Morphological characterization of nematodes of the genera *Capillaria*, *Acuaria*, *Amidostomum*, *Streptocara*, *Heterakis*, and *Ascaridia* isolated from intestine and gizzard of domestic birds from different regions of the temperate Kashmir valley

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Abstract During a random survey of parasitisation of poultry birds of Kashmir, conducted for 3 years more than 300 poultry birds were randomly collected from different parts of the Kashmir valley and were examined for the helminth parasites. The most dominant group of parasites which was parasitizing the poultry birds was found to be the Cestode, whose prevalence in the infected birds was 76.9 %. Nematodes were found to be the second dominant group of parasites after cestodes with the prevalence of 70 %. Among the different species of nematodes *Heterakis gallinae* were found infecting almost all the birds autopsied. The highest intensity of *H. gallinae* might be because of the fact that it requires cockroaches, beetles and grasshoppers as intermediate hosts in addition of having a direct life cycle. Nematodes which were recovered from the intestine and gizzard of the birds belong to the genera *Capillaria*, *Acuaria*, *Amidostomum*, *Streptocara*, *Heterakis*, and *Ascaridia*.

Keywords *Gallus domesticus* · Nematodes · *Capillaria* · *Acuaria* · *Amidostomum* · *Streptocara* · *Heterakis* · *Ascaridia*

Introduction

The organic poultry has access to open air and the ground, from which they are liable to pick up the infections. Some

of these infections have not been the major problems in the poultry industry under the strictly controlled, continuously housed conditions of intensive rearing. 75 % of the estimated 14.718 billion poultry population is found in developing countries, where they are commonly kept as free range chickens (Mukaratirwa and Khumalo 2010). Large number of parasites are known to inhibit the growth of the poultry birds, their egg production, quality of its meat and sometimes the parasites cause the premature death of the host (Soulsby 1982). Parasitic infections are the major factors responsible for economic losses through reduction in productivity and increased mortality. Parasites cause birds to be unthrifty which may include the loss of weight (Mamashly et al. 2011). Although many studies have reported the incidence of helminth parasites in free-range or backyard chickens in different parts of the country (Eshetu et al. 2001; Ashenafi and Eshetu 2004), but researchers and other stakeholders did not give attention to the effect of parasites on commercial poultry farms. Furthermore, climatic conditions (temperature and humidity) may alter the population dynamics of the parasites, resulting in dramatic changes in the prevalence and intensity of helminth infections (Magwisha et al. 2002). Moreover multiple genetic factors seem to control disease resistance and that sex is not a determinant for helminth infection but nutritional status of the host and availability of infective parasitic stages (Biu and Lillian 2004; Biu et al. 2012).

Materials and methods

The domestic birds, *Gallus gallus domesticus*, from the free range poultry randomly collected from different regions of the Kashmir valley were brought live to the lab and

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autopsied. The nematodes recovered were washed thoroughly and were fixed in hot 70 % alcohol. After fixing the parasites were preserved in glycerine alcohol. For quick clearing of nematodes, Lactophenol was used and for mounting Kaiser's Glycerine jelly was used. The nematodes isolated were studied and belonged to different genera. The *Description* of the isolated nematodes is given in the following pages.

Results

Capillaria anatis (Schrunk, 1790) Travssos (1915)

Eighteen domestic fowls and four domestic ducks were collected from different places of the valley and autopsied in the Parasitology Research Laboratory. Out of 18 hosts only 6 were found infected with the cestodes and nematodes. From the four domestic ducks only two were infected. The number of nematodes recovered was twenty and eight respectively from the intestine and the caecum. The percentage of infection was 33.3 and 50 %. These nematodes on close examination were found to belong to *Capillaria anatis* (Schrunk 1790; Travssos 1915). Description (Fig. 1).

