REVIEW ARTICLE
JIVA 22 (3) December 2024
https://doi.org/10.55296/JIVA/22.3.2024.53-64

Received on 10.10.2024
Accepted on 15.11.2024

PERSPECTIVE ON ANT AND BEETLE INTERMEDIATE HOSTS OF POULTRY TAPEWORMS IN INDIA AND THEIR CONTROL TO BOOST POULTRY PRODUCTION

Muraleedharan Kandayath

Professor and University Head of Veterinary Parasitology (Retired),
University of Agricultural Sciences, Bangalore-560065
B 2,Yasoram Tejus Apartments, High School Road, Vennala, Kochi- 682028

Corresponding author : kandayath@rediffmail.com

ABSTRACT

The important tapeworms (cestodes) of poultry of India are *Choanotaenia infundibulum*, *Raillietina cesticillus*, *R tetragona*, *R. echinobothrida* and *Cotugnia digonopora*. Altogether nine species of beetles and sixteen species of ants served as intermediate hosts which harboured cysticercoids of these tapeworms. The frequency of incidence of cysticercoids, micrometry of cysticercoids, minimum time for development of tapeworms in final hosts and periodicity of segment discharge are discussed. Significant importance has to be given for the selection of site and its location to construct poultry farms. The dumping yards of manure and vegetable wastes are to be located away. Filthy surroundings have to be avoided as they attract beetles to breed and multiply. Search may be made for the presence of ant-hills or nests nearby to poultry yards. Control measures against the intermediate hosts likely to enter poultry houses and their vicinities have to be implemented considering the eco-friendly surroundings safer for chicks Borax powder, diatomaceous earth (silica or silicon dioxide) or multi-control insecticide powders would be kept near ant-moving areas. Spreading borax powder around ant-hills or pouring boiling water on them would destroy ant-colony and mounds. Spraying insecticides on breeding places of beetles would check their multiplication.

Keywords: Poultry tapeworms, Intermediate hosts, Beetles, Ants, Control measures

INTRODUCTION

India is the world's third largest egg production country and sixth largest producer of broilers. Total egg production was 138.38 billion during the period of 2022-23. The poultry industry contributed over 1.44 crore to the National GDP and provided employment to more than 4 million people, either directly or indirectly.

Poultry meat presently contributed 51.14 per cent of the total meat consumed and the rest from all other livestock put together. Income from poultry enterprises could be further enhanced by implementing proper measures to control intermediate hosts (IH) of poultry tapeworms.

Intensive rearing and upgrading of breeds increased the susceptibility of poultry to several pathogens including number of parasites. The viral diseases are contained by vaccinations while bacterial and coccidian infections are controlled by medications. Most of the parasitic infections got reduced by anti-helminthic treatments. In spite of regular medications, the poultry tapeworms are recurring due to development of the resistance problem to drugs and involvement of IHs. The His are the tiny ants and dung beetles found roaming in poultry yards in search of food materials also carried gravid segments which developed to cysticercoids (CCs) in them and act as source to transmit fresh infections to chicken by devouring them.

The selection of site for the construction of poultry houses should be given importance considering their proper location away from residential areas, with basic amenities like road, water and electricity. Swampy or wet areas in the vicinity should be avoided or spread with soil. The dumping of poultry manure and wastes at least 50 meters from the poultry sheds would prevent the breeding places of beetles IHs. The absence of ant-nests or ant-hills nearby would be searched out near the poultry farms to check out the to-and-fro movements of ants IHs.

Contributions of Indian Scientists

It is noteworthy that among the major achievements of Indian scientists who contributed to the biology of fowl tapeworms, are the recognition of more than twenty-five new IHs of poultry tapeworms, discovery of the role of ants in the life cycle of *Cotugnia digonopora* and the experimental production of intestinal nodules in *Raillietina echinobothrida* as in natural cases for the first time.

