher temperatures and can withstand periods of dryness (De Chaneet, 1988). Significant numbers of adult *T. axei* have been recovered during the artificial digestion of the abomasal wall. There could be a possibility that *T. axei* undergoes a histotrophic phase in its life cycle, particularly in adult hosts. These findings are confirmed by Parnell, (1962); Muller, (1968). The highest

number of *Ostertagia* spp. are recorded during July-September. The high incidence of *Ostertagia* spp. could be attributed to the fact that the larvae of this parasite are abundant on the pasture from June to October when maximum temperature was below 15°C and the mean relative humidity at 1500 hours was above 60% (Anderson, 1972). Over the same period in these areas where the temperature during autumn season was almost consistent with that of described by Anderson (1972) for the development of free-living stages of *Ostertagia* spp. This species was favoured by cooler conditions with peak larval infection in late winter and in spring that were derived from faecal contamination in late summer and autumn (Southcott *et al.* 1976). Those animals that become infected in late winter, may carry substantial worm burden of this parasite on through the summer months (Soulsby, 1982). These finding are consistent with the present results. Highest prevalence of *Trichuris* spp. infection is recorded during the winter months. Cabaret (1983) also reported the high incidence of *Trichuris* spp. was reported during the winter season. According to Soulsby (1982) the development of the *Trichuris* spp.is related to soil moisture and temperature i.e (6-20C) These conditions are

almost satisfied during the winter and rainy seasons.

The intensity of the infection of *Bunostomum trigonocephalum* in the slaughtered animals is low and doesn't show any seasonal trend. This could be due to the susceptibility of the free-living stages of this parasites to winter and summer conditions (Shorb, 1940; Kates, 1947) result in their shorter survival time on the pasture under most of the climatic conditions.

The occurrance of only female of *Skrjabinema ovis* presented a unique feature. This feature has previously been reported by Shah *et al.* (1980) and he gave the reason that the life span of male so short that they are hardly to find during the post-mortem examination. Moreover in this study this parasite is recorded in goats only, which is in conformity with report of Siddiqi and Ashraf (1980) they had also reported the same parasite in goats.

IMMATURE WORM COUNTS

The results of immature worm counts reveal that they are

present in insignificant numbers throughout the study period. These findings are in consistent with the reports of Gupta *et al.* (1987) who had also reported the insignificant numbers of immature worms from the digested wall of the abomasum. The prevalence of immature worms could be due to the persistence of nematode infection is either due to the successful survival of the pre-parasitic stages on the pasture or of the adult or due to hypobiotic larvae in the host (Gupta *et al.*, 1987). It was also shown that the infective larvae of *Haemonchus contortus, Trichostrongylus* spp. and *Oesophagostomum* spp. were available to the grazing livestock throughout the year (Gupta *et al.*, 1987). Thus it appears that the infection of *Trichostrongylus* spp. is present in almost all round the year especially the livestock which comes from Rawalpindi-Islamabad and its adjoining areas, because the *Trichostrongylus* spp. immature worm are recovered from the animals of these areas. *Haemonchus contortus* immature worm has recovered from June to onwards as the climatic conditions are favourable for the development of pre-parasitic stages of this species. Moreover the weather pattern in rest of the areas surveyed shows the perennial irrigation of the field in the alluvial plains of the Punjab

and the rainfall in monsoon season provides sufficient moisture even during the dry spell is important to the translation and transmission of various nematode parasites.

EGG PER GRAM (e.p.g)

It is observed that higher numbers of strongyle eggs are shed in the faeces from July to November during this study period. This finding is in consistent with those of Reinecke (1961), Vercruysse (1983) and Gupta *et al.* (1987). They also had reported that the egg production was generally highest during the summer season, when the conditions for infection are more favourable. The higher faecal egg counts during this season may be largely due to highest prevalence of *Haemonchus contortus* from July-October, as this parasite is considered more prolific egg producer than *Trichostrongylus* spp. (Grant, 1981; Hunter and Heath, 1984). According to Vercruysse, (1983) heavy infestation (2000-3000 adult worms) was common in the rainy season and he further reported that the *Haemonchus contortus* together with *Oesophagostomum columbianum* contribute to elevate the level of eggs in the faeces. In this investigation low EPG level is recorded from

January to June this could be associated with the self cure phenomenon or due to low worm burden of *Haemonchus contortus* and other nematodes genera. One of the major drawback of the use of egg per gram technique is that it cannot provide the information about the composition of infection, as the eggs of various strongyle genera cannot be differentiated, thus eliminating the proper use of anthelminthic against the particular parasite. During this investigation no peri-parturient rise in the EPG level is observed. According to Jennsen (1987) peri-parturient rise in the EPG level was observed during the spring when the lambing had occurred. This study is based on slaughtered-house examination and therefore, all the females either sheep or goats that were included in this survey were non-pregnant. This eliminates the factors that are involved for the rise of EPG level during and after the pregnancy period.

