EPIDEMIOLOGY, PATHOLOGY AND CHEMOTHERAPY OF GASTRO-INTESTINAL HELMINTHIASIS IN GOATS

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C E R T I F I C A T E

This is to certify that this thesis entitled "Epidemiology, pathology and Chemotherapy of gastro-intestinal helminthiasis in goats" submitted in partial fulfilment of the requirements for the degree of Master of Veterinary Science in Parasitology of the Orissa University of Agriculture and Technology, Bhubaneswar is a bonafide and original research work carried out by Sri Pranabandhu Sahoo under my guidance and supervision. No part of this thesis has been submitted for any degree or diploma earlier.

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DEDICATED TO MY BELOVED

PARENTS

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(PRANABANDHU SAHOO)

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I N T R O D U C T I O N

India is primarily an agricultural country. Although the food production in India has gone up due to green revolution during the last 30 years and the agricultural production has been more than doubled yet the per capita consumption of food grains is low in comparison to developed nations. For combating this food problem in India rigorous attempts are being made to trigger up the green and white revolution. In spite of this "protein hunger" remains a serious concern of everybody.

Meat and meat products are excellent sources of protein for human dietary. With the increase in living standard and earning capacity there is a great demand for animal protein in Indian market. The source of meat in India are sheep, goat, pig and poultry. Out of these, goat is most popular meat animal in India. The highest percentage i.e., 35 % of meat produced in India is derived from goats (Mishra, 1976).

The goat is the earliest ruminant to be domesticated (Zeuner, 1963) and is very valuable animal for economic milk and meat production. Europe, England and America have long realised the value of goat, giving it the term "Poor man's cow" (Slater and Bhatia, 1939-40).

In Switzerland a milch goat is called the Swiss baby's foster mother (Singh, 1966).

India ranks first among the countries of the world in goat population having one-fifth of world's goat population. The goat is an ubiquitous animal. It can be well adopted to the hot humid climates of tropics. Goat is probably the only animal which is bred for multiple objects, viz., meat, hide, milk, manure and goat mohair. Besides its milk forms an ideal food for infants and children. Goat meat is preferred to mutton in India and fetches better price than other meat in most of the urban market. The dressing percentage is between 43 to 45 per cent. Goat skins are used for shoes, gloves, book bindings, jackets, water bags, cheap brief cases and other items. Mohair from Angora goats and Pashmina from Kashmir goats are greatly valued for the manufacture of superior fabrics and shawls. Intestines of this animal is used in the cat gut industry (Singh, loc. cit.). Nearly two quintals of manure is yielded by each goat over a year. Goat urine is equally rich in both nitrogen and potash and more valuable than that of any other animal. Thus in India, the economic value of the goats has been fully realised, and therefore, a great deal of attention for their improved breeding, proper management and disease control is being paid with a view to meet the rural poverty and increase the economy of the country. The I. C. A. R. has launched a few co-ordinated projects viz., D.R.D.A. (District Rural

Development Agency), M.A.D.A. (Mountainious Area Development Agency) and T.D.A. (Tribal Development Agency) for cross-breeding the local goats with improved breeds for increased milk and meat production. It has been seen that these programmes for multiplication of goats has not only increased the production of animal food but has also provided livelihood to a large number of scheduled class families and landless people in this State.

Among all important diseases of goats, the parasitic diseases play a great havoc in rural areas; where farmers are completely ignorant about the loss caused by the parasites. Unlike other animals, goats are comparatively less prone to some of the serious diseases. The helminthic infection, however, is fairly common, which undermines the health and productivity of this useful animal (Singh, loc. cit.). One of the greatest danger of optimal profit of stock is, however, the endoparasitic infection (Banks et al., 1966). The direct losses from helminthiasis are infinitesimal as compared to the indirect losses, such as failure to put on weight in spite of proper feeding and housing; decrease in the milk yield, meat and mohair, decrease in the number of off-springs; and worst of all a decreased resistance to intercurrent diseases. In a tropical country like India, helminths play more havoc than virus and bacterial diseases taken together, because of a protracted chronic onset of the parasitic infection resulting in uneconomic animals. Prasad (1949) gave a brief account

of chief groups of helminths of sheep and goats in India. He had opined that success and failure of mutton industry depends largely on the extent to which these parasitic diseases can be kept within bounds. Minnet (1950) while discussing the mortality of sheep and goats in India, concluded that the majority of deaths in goats due to helminthic infection occur before one year of age. Prevalence of helminths in goats at different places in India has been reported by several workers (Bhalerao, 1935; Pande, 1942; Moghe, 1945; Thapar, 1956; Sahu and Pandit, 1959; Patnaik, 1963; Endrejat, 1964; Misra and Ruprah, 1968; Misra, 1972 ; Dutt, 1980).

Misra et al. (1971) while studying the seasonal distribution of gastrointestinal helminths in sheep of Orissa, stated that in a tropical country like India, especially in Orissa, presence of varied physical features, varied climatic conditions, over stocking of the pastures and warm humid climate provide the most favourable conditions for the multiplication and dissemination of the parasites of livestock. Due to the expanding canal system, presence of enormous water logging areas and the prevalence of hot humid climate in the state, the statistical figures for parasitic infections are bound to change under the circumstances. Considering the importance of goats in uplifting the rural economy, the present investigation was undertaken with the following objectives with a view to

Provide adequate informations to the ignorant and poor farmers for minimizing the helminthic burdens in their goat herds, so as to make the mutton and milk industry more successful and profitable.

The objectives of the present investigation are to study:

1 Incidence and intensity of infection of gastro-intestinal helminths in local goats in relation to age, sex and season.

2 Population dynamics of parasitic larvae in and around the goat yard.

3 Pathological changes caused by gastro-intestinal helminths in naturally infected goats.

4 Efficacy of Panacur (Fenbendazole, Hoechst) against natural infections of gastro-intestinal helminths in goats.

REVIEW OF LITERATURE

A. POPULATION DYNAMICS OF GASTRO-INTESTINAL HELMINTHS IN GOATS

Bhalerao (1933) recorded Oesophagostomum asperum, O. columbianum and O. venulosum from the caecum of hill goats (Capra sibirica) at Mukteswar. He also recorded Gongylonema verrucosum in goats for the first time in the world.

Oldham and Morgan (1934) on an examination of 80 goats found 66 infected with Trichostrongylus capricola, Skrjabinema ovis, Trichuris ovis, Chabertia ovina, Ostertagia circumcincta, O. columbianum, Trichostrongylus vitrinus and Haemonchus contortus. In Allahabad Harshey (1934) recorded Gastrothylax elongatus, G. cruvenifer, Cotylophoron cvatum n.sp., C. orientalis n.sp., and C. elongatus n.sp. from indigenous goats.

Kogel (1935) in Turkey reported the prevalence of Moniezia spp., 17 %; H. contortus, 30 %; Trichostrongylus, 28 %; ostertagia, 23 %; Strongyloides, 14 %; Nematodirus, 12 %; Oesophagostomum, 20 %; Bunostomum, 12 %; Trichuris, 10 %; Cooperia, 1 % in goats. Bhalerao (1935) reported the occurrence of Avitellina centripunctata, A. goughi, A. lahorea, A. sudanea, M. expansa, Stilesia globipunctata, S. vittata, Bunostomum trigonocephalum, B. phlebotomum, Gaigeria pachyscelis, Gongylonema pulchrum, H. contortus,

O. circumcincta, O. columbianum, O. venulosum, Trichocephalus alcocki (possible) and T. ovis in goats. Ortlepp (1937) reported G. pachyscelis as a common parasite of sheep and goats in arid ranges of South Africa.

Rao (1939-40) recorded 30 % of goats harbouring T. axei and T. colubriformis, in Madras. Narayan (1940-41) while dealing with the parasites of domestic animals in Kedah, reported the occurrence of T. ovis, O. columbianum, G. pachyscelis, T. axei, T. colubriformis, C. punctata, Ostertagia ostertagi, H. contortus, Paramphistomum cervi and H. expansa in goats. Bhalerao (1942) reported the occurrence of T. colubriformis, T. extenuatus, T. probolurus, Cooperia pectinata, C. punctata and O. ostertagi in goats from Muktesvar, Poona and Punjab. While studying the worm burdens of goats in Uttar Pradesh in 120 goats, Pande (1942) reported Cysticercus tenuicollis, 25 %; H. expansa, 2.5 %; S. globipunctata, 33.3 %; S. vitata, 8.3 %; A. centripunctata, 8.3 %; A. laharea, 5 %; A. sudanea, 3.3 %; Paramphistomes, 8.3 %; H. contortus, 66.6 %; T. colubriformis, 20.8 %; B. trigonocephalum, 16.6 %; O. columbianum, 50 % and T. ovis, 77.6 %. Moghe (1945) made a general survey on nature and incidence of helminths in sheep, goats and cattle of Baroda, Bombay, Central provinces and Berar. He found goats infected with Cotylophoron cotylophorum, O. crumenifer, Neoistocirrus digitatus, S. globipunctata, A. centripunctata, O. venulosum, O. radiatum, G. pachyscelis and B. trigonocephalum. Sarwal (1945) while studying the

incidence of some nematodes of domestic ruminants in Punjab and United Provinces reported T. axei, T. probulurus, O. ostertagi, O. mentulata and T. globulosa in goats. Srivastava (1945) in a survey work in the Punjab, North West Frontier Province and Sindh reported C. cotylophorum, 18 %; P. cervi, 32 %; C. crumenifer, 30 %; H. contortus, 27 %; Bunostomum spp., 23 % and Oesophagostomum spp., 10 % infection in goats. While submitting the Annual report of the Imperial Veterinary Research Institute, Muktesvar and Izatnagar, Anon (1946) mentioned the occurrence of Helictometra giardi in goat at Ajmer. He also reported the occurrence of A. centripunctata, O. mentulata and T. globulosa in goat in Punjab.

Muralidhar and Alwar (1947) mentioned in the check list of parasites in Madras the occurrence of P. cervi, C. cotylophorum, C. crumenifer, Fiscoederius elongatus, F. cobboldi, H. haemoni, S. vitata and Cammerius gregarius in goats. Muralidhar (1947-48) in the check list of nematodes noted the prevalence of S. ovis, O. venulosum, C. pachyscelis, T. colubriformis and T. alecocki in goats in Madras.

Tinar and Chin (1949) reported the occurrence of T. globulosa and T. ovis together in the caecum of a goat at Kweiyang, China. Sanchez (1950) recovered T. globulosa from a goat along with H. contortus, O. ostertagi, O. venulosum and a single specimen of

C. ovina in Spain. Sprehn (1953-54) on an examination of 222 goat herds in Germany found 172 herds infected with helminths, out of which 127 had predominance of O. circumcincta and 45 of Trichostrongylus extenuatus. The other gastrointestinal helminths recovered were A. centripunctata, M. expansa and O. asperum.

Rathore et al. (1955) reported H. contortus, O. columbianum and T. ovis in goats of Rajsthan. Lal (1956) examined 335 goats in Sardinia and found all were infected with H. contortus, O. ostertagi, O. circumcincta, O. trifurcata, O. pinnata, T. extenuatus, T. capricola, T. vitrinus and T. colubriformis.

Thapar (loc.cit.) while studying the helminthic infections of domesticated animals in the States of Uttar Pradesh, Bihar, Bengal (including East Bengal), Assam and Orissa reported C. cotylophorum, F. cobboldi, F. elongatus, G. crumenifer, P. explanatum, P. orthocoelium, P. trigonocephalum, Q. pachycoelis, G. pulchrum, H. contortus, N. filicollis, O. asperum, O. columbianum, O. venulosum, O. circumcincta, S. papillosus, T. colubriformis, T. ovis, A. centripunctata, A. lahorea, A. roti, A. sudanea, A. woodlandi, M. benedeni, M. expansa, and M. denticulata in goats.

Varma (1957) while collecting the amphistomes from domesticated animals, reported C. cotylophorum, 47.3 %, and Calicophoron calicophorum, 14.9 % in goats at Bihar.

Rahman (1958) in a survey of helminths in East Pakistan examined 400 goats and reported O. venulosum, 58 %; O. columbianum, 60 %; Trichuris spp., 20 %; M. expansa, 90 %; C. tenuicollis, 58 %; P. cervi, 25 % and C. cotylophorum, 30 % infection. Sokoleva (1958) recorded Avitellina spp., M. benedeni, C. tenuicollis, M. spathiger, M. giratianus and M. marshalli in Kyzylorda region among goats.

Malek (1959) reported the occurrence of C. cotylophorum, M. expansa, Avitellina spp., H. contortus, T. axei, T. ovis and Oesophagostum spp. in Sudanian goats. While working on the epidemiology of Dunestomum infection in goats at Uzbekistan during 1953 to 1955, Sarimsakov (1959) reported the average incidence of H. trigonocephalum to be 1.1 % in semiarid zone and 83.1 % in foot hill zone. While conducting a survey on the helminth parasites of domestic animals in Madhya Pradesh, Saha and Pandit (loc.cit. examined 274 goats and reported C. cotylophorum, 88.7 %; O. crumenifer, 68.6 %; P. cervi, 12 %; M. expansa, 81.4 %; Avitellina spp., 76.6 %; Stilesia spp., 75.5 %; C. tenuicollis, 39.9 %; H. trigonocephalum, 80.3 %; O. pachyscelis, 59.1 %; T. ovis, 8.8 %; O. columbianum, 14.6 %; H. contortus, 20.9 %; and H. similis, 59.9 % infection in goats.

While giving a host parasite check list of nematodes of domesticated ruminants, Srundson (1960)

stated the occurrence of C. ovina, H. contortus, N. filicollis, O. venulosum, O. circumcincta, T. axei, T. capricola, T. colubriformis, T. vitrinus, T. globulosa, T. ovis and T. parvispiculum among goats in Newzealand. Sarwar (1960) while carrying a survey of helminth infection of goats showed the occurrence of Marshallgia, Camelostrongylus mentulata, Avitellina, Moniezia, Trichuris, Skrjabinema and Haemonchus in Baluchistan. Dalcampillo et al. (1960) reported the occurrence of M. marshali, O. ostertagi, O. circumcincta in goats in Spain.

Alwar and Lalitha (1961) mentioned the occurrence of O. asperum in goats at Madras. Powers (1961) while dealing with bionomics of the genus Trichuris recorded the incidence of T. ovis, T. globulosa and T. discolor. Round (1962) recovered O. columbianum, O. multifolimum, B. trigonocephalum, T. externatus, T. colubriformis, T. probulurus, T. vitrinus, O. circumcincta, O. ostertagi, H. contortus, T. globulosa, Skrjabinema spp., M. expansa, S. globipunctata, C. temuicollis, Camyerius manucunatus from goats in Kenya.

Patnaik (1963) stated the occurrence of S. papillosus, O. columbianum, O. venulosum, O. asperum, B. trigonocephalum, G. pachyscelis, H. contortus, H. contortus var Utkalensis, M. digitatus, T. colubriformis, O. ostertagi, O. circumcincta, S. ovis, G. pulchrum, T. ovis, T. discolor, S. globipunctata, M. expansa, M. benedeni, A. centripunctata, C. temuicollis, P. cervi, G. crumenifer, F. elongatus, F. cobboldi, C. gregarius,

Homalogaster paloniae in goats of Orissa. Katiyar and Varshney (1963) reported that the average percentage of morbidity and mortality due to amphistomiasis in goat was 68.59 % and 75.54 % respectively in Uttar Pradesh. The amphistomes involved were G. crumenifer, C. cotylophorum, P. cervi and P. explanatum.

Patnaik (1964 a) recovered four species of Trichuris among goats from Orissa; viz., T. ovis, T. globulosa, T. discolor and T. ovina. In the same year he recovered O. asperum from 11 goats in Orissa and stated that the occurrence of O. venulosum and O. columbianum was extremely rare. During an investigation on helminthic infections in Assam, Endrojet (loc. cit.) recovered Paramphistomum spp., 17 %; Moniezia spp., 41 %; Strongyloides spp., 24 %; Trichuris spp., 62 %; Capillaria spp., 3 %; Bunostomum spp., 3 %; Oesophagostomum spp., 60 %; Trichostrongylus spp., 46 %; H. contortus, 75 %; Cooperia spp., 25 % in goats in Assam. He also reported the occurrence of Stilesia spp., Thysanosoma spp., Gongylonema spp. in goats. Hassan (1964) examined 134 intestines of indigenous goats at Comilla and revealed that 82.1 % of them were infected with helminths. Pure infection and mixed infections were 36.3 % and 63.7 % respectively. He observed O. columbianum and O. venulosum, 92.7 %; T. ovis and T. globulosa, 30 % and H. expansa, 10.9 % and H. paloniae, 0.9 %.

Mukherjee (1966) while collecting amphistomes of goats, recorded and described Calicophoron orientalis from rumen of a goat at Bareilly.

