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Morphology of Ecto and Endoparasites of *Gallus gallus domesticus* Reared in Backyard Poultry System in Lucknow Region, Uttar Pradesh, India

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Abstract: Chicken meat is renowned for numerous health benefits due to its high nutritional value, rich protein content, and low levels of cholesterol, calories, and fat. Additionally, chicken meat is more economical compared to other meats such as pork, beef, and lamb. Consequently, chicken meat is in high demand among the masses.But free-range or backyard-reared domesticated chickens get infected by parasites. Parasites are organisms that live and obtain nutrients from host organisms and often cause harm or disease. It affects the productivity of poultry farming. Parasitic infection leads to nutritional loss in meat and economic loss for poultry farmers. This study aimed to provide an overview of the morphology of external and internal parasites that affect domestic chickens. Understanding the morphology of parasites facilitates identification and diagnosis, which is crucial for developing prevention strategies to control them. In the present study, indigenous chickens were selected from different sites in Lucknow, UP, India. Ectoparsites were isolated from the outer bodies of chickens using commercial insecticide, and dislodged ectoparasites were preserved and stored. Then the chickens were slaughtered, dissected, and different organs, including the alimentary canal, were observed for endoparasitic infection. Endoparasites were isolated and preserved. Permanent slides of ectoparasites and endoparasites were prepared. Light microscopy and scanning electron microscopy were performed to observe morphological features for their identification. Ectoparasites like lice, ticks, fleas, mites and endoparasites like *Ascaridia sp., Heterakis sp., Raillietina sp.,* and *Eimeria sp.* were observed.

Keywords: Morphology, Ectoparsites, Endoparasites, Light Microscopy, Scanning Electron Microscopy, Lice, Ticks, Fleas, Mites, *Gallus gallus domesticus*

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Introduction

Poultry is currently one of India's fastest-growing agricultural sectors and is a highly vertically integrated industry with efficiency levels comparable to many Western countries. India is now the world's third-largest producer of eggs (Dubey *et al.,* 2021). The unorganized sector,

commonly known as backyard poultry, plays a crucial role in helping the poorest of the poor generate additional revenue and provide for their families' nutritional needs. There are an estimated 30 million farmers who raise chickens in their backyards. Backyard poultry holds a special place since they are managed by women, require minimal maintenance, assist in pest management, and produce manure that can be used as fertilizer. This can be helpful in improving the social status of farmers and their financial independence. The primary goal of raising livestock and poultry is to produce safe and wholesome animal protein for the world's expanding population (Das *et al.*, 2021).

Poultry meat and egg products are natural sources to meet the emerging demand of consumers due to their low caloric value and high nutrient content. The World Cancer Research Fund and others (Bingham, 2006) have suggested that the consumption of large amounts (more than 500 g/week) of red meat may be unhealthy, especially processed meat, but not chicken meat. Poultry meat is an important source of essential polyunsaturated fatty acids (PUFAs), especially omega-3 fatty acids, particularly from scavenging birds due to the varied diet they consume (Farrell, 2013).

One of the main obstacle to backyard poultry farming in India is parasitic infection. In backyard farming, chickens come into direct contact with intermediate hosts of parasites, increasing the chance of infection. These parasitic infections are a constant hindrance to poultry production, with helminth parasite infections being the most pervasive and harmful (Shang *et al.*, 2018; Ruff *et al*., 2022). Poultry production in India has been confronted with various intestinal parasitic diseases of economic significance. Among them, nematodes, trematodes, and cestodes are considered the most common and prevalent parasites in scavenging chickens, which are extremely important for their breeding and production performance (Poulsen *et al*., 2000).

Ectoparasite infestations are also a major threat to poultry farming (Maxie, 2015) due to their multifaceted capacity to harm. Infested birds usually exhibit restlessness, feather loss, skin irritation, and itching (Amoussou, 2007). This condition leads to a decrease in food consumption and therefore to decreased or arrested growth, as well as the transmission of diseases because ectoparasites are vectors of several infections (Clayton *et al*., 2008; Murillo *et al*., 2017). Ectoparasites directly or indirectly contribute to an increase in the mortality rate in poultry (Bettridge *et al*., 2014; Baxter *et al*., 2018). Among the ectoparasites of birds, lice, ticks, fleas, and scabies are the most common in both commercial poultry farms (intensive systems) and small-scale poultry farms raised under extensive systems where sanitary control is very limited (Maggi, 2014; Murillo *et al.*, 2017).

In the present study, therefore, the parasitic burdens of the desi chickens reared in backyard farming were studied, along with a detailed investigation of the isolated parasites using microscopic methods. Light microscopy and scanning electron microscopy were performed to identify the morphological features of the parasites. Parasitic infections lead to nutritional and economic losses, so it is important to study the types of parasites and their morphological features, which will aid in their identification and in the development of management strategies as also for further studies.

