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STUDIES ON THE INCIDENCE, PATHOGENICITY AND CONTROL OF GASTRO-INTESTINAL NEMATODES IN CROSSBRED CALVES IN KERALA WITH SPECIAL REFERENCE TO STRONGYLOIDOSIS

By

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THESIS

Submitted in partial fulfilment of the requirement for the degree

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COLLEGE OF VETERINARY AND ANIMAL SCIENCES
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DECLARATION

I hereby declare that this thesis entitled "STUDIES ON THE INCIDENCE, PATHOGENICITY AND CONTROL OF GASTRO-INTESTINAL NEMATODES IN CROSS BRED CALVES IN KERALA WITH SPECIAL REFERENCE TO STRONGYLOIDOSIS" is a bonafide record of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Signature: G. Sukumara Pillai 11/7/88

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Place: Mannuthy

Date : 11-7-1988

CERTIFICATE

Certified that this thesis, entitled, "STUDIES ON THE INCIDENCE, PATHOGENICITY AND CONTROL OF GASTRO-INTESTINAL NEMATODES IN CROSS BREED CALVES IN KERALA WITH SPECIAL REFERENCE TO STRONGYLOIDOSIS " is a record of research work done independently by Shri.G.Sukumara Pillai under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to him.

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TO

MY BELOVED PARENTS

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INTRODUCTION

INTRODUCTION

In Kerala considerable increase in the milk yielding potentiality of the cows has been achieved after the introduction of Artificial insemenation and grading up programme with exotic germ plasm. A profitable dairy industry depends on productivity of the dairy cattle, resistance of the animals to adverse conditions and various diseases, reduced mortality and morbidity of young stock and adults etc.

The non descript cattle of Kerala are comparatively resistant to diseases, even though they are very poor milk producers, whereas, the newly evolved cross breds such as, Non-descript X Jersey, Non-descript X Brown swiss, Non-descript X Holstien Freshien are considered to be comparatively more susceptible to diseases especially of parasitic origin. This eventually leads to several problems in the live stock industry. One of such problems in calf mortality and morbidity, which in turn adversely affect the economic equilibrium of dairy farmers.

In the later parts of the neonatal life and prior to weaning, helminthic infections appear to be very

common in calves. They usually carry different species of nematodes in their gastro-intestinal tract. Nematodiasis usually play an important role in morbidity, delayed growth and even mortality in cross bred calves. Though large number of cases caused by different nematodes are being reported in the Veterinary Institutions of the State, practically very little work has been undertaken on the extent and control of nematode infection of cross bred calves. Hence a systematic study on the incidence, pathogenicity and control of gastro-intestinal nematodes with special reference to Strongyloides species will contribute much scientific information for the health and wealth of cattle of the state.

MATERIALS AND METHODS

MATERIALS AND METHODS

COLLECTION OF DATA FOR INCIDENCE STUDY

Data on the incidence of gastro-intestinal nematode infection in calves-belonging to different age group, breeds, at different seasons were collected from various live stock farms, Veterinary Hospitals and slaughter houses of different parts of Kerala. This study was made by examining the dung or by examining the viscera and by culturing the dung samples collected from different animals.

The entrials of cross bred calves were purchased from the slaughter houses. Details such as, breed, approximate age and locality from where the animals had been brought were also noted. The various parts of viscera were examined seperately. The contents and as well as the scrapings were thoroughly examined for the presence of helminths. Available lesions were fixed and preserved from time to time to study the pathological aspects of infection.

EXAMINATION OF DUNG

The presence of eggs of Ascaris sp. Trichuris sp. Strongyloides sp and Strongyle worms in the dung of calves were determined by sedementation method. Specific

identification of the strongyle species were made by studying the morphological features of infective larva isolated from faecal cultures.

FAECAL CULTURES

The dung samples collected from individual infected calves were placed in closed glass jars or bottles or petridishes after moistening with well water and incubated at room temperature. The cultures were aerated at frequent intervals by lifting the caps of the containers.

Larvae from cultures were isolated by Baermann's method (Soulsby,1965). The cultured faecal samples 15 to 20 gm. in weight were placed in wire guaze,contained enough water to cover the faeces. The funnels were allowed to stand for at least one hour. Small quantities of water from the rubber tube end were collected and examined microscopically for the presence of larvae.

COLLECTION OF WORMS

The worms were recovered from the gastro-intestinal tract of infected calves. The intestinal contents and mucus scrapings were subjected to repeated washings with water and decandation. The sediment was examined under Dissection microscope and the worms were picked up by

means of needles or brush.

EXAMINATION OF ADULT NEMATODES

All the nematodes collected were washed in normal saline to remove adherent mucus and dirt. Studies on easily observable morphological features were made by prepairing temporary aqueous mounts in normal saline. Finer details of morphology of thick specimens were studied from materials cleared in creosote.

STUDY OF INFECTIVE LARVAE

Larvae from cultures were mounted on a drop of normal saline and immobilised and straightened by application of gentle heat or by mixing with Gram's iodine prior to examination.

PRESERVATION

Adults worms, larvae and lesions were preserved in 10 per cent formalin.

DIAGRAMS

All diagrams were made with the aid of camera lucida.

MEASUREMENTS

Measurements were made with the aid of an eye piece micrometer and from camera lucida drawings. Measurements of thin worms and larvae were taken after killing and straightening them by the application of gentle heat.

PHOTOMICROGRAPHS

Photomicrographs were taken from the materials preserved and also from fresh materials.

HISTOPATHOLOGICAL STUDY

Tissues and organs showing lesions were fixed and preserved in 10 per cent formalin. Suitable areas of lesions were selected, trimmed and washed for 24 hours in running tap water. After embedding the cleared tissue in paraffin, sections of a thickness ranging from five to eight microns were prepared and stained with haemotoxylin - eosin for histopathological studies.

EVALUATION OF EFFICACY OF ANTHELMINTICS

Calves which were naturally infected with different species of gastro-intestinal nematodes were treated with various anthelmintics. The assessment of the result of the trial was done by compairing the premedication and the post treatment egg per gram of dung collected from naturally infected calves.

Stolls 'dilution' method was employed to determine the e.p.g. of faeces. Three grams of faeces was taken into a test tube graduated to 45 ml. The tube was then filled to the 45 ml. mark with water and 10 or 12 glass beads were added. The tube was then closed with a rubber

stopper and then shaken well to give a homogenous suspension of the faecal material. Then 0.15 ml of the well mixed suspension was drawn off with a pipette and placed on a slide. The total number of eggs in the 0.15 ml.sample was then counted and this multiplied by 100 gave the total number of eggs in one gram of faeces (Soulsby,1976).

Eight anthelmintics viz., Fenbendazole (Panacur-Hoechst), Mebendazole (Eben-Gufic), Thiabendazole (Thiabendole-M SD), Parbendazole (Helatac,SKF),Levamesole Hydrocloride (Levamesole-150-Khandel wal),Thiophanate (Nemafax-M & B), Morantel tartrate (Banminth II-Pfeizer) and Tetramesole hydrochloride (Nilverm,ICI) were used against natural infection of gastro-intestinal nematodes in calves. The average pre-medication e.p.g. was calculated by determining e.p.g. of dung in three consecutive days prior to medication in most of the cases or by taking the ep.g. on the previous day in certain cases. After medication, e.p.g. was determined on three consecutive days starting from 24 hour following medication. The drugs were administered orally at the prescribed dose rates. The dung samples collected 24 hour after medication were cultured to find out the ovicidal property of the drugs.

INCIDENCE

REVIEW OF LITERATURE

Incidence of nematodiasis in calves have been recorded by various authors in different parts of the world. In the year 1892 Giles recorded Cooperia curticei under the name Strongylus ventriculosus in Punjab and this observation was confirmed by Caiger (1915). Bhalerao (1933) recorded Capillaria bilobata and Haemonchus similis from cattle in India. Vaidhyanathan (1942) noted a heavy incidence of Strongyloides papillosus in Madras during routine examination of calf dung. Cooperia punctata and C.pectinata were recorded for the first time in Indian cattle by Rao (1940). An epidemiological investigation carried out in the government dairy farm at Vishakapattanam revealed the infection of Ascaris Vitulorum in 11 out of 120 calves aged between one month and 12 months (Anandaraman,1951). He also reported the presence of Ascaris vitulorum infection in two calves of 26 and 19 days of age respectively.

Lal (1956) reported 11 species of strongyles viz., Haemonchus contortus, Ostertagia ostertagi,O.circumcincta, O.trifurcata, O.pinnata, O.lyrata, Cooperia punctata, Trychostrongylus capricola, T.vitrinus, T.extenuatus and T.colubriformis in 168 of 339 cattle examined.

Supperer and Pfeiffer (1960) recorded about 35 per cent Strongyloides papillosus infection in week old calves of Australia.

Ikme (1970) examined 98 Fulani calves under 10 weeks age, around the plateau area of Northern Nigeria, for nematode infection and found 90 per cent and 81 per cent of the calves showed eggs of Strongyloides papillosus and Neoascaris vitulorum respectively in their faeces. Natural infection of Ostertagia and Cooperia sp. in calves had been reported by Brunsdon (1972). Pethkar and Hiregaudar (1972) recorded Ostertagia sp., Cooperia sp. and Meicistocirrus digitatus from five per cent, 19 per cent and 44 per cent of cattle examined respectively. They also reported the presence of Trichostrongylus sp.

Chauhan et.al.(1973) screened the dung of 625 cattle aged between three months and two years, for parasitic infection and obtained the incidence rates of 30.75 per cent, 12.10 per cent and 36.07 per cent respectively for Strongyloides papillosus, Neoascaris vitulorum and Trichostrongylus sp. Natural infection with Haemonchus placei, Trichostrongylus axei, T.colubriformis, Cooperia punctata, C.pectinata, C.onchophora and Ostertagia ostertagi were recorded in calves by Ciordia and McCampbell (1973).

Costa et al.(1973) screened 59 calves of mixed breeds in Brazil and recorded Cooperia sp.(C.punctata, C.pectinata and C.onchophora), in 100 per cent cases, Haemonchus sp. (H.contortus, and H.similis) in 80 per cent cases, Oesophagostomum radiatum in 80 per cent, Bunostomum phlebotomum in 80 per cent, Trichuris discolar in 83 per cent, Trichostronglus axei in 61 per cent and Strongyloides papillosus in 44 per cent of cases. Ueno et al.(1973) opiened that the important species of gastro-intestinal nematodes affecting cattle in Dominican Republic were Haemonchus contortus, H.placei, Bunostomum phlebotomum and Oesophagostomum radiatum.

A survey conducted by Malczewski et al. (1975) in Washington cattle during the period from 1972 to 1973 utilizing 3700 faecal samples from 29 herds and four feed lots and viscera from 55 cattle, revealed 44 per cent of 'Strongylinae' eggs, three per cent Nematodirrus eggs and two per cent Trichuris eggs. They also found Ostertagia sp., from all the viscera examined. Tongson et al.(1975) recorded different species of worms such as Cooperia sp., Oesophagostomum sp., Trichostrongyle sp.,Bunostomum sp., Haemonchus sp., Mecistocirrus sp. and Strongyloides sp. from calves of three to five months old, suffering from gastro-enteritis.

Yazwinski and Gibbs (1975) screened 94 adult cows, 78 heifers and 91 calves of Maine dairy cattle and reported Strongyles in 95.7, 98.7 and 96.7 per cent of the animals respectively. Strongyle species were identified as Ostertagia sp., Cooperia sp., Trichostrongylus sp., Haemonchus sp. and Oesophagostomum sp.. The authors also recorded 64.3 per cent of Strongyloides papillosus, 40.3 per cent of Bunostomum sp., 27.8 per cent of Nematodirrus sp., 27 per cent of Trichuris sp. and two per cent of Capillaria sp. in those animals.

Tongson et al.(1976) recorded the incidence of Cooperia sp. and Stongyloides sp. in young calves at the A.N.S.A. cattle and crop farm in Phillipines. The monthly mean counts of Strongyle ova of 20 calves aged one to five months were studied by Tongson and Trevola (1976) at Venadia ranch in Phillipines. Highest egg per gram of faeces was observed when animals were between two to four months old with Strongyloides sp., Cooperia sp., Oesophagostomum sp. and Bunostomum species. Gregory(1979) in the course of routine helminth survey of cattle in the Korhogo district of northern Ivory coast in 1974-'75, found a single case of Oesophagostomum multifoliatum in 300 faecal samples examined.

The effect of season on the incidence of helminthic diseases was observed by Chauhan et al.(loc.cit)

and opined that egg counts were highest in rainy season in buffaloes and during winter in cattle. Mitchell (1974) reported that Oesophagostomum radiatum infection was highest in July-August, about four months after Summer rain fall. According to Yazwinski and Gibbs (loc.cit.)Strongyloides infection was highest in May-June period and lowest in Winter period of January-February in calves. Tongson and Trevola (loc.cit.) stated that in Oesophagostomum sp., Bunostomum sp. and Haemonchus sp. infections, two secondary peaks coinciding with rain fall occurred in June and November were observed in calves at Vernadia ranch in Phillipines.

RESULTS

Out of 539 calves including 99 non-descript calves examined, 285 cross bred calves and 51 non-descript calves were found to harbour one or more species of nematodes.

In the present investigation, nematode infection was observed a total of eight species in 64.77 per cent cross bred calves and were encountered from their gastro-intestinal tract. The worms encountered were

Strongyloides papillosus, Neoascaris vitulorum, Oesophagostomum radiatum, Cooperia sp., Bunostonum phelobotomum, Trichostrongylus colubriformis, Haemonchus contortus, and Trichuris globulosa.

Strongyloides papillosus was found to more common in 99 cross bred calves and 16 non-descript calves giving a total highest incidence of 33.33 per cent. The lowest incidence (2.98 per cent) was that of Trichuris globulosa. (7 cross bred calves and 2 non-descript calves).

In non-descript calves 51.52 per cent were found positive for nematodiasis and among that Strongyloides papillosus was the highest (16.16 per cent) and the lowest was Bunostanum phlebotomum (2.02 per cent).

Strongyloides papillosus was recovered from 23.62 per cent of the 326 Jersy calves, which was the highest and 1.53 per cent incidence of trichuriasis came lowest.

Among the Brown-Swiss cross bred calves 55.43 per cent were infected and in that also Strongyloides papillosus predominated (21.74 per cent).

Among Holstein Friesian crosses 40.91 per cent were found infected with nematodes with highest incidence of Haemonchus contortus (18.18 per cent) and lowest (4.55 per cent) of N.vitulorum,Cooperia sp. and Bunostomum phlebotomum. The details of the rate of infection in different breeds of calves with different species were furnished in Table I.