Male

Body elongated, thread like, 10.5–12.9 mm in length and 0.06–0.09 mm in diameter. Esophageal length was 4.23–6.25 mm. Length of spicule varies from 1.0 to 1.02 mm and its width varies from 0.014 to 0.025 mm. The spicule has three longitudinal thickenings and is only slightly expanded proximally, 0.015–0.021 mm. Distally the spicule ends in a rounded tip which has internal thickenings. The spicular sheath bears spines which are directed towards the anterior end of the worm. Spicular sheath measures about 0.13–0.7 mm. At the caudal end of the body there are two lateral lobes. The cloacal opening is terminal.

Female

Body length in female nematode is 14.3–18.5 mm and 0.051–0.14 mm in diameter. Length of esophagus is 4.12–6 mm. The vulva is situated at about one-third of the body length 4.34–4.56 mm from the anterior end; it does not bear an appendage, the vagina is long, 0.025–0.65 mm. At the caudal end the body ends bluntly. The anus is subterminal. Eggs measure about 0.051–0.065 mm in length and 0.025–0.03 mm in width. Eggs with characteristic thick, rugose outer shell layer. The inner layer curls at the poles and forms a wide collar.

Remarks

When compared with the known species of the genus *Capillaria* Zeder, 1800 the present specimens agree with all the characters of *Capillaria anatis* Travssos, 1915. The differentiating characters of the present specimens are: the presence of rugose outer shell layer of eggs and the spines of the spicular sheath which are directed towards the anterior end as in *C. anatis*. However, there are variations in the size ratio of various organs. Since these variations are of minor significance, hence the present form is assigned to *C. anatis* Travssos, 1915. The species is recorded for the first time from this region.

Capillaria obsignata Madsen, 1945

Fifteen nematodes were recovered from the 6 domestic fowls out of 24 collected from different localities of Kashmir. These were identified and assigned to *Capillaria obsignata* Madsen, 1945. The percentage of infection was 25 %.

Description

Thread like worms, whitish in colour in colour. Cuticle transversely striated (Fig. 2).

Male

Length 8.25–14.2 mm and 0.035–0.04 mm in breadth. Oesophagus measures 5.31–9.98 mm in length and 0.03–0.033 mm in width. Spicule measures 0.98–1.05 mm in length 0.012 mm in width at the proximal end and is expanded into an open funnel 0.012–0.020 mm wide which bends towards the ventral surface. Distally the spicule is blunt with rounded tip. A rounded membrane supported by two dorso-lateral papillae forms a pseudobursa, 0.03–0.035 mm in length and 0.04 mm wide. Cloacal opening terminal. Spicular sheath transversely striated and is without spines.

Female

It measures 13–14.2 mm in length and 0.048–0.09 mm. Esophagus measures 4.54–98.69 mm. Vulva is situated at about one half of the body length from the anterior end, 5.27–7.4 mm, with slightly swollen borders. Vagina short and muscular. Anus subterminal. Eggs oval in outline and measure 0.04–0.06 mm in length and 0.028–0.03 mm in diameter. Inner egg shell layer forms a small collar at the poles.

Acuaria hamulosa (Diesing, 1845) Skrjabin et al. (1965)

Out of 108 domestic fowls collected from different localities only 36 were found infected. 8 nematodes were also

Fig. 1 *Capillaria anatis* (Schrunk, 1790) Travssos (1915) showing (1) anterior end of male, (2) Posterior end of male, (3) posterior end of female, (4) proximal end spicule, (5) vulval region, (6) Eggs

recovered underneath the horny lining of gizzard. The head of the worms was found embedded beneath the horny lining of gizzard. These were described herein as *Acuaria*

hamulosa (Diesing, 1845) Skrjabin et al. (1965). The percentage of the infection was 33.3 %. Description (Fig. 3a, b)

Fig. 2 *Capillaria obsignata* Madsen, 1945 showing (1) anterior end of male, (2) posterior end of male (ventral view), (3) posterior end of male (lateral view), (4) proximal end of spicule, (5) vulval region, (6) posterior end of female, (7) eggs

Lips triangular bearing two conical papillae. Cords arranged in double rows and in the form of plaques, extending from the anterior end up to the level of anterior end of larger spicule in male and up to the region of vulva in case of female. Spicules unequal.