Materials and Methods

Study Area:

Lucknow 26°51′N 80°57′E is the capital of Uttar Pradesh in India. The study areas for collection of samples are shown in Figure 1. Mohanlalgunj, Talibagh, Lucknowcantt, Janakipuram, Indira Nagar, Ghalia, Gomtinagar, Alambagh, Ahamamu, Ghushwal, Kalan, Aliganj, Bara Imambara are the locations from where the birds were selected.

Sample collection:

The birds were purchased from local residents engaged in backyard poultry farming in the selected study area. Desi adult chickens aged 32

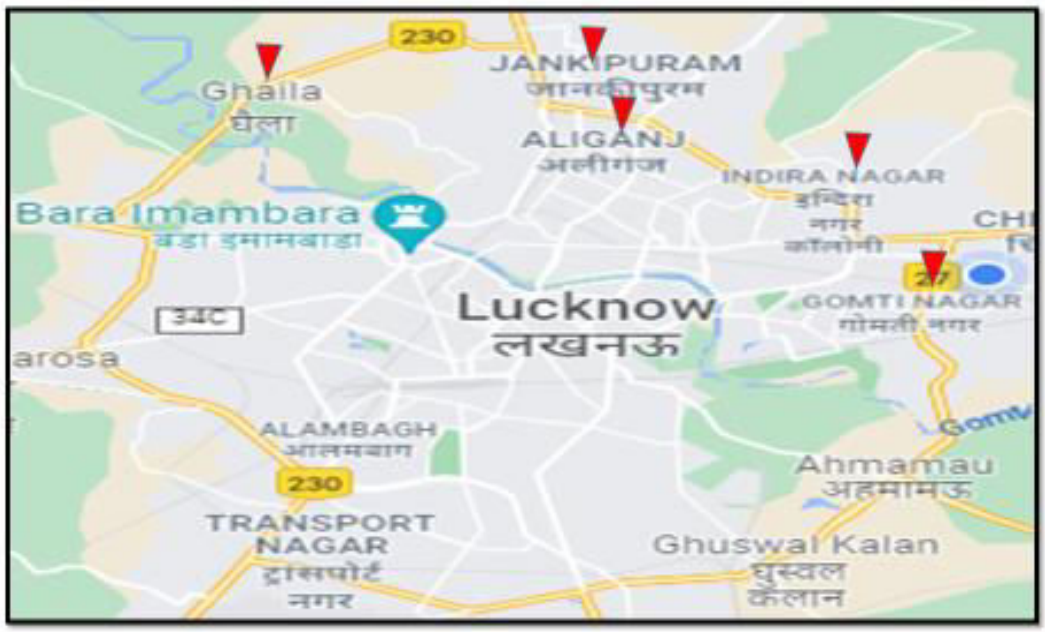

Fig.1: Different sites of Sample Collection

weeks were selected for the study. There were no gender restrictions on the selected chicks, and their ages were recorded at the owner's discretion. Randomly selected birds were inspected for infestation by ecto- and endoparasitic infections.

Collection and processing of ectoparasites from birds:

To collect ectoparasites, commercial insecticide Coopex (containing 250 g/kg pramethrin, diluted to 2 ml/500 ml) was sprayed for several seconds onto areas where parasites were visible to the naked eye. Then, the chicken's feathers were gently ruffled so that the parasites fell onto white paper. The dropped parasites were carefully picked up using forceps and stored in glass-topped bottles in 70% alcohol for further studies. For slide preparation, the ectoparasites were individually washed twice in distilled water and then heated in a 5% KOH solution until they became transparent. Afterwards, they were washed again in distilled water and gradually dehydrated in an alcohol solution with strengths of 30%, 50%, 70%, 90%, and absolute alcohol. Furthermore, the ectoparasites were treated with xylene. The specimen was transferred onto a glass slide, mounted in DPX, and observed under a light microscope.

Collection and processing of endoparasites from chicken:

After inspecting the birds for ectoparasites, they were taken to a local slaughterhouse, and following standard protocols and ethical standards, the birds were sacrificed in the butcher shop. To collect internal parasites, the bird's body was cut along the midsection, and various organs, including the digestive tract, were removed and placed in airtight containers. These containers were then transported in iceboxes to the Laboratory of Parasitology, Department of Zoology, Babasaheb Bhimrao Ambedkar University, Lucknow, India for further parasitological analysis. The gastrointestinal tracts were dissected following standard procedures and examined for parasitic infestation. Intestinal scrapings and floatation procedures were used to isolate the parasites (Soulsby, 1982; Wood *et al.*, 1982). The isolated parasites were rinsed in saline water, fixed in hot 70% alcohol, and stored in a glycerin alcohol solution with a ratio of 95:5, while

thicker parasites were preserved in lactophenol. Cestodes from the same host were similarly collected and stored in Carnoy's solution for further processing. Subsequently, they were dehydrated with an alcohol series of 30%, 50%, 70%, 90%, and 100%, and treated with Xylene to make them transparent. Permanent stained slides were prepared using Cable's methods. The processed specimens were then observed under a microscope, the morphology of the parasites was evaluated, and data were recorded.