COMPARASION BETWEEN EGGS PER GRAM AND STRONGYLE WORM BURDENS:

The ability to make reasonable deductions about the level of gastrointestinal nematode infection in sheep and goats is an essential requirement for the differential

diagnosis of the causes of unthriftness. That faecal egg counts provide a useful aid to such diagnosis is indicated by present investigation. The discrepancy between EPG and worm burden in an individual animal is likely to be reduced when egg counts of a large number of animals are available (Stampa and Linde, 1972; Roberts and Swan, 1981). When egg and worm counts were categorised according to the concept of low, moderate and high the association between them was found to be almost equally consistent in all age classes of sheep (McKenna, 1981). In this study the faecal egg counts is found to be a reliable measure of the size of the strongyle worm burdens. These results are in agreement with the findings of Roberts, 1957; Thomas and Boag, 1973; Kloosterman *et al.* 1974; McKenna, 1981. Many other authors found a poor relationship between the faecal egg counts and worm burdens (Rubin,1967; Smeal *et al.*, 1977; Rose and small, 1980). According to them faecal egg counts may be influenced by such variables as faecal output, composition of infection and host resistance. Moreover the egg counting provide the little information about the occurrance of immature worms.

SEX-WISE DISTRIBUTION OF PARASITES:

The sex-wise results reveal that the female goats are more infected with different species of helminth parasites than male goats, which is not in conformity with that of Mohiuddin *et al.* (1984) who had previously reported that males were more infected than female. However the findings of these results are in agreement with that of Asanji (1987) who had reported that female animals generally harboured a significantly higher worm load than male animals. The reason could be due to the fact that during the lactating days the female animals eat more pasture as compared to their normal days. Moreover according to Southcott *et al.* (1972) rises in egg output is unrelated to the season, but high due to low host resistance during parturation and lactation. Thus it may also be concluded that the lactating female goats might got the heavy infection during the previous year before they slaughtered. No such type of relationship in case of sheep is work out as the male sample size was not significantly high to that ewes.

BREED-WISE DISTRIBUTION OF PARASITES

Results of present investigation reveal a higher incidence of infection in Kaghani breed of sheep and goats, except for Balkhi breed of sheep which showed a small rise, all the rest of the sheep and goat breeds show a uniform infection in their respective categories. In case of Kaghani breed a small sample of three sheep was examined and all were positive for helminthic infection. Unless a large sample is examined the results cannot be representive of rate of infection. It is to be pointed out that Kaghani sheep and goat and Balkhi breed of sheep are reared by nomad tribes who roam about from one place to another in search of pastures. In winter they come to plains as far as Islamabad and Jhelum. This habit of migration makes sheep and goats more prone to helminthic infections. In the rest of the breeds of sheep and goats there is no migration of the breeders and the flocks remains settled in their particular areas. It may be also be pointed out that certain helminth parasites are also genetically controlled (Blood *et al.*, 1983) and thus genetic variations could also be the other factor, which still remains unexplored in this part of the world.

AREAS-WISE DISTRIBUTION OF PARASITES:

The incidence of nematode parasites in an area is directly related to the ability of the pre-parasitic stages to withstand the environmental conditions.(Gupta *et al.*,1987). According to Blood *et al.* (1983) variations in infection intensity could be due to differences in the micro and macro climate of the environment and volume and height of the pastures. The prevailing agroclimatic conditions of the areas surveyed such as overstocking of animals, grazing of young and adult animals together with poorly drained land provide an ideal conditions for the transmission and translation of gastrointestinal nematodes, particularly *Haemonchus contortus, Trichostrongylus* spp., *Ostertagia* spp. and *Oesophagestomum* spp. to build up clinical infections in the hosts. The low incidence of *H. contortus* was recorded in Swat region could be due to the fact that the prevailing climatic conditions are not suitable for the development and survival of the pre-parasitic stage of *H. contortus*. The highest incidence of *Trichostrongylus* spp. in Swat region could be attributed to the fact that the *Trichostrongylus* spp. are generally cool seasoned parasites thriving best when

mean monthly temperature range from 14-18°C and disappearing when temperature exceeds 20°C (Grant, 1981). These climatic conditions are satisfied in this region. Similarly the higher incidence of *Ostertagia* spp. in Swat region is also due to the climatic conditions that favoured the development and survival of pre-parasitic stages of this parasites. The lowest incidence of various nematodes in Chakwal district could be due to the prevailing summer conditions (high temperature and rapid evaporation) are deteterious for the translation and transmission of infective stages (Gupta *et al.*, 1987).