Male

These measure 10–10.65 mm in length and 0.29–0.33 mm in breadth. Cuticular striations lie 3 μ apart, cords measure 7.56–7.98 mm in length. Pharynx measures

Fig. 3 a *Acuaria hamulosa* (Diesing, 1851) Skrjabin et al. (1965) showing (1) Anterior end of male, (2) Posterior end of male showing spicules and papillae, (3) proximal end of spicule, (4) distal end of spicule. **b** *Acuaria hamulosa* (Diesing, 1851) Skrjabin et al. (1965) showing (5) vulval region, (6) eggs and (7) posterior end female

0.22–0.27 mm in length. Oesophagus divided into anterior muscular part and posterior glandular part. Muscular part of oesophagus measure 0.52–0.55 mm in length. Nerve ring lies at a distance of 0.22–0.24 mm from the anterior end. Caudal end coiled and provided with caudal alae. Tail

is 0.54–0.58 mm long. Spicules unequal. Larger spicule is 1.07–1.09 mm long with the proximal end about 0.035–0.037 mm in diameter. Smaller spicule short and broad about 0.28–0.29 mm in length. Caudal papillae 10 pairs, 3 pairs preanal, one pair adanal and 6 pairs postanal.

Fig. 3 continued

Female

These measure 18.5–23.9 mm in length and 0.35–0.55 mm in width. Cuticular striations well marked and are 4–7 μ apart. Cordons are 10.95–15.75 mm in length. Pharynx measures 0.29–0.35 mm in length. Muscular and glandular portions of the oesophagus measures 0.85–1.2 mm and 2.22–3.9 mm in length respectively. Vulva is situated at a distance of 9.15–10.35 mm. Tail is pointed and measures

0.57–0.62 mm in length. Eggs are oval and measures 45–50 μ in length and 28–30 μ in width.

Remarks

While comparing with the known species of the *Acuaria* the present form agrees in all the important morphological characters of *Acuaria hamulosa* as regards the body size, length of pharynx, spicular shape and size and position of

vulva, and the number of caudal papillae with minor variations in size ratios.

Amidostomum anseris Zeder, 1800

The domestic geese (*Anser domesticus*) numbering six were slaughtered at different places and were autopsied for the helminth infection. Only three birds harboured infection. Female worms were recovered from the intestine, and not a single male worm was found. The percentage of infection was 50 %.

Description

Description is based on females, since only female nematodes were recovered from the domestic geese (Fig. 4). The females measure 20–21.15 mm in length and 0.28–0.31 mm in width. Cuticle is transversely striated. Buccal capsule sub globular furnished with sharp tooth in its depth. The vulva is situated at a distance of 2.75–3.2 mm from the tip of the tail. The distance of anus from the tail is about 0.31–0.35 mm. Length of the tail is 0.37–0.39 mm. Egg size 0.0850–0.090 × 0.045–0.05 mm.

Remarks

The *Description* is based only on the females which showed all the characters of *Amidostomum anseris* Zeder, 1800 to which these were assigned.

Streptocara pectinifera Neumann, 1900

The domestic ducks numbering four were scanned for the helminth infection and among the four only one was infected. A single female nematode was recovered underneath the horny covering of the gizzard. This on close examination turned out to be *Streptocara pectinifera* Neumann, 1900. The percentage of the infection was 25 %.