During the period of June, July, August and October, all the calves examined were found to harbour one or more species of nematodes with a highest incidence of Strongyloides papillosus (55.56 per cent). Lowest incidence of S.papillosus (6.4 per cent) was obtained during the month of January. The highest and lowest incidence of other worms were:- Neoascaris vitulorum (50 per cent in June and no infection noticed in January and April; Bunostomum phlebotomum (18.75 per cent in October and nil in November); Haemonchus contortus (14.9 per cent in January and nil in June and October); Oesophagostomum radiatum (25 per cent in September and nil in January and December); Cooperia sp. (10.6 per cent in January and nil in May, August and September; Trichostrongylus axei (19.1 per cent in January and nil in June and October) and Trichuris globulosa (6.67 per cent in April and nil in February, June, August, September, October and November). The data on the

seasonal incidence was furnished in the Table II.

DESCRIPTION OF THE WORMS ENCOUNTERED

Strongyloides papillosus

Body was slender, long, filiform and attenuated anteriorly. Buccal capsule was practically absent. The female worm measured 4.48 mm in length and 64.94 microns in thickness at the vulval region. Esophagus was cylindrical and without a posterior bulb and have got a length of 844.6 microns. Mouth was provided with three indefenite lips. The nerve ring was situated at 171 microns and excretory pore at 181 microns from the anterior end. Vulva was at 2.99 mm from anterior end and provided with distinct lips. Vagina was transverse, uterine branches were opposed, twisted and contained 5 to 6 embryonated eggs at a time. Length of the ovijector came about 360.8 microns. Tail was 65 microns long and conical (Plate I, Figs. 1 and 2).

The eggs were oval, thin shelled, contained actively motile first stage larva inside and measured 53.94 microns long and 33.66 microns wide. The eggs hatched in about 9.30 hours to 11.15 hours after it was being voided.

PLATE I

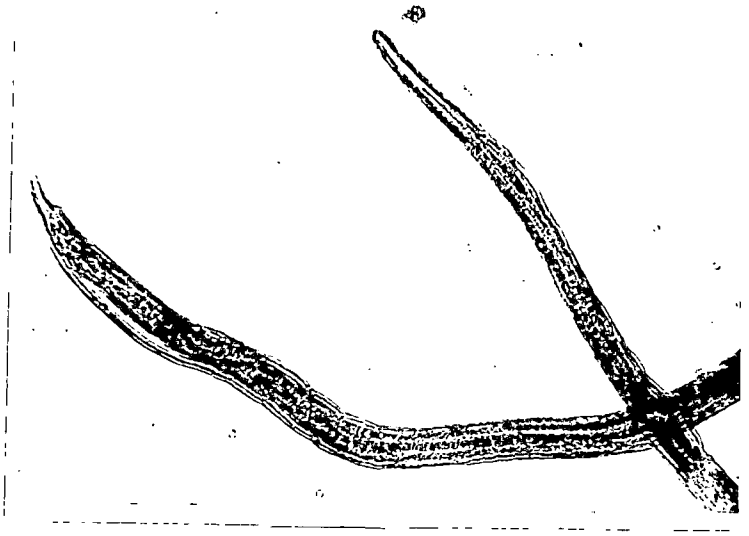

Fig. 1

Fig. 2

Infective larva (Plate II, Figs. 1,2,3 and 4)

Infective larvae could be seen in the cultures from 36 to 48 hours onwards. The diagnostic features of the larva were the absence of the sheath and the characteric filiform oesophagus. The larva measured 619.69 microns in length and 18.81 microns in thickness. Oesophagus was 262.97 microns long. The nerve ring and the excreatory pore were 56.41 and 75 microns respectively from the anterior end. The genital primordium was situated at 328.36 microns from anterior end. Tail was 68.4 microns long.

Cooperia.sp.

The head end was thin, without clearly demarkated lips with poorly defined head papillae. The head end was fitted with vesicle or cuticular thickenings of different shape and sizes and bear transverse striations. (Plate III, Figs 1,2 and 3; Plate IV, Fig. 1). In the remainder portion of the body the cuticle displayed 8 to 16 longitudinal lines. The mouth cavity was small.

The male worms measured 5.64 to 7.48 mm in length and 75 to 112.5 microns width. The length and breadth of the head vesicle was 92.5 to 115 microns and 37.5 to 49.5 microns respectively. Nerve ring was located at a

PLATE II

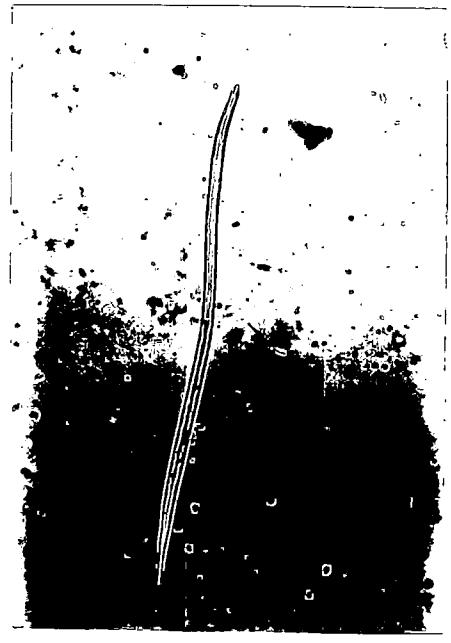

Fig.1

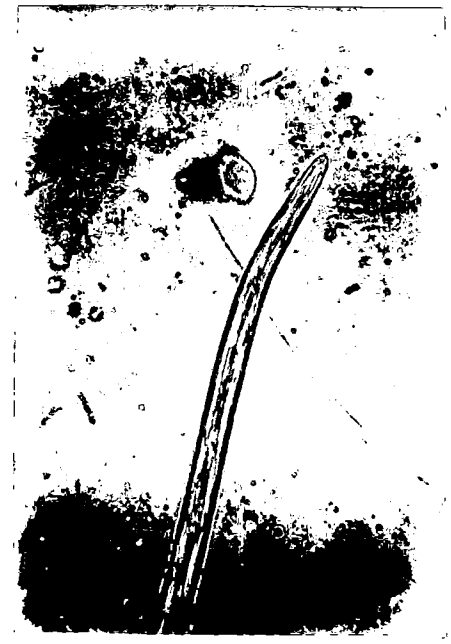

Fig.2

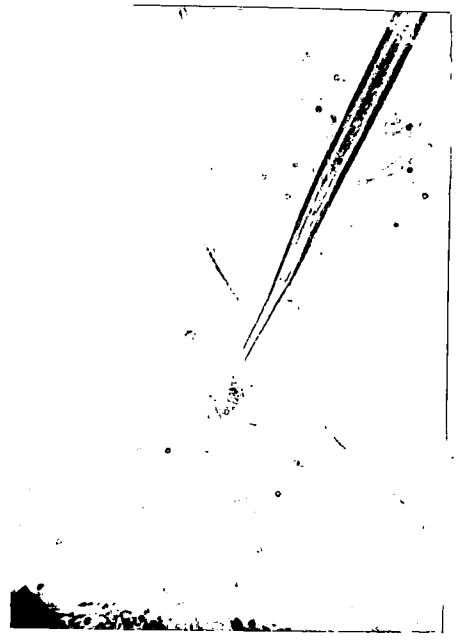

Fig.3

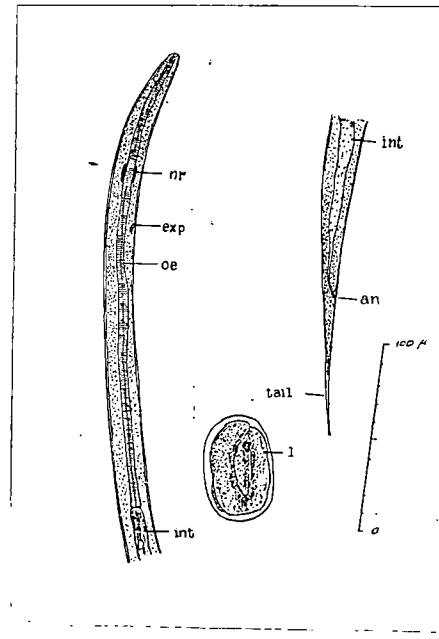

Fig.4

PLATE III

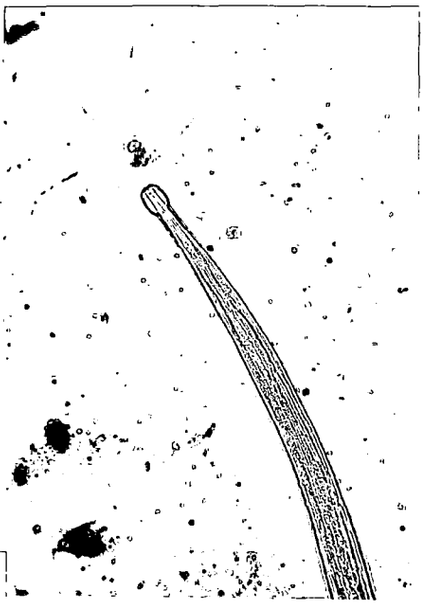

Fig.1

Fig.2

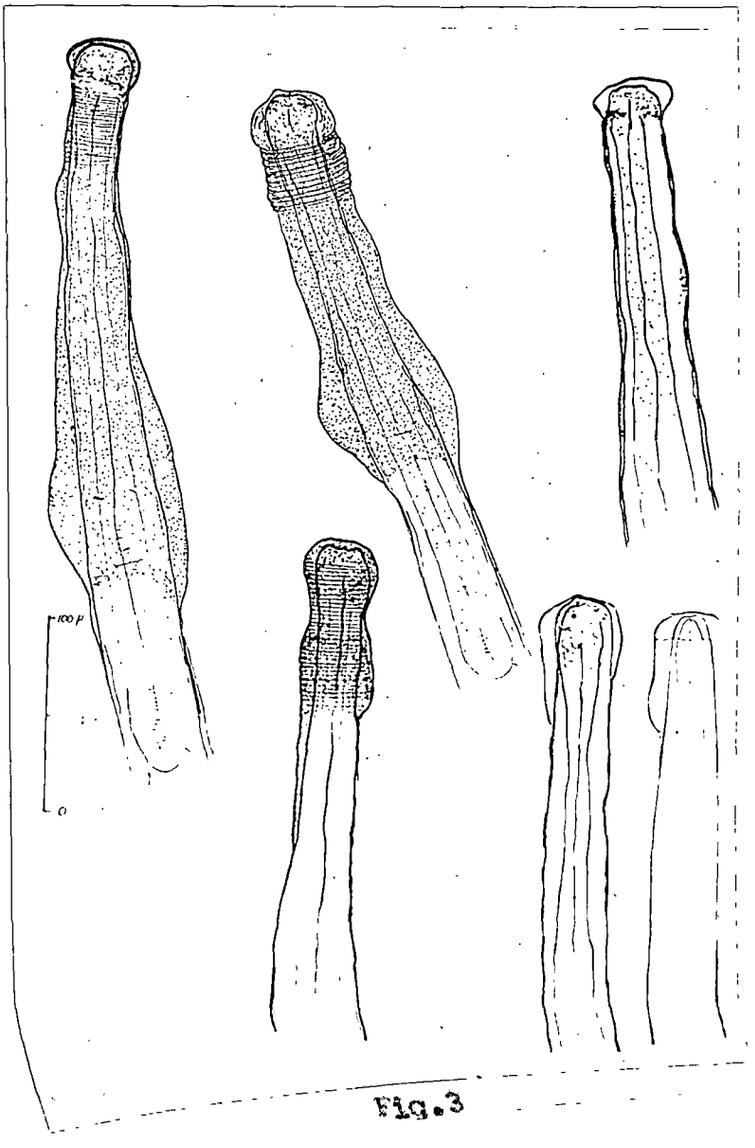

Fig.3

distance of 237.5 to 277.5 microns from the head end. Oesophagus measured 337.5 to 352.5 microns and had 25 to 30 microns width at the level of the oesophageal bulb. Spicules were equal and similar with a deep concavity about the middle of the ventral aspect and bent ventrally at the distal portion. They were brown in colour and measured 150 to 237.5 microns in length and 22.5 microns broad. (Plate IV, Fig 2, 3 and 4). Bursa was comparatively long and three lobed. The dorsal rib was thin and measured 100 to 137.5 microns length and 10 microns broad. Approximately in the middle of its length, at about 52.5 to 75 microns from its base, a pair of lateral stem branched off from it and it bent ventrally and anteriorly. It measured 37.5 microns long and 3.75 microns broad. At this same level the dorsal stem divided in the form of a 'horse shoe' appearance, each of which ended in two dichotomous ramification of which the outer one was larger and inner one short. The externo-dorsal ray originated from the base of the dorsal ray, run laterally, bent posteriorly in acute angle and reached almost the edge of bursa. The antero-lateral rib was very stout as compared to medio-lateral and the postero lateral thin. The ventro ventral was shorter and thinner than other ones. The latero ventral was thick and the distal extremity was pointing anteriorly. There

PLATE IV

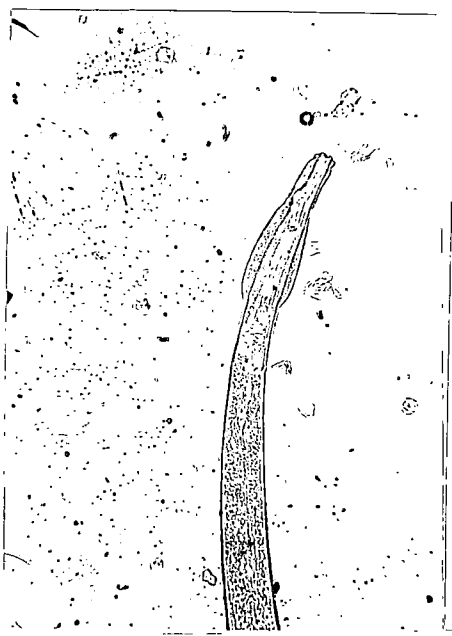

Fig.1

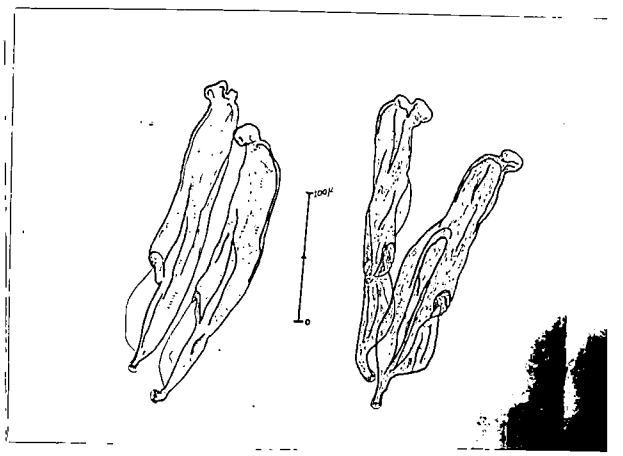

Fig.2

Fig.3

Fig.4

were fine mammilations on the bursal cuticle between the ventro ventral and postero-lateral rays on each lateral lobes. The genital cone was characteristic, triangular with apex posteriorly and had two papillae at the apex. (Plates V Figs, 1and 2; Plate VI, Figs., 2 and 3).