Manuel and Madriaga (1967) studied the "helminth fauna of Philippine goats". They examined 20 adult goats at Quezoncity and Manila, Philippines and recovered O. columbianum, H. contortus, T. ovis, Trichostrongylus spp. and M. expansa from 17, 15, 5 and 5 goats respectively. Misra and Ruprah (1968) examined 120 goats at Hissar. Out of which 112 harboured 20 species of helminths. The percentage of infection was G. cruménifer, 0.83 %; C. cotylophorum, 0.83 %; Immature amphistomes, 0.83 %; M. expansa, 4.16 %; M. benadeni, 1.6 %; M. denticulata, 0.83 %; T. giardi, 0.83 %; Avitellina spp., 36.7 %; S. globimunctata, 57.5 %; C. temuicollis, 16.6 %; C. pulchrum, 21.7 %; Haemonchus spp., 60.0 %; Ostertagia spp., 1.6 %; T. colubriformis, 16.7 %; S. trigonocephalum, 0.83 %; C. pachyscelis, 15.8 %; S. ovis, 66.5 %; T. ovis, 22.5 %; T. globulosa, 22.5 %; O. columbianum, 45.8 %. The most common parasites were T. ovis, Haemonchus spp., S. globimunctata and O. columbianum.

Nath (1970) at different places of Uttar Pradesh examined 3002 goats and found 329 goats positive for amphistomes. The percentage of infection was 10.8 %. The common species were C. cotylophorum, 73.3 %; C. calicophorum, 0.6 %; C. ijimai, 0.3 %; P. cervi, 7.3 %;

C. crumenifer, 50.1 %; *F. elongatus*, 11 %; *F. cobboldi*, 0.6 %; *C. gregarius*, 0.3 %; *C. spatiosus*, 0.60 %.

Fabiyi (1970) in a survey of 150 West African dwarf goats from 1966-67 revealed the presence of 12 species of nematodes, 4 cestodes and 4 trematodes. *S. ovis* and *T. capricola* were recorded for the first time in Nigerian domestic ruminants and *H. placei* for the first time in Nigerian goats. Fitz (1971) encountered *H. contortus*, *Trichostrongylus*, *Ostertagia*, *Bunostomum*, *Oesophegostomum*, *Nematodirus*, *Cooperia*, *Gongylonema*, *Trichuris*, *Skrjabinema* and *Strongyloides* in South Africa from goats.

Saithiaesan and Peter (1972) reported *C. caprae* in one goat in Kerala. Misra (1972) studied the epidemiology of parasitic gastro enteritis of goats in Orissa and revealed the presence of *C. cotylophorun*, 81 %; *C. crumenifer*, 75 %; *F. elongatus*, 20 %; *F. cobboldi*, 5 %; *C. gregarius*, 2 %; *C. spatiosus*, 3 %; *M. expansa*, 16 %; *M. benedeni*, 8 %; *M. denticulata*, 1.5 %; *S. globimunctata*, 55 %; *S. vitata*, 5 %; *A. centripunctata*, 24 %; *A. lahorea*, 5 %; *A. sudanea*, 3 %; *C. tenuicollis*, 30 %; *O. verrucosum*, 16 %; *T. colubriformis*, 12 %; *H. contortus*, 80 %; *M. digitatus*, 23 %; *O. columbianum*, 71 %; *T. ovis*, 66 %; *T. globulosa*, 30 %. In the same year he further reported that 85 % of 200 goats harboured seven species of

amphistomes viz., C. cotylophorum, G. crumenifer, P. cervi, F. elongatus, F. cobboldi, C. spatiosus, C. gregarious.

Contreas et al. (1976) studied the occurrence of H. contortus, Trichostrongylus, S. papillosus, Ostertagia, Bunostomum and T. ovis in 2700 goats in several areas of Venezuala and Haemonchus was found to be the most common parasite with 69 %, infection rate and 10 - 30 % mortality rate.

Bali and Singh (1977 a) studied the prevalence of H. contortus in 350 goats from May, 1976 to April, 1977 and observed that 222 (63 %) goats were infected with H. contortus. Gaur (1980) observed that 26.68 % (202) of 754 goats in certain parts of Uttar Pradesh harboured C. tenuicollis.

Ansari and Singh (1981) stated that 9.4 % of goats were infected with G. pachyscelis and average worm burden was 13.71.

Tongson et al. (1981) studied the helminthic fauna on 1230 goats in Philippines and observed that 90 % were infected with Trichostrongylus, 87 % with Haemonchus, 85 % with Oesophagostomum, 47 % with Strongyloides and 87 % with Moniezia. Postmortem examination of 39 goats also revealed small number of Cooperia, Bunostomum, T. ovis, Carmyerius spatheg and F. cobboldi.

Prasad and Singh (1982) examined 1295 abomasum of slaughtered goats at Hissar and found 967 (74.7 %) were

infected with H. contortus. Lalitha and Anandan (1983) reported the occurrence of Orthocoelium spp., Calicophoron spp. and G. crumenifer in goats at Madras.

B. SEASONAL VARIATION ON THE INCIDENCE AND INTENSITY OF HELMINTHIC INFECTION

Thapar (loc.cit.) studied the seasonal variation on the incidence and intensity of helminths in India among goats along with other domesticated animals. He reported that the infection of G. crumenifer, C. cotylophorum, S. trigonocephalum, H. contortus, O. columbianum and S. globirunctata was highest in rainy season. Occurrence of G. pachyscelis was almost equal during summer and rainy season. The high incidence for S. papillosus was in spring, for H. expansa throughout the year and A. centripunctata in summer. He could not record S. papillosus in summer (April to June) and in rainy season (July to September). G. pachyscelis was not recorded during monsoon and spring.

Haq and Shaikh (1969) observed that O. columbianum and H. contortus were the predominant species among goats in Mymensingh and the incidence was higher during and just after the rainy season than at other season. Mc Culloch and Kasimbala (1969) reported that the count of H. contortus were at their highest in wet season and lowest in dry season. In his opinion climate had no effect on the distribution of T. colubriformis and O. columbianum in Sukuma land.

Misra and Ruprah (1968) reported that most of the helminths in goats were recovered in summer at Hissar but the percentage was the highest in autumn and in some cases in winter. Moniezia spp. were recovered either in summer or in autumn. They were of opinion that due to excessive heat and low relative humidity towards the month of June, the infection and intensity percentage of Haemonchus spp. was low in the beginning of summer season. As a result of occasional rain fall towards the last week of June, there was a gradual increase in the infection and intensity percentage upto October. The fully mature and well developed worms were recovered from November onwards till the end of April. No specimen of Haemonchus was recovered in May. The worm burden of Haemonchus spp. was the highest in summer, comparatively low in autumn and winter, and lowest in spring.

Nath (1971 a) worked on the seasonal incidence and severity of infection of immature amphistomes in sheep and goats at different places of Uttar Pradesh and recorded that the disease occurred from September to March. Narain (1971) observed seasonal variations of S. trigonocephalum infection in sheep at Lukhnow and mentioned that there were two peaks of infection (May to July and January to February).

Misra et al. (1972 b) while studying the epidemiology of parasitic gastro-enteritis of goats in Orissa observed that the incidence and intensity of infection with amphistomes and H. contortus were the highest in

rainy season and lowest in summer. Incidence and intensity of O. columbianum was higher in winter and that of hookworms was higher in summer; whereas other species were more or less uniformly prevalent throughout the year.

Fabiyi (1973) recorded that high counts of Haemonchus and Strongyloides started early in rains. High counts of Gaigeria, Oesophagostomum and Trichostrongylus did not occur until late in wet season; this was explained either by low fecundity constant (Trichostrongylus) or long generation intervals (Gaigeria, Oesophagostomum), both of which caused delayed outbreaks. Riche et al. (1973) conducted a survey on helminths of sheep and goats in Cyprus and observed that most of the worms had a peak in spring and another in autumn. During summer, the infection was low. There was variations in the distribution pattern of Trichostrongylus in which spring peak was more pronounced than autumn peak. The reverse occurred with Ostertagia, Chabertia and Oesophagostomum.

Bali and Singh (1977 a) studied the prevalence of H. contortus in goats and observed that (100 %) in August and lowest (15 %) in February and March at Hissar. The infection percentage in goats was maximum in autumn followed by summer and winter and lowest in spring. Atmospheric temperature, relative humidity and rain fall apparently influenced the prevalence of H. contortus infection.

Sugarao and Savitskii (1980) studied the seasonal and age dynamics of helminthiasis at the goat farm "Yuzhnyi" orenburg region and observed a high prevalence of Trichostrongylid and Moniezia infections throughout the year in goats of all ages. The intensity of infection increased from June to November and declined in winter. Ansari and Singh (loc.cit.) stated that incidence of G. pachyscelis in sheep and goat was minimum in pre-monsoon months, moderate in monsoon period and maximum in the post-monsoon and winter months at Bareilly.

C. INFLUENCE OF AGE AND SEX ON INCIDENCE AND INTENSITY OF HELMINTHIC INFECTION

(a) Influence of Age

Vaidyanathan (loc.cit.) reported that S. ovis occurred among younger lots of goats. Lapage (1968) has mentioned that young animals are more often infected with Moniezia than old goats.

Khudoshin (1974) reported that M. expansa and M. benedeni were wide spread in northern zone of lower Povolshya; whereas, M. autumnalis was found in 8-month old lambs in steppe zone. Mohiuddin et al. (1982) studied the incidence of amphistomiasis in sheep and goats of different ages in Sind. They recorded an incidence of amphistomiasis of 12 % under one year age, 35 % between one to two years of age and 39 % in more than 2 years of age of sheep and goats.

(b) Influence of Sex

Scanty information is available on the influence of sex on the incidence and intensity of helminthic infections in goats. From the available literature, it appeared that perhaps sex did not influence the incidence and intensity of helminthic infections in goats. However Mc Culloch and Kasimbala (loc.cit.) remarked that female sheep carried smaller burdens of some nematodes than male sheep. Malhotra (1962) while working on the infection of Moniezia in Gharwal observed that males tended to be more heavily infected with Moniezia than females.

D. MULTIPLE INFECTION

The occurrence of two or more species of helminths infesting the same organ of goats has been observed by several workers (Bhatarjee, 1937-38; Pande, loc.cit.; Thapar, loc.cit. and Misra and Ruprah, 1968).

Bhatacharjee (loc.cit.) collected M. expansa, A. centripunctata and A. gonghi from intestine of goats in Burma. Pande (loc.cit.) reported multiple infection of S. trigonocephalum with T. colubriformis in the small intestines and O. columbianum with T. ovis in large intestine of goats. Spiehn (loc.cit.) noted the multiple infection of M. expansa, A. centripunctata and T. extenuatus in the intestines of goats in Germany. The multiple infection of F. orthocoelium with C. cotylophorum or G. crumenifer in rumen; S. trigonocephalum with

O. pachyscelis, *S. papillosus*, *T. colubriformis*, *O. columbianum* and *O. venulosum* in the intestines; *H. contortus* with *S. globipunctata* in the duodenum; *T. ovis* with *O. columbianum* in the caecum; and *S. globipunctata*, with *M. expansa* and *M. benedeni* in the intestine of goats in India were observed by Thapar (loc.cit.)

Misra and Rupreh (1960) reported the multiple infection of helminths in goats at Hissar; such as, *O. cruneifer* with *C. cotylophorum*, *Haemonchus* spp. with *T. colubriformis*, *Setertagia* spp. in abomasum; *T. colubriformis* with *O. pachyscelis* and *B. trigonocephalum*, *Avitellina* spp., *S. globipunctata*, *Thysaniezia* spp. and *S. globipunctata* with *Avitellina* spp., and *O. panchyscelis* in the jejunum and ileum; *T. ovis* with *T. globulosa*, *S. ovis* and *O. columbianum* in the caecum; and *O. columbianum* with *T. ovis* in colon.

E. POPULATION DYNAMICS OF PARASITIC LARVAE IN AND AROUND GOAT YARD

The pasture is of most considerable importance as a focus for dispersal and exchange between goat and parasitic population. The rate of egg deposition on pasture is enormous and even in very light infected flock, each acre of pasture may receive 50,000 eggs per day would not be an over estimate (Crofton, 1963).

Data collected by Taylor (1939) suggested that an average sheep pasture towards the end of summer carried about 2000 infective larvae per pound of herbage, a heavily infected one carried up to 500 and where sheep suffering from active parasitic gastritis were grazing would carry 1000 to 2500 larvae per pound of herbage. Crofton (1948) stated that in the warmer period from June to October when the maximum temperature was above 10^{0}C more than 200 larvae per pound of grass were recovered on each occasion. When the maximum temperature fell between 10^{0}C (November and December) less than 50 larvae per pound of grass were received. The greatest number of larvae occurred at the end of August, whereas, the warmest period was during the first week of July. In 1949 he noted a gradual increase in the number of larvae on pasture during summer but this peak did not coincide with maximum temperatures. During winter the number of larvae on herbage was negligible, the low temperature having detrimental effects on hatching. In 1952, he studied the larval population on eight low land pastures, where clinical signs of parasitosis had been observed in the lambs. Between June and September, he found 900 to 39000 larvae per pound of grass. The higher counts (3300 - 3900) were obtained on farms where Haemonchus was known to be present.

Misra and Ruprah (1973) while studying the larval population of pasture at Hissar observed that the pastures were highly contaminated with Haemonchus larvae from

August to November. The larval population decreased from December to February, with a slight increase in March. Least number of larvae were recovered in the last week of April to June, the hottest months of the year at Hissar with comparatively higher atmospheric temperature and low relative humidity.

Gibson and Everett (1981) studied the ecology of free living stages of *N. battus* by placing sheep faeces containing eggs of the worm on grass plots in South England. On those contaminated between January to June the larval populations of the herbage peaked in September to October. There was a further peak in February. Plots contaminated in September to December did not bear infective larvae until the following year (March - July).

F. PATHOLOGICAL CHANGES

IMMATURE AMPHISTOME INFECTION

Macroscopic Changes

Sawa (1939) observed that numerous immature amphistomes were found embedded in the mucosa coat of the duodenum and small intestine, setting up varying degree of inflamation and pinhead haemorrhages. Deorani and Katiyar (1967) observed that the infected parts of the intestine were thickened and oedematous, with pitted mucosal surface showing the sites of attachment by amphistomes in sheep. The mucosa was rough and coated with dirty mucus. Many elevated ridges were present giving it a corrugated

appearance and there were haemorrhagic spots. Many immature worms were seen embedded in the mucosa. Dutt (1980) stated that the pathognomonic gross lesions of acute paramphistomiasis were localised in the abomasum and the first 2 - 3 meters of the small intestine, where large numbers of immature paramphistomes were found attached to and embedded in the mucosa. The wall and folds of the abomasum and the wall of the small intestine showed patchy congestion, petechial haemorrhages, erosion, oedema and hypertrophy, and the mucosa was wrinkled and covered with mucoid exudate. Immature amphistomes were seen in the fluid ingesta containing slight amount of blood.

Microscopic Changes

Deorani and Kotiyar (1967) described the histopathological changes of immature amphistomiasis in sheep and goats in three heads, viz. Mucosal phase, Sub-mucosal phase and Post-migration phase. In the mucosal phase, they observed that the young amphistomes attached to the superficial part of the duodenal mucosa caused proliferation and cellular infiltration. On entering the deeper parts of duodenal mucosa, the mucosa around the site of entry was hypertrophied, infiltrated with mono-nuclear cells and superficial parts of the mucosa showed mild necrotic changes. When amphistomes entered the mucosa, there was hypertrophy, superficial necrosis and desquamation of the mucosa and there was signs of traumatic destruction

of tissues around the worm. The mucosa was congested and infiltrated with macrophages and showed haemorrhagic spots at places. Marked increase in the number of goblet cells in the mucosa and large number of mononuclear infiltration in the lamina propria along with worms on one side gave the appearance of catarrhal enteritis. In the sub-mucosal phase young amphistomes reached the Brunner's gland in the sub-mucosa. Much of the superficial mucosa desquamated and was thinned out. Hypertrophy of glands was observed. Mucosa and sub-mucosa were infiltrated with mononucleears and eosinophils. Few worms showed ingested epithelial cells in their caeca. In the post-migration phase Brunner's glands appeared as islands amidst proliferated sub-mucosal connective tissue. Epithelial cells of mucosa were proliferated. According to Soulsby (1968) the worms were embedded in the mucosa by drawing pieces of mucosa into the suckers, thereby resulting in necrosis and haemorrhage. Extensive catarrhal and haemorrhagic inflammation of the duodenum and jejunum with destruction of the intestinal glands, degeneration of the associated lymph nodes were evident. Dutt (1980) stated that the damage caused by the flukes was mainly mechanical destruction of the tissue resulting from their attachment to the epithelial layer and penetration of the intestinal wall. Both in the epitholium and in the sub-mucosa the flukes drew a small piece of tissue into their acetabulum causing strangulation and frequently pieces of tissue were seen inside their oral

organ. In addition to the presence of immature amphistomes in sections, the affected tissue showed other pathological features, such as epithelial proliferation in the superficial tissues, cellular infiltration, erosion, desquamation and necrosis. Deeper layers showed congestion and sometimes rupture of the capillaries, necrosis of muscularis mucosa, hypertrophy of Brunner's glands and infiltration of submucosa and other tissue with eosinophils, lymphocytes and plasma cells.

