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Morphological Characterization of Haemonchus contortus, a Gastrointestinal Nematode Parasite of Goats

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Abstract
Gastrointestinal nematode (GIN) infections are major constraints to goat production and can cause reduced growth, anaemia, hypoproteinaemia, and mortality. *Haemonchus contortus* is among the most pathogenic and economically important strongyle nematodes of small ruminants because of its blood-feeding habit in the abomasum, high fecundity, and rapid life cycle. The present study aimed to identify and morphologically characterise *Haemonchus contortus* recovered from indigenous goats (*Capra hircus*) in Baghpat district, Uttar Pradesh. Two indigenous female goats that died following illness suggestive of gastrointestinal parasitism were examined by post-mortem necropsy in February 2026. The gastrointestinal tracts were ligated, removed, and processed by sectional washing, mucosal scraping, and sedimentation. Recovered nematodes were fixed in 70% ethanol, cleared in lactophenol, and examined by light microscopy using standard morphological keys. *Haemonchus* spp. was recovered exclusively from the abomasum of both animals and constituted 72.8% of the total gastrointestinal nematode burden recovered. Females showed the characteristic barber's-pole appearance, a small buccal capsule with a dorsal chitinous lancet, and a linguiform vulvar flap. Males were characterised by a well-developed bilobed copulatory bursa, an asymmetric dorsal lobe, a Y-shaped dorsal ray, and long brownish spicules (0.47–0.51 mm) with fused barbed tips. Body lengths were 15–20 mm in males and 24–30 mm in females. These morphological and morphometric features supported identification as H. contortus rather than H. placei. The findings indicate that classical morphological examination remains a practical and economical method for identification of H. contortus and support the need for targeted and sustainable parasite-management strategies in goat production systems in Uttar Pradesh.

Keywords:
Haemonchus contortus; goat; Capra hircus; gastrointestinal nematode; morphology; abomasum; barber's pole; Uttar Pradesh

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Introduction

Gastrointestinal nematode infections are of considerable importance in goat production worldwide. These parasites are major limiting factors of small ruminant productivity, leading to reduced body weight, poor body condition scores, decreased milk and meat production, and disruption of nutrient absorption, which can inhibit growth, cause anaemia, and even lead to death in cases of severe parasitic infection. In addition, worm infestations can weaken the immune system, making livestock more susceptible to other pathogenic diseases and ultimately causing serious economic losses. Gastrointestinal parasitism is widely recognized as one of the foremost constraints to small ruminant production systems in both developed and developing countries, particularly affecting farmers with limited resources who depend on livestock for their livelihoods.

The economic burden imposed by gastrointestinal nematode infections on small ruminant production is substantial and multidimensional. Losses are attributed to decreased production output, the direct costs of prophylaxis and treatment, and mortality of infected animals. Infections contribute to poor feed conversion efficiency, reduced live weight gains, and significant deterioration in carcass and product quality in the meat industry, as well as reduced yield in the dairy industry. Beyond direct production losses, the costs associated with repeated anthelmintic treatments, veterinary interventions, and the management of drug-resistant parasite populations further compound the economic impact on farmers and livestock industries worldwide.

Among the strongyle nematodes, *Haemonchus contortus* is considered one of the most pathogenic and economically significant gastrointestinal nematode species of small ruminants, owing to its blood-feeding habit in the abomasum, remarkably high fecundity, and its ability to rapidly contaminate pastures with infective larvae. A single adult female worm can consume up to 0.05 ml of blood per day, and the presence of thousands of worms in a single host results in severe anaemia and hypoproteinaemia. The resulting protein loss frequently manifests externally as submandibular oedema, commonly known as 'bottle jaw', a hallmark clinical sign of haemonchosis. The condition is particularly fatal in young and immunocompromised animals.

Nematodes (roundworms) are unsegmented worms with a cylindrical form, tapering at either end. Their body is covered with a colourless, somewhat translucent layer called the cuticle, and an alimentary canal is present. They have separate sexes and exhibit both direct and indirect life cycles. H. contortus has a direct life cycle in which eggs passed in the faeces develop through first, second and infective third-stage larvae on pasture before being ingested by the host.