The findings of this investigation reveals that sheep are more prone to parasitic infection as compared to goats are in agreement with that of Mohiuddin *et al.* (1984), Al-Quaisy (1987), Marwat *et al.* (1988) and Khan *et al.* (1989). This is because of peculiar grazing habits of goats which prefer to graze upon the shrubs, thus reducing the chances of contamination from the ground. The higher overall incidence of helminthic infection in the areas surveyed could be attributed to malnutrition and poor pasture management of livestock. All the livestock in Barani areas largely depends

on grazing in deteriorated range-lands because they cannot fullfil the food requirements of the livestock. It is also observed that the farms in these areas lack perimeter fences, and cattle, sheep and goats use the same pasture at high stocking rates. Moreover there are two distinct periods when the grazing land produce forage at a faster rate i.e. from March-April and July to September. During this period humidity and temperature are ideally suitable for the development of free-living stages of many nematodes and also the availability of intermediate hosts. It is well known that poorly fed animals are more prone to the effects of helminth parasites. Poor pasture management also play an important role in the survival of parasitic larvae (Blood *et al.*, 1983). The low worm burden is reported during this investigation is may be two fold. In the first instance the poor water facilities in the surveyed areas, especially Chakwal, Attock, Rawalpindi-Islamabad which could hardly have created favourable conditions for the hatching of nematode larvae and their release from pellets. The second possible explanation is the age of the animals slaughtered in the early part of the season may well have precluded them from harbouring a heavy worm burdens or may also be due to

previously used anthelminthic treatments. On the basis of the forgoing results, it has been concluded that some control measures for the gastrointestinal helminth parasites should be undertaken to reduce the intensity of infection. For this it is advised that these animals should not be grazed on poorely managed pastures or poorly drained area, stocking rate should be kept low, the forced grazing should be discouraged and young and adult animals should be grazed separately. It has also been suggested that infection in which the intermediate hosts are involved some control measures should be taken to reduce their population density especially in those areas having the extensive irrigation facilities. The results reveal that the infection is high during the rainy season because of an ideal prevailing climatic conditions that faciliates to enhance their development and survival rates thus elevating the risks of re-infection in the rainy season. Therefore it is advised to use the broad spectrum anthelminthic drugs after 30-40 days.

A qualitative and quantitative survey and seasonal variations of gastrointestinal helminth parasites of sheep and goats slaughtered at Rawalpindi-Islamabad abattoirs was carried out from January, 1990 to January, 1991. The following twenty species of helminths were recorded:- *Paramphistomum cervi, Cotylophoron cotylophorum, Gastrothylax crumenifer, Moniezia expansa, Moniezia benedeni, Stilesia vittata, Avitellina centripunctata, Haemonchus contortus, Ostertagia ostertagi, Ostertagia circumcineta, Trichostrongylus axei, Trichostrongylus colubriformis, Trichuris ovis, Trichuris lani, Trichuris globulosa, Skrjabinema ovis* and *Bunostomum trigonocephalum* the last two were not found in sheep *Cotylophoron cotylophorum, M. expansa* and *H. contortus* were the dominant species of each class. Sheep harboured 18, while goats 20 species of helminths. No single host contained all the 20 helminth species, but the number of individual helminth harboured by each host ranged from one to seven. The overall mean annual prevalence of infection for sheep and goats was 88.42% and 84.83% respectively. There was seasonal variation in the relative

densities of all helminth except *B. trigonocephalum* and *Skrjabinema ovis* which showed a rainy season rise from July-October.

Faecal examination showed that a higher number of eggs was shed from July to October and was found a reliable measure of the size of strongyle worm burdens. Insignificant numbers of immature worms were recorded during the digestion of abomasal wall. The young animals were more infected as compared to old ones. On the basis of sex female goats was more prone to infection as compared to male goats, while no such relationship was worked out in sheep. The Balkhi breed of sheep and Kaghani breed of sheep and goats were found more infected as compared other breeds of sheep and goats of their respective categories. By area-wise trematodes were prevalent in the Sargodha, Khushab, Gujrat and Jhelum district, while cestodes and nematodes were present in almost all the districts surveyed so far.

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APPENDIX

Table: 27

Monthly incidence of Cotylophoron cotylophorum

Host:- Sheep

Months	Total GI Examined in a Month	Number of total GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	1	5	3	0 - 3	3
Feb.	23	2	8.69	22	8 - 14	11
March.	25	3	12	45	1 - 27	15
April	24	1	4.16	31	0 - 31	31
May	28	-	-	-	-	-
June	28	-	-	-	-	-
July	27	13	48.14	213	1 - 52	16
Aug.	29	12	41.37	211	1 - 75	17
Sept.	28	10	3.57	166	1 - 61	16
Oct.	29	7	24.13	85	1 - 31	12
Nov.	21	4	19.04	87	10--31	21
Dec.	29	3	10.34	29	7 - 12	9