MATURE AMPHISTOME INFECTION

Macroscopic Changes

Basak and Singh (1978) observed many amphistomes remained in the form of pure colonies and others remained in scattered form in rumen. Knob was formed at the point of attachment of the papillae and ultimately knob was punched out. The affected area looked whitish in colour due to scar tissue and showed complete denudation of the rumen papillae at some places. In severe cases 60 % of the total area of rumen were denuded.

Microscopic Changes

Mukharjee and Deorani (1962) observed that only at places where parasites were seen in association with mucosal wall there were proliferation of the stratified squamous epithelium with occasionally necrosis and some hypertrophy of stratum cornuemm. The papillae were

hypertrophied. No cellular reaction was observed. The distal extremity of papillae showed frequent degeneration and sloughing. The proliferation of stratified squamous epithelium was so much at places that connective tissue of lamina propria was partially or completely obliterated. Basak and Sinha (1978) observed maximum changes in the cornutum, stratum granulosum and stratum germinativum which increased in thickness. There were signs of hyperkeratinization and even partial desquamation of stratum corneum. Cellular infiltration in the affected tissues were well marked. In some knobs there were necrotic changes. In extreme cases there was total disappearance of superficial layer leaving only a thin layer of connective tissue.

STILESIA GLOBIPUNCTATA INFECTION

Macroscopic Changes

Amjadi (1971) observed numerous nodules, from which the posterior segments of S. globipunctata were protruded. Misra (1931) described the pathological changes caused by S. globipunctata in goats. The marked pathological changes were inflammation, thickening of duodenal mucosa along with presence of large number of nodules with depressed centres containing scolices of S. globipunctata.

Microscopic Changes

Dorani and Tewari (1968) observed typical unarmed scolices of S. globipunctata in the duodenal mucosa

and sub-mucosa which were damaged. Benkov (loc.cit.) observed proliferative changes, cellular infiltration, nodule formation, desquamation of epithelium and thickening of the wall of the intestine of sheep infected with S. globipunctata. Misra (1981) observed microscopic changes, such as, pressure atrophy of intestinal glands and villi, extensive infiltration of mononuclear cells in the lamina propria, primarily consisting of lymphocytes, some plasm cells, eosinophiles, macrophages and occasionally neutrophils at the site of location.

HAEMONCHUS INFECTION ✓

Macroscopic Changes

Misra and Ruprah (1972) observed pin point haemorrhages at some places of abomasal mucosa and small blood clots over the folds and granular mucosa in experimental infection with H. contortus in lambs. Large amount of sand particles were obtained from abomasum. Typical angry looking ulcers in the abomasal mucosa was the common feature of haemonchosis. Ghosh et al. (1976) observed that abomasum was highly congested and filled with chocolate coloured contents along with adult worms in goats with Haemonchus infection.

Microscopic changes

Bhatia (1960) studied the abomasal tissue infected with H. contortus. Serial sections revealed the presence

of the developing larvae in gastric pits. A few of the 4th stage larvae were present in the glandular region. Some evidence of haemorrhage and presence of reactionary cells, viz., the eosinophils were observed in the neighbouring areas of the larvae. Charleston (1965) observed the presence of developing larvae usually within or below the mucous layer in experimental haemonchosis in sheep. There was muscular hypertrophy. Both mononuclear and eosinophil leucocytes were collected around the deeper proprial vessels, some moving further into the mucosa and lamina. Many of the nematode gut sections were apparently empty, some contained amorphous eosinophilic material and very occasionally a few identifiable erythrocytes. Misra and Ruprah (1972) observed the cross sections of parasites in pyloric and fundus region in the prepared histological sections. The affected parts showed cellular debris and there was proliferation of macrophages and fibroblast along with slight infiltration of lymphocytes and comparatively more eosinophils.

HOOKWORM INFECTION (*A. trigonocephalum*, *G. pachyscelis*)

Macroscopic Changes

Soulsby (1968) observed abnormalities in small intestine due to severe hookworm infection (*G. pachyscelis* and *A. trigonocephalum*). Intestinal contents became haemorrhagic and mucosa was swollen, covered with mucus. Numerous small, red bite marks of the worms were present.

Misra and Ruprah (1968) observed that heads of worms were embedded in the intestinal mucosa of goats. These portions were haemorrhagic indicating enteritis.

Microscopic Changes

Soulsby (1968) observed that the villi were clubbed or fused in large masses and columnar cells were distorted. Peregudov et al. (1977) observed that the mucosa of small intestine was severely damaged around the site of attachment of the parasite. There was necrosis of the upper part of the villi, lymphoid and eosinophil infiltration of the mucosa propria, and destrophy and necrosis of the epithelial lining of the glands and crypts. Ingestion of epithelium by the nematode was observed and fragments of epithelial and other cells were seen in its oesophagus. ✓

TRICHURIS INFECTION

Macroscopic Changes

Soulsby (1968) reported that heavy infections produced thickening of caecal wall with copious amount of mucus. Jain and Kamalpur (1970) observed that larvae and adult parasites were attached to caecum of sheep. The anterior oesophageal portion of the larvae and adults were embedded superficially in the mucus membrane and were surrounded by a thin layer of fibrinous exudate. There was slight congestion at the site of attachment. Misra (1994)

reported that thickening of the wall of caecum occurred in Trichuris infection at the site of attachment of the parasite. The anterior parts of the parasites were embeded in the caecal mucosa.

Microscopic Changes

Powers (1961) observed the sloughing of tissues, inflammation with infiltration of eosinophils and monocytes were the common feature of Trichuris infection. Soulsby (1968) reported haemorrhagic necrosis and oedema of caecal mucosa in T. discolor infection.

OESOPHAGOSTOMUM INFECTION

Macroscopic Changes

Ersov (1968) stated that intestinal mucosa became hyperaemic and oedomatous in Oesophagostomum infection in ruminants. On the fifth day of infection the developed nodules were visible to unaided eye. Petechiae with yellow spot at the centre surrounded by hyperaemic mucosa were evident. Occasional necrotic changes of the nodules and pus formation occurred during that period. On 7th to 8th day ulcerative colitis was marked. Thousands of nodules with size ranging from a pin head to that of a pea and consisting of thick connective tissue fibres and caseous contents were encountered. Larvae were detected only in early nodules. Tewari and Ramchandra Iyer (1961) observed that nodules were distributed throughout the intestine but

in heavy infections caecum and colon were the chief sites of nodule formation. A number of nodules also occurred in the serous coat of intestine, omentum, peritoneal cavity, liver and associated lymph glands. Patnaik (1964 b) observed no nodules in the large intestine in 11 goats infected with O. asperum. Chhabra (1965) observed nodule formation in the intestine in experimentally infected kids with O. vermiosum. Some of the nodules contained pus. Srivastava and Singh (1965) observed the nodule formation in the caecum and colon being embedded in the submucosa. Similar nodules were also observed in the serosa, mesenteric lymph nodes, omentum and liver. Shatanagar et al. (1978) in experimentally infected lambs with O. columbianum found nodules of varying sizes in the small and large intestines, enteric lymph nodes, liver, kidneys, pancreas and uterus.

Microscopic Changes

Tewari and Ramachandra Iyer (loc. cit.) found nodule formation in different coats of the intestine of goats. In some nodules larvae were encysted against muscularis mucosae. In other nodules of varying sizes were present in the longitudinal and circular muscle layers, extending in some cases right up to serosa, stained more or less uniformly pink with eosin with degenerated remnants of parasite. At some places nuclear debris were seen in greater abundance towards the periphery of nodules at the junction of living and necrotic zone of cells.

Towards the periphery of the nodule there was evidence of fibroblastic activities. Number of nodules in the serosa of intestine presented necrotising and caseating lesions surrounded by a zone of epitheloid cells, and few foreign body giant cells. Other nodules appeared as frank abscesses surrounded by well developed fibrous connective tissue capsule. These abscesses in a number of instances completely damaged the muscular layer. Some nodules showed migrating tracts made by the larvae. Srivastava and Singh (loc.cit.) observed three types of lesions. The sub-mucosal lesions varied from sub-microscopic aggregations of inflammatory cells to large necrotic and caseous masses surrounded by a well developed granulomatous reaction. Nodular lesions in the serosa were somewhat similar to those of submucosa and were firmly encapsulated. Calcification was slight in the nodules of the intestine but severe in those of mesenteric lymph nodes and liver. Collagen was the main constituent of fibrous capsule, plasma cells invariably surrounded the nodule and severely infiltrated the mucosa. Escherichia coli, E. freundii and non toxigenic Clostridium perfringens were isolated from the nodules. Sporulating rod-shaped organisms were seen in sections stained with giemsa stain.

Bhatnagar et al. (loc.cit.) stated that the nodules contained a mass of necrotic tissue with numerous macrophages, epitheloid cells and occasional giant cells.

The necrotic mass was surrounded by fibrous tissue proliferation being infiltrated with lymphocytes and eosinophils. Sections of the larvae were sometimes visible at the periphery of nodules.

C. CHAEMOTHERAPY

Number of drugs are available in the market for the treatment of gastro-intestinal helminths, but a perusal of the literature shows so much variation on the efficacy of the drugs that it is bewildering for the clinician to decide an efficaceous choice. The anthelmintics should be comparatively evaluated regarding their safety, efficacy, easy administration and cost.

The efficacy and safety of panacur, (Hoechst Pharmaceutical Ltd.) was taken as part of this study and hence the available literatures are reviewed as under.

PANACUR [(Fenbendazole) - (methyl - 5 (Phenylthio) - 2 - benzimdazole carbamate]

panacur (Fenbendazole) is a broad spectrum anthelmintic of Benzimidazole group and marketed by Hoechst Pharmaceuticals. It is claimed to be an ideal deworming agent for gastro-intestinal nematodes, lungworms and tapeworms in sheep.

Dilwel et al. (1974) found that a single oral dose of Fenbendazole at 5 mg per kg body weight reduced

egg counts more than 90 %. Postmortem examination of 12 treated sheep revealed a 100 % elimination of both immature and adult Ostertagia, Trichostrongylus, Bunostomum, Nematodirus and Chabertia.

Behrens and Matchullad (1975) found Fenbendazole as 2.5 % solution given orally to sheep at 5 - 50 mg per kg body weight had no adverse effects. A single dose of 5 mg/kg was highly effective against adult and immature forms of B. trigonocephalum, Cooperia spp., H. contortus, Nematodirus spp., Oesophagostomum spp., Ostertagia spp., S. papillosus and Trichostrongylus species. Kennedy and Todd (1975) at the dose rate of 3.5, 5.0 and 7.5 mg per kg body weight found fenbendazole to be 100 % effective against Ostertagia, Trichostrongylus, Cooperia, Oesophagostomum. But efficacies for 3 doses against Haemonchus were 93.4 95.3 and 99.8 % respectively. Efficacies for the doses against Trichuris were 69.1, 83.6 and 98.2 %. No toxic effect was seen although the lambs were severely debilitated.

Bali and Singh (1977 b) observed that a single dose of fenbendazole (5 mg per kg body-weight) totally eliminated the eggs of H. contortus, Oesophagostomum spp. and Trichostrongylus spp. from the faeces of naturally infected goats by 10th day post treatment. The egg counts of Trichuris spp. remained unaffected. Anon (1977) conducted a trial to evaluate the efficacy of fenbendazole against Moniezia spp. and Trichuris spp. in naturally infected

sheep. With the dose rate of 5, 7.5, 10, 12.5 and 20 mg/kg body weight respectively to five groups of sheep showed absence of ova of Moniezia spp. on the 7th day post treatment. At the dose rate of 7.5, 12.5 or 20 mg fenbendazole per kg body weight showed absence of ova of Trichuris species. The reduction of worms (Trichuris spp.) was 90 %, 89 %, 87 %, 95 % and 94 % respectively for different groups. Mc Beath et al. (1977) in an efficacy trial of fenbendazole among 400 lambs naturally infected with tapeworms at 5 mg per kg body weight on day 1, 20 and 56, found Moniezia egg counts, reduced to nil on dosing day and at slaughter on 82 day. In a critical trial, 10 infected lambs drenched with 5 mg/kg fenbendazole and kept on concentrate for 6 days were found negative for Moniezia egg on slaughter and no scolices could be recovered at postmorten.

Kalita et al. (1978) reported Fenbendazole at 5 mg per kg body weight to be 100 % effective against natural infection of Haemonchus spp. in sheep as revealed by faecal examination on 7th day post treatment. The drug in the same dose rate was ineffective against Trichuris spp. and Moniezia species.

Cabaret et al. (1979) tested fenbendazole at 10 - 15 mg per kg against immature stage of Moniezia spp. in sheep and found that it was effective against Moniezia infection. The egg output was practically nil for three weeks after treatment. Townsend (1979) found fenbendazole

at 5 mg per kg body weight or above to be 91 % effective against Moniezia and greater than 92 per cent against T. ovis in sheep. In the same dose rates efficacy on egg supression was 100 per cent for Moniezia and greater than 97 per cent for Trichuris.

Bali and Singh (1980) reported that 5 mg per kg body weight of fenbendazole in sheep eliminated strongyle eggs from the faeces and no strongyle worm could be recovered at slaughter. The drug was ineffective for Trichuris.

Gupta et al. (1981) reported fenbendazole at 2.2 mg per kg body weight for three days was highly effective against common gastro-intestinal nematodes; viz, H. contortus, Trichostrongylus spp. and Oesophagostomum spp. but ineffective against T. ovis, tapeworm scolices (Anoplocephalidae) and mature and immature paramphistomes in sheep. At 2.2 mg per kg body-weight for six days the drug exhibited additional efficacy of 100, 74, 27 and 50 % against T. ovis, tapeworm scolices, mature and immature paramphistomes respectively. At 4.4 mg per kg body weight daily for six days, exhibited additional activity of 69 % against immature amphistomes.

Patnaik et al. (1983) in naturally infected goats assessed the efficacy of panacur against gastro-intestinal strongyles, Trichuris spp. and Moniezia species. A single dose of 10 mg per kg body weight was found to be 94.00, 95.56 and 91.60 per cent effective against Moniezia

strongyles and Trichuris spp. respectively. On sacrifice at the termination, the goats harboured eight species of helminths viz., H. expansa, H. benedeni, H. contortus, O. columbianum, T. ovis, T. globulosa, B. trigonocephalum and C. pachyscelos. Nafees et al. (1983) in natural helminthic infections of lambs found that Panacur at recommended dose of 5 mg/kg body-weight was 83.3 % effective against strongyle infections and 66.6 % against Trichuris infection. At 25 % or more than the recommended dose, it was 90 % and 72 % effective against strongyle and Trichuris infections.

MATERIALS AND METHODS

The present investigation was conducted at Bhubaneswar from January, 1983 to December, 1983 in the Department of Veterinary Parasitology, College of Veterinary Science and Animal Husbandry, Orissa University of Agriculture and Technology, Bhubaneswar. The studies on the epidemiology, pathology and chemotherapy of gastro-intestinal helminthiasis in goats included the following steps.

POPULATION DYNAMICS OF GASTRO-INTESTINAL HELMINTHS IN GOATS

A total of 120 goats belonging to either sex and of various age groups were examined at random at the rate of 10 goats per month, starting from January, 1983 upto the end of December, 1983. Of the goats examined 50 were males and 70 were females. Among the goats examined 18 were the age group of 1 - 4 months, 36 of 5 - 8 months, 36 of 9 - 12 months and 30 over one year of age. Gastro-intestinal tracts of freshly slaughtered goats for the project were obtained from the local slaughter house, at which goats usually obtained from various parts of the State are slaughtered. All the animals at the time of slaughter were apparently in good health.

The studies on the population dynamics of gastro-intestinal helminths in goats consisted of the following:

A. Antemortem examination of the goats to be slaughtered.

B. Collection of helminths from different parts of the gastro-intestinal tract.

C. Counting of the worms.

D. Processing the worms including:

(a) Flattening and fixing the trematodes and cestodes.

(b) Fixing the nematodes.

E. Identification as far as possible upto the species by staining the trematodes and cestodes, and clearing the nematodes.

A. Antemortem Examination

The sources of goats were enquired from the butcher. The age, sex and general condition of the goats were noted. The goats were classified into four age groups; (i) 1 - 4 months, (ii) 5 - 8 months, (iii) 9 - 12 months and (iv) Above one year.

B. Collection of Helminths

Soon after slaughter and opening of the carcass, the entire alimentary tract starting from the proximal end of oesophagus to the rectum was collected from each goat. Before removing the alimentary canal, the peritoneal cavity was thoroughly searched for the presence of any cysticercus. The bladder worms were removed carefully and kept in a petridish containing normal saline. Then, the different

parts of the gastro-intestinal tract were ligated and opened separately in separate trays. The contents were collected in separate trays along with the washings of the gastro-intestinal tract. The wall of each part of alimentary tract was washed under tap water in each tray. For the collection of Trichostrongylus and Strongyloides species the intestinal wall was thoroughly examined under a hand lens and scraped by a blunt scalpel. The entire collection was washed several times by stirring the water till an even suspension was made. The suspension was allowed to stand undisturbed at least for half an hour. The helminths and heavy materials were allowed to settle to the bottom. The supernatent fluid was poured off very gently. This process was repeated until the supernatent fluid was clear. The remaining sediment was searched thoroughly and the helminths were collected separately in petridishes containing normal saline. For the small helminths, viz., Trichostrongylus, Ostertagia, Strongyloides spp; the sediment was examined under the stereoscope. Gongylonema species being embeded in tissues of the oesophageal mucosa and mucosa of rumen were collected by teasing the mucosa with a fine needle.