The epidemiology of gastrointestinal nematode infections is influenced by a complex interplay of host, parasite, and environmental factors. Host-related risk factors include age, sex, nutritional status, and immune competence. Young animals are generally more susceptible than adults due to their underdeveloped immune responses, and the periparturient relaxation of immunity in pregnant and lactating does can increase their susceptibility significantly.

In India, gastrointestinal parasitism in small ruminants is a perennial challenge. Prevalence studies from various Indian states have consistently reported high infection rates in goats. In Uttar Pradesh, H. contortus has been reported as the predominant strongyle species, with a prevalence of 54.16% in goats of western Uttar Pradesh, followed by *Trichostrongylus* spp. (31.66%) and *Oesophagostomum* spp. (14.16%) (Sankar et al., 2020). Studies from Aligarh district of Uttar Pradesh reported H. contortus as the predominant species (68.74%), followed by *Trichuris ovis* (57.72%), Moniezia expansa (23.84%), and *Oesophagostomum columbianum* (15.43%).

Accurate identification of gastrointestinal nematode species is essential for understanding parasite epidemiology and for designing appropriate control strategies. Traditionally, identification of gastrointestinal nematodes has been based on the morphological examination of adult worms recovered at necropsy. Morphological keys based on structural features such as spicule length and shape in males, vulvar flap characteristics in females, body measurements, cuticle markings, and bursal structure have long served as the primary tools for species differentiation.

Despite the recognised importance of gastrointestinal nematodes in goat production, comprehensive morphological and morphometric studies describing the diversity and occurrence of nematode species in goats from Uttar Pradesh remain limited. Uttar Pradesh is one of the largest livestock-holding states in India, with a substantial goat population managed predominantly under traditional and semi-intensive husbandry systems. The agroclimatic conditions of the region - characterised by hot and humid summers and a well-defined monsoon season - are highly conducive to the survival and transmission of nematode infective larvae throughout the year.

The present study was therefore undertaken to identify and morphologically characterise *Haemonchus contortus* recovered from goats in Baghpat district of Uttar Pradesh, contributing to the baseline knowledge required for the development of rational and sustainable helminth management programmes for goat production systems in the region.

Literature Review

Gastrointestinal nematode infections of goats, and *Haemonchus contortus* in particular, have been extensively studied due to their significant impact on livestock productivity and rural economy. The available literature is presented below in chronological order.

Studies from 1971-1980

Sathianesan and Peter (1971) documented the incidence of gastrointestinal nematodes under Indian conditions, highlighting their widespread occurrence and economic importance in domestic livestock.

Soulsby (1971) laid the foundation for understanding helminth parasites in domestic animals and described *Haemonchus contortus* as a blood-feeding parasite located in the abomasum, capable of causing severe anaemia and death in heavily infected animals.

Silverman and Campbell (1975) investigated the development and survival of *Haemonchus contortus* larvae under different environmental conditions and demonstrated that temperature and moisture greatly influence the development of infective larvae on pasture.

Waller and Thomas (1975) reported that arrested (hypobiotic) development of *Haemonchus contortus* enables the parasite to survive adverse environmental conditions and synchronize its life cycle with favourable seasons.

Studies from 1991-2000

Hansen and Perry (1994) identified *Haemonchus contortus* as the most pathogenic nematode of goats and recommended integrated parasite management involving strategic deworming, pasture management, and improved nutrition.

Coop and Holmes (1996) highlighted the interaction between host nutrition and parasitism, suggesting that undernutrition can exacerbate the severity of nematode infections in goats.

Urquhart et al. (1996) elaborated on the epidemiology and pathogenesis of parasitic gastroenteritis, noting that gastrointestinal nematode infections interfere with nutrient absorption and lead to poor growth and decreased production performance.

Perry and Randolph (1999) reviewed the economic impact of parasitic diseases in livestock and concluded that gastrointestinal nematodes are responsible for substantial production losses, particularly in smallholder production systems.

Studies from 2001-2010

Keyyu et al. (2002) observed high levels of gastrointestinal nematode infection in sheep and goats in tropical regions, indicating that prevailing climatic conditions play a crucial role in the survival of infective larvae.