Table: 28

Monthly incidence of *Cotylophoron ovatum*

Host: Sheep

Months	Total GI Examined in a Month	Number of GI Infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	–	–	–	–	–
Feb.	23	–	–	–	–	–
March.	25	–	–	–	–	–
April	24	1	4.16	2	0-2	2
May	28	–	–	–	–	–
June	28	–	–	–	–	–
July	27	6	22.22	67	3-24	11
Aug.	29	2	6.89	22	8-14	11
Sept.	28	4	14.28	30	3-11	7
Oct.	29	3	10.34	24	2-9	8
Nov.	21	2	9.52	29	12-17	14
Dec.	29	–	–	–	–	–

Table: 29

Monthly incidence of *Gastrothylax crumenifer*

Host:-Sheep

Months	Total GI Examined in a Month	Number of GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	3	15	81	7-15	27
Feb.	23	2	8.69	94	33-61	47
March.	25	-	-	-	-	-
April	24	-	-	-	-	-
May	28	5	17.85	122	9-45	24
June	28	1	3.57	14	0-14	14
July	27	7	25.92	345	6-130	49
Aug.	29	8	27.58	213	8-75	26
Sept.	28	8	28.57	126	4-56	15
Oct.	29	5	17.24	103	7-71	20
Nov.	21	1	4.76	18	0-18	18
Dec.	29	-	-	-	-	-

Table: 30

Monthly incidence of *Paramphistomum cervi*

Host:-Sheep

Months	Total GI Examined in a Month	Number of GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	5	25	90	1-48	18
Feb.	23	3	13.04	76	9-50	25
March.	25	4	16	65	1-35	16
April	24	1	4.16	9	0-9	9
May	28	1	3.57	15	0-15	15
June	28	6	-	-	-	-
July	27	2	7.40	70	23-47	35
Aug.	29	8	27.56	163	1-115	20
Sept.	28	9	32.14	199	2-112	22
Oct.	29	8	27.56	356	1-107	44
Nov.	21	-	-	-	-	-
Dec.	29	3	10.43	227	35-101	75

Table: 31

Monthly incidence of *Moniezia benedeni*

Host:- Sheep

Months	Total GI Examined in a Month	Number of GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	3	15	9	1-6	3
Feb.	23	4	17.39	22	1-9	5
March.	25	5	20	23	2-8	4
April	24	3	12.5	14	1-10	4
May	28	4	14.28	23	3-9	5
June	28	2	7.14	14	6-8	7
July	27	1	3.70	2	0-2	2
Aug.	29	2	6.89	10	1-4	2
Sept.	28	3	10.71	10	1-6	3
Oct.	29	4	13.79	17	1-8	4
Nov.	21	3	14.28	11	2-6	3
Dec.	29	1	3.44	7	0-7	7

Table:- 32

Monthly incidence of *Stilesia vittata*

Host:- Sheep

Months	Total GI Examined in a Month	Number of GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	1	5	5	0-5	5
Feb.	23	-	-	-	-	-
March.	25	1	4	12	0-12	12
April	24	3	12.5	22	4-10	7
May	28	-	-	-	-	-
June	28	-	-	-	-	-
July	27	-	-	-	-	-
Aug.	29	-	-	-	-	-
Sept.	28	5	17.85	41	2-14	8
Oct.	29	-	-	-	-	-
Nov.	21	-	-	-	-	-
Dec.	29	-	-	-	-	-

Table: 33

Monthly incidence of *Avitellina centripunctata*

Host:-Sheep

Months	Total GI Examined in a Month	Number of GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	4	20	23	1-11	5
Feb.	23	5	21.73	34	2-13	6
March.	25	5	20	28	2-10	5
April	24	10	41.66	63	1-14	6
May	28	9	32.14	70	1-16	7
June	28	10	35.71	79	1-15	7
July	27	13	48.14	95	1-19	7
Aug.	29	9	31.03	67	1-15	7
Sept.	28	10	35.71	60	1-18	6
Oct.	29	10	34.48	64	1-13	6
Nov.	21	9	42.85	93	3-25	10
Dec.	29	8	27.58	85	2-20	10

Table: 34

Monthly incidence of *Moniezia expansa*

Host:- Sheep

Months	Total GI Examined in a Month	Number of GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	8	40	38	2-9	4
Feb.	23	5	21.73	17	1-7	3
March.	25	4	16	16	3-6	4
April	24	3	12.5	9	1-5	3
May	28	3	10.71	17	3-8	5
June	28	-	-	-	-	-
July	27	8	29.62	45	1-11	5
Aug.	29	14	48.27	66	1-10	4
Sept.	28	13	46.42	65	1-9	5
Oct.	29	10	34.48	42	1-9	4
Nov.	21	8	38.09	37	1-8	4
Dec.	29	12	41.37	48	1-9	4