C. Counting of Helminths

The trematodes were counted one after another, while the cestodes were counted by the number of scolices. The nematodes were fixed, sexed and counted. The small helminths such as Trichostrongylus spp., Ostertagia spp.,

Strongyloides spp. and large helminths like Gongylonema spp. were separated into males and females under the stereoscope and counted.

D. Processing of Helminths

From the gross appearance, size, shape and location in the gastro-intestinal tract, the helminths were identified upto genera, at the time of collection and were processed further as detailed below:

Trematodes

Soon after collection 10 % of trematodes, selected at random, were flattened by pressing them in between two slides and tied with a thread and fixed in 10 % formal saline solution; while others were preserved as such in seperate bottles with 10 % formal saline.

Cestodes

The cestodes like Stilesia spp. and Avitellina spp. were kept at 10°C over night in a refregerator. Next morning these were flattened in 10 % formalin either by drawing the parasite over the edge of petridish or by moving it up and down several times for 5 - 10 minutes with the aid of a bent needle and preserved in 10 % formaline solution. Thick cestodes like Moniezia spp. were put into warm water and drawn over the edge of the petridish several times for 5 - 10 minutes for complete relaxation and then pressed between two glass slides and preserved in 10 % formalin.

Nematodes

The nematodes were washed in normal saline and then transferred to a clean petridish. The parasites were separated from each other as far as possible. Fixation was then done with 70 % simmering alcohol by pouring over the nematodes and preserved as such in bottles by adding a small amount of glycerine to check evaporation.

E. Identification

Identification was done by

(a) Measurement

(b) Staining

(c) Clearing the nematodes in lactophenol

(d) Processing the nematodes in 10 % Potasium hydrochloride solution

(a) Measurement

The large size parasites were measured by a small scale (metre rod) and small ones by micrometer. The microscopic structures like oesophagus, spicules etc. were measured by micrometer.

(b) Staining

Staining Platyhelminthes: The Platyhelminthes were stained either in acetic-alumcarmine or borax carmine (both alcoholic and aqueous).

i. Best specimens of the flattened and formalin preserved ones were selected under the stereoscope.

ii. Formalin was removed by several changes of water for small ones. The thicker ones were made free of formalin by keeping them under running tap water over night.

iii. After washing, the Platyhelminthes were transferred to acetic-alum-carmine or borax carmine. For alcoholic borax-carmine, these were gradually brought upto 70 % alcohol from 30 %. The parasites were left in the staining petridish over night for over staining.

iv. Differentiation was achieved in saturated solution of potasium alum-carmine; and in 1 % hydrochloric acid for aqueous borax-carmine solution. For borax-carmine alcoholic stain acid alcohol 1 % was used for destaining the parasites.

v. Dehydration was done in 90 % and absolute alcohol for borax-carmine alcoholic stain, whereas, dehydration was achieved in ascending grades of alcohol starting from 30 % to absolute alcohol for acetic-alum-carmine and borax-carmine aqueous stains.

vi. Clearing was done in ceder wood oil.

Staining the Nematodes

Staining of nematodes with alcoholic borax-carmine was done as follows:

i. Best specimens of nematodes preserved in 70 % alcohol were selected under the microscope.

ii. By means of a microscopic needle, the nematodes were pricked at anterior, middle and posterior part of the body on different sites and care was taken to keep the internal structures such as the mouth parts, gubernaculum and spicules uninjured.

iii. Then the parasites were put into alcoholic borax carmine for over night for over staining.

iv. Destaining was done with acidulated alcohol.

v. Dehydration was done in ascending grades of alcohol.

vi. Clearing was done in xylol and then transferred to a square cavity block with xylol to cover them. Canadabalsam was added drop by drop at intervals till the consistency of xylol approached nearly to that of canadabalsam. This was viewed from time to time under the stereoscope after the addition of each drop of canadabalsm till the canadabalsm penetrated into the body of the worm.

For Further detailed study, the permanent preparations of stained specimens of trematodes, cestodes and nematodes were prepared in D.P.X. mountant or canadabalsam. Permanent preparations were kept in the incubator at 40°C for a sufficient time till completely dried. Prepared specimens were studied thoroughly under the stereoscope and compound

microscope. From their morphological characters, these were identified upto the species as far as possible.

(c) Clearing in Lactophenol

The nematodes were cleared in lactophenol (1 part lactic acid, 1 part carbolic acid, 2 parts glycerine and 1 part water) and observed under the stereoscope. The specimens were also manipulated by rolling them in lactophenol under the cover glass and were viewed under the compound microscope for detailed study.

(d) Processing the Nematodes in 10 % Potassium Hydroxide

In order to study the chitinous structures like the buccal teeth, spicules, gubernaculum etc. the specimens were graded back from 70 % alcohol to water and then taken on a glass slide with a cover slip over it. Drops of potassium hydroxide 10 % was inserted and the specimen was watched so that it may not go dry. When most of the structures dissolved in the caustic solution, the chitinous structures were studied.

POPULATION DYNAMICS OF PARASITIC LARVAE IN AND AROUND THE GOAT YARD

To determine the population dynamics of parasitic larvae in and around the goat yard, the soil samples from the floor of goat yard (Goat Breeding Farm, Orissa University of Agriculture and Technology, Bhubaneswar) and the grass

samples from a posture adjacent to the above goat yard were obtained. The soil samples and grass samples were obtained three times a day, i.e., morning, noon and evening, from both the goat yard and its adjacent pasture on the same day. The temperature and relative humidity were recorded at the time of each collection and the condition of the day was also noted. Fifteen samples of soil (100 g each) and fifteen samples of grass (100 g each) were examined in every month i.e., from January, 1983 to December, 1983. The larvae were collected from each soil and grass samples separately by means of Baermann technique after a period of six hours. The larvae were allowed to settle down by keeping the material at a low temperature and the supernatent fluid was poured off to bring the larval suspension to a fixed volume. Larval population was counted by estimating the number of infective larvae present in an even suspension of a fixed volume after withdrawal of a drop of suspension. The number of infective larvae present in three such drops were counted by placing on separate slides, under a compound microscope and an average was taken. Identification of each larva was based on its total length, length of the oesophagus, length from anterior end to genital primordium, length of the tail, appearance of the anterior end of oesophagus and buccal cavity, with reference to Soulsby (1965). Thus, the number of each type of larvae present in 100 g of the grass or soil was estimated and this gave an approximate idea about the degree of contamination of

the goat yard and its adjacent pasture. Grass samples and soil samples were examined from the goat yard and its adjacent pasture five times in a month.

PATHOLOGICAL CHANGES CAUSED BY GASTRO-INTESTINAL HELMINTHS

After washing the gastro-intestinal vall of freshly slaughtered goats under the tap water, due attention was paid to note the gross pathological changes caused by different species of gastro-intestinal helminths in various parts of the alimentary canal. The site(s) of attachment of parasites were carefully observed and the macroscopic changes caused by the helminths in the tissues of the alimentary tract were described. portions of alimentary tract showing characteristic pathological lesions along with the parasites were cut and kept preserved in 10 % formalin for further study. A record of the pathological lesions caused by various species of gastro-intestinal helminths was maintained.

For studying the microscopic changes, the infected tissues were processed by usual laboratory procedure. The serial sections were cut and stained in haemotoxylin and eosin stains and were studied under a compound microscope for the histopathological changes caused by different species of gastro-intestinal helminths at their sites of attachment.

CHEMOTHERAPY

To evaluate the efficacy of Panacur (Fenbendazole) against gastro-intestinal helminths, 12 goats of both sexes and of six months to one year of age harbouring natural mixed infections of paramphistomes, Moniezia spp., strongyles and Trichuris spp. (as evinced from faecal examination), reared under similar environmental conditions, were selected. The EPG of each goat for each of the above types of helminthic infection was determined. The goats were then divided into two equal groups at random in such a manner that the average EPG of both groups was nearly equal. The goats belonging to Group A were treated with Panacur at the rate of 10 mg per kg body-weight; whereas, the goats belonging to Group B served as infected but untreated control till the termination of the chemotherapeutic trial. The faecal examination of all the goats was done on the 2nd, 5th and 7th day of the administration of the anthelmintic. The efficacy of Panacur against different gastro-intestinal helminths, as mentioned above, was assessed on a comparison of the egg output per g of faeces, both prior and after treatment.

Further, the strongyles were identified on faecal culture by obtaining the infective larvae upto the genus level.

FAECAL CULTURE

For identifying the various strongyles present in goats used for the chemotherapeutic trial, the faecal culture was done before and after administration of the anthelmintic. From each goat 50 g of faeces were collected and taken in a large petridish. The faecal pellets were broken off. A small quantity of wood charcoal was added to the faeces in order to prevent fermentation. The faeces were then incubated at 25 - 30°C for seven days. Care was taken to prevent the dryness of faeces by sprinkling of water over the faeces and fungal growth remained supress by slight stirring the faeces at every two days interval. At the end of seven days, the larvae were collected by means of Baermann technique by using water at 35 - 40°C and larvae were collected after 12 hours. The efficacy of the anthelmintic against strongyles were assessed by comparison of the larval cultures before and after the administration of the drug. The different strongyle larvae were identified according to the key given by Soulsby (1965).

OBSERVATIONS AND RESULTS

RECORD OF HELMINTHS

Out of 120 goats examined in the present investigation, 118 harboured gastro-intestinal helminths, which are detailed in Table 1.

Table 1

Record of helminths and their location in the host

Sl. No.	Name of the helminth	Location in the host
1	2	3
1	C. cotylophorum	Rumen and reticulum
2	C. crumenifer	Rumen
3	P. cervi	Rumen and reticulum
4	P. elongatus	Rumen
5	P. cobboldi	Rumen
6	C. spatiosus	Rumen
7	C. gregarius	Rumen
8	H. paloniae	Caecum
9	Immature amphistomes	Duodenum (Anterior part). Abomasum
10	H. expansa	Jejunum, Ileum
11	H. benoderi	Jejunum, Ileum
12	S. globirunctata	Small intestine

1	2	3
13	S. vitata	Small intestine
14	A. centripunctata	Small intestine
15	A. lahorea	Small intestine
16	A. sudanea	Small intestine
17	C. tenuicollis	Peritoneal cavity
18	G. verrucosum	Rumen
19	H. contortus	Abomasum
20	T. colubriformis	Abomasum and small intestine
21	B. trigonocephalum	Small intestine
22	G. pachyscelis	Small intestine
23	O. columbianum	Caecum and colon
24	O. venulosum	Caecum and colon
25	O. asperum	Caecum and colon
26	T. ovis	Caecum and colon
27	T. globulosa	Caecum and colon
28	T. discolor	Caecum and colon

The record of gastro-intestinal helminths in goats indicated that as many as 15 species were recovered from a single goat, which included C. cotylophorum, G. crumenifer, C. spatiosus, C. gregarius, S. globipunctata, S. vitata, A. centripunctata, H. bonedeni, H. contortus, G. pachyscelis, T. ovis, T. globulosa, O. columbianum,

O. asperum and O. venulosum; whereas, H. contortus was the only species recovered from a single goat.

IDENTIFICATION

The unstained and stained specimens of the helminths recovered in the present investigation were studied under the stereoscope and compound microscope and identified according to previous workers (Bhalerao, 1935 and 1936; Wardle and Mc Leod, 1968; Lapage, 1968; Soulsby, 1965 and 1982).

INCIDENCE AND INTENSITY OF INFECTION

The incidence and intensity of infection of gastro-intestinal helminths are presented in Table 2 and 3.

The percentage of infection was calculated on the basis of the number of infected animals to the total number of animals examined at random. The overall infection was 98.33 per cent. A perusal of Table 2 revealed that the highest incidence of infection was recorded for H. contortus (82.50 %). Next in descending order of incidence of infection was with C. cotylophorum, C. crumenifer, S. globirunctata, immature amphistomes and T. ovis. Lowest incidence of infection was recorded for H. paloniae and A. sudanen. Among Oesophagostomum spp. recovered in the present investigation, O. asperum was more prevalent than the other species. Similarly T. ovis predominated among Trichuris species. Studies on the

Table 2

Incidence of helminths in goats

Sl. No.	Name of the helminth	No.of goats infected	Infection percentage
1	C. cotylophorum	94	78.33
2	G. crumenifer	84	70.00
3	P. cervi	45	37.50
4	F. elongatus	27	22.50
5	F. cobboldi	8	6.66
6	C. spatiosus	18	15.00
7	C. gregarius	12	10.00
8	H. paloniae	4	3.33
9.	Immature amphistomes	61	50.83
10	H. expansa	15	12.50
11	H. benedeni	9	7.50
12	S. globipunctata	74	61.66
13	S. vitata	6	5.00
14	A. centripunctata	24	20.00
15	A. lahorea	6	5.00
16	A. sudanea	4	3.33
17	C. tenuicollis	31	25.83
18	G. verrucosum	14	11.66
19	H. contortus	99	82.50
20	T. colubriformis	14	11.66
21	B. trigonocephalum	13	10.83
22	G. pachyscelis	24	20.00
23	O. columbianum	25	20.83
24	O. venulosum	12	10.00
25	O. asperum	48	40.00
26	T. ovis	61	50.83
27	T. globulosa	28	23.33
28	T. discolor	13	10.83

Table 3

Intensity of infection of helminths in goats

Sl. No.	Name of the helminth	No. of goats infected	No. of worms collected		Total No. of worms collected	Average worm load (worm burden)
			Minimum	maximum		
1	2	3	4	5	6	7
1.	C. cotylophorum	94	43	2423	49632	528.00
2.	G. crumenifer	84	19	1827	32256	384.00
3.	P. cervi	45	7	623	6165	137.00
4.	P. elongatus	24	5	185	1968	82.00
5.	P. cobboldi	8	9	27	192	24.00
6.	C. spatiosus	18	6	51	558	31.00
7.	C. gregarius	12	5	26	192	16.00
8.	H. pelonias	4	2	5	14	3.50
9.	Immature amphistome	61	31	1107	12627	207.00
10.	M. expansa	15	1	9	38	2.53
11.	M. benedeni	9	1	4	23	2.55
12.	S. globiurcatata	74	6	103	2664	36.00

1	2	3	4	5	6	7
13.	S. vitata	6	2	17	48	8.00
14.	A. centrimunctata	24	2	23	396	16.50
15.	A. lehorea	6	1	23	65	12.50
16.	A. sudanea	4	1	12	34	8.50
17.	C. tenuicollis	31	3	35	496	16.00
18.	C. verrucosum	14	4	7	70	5.00
19.	M. contortus	99	3	1863	19584	197.91
20.	T. colubriformis	14	11	37	342	24.50
21.	B. trigonocephalum	13	2	17	104	8.00
22.	G. pachyscelis	24	4	51	288	12.00
23.	O. columbianum	25	5	42	325	13.00
24.	O. asperum	48	6	69	1296	27.00
25.	O. venulosum	12	1	21	108	9.00
26.	T. ovis	61	3	94	1586	26.00
27.	T. globulosa	28	2	34	392	14.00
28.	T. discolor	13	1	29	117	9.00

incidence of infection of gastro-intestinal helminths indicated that six species of helminths, viz., H. contortus (82.50 %), C. cotylophorum (78.33 %), G. crumenifer (70.00 %), S. globipunctata (61.66 %), T. ovis (50.83 %) and O. asperum (40.00 %) were highly prevalent in the local goats. Among the paramphistomes H. paloniae was observed as a rare parasite (3.33 %) in the local goats.

The intensity of infection was calculated on the basis of the worm burden of infected animals. The data presented in Table 3 indicated that C. cotylophorum, G. crumenifer, H. contortus, T. ovis had higher infection intensity; whereas, the infection intensity of H. explanus, H. benedeni and H. paloniae was very low.

SEASONAL VARIATION

Since summer, rainy and winter seasons predominate in Orissa, in the present studies the whole year was divided into three seasons, i.e., summer (March - June), rainy (July - October) and winter (November - February). The seasonal variation on the incidence and intensity of gastro-intestinal helminths in goats is presented in Table 4 and 5 respectively.