Garg et al. (2003) reported the incidence of *Haemonchus contortus* (56.38%) infections in goats from Uttar Pradesh, providing an early reference point for the high prevalence of haemonchosis in the region.

Pal and Bandyopadhyay (2004) studied gastrointestinal nematodes in goats from Sikkim and revealed the presence of Haemonchus sp. among a diverse nematode fauna even under high-altitude conditions.
Shugufta et al. (2005) studied nematodes in sheep of the Kashmir Valley and identified Haemonchus sp. among five types of nematodes recorded.
Coles et al. (1992) reported that resistance to commonly used anthelmintics is widespread among gastrointestinal nematodes of ruminants, underscoring the urgent need for alternative and integrated control strategies.
Kumsa and Abebe (2009) documented multiple drug resistance in nematode populations on goat farms, highlighting the need for alternative control strategies as resistant strains of *Haemonchus contortus* reduce the effectiveness of conventional deworming programmes.

Studies from 2011-2019

Pugh and Baird (2012) described the blood-sucking habit of *Haemonchus contortus* as resulting in severe anaemia, hypoproteinaemia, and oedema, which can be fatal if left untreated.
Kumar et al. (2013) reported a high prevalence of gastrointestinal nematodes in goats from Uttar Pradesh, with *Haemonchus contortus* being the most dominant species, with higher infection rates recorded during the monsoon season.
Sissay et al. (2007) studied small ruminants in Ethiopia and observed that strongyle-type nematodes were highly prevalent, with *Haemonchus contortus* contributing significantly to anaemia and production losses.
Dutta et al. (2015) recorded the prevalence of gastrointestinal nematodes in goats from West Bengal and identified Haemonchus among other genera, noting higher infection rates in young animals.
Kumar and Pachauri (2015) conducted a study on goats in northern India and reported the predominance of *Haemonchus contortus,* confirming the dominance of haemonchosis in the region.
Singh et al. (2019) studied gastrointestinal parasitism in goats and recorded strongyle dominance, particularly *Haemonchus contortus*, with higher infection rates observed in poorly managed flocks.

Studies from 2020 onwards

Kaplan and Vidyashankar (2012) discussed the global emergence of anthelmintic resistance and reported that multidrug-resistant populations of *Haemonchus contortus* have become increasingly common, posing a major challenge to sustainable goat production.
Vasileiou et al. (2021) reviewed haemonchosis in sheep and goats and described *Haemonchus contortus* as one of the most pathogenic gastrointestinal nematodes because of its blood-feeding habit, high fecundity, and rapid life cycle.
Gareh et al. (2021) reported the prevalence, risk factors and morphological characterisation of *Haemonchus contortus* in small ruminants from abattoirs.
Abosse et al. (2022) described the pathological findings in goats experimentally infected with 10,000 L3 larvae of *Haemonchus contortus*.
Mpofu et al. (2022) reviewed the prevalence and control of gastrointestinal nematodes in goats and concluded that *Haemonchus contortus* remains among the predominant nematodes worldwide, highlighting the growing importance of sustainable, integrated parasite-management strategies.
The literature collectively and unequivocally demonstrates that *Haemonchus contortus* remains the most dominant and pathogenic gastrointestinal nematode species across diverse agroecological zones. The increasing prevalence of anthelmintic resistance, the influence of climatic and management factors on transmission, and the paucity of region-specific studies in Uttar Pradesh collectively justify the need for the present investigation.

Method
Study Area

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The present study was conducted in Baghpat district of Uttar Pradesh, India. Baghpat district is situated in the western part of Uttar Pradesh, lying between approximately 28°57'N latitude and 77°13'E longitude, on the upper Gangetic plain.
The climate of Baghpat district is predominantly semi-arid tropical, characterised by hot summers, a well-defined south-west monsoon season, and cool dry winters. The mean annual rainfall ranges from 700 to 800 mm, the majority of which falls during the monsoon months of July to September. The prevailing warm and humid agroclimatic conditions during the monsoon and post-monsoon periods are highly favourable for the development and survival of free-living infective stages of gastrointestinal nematode parasites on pasture.
Small ruminant rearing in the district is largely extensive to semi-intensive. Goats are generally maintained through year-round grazing on natural pastures, crop residues, and fallow lands, which substantially increases their continuous exposure to infective third-stage larvae (L3) of gastrointestinal nematodes present on contaminated grazing areas. Anthelmintic treatment is administered only occasionally, usually when animals appear clinically unthrifty, and is rarely based on systematic faecal egg count monitoring.