Morphology and identification of parasites:

Light Microscopy:

The parasites on permanent slides were observed at several magnifications (10X, 40X, and 100X) using a light brilliant field microscope, and photographs were taken using an Evos XL image microscope. Identification of parasites was performed using descriptions and established taxonomic keys (Soulsby, 1982).

Scanning Electron Microscopy (*SEM*):

For SEM, isolated sample of parasite was taken and fixed in a 2.5% gluteraldehyde solution for 4 h at 4°C, then washed in a 0.1% phosphate buffer and kept for 15 min at 4°C. This process was repeated three times. After that, the sample was fixed in a 2.5% osmium tetraoxide solution for 2 h at 4 °C. Then, the sample was washed with a 0.1% PBS solution and kept for 15 min at 4 °C. The process was repeated three times. Then they were dehydrated with an acetone series of 30, 50, 70, 90, and 100% acetone.

Data Analysis:

Parasite prevalence was measured and reported using the formula given by Margolis *et al.* (1982).

Results and Discussion

Prevalence of ectoparasites in Gallus gallus domesticus:

The prevalence of ectoparasites in *Gallus gallus domesticus* (domestic chickens) was investigated, revealing significant infestation rates among the studied population. Table 1 illustrates the percentage prevalence of various ectoparasites including lice, fleas, mites, and ticks.

Lice infestation was observed in 207 out of 630 birds inspected, resulting in a prevalence of 32.9%. This indicates a substantial presence of lice among the domestic chicken population. Lice infestation in poultry can lead to various health issues such as skin irritation, decreased egg production, and decreased weight gain, potentially impacting both the welfare of the birds and the economic productivity of poultry farms.

Similar to lice, fleas were found to be prevalent among the examined birds, with 205 out of 630 birds (32.6%) being infested. Fleas are known to cause discomfort and stress to chickens, often resulting in scratching and feather damage. Additionally, they can serve as vectors for various diseases, posing risks to both poultry and humans.

Mites were detected in 175 out of 630 birds (27.9%), indicating a significant presence within the population. Mite infestation can lead to dermatitis, anemia, and reduced egg production in chickens. Moreover, some mites are known vectors for diseases such as avian pox and Newcastle disease, further highlighting the importance of controlling mite infestations in poultry (Moro *et al.*, 2005).

Among the ectoparasites examined, ticks exhibited the highest prevalence, with 223 out of 630 birds (36.5%) being infested. Ticks are of particular concern due to their role as vectors for various pathogens that can cause diseases such as Lyme disease, tick-borne encephalitis, and anaplasmosis. Tick infestation can lead to decreased productivity and increased mortality rates among poultry, thus necessitating effective control measures.

The high prevalence of ectoparasites observed among the domestic chicken population underscores the importance of implementing robust pest management strategies in poultry farms. Effective control measures, including regular monitoring, proper sanitation practices, and the use of appropriate acaricides and

Table 1: Percentage prevalence of ectoparasites in *Gallus gallus domesticus* reared in backyard poultry system

Ectoparasite	Number of infected birds/total number of birds inspected	Prevalence (in %)
Lice	207/630	32.9
Fleas	205/630	32.6
Mites	175/630	27.9
Tick	223/630	36.5

Table 2: Percentage prevalence of endoparasites in *Gallus gallus domesticus* reared in backyard poultry system.

Endoparasite species	Number of infected intestine/Total number of intestine checked	Prevalence (in %)
Ascaridia sp.	201/630	31.9
Raillietina sp.-1	113/630	17.9
Heterakis sp.	166/630	26.3
Eimeria sp.	122/630	19.3
Raillientia sp.-2	78/630	16.7
Catugnia sp.	103/630	20.1

insecticides, are essential for mitigating the impact of ectoparasites on poultry health and productivity. Furthermore, continued research into alternative and sustainable methods for ectoparasite control is warranted to ensure the welfare and sustainability of poultry production systems.

Prevalence of endoparasites in Gallus gallus domesticus:

The prevalence of endoparasites in *Gallus gallus domesticus* (domestic chickens) was investigated, revealing significant infestation rates among the studied population. Table 2 illustrates the percentage prevalence of various endoparasite species including *Ascaridia sp.*, *Raillietina sp.*, *Heterakis sp.*, *Eimeria sp.*, and *Raillientia sp.*

Ascaridia sp. was found to have the highest prevalence among the examined endoparasites, with 201 out of 630 intestines checked (31.9%) being infected. *Ascaridia* worms, commonly known as roundworms, are intestinal parasites that can cause health issues such as decreased growth rate, lower production of egg, and blockages of intestine in chickens. Control measures such as regular deworming and proper hygiene management are crucial for minimizing the impact of Ascaridia sp. infestation on poultry health and productivity.