Development of CCs and their morphology

The affected fowls pass mature segments of tapeworms in their droppings. On disintegration of segments, they release egg capsules which are swallowed by the IHs and enter their midgut. They develop to larvae having hooks which enable them to penetrate gut wall to reach abdominal cavity where they transform to cysts called CCs. The future development of scolex and rostellum showing their characteristic features like position, size and shape which can be viewed with the aid of dissection microscope.

The CCs are mostly elliptical or nearly ovoid in some species, with a deep invagination at the broader pole. The calcareous corpuscles of more or less uniform size and distributed evenly on the sides of the notch where they occur in large numbers. The morphology of CCs helps in the identification of tapeworm species by the oval or round-shaped suckers and small or wider rostellum with hooks. The suckers possessing hooks are seen only with two species of poultry tapeworms, *R. tetragona* and *R. echinobothrida*. The identification of tapeworms is confirmed by recovery of adult worms on autopsy by feeding CCs to infection-free chickens when they start passing few gravid segments in their droppings. The period required for the host to pass the first tapeworm segment in droppings is called as prepatent period (PPP) which may be varied from 12 to 28 days depending on the species of tapeworms.

Various tapeworms and details of their IHs

Out of the five tapeworms under this purview, *R. cesticillus* and *Choanotaenia infundibulum* are transmitted through beetle IHs while *R. tetragona, R. echinobothrida* and *C. digonopora* are through ant IHs. The beetles belonged to the Order Coleoptera (with sheath wing). The forewings of beetles called elytra are hard and rigid and served as protective covering to their hind wings which are used for flying. They usually breed in manure and decaying vegetable wastes. Ants belong to the Order Hymenoptera and they do not usually possess wings except in male called drone. Both beetles and ants have four stages to complete their life-cycle such as egg, larva, pupa and adult. Each of this stage is entirely different from other. The knowledge on the biology of IHs is helpful to formulate their control.

The dung beetles multiply in the litter accumulated near the farm. The ants build ant-hills or nests above ground in slightly moist soil for their colonization and breeding. They are social insects and their colony consists of queen, males called drones, many workers and soldier ants which are allotted specific duty to perform. The soldier ants protect the brooding ants in the colony. The worker ants remove soil below the ground for the construction of tunnel and nest chambers. The soil thus collected brought above and deposited there forming the mound. One of the female ants treated as queen ant which will be cared and fed well by worker ants so as to enable to give off-springs. After mating with queen, male ant dies soon, but queen ant lives for many years. The rest of the female ants appear as infertile during the life period of queen ant. A queen lays a few eggs in the beginning and after being

fed well, it lays hundreds of eggs per day in their life-span. Worker ants come out in search of food to feed brooding ants. Such natural habits of movements for picking up of food and storing in the nest indirectly played the role in propagation of ant IH.

IHs of *R. cesticillus*

As a part of the experiments of Dutt *et al*. (1961) of IVRI, Izatnagar Uttar Pradesh, allowed beetles, grasshoppers and ants to feed on gravid segments of *R. cesticillus* and found that only beetles became infected. Out of the ten species of beetles used in their experimental trial, only four species namely *Anthicus confucii, Dermestes maculatus*, *Hister orientalis* and *Opatroides vicinus* acted as natural IH of *R. cesticillus*. Among them, *A. confucii* was recognized as the major IH of *R. cesticillus*. Of the 730 beetles examined, 5.6 per cent infection was noticed and the maximum number of 44 CCs was reported. The fully formed CCs measured 260-430 x 245-340 mμ. They administered CCs to 14 chicks in gelatin capsules and gravid segments started passing in their droppings in a minimum PPP of the range of 13 to 16 days (mean 13.6).