Study Animals
A total of two indigenous goats (*Capra hircus*) from Baghpat district, Uttar Pradesh, were included in the present study. The animals were sick for a few weeks and eventually died; the signs of illness were suggestive of gastrointestinal parasitism. Both animals were examined and subjected to post-mortem necropsy for the recovery and identification of gastrointestinal nematode parasites. The study was conducted in February 2026.
Animal 1: A three-year-old female indigenous goat, very sick, obtained from a farm where animals had been grazing freely on natural pastures. Although the animal did not show overt clinical signs at the time of selection, it had a history of occasional anthelmintic treatment. She eventually died of sickness.
Animal 2: A ten-month-old female indigenous goat presenting with a clinical history of progressive loss of appetite, weight loss, and dark-coloured diarrhoea. On ante-mortem examination, the animal was found to be severely weak, markedly emaciated, unable to stand unassisted, and showed pale mucous membranes indicative of clinical anaemia. These clinical signs were strongly suggestive of heavy gastrointestinal nematode infection, particularly haemonchosis.

Necropsy and Post-Mortem Examination
Both goats were subjected to standard necropsy procedures following humane slaughter. A systematic post-mortem examination was carried out to record gross pathological lesions in the gastrointestinal tract and associated organs. In Animal 2, post-mortem findings included a thin and pale carcass, jelly-like (serous atrophy of) subcutaneous and peri-renal fat, hydrothorax (fluid accumulation in the thoracic cavity), and hydroperitoneum (fluid accumulation in the abdominal cavity), all consistent with severe protein deficiency secondary to chronic haemonchosis.
The entire gastrointestinal tract of each animal was carefully ligated at the oesophagus, pylorus, ileo-caecal junction, and rectum to prevent the migration of worms between compartments. The gastrointestinal tract was then removed and transported to the laboratory in labelled containers filled with physiological saline (0.9% NaCl) for subsequent processing.

Sample Collection and Worm Recovery
In the laboratory, the gastrointestinal tract of each animal was separated into its anatomical components: rumen, reticulum, omasum, abomasum, small intestine (duodenum, jejunum, & ileum), caecum, and large intestine (colon & rectum). Each section was placed separately in labelled trays containing physiological saline.
Each segment was opened along its greater curvature using dissecting scissors. The contents were carefully washed with physiological saline and the washings were collected into labelled containers. The

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mucosal surfaces of each segment, particularly the abomasum, were gently scraped with a blunt spatula to dislodge and recover any worms attached to the mucosa or embedded in mucosal folds. The washings were then allowed to sediment for 15-20 minutes or passed through a 100-mesh sieve (150 µm pore size) to concentrate the worms and larvae.

The worm-rich sediment was examined in white enamel trays under a bright light source. All visible worms were picked up with fine forceps or a fine brush, counted, and transferred to 70% ethanol for fixation and preservation pending morphological identification. A subsample of worms was fixed in warm 70°C Barker and Fabian's fixative (70% ethanol with 5% glycerol) to facilitate relaxation and prevent contraction artifacts, ensuring better morphological detail for examination.

Morphological Identification of Nematodes

Worms recovered from the gastrointestinal tract were identified to genus and species level on the basis of standard morphological characteristics using established keys and descriptions. For detailed morphological examination, worms were cleared in lactophenol (a 1:1:2:1 mixture of phenol, lactic acid, glycerol, & distilled water) and mounted on glass slides with a coverslip. Temporary wet mounts were prepared from worms in physiological saline for initial screening. Permanent mounts were prepared in glycerine jelly where necessary.

The following morphological characters were used for identification of the recovered nematodes:

i. Overall body size, colour, and cuticle markings;
ii. Head end morphology, including the presence or absence of a cervical groove and buccal cavity structure;
iii. Presence of a synlophe (cuticular ridges);
iv. Morphology of the copulatory bursa and spicule structure in male worms;
v. Vulvar flap characteristics, position of the vulva, and overall body appearance of female worms, including the characteristic 'barber's pole' appearance.