The seasonal variation on the incidence and intensity of gastro-intestinal helminths in the local goats revealed that paramphistomes, H. contortus, Oesophagostomum spp., Trichuris spp. and Stilesia spp. were prevalent

Table 4

Seasonal variation on the incidence of infection

Sl. No.	Name of the helminth	Percentage of infection in different season		
		Summer	Rainy	Winter
1	2	3	4	5
1.	C. cotylophorum	70.00	95.00	80.00
2.	G. crumenifer	45.50	95.00	62.50
3.	P. cervi	20.00	52.50	40.00
4.	P. elongatus	7.50	37.50	22.50
5.	P. cobboldi	2.50	10.00	7.50
6.	C. spatiosus	2.50	27.50	15.00
7.	C. gregarius	2.50	15.00	12.50
8.	H. paloniae	-	7.50	2.50
9.	Immature amphistomes	5.00	67.50	55.00
10.	M. expansa	-	25.00	12.50
11.	M. benedeni	-	15.00	7.50
12.	S. globipunctata	45.00	90.00	50.00

1	2	3	4	5
13.	S. vitata	2.50	7.50	5.00
14.	A. centripunctata	10.00	30.00	20.00
15.	A. lahorea	-	10.00	5.00
16.	A. sudanea	-	7.50	2.50
17.	C. tenuicollis	15.00	35.00	27.50
18.	G. verrucosum	-	22.50	7.50
19.	H. contortus	42.50	87.50	75.00
20.	T. colubriformis	-	25.00	10.00
21.	B. trigonocephalum	5.00	20.00	7.50
22.	O. pachyscelis	5.00	35.00	17.50
23.	O. columbianum	15.00	27.50	20.00
24.	O. asperum	27.50	52.50	40.00
25.	O. venulosum	5.00	17.50	7.50
26.	T. ovis	40.00	65.00	47.50
27.	T. globulosa	12.50	32.50	25.00
28.	T. discolor	5.00	17.50	10.00

Table 5

Seasonal variation on infection intensity

Name of the helminth	Summer			Rainy			Winter		
	No. of goats infected	Total No. of worms collected	Average worm load per goat	No. of goats infected	Total No. of worms collected	Average worm load per goat	No. of goats infected	Total No. of worms collected	Average worm load per goat
1	2	3	4	5	6	7	8	9	10
C. cotylocherum	28	2898	103.50	38	2409	634.05	32	12640	395.00
G. Crumenifer	19	1653	87.00	38	32256	675.31	27	4941	183.00
P. cervi	8	282	53.00	21	4269	203.28	16	1472	92.00
F. elongatus	3	79	26.33	14	1403	100.14	10	730	73.00
F. cobboldi	1	9	9.00	4	155	38.75	3	72	24.00
C. spatiosus	1	6	6.00	11	390	35.45	6	162	27.00
C. gregarius	1	4	4.00	6	123	20.50	5	115	13.00
H. paloniae	-	-	-	3	13	4 .33	1	2	2.00
Immature amphistome	2	61	30.50	37	9068	245.08	22	3498	159.00
H. expansa	-	-	-	10	28	2.80	5	10	2.00
H. benedeni	-	-	-	6	18	3.00	3	5	1.66
S. globisunctata	18	234	13.00	36	1852	50.55	20	580	29.00
S. vitata	1	3	3.00	3	32	10.66	2	13	6.50

1	2	3	4	5	6	7	8	9	10
A. centrisunctata	4	23	5.75	12	261	21.75	8	112	14.00
A. lahorea	-	-	-	4	47	11.75	2	18	9.00
A. sudanea	-	-	-	3	37	12.33	1	1	1.00
C. tenuicollis	6	27	4.50	14	346	24.71	11	123	11.18
G. verrucosum	1	4	4.00	8	43	5.37	5	30	4.60
H. contortus	27	1071	39.66	39	14253	365.46	33	4260	129.09
T. coluboriformis	-	-	-	10	326	32.60	4	64	16.00
H. trigonocephalum	2	7	3.50	8	66	8.25	3	31	10.33
G. pachyscelis	2	11	5.50	14	214	15.28	7	63	9.00
O. columbianum	6	45	7.50	11	204	18.54	8	76	9.50
O. asperum	11	103	9.36	21	957	45.57	16	296	18.50
O. venulosum	2	8	4.00	7	76	10.85	3	24	8.00
T. ovis	19	285	15.00	26	621	23.88	16	336	21.00
T. globulosa	5	37	7.40	13	259	19.92	10	96	9.60
T. discolor	2	5	2.50	7	86	12.28	4	26	6.50

throughout the year, although the peak of infection occurred in rainy season. Helminths, such as, H. *palonias*, H. *emanea*, H. *benedeni*, A. *lahorea*, A. *sudanea* and T. *colubriformis* were not recovered during summer season from any of the goats examined. It was further observed that the overall incidence and intensity of infection was highest in the rainy season, moderate in winter season and lowest in summer. On close observation it was further found that the incidence and intensity of infection with immature stages of amphistomes and H. *contortus* decreased considerably from April to May and there occurred a gradual increase both in the incidence and intensity of infection starting from the last week of July till the end of September.

VARIATION DUE TO AGE ON INCIDENCE AND INTENSITY OF HELMINTHIC INFECTION

In the present studies, 18 goats of 1 - 4 months, 36 of 5 - 8 months, 36 of 9 - 12 months and 30 of above one year of age were examined. The variation due to age on incidence and intensity of helminthic infection in goats has been illustrated in Table 6 and 7.

On perusal of Table 6 it is revealed that out of 98.33 % overall infection, nematode infection was 1.66 %, mixed infection of trematodes and cestodes was 2.50 %, mixed infection of trematodes and nematodes was 2.50 %, mixed infection of cestodes and nematodes was 4.16 % and mixed infection of trematodes, cestodes along with nematodes was 87.50 %. None of the goats were observed

Table 6

Nature of incidence in different age groups

Sl. No.	Observations	Grand total	Age groups			
			1 - 4 months	5 - 8 months	9 - 12 months	More than one year.
1.	No. of goats examined	120	18	36	36	30
2.	Found infected with helminths	118	17	36	36	29
3.	Harbouring trematodes only	-	-	-	-	-
4.	Harbouring cestodes only	-	-	-	-	-
5.	Harbouring nematodes only	2	1	1	-	-
6.	Harbouring trematodes and cestodes	3	-	-	1	2
7.	Harbouring trematodes and nematodes	3	-	1	2	-
8.	Harbouring cestodes and nematodes	5	1	2	1	1
9.	Harbouring trematodes, cestodes and nematodes	105	15	32	32	26

Table 7

Variation due to age in incidence and intensity of helminthic infection

Name of the helminth	1 - 4 months of age		5 - 8 months of age		9 - 12 months of age		Above one year	
	Percentage of infection	Average worm load	Percentage of infection	Average worm load	Percentage of infection	Average worm load	Percentage of infection	Average worm load
1	2	3	4	5	6	7	8	9
C. cotylophorum	38.88	123.00	88.88	403.00	83.33	357.00	83.33	713.70
C. crumenifer	33.33	143.00	75.00	417.00	72.22	398.00	83.33	391.64
P. cervi	22.22	102.00	41.66	139.00	37.77	136.00	33.33	164.00
P. elongatus	11.11	43.00	27.77	83.00	25.00	81.00	6.66	120.00
P. cobboldi	5.55	17.00	8.33	32.00	8.33	21.00	3.33	16.00
C. spatiosus	11.11	22.00	16.77	47.28	16.66	25.00	10.00	28.00
C. gregarius	-	-	13.88	14.00	13.88	20.00	6.66	11.00
H. palonise	-	-	2.77	2.00	8.33	4.00	-	-
Immature amphistome	61.11	145.45	66.66	145.45	63.88	191.00	10.00	61.00
M. expansa	27.77	1.80	16.66	2.85	11.11	1.66	-	-
M. benedeni	16.66	2.00	27.77	1.00	13.78	3.20	-	-
S. globipunctata	66.66	21.00	69.44	37.00	58.33	29.00	43.33	37.76

1	2	3	4	5	6	7	8	9
S. vitata	5.55	2.00	8.33	9.33	5.50	9.00	-	-
A. centripunctata	22.22	17.00	27.77	18.05	25.00	15.00	3.33	2.00
A. laherea	5.50	1.00	8.33	17.00	5.50	6.50	-	-
A. sudanea	5.50	3.00	5.50	9.50	2.22	12.00	-	-
C. temuicollis	16.66	6.00	33.33	22.00	19.40	7.00	30.00	13.88
C. verrucosum	-	-	11.11	4.50	13.88	5.00	13.33	6.75
H. contortus	66.66	165.00	80.55	221.00	77.77	201.00	50.00	12.75
T. colubriformis	11.11	12.00	19.44	35.00	13.88	31.00	6.66	21.00
B. trigonocephalum	11.11	4.50	13.88	11.00	11.11	6.50	6.66	21.00
O. pachyscelis	16.66	7.00	25.00	12.00	19.44	15.00	16.66	4.90
O. columbianum	22.22	7.00	22.22	9.00	22.22	4.00	10.00	11.00
O. aspefum	38.88	12.00	44.44	27.00	41.66	31.00	33.33	2.75
O. venulosum	5.50	1.00	13.33	13.40	11.11	7.00	6.66	12.00
T. ovis	55.55	12.00	50.00	51.00	52.77	24.30	50.00	47.00
T. globulosa	26.88	15.00	50.00	16.00	30.55	14.00	33.33	6.33
T. discolor	11.11	4.50	16.66	9.50	26.88	8.20	-	-

to harbour pure infection of either trematodes or cestodes only.

From the perusal of Table 7 it was revealed that the incidence and intensity of infection with most of the helminths were highest in goats belonging to age group of 5 - 8 months and lowest in age group of 1 - 4 months; whereas, moderate incidence and intensity of infection occurred in age group of 9 - 12 months. Some of the helminths such as Moniezia spp. did not occur in goats above one year of age and paramphistomes had a considerably less incidence and infection intensity in goats below 4 months of age.

FREQUENCY OF DISTRIBUTION

The number of each species of trematodes, cestodes and nematodes harboured by the number of infected goats is illustrated in Table 8, 9 and 10 respectively.

On perusal of the above, it was revealed that the frequency distribution of F. cotylophorum, G. cruminifer, F. cervi and H. contortus was higher in the infected goats; whereas, a lower frequency distribution occurred in case of F. cobboldi, G. gregarius, C. spatiosus, H. palaniae, H. expansa, H. honedoni, S. vitata, A. centripunctata, A. lahorea, A. sudanea, B. trigonocephalum, O. venulosum and T. discolor. Rest of the helminths had a moderate frequency distribution in the infected goats.

Table 8

Frequency distribution of trematodes in goats

No. of worms	Frequency distribution of various trematodes								
	C. cotylophorum	*G. crumenifer*	*P. cervi*	*F. elongatus*	*F. cobboldi*	*C. spatiosus*	*C. gregarius*	*H. paloniae*	Immature amphistomes
1	2	3	4	5	6	7	8	9	10
0	26	36	75	96	112	102	108	116	59
1	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	1	-
3	-	-	-	-	-	-	-	1	-
4	-	-	-	-	-	-	-	1	-
5	-	-	-	1	-	-	1	1	-
6	-	-	-	-	-	1	2	-	-
7	-	-	1	1	-	1	3	-	-
8	-	-	-	2	-	2	2	-	-
9	-	-	-	1	1	1	1	-	-
10	-	-	-	1	3	2	1	-	-
11-20	-	1	2	2	2	4	1	-	-
21-30	-	1	4	1	2	3	1	-	-
31-40	-	2	1	1	-	1	-	-	4

1	2	3	4	5	6	7	8	9	10
41-50	1	2	3	2	-	2	-	-	2
51-60	2	3	1	3	-	1	-	-	3
61-70	1	1	2	2	-	-	-	-	11
71-80	3	2	2	3	-	-	-	-	6
81-90	4	1	6	1	-	-	-	-	12
91-100	9	2	8	2	-	-	-	-	5
101-200	13	3	4	1	-	-	-	-	3
201-300	2	2	2	-	-	-	-	-	6
301-400	5	7	4	-	-	-	-	-	2
401-500	14	14	3	-	-	-	-	-	1
501-600	9	12	1	-	-	-	-	-	1
601-700	5	19	1	-	-	-	-	-	2
701-800	-	-	-	-	-	-	-	-	-
801-900	11	8	-	-	-	-	-	-	1
901-1000	12	3	-	-	-	-	-	-	1
1001-2000	2	1	-	-	-	-	-	-	1
2001-3000	1	-	-	-	-	-	-	-	-
3001-4000	-	-	-	-	-	-	-	-	-
	120	120	120	120	120	120	120	120	120

Table 9

Frequency distribution of cestodes in goats

No. of worms	Frequency distribution of various cestodes							
	M. expansa	*M. benedeni*	*Stilesia globipunctata*	*S. hepatica*	*Avitellina centripunctata*	*A. lahorea*	*A. sudanea*	*Cittotaenia ctenoides*
0	105	111	46	114	96	114	116	89
1	4	2	-	-	-	1	1	-
2	6	2	-	1	2	-	-	-
3	3	3	-	-	-	2	-	1
4	1	2	-	-	-	-	-	-
5	-	-	-	1	-	-	1	-
6-10	1	-	9	3	15	1	-	6
11-20	-	-	2	1	4	1	2	2
21-30	-	-	6	-	3	1	-	12
31-40	-	-	16	-	-	-	-	10
41-50	-	-	3	-	-	-	-	-
51-60	-	-	15	-	-	-	-	-
61-70	-	-	14	-	-	-	-	-
71-80	-	-	3	-	-	-	-	-
81-90	-	-	3	-	-	-	-	-
91-100	-	-	1	-	-	-	-	-
101-120	-	-	2	-	-	-	-	-
	120	120	120	120	120	120	120	120

Table 10

Frequency distribution of nematodes in goats

No. of the worms	Frequency distribution of various nematodes										
	O. verrucosum	H. contortus	T. colubriformis	T. trigonocephalum	O. pachyaccelis	O. columbianum	O. asperum	O. venulosum	C. ovis	T. globulosa	T. discolor
1	2	3	4	5	6	7	8	9	10	11	12
0	106	36	106	107	96	95	72	108	59	92	107
1	-	-	-	-	-	-	-	1	-	-	1
2	2	-	-	1	-	-	-	-	-	1	-
3	1	1	-	-	-	-	-	-	1	-	1
4	4	-	-	1	2	-	-	1	2	1	-
5	7	-	-	-	-	1	-	2	1	-	2
6	-	-	-	-	1	2	2	1	-	2	1
7	-	1	-	1	1	1	3	1	2	3	-
8	-	-	-	3	1	1	2	-	1	1	1
9	-	1	-	2	2	3	2	2	1	-	1
10	-	1	-	2	5	2	2	1	3	4	3
11-20	-	2	2	3	2	3	12	2	6	9	1
21-30	-	2	10	-	5	6	3	1	2	5	2
31-40	-	3	2	-	3	4	5	-	6	2	-

1	2	3	4	5	6	7	8	9	10	11	12
41-50	-	4	-	-	2	2	4	-	10	-	-
51-60	-	5	-	-	-	-	11	-	11	-	-
61-70	-	2	-	-	-	-	2	-	4	-	-
71-80	-	7	-	-	-	-	-	-	5	-	-
81-90	-	14	-	-	-	-	-	-	3	-	-
91-100	-	1	-	-	-	-	-	-	2	-	-
101-200	-	12	-	-	-	-	-	-	1	-	-
201-300	-	16	-	-	-	-	-	-	-	-	-
301-400	-	3	-	-	-	-	-	-	-	-	-
401-500	-	2	-	-	-	-	-	-	-	-	-
501-600	-	3	-	-	-	-	-	-	-	-	-
601-700	-	2	-	-	-	-	-	-	-	-	-
701-800	-	-	-	-	-	-	-	-	-	-	-
801-900	-	1	-	-	-	-	-	-	-	-	-
901-1000	-	-	-	-	-	-	-	-	-	-	-
1001-2000	-	1	-	-	-	-	-	-	-	-	-
	120	120	120	120	120	120	120	120	120	120	120

MULTIPLE INFECTION

During the course of study multiple infection with two or more species of helminths in goats above five months of age was a common feature; whereas, single infection was observed in most of the goats below four months of age. The nature of multiple infection of helminths observed in the present study is detailed in Table 11.

Table 11

Nature of multiple infections of helminths

Part of the gastro-intestinal tract	Occurrence of multiple infection
1	2
Rumen	(a) G. crumenifer with C. cotylophorum
	(b) G. crumenifer with C. cotylophorum and F. cervi
	(c) G. crumenifer with C. cotylophorum, C. spatiosus and C. gregarius
	(d) G. crumenifer with F. cobboldi and F. elongatus
	(e) C. cotylophorum with C. gregarius and F. elongatus
	(f) C. cotylophorum with C. spatiosus, F. cobboldi and G. crumenifer

1		2
Abomasum	(a)	H. contortus with T. colubriformis
	(b)	H. contortus with T. colubriformis and immature amphistomes
Intestine	(a)	T. colubriformis with immature amphistomes and Stilesia spp.
	(b)	Immature amphistomes with Avitellina spp. or Stilesia spp.
	(c)	B. trigonocephalum with immature amphistome and Stilesia spp.
	(d)	B. trigonocephalum with C. pachyscelis and Stilesia spp.
	(e)	B. trigonocephalum with C. pachyscelis and H. expansa
	(f)	C. pachyscelis with H. expansa or H. benedeni
Caecum and colon		Trichuris spp. with Oesophagostomum spp.

LARVAL POPULATION DYNAMICS ON NATURALLY INFECTED PASTURE

The population of infective larvae on the pasture adjacent to Goat Breeding Farm, O. U. A. T., Bhubaneswar was studied after Baermanning 100 g grass samples collected three times a day i.e., morning, noon and evening for 5 occasions in a month. The average number of larvae recovered from 100 g of herbage in each month, starting

from January, 1983 to December, 1983 has been presented in Table 12.