Table: 35

Monthly incidence of *Paramphistomum cervi*

Host:- Goats

Months	Total GI Examined in a Month	Number of GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	4	20	78	2-35	19
Feb.	25	3	12	55	3-38	18
March.	31	3	9.67	28	8-11	9
April	24	2	8.33	17	2-15	8
May	22	-	-	-	-	-
June	29	-	-	-	-	-
July	29	2	6.89	45	18-27	22
Aug.	31	8	25.80	64	2-17	8
Sept.	30	9	30	101	2-21	11
Oct.	33	10	30.30	156	2-56	15
Nov.	37	3	8.10	45	6-27	15
Dec.	31	6	19.35	53	2-18	8

Table: 36

Monthly incidence of *Gastrothylax crumenifer*

Host:- Goats

Months	Total GI Examined in a Month	Number of GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	2	10	34	12-22	17
Feb.	25	1	4	15	0-15	15
March.	31	2	6.45	37	6-31	18
April	24	-	-	-	-	-
May	30	-	-	-	-	-
June	22	-	-	-	-	-
July	29	6	20.68	99	2-37	16
Aug.	31	8	25.80	65	2-21	8
Sept.	30	4	13.37	63	3-29	15
Oct.	33	2	6.06	47	11-36	23
Nov.	37	4	10.81	41	6-15	10
Dec.	30	1	3.22	21	0-21	21

Table: 37

Monthly incidence of Cotylophoron cotylophorum

Host:- Goats

Months	Total GI Examined in a Month	Number of GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	3	15	23	2-15	7
Feb.	23	7	30	57	1-21	8
March.	31	5	16.12	111	6-48	22
April	24	2	8.33	14	0-14	7
May	30	-	-	-	-	-
June	22	-	-	-	-	-
July	29	2	6.89	22	1-21	11
Aug.	31	8	25.80	65	1-18	8
Sept.	30	6	20	45	2-17	7
Oct.	33	3	9.09	50	12-21	16
Nov.	37	6	16.21	112	2-46	18
Dec.	31	1	3.22	8	0-8	8

Table: 38

Monthly incidence of *Cotylophoron ovatum*

Host:- Goats

Months	Total GI Examined in a Month	Number of GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range burden	Average worm burden
Jan.	20	-	-	-	-	-
Feb.	25	-	-	-	-	-
March.	31	-	-	-	-	-
April	24	-	-	-	-	-
May	30	-	-	-	-	-
June	22	-	-	-	-	-
July	29	1	3.44	2	0-2	2
Aug.	31	-	-	-	-	-
Sept.	30	2	6.66	4	1-3	2
Oct.	33	1	3.03	2	0-2	2
Nov.	37	-	-	-	-	-
Dec.	31	-	-	-	-	-

Table: 39

Monthly incidence of *Moniezia expansa*

Host:- Goats

Months	Total GI Examined in a Month	Number of total GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	3	15	14	2-7	4
Feb.	25	4	16	19	2-9	4
March.	31	12	38.70	55	1-11	4
April	24	10	41.66	45	1-7	4
May	30	11	36.66	47	1-9	4
June	22	1	4.54	7	0-7	7
July	29	89	27.58	41	1-9	5
Aug.	31	20	64.51	89	1-8	4
Sept.	30	6	20	40	1-13	6
Oct.	33	15	45.45	59	1-8	4
Nov.	37	10	27.02	51	1-9	5
Dec.	31	5	16.12	23	1-9	4

Table: 40

Monthly incidence of *Moniezia benedeni*

Host:- Goat

Months	Total GI Examined in a Month	Number of total GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	1	5	7	0-7	0.35
Feb.	25	3	12	14	2-8	4
March.	31	2	6.45	16	7-9	8
April	24	4	16.66	24	2-8	6
May	30	5	16.66	25	1-9	5
June	22	-	-	-	-	-
July	29	3	10.34	8	1-6	2
Aug.	31	2	6.45	15	6-9	7
Sept.	30	4	13.33	14	1-7	3
Oct.	33	3	9.09	19	1-10	6
Nov.	37	1	2.70	10	0-10	10
Dec.	31	2	6.45	15	6-9	7

Table: 41

Monthly incidence of *Avitellina centripunctata*

Host:- Goat

Months	Total GI Examined in a Month	Number of total GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	2	10	18	7-11	9
Feb.	25	3	12	76	1-11	25
March.	31	2	6.45	10	3-7	5
April	24	6	25	34	2-8	5
May	30	10	33.33	40	1-9	4
June	22	8	33.36	46	2-8	5
July	29	14	48.27	114	1-44	8
Aug.	31	15	48.38	96	1-16	6
Sept.	30	13	43.33	80	1-11	6
Oct.	33	9	27.27	56	1-9	6
Nov.	37	10	27.02	25	1-6	2
Dec.	31	8	25.8	41	1-7	5