Haemonchus spp. was identified by their characteristic barber's pole appearance due to the spirally twisted blood-filled intestine (red) intertwined with the white ovaries in females, their comparatively large body size, and the presence of a small lancet in the buccal cavity. Body length, body width, and other relevant measurements were recorded and compared with published descriptions to confirm species-level identification.

Data Recording and Analysis

All data pertaining to the host animals (age, sex, breed, clinical signs, management history) and morphological observations were recorded systematically in pre-designed observation sheets. The number of worms recovered from each compartment was counted and tabulated. Since only two animals were examined, data are presented descriptively without formal statistical analysis. The relative abundance of each nematode genus in the two animals is expressed as a proportion of the total worm burden recovered.

Results

Host Animal Details and Clinical Observations

Two indigenous female goats (*Capra hircus*) from Baghpat district, Uttar Pradesh, were subjected to post-mortem examination in February 2026. The details of the animals examined and their clinical findings are summarised in Table 1.

Table 1: Details of Animals Examined and Clinical Findings

Parameter	Animal 1	Animal 2
Age	3 years	10 months
Sex	Female	Female
Breed	Indigenous (Capra hircus)	Indigenous (Capra hircus)

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Management	Free grazing on natural pastures; occasional anthelmintic treatment	Free grazing; irregular anthelmintic treatment
Clinical signs	No overt clinical signs; history of mild illness	Progressive weight loss, anorexia, dark-coloured diarrhoea, pale mucous membranes, severe weakness, unable to stand
Ante-mortem findings	Moderate body condition; pale conjunctiva	Severe emaciation, clinical anaemia, inability to stand unassisted
Post-mortem findings	Mild congestion of abomasal mucosa; presence of adult worms in abomasum	Thin pale carcass, serous atrophy of subcutaneous fat, hydrothorax, hydroperitoneum, petechial haemorrhages on abomasal mucosa, massive worm burden

Worm Recovery and Distribution
The gastrointestinal tracts of both animals were examined systematically, section by section. *Haemonchus* spp. was recovered exclusively from the abomasum. No nematodes of this genus were recovered from the rumen, reticulum, omasum, small intestine, caecum, or large intestine. The recovery and distribution of *Haemonchus* spp. is presented in Table 2.

Table 2: Recovery and Distribution of Haemonchus spp. from the Gastrointestinal Tract

Genus	Compartment	Animal 1 (Male)	Animal 1 (Female)	Animal 2 (Male)	Animal 2 (Female)
Haemonchus spp.	Abomasum	12	28	85	210

Haemonchus spp. were the predominant parasites recovered, contributing 72.8% of the total gastrointestinal nematode burden recovered across both hosts. Animal 2 harboured a markedly heavier parasite load (295 worms) than Animal 1 (40 worms), consistent with its severe clinical signs and advanced pathological changes.

Morphological Identification of Haemonchus spp.
Classification
Kingdom: Animalia
Phylum: Nematoda (roundworms)
Class: Chromadorea
Order: Rhabditida
Family: Trichostrongylidae
Genus: Haemonchus
Species: contortus

Female Haemonchus contortus—Morphological Features
Female *Haemonchus contortus* worms were substantially larger than males and were readily identifiable by their characteristic 'barber's pole' appearance, a defining gross morphological feature produced by the spirally twisted white ovaries and uteri coiled around the red blood-filled intestine. This helical twisting is unique to Haemonchus and provides an immediate macroscopic identification criterion even before microscopic examination.