Female worms were longer and measured 6.75 to 7.875 mm by 87.5 to 100 microns. Nerve ring was 275 to 287.5 microns from the anterior end. Oesophagus measured 350 to 375 by 22.5 to 37.5 microns. The vulva was 1.44 mm from the tail end and was marked by longitudinal opening guarded by thick crescent shaped lips. The combined length of ovijector including spincters was 375 to 380 microns.(Plate VII,Figs 1 and 2; Plate VIII, Fig. 1). The uteri were opposed and met about the region of the vulva in a common vagina. The tail was slender and tapered gradually to a sharp point. (Plate VII Fig.1). The anus was situated about 132.5 to 187.5 microns from the hind end of the worm. The eggs were oval, thin shelled and measured 65 to 67 microns x 32.5 to 35 microns.

Infective larva (Plate VIII, Figs. 2, 3 and 4).

The infective larva was provided with two conspicuous oval bodies at the posterior end of the buccal capsule. They measured 735.3 to 780 microns in

PLATE V

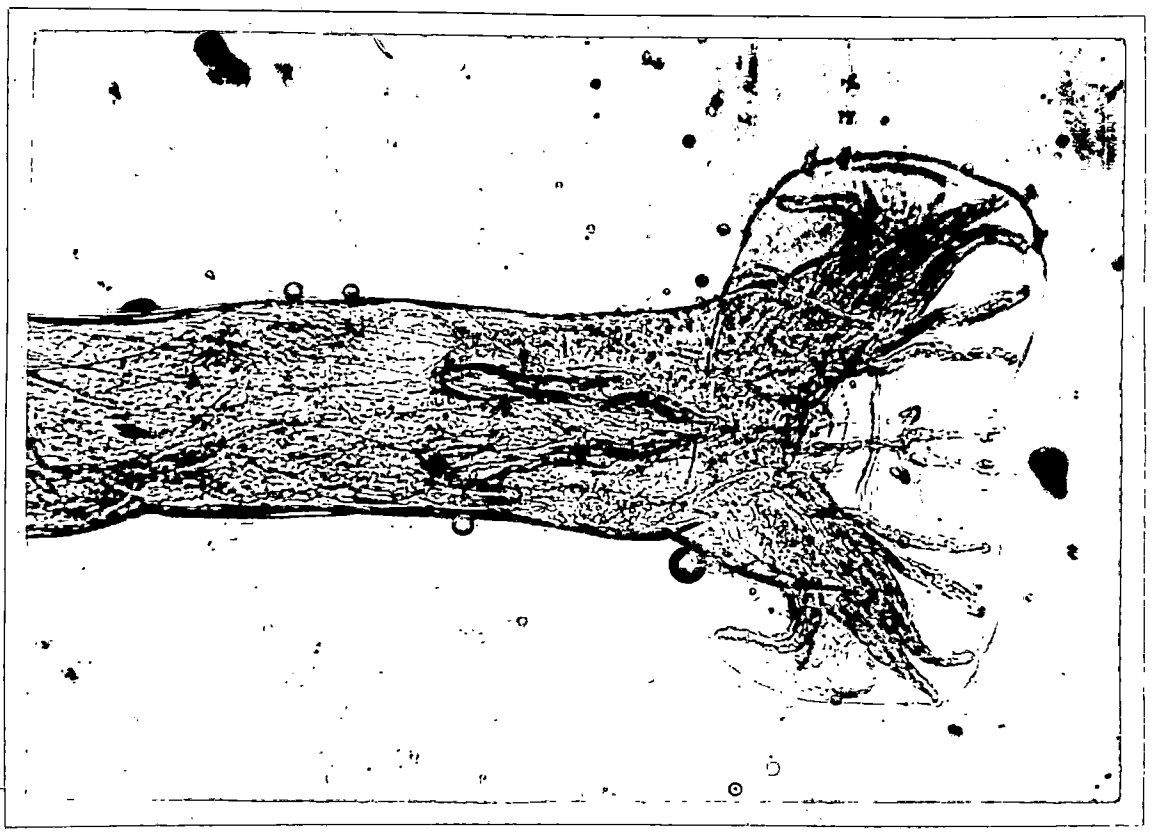

Fig.1

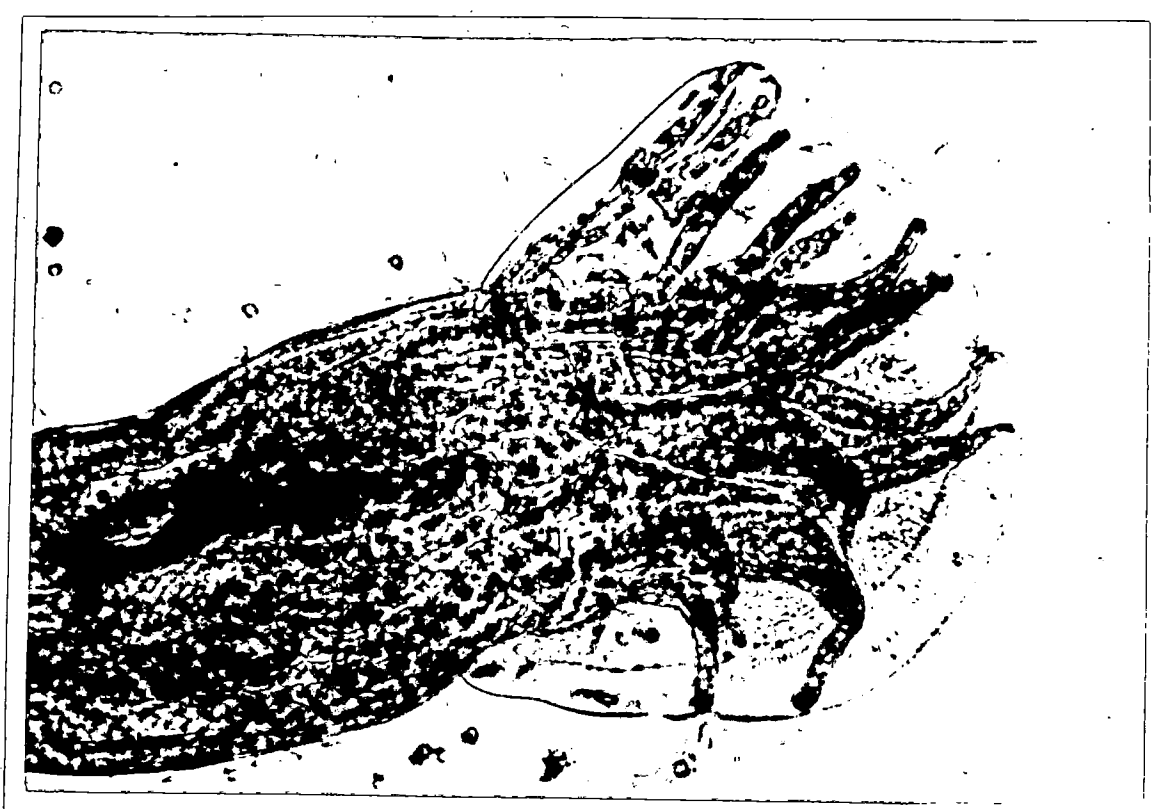

Fig.2

PLATE VI

Fig.1

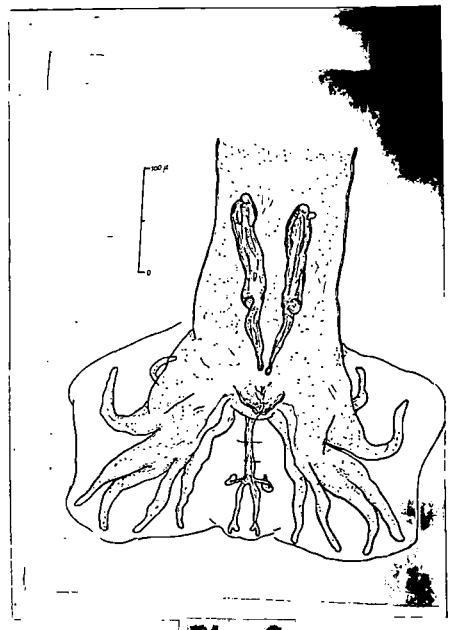

Fig.2

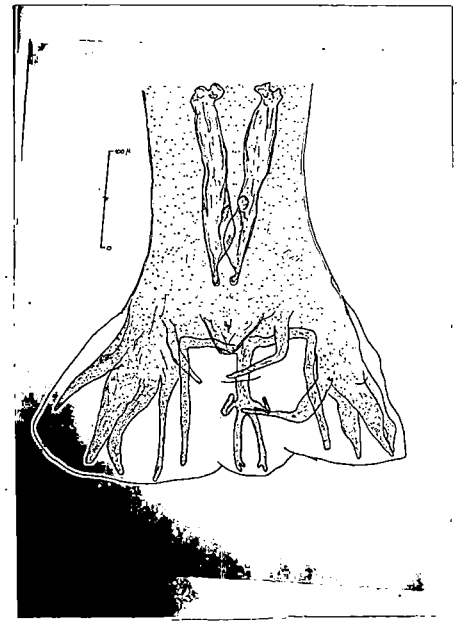

Fig.3

PLATE VII

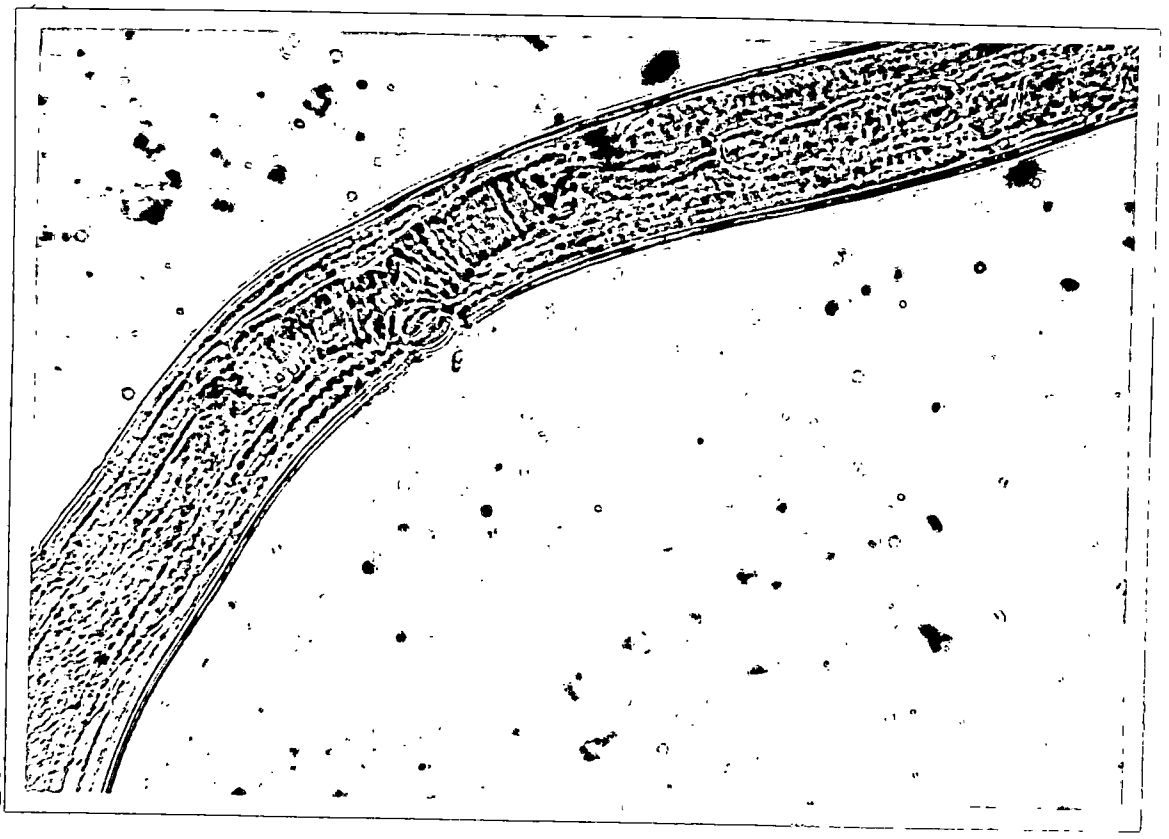

Fig.1

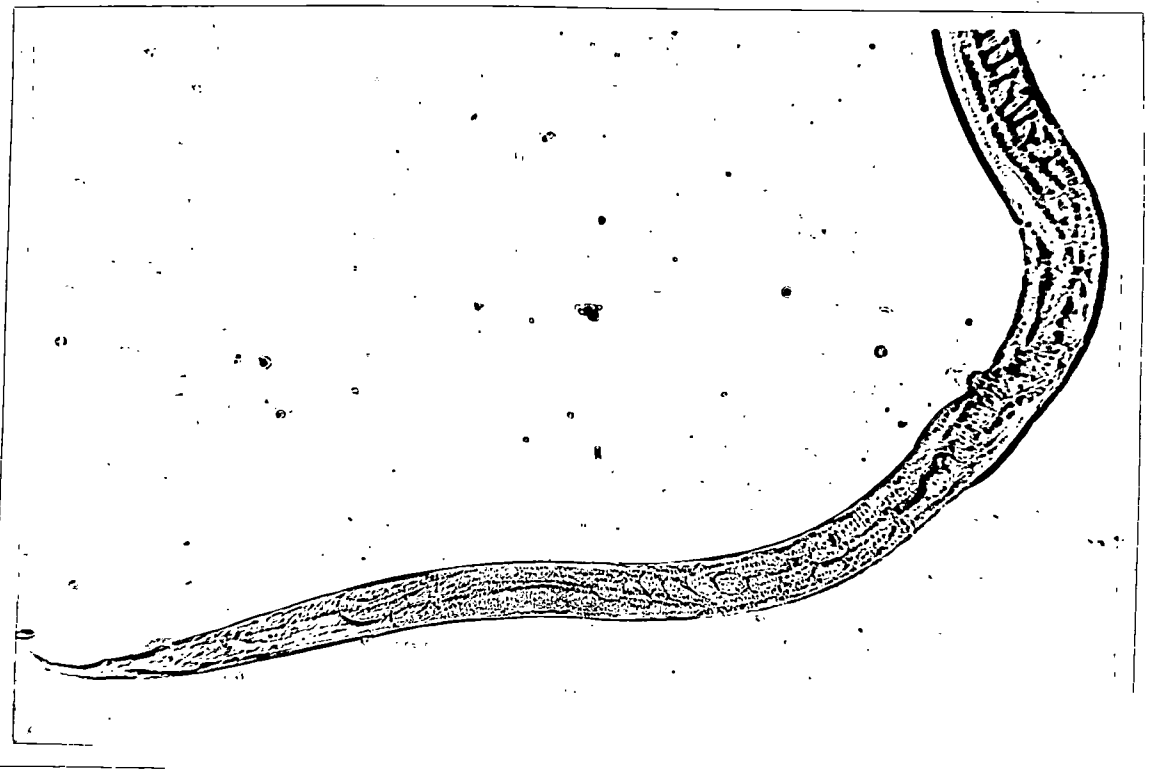

Fig.2

PLATE VIII

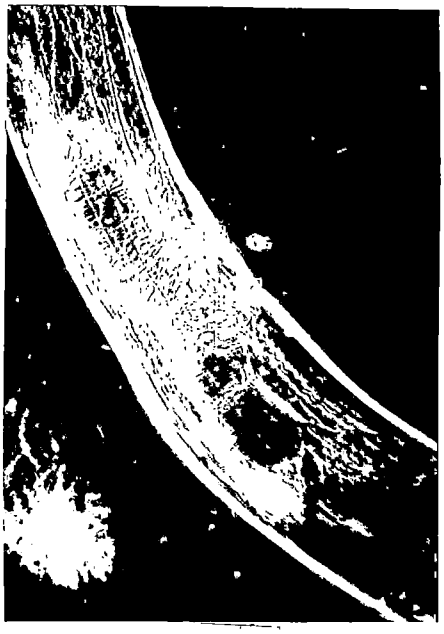

Fig.1

Fig.2

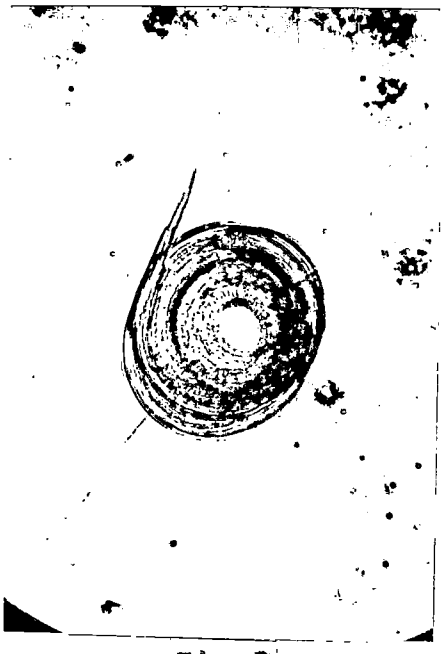

Fig.3

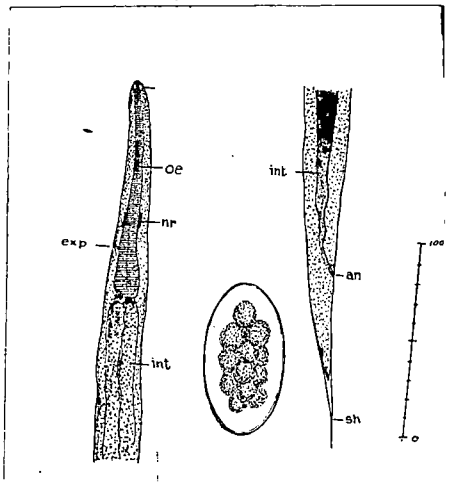

Fig.4

length and 27.36 microns thick. The oesophagus measured 143.06 microns long. The nerve ring and the excretory pore were at 44.46 microns and 52.03 microns respectively, from the anterior end. The length of tail sheath was 47.88 microns and ended in a conspicuous whip like filament.

Oesophagostomum radiatum

The body was elongated and the buccal capsule provided with internal leaf crown. The cephalic vesicle was large and voluminous and with a constriction at its middle. The cervical grove was complete. (Plate IX Fig.1) The lateral membranes were well developed extending nearly the entire length of the body.

The males worms were 14.27 to 16 mm in length and 384.1 microns thick. The diameter of the head at the anterior end was 157.32 microns. Cephalic vesicle measured 290.7 microns in length. The constriction of the cephalic vesicle was at 188.1 microns from the anterior end. Oesophagus was 738.0 microns long. Spicules were equal and measured 738 microns long. The length of the gubernaculam was 110 microns. The ventral rays of the bursa run parellel and equal in length and the lateral rays arose from a common stem. The externo-dorsal rays arose from the dorsal ray and bifurcations

PLATE IX

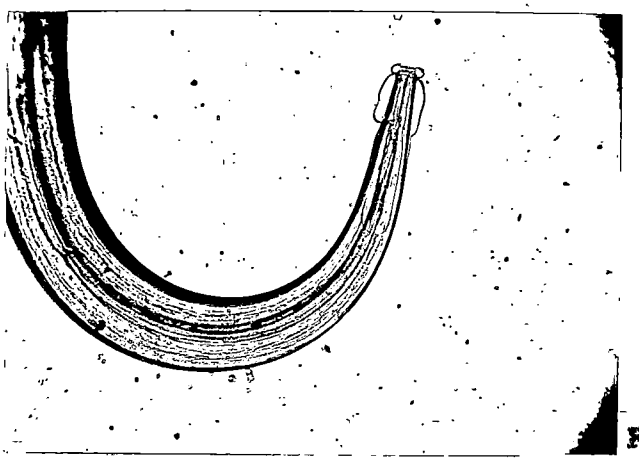

Fig.1

Fig.2

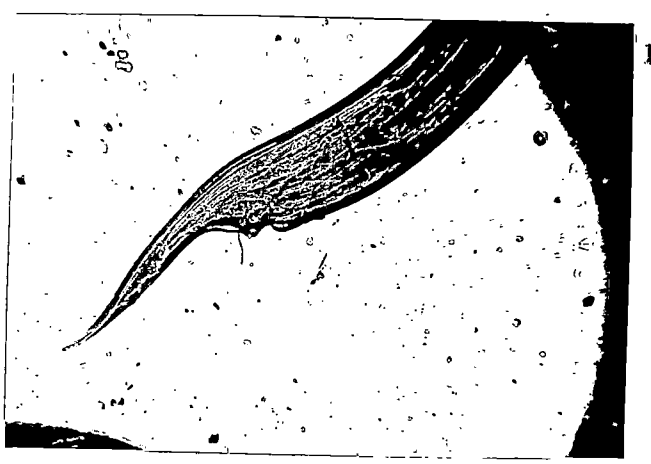

Fig.3

of the latter gave two small external projections. (Plate IX, Fig.2).

The female worms measured 16.15 to 20.4 mm in length. The length of the oesophagus was 721.6 microns. The vulva was located 1.033 mm from the tail end. Posteriorly the tail diminished markedly in size to taper gradually to a slender tail measuring 393.6 microns (Plate IX, Fig.3). Eggs were oval thin shelled and measured 70 to 76 by 36 to 40 microns.

Infective larva (Plate X, Figs.1,2 and 3).

The infective larvae were 738.0 to 770.8 microns long and 23.94 to 34.2 microns thick. The oesophagus was 102 to 130 microns in length. Nerve ring and the excretory pore were located 88.92 and 95.3 microns from the anterior end respectively. The length of the tail and the sheath were respectively 68.4 microns and 167.58 microns. The sheath was coarsely ridged transversely and this being noticed in the inner edge of the larvae when it was lying in a curved position.

Neoascaris vitulorum

The body was soft and translucent in appearance. Anteriorly there were three lips which were broad at the base, measured 85 microns wide and pointed at the tip. The three lips were arranged as one dorsally and two subventrally.