Description

The *description* is based on a single female nematode, which was recovered from domestic duck. Body long and filiform. Cuticle bears transverse striations. Body attenuated anteriorly in the vestibular region, the rest of the body is more or less uniform in thickness. Mouth consists of triangular lips, each bearing a cuticular tooth at mid summit. Head armed with a collerette in the form of equapleties whose free edge is fringed with posteriorly directed spines. Two cervical papillae are crescentic in shape, each having posteriorly directed cusps which are five in number and towards the free concave end. Cervical papillae lie at a distance of 40 µ from the anterior end. The worm measures

8 mm in length and 0.2 mm in breadth. Vulva situated little behind the middle of the body at a distance of 4.8 mm from the anterior end. Tail end blunt and rounded. Anus sub-terminal. Eggs oval and measure 0.035–0.045 mm in length and 0.25–0.28 mm in width (Fig. 5).

Remarks

Since the description is based on a single female nematode, which shows similarity in its morphological features to *Streptocara pectinifera* to which it was assigned.

Streptocara indica Fotedar and Chishti, 1974

The domestic fowls, numbering 18 were autopsied and 9 were found to be infected. Four nematodes, two males and two females, were recovered from under the lining of gizzard, besides the other helminths. These on close examination were found belong to *Streptocara indica* Fotedar and Chishti, 1974. *Description* (Fig. 6).

Male

The worms are long and filiform, measuring 3.16–4.16 mm in length with a maximum breadth of 0.08–0.12 mm. The cuticle bears transverse striations. The body is attenuated anteriorly in the vestibular region, the rest of the body more or less uniform in thickness. The mouth consists of two triangular lips, each bearing a cuticular tooth at the mid summit and two submedian papillae towards both dorsal and ventral corners. The head is armed with a collerette in the form of equaplettes whose free edge is fringed with posteriorly directed spines. The two cervical papillae are crescentic in shape, each having posteriorly directed cusps which are five in number. The cervical papillae lie at a distance of 20–25 µ from the anterior end. The vestibule is short and esophagus is long measuring 0.65–0.72 mm. The caudal end of the male is spirally coiled. The tail is 0.04–0.054 mm in length. Twelve pairs of caudal papillae are found in males of which five pairs are pre-anal, seven pairs are post-anal. Spicules are unequal, the larger spicule is slender with a slightly broader proximal end, measures 0.30–0.32 mm in length. The smaller spicule is broader than long, measuring 0.065–0.072 mm in length.

Female

Females measure 8.67–10.5 mm in length and 0.25–0.28 mm in maximum breadth. The esophagus is 1.82–2.52 mm in length. Vulva is located in posterior half of the body 5.5–6.5 mm from the anterior extremity. Tail end is blunt and rounded. Anus is subterminal. The eggs are embryonated and measure 0.032–0.38 mm × 0.018–0.02 mm.

Fig. 4 *Amidostomum anseris* Zeder, 1800 showing (1) anterior end of female, (2) anterior end enlarged view. (3) Vulval region, and (4) posterior end of female

Fig. 5 *Streptocara pectinifera* Neumann, 1909 showing (1) anterior end of female, (2) vulval region, (3) posterior end female, (4) eggs

Fig. 6 *Streptocara indica* Fotedar and Chishti, 1974 showing (1) anterior end of female, (2) vulval region, and (3) posterior end female

Remarks

The present specimens show certain morphological peculiarities which are in conformity with the already

known species of the genus *Streptocara indica* (Fotedar and Chishti, 1974). However, there are certain minor variations in size ratio of various structures, which are of minor significance.

Table 1 Prevalence of nematodes in domestic birds of Kashmir valley

Host	Parasite	Number of hosts examined	Number of hosts infected	Prevalence
<i>Gallus gallus domesticus</i>	<i>Heterakis gallinae</i>	110	77	70
	<i>Acuaria hamulosa</i>	108	36	33.3
	<i>Ascaridia galli</i>	90	30	33.3
	<i>Ascaridia compar</i>	20	7	35
	<i>Capillaria obsignata</i>	24	6	25
<i>Anas platyrhynchos domesticus</i>	<i>Capillaria anatis</i>	4	2	50
	<i>Streptocara pectinifera</i>	4	1	25
<i>Anser domesticus</i>	<i>Amidostomum anseris</i>	6	3	50

Heterakis gallinae Gmelin, 1790

The domestic fowls numbering 110, were scanned for helminth infections after collecting from different parts of the Kashmir. Total worm burden reported was 224 and among these the number of nematodes was 188. The percentage of infection of *Heterakis gallinae* infecting poultry birds is 70 % (see Table 1). These nematodes were most commonly encountered and showed higher intensity as compared to *Ascaridia galli*. Description (Fig. 7).