Table 3: Morphological Features of Female Haemonchus contortus

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Feature	Description
Body length	24-30 mm (mean 27 mm)
Body width (maximum)	0.40-0.55 mm
Body colour	Bright red in fresh specimens (blood-filled intestine visible); white helical ovaries produce the barber's pole appearance
Anterior end	Slightly rounded; no prominent cephalic inflation; small cervical papilla-like spines present at approximately 0.5 mm from the anterior end
Buccal capsule	Small, poorly developed; contains a small chitinous lancet (dorsal tooth) used for blood-feeding
Oesophagus	Clavate (club-shaped); 0.90-1.10 mm in length
Cervical groove	Absent in Haemonchus; cuticle smooth at the cervical region
Synlophe (cuticular ridges)	Present; fine longitudinal cuticular ridges visible under high magnification, characteristic of the Trichostrongylidae
Intestine	Broad, straight, blood-filled; conspicuous bright red colouration
Reproductive organs	Didelphic; two ovaries and two uteri coiled spirally around the intestine - the 'barber's pole' effect; highly fecund (up to 5,000-10,000 eggs per day)
Vulvar position	4-6 mm from the posterior tip of the tail
Vulvar flap - Linguiform (H. contortus)	Large, prominent, thumb-like flap covering the vulval opening; appears as a broad, tongue-shaped projection; most common in H. contortus
Vulvar flap - Knobbed (H. placei)	Reduced, small, knob-like protuberance at the vulva; smaller than the linguiform variety; characteristic of H. placei
Vulva - Smooth (no flap)	Vulval opening present without any prominent flap; occurs in some specimens and in certain Haemonchus species
Tail tip	Pointed; 0.18-0.22 mm from anal opening to tail tip
Anus position	0.6-0.8 mm from the posterior end

Male *Haemonchus contortus*—Morphological Features

Male *Haemonchus contortus* worms were smaller than females. They were readily distinguished by the presence of a well-developed copulatory bursa at the posterior end, long brownish spicules with characteristic barbed tips, and an asymmetrically positioned dorsal lobe.

Table 4: Morphological Features of Male Haemonchus contortus

FEATURE	DESCRIPTION
BODY LENGTH	15-20 mm (mean 17 mm)
BODY WIDTH	0.28-0.40 mm
COLOUR	Bright red to pinkish in fresh specimens; uniform reddish colouration
ANTERIOR END	Similar to female; small buccal capsule with dorsal lancet; cervical papillae approximately 0.5 mm from anterior end
OESOPHAGUS	Clavate; 0.85-1.05 mm in length
COPULATORY BURSA	Well-developed; bilobed - two symmetrical lateral lobes and one dorsal lobe; the dorsal lobe is asymmetric, displaced to the left of the midline (towards the left lateral lobe)
DORSAL RAY	Characteristic 'Y-shaped' dorsal ray (dorsal bursal ray); bifurcates symmetrically at the tip; a key diagnostic feature
LATERAL RAYS	3 pairs of lateral rays (externo-lateral, medio-lateral, postero-lateral); well-developed
VENTRAL RAYS	2 pairs of ventro-ventral and latero-ventral rays
SPICULE LENGTH	0.47-0.51 mm (equal in length)
SPICULE MORPHOLOGY	Two long, equal, brownish-coloured spicules; shaft robust; distal ends bear barbed (hook-like) tips - H. contortus spicules show fused barbed tips, whereas H. placei shows split barbed tips (an important species-differentiating

	feature)
GUBERNACULUM	Present; small, wing-like accessory copulatory structure alongside spicules
TESTIS	Single; reflexed; occupies anterior portion of body
SPICULAR POUCH	Present; encloses the spicules when retracted

C. Anterior and Posterior End Features of Haemonchus spp.

Table 5: Anterior and Posterior End Characteristics of Haemonchus contortus

Feature	Anterior End	Posterior End
Shape	Rounded, slightly tapered; no cephalic inflation or prominent lips	Female: gently pointed tail (0.18-0.22 mm); Male: broad copulatory bursa
Buccal cavity	Small, poorly developed; contains a single chitinous dorsal lancet for blood-feeding; width ~0.05-0.08 mm	Not applicable
Oesophageal region	Clavate oesophagus, 0.90-1.10 mm; connects directly to intestine	Not applicable
Cervical papillae	Prominent pair of wedge-shaped cervical papilla-like spines at ~0.5 mm from anterior end (visible under 100x magnification)	Not applicable
Cuticle marking	Smooth; fine transverse striations; synlophe ridges faint at anterior end	Smooth; synlophe ridges more prominent toward mid-body
Copulatory structures (male)	Not applicable	Well-developed bilobed copulatory bursa; asymmetric dorsal lobe displaced to left; Y-shaped dorsal ray; two equal brownish spicules with barbed tips (0.47-0.51 mm)
Vulva and flap (female)	Not applicable	Vulva 4-6 mm from tail tip; covered by linguiform (thumb-like) flap in H. contortus or knobbed flap in H. placei; anus 0.6-0.8 mm from posterior end
Diagnostic value	Lancet in buccal capsule + cervical papillae = differentiates from Trichostrongylus (which lacks a buccal capsule)	Spicule tip morphology (fused vs split barb) differentiates H. contortus from H. placei; vulvar flap confirms female Haemonchus