A species of beetle, *Carcinops* 14-*striatus*, was reported as IH by Mathur and Pande (1969) from the Department of Parasitology, Veterinary College, Mathura, Uttar Pradesh. An unidentified beetle was observed as common in poultry yards conveying this infection in Kolkata, West Bengal (Bowmik *et al*., 1982). Gogoi and Choudhury (1982a) of the Department of Parasitology, Veterinary College, Guwahati, Assam reported that out of the different species of beetles examined, 7.63 per cent of *Tribolium confusum* were harbouring the CCs of *R. cesticillus* and the PPP of this tapeworm was found to be 13 days. In the infectivity experiment conducted by placing gravid segments of *R. cesticillus* near the breeding place, the CCs appeared in the beetle, T. cofusum after 13 days (Gogoi and Choudhury, 1982b). They noted that 57 per cent of the CCs fed to chicks developed adult cestodes.

In Tamil Nadu, Ponnudurai and Chellappa (2001) recorded that tenebrionid beetles acted as IH of both *R.cesticillus* and *Ch. infundibulum* and they noticed 80 per cent infection in them. The size of CCS was 292 x 212 mμ. The maximum number of 150 CCs was collected from a beetle. The PPP was found to be 14 days and the maximum segment discharge (MSD) was between 12 noon and 3 p.m.

Velusamy *et al*. (2014) collected beetles from litters of 12 poultry farms in and around Namakkal, Tamil Nadu. Of the 1880 beetles collected, 205 (10.90 per cent) of the nine farms were found

infected with CCs of *R. cesticillus*. The beetles were identified as *Opatroides frater* (ground beetle) and it was the first report of this beetle serving as natural vector of Namakkal areas. The mature CCs measured average size of 371 x 281 mμ. The rostellum possessed double rows of hooks and suckers were unarmed, as characteristic of *R. cesticillus*. The maximum number of CCs collected from a beetle was 485. The PPP was 12-13 days and MSD was noticed between 3 and 4 p.m. In chicks fed with 25 CCs, an average number of 17 (68 per cent) developed to adult tapeworms

Velusamy *et al*. (2023) happened to collect beetles from manure pit of a poultry farm from Orathanadu of Tamil Nadu and the beetles were found positive for CCs of *R. cesticillus*. The beetles were identified as *Alphitobius diaperinus* (lesser mealworm beetle) which was recorded as IH for the first time. Of the total of 713 beetles examined for one-year period, 208 (29.17 per cent) were found infected with CCs. Further analysis indicated that of about equal number of beetles examined in the first and second half of the year, 33.42 per cent and 24.78 per cent were positive respectively. The maximum intensity of infection was 16 and the number of CCs recovered from a single beetle was 457. They found that CCs appeared smaller in size in heavy infection than those in light infection and occasionally malformed CCs were observed along with the normal ones.

IHs of *Ch. infundibulum*

Dutt and Sinha (1961) of IVRI, Izatnagar, U. P. observed that beetles, *A. confucii* and *O. vicinus* served as IH of *Ch. infundibulum*. They were of the opinion that the former species was most suited IH. The maximum of eight CCs was recovered. Ponnudurai and Chellappa (2001) found that *Dermestes* sp. beetle acted as IH of *Ch. infundibulum* in Namakkal district, Tamil Nadu. The infection rate was 25 per cent and they recovered 418 CCs from a beetle. The tenebrionid beetles acted as IH of both *R. cesticillus* and *Ch.infundibulum* as well and their combined rate of infection was 80 per cent. The maximum number of CCs recovered was 150. The PPP recorded for *Ch. infundibulum* was 15 days.