PLATE X

Fig.1

Fig.2

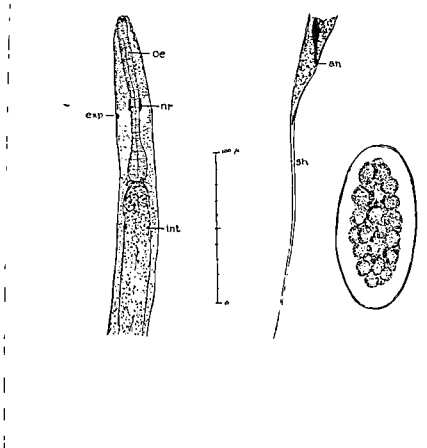

Fig.3

The males were 15 to 25 cm in length and 3 to 4 mm in thickness. Oesophagus was simple and measured 820.8 microns in length. The ventral surface of the tail possess two irregular rows of 10 to 15 papillae and at the tip of the tail possess a spike like appandage of about 44.46 microns long. Anus is situated 51.3 microns from the tip of the spike. Spicules were equal and measured 950 to 1250 microns.

In females the length and thickness were found as 20 to 25 cm and 3 to 5 mm respectively. Vulva opened at the anterior 6th of the body.

Eggs were thick shelled, subglobular surrounded by finely pitted albuminous coat and measured 85.8 by 71.82 microns (Plate XIV,Fig.1 a).

Bunostomum phlebotomum

The anterior end was bent dorsally. The buccal capsule was infundibular, with two semilunar cutting plates at the margin, two lancets near the oesophagus and a pair of subventral lancels in the lateral wall of the capsule (Plate XI,Fig.1). The dorsal cone was well developed. The males were 10 to 12 mm long and 450 to 475 microns wide with a relatively pointed tail of 400 to 500 microns long. The spicules were equal, filiform, alate and measured 3.5 to 4 mm in length.

The bursa was funnel shaped and the dorsal ray was asymmetrically branched. The lateral lobes were continuous ventrally (Plate XI, Fig.2). The female measured 22 to 27 mm in length. The posterior end of the body was gradually attenuated and terminated into a bluntly pointed tail.

The egg measured 85.50 to 103 microns in length and 47.88 to 56.33 microns wide.

Infective larvae

The third stage larvae were 688.8 microns long and 23.94 microns broad. The oesophagus measured 150.48 microns long. The nerve ring and the excretory pore were 51.3 and 80 microns respectively from the anterior end. Genital primordium was 343.7 microns from the anterior end. The tail and sheath measured about 37.62 and 68.4 microns respectively. The tail sheath was very slender and the tail was bluntly rounded (Plate XII, Figs 1, 2 and 3).

Haemonchus contortus

They were comparatively larger worms with head less than 50 microns in diameter, with a small buccal cavity and three conspicuous lips. A slender tooth or lancet originated from the base of the buccal cavity. The cervical papillae were prominent and spine like which was about 300 microns from the anterior end.

PLATE XI

Fig.1

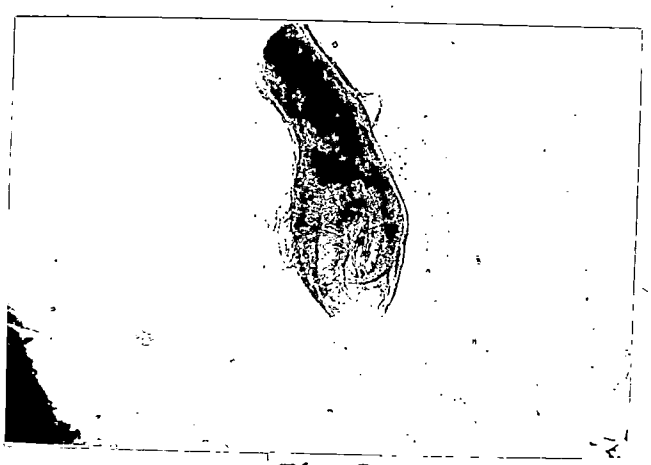

Fig.2

PLATE XII

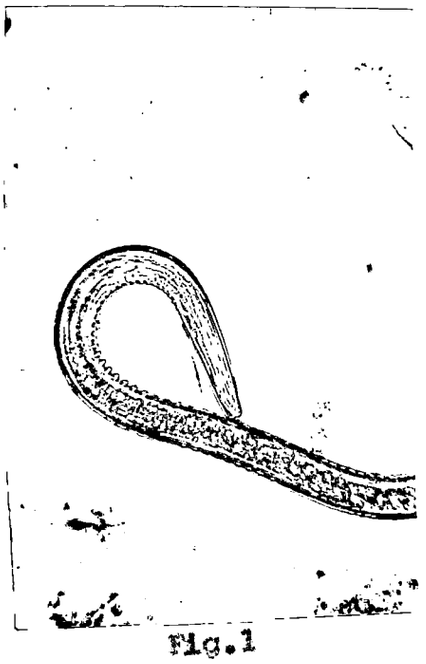

Fig.1

Fig.2

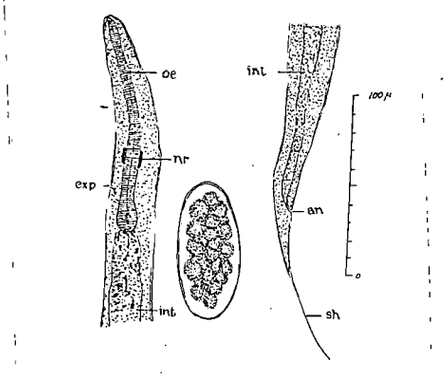

Fig.3

The male worm measured 10 to 20 mm in length by 400 microns wide. The spicules were 425 to 440 microns long and provided with a hook at the distal end. Gubernaculam was 200 microns long and 20 to 28 microns wide. Bursa had large lateral lobes and a small asymmetrical dorsal lobe. The drosal ray was inverted 'Y' shaped (Plate XIII, Fig. 1).

The female was 20 to 30 mm long and 500 microns wide with a slender sharply pointed tail measuring 425 to 600 microns long. The vulva was located 3 to 4 mm from the anterior end and was covered with a prominent flap which projected posteriorly(Plate XIII, Fig.2). The white ovaries wind spirally around the red intestine giving the females a barbers-pole appearance.

The freshly voided egg measured 71.82 by 37.62 microns.

Infective larvae

The third stage sheathed larvae measured 754.4 microns length and 20.52 microns in breadth. (Plate XIII, Figs 3 and 4). The nerve ring and the excretory pore were at 85.80 and 102 microns from the anterior end respectively. Genital primordium was at 256.5 microns from the anterior end. Anus was at 44.46 microns from posterior end and the sheath measured

PLATE XIII

Fig.1

Fig.2

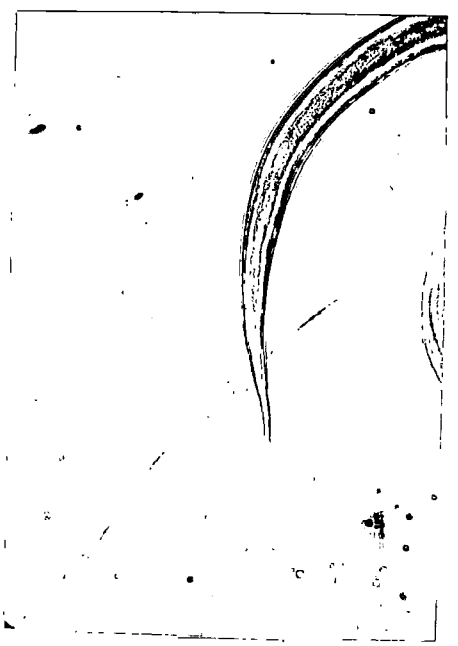

Fig.3

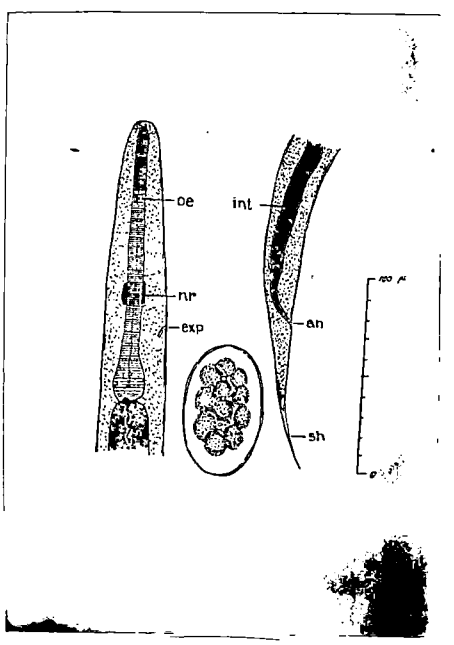

Fig.4

71.82 microns. The tail sheath had a kink just posterior to the larva tail.