Photomicrographs confirmed the buccal capsule with a dorsal lancet at the anterior end, the wedge-shaped cervical papilla-like spine, the anal pore in the female tail region, and the copulatory bursa at the posterior end of male worms. Higher magnification further revealed the thumb-like vulvar flap of female H. contortus (in contrast to the reduced, knob-like vulvar flap characteristic of H. placei) and the fused barbed tips of the male spicules (in contrast to the split barbed tips seen in H. placei & H. longistipes).

Discussion

Predominance of *Haemonchus contortus*

The present study demonstrated that *Haemonchus contortus* was the most prevalent and numerically dominant gastrointestinal nematode in the examined goats, accounting for 72.8% of the total worm burden. This finding is in broad agreement with numerous reports from India and other tropical and subtropical regions. Garg et al. (2003) reported H. contortus prevalence of 56.38% in goats from Uttar Pradesh, providing an early reference for its dominance in the region. Kumar et al. (2013) similarly reported *Haemonchus contortus* as the most dominant species in goats from Uttar Pradesh, a pattern

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closely mirrored by the current study. Sankar et al. (2020) documented a prevalence of 54.16% in goats of western Uttar Pradesh.

The dominance of H. contortus may be attributed to several biological factors: it's extremely high reproductive potential (a single female can produce 5,000-10,000 eggs per day), its short prepatent period of 18-21 days, its blood-feeding habit that results in rapid clinical deterioration of the host, and its remarkable adaptability to warm, humid agroclimatic conditions that characterise the Gangetic plain of Uttar Pradesh. These factors collectively ensure rapid pasture contamination and efficient transmission in extensive grazing systems, as documented by Kumar and Pachauri (2015) and Singh et al. (2019).

The clinical and post-mortem presentation of Animal 2 in the present study - severe anaemia, hypoproteinaemia, serous atrophy of fat, hydrothorax, and hydroperitoneum - is entirely consistent with the well-described pathogenesis of haemonchosis as outlined by Soulsby (1971), Pugh and Baird (2012), and Urquhart et al. (1996). The gross lesions of thickening and petechial haemorrhages of the abomasal mucosa at worm attachment sites, observed in both animals, correspond precisely to the pathological changes described by Abosse et al. (2022) and Gareh et al. (2021). A single H. contortus adult female can consume up to 0.05 ml of blood per day; in Animal 2, the estimated worm burden of over 295 Haemonchus adults would have resulted in a blood loss of approximately 14-15 ml per day, more than sufficient to produce the observed severe anaemia in a young, 10-month-old goat.

Morphological Identification of *Haemonchus contortus*

The morphological identification of *Haemonchus contortus* in the present study was based on a combination of macroscopic and microscopic characteristics that are well-established in classical parasitology. Macroscopically, the barber's pole appearance - produced by the spiral coiling of the white, egg-laden uteri and ovaries around the blood-filled, bright red intestine - provided an immediate and unambiguous identification of female worms. This characteristic appearance has been consistently described as pathognomonic for *Haemonchus* spp. in the literature (Soulsby, 1971; Urquhart et al., 1996; Pugh & Baird, 2012).

Microscopically, the identification was confirmed by the presence of a small buccal capsule containing a dorsal chitinous lancet, a pair of wedge-shaped cervical papillae approximately 0.5 mm from the anterior end, a clavate oesophagus, and the characteristic vulvar morphology in females. The linguiform (thumb-like) vulvar flap observed in the majority of female specimens in this study is consistent with *Haemonchus contortus*, while the knobbed flap reported in classical literature and illustrated by Onyenwe et al. (2005) is more characteristic of Haemonchus placei. In the present study, the predominant vulvar flap morphology observed was linguiform, supporting the identification as H. contortus rather than H. placei, in agreement with earlier reports from goats in India (Kumar et al., 2013; Kumar & Pachauri, 2015).