IHs of *R. tetragona*

Ants as IH of *R. tetragona* were first recognized by Chand (1964a), Department of Parasitology, Veterinary College, Ludhiana, Punjab and the species were identified as *Monomorium salmonis indicum* and *Pheidole fossulata*. Mathur and Pande (1969) reported three species of ants, *Monomorium* sp., *M. floricola* and *P. rhombinoda* from Mathura, U. P. The new genus, *Tetramorium simillimum* as IH

was discovered by the scientists of PL-480 Research Project (financed by a grant, FG-In-387 under USDA) at the Department of Zoology, Mar Ivanios College, Trivandrum, Kerala (Nadakal *et al*., 1970a).The present author was one among the investigators. The average percentage of ants positive for infection was 4.8 and the number of CCs harboured by individual ant was 1 to 13. The PPP ranged from 12 to 18 days and average being 14.60 days. It was noted that with single CC infection, the percentage of development of adult tapeworm was higher in 15 day-old-chicken than one-day-old. Nadakal *et al*. (1970a) remarked that feeding of CCs to chicks in gelatin capsules had no special advantage and their administration in a few drops of physiological saline using sterile dropper was found successful.

Ants, *Tetramorium* sp. 2 and *Pheidole* sp., *Triglyphothrix striatidens* and *Xiphomyrmex* sp. were also acted as IHs (Nadakal *et al*., 1971; 1973). The maximum incidence of CCs of 10 per cent, 16.3 per cent and 26.6 per cent occurred in *T. simillimum*, *Pheidole* sp. and *Tetramorium* sp.2 respectively and the last species appeared as the most suitable IH (Nadakal *et al*., 1971). Gogoi and Hazarika (1985) from the Department of Parasitology, Veterinary College, Guwahati, Assam recognized *Tetramorium tortosum* as new IH of *R. tetragona*. Out of 1086 ants examined, 48 (4.4 per cent) of *T. tortosum* were found to harbour CCs of *R. tetragona*. The number of CCs found in infected ants varied from 1 to 19. All the five 21-day-old chicks fed its CCs passed gravid segments after completing 13 days PPP. Gogoi and Chaudhury (1982a) reported that 13.52 per cent of *T.tortosum*, 15.11 per cent of *T.rothneyi*, 5.42 per cent of *T.simillimum* and 1.06 per cent of *Pheidole* sp. were found positive for *R. tetragona* infection and noted that PPP of 13 days. All these ant-species served as new IHs of this tapeworm from Assam. The infectivity of newly formed CCs to ant IHs was also observed by Gogoi and Chaudhury (1982b). For this purpose, they left the gravid proglottids of *R tetragona* behind an ant-hill. The worker ants came out in search of food and during their return, they carried the eggs capsules from the disintegrated gravid segments as solid food to be fed to the immature broods inside ant-hill. After leaving the gravid segments, CCs appeared in ants belonged to *Pheidole* sp. on 19th day and when these CCs fed to chicks, 40 per cent of them developed to adult cestodes.

IHs of *R. echinobothrida*

Chand (1964 a,b) reported that the ants, *M. salmonis indicum* and *P. fossulata served as* IHs of *R. echinobothrida* with low infection rate of 0.1% from the Department of Parasitology, Ludhiana, Punjab. Nadakal *et al*. (1973) incriminated

ants, *Tetramorium* sp.1, *Tetramorium* sp. 2 *Pheidologeton* sp., *Tryglyphothrix striatidens* and *Xiphomyrmex* sp. as IH for the first time from Trivandrum, Kerala. The intensity of infection in these five species ranged from 4.44 per cent, 4.28 per cent, 4.54 per cent, 3.48 per cent and 0.31 per cent respectively. The largest number of 17 CCs was recovered from *Xiphomyrmex* sp. When seven-day-old chicks each infected with one CC and ten CCs, they developed 55.5 per cent and 82.5 per cent adult cestodes respectively. The average PPP of 7- and 40-days-old chicks fed with one CC each was 18.2-19.0 days respectively which was within the range of 17-22 days to those fed one CC and 10 CCs.