Table: 42

Monthly incidence of *Stilesia vittata*

Host:- Goats

Months	Total GI Examined in a Month	Number of total GI infected	Percentage of infection (%)	Total worm burden in a month	Monthly Range	Average worm burden
Jan.	20	5	25	39	2-13	7
Feb.	25	-	-	-	-	-
March.	31	1	3.22	3	0-3	3
April	24	2	8.33	13	5-8	6
May	30	-	-	-	-	-
June	22	-	-	-	-	-
July	29	-	-	-	-	-
Aug.	31	-	-	-	-	-
Sept.	30	1	3.33	10	0-10	10
Oct.	33	-	-	-	-	-
Nov.	37	-	-	-	-	-
Dec.	31	-	-	-	-	-

Table: 43

Monthly incidence of: Trichuris globulosa

	GOATS			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	1	5	10	0-10	10
Feb.	25	1	4	13	0-13	13
March	31	2	6.45	10	5-10	5
April	24	6	25	69	3-68	12
May	30	4	13.33	42	4-14	10
June	22	-	-	-	-	-
July	29	1	3.44	3	0-3	3
Aug.	31	-	-	-	-	-
Sept.	30	-	-	-	-	-
Oct.	33	3	9.09	21	5-10	7
Nov.	37	2	5.40	25	12-25	12
Dec.	31	2	6.45	39	13-39	13

Table: 44

Monthly incidence of: Haemonchus contortus

	SHEEP			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	3	15	20	2-10	6
Feb.	23	5	21.73	50	1-18	10
March	25	6	24	77	3-18	12
April	24	10	41.66	177	5-31	17
May	28	21	75	2112	8-198	100
June	28	25	89.28	5796	62-625	231
July	27	25	92.59	9216	108-938	368
Aug.	29	28	96.55	10440	61-1188	372
Sept.	28	28	100	16640	35-1360	594
Oct.	29	27	93.10	7600	18-732	281
Nov.	21	18	85.71	2510	17-661	139
Dec.	29	15	51.72	905	15-505	60

Table: 45

Monthly incidence of Oesophagostomum columbianum

	SHEEP			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	12	60	468	4-87	39
Feb.	23	12	52.17	271	6-47	22
March	25	16	64	611	8-98	38
April	24	18	75	763	1-127	42
May	28	20	71.42	711	1-181	35
June	28	15	53.57	863	2-239	57
July	27	12	37.03	319	4-75	26
Aug.	29	12	41.37	291	1-54	24
Sept.	28	11	39.28	123	1-16	11
Oct.	29	25	86.20	464	2-39	18
Nov.	21	19	80.95	329	1-25	17
Dec.	29	24	82.75	621	2-84	25

Table: 46

Monthly incidence of Oesophagostomum venulosum

	SHEEP			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	–	–	–	–	–
Feb.	23	–	–	–	–	–
March	25	–	–	–	–	–
April	24	2	8.33	13	3-10	6
May	28	4	14.28	88	5-24	22
June	28	5	17.85	69	2-21	13
July	27	6	22.22	53	1-11	8
Aug.	29	1	3.44	9	0-9	9
Sep.	28	2	7.14	18	3-15	9
Oct.	29	2	6.89	10	3-7	5
Nov.	21	6	28.57	71	6-13	11
Dec.	29	3	10.34	30	4-12	10

Table: 47

Monthly incidence of Trichuris ovis

Month	SHEEP			WORMS		
	Examined	Infected	% infected	Total	Range	Average
Jan.	20	13	65	369	3-102	28
Feb.	23	10	43	255	6-45	25
March	25	4	16	93	2-38	23
April	24	9	37.5	81	14-28	9
May	28	11	39.28	205	9-52	18
June	28	3	10.71	31	2-21	10
July	27	4	14.81	53	2-15	13
Aug.	29	8	27.58	157	2-21	19
Sept.	28	5	17.85	108	2-39	21
Oct.	29	12	41.37	238	2-61	19
Nov.	21	14	66.66	384	6-67	27
Dec.	29	13	44.82	254	4-39	19

Table: 48

Monthly incidence of Ostertagia ostertagi

	SHEEP			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	5	25	54	4-20	10
Feb.	23	3	13.04	60	4-27	20
March	25	15	60	641	3-101	42
April	24	11	45.83	624	6-167	56
May	28	8	28.57	276	7-81	34
June	28	10	35.71	1240	28-320	124
July	27	23	85.18	4217	7-763	183
Aug.	29	28	96.55	7357	11-765	262
Sept.	28	26	92.85	5075	7-635	195
Oct.	29	18	62.06	3324	11-400	184
Nov.	21	12	57.14	1077	6-202	89
Dec.	29	9	31.03	645	7-173	71