Raillietina sp.-1 exhibited a prevalence of 17.9%, with 113 out of 630 intestines checked showing infestation. *Raillietina sp*. are tapeworms that inhabit the intestines of chickens and can lead to symptoms such as weight loss, diarrhea, and poor feed conversion efficiency. Effective management strategies, including deworming and preventing access to intermediate hosts such as insects, are essential for controlling *Raillietina sp.* infestation in poultry (Kaufmann, 2013).

Heterakis sp. was detected in 166 out of 630 intestines checked, resulting in a prevalence of 26.3%. These nematodes are known to transmit histomoniasis, a parasitic disease that can cause significant mortality in chickens (McDougald, 2005). Proper biosecurity measures, including sanitation and control of intermediate hosts such as earthworms, are critical for preventing and managing *Heterakis sp.* infestation in poultry flocks.

Eimeria sp. showed a prevalence of 19.3%, with 122 out of 630 intestines checked being infected. *Eimeria sp.* are protozoan parasites that cause coccidiosis, a common and economically significant disease in poultry characterized by diarrhea, decreased weight gain, and mortality. Prevention and control measures, including vaccination, medication, and improved management practices, are essential for minimizing the impact of *Eimeria sp.* infestation on poultry production (Lindsay, 2019).

Raillietina sp.-2 had a prevalence of 16.7%, with 78 out of 630 intestines checked showing infestation. *Raillietina sp.* are tapeworms that can infect the intestinal tract of chickens, leading to symptoms similar to those caused by other tapeworm species. Control measures targeting intermediate hosts and proper deworming protocols are necessary for managing *Raillietina sp.* infection in poultry.

Menacanthus sp., commonly known as the chicken body louse, is a species of ectoparasitic louse that infests domestic chickens (*Gallus gallus domesticus*). This species is elongated and cylindrical in shape, as depicted in the images. It was found that the louse is of average length 2.9 mm and straw in color, and the body is composed of ten segments, each contributing to its overall elongated appearance. In the dorsal view (Fig. 2), the three divisions of the body (head, thorax, and abdomen) can be seen. In ventral view (Fig. 3), three pairs of legs on the thorax segmented body are evident. The head is narrow at the anterior end and wide at the posterior end. Palps and antenna are conspicuous because of the narrow shape of the anterior part of the head (Figs. 4, 6, 7). Antennas, are sensory organs crucial for detecting environmental cues and potential hosts, Each segment of *Menacanthus sp*. is equipped with a pair of tracheal spiracles, as illustrated in the images. and a dense array of medium-sized setae can be observed on dorsal segments of the abdomen (Figs. 6, 7). Understanding its morphology and biological features is essential for effective management and control strategies in poultry production systems.

Ascaridia sp.: The body is creamy white, slightly translucent, and tapered at both ends. Females are longer than males. The average length of females was found to be 71 to 106 mm, while males are shorter and of average length 50–76 mm. Males have a curved posterior end with a pre-cloacal sucker (Figs. 8, 9, 11). Females are more robust, have an opening of the vulva in the center (about halfway between the front and rear ends) of the body, and an anus is observed at the rear end. Females' tail ends are generally blunt and straight, with a characteristic pointed tail (Figs. 8, 9, 12, 14). Eggs are oval in shape and can be seen in the uterus of female *Ascaridia sp.* (Figs. 15, 16).

It was observed in SEM that the body was covered with a hard protein layer called the cuticle. The cuticle is a protective layer. The cuticle is transversely striped along the entire body. The ventral edge appears to be defined by a continuous ridge along the body's longitudinal axis (Fig. 10).

The mouthparts of *Ascaridia sp.,* viewed in both front and lateral views (Figs. 11, 12), were characterized by wide bases tapering towards the apex. Lips serve as a mechanical gastrointestinal tract, featuring median and lateral lobes forming a cup shape together. Serrated ridges on the inner surface of the median lobe consist of cuticular processes aiding in feeding.

Raillietina sp. species commonly inhabit the small intestines of poultry birds, causing slowed growth, weakness, and gastrointestinal obstruct-tion, resulting in mucoid diarrhea and poor

performance. Granulomas can also occur in the damaged walls of diseased birds. *Raillientia cysticercidae* larvae develop in arthropod intermediate hosts.

Raillietina species are traditionally identified by the characteristics of the scolex (shape and dimension), the rostellum (armed with either a single or double row of hooks), suckers (armed or unarmed), the genital pore (the position and number) within each proglottid, and the number of eggs per egg capsule (Butboonchoo *et al.,* 2016).