Male

Males measure 4.75–6.7 mm in length and 0.27–0.35 mm in diameter. The cuticular striations are extremely fine. The esophagus along with the bulb measures 0.75–1.1 mm.

The esophageal bulb is 0.19–0.22 mm in diameter. The caudal alae of the male are well developed about 0.05–0.055 mm in diameter. The tail is about 0.2–0.5 mm long and tapers beyond the alae to a fine filament. The sucker is situated at a distance of 0.09–0.11 mm from the cloacal aperture. There are twelve pairs of caudal papillae of which five pairs have peduncles and project into the alae. The two pairs at the sides of the sucker may be called the para sucktorial papillae, the group surrounding the cloacal aperture the paracloacal papillae, and the group near the posterior end are called caudal papillae. The spicules are unequal. The right spicule being the longer and 1.54–2.1 mm long. The left spicule is 0.38–0.65 mm long. The proximal end of the spicule is alate 0.03 mm in diameter. The distal end is pointed.

Female

Body length 7–9.78 mm and 0.3–0.4 mm in width. The vulva is situated slightly behind the middle body at a distance of 3.55–4.65 mm from the tip of the tail. Tail is tapering and sharply pointed and measures about 0.8–0.95 mm from the posterior end.

Remarks

The present form agrees to the characters of *Heterakis gallinae* Dujardin, 1845, as regards the number of caudal papillae and their shape, arrangement and number of spicules, the size of spicules. However, there are variations in the size ratio of various organs. Since these variations are intraspecific, hence the present specimens are assigned to *H. gallinae* Dujardin, 1845.

Ascaridia galli Freeborn, 1923

Out of the 90 domestic fowls slaughtered at different sites were examined for the endoparasites. The number of birds infected was 30. The highest number of *Ascaridia galli* recovered was 31. The prevalence of infection was 33.3 %. Description (Fig. 8).

Worms medium to large sized, cylindrical and creamy white in colour. Mouth surrounded by three lips. The dorsal lip somewhat broader than the subventral lips and bears a pair of large papilla. A pair of feebly developed and extremely narrow lateral alae present. Esophagus without a posterior bulb. Well developed cuticular striations on the body are present.

Male

Males smaller and more slender, measuring 43–45 mm in length and 0.43–1.5 mm in maximum breadth. Esophagus measure 2.12–2.35 mm in length. Preanal sucker oval in shape with a chitinous rim. Its size varies from 0.2 to 0.27 mm in length and 0.15–0.17 mm in diameter. It lies at a distance of 0.25–0.55 mm in front of cloaca. Distance of cloaca from the tip of tail is 0.6–0.75 mm. Ten pairs of caudal papillae are in the following four groups (i) preanal three pairs (ii) adanal one pair (iii) postanal three pairs (iv) subterminal three pairs. Spicules similar, equal, measuring 1.4–1.65 mm in length. Proximal end of spicules are expanded and measure 0.075–0.09 mm in breadth.

Fig. 7 *Heterakis gallinae* Gmelin, 1790 showing (1) anterior end of male, (2) posterior end of male showing spicules and anal sucker, (3) vulval region, (4) eggs and (5) posterior end of female

Female

Females measure 30–62 mm in length and 0.3–0.45 mm in width at the anterior end and 1–1.55 mm at the level of vulva. Esophagus measures 1.5–3 mm in length. Vulva is situated a little posterior to the middle of the body.