Table: 49

Monthly incidence of *Ostertagia circumcincta*

	SHEEP			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	–	–	–	–	–
Feb.	23	1	4.34	23	0–23	23
March	25	1	4	28	0–28	28
April	24	–	–	–	–	–
May	28	–	–	–	–	–
June	28	2	7.14	44	12–32	22
July	27	2	7.40	21	6–15	10
Aug.	29	4	13.79	68	3–34	17
Sept.	28	2	7.14	15	3–12	7
Oct.	29	4	13.79	46	6–23	11
Nov.	21	1	4.76	8	0–8	8
Dec.	29	–	–	–	–	–

Table: 50

Monthly incidence of Trichostrongylus axei

	SHEEP			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	10	50	1015	7-24	101
Feb.	23	11	47.82	784	5-152	71
March	25	10	40	682	9-198	68
April	24	14	58.33	1319	18-208	94
May	28	12	42.85	2691	112-455	224
June	28	9	32.14	3058	8-781	339
July	27	14	51.85	2386	17-779	170
Aug.	29	20	68.96	41 93	13-769	209
Sept.	28	19	67.85	3064	8-611	161
Oct.	29	16	55.17	1904	5-307	119
Nov.	21	11	52.38	583	6-131	53
Dec.	29	14	48.27	946	8-181	67

Table: 51

Monthly incidence of *Trichostrongylus colubriformis*

	SHEEP			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	7	35	319	2-53	45
Feb.	23	11	47.82	534	4-49	48
March	25	8	32	281	11-38	35
April	24	4	16.66	171	4-79	42
May	28	3	10.71	69	6-38	23
June	28	4	14.28	43	2-26	10
July	27	5	18.51	61	1-31	12
Aug.	29	18	62.06	146 3	18-319	81
Sept.	28	12	42.85	819	13-197	68
Oct.	29	16	55.17	1013	22-281	63
Nov.	21	9	42.85	398	9-135	44
Dec.	29	8	27.58	464	6-81	58

Table: 52

Monthly incidence of Trichuris lani

	SHEEP			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	1	5	4	4	0-4
Feb.	23	1	4.34	16	16	0-16
March	25	1	4	13	13	0-13
April	24	-	-	-	-	-
May	28	-	-	-	-	-
June	28	-	-	-	-	-
July	27	-	-	-	-	-
Aug.	29	-	-	-	-	-
Sept.	28	-	-	-	-	-
Oct.	29	-	-	-	-	-
Nov.	21	-	-	-	-	-
Dec.	29	-	-	-	-	-

Table: 53

Monthly incidence of Trichuris globulosa

	SHEEP			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	–	–	–	–	–
Feb.	23	–	–	–	–	–
March	25	1	4	12	0–12	12
April	24	2	8.33	28	5–23	14
May	28	1	3.57	9	0–9	9
June	28	–	–	–	–	–
July	27	–	–	–	–	–
Aug.	29	1	3.44	19	0–19	19
Sept.	28	1	3.57	11	0–11	11
Oct.	29	2	6.89	30	14–16	15
Nov.	21	–	–	–	–	–
Dec.	29	–	–	–	–	–

Table: 54

Monthly incidence of Trichostrongylus axei

	GOATS			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	11	55	87	2-19	7
Feb.	25	14	56	168	2-39	12
March	31	16	51.61	546	6-81	34
April	24	10	41.66	63	1-14	6
May	30	9	30	56	1-17	6
June	22	8	36.36	20	1-6	2
July	29	11	37.93	84	1-21	7
Aug.	31	23	74.19	1258	8-162	54
Sept.	30	23	76.66	1422	7-189	61
Oct.	33	21	63.63	1443	11-231	68
Nov.	37	26	70.27	2299	6-301	88
Dec.	31	18	58.86	798	4-251	44

Table: 55

Monthly incidence of Trichostrongylus colubriformis

	GOATS			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	5	25	57	4-13	11
Feb.	25	8	32	155	2-71	19
March	31	4	12.90	68	8-29	17
April	24	4	16.66	95	7-43	23
May	30	4	13.33	132	10-61	33
June	22	1	4.54	3	0-3	3
July	29	5	17.24	48	4-18	9
Aug.	31	20	64.51	653	3-99	32
Sept.	30	17	56.66	726	1-127	42
Oct.	33	13	39.39	418	1-171	32
Nov.	37	12	32.43	387	1-121	32
Dec.	31	2	6.45	21	3-181	10