On perusal of the Table 12, it was revealed that the pasture was highly contaminated with infective larvae of Haemonchus, Strongyloides, Oesophagostomum, Bunostomum, Gaigeria and Trichostrongylus species. The peak of larval population was observed from July to October, the highest number being encountered during September. The number of larvae per 100 g of herbage declined sharply from December to February with a rise in March and again a sharp decline occurred in April and May. However the larval count started to increase in number from middle of June.

The infective larvae were observed to occur on herbage in larger numbers during the morning hours as compared to noon and evening hours.

LARVAL POPULATION DYNAMICS IN GOAT YARD

Soil samples weighing 100 g were collected from five different sites of the goat yard, Goat Breeding Farm, O. U. A. T., Bhubaneswar and brought to the laboratory. The infective larvae were recovered by Baermen technique. The data on the larval population in the goat yard beginning from January, 1983 to December, 1983 have been presented in Table 13.

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Table 12

Population of infective stage larvae in 100 g of herbage of naturally infested pasture

Month	Average number of infective larvae recovered from 100 g of grass					
	Haemonchus spp.	Trichostrongylus spp.	Bunostomum spp.	Gaigeria spp.	Oesophagostomum spp.	Strongyloides spp.
January	19	13	5	6	27	9
February	18	11	2	3	21	7
March	42	16	4	10	33	11
April	9	7	2	4	5	6
May	-	1	1	3	2	1
June	33	17	6	7	16	15
July	122	31	9	11	21	42
August	151	44	12	14	39	45
September	159	51	19	38	51	57
October	143	41	11	35	45	27
November	107	28	8	29	31	23
December	38	16	6	19	29	10

Table 13

Population of infective stage larvae in 100 g of soil sample of goat yard

Month	Average number of larvae recovered from 100 g of soil sample					
	Haemonchus spp.	Trichostrongylus spp.	Bunostomum spp.	Gaigeria spp.	Oesophagostomum spp.	Strongyloides spp.
January	23	19	6	7	11	6
February	19	17	4	5	14	3
March	45	26	8	12	37	7
April	12	8	4	9	14	4
May	-	-	1	2	5	-
June	36	21	1	8	18	10
July	127	36	7	13	22	12
August	158	49	11	14	43	19
September	163	60	27	34	59	23
October	146	43	22	22	47	17
November	114	32	15	15	38	14
December	39	22	9	12	32	10

A perusal of Table 13 indicated that the larval population was higher in the goat yard than the adjacent pasture, where the goats used to graze daily. The peak of larval count was observed from July to October and a sharp fall was observed from November to February. There occurred an increase in larval population in March; whereas, the population started to decline from April upto the middle of June.

PATHOLOGY OF GASTRO-INTESTINAL HELMINTHIASIS

IMMATURE AMPHISTOME INFECTION

Macroscopic Changes

Most of the immature worms were deeply embedded in the mucosa and submucosa of the duodenum and a few were scattered in the lumen of the small intestine. The infected mucosa of the duodenum was thickened, congested and ulcerated. Besides there was catarrhal and haemorrhagic duodenitis and also similar inflammation of the pyloric part of the abomasum in few cases. The pitted appearance of the mucosal surface of the intestine showed the sites of attachment of the immature worms.

Microscopic Changes

Serial sections of infected duodenal tissues showed the presence of immature amphistomes in the mucosal and submucosal layers (Fig. 1). The mucosa near the points of entry of the worms revealed hypertrophy, superficial

PLATE I

Fig. 1. Section of duodenum showing the section o immature amphistomes in the mucosal and submucosal layers with reactive changes. H. & E. X 80.

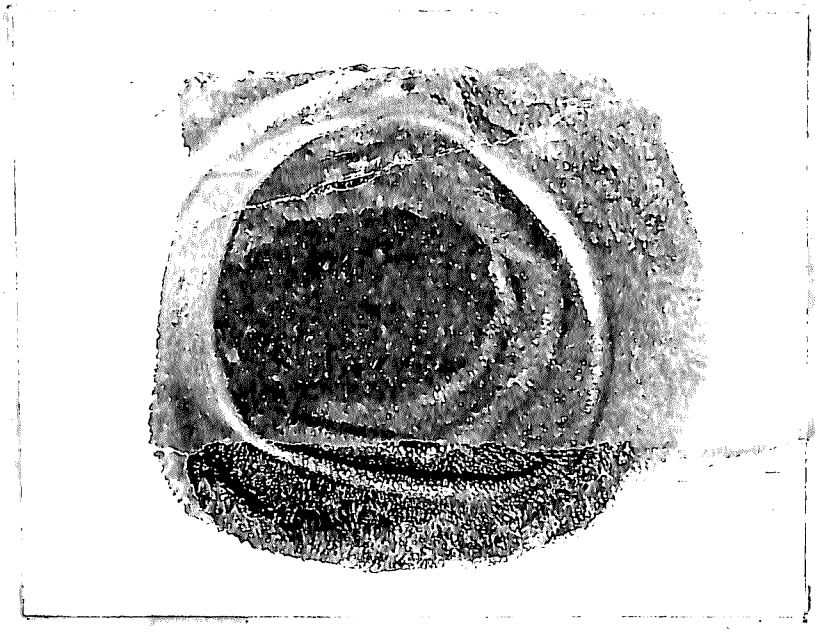

Fig. 2. Ruminal wall showing the attachment of mature amphistomes in form of a colony.

PLATE II

Fig. 3. Section of ruminal wall infected with mature amphistomes. No reactive changes could be seen.
H. & E. X 25.1.

Fig. 4. Duodenal mucosa showing attachment of scolices of S. globipunctata.

The broader anterior portion of unarmed scolices (Fig. 5) were seen deeply embedded into the dialated crypts of the mucosa causing ulceration and destruction of the tissues. In some cases the scolices were encysted (Fig. 6) in the submucosa. There was pressure atrophy of the intestinal glands and villi.

MONIEZIA INFECTION

Macroscopic Changes

Both M. expansa and M. benedeni occurred in the jejunum and ileum. In one case the intestinal lumen was blocked with these parasites from which 9 adult parasites were recovered (Fig. 7). No discernible gross lesions could be ascribed due to Moniezia infection; however in heavy infection the intestinal wall was slightly thickened. In none of the infected goats, the site of attachment of the parasite could be traced out.

HAEMONCHUS INFECTION

Macroscopic Changes

In heavily infected goats enormous pinpoint haemorrhages and small blood clots over the folds and glandular mucosa were present indicating severe gastritis. In general the typical angry looking like ulcers in the abomasal mucosa was the characteristic features of haemonchosis. The infected portion of the abomasal wall was highly congested and in some cases the abomasal content

PLATE III

Fig. 5. Duodenal mucosa showing the scolices of S. globipunctata penetrating through the crypts.
H. & E. X 25.1

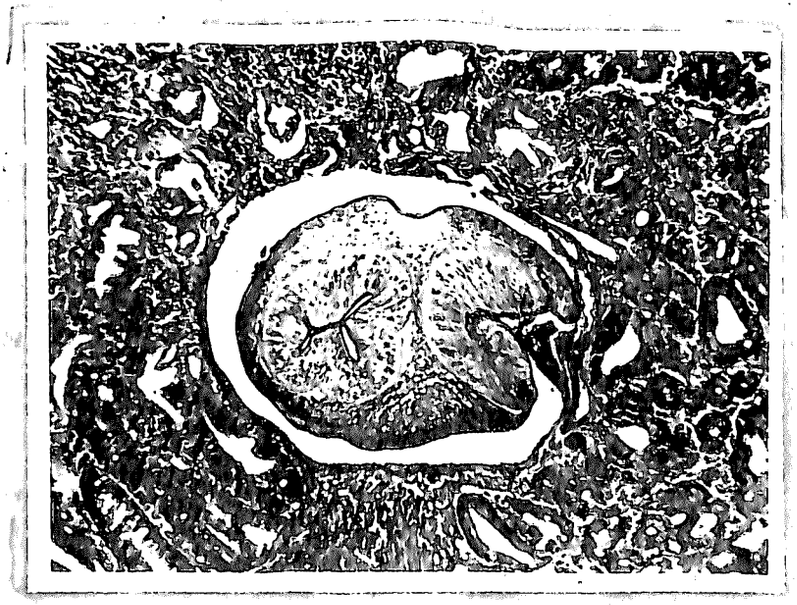

Fig. 6. Section of duodenum showing the section of S. globipunctata.
H. & E. X 25.1

PLATE IV

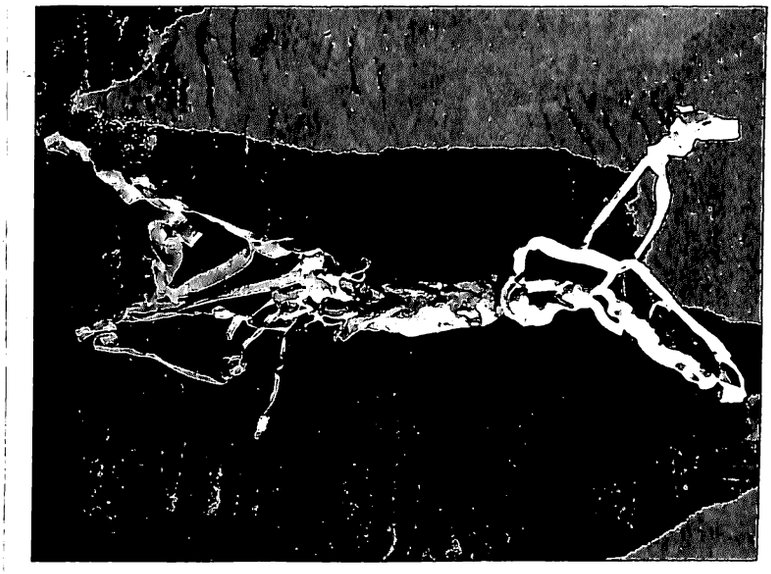

Fig. 7. Intestinal lumen packed with Moniezia species.

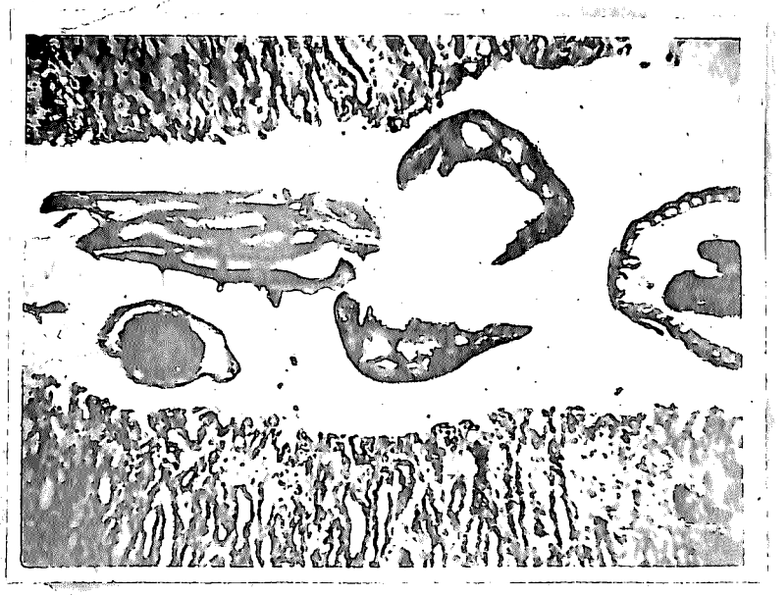

Fig. 8. Section of abomasal wall showing mature Haemonchus worms cut at various planes and cellular changes.
H. & E. X 25.1

appeared chocolate in colour containing a number of freely moving parasites at various stages of development. Most of the worms were recovered from the abomasal folds rather than the abomasal lumen. In heavily infected goats a large amount of sand particles were recovered from the abomasum along with the parasites.

Microscopic Changes

Sections of abomasum revealed chronic catarrhal gastritis associated with infiltration of lymphocytes and monocytes. The mucosa was hyperaemic and showed focal erosions with a number of sectioned parasites remaining free in the lumen (Fig. 8). The submucosal vessels were congested and oedematous. The muscular coat also revealed infiltration of lymphocytes, monocytes and comparatively more eosinophils.

HOOKWORM INFECTION

Macroscopic Changes

In general, a light infection with hookworms (G. trigonocephalum and G. pachyscelis) was observed and the parasites were firmly attached to the intestinal mucosa (mostly ileum and sometimes jejunum) by the help of their buccal capsules. At the sites of attachment, the intestinal mucosa was red in colour. Haemorrhagic focal enteritis was a common feature of this infection.

Microscopic Changes

In general, the microscopic changes consisted of desquamation and degenerative changes of the intestinal mucosa, oedema of varying degrees, congestion with or without haemorrhages and lymphocytic infiltration. The intestinal mucosa and submucosa were markedly thickened due to inflammatory reaction with infiltration of lymphocytes and monocytes. The mucosa revealed catarrhal enteritis with goblet cell hyperplasia and frequent degeneration ulceration and superficial necrosis of mucosa (Fig. 9). In the submucosa there was ulceration of payer's patches and severe desquamation and/or atrophy of Brunner's glands. In some cases the mucosa of the small intestine was severely damaged, particularly around the sites of attachment of the parasites. Necrosis of the upper part of the villi, lymphoid and eosinophil infiltration of the mucosa propria, and dastrophy and necrosis of the epithelial lining of the glands and crypts were also observed.

TRICHURIS INFECTION

Macroscopic Changes

The anterior portions of the parasites were embedded superficially in the caecal mucosa (Fig. 10) and the infected portion of the caecum was thickened and oedematous. Heavy infections with these parasites were observed to cause swelling of the caecal mucosa with profuse secretions of mucus.

PLATE V

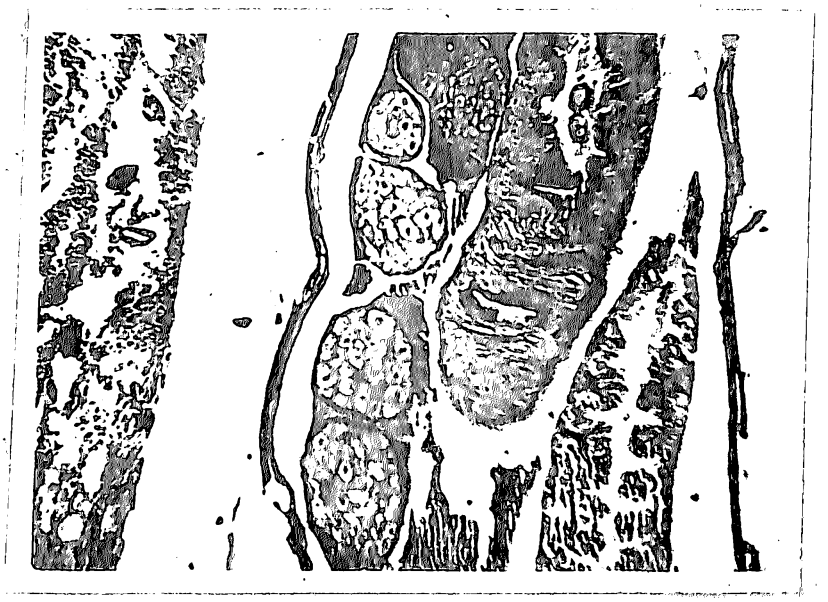

Fig. 9. Section of intestinal wall showing cellular changes due to *G. pachycolis* infection and the section of parasites.
H. & E. X 25.1

Fig. 10. Caecal wall showing attachment of *Eriborin* worm.

In general a light infection with this parasite occurred, in which no noticeable gross lesions could be observed.

Microscopic Changes

Microscopically, the changes in general were loss of surface epithelium, necrotic changes of coagulative types of the tips of the villi and mild to moderate oedema with leucocytic infiltration. The caecal mucosa and submucosa were markedly thickened due to infiltration of large number of lymphocytes, monocytes and plasma cells. The lining epithelial cells of mucosa revealed marked goblet cell hyperplasia and frequently superficial mucosa revealed coagulation necrosis. A large number of sectioned parasites were seen embedded into the mucosa (Fig. 11). In some cases, the lamina propria was moderately infiltrated with lymphocytes and eosinophils with occasional macrophages and majority of the intestinal villi revealed desquamation of the epithelial lining cells.