A new species of ants identified from Assam were *Tetramorium tortosum* with 17.40 per cent infection (Gogoi and Hazarika, 1985). The maximum PPP recorded was 14 days. Later investigation revealed that in addition to *T. tortosum,* other three species of ants such as *T. rothneyi*, *T. simillimum* and *Pheidole* sp. also served as IHs (Gogoi and Choudhury, 1982a). The result of the infectivity trials conducted by Gogoi and Choudhury (1982b) by placing gravid segments of tapeworm near an ant-hill, the newly formed CCs of *R. echinobothrida* appeared in ants, *T. simillimum* after 25 days, and when these infected CCs fed to chicks, 45 per cent of the birds developed adult tapeworms.

IHs of *Cotugnia digonopora*

The role of ants in the life-cycle of *C. digonopora* was not known till 1964. But it was established after the discovery of CCs of this tapeworm in ant, *Monomorium* (*Holcomyrmet*) *scabriceps* by Chand (1964b) at the Department of Parasitology, Veterinary College, Ludhiana, Punjab. He observed only very low intensity of 0.04 per cent of infection and the maximum number of CCs observed was eight from one ant. The minimum PPP was 22 days. The MSD was between 7 am and 3 p.m. and only very few found between 3 p.m. and 7 p.m.

During the routine screening of various species of ants from different poultry yards in Trivandrum, Kerala by the scientists of PL 480 Project, Mar Ivanios College were recovered CCs of *C.digonopora* from two new species of ants, *M. gracillimum* and *M. destructor* (Nadakal *et al*., 1970b). Out of 633 ants of the former species, 142 (22.3 per cent) yielded 489 CCs and of the 655 ants of the latter species 5 (0.76 per cent) yielded only 10 CCs. The number of CCs in *M. gracillimum* ranged from 1 to 11 and and *M. destructor* from 1 to 3. The former species was more suitable host compared to the latter species though almost equal number of ants was examined.

Micrometry of CCs

The micrometry of CCs of *C. digonopora* noted by Chand (1964b) were within the range of 375-500 x 250-300 mμ as reported by Nadakal *et al*. (1970a), but the size of suckers recorded by Chand (1964b) was conspicuously smaller and number of rostellar hooks was found less. The CCs appeared elliptical with sharp notch at one of the poles. Other characteristic features were the presence of rostellum armed with a double row of hooks and the unarmed suckers (Nadakal *et al*., 1970b).

Chand (1964b) reported that the minimum PPP for *C. digonopora* was 22 days whereas Nadakal *et al*. (1970b) found that the average PPP was 24.2 days, within the range of 22-26 days. Significant observation noted by Nadakal *et al*. (1970b) was that the percentage of CCs developed to maturity to adults was 57 and 21 in two groups of chicks each of which had received one CC and more CCs respectively. It was further noted that the chicks fed one CC developed higher number of worms than chicks fed more CCs. They found that MSD was between 6 a.m. and 12 noon.

Joseph *et al*. (1987) reported that one ant of *Pheidole* sp. examined at Erode, Tamil Nadu showed the presence of CC of *C.digonopora*. Sundar and Chellappa (2001) were observed CCs in *M. floricola* which was the first record of this of IH *C.digonopora* from Namakkal, Tamil Nadu. Out of 151 ants, 139 (92.05 per cent) were positive for CCs which was the highest figure recorded so far. The number of CCs in infected ants varied between 1 and 5. Measurements of CCs were 367-473 x 271-378 μm. Intensity of infection ranged from 1-7 and the PPP was 21 days.

Experimental nodular formation

To observe the formation of intestinal nodules (parasitic granuloma) peculiar to *R. echinobothrida*, two chicks were infected with 50 CCs and autopsied three months post-infection, but they did not show nodules. But the third chick fed with 200 CCs, exhibited nodules in the intestine on six months post-infection and their size were comparable to tubercular nodules (Nadakal *et al.*, 1973). The formation of nodules in experimentally infected fowl was not reported in US (Reid, 1962) though they were commonly found in natural cases. As far as the author understands that the nodular formation due to *R. echinobothrida* has not reported till now.