Trichostrongylus colubriformis

These were small, slender worms with a small head and without a buccal cavity or cervical papillae. The males were 4.3 to 7.7 mm long. The bursa was large and the dorsal lobe was very small. (Plate XIV, Fig.2). Spicules were dark brown, sub-equal and bent ventrally. The left and right spicule measured 136 to 171 microns and 123 to 154 microns in length respectively. Gubernaculam was 66 to 88 microns long and boat shaped.

The females were 5 to 8.5 mm long with a slit like vulva. There were well developed ovijectors and were 400 to 500 microns long (Plate XIV, Fig.3). Anus was located at about 65 to 90 microns from the tail end.

The egg measured 85.50 to 103 microns in length and 47.88 to 56.33 microns in width.

Infective larvae

The third stage larvae was 688.88 microns long and 23.94 microns in broad. (Plate XV, Figs.1,2 and 3). The oesophagus measured 150.48 microns long. The nerve ring and the excretory pore were 51.3 and 80 microns respectively from the anterior end. Genital primordium was 343.7 microns from the anterior end. The tail and the sheath measured 37.62 and 68.4 microns respectively. The tail sheath was very slender and the tail was

PLATE XIV

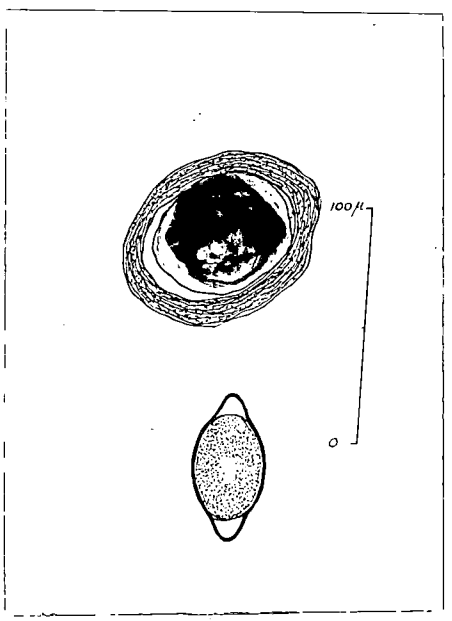

Fig.1

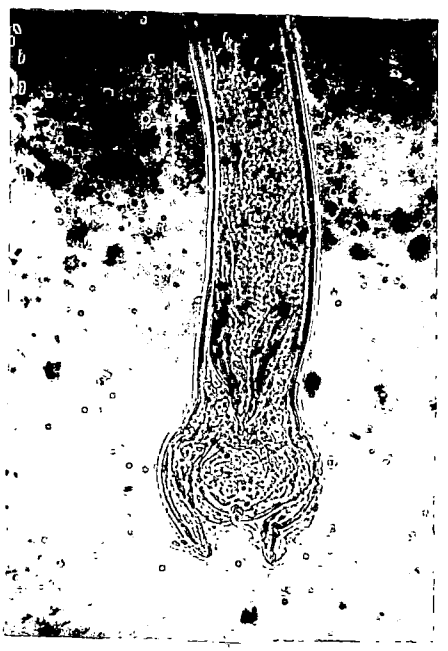

Fig.2

Fig.3

bluntly rounded.

Trichuris globulosa

The body was composed of a very slender long anterior and a much thicker posterior portions. The cuticle was transversily striated. The males were 40 to 65 mm long and 700 microns wide. The slender portion constituted about 2/3 of the body. The single spicule measured 3.8 to 5.7 mm and 35 to 85 microns wide with a large flare at base and ends in a sharp point.(Plate XVI,Fig.1). Specule sheeth was covered with spines which were 6 to 8 microns long as the proximal end and 17 to 19 microns long on the distal end.

The females (Plate XVI,Fig.2), were 42 to 70 mm long and 870 microns wide. The slender anterior part constituted 3/4 of the body length. The vulva was a little behind the posterior end of oesophagus.

Eggs were barrel shaped, dark brown with bipolar plugs, contained unsegmented embryo. It measured 60.40 to 71.82 microns in length and 30.78 to 34.2 microns in breadth. (Plate XIV,Fig. 1 b).

PLATE XV

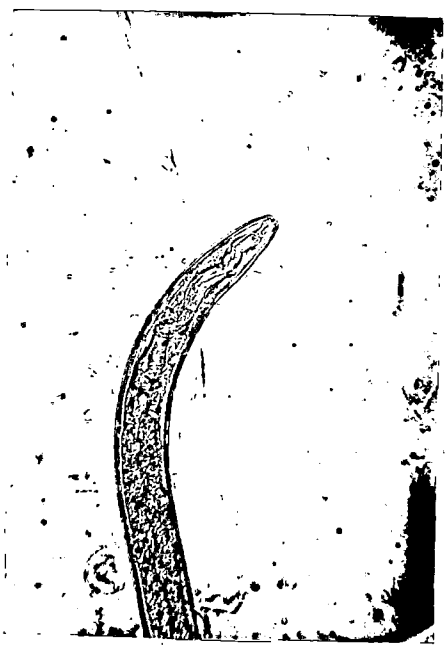

Fig.1

Fig.2

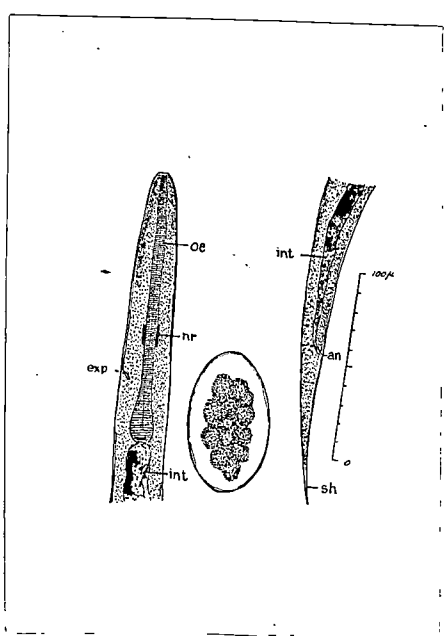

Fig.3

Table I.

Breed wise incidence of Gastro-intestinal nematodes of calves in Kerala

Kind of animal examined.	Total Nos. examined.	+ve	% of infection (nematodes)	S.papillosus Nos. +ve	S.papillosus %	N.vitulorum Nos. +ve	N.vitulorum %	O.radiatum Nos. +ve	O.radiatum %	Cooperia sp. Nos. +ve	Cooperia sp. %	B.phlebotomum Nos. +ve	B.phlebotomum %	T.colubriformis Nos. +ve	T.colubriformis %	H.contortus Nos. +ve	H.contortus %	T.globulosa Nos. +ve	T.globulosa %
Non-descript	99	51	51.52	16	16.16	6	6.06	11	11.11	5	5.05	2	2.02	5	5.05	3	3.03	3	3.03
Jersey cross	326	225	69.02	77	23.62	24	7.36	22	6.75	12	3.68	37	11.35	24	7.36	24	7.36	5	1.53
Brown swiss cross	92	51	55.43	20	21.24	9	9.78	2	2.17	4	4.35	4	4.35	3	3.26	7	7.61	2	2.17
Holstein friesian cross	22	9	40.91	2	9.09	1	4.55	0	0	1	4.55	1	4.55	0	0	4	18.18	0	0
Total	539	336	62.34	113	33.33	40	11.9	35	10.42	22	6.54	44	13.08	32	9.51	38	11.31	10	2.98

Table II.

Seasonal incidence of gastro-intestinal nematode infection in calves in Kerala

Month	Total examined.	+ve	% of infection (nematodes)	S.papillosus Nos. +ve	S.papillosus %	N.viturolorum Nos. +ve	N.viturolorum %	B.phlebotomum Nos. +ve	B.phlebotomum %	H.contortus Nos. +ve	H.contortus %	O.radiatum Nos. +ve	O.radiatum %	Cooperia sp. Nos. +ve	Cooperia sp. %	T.colubriformis Nos. +ve	T.colubriformis %	T.globulosa Nos. +ve	T.globulosa %
January	47	29	59.2	3	6.4	0	0	4	8.5	7	14.9	0	0	5	10.6	9	19.1	1	2.1
February	89	52	5843	16	17.98	6	6.74	8	8.99	7	7.87	6	6.74	4	4.49	5	5.62	0	0
March	72	43	59.72	12	16.67	7	9.72	4	5.56	4	5.56	6	8.33	6	8.33	3	4.17	2	2.78
April	60	26	43.33	5	8.33	0	0	4	6.67	3	5.00	5	8.33	1	1.67	4	6.67	4	6.67
May	80	39	48.75	17	21.25	6	7.50	4	5.00	5	6.25	4	5.00	0	0	1	1.25	2	2.50
June	14	14	100	3	21.4	7	50.0	1	7.1	0	0	2	14.3	1	7.1	0	0	0	0
July	37	29	78.38	9	24.32	2	5.41	5	13.51	3	8.11	3	8.11	2	5.41	3	8.11	1	2.70
August	18	17	94.44	10	55.56	1	5.56	1	5.56	2	11.11	2	11.11	0	0	1	5.56	0	0
September	32	22	68.75	7	21.88	3	9.38	2	6.25	4	12.50	8	25.00	0	0	1	3.12	0	0
October	48	40	83.33	25	52.08	1	2.08	9	18.75	0	0	2	4.17	3	6.25	0	0	0	0
November	33	18	54.5	7	21.2	4	12.1	0	0	1	3.0	2	6.1	1	3.0	3	9.1	0	0
December	31	12	38.7	3	9.7	3	9.7	1	3.2	1	3.2	0	0	1	3.2	2	6.5	1	3.2

DISCUSSION

The incidence of *Strongyloides papillosus* was found to be 33.33 per cent in the present investigation was in confirmity with Supperer and Pfeiffer (1960) who recorded an incidence of 35 per cent in cattle, whereas Ikme (1970), Costa *et al.* (1973), and Yazwinski and Gibbs (1975) reported a high incidence of *Strongyloides papillosus* (61 to 90 per cent).

Bunostomiasis was the next major infection detected and was found to be 13.08 per cent, whereas Costa *et al.*(loc.cit.) and Yawzwinski and Gibbs (loc.cit.) reported 80 per cent and 40.37 per cent of incidence of *Bunostomum phlebotomum* in cattle respectively. *Ncoascaris vitulorum* was recorded from 11.9 per cent of cross bred calves examined in Kerala, whereas, Anantharaman (1951) got 9.2 per cent and Chauhan *et al.*(loc.cit.) reported 12.10 per cent ascaris infection in calves. But Ikme (1970) reported an incidence of 81 per cent ascariasis in Nigeria.

The incidence of other Strongyles and *Trichuris* was very low in the present investigation as compared to the observations made by Chauhan *et al.*(loc.cit.)

Mitcheal (1974) reported that eggs of Oesophagostomum sp. was highest in July - August months. But in the present study Oesophagostomiasis was found to be more in September (25 per cent). According to Yazwinski and Gibbs (loc.cit.), Strongyloides infection was more in May-June period, whereas, the present study revealed the highest incidence of strongyloidosis in August and October (55.56 and 52.08 per cent respectively).

PATHOGENICITY

Review of literature

According to Veegors (1954), symptoms of Strongyloides infection in calves were diarrhoea, loss of appetite, retarded growth and emaciation. A pustular dermatitis was reported on abdomen, udder and limbs, as they were the parts which come in contact with infected bedding. Supperer and Pfeiffer (1960), also reported that the infection due to Strongyloides papilloses was very mild in some week old calves. Heavy strongyloidiosis was characterised by coughing, cessation of growth and some times diarrhoea.

Gross lung damage were noticed two days after infection due to the penetration of S.papillosus larvae and reached its maximum in about three days. At that time the lung surface were covered with petechiae and ecchymosis. (Turner and Shalikop,1958). In lungs from 48 hours onwards haemorrhage and oedema or petechieal haemorrhages in the upper parts were apparent(Gillard,1967).

The intestines appeared to be voluminous and purplish blue and their contents were liquid,brown or black, haemorrhagic with large erosions of the epithelium of the duodenum and jejunum. The wall was inflammed,congested and thickened. (Morrel and Fogel,1954).

Lesions of strongyloidosis consisted of catarrhal inflammation of the small intestine while in severe

infections there must be necrosis and sloughing of mucosa. (Soulsby,1976) Damage to the intestine was generally confined to the duodenum and jejunum in the form of catarrhal enteritis. Srivasthava and Pande (1965) described that the adult females, staying in the submucosa were found encapsulated, some times with phagocytosis.

In lungs, severe Strongyloides infection caused subpleural petechiael ecchymosis and some times patches of consolidation. Tissue sections taken on the 4th or 5th day revealed marked congestion with blood having passed into alveoli. (Gillard, loc.cit.). The smaller branches of the pulmonary artery showed an inflammatory reaction characterized by the presence of eosinophils adherent to the endothelium. The simplest reaction was an atypical hyperplasia of the epithelium, whereby it became pseudostratified with poorly differenciated cells with all layers of bronchiolar wall infilterated by eosinophils. The larvalworms were frequently found in the bronchioles, surrounded by eosinophils. The granulomas formed in the lungs were not organised in the conventional manner, except which they surround dead parasites, but consisted of wide cuff's of a mixture of histiocytes and eosinophils with a variable number

multinucleate giant cells and extra vasated erythrocytes. (Jubb and Kennedy (1970), Moczon (1972) found that the larvae of injury with disruption of alveoli, severe extra vasation and choking of the bronchioles with mucus in the lungs.

According to Gillard (loc.cit.) the inflammatory reaction in the intestine was due to the intense infiltration with macrophages, eosinophils, lymphocytes and giant cells.

RESULTS

The clinical symptoms associated with strongyloidosis consisted of mainly diarrhoea, even though it was not observed in all cases. The affected animals showed loss of appetite, signs of mild bronchitis with nasal discharge. The mucous membrane was anaemic.

There was not much gross lesions observed in the intestine except haemorrhagic areas in the mucosa at different regions.