Raillietina sp. had a dorso-ventrally flattened body that was divided into three parts: the scolex, the not-segmented region of the neck, and the segmented portion of the strobila. The average length was found to be 29 mm, and the average width was 1.5 mm. Ribbon-like, segmented portions are called proglottids (Fig. 17). The width of proglottids increases from the anterior to posterior ends of the body. The scolex head has a rostellum with four oval suckers. Mature proglottids were found at the posterior end of the body. The scolex has an apical, rounded rostellum equipped with 100-minute hooks grouped in a single row. *Raillietina sp*. is a hermophrodite and has ovaries and testes in proglottids (Fig. 17).

The high prevalence of endoparasites observed among the domestic chicken population highlights the importance of implementing effective parasite control measures in poultry production systems.

Menacanthus sp. lice are common ectoparasites in chickens. This genus includes four species that infect chickens: *Menacanthus stramineus*, *Menacanthus pallidulus, Menacanthus zumpti and Menacanthus cornutus*, known as the "Chicken Body Louse," one of the most prevalent lice discovered in backyard-reared and free-range-reared fowls worldwide.

Menacanthus sps. have straw-colored bodies and an average length of 3.5 mm. They move swiftly and disperse when light is exposed to them. *Menacanthus sp*. lives near the skin of birds and primarily feeds on feather detritus but occasionally on blood. These parasites are commonly found around the head, breast, beneath the wings, and vent. The female's eggs are usually glued in groups near the base of the feathers of chickens (Saif, 2009). Yeevstafieva (2015) observed straw-colored *Menacanthus sp.* ranging from 2.28 to 3.12 mm in length, with wider heads than length, a parabolic rounded forehead, an oblong oval abdomen, and a rounded ventral surface covered with fine hairs. Similar results were found in the present study, with lice averaging 2.9 mm in length, straw-colored, and consisting of ten segments contributing to their elongated appearance. Each segment of *Menacanthus sp.* is equipped with a pair of tracheal spiracles, and a dense array of medium-sized setae can be observed on the dorsal segments of the abdomen.

Ascaridia sp. is the biggest nematode in birds. The body is creamy white, semitransparent, and cylindrical in shape. The front end features a big mouth encircled by broad, three-trilobed lips. The margins of the lips have teeth-like denticles, with females ranging from 72 to 112 mm. as reported by Ashour (1994). In the present study, similar results were found: females are taller than males, and the average length found was 71 to 106 mm, with a semitransparent, creamy, and cylindrical body and three tri-lobed lips present on the anterior end of the body. Lalchhandama *et al.* (2009) have reported that the complete body is coated with a thick proteinaceous layer known as the cuticle. The cuticle is transversely striated down the body length and has weakly developed cuticular alae. Two prominent papillae are seen on the dorsal lip and one on each of the subventral lips. In the present study, it was also found that the body is covered with a proteinaceous covering cuticle, and papillae are found on the subventral lips of the body. These papillae are the nematode's sense organs. It was reported by Ackert (1994) that *A. galli* has strong sexual dimorphism. Females are more robust and much longer, with opening of vulva in the center (about halfway