Table: 56

Monthly incidence of Trichuris ovis

	GOATS			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	9	45	80	8	3-18
Feb.	25	8	32	152	19	4-39
March	31	10	32.25	204	20	6-63
April	24	6	25	222	37	8-71
May	30	2	6.66	53	26	15-38
June	22	-	-	-	-	-
July	29	-	-	-	-	-
Aug.	31	8	25.80	421	52	4-142
Sept.	30	8	26.26	503	62	8-150
Oct.	33	9	27.2	556	61	6-161
Nov.	37	8	21.62	625	78	18-135
Dec.	31	10	32.25	278	27	4-61

Table: 57

Monthly incidence of Ostertagia circumcincta

	GOATS			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	–	–	–	–	–
Feb.	25	–	–	–	–	–
March	31	–	–	–	–	–
April	24	1	4.16	18	0–18	18
May	30	1	3.33	21	0–21	21
June	22	–	–	–	–	–
July	29	7	24.13	58	6–16	8
Aug.	31	6	19.35	139	8–45	23
Sept.	30	6	20	258	10–89	43
Oct.	33	3	12	21	2–11	7
Nov.	37	2	5.40	23	8–15	11
Dec.	31	–	–	–	–	–

Table: 58

Monthly incidence of Haemonchus contortus

	GOATS			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	3	15	5	1-30	1
Feb.	25	6	24	17	1-10	2
March	31	10	32.25	49	2-18	4
April	24	11	45.83	162	1-38	14
May	30	20	66.66	675	1-142	33
June	22	5	22.72	345	2-80	69
July	29	23	79.31	1102	4-125	47
Aug.	31	29	93.54	2594	8-239	89
Sept.	30	28	93.33	3804	11-411	135
Oct.	33	28	84.84	4903	19-531	175
Nov.	37	27	72.97	5120	45-739	189
Dec.	31	20	64.51	2552	11-419	127

Table: 59

Monthly incidence of Oesophagostomum venulosum

	GOATS			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	-	-	-	-	-
Feb.	25	-	-	-	-	-
March	31	-	-	-	-	-
April	24	1	4.16	3	0-3	3
May	30	-	-	-	-	-
June	22	-	-	-	-	-
July	29	1	3.44	6	0-6	6
Aug.	31	2	6.46	13	4-9	6
Sept.	30	3	10	28	2-10	9
Oct.	33	5	15.15	5103	4-12	10
Nov.	37	1	2.70	41	0-4	41
Dec.	31	1	3.22	8	0-8	8

Table: 60

Monthly incidence of Oesophagostomum columbianum

	GOATS			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	8	40	78	1-29	9
Feb.	25	10	40	154	3-43	15
March	31	10	32.25	219	1-63	21
April	24	15	62.5	384	3-61	25
May	30	20	66.66	1120	2-130	56
June	22	11	50	30	1-9	2
July	29	22	75.86	1043	4-187	47
Aug.	31	20	64.51	1290	3-193	64
Sept.	30	20	66.66	1339	5-287	66
Oct.	33	23	69.69	1241	1-197	53
Nov.	37	26	70.27	1318	1-231	50
Dec.	31	20	64.51	987	1-201	49

Table: 61

Monthly incidence of Ostertagia ostertagi

	GOATS			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	3	15	10	2-5	3
Feb.	25	10	40	41	2-9	4
March	31	10	32.25	219	3-51	21
April	24	11	45.83	291	2-40	26
May	30	5	16.66	99	1-34	17
June	22	5	22.72	66	2-23	13
July	29	21	72.41	1103	6-121	52
Aug.	31	28	90.32	2631	10-147	93
Sept.	30	26	86.66	3715	13-181	142
Oct.	33	22	66.66	4094	21-270	186
Nov.	37	23	62.16	2139	8-159	93
Dec.	31	8	25.80	639	1-139	79

Table: 62

Monthly incidence of Skrjabinema ovis

	GOATS			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	–	–	–	–	–
Feb.	25	1	40	101	1–101	101
March	31	1	3.22	55	0–55	55
April	24	2	8.33	163	25–163	81
May	30	1	3.33	714	0–714	714
June	22	–	–	–	–	–
July	29	–	–	–	–	–
Aug.	31	–	–	–	–	–
Sept.	30	–	–	–	–	–
Oct.	33	–	–	–	–	–
Nov.	37	–	–	–	–	–
Dec.	31	–	–	–	–	–

Table: 63

Monthly incidence of Bunostomum trigonocephalum

	GOATS			WORMS		
Month	Examined	Infected	% infected	Total	Range	Average
Jan.	20	–	–	–	–	–
Feb.	25	–	–	–	–	–
March	31	–	–	–	–	–
April	24	–	–	–	–	–
May	30	–	–	–	–	–
June	22	–	–	–	–	–
July	29	2	6.89	3	1–2	1
Aug.	31	1	3.22	4	0–4	4
Sept.	30	2	6.66	6	3–6	3
Oct.	33	2	9.09	6	2–4	3
Nov.	37	–	–	–	–	–
Dec.	31	–	–	–	–	–