Histologically, the tissue sections taken from the haemorrhagic areas showed catarrhal enteritis with distruction of the glands and villi. (Plate XVI, Fig.3). The acini of the glands of the intestine and villi

PLATE XVI

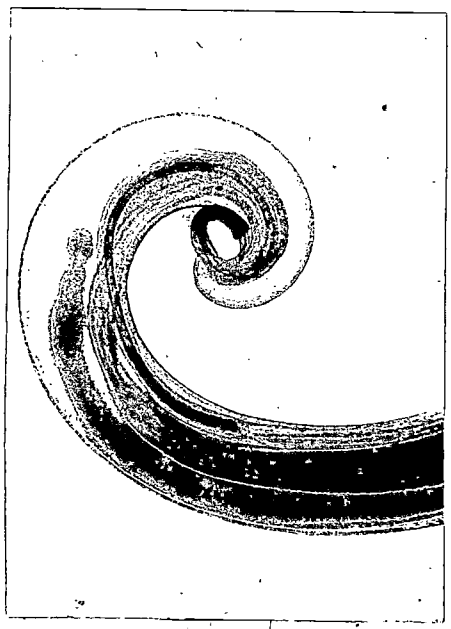

Fig.1

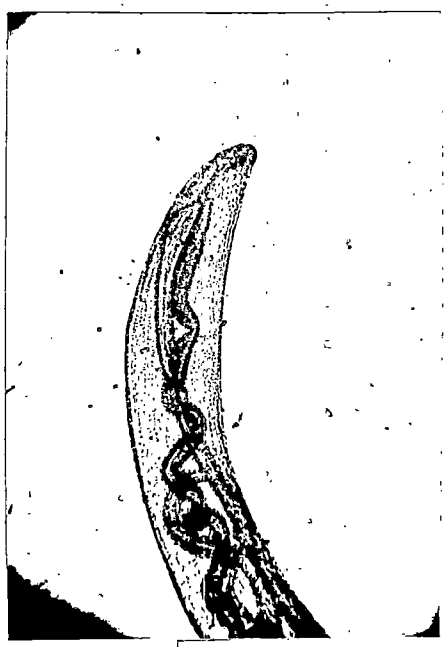

Fig.2

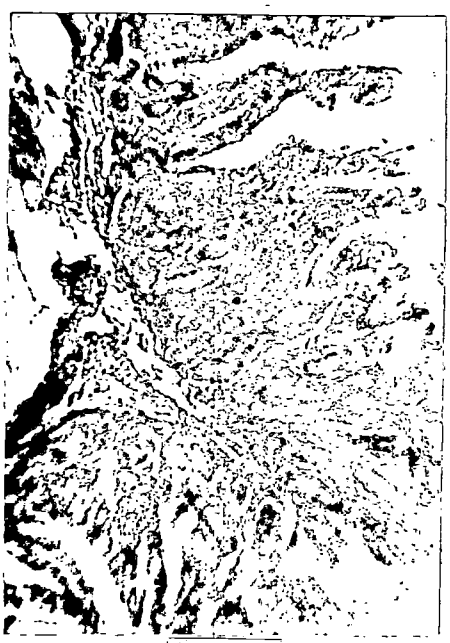

Fig.3

Fig.4

contained haemorrhagic areas. Hypertrophy and increase in the number of the glands as such were detected. Free R.B.C.'s were also seen. In certain areas moderate interstitial proliferation with connective tissue and atrophy of the cells were noticed. Majority of the infiltrating cells were mononuclear cells, eosinophils and macrophages. (Plate XVI,Fig.4). The capillaries of the affected areas seems engorged with blood. Desquamation of the mucosa and exudate formation were observed in certain areas.

DISCUSSION

Pathogenicity of *S.papillosus* in calves was comparatively less severe except in very heavy infection. Veegors (1954) reported that the symptoms were less in calves. Supperer and Pfeiffer (loc.cit.) also agreed with the present observation regarding the clinical symptoms. Morrel and Fogel (loc.cit.) reported gross lesions in intestine as seen in the present study.

The observations obtained by Gillard (loc.cit.), Soulsby (loc.cit.) showed that there was a catarrhal type of inflammation with intensive proliferation of macrophages, eosinophils, lymphocytes and giant cells which were also noticed in the present study.

TREATMENT

Many of the older drugs used for removal of helminth parasites were plant products which have been used since ancient times. Within recent years a number of synthetic compounds have been brought to the field and the number is constantly increasing. Parasitic gastro-enteritis can be caused by very many worms. Under certain conditions, it is found that one species, or perhaps two predominates, but often a drug having a wide range of activity is desirable for effective treatment.

In the present investigation the anthelmintic efficacy of eight different drugs were studied viz., Fenbendazole, Thiabendazole, Mebendazole, Parbendazole, Levamisole, Thiophanate, Morantel tartrate and Tetramizole hydrochloride against natural infection of gastro-intestinal nematodes in calves.

Review of literature

Fenbendazole (Panacur-Hoechst)

(methyl 5 (phony thio-2-benzimidazole)carbamate)

Panacur was a product of M/s. Hoechst Pharmaceuticals, and was supplied as 25 per cent powder.

Reuss (1974) treated 699 cattle of about one year age with a dose rate of 7.5 mg or 10 mg per kg body weight of fenbendazole, in ten per cent suspension or in granular form. Of these 316 were found to be infected with gastro-intestinal nematodes and only 22 of these (7 per cent) were observed to be excreating eggs during a period of eight to 25 days after treatment. None of those showed more than 50 eggs per gram of faeces. No adverse reaction noticed in any of the treated cattle. Chroust and Dyk (1975) conducted field trials against Ostertagia sp., Cooperia onchophora, Trichostrongylus sp., Oesophagostomum radiatum, and Strongyloides papillosus at dose rates of 5 mg and 7.5 mg per kg body weight as suspension and 5 mg per kg as granules and observed reduction in egg output by 90.8, 90.6 and 86.8 per cent respectively.

Duncan et al.(1976) found that fenbendazole was completely effective against Ostertagia ostertagi, Trichostrongylus axei and Cooperia sp. Todd et al.(1976) treated 10 calves experimentally infected with gastro-intestinal helminths with 3.5, 5, or 7.5 mg per kg body weight fenbendazole and reported that Haemonchus sp. was reduced by 96.7, 99.2 and 99.8 per cent, Ostertagia sp. by 97.2, 97.2 and 99.8 per cent respectively and

Cooperia sp.by 99 per cent in all doses. Great reductions were also recorded in case of Trichostrongylus, Nematodirrus, Oesophagostomum, Trichuris and Capillaria spp. Anderson (1977) found the efficacy against Ostertagia ostertagi at 7.5 mg, 11.25 mg and 15 mg per kg body weight as 85 to 89 per cent. There was no increased effect as the dose rates were increased. An efficacy of 98.7 per cent and 86 per cent were obtained against adult and early fourth stage. Ostertagia ostertagi at a dose rate of 7.5 mg per kg body weight (Searson and Doughly, 1977). According to Duwel(1979 a) fenbendazole at a dose rate of 5 mg per kg orally was 99 to 100 per cent effective against immature Ostertagia ostertagi, Trichostrongylus axei, Cooperia onchophora and Oesophagostomum radiatum in experimentally infected calves.

When naturally parasitized steer calves of nine to 12 months old were allowed free access to a feed block containing 840g.fenbendazole per ton for ten days, adult Ostertagia ostertagi were completely eleminated along with 97.5 per cent of the inhibited fourth stage larvae. In dose rates of one mg per kg per day for 10 days was also completely effective against Trichostrongylus axei, Nemattodirrus helvatianus and Cooperia sp.(Mc Beth 1977).

Duwel and Kirsch (1975) and Enigk et al.(1975) also conducted trials with fenbendazole and found it effective in calves.

Todd (1974) demonstrated the ovicidal activity of fenbendazole for the first time. Experiments on ovicidal activity and larvicidal action were carried out in vitro in sheep and cattle by Duwel (1979 b) against Strongyloides, Trichostrongylus, Cooperia, Haemonchus, Ostertagia, Nematodirrus, Oesophagostomum and Bunostomum spp. Admixture of five to 10 mg fenbendazole with 100 g. faeces - a concentration similar to that found in sheep faeces 24 to 28 hours after medication with therapeutic dose - inhibited the development of trichostrongyloid larvae by 90 per cent and reduced the infectivity of those that survived also by 90 per cent. Experiments on cattle showed that egg excretion ceased 22 to 36 hours after treatment. Larvae became incapable of development just 10 hours after anthelmintic medication. No difference was found in experiments between 7.5 and five mg doses. Kirsch (1978) reported ovicidal activity on eggs of Ostertagia ostertagi, Haemonchus contortus and Trichostrongylus colubriformis and inhibition of development was noted 10 hours after treatment at five mg per kg.

Levamisole (Vermisol 150)

(1-2, 3,5,6-tetrahydro-6-phenylimidazo (2,1-b)thiazole) as hydrochloride)

'Vermisol 150' was a product of M/s Khandelwal laboratories Pvt.Ltd.,Bombay - supplied as tablets which contain 150 mg levamisole (l-tetramisole).

Rubin and Hibler (1968) carried out controlled test with levamisole in artificially infected calves and found that four mg per kg given as a drench removed 99 per cent of adult Ostertagia ostertagi, 27 per cent Trichostrongylus axei, and 100 per cent of Cooperia sp. When the dose rate was raised to 8 mg per kg the activit against Trichostrongylus axei was also improved to 60 per cent. The drug given as a drench (eight mg per kg) and bolus (5.4 mg per kg) were 94 to 100 per cent effective against Haemonchus placei, Cooperia spp., Trichostrongylus colubriformis, Ostertagia ostertagi, Oesophagostomum radiatum and Bunostomum phlebotomum. Bak and Fisk (1972) treated young beef cattle with levamisol in drinking water at a dose rate of 7.8 mg per kg body weight. The drugs was dissolved in less amount of water consumed in 24 hours and they found that the effecacy against Ostertagia ostertagi was 78 per cent against Trichostrongylus axei 76 per cent against Cooperia sp.

99 per cent against Nematodirrus helvitianus 100 per cent, against Trichuris sp. 32 per cent and against Oesophagostomum radiatum was 100 per cent. When the drug was given in one half amount of water drunk in a day, the mean effeciencies were Ostertagia ostertagi 99 per cent Trichostrongylus axei, 97 per cent Cooperia sp., 99 per cent Nematodirrus helvitianus 99 per cent, Trichuris sp. 67 per cent and Oesophagostomum radiatum 100 per cent. Santiago et al. (1972) found levamisole highly effective against nematodes when given at five mg per kg as intramascular injection. Turton (1973) observed the effeciencies at 7.5 mg per kg body weight given in feed in calves and sheep. In calves the effeciencies against Ostertagia ostertagi, Trichostrongylus axei, Nematodirrus helvitianus Cooperia oncophora and Trichostrongylus colubriformis were 99.9, 93.7, 100, 99.4 and 99.4 per cent respectively. According to Girardi and Valle (1974), at 5 mg per kg it completely eleminated Haemonchus, Ostertagia, Trichostrongylus, Cooperia, Nematodirrus and Oesophagostomum spp. from cattle.

The effect of levamisole when injected subcutaneously at a dose rate of 8 mg per kg body weight at three different sites were reported by Kistner and Wyse (1975)

and it was effective in reducing (88.3 to 99.8 per cent) the number of abomasal and small intestinal worms in naturally infected sheep.

Lyous et al.(1975)administered levamisole at eight mg per kg through different routes viz.drinking water, subcutaneous injection or alfalfa pellet premix, to calves. The removal of fourth stage Ostertagia sp. was 64, 23 and 0 per cent and mature Ostertagia ostertagi sp. was 90, 93 and 83 per cent, Trichostrongylus axei 92, 99 and 92 per cent respectively. For all those trials removal was 100 per cent for fourth stage Cooperia oncophora C.punctata and Oesophagostomum radiatum. Anderson (1977) obtained variable effeciencies of 81 and 49 per cent for levamisole against adult Ostertagia ostertagi in naturally acquired infections in cattle.

Rowland and Berger (1977) found levamisole effective against gastro-intestinal nematodes when applied dermally in dermal absorption base with 10 per cent levamisole. When it was applied on both sides of the lumbar spine at 10 mg per kg, the reduction in the worm burden were equivalent to those reported for per os dosage at 7.5 to 10 mg per kg. Against fourth and fifth stage larvae and adults the efficiencies were respectively, Haemonchus placei 72, 99.3 and 100 per cent. Ostertagia ostertagi 85.5, 38.1 and 74.5 per cent Cooperia sp. 98.9, 99.9 and

100 per cent Bunostomum phlebotomum 83, 100 and 98.5 per cent and Oesophagostomum radiatum 47.4, 94.9 and 99.6 per cent.

Thiophanate (Nemafax)

(diethyl 4, 4'-O-phenylene bis(3-thioallophanate)

Nemafax was a product of M/s May and Baker, marketed as 70 per cent w/w wettable powder.

Thiophanate was first introduced by Eichler(1973) against gastro-intestinal nematodes of sheep and cattle. He reported that in natural and mixed infections 50 mg per kg body weight thiophanate reduced all stages of total infection, from 150-1400 to 50 eggs per gram of feces in three weeks. At 50 mg per kg it was 96-100 per cent effective against 23rd day infection with Haemonchus contortus and Trichostrongylus colubriformis and 76 per cent against Nematodirrus battus. In cattle, 97 to 100 per cent efficacy was obtained in all species except Cooperia oncophora (82 to 85 per cent) and retarded fourth stage Ostertagia ostertagi larvae. Chandrasekharan et al. (1978) reported an efficacy of 100 per cent against Oesophagostomum radiatum, 93.75 to 100 per cent against Haemonchus contortus, 88.67 to 100 per cent against Trichostrongylus colubriformis, 99.46 per cent against Neoascaris vitulorum, 73.08 per cent

against Strongyloides papillosus and 57.14 to 82.35 per cent against Trichuris sp. at a dose rate of 50 mg per kg against natural infection in calves.

In a trial Ogunsusi (1978) at 100 mg per kg body weight obtained high efficacy in removing all stages of development of helminths including the inhibited stages. Duncan et al.(1979) reported 99.3 to 100 per cent efficacy at 132 mg per kg body weight against adult worms of Trichostrongylus axei, Cooperia and Ostertagia ostertagi and 68.3 per cent efficacy against inhibited fourth stage of Ostertagia ostertagi. When the drug was given at 20 mg per kg in feed for five days similar results were obtained against adult worm, but the efficacy against Ostertagia larva rose to 97.3 per cent.

At 50 mg per kg it removed all but some inhibited early fourth stage and a few late fourth and fifth stage Cooperia punctata, C.pectinata and Haemonchus placei in a limited trial in zebu (Fabiyie et al.1979).Nice et al. (1979) administered the drug at 50 mg per kg and 60 mg per kg to calves and obtained 100 per cent efficacy against Haemonchus sp., Cooperia mcmasteri, Oesophagostomum radiatum, Chabertia ovina and Trichuris ovis, 94.8 to 99.5 per cent against Cooperia oncophora,

Trichostrongylus axei and Cooperia spp. Against Ostertagi sp. the percentages of seven, 10, 14 and 25 day old worms removed were respectively 43, 39, 79 and 98. Against Trichostrongylus axei the percentages were 91, 100, 98 and 100 and against Cooperia sp. 100 per cent efficacy was recorded. At 30 mg per kg, the efficacy against 14 day old Ostertagia ostertagi increased to 96 per cent. In controlled tests done by Theodorides et al (1968) in cattle the drug at 10 mg per kg intrarumenally was found very effective against Haemonchus, Ostertagia, Trichostrongylus, Strongyloides, Cooperia and Oesophagostomum spp. Increasing the dose to 20 mg per kg improved the efficacy against Trichuris sp. to 83 per cent and a further more increase to 40 mg per kg brought the efficacy against Nematodirrus sp. upto 99per cent.