OESOPHAGOSTOMUM INFECTION

Macroscopic Changes

The goats harbouring large number of adult Oesophagostomum spp. showed the thickening and inflammation of the wall of caecum and colon and the presence of large amount of mucus in their lumen. In moderate infections the yellowish green nodules containing larvae were seen both in the small and large intestine. On teasing the nodules under the stereoscope, the larvae were obtained from most of the nodules. The size of the nodules varied from a

PLATE VI

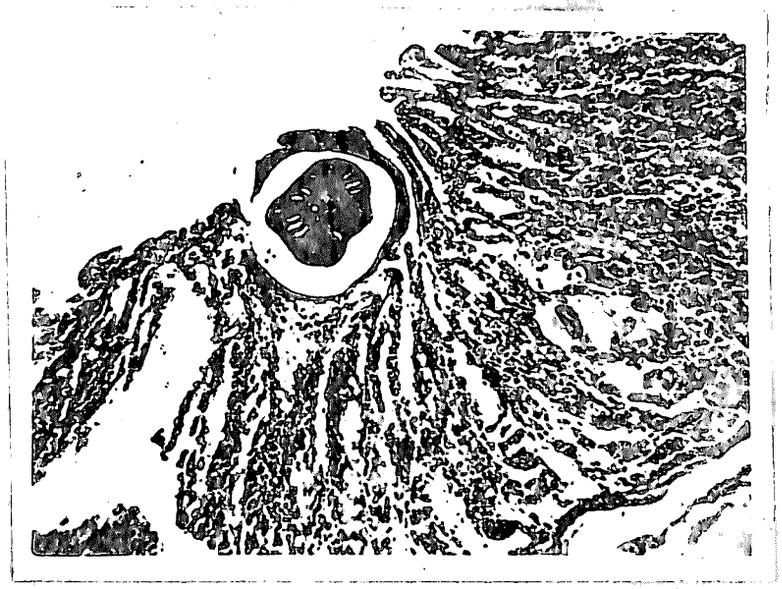

Fig. 11. Section of caecal wall showing cross section of Trichuris ovis embeded in the mucosa.
H. & E. X 25.1

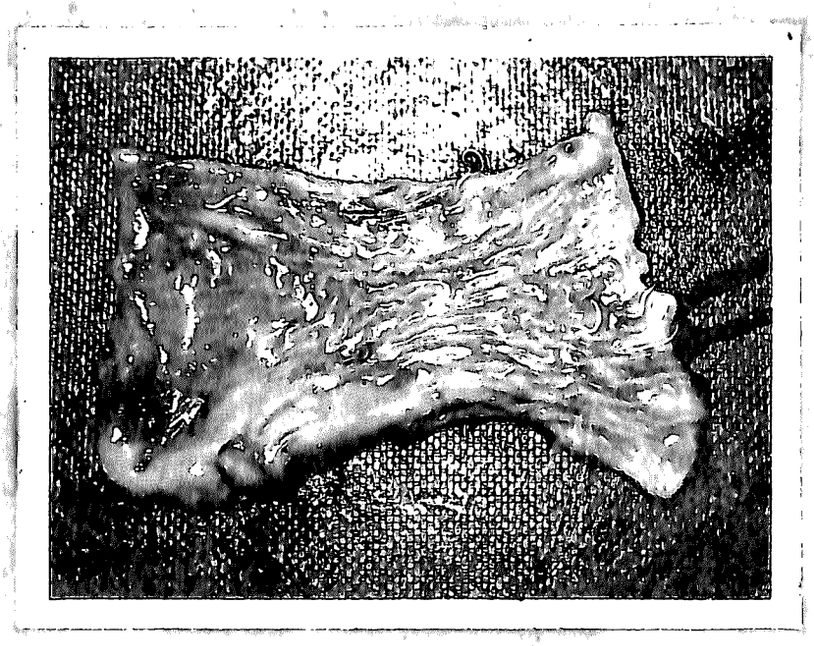

Fig. 12. Caecum showing the mucosal nodules protruding into the lumen and mature worms of O. columbianum being attached to the mucosa.

millet to a pea and the elevations were observed on either surfaces of intestinal wall. These nodules were observed in goats infected with O. columbianum and O. venulosum (Fig. 12); where as, no nodule formation could be observed in any of the goats infected by O. asperum. Goats infected with O. asperum only showed thickening and swelling of the intestinal wall containing a large amount of mucus (Fig. 13).

Microscopic changes

The sections of caecum showed caseonecrotic nodules in different stages of development in submucosa, muscular and serous coats. The size of nodules depended upon the age of the lesion. The younger nodules were characterised by caseonecrotic lesions with karryorrhectic nuclei and increased in eosinophilic areas surrounded by foreign body giant cells, macrophages and lymphocytes (Fig. 14). In the older nodules the caseonecrotic lesion was encapsulated by dense fibrous connective tissue capsule. The mucosa revealed marked catarrhal enteritis associated with infiltration of large number of lymphocytes, monocytes and plasma cells; while the submucosa, muscular coat and serosa which were free from the nodules were markedly thickened due to infiltration of lymphocytes, monocytes, plasma cells, neutrophils and eosinophils.

PLATE VII

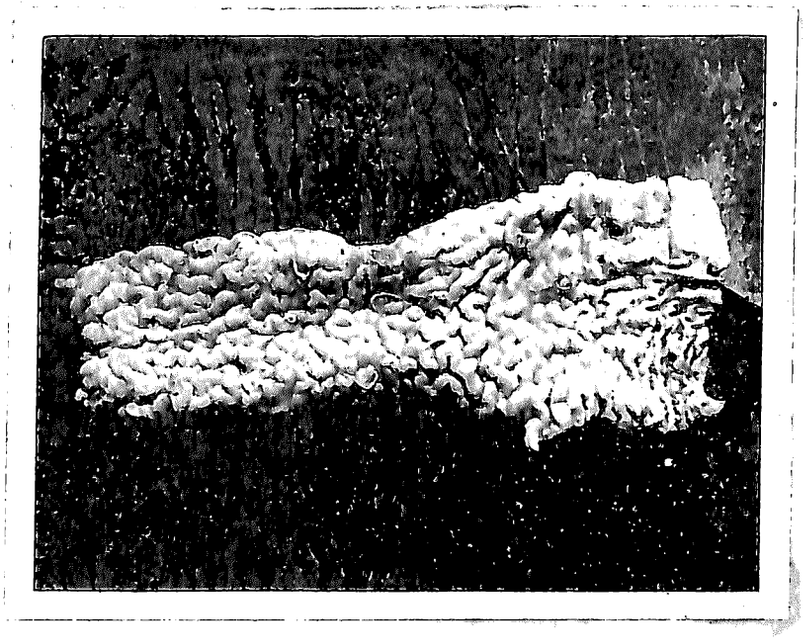

Fig. 13. Caecum infected with O. asperum

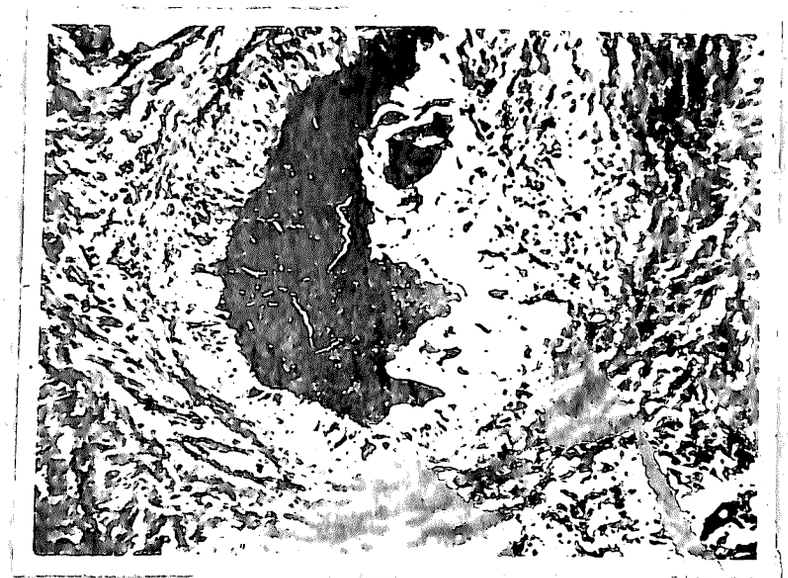

Fig. 14. Section of caecum showing caseonecrotic lesions surrounded by macrophages, giant cells and fibrous connective tissue of oesophagostomum nodule.
H. & E. X 15.

CHEMOTHERAPY

The efficacy of panacur against gastro-intestinal helminthiasis involving paramphistomes, Moniezia spp., strongyle and Trichuris spp. in naturally infected goats was evaluated on the basis of the reduction in the faecal egg output and larval culture before and after the medication. The results obtained in the above trial are presented in Table 16.

It was observed that Panacur at 10 mg per kg body-weight against paramphistomes, Moniezia spp. strongyle and Trichuris spp. in naturally infected goats shewed 42.92 %, 84.67 %, 97.01 % and 64.68 % efficacy respectively. On the second day of treatment there occurred a marked reduction in the egg output of Moniezia spp. and strongyles; whereas, the reduction in the egg output of paramphistomes and Trichuris spp. was only 33.82 % and 55 % respectively, thereby, indicating low efficacy of the drug against these two parasites. On the other hand there occurred a sharp rise in the egg output of the helminths in the infected and untreated goats.

For determining the efficacy of Panacur against various strongyles, the faeces of each goat were cultured before the administration of the drug. In all the cases the faecal cultures were highly positive for Haemonchus and Oesophagostomum larvae, whereas, a few Trichostrongylus and hookworm larvae were obtained from the faeces of 6 goats

Table 14

Efficacy of Panacur on gastro-intestinal helminths in naturally infected goats

Group	Goat No.	EPG before treatment	Average EPG before treatment	EPG on post treatment			Average EPG on 7th day	Percentage of efficacy
				2nd day	5th day	7th day		
1	2	3	4	5	6	7	8	9
Group - A (Infected but treated)	2234	P 155		P 103	P 102	P 99		
		M 317		M 78	M 62	M 54		
		S 157		S 24	S 11	S 8		
		T 24		T 11	T 10	T 9		
	2243	P 541		P 450	P 407	P 403		
		M 378		M 93	M 80	M 59		
		S 163		S 14	S 12	S 9		
		T 30		T 15	T 12	T 11		
	2262	P 364		P 211	P 198	P 195		
		M 247		M 81	M 46	M 31		
		S 242		S 5	S 4	S 3		
		T 10	P 337.00	T 7	T 6	T 5	P 192.33	P 42.92
			M 280.50				M 43.00	M 84.67
	2272	P 359	S 201.16	P 207	P 193	P 191	S 6.33	S 97.01
		M 137	T 20.16	M 41	M 32	M 17	T 7.16	T 64.68
		S 228		S 16	S 12	S 10		
		T 19		T 11	T 8	T 7		
	2297	P 202		P 87	P 81	P 67		
		M 403		M 69	M 47	M 34		
		S 225		S 3	S 1	S Nil		
		T 23		T 12	T 8	T 6		
	2299	P 401		P 290	P 207	P 199		
		M 137		M 41	M 32	M 17		
		S 192		S 9	S 2	S Nil		
		T 15		T 10	T 8	T 6		

Table 14

Efficacy of Panacur on gastro-intestinal helminths in naturally infected goats

Group	Goat No.	EPG before treatment	Average EPG before treatment	EPG on post treatment			Average EPG on 7th day	Percentage of efficacy
				2nd day	5th day	7th day		
1	2	3	4	5	6	7	8	9
Group - A (Infected but treated)	2234	P 155		P 103	P 102	P 99		
		M 317		M 78	M 62	M 54		
		S 157		S 24	S 11	S 8		
		T 24		T 11	T 10	T 9		
	2243	P 541		P 450	P 407	P 403		
		M 378		M 93	M 80	M 59		
		S 163		S 14	S 12	S 9		
		T 30		T 15	T 12	T 11		
	2262	P 364		P 211	P 198	P 195		
		M 247		M 81	M 46	M 31		
		S 242		S 5	S 4	S 3		
		T 10	P 337.00	T 7	T 6	T 5	P 192.33	P 42.92
			M 280.50				M 43.00	M 84.67
	2272	P 359	S 201.16	P 207	P 193	P 191	S 6.33	S 97.01
		M 137	T 20.16	M 41	M 32	M 17	T 7.16	T 64.68
		S 228		S 16	S 12	S 10		
		T 19		T 11	T 8	T 7		
	2297	P 202		P 87	P 81	P 67		
		M 403		M 69	M 47	M 34		
		S 225		S 3	S 1	S Nil		
		T 23		T 12	T 8	T 6		
	2299	P 401		P 290	P 207	P 199		
		M 137		M 41	M 32	M 17		
		S 192		S 9	S 2	S Nil		
		T 15		T 10	T 8	T 6		

1	2	3	4	5	6	7	8	9
Group - B (Infected but untreated control)	2227	P 331 M 208 S 228 T 22		P 342 M 216 S 290 T 26	P 352 M 218 S 305 T 27	P 363 M 225 S 315 T 31		
	2239	P 362 M 321 S 152 T 32		P 376 M 325 S 156 T 36	P 388 M 329 S 159 T 37	P 392 M 334 S 164 T 39		
	2247	P 492 M 315 S 144 T 23	P 328.16 M 277.83 S 200.33 T 21.83	P 501 M 321 S 148 T 26	P 509 M 327 S 149 T 26	P 515 M 329 S 154 T 27	P. 356.66 M 292.50 S 222.16 T 27.50	- - - -
	2261	P 167 M 188 S 276 T 20		P 203 M 199 S 281 T 22	P 209 M 202 S 285 T 23	P 214 M 211 S 301 T 25		
	2268	P 311 M 229 S 219 T 13		P 318 M 234 S 224 T 16	P 327 M 235 S 231 T 16	P 332 M 239 S 236 T 17		
	2285	P 306 M 406 S 123 T 21		P 310 M 408 S 134 T 24	P 317 M 410 S 157 T 25	P 324 M 417 S 163 T 26		

P = Paramphistome M = Moniezia
S = Strongyle T = Trichuris

only. The faecal culture on the 7th day of treatment revealed complete absence of strongyle larvae in two of the treated goats and in the rest of four treated goats there occurred a marked reduction in the strongyle larvae. On the other hand the faecal cultures of the infected and untreated goats showed enormous strongyle larvae.

None of the goats treated with Panacur showed any untoward reaction and the drug was well tolerated by each goat. All the goats were kept under close observation for a period of one month after medication and it was observed that the treated goats showed a marked improvement in their general body condition; whereas, the untreated goats were observed to develop diarrhoea, weakness and rough hair coat.

D I S C U S S I O N

Environmental factors (climate, weather, temperature, and soil), susceptibility, resistance and nutritional status of the host and methods of husbandry are always taken into consideration, while studying the epidemeology of parasitic diseases in livestock of a particular geogrephical region.

On the basis of the incidence and levels of infection, H. contortus (82.50 %), G. crumenifer (70.00 %), S. globipunctata (61.66 %) and T. ovis (50.83 %) were observed as the most common helminths infecting the local goats, which confirmed the report of Misra (1972). Besides the common occurrence of O. asperum (40.00 %) in local goats was in general agreement with the observation of Patnaik (1964 b). The occurrence of C. cotylophorum, G. crumenifer, A. centripunctata, M. expansa, M. benedeni, C. tenuicollis, G. verrucosum, H. contortus, T. ovis and O. columbianum reported by Thapar (1956), Patnaik (1963), Misra (1972); B. trigonocephalum, G. pachyscelis, O. asperum and O. venulosum reported by Thapar (1956) and Patnaik (1963); T. colubriformis, P. cervi, F. elongatus, F. cobboldi, C. spatiosus, C. gregarius, S. globipunctata, T. globulosa by Patnaik (1963) and Misra (1972); H. paloniae and T. discolor by Patnaik (1963); and S. vitata, A. lahorea, A. sudanea by Misra (1972) in goats of Orissa has been confirmed in the present study. However G. pulchrum

reported by Thapar (1956), Patnaik (1963) and Misra (1972); H. digitatus by Patnaik (1963) and Misra (1972); S. papillosus, O. ostertagi, O. circumcincta, O. curticei, S. ovis by Patnaik (1963) and T. ovina by Patnaik (1964 a) in Orissa could not be encountered in the present investigation and it may be explained by the fact that the source of the goats might be different from those of previous workers.

All the gastro-intestinal helminths recorded in the present investigation were observed to occur at their normal sites.

The overall 98.33 % infection of gastro-intestinal helminths in the present investigation is higher than the report of Misra (1972) i.e., 85.00 % and this increase in the incidence of helminths is evidently due to the extension of canal system in the state during the recent years. Among the helminths recovered, the highest incidence of infection was recorded for H. contortus (82.50 %). Next in descending order of incidence of infection was observed with C. cotylophorum, G. crumenifer, S. globipunctata, immature amphistomes and T. ovis. This finding is in general agreement with the report of Misra (1972). The incidence and intensity of infection with H. contortus and paramphistomes were highest in rainy season and lowest in summer. The higher incidence and intensity of infection with paramphistomes in rainy season may be due to the

presence of many water logging areas, which provide the most favourable conditions for the survival of the snails (intermediate host); thereby facilitating the dissemination of the parasite. The drop on the incidence and intensity of infection with H. contortus in summer may be due to the lethal effects of relative high atmospheric temperature and low relative humidity on the development and survival of the larvae on the pastures (Misra and Ruprah, 1972 and 1973). Dinnik and Dinnik (1958) also studied about the lethal effects of dry season climate in the survival of eggs and developing larval stages. The rainy season provides the favourable environment for the development and dissemination of exogenous stages of the strongyle worms resulting in an increase incidence and intensity of infection. The observation on the low to moderate infection intensity with Avitellina spp., Moniezia spp., Fischoederius spp., Carmyerius spp., Bunostomum spp., Gaigeria spp. Trichostrongylus spp., Oesophagostomum spp. and Trichuris spp. was in general agreement with the report of Misra (1972). The distribution pattern of gastro-intestinal helminths in the local goats were influenced by rain fall and similar observation were also made by Maculloch and Kasimbala (1968). On close observation it was further found that the incidence and intensity of infection with H. contortus decreased considerably in April and May and there occurred a gradual increase in the incidence and intensity of infection starting from the last week of July

till the end of September. Misra and Ruprah (1968) also stated that the infection and intensity percentage with H. contortus was low in the beginning of sumer, as the conditions for the development of these worms were unfavourable. As a result of occasional rainfall towards the last week of June, the favourable environment for the parasitic development caused a gradual increase in the infection and intensity percentage. They also could not recover Haemonchus spp. from goats in the month of May.