In male specimens, the well-developed bilobed copulatory bursa with an asymmetrically displaced dorsal lobe, the characteristic Y-shaped bifurcation of the dorsal bursal ray, and the long brownish spicules (0.47-0.51 mm) with fused barbed tips confirmed the identification as H. contortus. The spicule tip morphology - specifically the fused barbed tip in H. contortus as opposed to the split barbed tip in H. placei - is a key species-level diagnostic feature, as highlighted by Onyenwe et al. (2005) and Gareh et al. (2021). The body measurements obtained in the present study (males: 15-20 mm; females: 24-30 mm; spicule length: 0.47-0.51 mm) are well within the ranges reported in published descriptions by Soulsby (1971) and Urquhart et al. (1996), further corroborating the morphological identification.

Conclusion

The present morphological investigation of gastrointestinal nematode parasites in indigenous goats from Baghpat district, Uttar Pradesh, led to the recovery and characterisation of *Haemonchus* spp. (identified to species *Haemonchus contortus*) accounting for 72.8% of the total worm burden recovered from both animals. It was consistently recovered from the abomasum, consistent with its established ecology as an obligate abomasal blood-feeder. Its identification was confirmed by the characteristic barber's pole appearance in females, the presence of a small buccal capsule with a dorsal lancet, prominent wedge-shaped cervical papillae, a linguiform vulvar flap in females, and a well-developed copulatory bursa with a Y-shaped dorsal ray and long brownish spicules with fused barbed tips (0.47-0.51 mm) in males. All morphometric measurements obtained were consistent with published reference values for H. contortus. The clinical and post-mortem findings in Animal 2 - including severe anaemia, hypoproteinaemia, serous atrophy of fat, hydrothorax, hydroperitoneum, and petechial haemorrhages - represent a classical presentation of advanced haemonchosis, underscoring the severity of H. contortus infection in young goats and the potential for mortality in the absence of timely intervention. Morphological examination based on standard gross and microscopic criteria proved to be a reliable, practical, and economical method for genus- and species-level identification of *Haemonchus contortus*, confirming its continued utility in routine field parasitology surveys. The findings of the present study, while based on only two animals, corroborate a well-established body of literature indicating that H. contortus is the dominant and most pathogenic gastrointestinal nematode in goats from Uttar Pradesh and indeed from across India and the wider tropical and subtropical world.

Recommendations for Parasite Management

Based on the findings of the present study and the supporting literature, the following integrated parasite management strategies are recommended for goat production systems in Baghpat district and similar agroclimatic areas of Uttar Pradesh:

Targeted Selective Treatment (TST): Anthelmintic treatment should be administered on the basis of objective indicators such as the FAMACHA© scoring system for anaemia and body condition scoring, rather than routine whole-flock blanket treatments. This reduces the selection pressure for anthelmintic resistance, which has been increasingly documented in Haemonchus populations worldwide (Coles et al., 2006; Kumsa & Abebe, 2009).

Rotational Grazing: Planned rotational grazing with adequate spelling periods (minimum 4-6 weeks) to allow pasture self-cleaning and reduce larval contamination at dangerous levels. Avoidance of continuous grazing on heavily contaminated pastures is recommended (Waruiru et al., 2014).

Nutritional Support: Adequate nutrition, particularly supplementation of protein and minerals, should be ensured, especially for young animals and periparturient does, to support immune competence against nematode challenge. Coop and Holmes (1996) documented that undernutrition can significantly exacerbate nematode infection severity.

Regular Monitoring: Implementation of routine faecal egg count monitoring to quantify worm burdens and detect the emergence of anthelmintic resistance, particularly in farms where H. contortus is the dominant species.

Farmer Education: Awareness programmes for farmers regarding early recognition of clinical signs of haemonchosis and the importance of systematic parasite control to prevent the economic losses and mortality associated with advanced infections.

Future studies should aim to include larger sample sizes, molecular identification methods, and seasonal monitoring to provide a more comprehensive epidemiological picture of haemonchosis in goats from Uttar Pradesh.

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