Rubin (1969) reported 92 to 100 per cent efficacy against Haemonchus placei, Ostertagia ostertagi, Trichostrongylus axei, Cooperia sp., Nematodirrus filicollis and Oesophagostomum radiatum at 30 mg per kg level. Ross (1970) in a treatment trial in calves experimentally infected with Ostertagia ostertagi and Cooperia punctata, a dose of 30 mg per kg per os removed 89, 36 and 100 per cent of three, 10 and 20 day old

Ostertagia ostertagi against Cooperia punctata the percentage were 100, 99 and 100 respectively. Chandrasekharan et al. (1974) administered 20 mg per kg parbendazole in cattle and sheep and obtained 100 per cent efficacy against Haemonchus contortus and Trichostrongylus colubriformis. An efficacy of 87.5 to 100 per cent and 98.5 to 100 per cent were obtained against Strongyloides papillosus and Ascaris vitulorum respectively. They also reported ovicidal action to the drug at 20 mg per kg body weight. Borgsteede (1974) obtained the reduction rates in two, 14 and 28 days after treatment at 30 mg per kg as 100, 87.5 and 69.9 per cent against Ostertagia ostertagi, 100, 99.9 and 99.1 per cent against Cooperia oncophora, 100, 99.7 and 99.8 per cent against C.punctata, 100, 99.9 and 99.9 per cent against Trichostrongylus sp. 100, 99.9 and 100 per cent against Haemonchus contortus and 100, 100 and 100 per cent against Strongyloides papillosus respectively.

Weissienburg and Miela (1974) got excellent efficiency against mature form of Ostertagia ostertagi, Cooperia oncophora, Ostertagia circumcinta and O.lyrata. Its effect was less against immature forms but on an average 88 per cent of the Cooperia oncophora larvae was reduced than controls.

Tetramisole (Nilverm-ICI)

(dl 2,5,5-tetra hydro-6-phenyle-imidaza (2,1,-6) thiazole hydrochloride)

Tetramisole was first introduced by Thienpont et al.(1966) as a broad spectrum anthelmintic in man, poultry, sheep, cattle and dog. Enigk et.al. (1966) tried it against experimental infections of Ostertagia ostertagi and Cooperia oncophora in calves at 10 mg per kg as subcutaneous injection and found that it was 99.5 per cent and 99.6 per cent effective against adult worms and 19.5 per cent and 97.3 per cent against 14 day old worm respectively. Forsyth (1966) evaluated the drug at 15 mg per kg and found highly effective against gastro-intestinal nematodes. He opiened that Haemonchus sp. was most susceptible and Ostertagia sp. was most resistant, but 90 to 100 per cent efficacy was obtained against adults at 15 mg per kg dose level, although 20 mg per kg dose appeared to be required for complete elimination of immature forms. Considerable reduction in the worm burden was demonstrated in experimental infection with Cooperia oncophora, Ostertagia ostertagi and natural infection with trichostrongylids at a dose rate of 10 mg per kg body weight (Supperer and Pfeiffer, 1966).

Negru et al.(1970) reported that tetramisole was highly effective against Neoascaris vitulorum and Strongyloides papillosus in young cattle. According to Tongson and Aragen (1971) subcutaneous administration of tetramisole at five mg per kg caused a drop in the mean egg counts of Cooperia, Strongyloides, Bunostomum and Oesophagostomum spp.

Vandenbussche et al.(1967) and Shien et al(1974) recorded a very high efficacy against gastro-intestinal parasites for tetramisole when compared with various other drugs in common use.

Kagota et al.(1974) studied on the toxicity of the drug in calves and found that two to eight times the conventional dose developed symptoms of toxicity and subcutaneous injection caused strong local reactions.

Thiabendazole (Thiabendole-Merck Sharp and Dhome)

(2-(4'thiazolyl)-benzimidazole)

Brown et al.(1961) reported for the first time that thiabendazole was an efficient anthelmintic against gastro-intestinal nematodes in domestic animals. The critical tests conducted by Bell et.al.(1962)revealed that thiabendazole was highly effective in removing trichostrongylids from naturally parasitized calves

treated with 100 to 150 mg thiabendazole per kg body weight. Ames et al.(1963) reported that in controlled tests using artificially infected calves a dose of 75 mg per kg removed 94 per cent of the 10 day old Ostertagia ostertagi and 85 per cent of 10 day old Cooperia oncophora. When the dose rate was increased to 100 mg per kg respectively 99 and 83 per cent of the mature forms of those species were eliminated.

A dose of 67 mg per kg removed 88 per cent of the mature forms and 25 per cent of the immature forms of Cooperia oncophora. The efficacy rose to 92 to 78 per cent respectively when the drug was given at 100 mg per kg body weight. At this rate it was also found to remove 100 per cent of adults Ostertagia ostertagi, but only 55 per cent of the immature forms (Rubin et al. 1965). An efficiancy of 90 per cent and 64 per cent against mature and immature Ostertagia ostertagi were obtained respectively in bovines. At 220 mg per kg about 94 per cent of the adult worms were eliminated (Armour et al. 1967).

Restani and Borrelli (1969) treated about five calves artificially infected with Strongyloides papillosus at a dose rate of 100 mg per kg. The ova were completely removed from the faeces of the treated

calves and nearly all of the adult worms from the small intestine. Chroust and Dyk (1975) reported that oral treatment of thiabendazole at 15 mg per kg in heifers was 82.3 per cent effective to Ostertagia ostertagi, Cooperia oncophora, Trichostrongylus sp., Oesophagostomum radiatum and Strongyloides papillosus.

Ogunsusi (1978) in a trial in natural infection of trichostrongyles in sheep, thiabendazole at 220 mg per kg was found highly effective in removing all stages of development of helminths including inhibited stages.

Faecal samples cultured at intervals from six hours, of yearlings. Naturally infected with Cooperia sp. and Ostertagia sp. and treated at a dose rate of 110 mg per kg thiabendazole showed no ovicidal property (Larbique et al.1975).

According to Bell et al.(1962) 200 mg per kg and 400 mg per kg caused rapid breathing and salivation after treatment but those effects passed off within 24 hours. Reinecke and Rossiter (1962) reported that calves could tolerate doses of 800 mg per kg, but a dose of 100 mg per kg caused toxic signs, although no permenent ill effects were observed.

Morantel tartrate (Banminth II-Pfizer)

Errecalde (1970) reported that an oral dosage of 10 mg per kg body weight caused 23 to 25 per cent weight gain in treated calves than controls. Egg counts were nil on the third day. Chandrasekharan et al.(1973) treated with 10 mg per kg body weight, 20 calves and five kids naturally infected with Haemonchus contortus, Bunostomum phlebotomum, Oesophagostomum radiatum, Ascaris vitulorum, Strongyloides papillosus and Trichuris spp.and obtained the efficacy as 98.3 to 100 per cent, 90.6 to 93.3 per cent, 100 per cent, 100 per cent, 43.9 to 59.08 per cent and 36 per cent respectively. They also reported that the drug had no ovicidal effect.

At 10 to 11.5 mg per kg body weight, Ciordia and Mc Campbell (1973) found the drug very effective against Haemonchus placei, Trichostrongylus axei,T.colubriformis, Cooperia punctata, C.pectinata and Cooperia oncophora but less effective against Ostertagia ostertagi in naturally infected calves. Conway et al.(1973) also found that 7.5 to 15 mg per kg, it was less effective against Ostertagia sp. and Trichostrongylus axei.

Controlled anthelmintic trials against experimental infection in calves by Conway et al. (1973 a) recorded a high activity of 98 to 99 per cent

against 14 to 21 day old Haemonchus contortus and Cooperia oncophora at 10 to 20 mg per kg. The response of seven day old larvae of these two species at 10 mg per kg was 12 and 59 per cent respectively. Adults (21 day old) Ostertagia ostertagi were highly susceptible at doses of five to 10 mg per kg body weight, but histotropic stages at three, seven and 14 days after infection were not affected by 10 mg per kg.

Troncy and Oumati (1973) reported that at 7.5 mg per kg body weight it was highly effective against Haemonchus contortus, Cooperia and Oesophagostomum spp. A dose of five mg per kg was insufficient to eliminate Strongyloides papillosus, though the number of eggs were reduced. A dose of 15mg per kg body weight was required to eliminate the worm.

At five mg per kg body weight, the drug administered by stomach tube, was found very effective against experimental infection with Haemonchus placei, Ostertagia ostertagi, Cooperia pectinata, C. punctata, Bunostomum phlebotomum and Oesophagostomum radiatum in calves (Anderson and Marais, 1975).

Cornwell et al. (1973 a) proved its margin of saftey and they suggested that the maximum tolerated dose in calves was 200 mg per kg body weight.

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Mebendazole (Eben-Gufic Laboratories)

(methyl N(5-benzoyl-2-benzimidozolyl) carbamate)

Guilhon et al.(1972) treated sheep naturally infected with mixed infection of Haemonchus, Ostertagia, Cooperia, Trichostrongylus, Nematodirrus, Bunostomum, Chabertia and Trichuris spp., at 35 mg per kg level and found it 100 per cent effective against those worms. At dosages of 12.5 mg per kg body weight and above Kelly et al.(1975) found mebendazole more than 99 per cent effective in removing the naturally acquired infections of Haemonchus contortus, Ostertagia curcumcinta, Trichostrongylus colubriformis, Oesophagostomum venulosum and Strongyloides papillosus in sheep.

Enigk et al.(1976) had given the drug in food at 30 ppm to pigs. In trichuriasis treated for five days the egg out put reduced to 76 per cent, in ten days it was 99.9 per cent reduced. Treatment for Strongyloides infection for ten days 79 per cent reduction of egg out put were noticed. It could eleminate ascaris eggs 100 per cent in three days.

Mebendazole was found in active at doses of 6.26 and 12.5 mg per kg against resistant strains of

Haemonchus contortus, although significant reduction occurred at 25 mg per kg level (Hall et al.1978). Ribbeck and Winter (1978) had given mebendazole at 10 mg per kg in goats naturally infected with gastro-intestinal nematodes (mainly Ostertagia and Haemonchus spp.) and obtained an efficacy of 99.8 per cent. Zagicek et al.(1978) got an efficiancy of 97.01 to 99.05 per cent in lambs artificially infected with Haemonchus contortus and Trichostrongylus colubriformis which were treated with mebendazole at 10 mg per kg on three successive days.

Several other investigators such as Faizyev(1974), Kutzer et al.(1974), Kavai et al.(1977) and Mc Curdy et al.(1977) had been conducted anthelmintic trials with mebendazole in horses and found it very effective against gastro-intestinal nematodes.

Varga and Janisch (1975) reported that a single dose of mebendazole as high as 320 mg per kg produced no toxic effect in sheep even in pregnant ones.

RESULTS

Febendazole

The effect of fenbendazole at five mg per kg body weight was 81 to 100 per cent while at 7.5 mg per kg body weight it was 73 to 100 per cent against Strongyloides papillosus (Table III).

Regarding the ovicidal property with both the doses on the eggs larvae hatched in cultures kept after medication. But the first stage larvae failed to attain infectivity and were found dead on the second day.

No signs of toxicity were detected in the medicated animals.

Against Neoascaris infection, an efficacy of 78 to 100 per cent was obtained at 5 mg per kg body weight. Against strongyle worms the drug at five mg per kg body weight showed efficacies of 85 to 100 per cent, 100 per cent, 100 per cent and 100 per cent for Oesophagostomum sp., Trichostrongylus sp., Cooperia sp., and Haemonchus sp. respectively. Against Trichuris species the efficacy obtained was 50 to 100 per cent at five mg per kg.

Ovicidal property was noticed against strongyle group eggs. The results are furnished in Table IV.

Thiophanate

At a dose rate of 70 mg per kg body weight an efficacy of 76 to 100 per cent was obtained against Strongyloides papillosus in calves. When the dose rate was increased to 100 mg per kg the efficacy also improved to 100 per cent (Table V).

The culture kept on the first day after medication failed show infective larvae, proving the ovicidal property of the drug.

Mebendazole

Mebendazole at 10 mg per kg body weight showed 62 to 100 per cent efficacy against Strongyloides papillosus and at 15 mg per kg body weight, the efficacy also rose to 100 per cent (Table VI).

Levamisole

Levamisole exerted an efficacy of 95 to 100 per cent at 10 mg per kg body weight and 100 per cent efficacy at 15 mg per kg body weight against Strongyloides papillosus (Table VII).

The culture failed to show infective larvae and thus proved its ovicidal activity.

Thiabendazole

An efficacy of 100 per cent was obtained with Thiabendazole at 100 mg per kg body weight against Strongyloides papillosus (Table VIII).

Few numbers of infective larvae were present in certain faecal cultures. So the drug had no ovicidal action.

Parbendazole

Parbendazole showed 82.69 to 97.14 per cent efficacy at 30 mg per kg body weight against Strongyloides papillosus. When the dose rate was raised to 45 mg per kg, 100 per cent efficacy was obtained. (Table IX).

The drug had exerted ovicidal action as no infection larvae could be obtained in the dung cultures kept after medication.

Morantel tartrate

Against Strongyloides papillosus, Morantel tartrate had an efficacy of 88.10 to 97.52 per cent at 10 mg per kg body weight while at 15 mg per kg body weight an efficacy of 100 per cent was obtained. (Table X).

Infective larvae could be obtained in the dung cultures kept after treatment, hence the drug exerted

no ovicidal effect on Strongyloides eggs.

Tetramisole hydrochloride

Tetramesole hydrochloride was 93 to 100 per cent efficient against Strongyloides papillosus at 15 mg per kg body weight. The efficacy increased to 100 per cent at 20 mg per kg body weight (Table XI). Dung cultures maintained after medication also showed no larvae.

DISCUSSION

Fenbendazole

Fenbendazole was found highly effective against strongyles and Strongyloides sp. Chroust and Dyk(1975) obtained 86.8 per cent efficacy against Strongyloides papillosus at five mg and 7.5 mg level. The results obtained by Ruess (1974), Duwel and Kirsch (1975), Enigk et al.(1975), Duncan et al.(1976) and Todd et al. (1976) were more or less supporting the present results. Anderson (1977) reported that there was no increased effect when the dose rate were increased. During the present investigation also no increase in the efficacy was noticed when the dose rate was increased from five mg to 7.5 mg per kg body weight.

Todd (1974) and Duwel (1979 a) observed ovicidal property or inhibited development of the larvae which was also in full agreement with the present trial.

Thiophanate

Thiophanate was found highly effective to Strongyloides papillosus at higher dose rate (100 mg per kg). Similar observations were also reported by Ogunsusi (1978).