Both sexes of goats were found equally infected with gastro-intestinal helminths. This observation differed from that of Malhotra (1982) who studied that males were more heavily infected with Moniezia than females.

Lepage (1969) mentioned that young animals were often infected with Moniezia spp. than old ones. In the present investigation Moniezia spp. did not occur in goats above one year of age and the probable reason may be the development of age resistance in adult animals or some break in host-vector or host-parasite relationship (Mohiuddin et al., 1982). It may be further explained by the fact that adult Moniezia parasites are spontaneously eliminated from the host body within 6 months (Worley et al., 1974). Paramphistomes were observed to have a considerably less incidence and infection intensity in goats below 4 months of age and it may be due to the fact that these young kids are mostly confined to the sheds, thereby not

being exposed to the water logging areas contaminated with the infected snails. The highest incidence and intensity of infections with most of the helminths were observed in goats belonging to 5 - 8 months of age. Moderate incidence and intensity of infection occurred in age group of 9 - 12 months, which was presumed to be due to acquired immunity (Zimin, 1971).

In the present investigation, except one all the infected goats 117 i.e., 97.50 % harboured mixed infections of two or more gastro-intestinal helminths. This finding differed from the report of Misra and Ruprah (1968) who recorded 21.60 % pure infection and 70.00 % mixed infection among the infected goats at Hissar. Hassan (1964) in East Pakistan recorded 36.3 % pure infection and 63.70 % mixed infection among the goats. The increased incidence of mixed infection in the local goats may be due to the prevalence of warm humid climatic conditions and presence of many water logging areas in this part of the country favouring the multiplication and dissemination of the parasites of livestock. None of the goats harboured pure infection of either trematodes or cestodes which closely tallied with the observations of Misra and Ruprah (1968). The mixed infection with trematodes, cestodes and nematodes (87.50 %) was of common occurrence in the local goats.

Since pasture acts as a focus for dispersal and exchange between domestic animals and parasitic population,

the worm burden in animals is directly related to the number of larvae per unit of herbage. Pasture larval counts have been used by several workers for estimating the levels of contamination of pasture with the 3rd stage nematode larvae (Crofton, 1949; Michel et al., 1970; Misra and Ruprah, 1973). Studies on the larval population on the pasture adjacent to the Goat Breeding Farm, O. U. A. T., Bhubaneswar (pasture known to be grazed by the goats) indicated that it was highly contaminated with Strongyloides and strongyle larvae (Haemonchus spp., Trichostrongylus spp., Bunostomum spp., Gaigeria spp. and Oesophagostomum spp.). Larval population was higher from July to October with a peak in the month of September and it decreased from November to February with a slight increase in March. The least number of larvae were recovered during April and May. The drop in the population of the larvae during the winter and mid summer may be due to the lethal effects of cold and hot climates on the survival rate of eggs and developing larvae (Dinnik and Dinnik, 1958 and Misra and Ruprah, 1973). The rain fall during the month of July to September caused an increase in larval population in the pasture. The correlation between the strongyle population in goat and on pasture was found positive, which is in agreement with the findings of Suzoby et al. (1963). The larval population in the goat yard and adjacent pasture was studied simultaneously and the number of larvae per 100 g

of the soil collected from goat yard was compared with the number of larvae per 100 g of grass sample collected from the adjacent pasture. It was observed that the larval population of the goat yard was always more than that of adjacent pasture although the pattern of distribution of larvae in various seasons inside the goat yard was similar to that of the adjacent pasture. The higher population of larvae inside the goat yard may be due to the presence of moisture throughout the year particularly around the watering troughs favouring the development and hatching of the nematode eggs, expelled out through the faeces of infected goats.

Parasitic gastro-enteritis in goats is one of the most frequent cause of ill health and it is associated with complex series of nutritional, biochemical and pathological changes.

The immature amphistomes were deeply embedded in the mucosa and submucosa of duodenum. The duodenal mucosa was congested, ulcerated and oedematous and these observations were in confirmity with the report of D'Souza (1949), Deorani and Katiyar (1967) and Misra (1982). Microscopical changes revealed the presence of cross sections of the amphistomes inside the duodenal mucosa and the presence of plasma cells, eosinophils and macrophages in the lamina propria (Deorani and Katiyar, 1967; Boray, 1971; Kranenburg and Boschs, 1978). Similar

microscopic changes due to immature amphistomes were observed in the present study.

The observations of gross pathological changes such as varying degree of chronic catarrhal enteritis, presence of enormous nodules with depressed centres particularly in the anterior part of the duodenum and the thickening of the duodenal mucosa in Stilesia infection are in accordance with Deorani and Tewari (1967) and Misra (1981). The presence of typical unarmed scolices of S. globipunctata embedded in the nodules and damaging mucosal and submucosal layers of the duodenum was similar to the observation of Deorani and Tewari (1967). The microscopical pictures were similar to those described by Sankov (1971) and Misra (1981), which consisted of pressure atrophy of intestinal glands and villi, infiltration of mononuclear cells in lamina propria primarily of lymphocytes, plasma cells, eosinophils and macrophages.

No discernible gross lesions could be ascribed due to Moniezia infection in the present study except slight thickening of intestinal wall, thereby proving that the parasite is not much pathogenic (Soulsby, 1965).

In Haemonchus infection pin point haemorrhages and small blood clots over the folds and glandular mucosa, typical angry looking ulcers in the abomasal mucosa and the microscopic changes, such as, chronic catarrhal gastritis with infiltration of lymphocytes and monocytes and

eosinophils are in close confirmity with the observation of Misra and Ruprah (1972).

In hookworm infections the parasites were closely adhered to the mucosa of small intestine. Enteritis and congestion of intestinal mucosa are in confirmity with the findings of Misra and Ruprah (1968). Microscopically desquamation and degenerative changes, oedema, congestion and haemorrhage of small intestine along with leucocytic infiltration and hyperplasia of goblet cells were observed, thereby proving the high pathogenicity of these parasites. Similar changes were also described by Peregudove et al. (1977).

The observations on macroscopic changes in the caecal wall of the goats due to trichuriasis tallied closely with the observations of Jain and Kamalpur (1970) and Misra (1984), who described that the caecal wall was congested, thickened and oedematous and contained the anterior portions of the parasites superficially along with large amount of fibrinous exudate. Microscopical changes consisted of loss of surface epithelium, necrotic changes of coagulative types of the villi, mild to moderate oedema with leucocytic infiltration, thickening of mucosa and submucosa of the caecum along with infiltration of lymphocytes, monocytes and plasma cells, which corroborate the findings of Powers (1961) and Jain and Kamalpur (1970).

The formation of nodules throughout the intestine due to O. columbianum and O. venulosum infections and the microscopic changes consisting of necrosis and caseation and cellular infiltration of lymphocytes, epithelial cells and giant cells confirmed the reports of previous workers (Tewari and Ramchandra Iyre, 1961; Bhatnagar et al., 1978 and Clark et al., 1978). Oesophagostomum asperum was not associated with the formation of nodules in any of the goats harbouring pure infection of the parasite. Patnaik (1964 b) also did not observe the formation of nodules in this infection of 11 goats examined by him.

Although T. colubriformis is much pathogenic (Soulsby, 1982), no marked pathological changes could be observed, except slight congestion of the duodenal and abomasal mucosa which might be due to their occurrence in very less numbers.

Most naturally aquired helminth infestations are multiple for which emphasis has been directed towards the development of broad spectrum anthelmintics. Among the available newer and broad spectrum anthelmintics, Panacur has been claimed to have very wide margin of safety and is effective against wide range of gastro-intestinal as well as other helminths infecting the goats. Therefore, Panacur was used in the present study to evaluate its efficacy in goats naturally infected with gastro-intestinal helminths. Studies on the efficacy of Panacur at 10 mg per kg body

weight showed 97.01 %, 84.67 %, 64.69 % and 42.92 % effective against strongyles, Moniezia spp., Trichuris spp. and paramphistomes respectively on the basis of faecal egg count and larval counts before and after the medication. The high efficacy of Panacur against strongyles and Moniezia spp. has been fully confirmed in the present study. Similar observations on the high efficacy of this drug against strongyle and Moniezia spp. has been reported by the previous workers (Dimel et al., 1974; Behrens and Matchullad, 1975; Bali and Singh, 1977 b; Cabaret et al., 1979 and Patnaik et al., 1983). A perusal of the available literature on the efficacy of this drug against Trichuris worms showed that there exists divergence in the opinion. Some of the workers such as Moverka et al. (1975), Kelly et al. (1975), Bali and Singh (1977 b, 1980), Kalita et al. (1978) have reported that Panacur at 5 mg per kg body weight was ineffective against Trichuris worms; whereas, other workers such as Kennedy and Todd (1975) reported that Panacur at the dose rate of 3.50 mg, 5.00 mg and 7.50 mg per kg body weight was 69.10 %, 83.60 % and 98.20 % effective respectively. Townsend (1979) observed more than 92.00 % efficacy of the drug at 5 mg per kg body weight and Hafez et al. (1983) found Panacur at 5 mg per kg body weight was 66.60 % effective and at 25.00 % or more than the recommended doses it was 72.00 % effective for Trichuris. Further Patnaik et al. (1983) observed

that Panacur at 10 mg per kg body weight was 91.60 % effective. In the present study 64.68 % efficacy of the drug against Trichuris worms was obtained at a dose rate of 10 mg per kg body weight, thereby suggesting further trial of the drug at a very large scale and at various dose rates for the proper assessment of the drug against the Trichuris worms. Except the work of Gupta et al. (1981), no other report is yet available in India on the efficacy of the drug against paramphistome infection and these workers used Panacur at 2.2 mg per kg body weight for 3 days, for 6 days and 4.4 mg per kg body weight for 6 days and obtained 0 %, 50 % and 69 % efficacy against the immature paramphistomes respectively. In the present investigation the drug at 10 mg per kg body weight showed only 42.92 % efficacy in goats harbouring natural infections of paramphistomes. However further trial is desirable for evaluating the efficacy of the drug against paramphistomes since no suitable anthelmintic is available for complete cure of paramphistomiasis under field conditions (Nath, 1971 b and Dutta and Chakrabarty, 1971). The drug at 10 mg per kg body weight was easily accepted by all the goats without showing any adverse effects.

S U M M A R Y

An investigation was conducted on the "Epidemiology, pathology and chemotherapy of gastro-intestinal helminthiasis in goats" in the Department of Veterinary Parasitology, Orissa College of Veterinary Science and Animal Husbandry, Orissa University of Agriculture and Technology, Bhubaneswar, from January, 1983 to December, 1983. The project was designed to study (1) the incidence and intensity of gastro-intestinal helminths in goats in relation to age, sex and season, (2) the population dynamics of parasitic larvae in and around goat yard, (3) the pathological changes caused by gastro-intestinal helminths in naturally infected goats and (4) the efficacy of Panacur (Fenbendazole, Hoechst) in goats harbouring natural infections of paramphistomes, Moniezia spp. strongyles and Trichuris species. A total of 120 goats of both sexes (male 50, female 70) belonging to 4 age groups (1 month to 4 months, 18; 5 months to 8 months, 36; 9 months to 12 months, 36 and above one year, 30) were examined in the present investigation.

Out of 120 goats examined, 118 (98.33 %) harboured 28 species of gastro-intestinal helminths; viz., C. cotylophorum, 78.33 %; C. crumenifer, 70.00 %; T. cervi, 37.50 %; T. elongatus, 22.50 %; T. cobboldi, 6.60 %; C. spatiosus, 15.00 %; C. gregarius, 10.00 %; H. palonise,

3.33 %; immature amphistomes, 50.03 %; *H. expansa*, 12.50 %; *H. benedeni*, 7.50 %; *S. globipunctata*, 61.66 %; *S. vitata*, 5.00 %; *A. centripunctata*, 20.00 %; *A. lahorea*, 5.00 %; *A. sudanea*, 3.33 %; *C. tenuicollis*, 25.03 %; *G. verrucosum*, 11.66 %; *H. contortus*, 82.50 %; *T. colubriformis*, 11.66 %; *B. trigonocephalum*, 13.33 %; *O. machyscelis*, 20.00 %; *O. columbianum*, 20.33 %; *O. venulosum*, 10.00 %; *O. asperum*, 40.00 %; *T. ovis*, 50.03 %; *T. globulosa*, 23.33 % and *T. discolor*, 10.03 %.

Six species of helminths; viz., *H. contortus*, *C. cotylophorum*, *G. crumenifer*, *S. globipunctata*, *T. ovis* and *O. asperum* were observed as the most common and highly prevalent in the local goats and *H. palonias* was of rare occurrence.

Paramphistomes, *H. contortus*, *Oesophagostomum* spp., *Trichuris* spp. and *Stilesia* spp. were prevalent throughout the year although peak of infection occurred in rainy season. Helminths such as *H. palonias*, *H. expansa*, *H. benedeni*, *A. lahorea*, *A. sudanea* and *T. colubriformis* were not recovered during summer months from any of the goats. The overall incidence and intensity of infection was highest in rainy season, moderate in winter and lowest in summer. The effect of seasonal variation on the degree of infection and intensity varied in case of individual parasite.

The incidence and intensity of infection were highest in goats belonging to age group of 1 - 4 months. Moderate intensity of infection occurred in age group of 9 - 12 months and above one year of age. Moniezia spp. did not occur in goats above one year of age and paramphistomes had a considerable low incidence and infection intensity in goats below 4 months of age.

Multiple infection consisting of two or more species occurred mostly in goats above 5 months of age and single infection occurred mostly in goats below 4 months of age.

Overall infection of gastro-intestinal helminths in goats was 98.33 %, out of which pure nematode infection was 1.66 %, mixed infection of trematodes and cestodes was 2.50 %, mixed infection of trematodes and nematodes was 2.50 %, mixed infection of cestodes and nematodes was 4.16 % and mixed infection of trematodes, cestodes along with nematodes was 87.50 %. None of the goats was observed to harbour pure infection of either trematodes or cestodes only.

The total number of helminths recorded from a goat varied from 29 to 2607 and types of helminths recovered from a single goat from a single species to 15 species.

Larval population dynamics of the goat yard of Goat Breeding Farm, O. U. A. T., Bhubaneswar and pasture

adjacent to the farm were studied. The pasture was highly contaminated with Strongyloides and strongyle larvae (Haemonchus spp., Oesophagostomum spp., Bunostomum spp., Gaigeria spp. and Trichostrongylus species). More number of larvae were recovered from the pasture during the months of July to October with the peak of infection in September. The number of infective larvae declined from December to February with a rise in March and again a sharp fall occurred in April and May. Larval count started to increase in number from the middle of June. In general the larval population in the goat yard was higher than the adjacent pasture.

Salient macro and microscopic features of gastro-intestinal helminthic infections such as paramphistomiasis, haemonchosis, oesophagostomiasis, monieziasis, Stilesia infection, hookworm infection and Trichuris infection were recorded.

Common gross changes of intestinal helminthiasis were catarrhal enteritis, oedema, congestion and pin point haemorrhages. Focal thickening with attached parasites and presence of parasites free in the lumen of intestine were observed. Other types of changes in some worms like Oesophagostomum infection consisted of nodule formation in the intestinal wall varying from millet to pea size. Denudation of rumen papillae along with scar tissue formation on the ruminal wall was a characteristic feature of

mature paramphistomiasis infection. The typical angry looking ulcers and congestion of the abomasal wall, presence of enormous pin point haemorrhages and a large amount of sand particles in the abomasal lumen were the common features of haemonchosis in goats. Microscopically in general there was moderate chronic inflammatory cellular reaction and mucus degeneration of the intestinal glands due to gastro-intestinal helminthiasis. In some cases necrosis of the tips of villi and desquamation of the lining epithelial cells were seen. Sections of helminths along with reactive changes were seen in mucosal and submucosal layers of the intestine. Scolices of Stilesia were found embedded in intestinal mucosa and submucosa. Nodules caused by Oesophagostomum spp. were seen on any part of the intestine. Chronic granulomatous reaction along with encapsulation of larvae were observed. No microscopic change was observed in the wall of rumen in adult paramphistome infection. Catarrhal gastritis associated with infiltration of lymphocytes, monocytes and eosinophils along with sections of parasite in the abomasum were observed in H. contortus infection.

On the basis of faecal egg count and larvae culture before and after the medication, Panacur at 10 mg per kg body-weight was 97.01 %, 84.67 %, 64.68 % and 42.92 % effective against strongyle, Moniezia spp., Trichuris spp.

and paramphistomes respectively, in naturally infected goats. No untoward reaction could be observed in any of the goats treated with Panacur. Panacur was easy to administer and was readily accepted by all the medicated goats.

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