Distance of vulva from the anterior end varies from 18 to 33 mm. Distance of anus from the tip of tail varies from 0.55 to 0.65 mm. Tail is straight with a caudal spine and measures 0.65–0.95 mm in length. Eggs large, oval and measures 0.055–0.065 mm in length and 0.04–0.05 mm in width.

Fig. 8 *Ascaridia galli*
Freeborn, 1923 showing (1)
anterior end of male, (2)
posterior end of male, (3) eggs,
(4) posterior end of female, (5)
proximal end of spicule

Ascaridia compar Travassos, 1849

The domestic fowls numbering twenty collected from Chattabal and Qamarwari were autopsied for any parasitic infection. Out of 20 only 7 birds were found to harbour infection. Nematodes of larger size were recovered and the prevalence of infection was 35 %. On close examination,

they were assigned to *Ascaridia compar* Travassos, 1849. Description (Fig. 9a, b).

Large worms with stout body, white in colour and tapering posteriorly. Oral aperture encircled by three rounded lips. Lateral alae absent. Oesophagus somewhat clavate, widening posteriorly, but not forming a true bulb. Tail conically pointed.

Fig. 9 a *Ascaridia compar* Travassos, 1849 showing (1) anterior end of male, (2) anterior end enlarged view, (3) posterior end of male showing spicules and papillae.
b *Ascaridia compar* Travassos, 1849 showing (4) vulval region, (5) posterior end of female, (6) eggs

Fig. 9 continued

Male

Body measures 48–51 mm in length and 0.48–0.69 mm in width. Oesophagus 2.9–3.5 mm long. Lateral caudal alae

well developed and supported by nine pairs of papillae, of which two pairs are preanal, two adanal, and five are postanal. Preanal sucker rounded or oval, measures 0.19–0.25 mm in length 0.16–0.2 mm in diameter. Spicules equal 1.9 mm in length. Width of spicules gradually increases from distal to proximal end. Proximal end is 0.08 mm in diameter. Distance of cloaca from the tip of tail is 0.66–0.69 mm. Length of tail varies from 0.32 to 0.4 mm.

Female

Body length 19–49 mm in length and 0.5–1.0 mm width. Vulva lies near midbody, 10.2–23.8 mm from the anterior end. Vagina short, branches into two uteri. Anus lies at a distance of 0.35–0.4 mm from the tip of tail. Length of tail 0.39–1.5 mm. Eggs oval with thick shell, 0.055–0.059 mm in length and 0.04–0.042 mm in width.

Remarks

Morphological peculiarities of the present specimens are in conformity with that of *Ascaridia compar* as regards the shape and size of body, number of caudal papillae, absence of lateral alae, presence of caudal alae, position of vulva and shape and size of spicules. However, the present form differs from the type specimen in the size of eggs.

Discussion

During the present study more than three hundred poultry birds were investigated for helminth infestations. Groups of helminth parasites viz cestodes, trematodes, nematodes and acanthocephala represented by more than 25 species were found, infecting poultry birds. The high incidence of helminth infections in free range poultry has also been reported by a number of workers (Pandit et al. 1991; Marco et al. 2008; Yacob et al. 2009; Mukaratirwa and Khumalo 2010; Khayatnoui et al. 2011). However, among these groups Cestodes were dominant as per the present study, which is in conformity with the results given by Ramulu et al. (1985), Eslami et al. (2009), and Khayatnoui et al. (2011) and were followed by Nematodes. Among nematodes *Heterakis gallinae* is a very common parasite of domestic fowl which was reported in almost all the fowls collected randomly from different localities of Kashmir. Together with this nematode *Ascaridia galli*, *A. compar*, *Capillaria obsignata*, *Capillaria anatis*, *Streptocara indica*, *Acuaria hamulosa* and *Acuaria* sp. have also been recovered. From domestic duck and *Anser domesticus*,

Streptocara pectinifera, *Capillaria anatis*, *Acuaria* sp. and *Amidostomum anseris* have been reported in this study.

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Conflict of interest None.

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