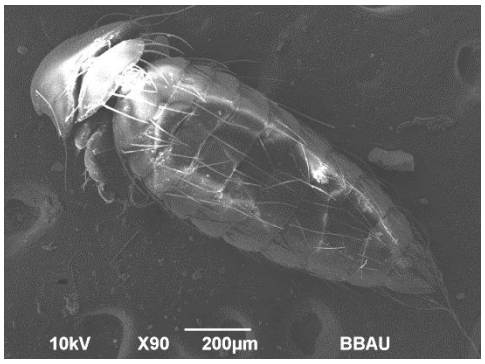

Fig. 2: Dorsal View of *Menacanthus sp.*

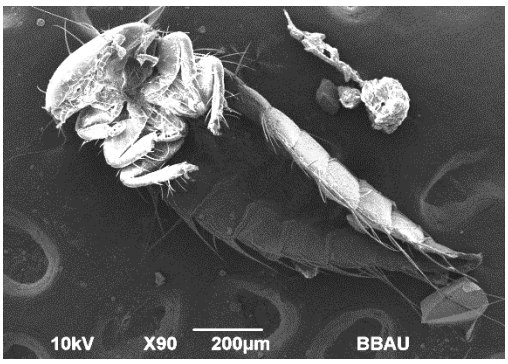

Fig 3: Ventral view of *Menacanthus sp*

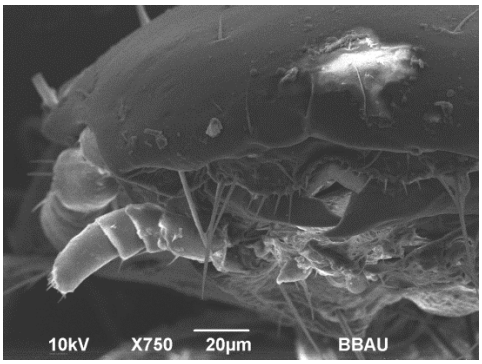

Fig. 4: Side view; antenna of *Menacanthus sp.*

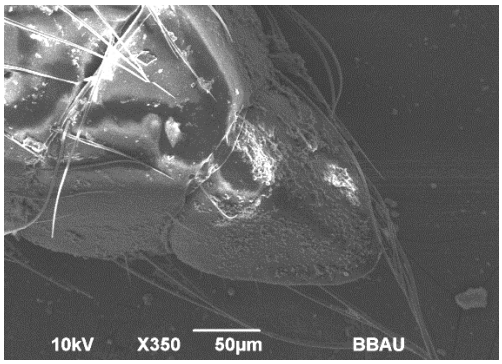

Fig. 5: Lower segment showing and mouth part of *Menacanthus sp.*

Fig. 6: Dorsal segments of abdomen

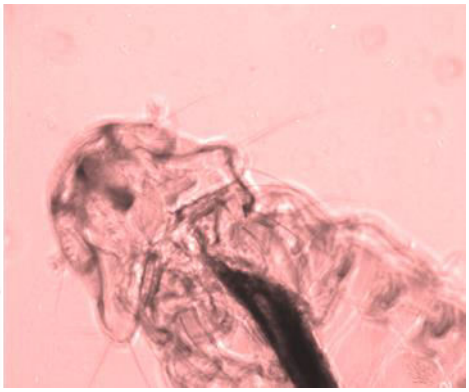

Fig. 7: Dorsal segments of abdomen

between the front and posterior ends) of the body and an anus is present at the rear end. Females' tail ends are generally blunt and straight. While males are shorter and smaller (50–76 mm in length), with a characteristic pointed and curled tail. Similar observations are noticed in the present study also, females are longer than males, having a vulva at the center portion of the body and anus at the lower portion of the posterior end of the body. The body length of males was 51–72 mm with a curved posterior end, while females had a straight posterior end

Fig. 8

Fig. 9

Figs 8, 9: The body of *Ascaridia sp.* is creamy white, slightly translucent, and tapered at both ends. Females are longer than males; males are curved and have a curved posterior end.

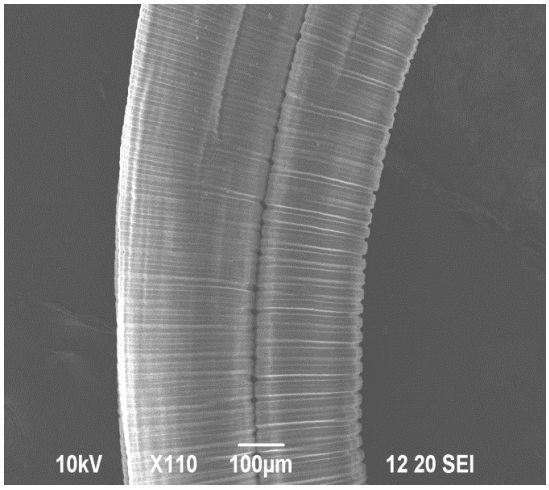

Fig. 10: A continuous ridge along the longitudinal axis of the body of *Ascaridia sp.* appears to mark the ventral margin.

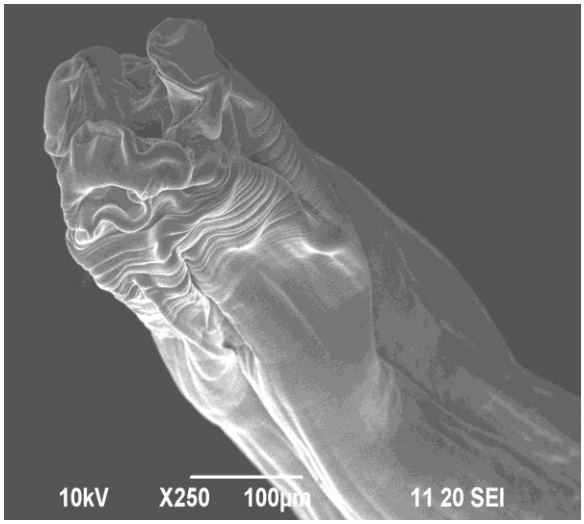

Fig. 11: Front view of Mouth of *Ascardia sp.*

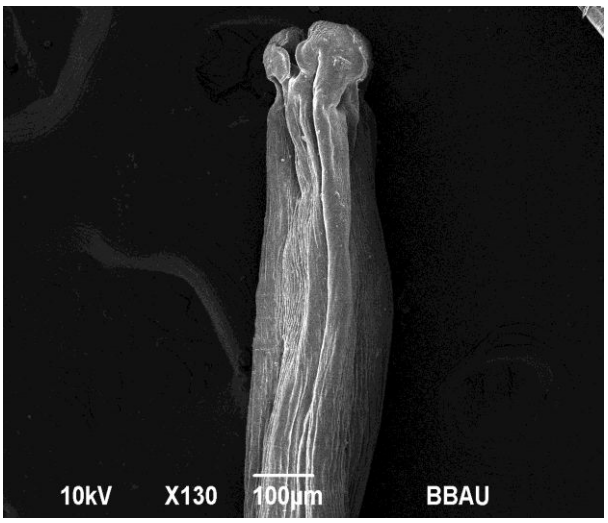

Fig. 12: Lateral view of *Ascardia sp*.: Each lip is wide at the base and gradually tapers towards the apex. These lips serve as a mechanical gastrointestinal tract. There is one median lobe in the center of each lip and two lateral lobes on each side. Form a cup shape together.