Mebendazole

Little work had been undertaken against gastro-intestinal nematodes especially against Strongyloides papillosus in calves. It was found highly effective against Strongyloides papillosus at 15 mg per kg body weight and was comparable with the findings reported by Kelly et al.(1975), Faizyev (1974), Kutzer (1974), Kavai et al.(1977) and Mc Curdy et al. (1977).

Levamisole

Levamisole was found as an effective drug against Strongyloides papillosus in calves. It also showed a high efficacy at higher dose level. The results were in agreement with the observations made by Rubin (1968), Baker and Fisk (1972), Santiago et al.(1972),

Turton (1973), Girardi and Valle (1974), Lyous et al.(1975) .

Thiabendazole

Thiabendazole was found to be a very effective drug at 100 mg per kg body weight against Strongyloides papillosus Restani and Borreili (1969) also obtained 100 per cent removal of Strongyloides papillosus worm whereas Chroust and Dyk (1975) reported only 82.3 per cent efficacy at a dose rate of 15 mg per kg.

As in the present trial Larbique et al.(1975) also did not get ovicidal action in cases treated with 110 mg per kg dose level against Ostertagia sp. and Cooperia sp.

Parbendazole

Parbendazole was found highly effect against different development stages of the worm at 30 mg per kg body weight whereas the present trials revealed only 82.19 to 97.14 per cent of efficacy. But the drug was proved to 100 per cent effective at 45 mg per kg body weight against Strongyloides papilloses.

Morantel tartrate

Chandrasekharan et al.(1973) obtained only

43.9 to 59.09 per cent efficacy against Strongyloides papillosus at 10 mg per kg level while an efficacy of 88.10 to 97.52 per cent were obtained in the present investigation at the same level. But 100 per cent efficacy was noticed at higher dosage of 15 mg per kg body weight.

Chandrasekharan et al.(loc.cit.) reported that the drug had no ovicidal effect as in the present investigation.

Tetramisole hydrochloride

This drug showed an increased effect at higher dose level of 20 mg per kg body weight against Strongyloides papillosus. The present observations were in accordance with that of Tongsen and Aragen (1971).

Table III.

Showing the percentage of efficacy of Fenbendazole against *Strongyloides papillosus*

Sl.number of animal treated	Mean Premedication E.P.G.	Dose rate mg/kg b.wt.	Post medication E.P.G. 24 hrs after	48 hrs after	72 hrs after	Percentage of efficacy at the 3rd day.
1	1600	5	700	500	200	87.5
2	300		200	100	0	100.0
3	1600		1300	300	300	81.25
4	400		100	0	0	100.0
5	500		500	0	0	100.0
6	3100		2000	700	500	83.87
1	200	7.5	100	0	0	100.0
2	4200		2300	900	1100	73.81
3	40000		18000	5500	2400	94.0
4	800		400	100	0	100.0
5	1600		1600	500	100	87.5
6	500		600	200	0	100.0

Table IV.

Showing percentage of efficacy of fenbendazole against Strongyle, *Ascaris* and *Trichuris* worms.

Sl.No.	Species of worms.	Mean Pre-medication E.P.G.	Dose rate mg/kg b.wt.	Post medication E.P.G. 24 hrs after	48 hrs after	72 hrs after	Percentage of efficacy at the 3rd day.
1	*N.vitulorum*	200	5	100	0	0	100.0
2		700		500	0	0	100.0
3		46000		16000	9400	300	99.35
4		2500		2300	300	0	100.0
5		100800		167200	83900	13200	86.90
6		103800		99600	48800	8100	92.20
7		251000		136200	43500	5500	78.09
1	*Oesophagostomum* sp.	400	5	100	300	300	85.00
2		200		0	0	0	100.0
3		300		100	0	0	100.0
4		100		0	0	0	100.0
5		200		100	0	0	100.0
1	*Trichostrongyle* sp.	100	5	0	0	0	100.0
2		200		100	0	0	100.0
3		300		0	0	0	100.0
4		200		100	0	0	100.0
1	*Cooperia* sp.	200	5	200	0	0	100.0
2		100		0	0	0	100.0
1	*Haemonchus* sp.	200	5	100	0	0	100.0
1	*Trichuris* sp.	200	5	100	0	0	100.0
2		300		300	200	100	66.67
3		400		300	200	200	50.0

Table V. Showing the efficacy of Thiophanate against *Strongyloides papillosus*

Sl.number of animal treated	Mean Premedication E.P.G.	Dose rate mg/kg b.wt.	Post medication E.P.G. 24 hrs after	48 hrs after	72 hrs after	Percentage of efficacy at the 3rd day.
1	533	70	600	100	0	100.0
2	6867		2700	2400	700	90.0
3	1433		1500	0	0	100.0
4	233		100	0	0	100.0
5	8867		2100	1500	1100	88.0
6	3767		1300	500	900	76.0
1	1700	100	1500	200	0	100.0
2	2400		1200	600	0	100.0
3	1500		400	100	0	100.0
4	2800		400	100	0	100.0

Table VI.

Showing the efficacy of Mebendazole against *Strongyloides papillosus*

Sl.number of animal treated	Mean Premedication E.P.G.	Dose rate mg/kg b.wt.	Post medication E.P.G. 24 hrs after	48 hrs after	72 hrs after	Percentage of efficacy at the 3rd day
1	267	10	200	0	0	100.0
2	200		400	0	0	100.0
3	400		100	0	0	100.0
4	2067		3600	900	700	66.13
5	2100		1800	300	800	62.0
6	1533		900	0	0	100.0
1	300	15	400	100	0	100.0
2	800		500	200	0	100.0
3	1300		1600	200	0	100.0
4	200		0	0	0	100.0

Table VII.

Showing the efficacy of Levamisole against *Strongyloides papillosus*

Sl.number of animal treated	Mean Premedication E.P.G.	Dose rate mg/kg b.wt.	Post medication E.P.G. 24 hrs after	48 hrs after	72 hrs after	Percentage of efficacy at the 3rd day
1	2033	10	27000	200	100	95.0
2	2567		800	0	0	100.0
3	433		100	0	0	100.0
4	1967		1500	0	0	100.0
5	5067		9600	100	100	98.0
6	200		300	100	0	100.0
1	300	15	100	0	0	100.0
2	200		100	0	0	100.0
3	500		300	0	0	100.0
4	200		0	0	0	100.0

Table VIII.

Showing the efficacy of Thiabendazole against *Strongyloides papillosus*

Sl.number of animal treated	Mean Premedication E.P.G.	Dose rate mg/kg b.wt.	Post medication E.P.G. 24 hrs after	48 hrs after	72 hrs after	Percentage of efficacy at the 3rd day
1	200	100	100	0	0	100.0
2	300		100	0	0	100.0
3	1100		1000	500	0	100.0
4	1300		1500	400	0	100.0
5	200		100	0	0	100.0
6	400		300	100	0	100.0

Table IX.

Showing the efficacy of Parbendazole against *Strongyloides papillosus*

Sl.number of animal treated	Mean Premedication E.P.G.	Dose rate mg/kg b.wt.	Post medication E.P.G. 24 hrs after	48 hrs after	72 hrs after	Percentage of efficacy at the 3rd day
1	6866.6	30	7800	1100	500	92.72
2	3466.67		3500	1500	600	82.69
3	10233.33		12500	2500	1500	85.34
4	2233.33		3500	1000	300	86.57
5	7000.0		9500	1000	200	97.14
6	5700.0		6700	1700	300	94.74
1	4533	45	4900	0	0	100.0
2	8167		9500	1000	0	100.0
3	8533		10500	500	0	100.0
4	5467		5700	500	0	100.0
5	12600		13000	1500	0	100.0
6	1867		1700	0	0	100.0

Table X.

Showing the efficacy of Morantel tartrate against *Strongyloides papillosus*

Sl.number of animal treated	Mean Premedication E.P.G.	Dose rate mg/kg b.wt.	Post medication E.P.G. 24 hrs after	48 hrs after	72 hrs after	Percentage of efficacy at the 3rd day
1	1200	10	1200	600	100	91.67
2	8400		9100	2000	1000	88.10
3	5667		7500	1500	500	91.18
4	3833		4900	1400	300	92.17
5	4033		4900	700	100	97.52
6	2867		2500	600	100	96.51
1	8467	15	6500	0	0	100.0
2	2000		3100	400	0	100.0
3	8600		8500	0	0	100.0
4	2167		2500	0	0	100.0
5	7600		7900	300	0	100.0
6	5733		8400	500	0	100.0

Table XI.

Showing the efficacy of Tetramisole hydrochloride against *Strongyloides papillosus*

Sl.number of animal treated	Mean Premedication E.P.G.	Dose rate mg/kg b.wt.	Post medication E.P.G. 24 hrs after	48 hrs after	72 hrs after	Percentage of efficacy at the 3rd day
1	11900	15	9500	1500	300	97.48
2	7500		9100	2000	500	93.00
3	6100		8500	800	0	100.00
4	5833		7900	600	200	96.57
5	8467		9900	1500	300	96.46
6	4133		3700	400	100	97.58
1	3633	20	5500	400	0	100.00
2	8700		10500	600	0	100.00
3	3133		3000	0	0	100.00
4	7900		7900	100	0	100.00
5	1333		2000	0	0	100.00
6	2567		3100	0	0	100.00

SUMMARY

SUMMARY

1. An investigation has been made into the incidence of gastro-intestinal nematodes of calves in Kerala State by examining dung samples and entrails of 99 non-descript calves and 440 cross bred calves.

2. The specific identity of the different strongyles and the Strongyloides species harboured by the animals has been made by recognizing their third stage larvae in the faecal cultures.

3. A total of eight species of gastro-intestinal nematodes has been encountered, viz., Strongyloides papillosus, Neoascaris vitulorum, Oesophagostomum radiatum, Cooperia sp., Bunostomum phlebotomum, Trichostrongylus colubriformis, Haemonchus contortus and Trichuris globulosa from different parts of the gastro-intestinal tract.

4. Jersey cross calves were found to be more susceptible to nematodiasis with a highest incidence of 69.02 per cent and the lowest incidence of 40.91 per cent recorded in Holstein-Friesian crosses. Out of the 99 non-descript calves 51.52 per cent and 55.43 per cent of 92 Brown Swiss cross calves

were found to infected with one or more species of nematodes.

5. Strongyloides papillosus was the predominating species in all the calves except in Hostein friesian crosses, in which Haemonchus contortus was the common species.

6. Maximum incidence of nematodes was observed during rainy seasons in the months of June (100 per cent), July (73.78 per cent) and August(94.44 per cent) and the lowest in winter, December (38.7 per cent).

7. The morphological features of the adult worms, their infective larvae and eggs, encountered, were studied and described in detail.

8. Pathogenicity of Strongyloides papillosus was studied in naturally infected calves. Strongyloidosis was characterized by a catarrhal enteritis with distruction of the gland in certain areas, and infiltration of mononuclear cells, eosinophils and macrophages. The infected animals exhibited diarrhoea with mucus, weakness and emaciation.

9. Eight broad spectrum anthelmintics viz., Fenbendazole, Thiophanate, Levamisole, Parbendazole, Mebendazole, Thiabendazole, Morantel tartrate and

Tetremisole hydrochloride were tried against naturally infected Strongyloides cases. Fenbendazole was also tried against strongylosis, ascariasis and trichuriasis. The efficacy of all the anthelmintics were determined.

Fenbendazole at five mg and 7.5 mg per kg body weight were 81 to 100 per cent and 73 to 100 per cent effective against Strongyloides papillosus respectively. The drug at five mg per kg body weight was also found to be 78 to 100 per cent effective against Neoascaris vitulorum, 65 to 100 per cent against Oesophagostomum sp., 100 per cent against Trichostrongylus sp.,Cooneria sp. and Haemonchus sp. and 50 to 100 per cent against Trichuris sp.

Thiophanate was 76 to 100 per cent effective against Strongyloides papillosus at 70 mg per kg body weight and 100 per cent effective at 100 mg per kg body weight.

Mebendazole showed an efficacy of 62 to 100 per cent at 10 mg per kg body weight and 100 per cent at 15 mg per kg body weight against Strongyloides papillosus.

Levamisole was 95 to 100 per cent effective at 10 mg per kg level and 100 per cent effective at 15 mg per kg body weight.

Thiabendazole showed 100 per cent efficacy at 100 mg per kg body weight.

Parbendazole at 30 mg and 45 mg per kg body weight was 82.69 to 97.14 per cent and 100 per cent effective against Strongyloides papillosus respectively.

An efficacy of 88.10 to 97.52 at 10 mg per kg and 100 per cent at 15 mg per kg body weight were obtained against Strongyloides papillosus in case of morantel tartrate.

Tetramisole hydrochloride was 93 to 100 per cent effective against Strongyloides papillosus at 15 mg per kg level and 100 per cent at 20 mg per kg level.

10. Thiophanate, Tetramisole hydrochloride, Mebendazole, Levamisole, Fenbendazole and Parbendazole were exerted ovicidal property to Strongyloides eggs.

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STUDIES ON THE
INCIDENCE, PATHOGENICITY AND CONTROL OF GASTRO-INTESTINAL NEMATODES IN CROSSBRED CALVES IN KERALA WITH SPECIAL REFERENCE TO STRONGYLOIDOSIS

By

G. SUKUMARA PILLAI

ABSTRACT OF A THESIS

Submitted in partial fulfilment of the
requirement for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Parasitology
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY - TRICHUR

1980

ABSTRACT

The non-descript and cross bred calves of Kerala were infected with eight species of gastro-intestinal nematodes viz. *Strongyloides papillosus*, *Neoascaris vitulorum*, *Cooperia* sp., *Haemonchus contortus*, *Bunostomum phlebotomum*, *Strongyloides Oesophagostomum radiatum*, *Trichostrongylus colubriformis*, and *Trichuris globulosa* and of which *Strongyloides papillosus* was the commonest. Incidence of nematodes was more in cross bred calves (64.8 per cent) as compared to non-descript calves (51.52 per cent). Out of the cross bred calves, Jersey cross bred calves were found to more susceptible to nematodiasis. Nematodiasis was observed more during the rainy season of the State (June to August). Morphological features of adult worms and infective larvae were redescribed in detail. *Strongyloides papillosus* produced catarrhal enteritis and frequent diarrhoea in naturally infected cross bred calves. Thiophanate at 100 mg per kg body weight, Mebendazole at 15 mg per kg body weight, Levamisole at 15 mg per kg body weight., Thiabendazole at 100 mg per kg body weight, Tetramisole hydrochloride at 20 mg per kg body weight, Morantel tartrate at 15 mg per kg body weight and

Parbendazole at 45 mg per kg body weight exerted 100 per cent efficacy against Strongyloides papillosus, whereas, Fenbendazole at 5 mg per kg body weight showed only 83 to 100 per cent efficacy against Strongyloides papillosus, 78 to 100 per cent against ascariasis, 85 to 100 per cent against Strongylosis and 50 to 100 per cent against Trichuriasis.

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