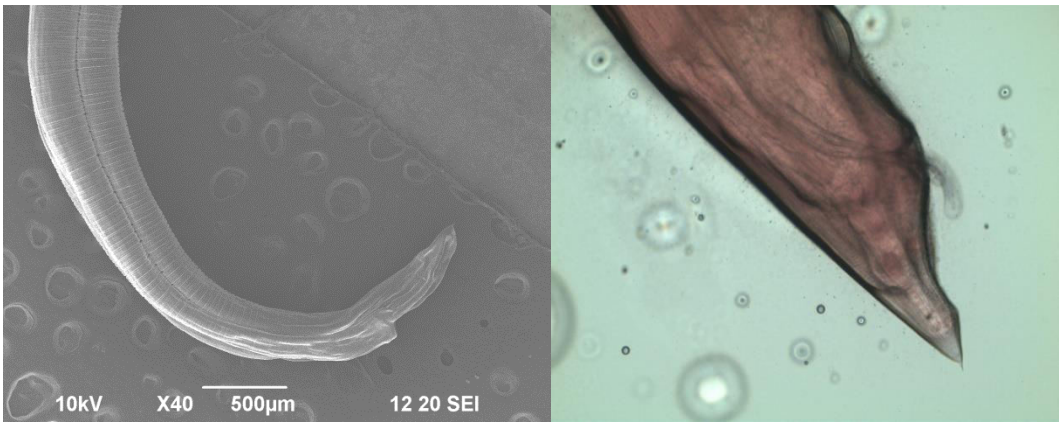

Fig. 13: Males of *Ascardia sp.* have ventrally folded tail and a pre-cloacal sucker. It was observed that male rear end was noticeably more elaborate and complex than female.

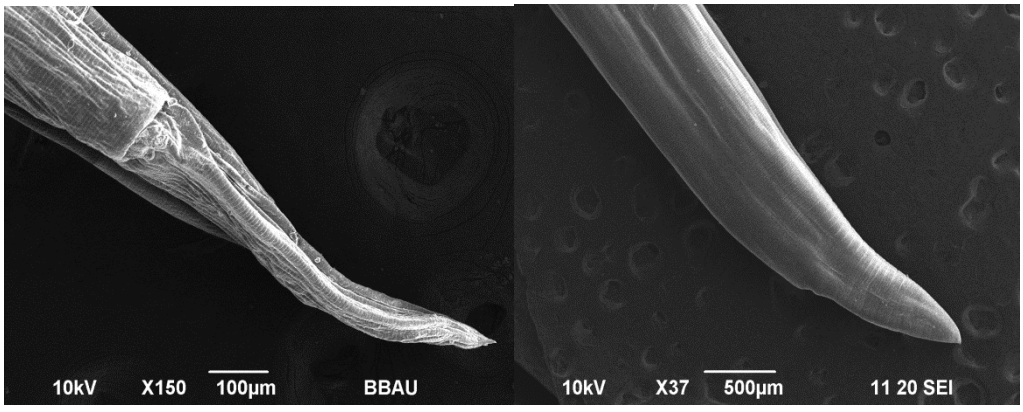

Fig. 14: Female of *Ascaridia sp.* posterior end straight and blunt in shape.

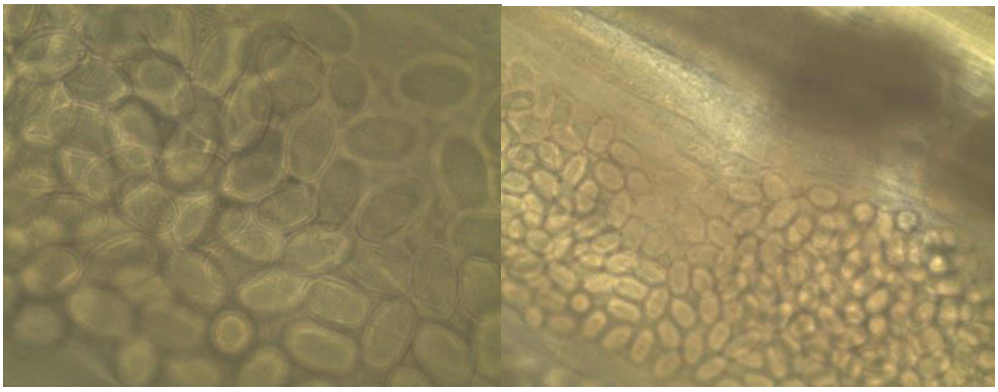

Fig. 15 Fig. 16

Figs. 15, 16: Light microscopy images of uterus of female of *Ascardia sp.* containing oval shaped egg and vulva region.

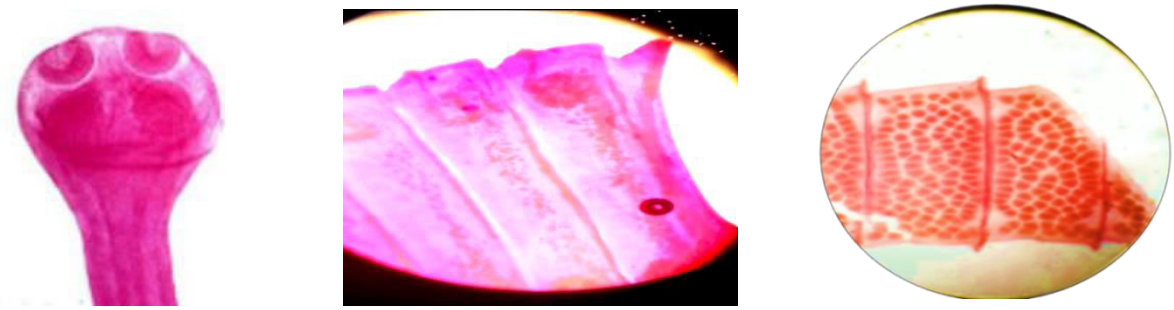

Fig. 17: *Raillietina sp.:* Scolex bears a rostellum surrounded by four ovoid suckers and small, hammer-shaped hooks. It has a more elongated neck compared to other species. Mature proglottids exhibit a unilateral opening of the genital pore, with many eggs per egg capsule.

with a blunt shape. *Ramdan et al.* (1994) have reported that ten pairs of caudal papillae are situated near the body's tail and are grouped linearly into well-defined groups such as pre-cloacal (three pairs), cloacal (one pair), pos-tcloacal (one pair), and sub-terminal (three pairs). Similar observations are also found in the present study whereby it was observed that the male posterior end is more elaborated and complex than female and with caudal papillae, pre-cloacal, cloacal and post-cloacal apertures. In a previous study, Ashour (1994) observed that each lip of *Ascardia sp.* is wide at the base and gradually tapers towards the apex. These lips serve as a mechanical gastrointestinal tract. There is one median lobe in the center of each lip and two lateral lobes on each side that form a cup shape together. Each lateral lip has a single serrated ridge on the inner surface of the median lobe, which consists of a row of small teeth, the well-known cuticular processes. In the current study, it was seen that the three tri-lobed lips serve as a mechanical gastrointestinal tract, featuring median and lateral lobes and forming a cup shape together. Serrated ridges on the inner surface of the median lobe consist of cuticular processes that aid in feeding.

Raillietina sp. is a long avian tapeworm, growing up to 30 cm long, 1-1.5 cm wide, pale in color, dorso-ventrally flattened, and completely covered with a tegument. The body is divided into three parts: the head area known as 'scolex', the

non-segmented 'neck', and the heavily segmented body known as the strobila. The strobila is made up of a sequence of body segments that are ribbon-like, known as proglottids, that gradually enlarge from the front to the back, as reported by Mu. (2009). Similar findings are found in the present study: *Raillietina sp*. was dorso-ventrally flattened, with an average body length of 29 cm and an average width of 1.5 cm. The body is segmented with ribbon-like structures called proglottids. The width of proglottids increases from the anterior to posterior ends of the body. The Scolex head has a rosetellum and four oval suckers. Mature proglotids at the posterior end of the body have ovaries and testes. The scolex has an apical, rounded rostellum equipped with 100 minute hooks grouped in a single row.

Conclusion

The investigation revealed heavy infestations of parasites such as *Menacanthus sp.*, ticks, mites, fleas *Ascaridia sp*., *Raillietina sp*., parasites are found in backyard reared desi chickens of Lucknow region. Morphological features were observed uaing standard protocol for their identification. High infestation of parasite observed in chickens indicates the poor management practices. Recommendations include implementing proper management practices to alleviate infestation burdens and promote the financial and health benefits of domestic chicken farming in the study area. Regular monitoring, proper hygiene management, deworming protocols, and biosecurity measures are essential for minimizing the impact of endoparasite infestations on poultry health and productivity. Furthermore, continued research into alternative control methods and vaccine development is warranted to improve the sustainability and welfare of poultry production systems.

This comprehensive study provides valuable insights into the morphology and characteristics of various parasites infesting domestic birds, contributing to the understanding and management of parasitic infestations in poultry farming.

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