Concurrent infections

Concurrent infections of CCs of *R. tetragona* and *R. echinobothrida* were observed in certain ants such as *Tetramorium* sp.2. *Tryglyphothrix*

striatidens and *Xiphomyrmex* sp. in which CCs of *R. tetragona* occurred in higher number than *R. echinobothrida* (Nadakal *et al*., 1971: 1973).

Percentage of infections and range of CCs.

The percentage of infections *Tetramorium* sp.1, *Tetramorium* sp.2 and *Pheidologeton* sp. with CCs *R. echinobothrida* was about 4.6.The number of CCs in ants ranged between 1 and 13 in *T. simillimum*, 1 and 11 in *Pheidole* sp. and 1 and 19 in *Tetramorium* sp.2. It was not uncommon to have more than ten CCs in one ant of *Tetramorium* sp.2 and more than five in *Pheidole* sp. whereas in *T. simillimum*, it was less than five (Nadakal *et al*., 1970). Gogoi and Hazarika (1975) from Assam reported that *T. tortosum* showed only 4.4 per cent infection of *R. tetragona* while *R. echinobothrida* exhibited about four times higher infection rate of 17.40 per cent.

Variations in incidence of CCs

Significant monthly or yearly variation in the frequency and incidence of CCs were noted. The incidence of infection in CCs of *R.cesticillus* in IH, *A. diamperinus* in the first half of the year was 8.64 per cent higher than that observed in the second half of the year as indicated by Velusamy *et al*. (2023). Nadakal *et al*. (1971) noted that variation in the incidence of infection in *T simillimum* in the five months period of the particular year (August to December, 1968) and the same months of the subsequent year (August to December, 1969). Another interesting finding was that although large number of CCs of *C. diagnopora* occurred during March and April 1969, none could be recovered during the rest eight months of the year (Nadakal *et al*., 1970a). This result indicated that good number of ants (at least 100 to 200) should be screened during every month for one-year period to know their positivity and the months in which they would be positive.

Control of IHs

Control of tapeworms in back-yard poultry keeping is not so easy due to the intervention of IHs for their transmission of CCs to chicks which is the final hosts. This should be made possible by checking or blocking the entry of IHs to poultry yards and pens. As devised by the author to maintain cestode-free chicken for his experimental works, all the four sides of the poultry houses, both inside and outside, were provided with narrow channels of water mixed with antiseptic lotion like Dettol and the legs of poultry cages dipped in water containing Dettol assured full protection from the entry of IHs. Placing chemicals like borax (0.5- 1 per cent), multi-purpose insecticide powders available sold in the market as ant-powder,

silicon dioxide or diatomaceous earth. near ant moving areas in poultry yards kill ants and at the same time they are safer to back-yard chicken. The spraying of insecticides at the breeding places of beetles in manure once in a week is effective measure. The spreading borax powder around the ant-hills checks to-and-fro movements of ants. Pouring about 10-12 liters boiling water (maintained hot on electric heater) on ant-hill destroys the entire ants inside the colony and also collapses the mounds of ant-hill.

SUMMARY

At present, the information on beetle and ant IHs is only available from nine localities across six states of the country such as 1. Izatnagar and 2. Matlhura (Uttar Pradesh), 3. Ludhiana (Punjab), 4. Guwahati (Assam), 5. Kolkata (West Bengal), 6. Namakkal, 7. Orathanadu and 8. Erode (Tamil Nadu) and 9.Trivandrum (Kerala) .Whereas new locations including other 22 states and eight union territories might be explored and the information gained be utilized to implement proper control measures against them. All the control measures if followed simultaneously, would boost poultry production.

REFERENCES

Bowmik, M.K., Sasmal N.K. and Chakraborty A.K.1982. Effect of *Raillietina cesticillus* infection on the meat and egg production of fowl. *Indian Vet. Med. J.*, **6:** 100-102.

Chand, K., 1964a. Taeniasis in poultry. *Indian Poul. Gaz*., **48:** 47-49/.

Chand, K., 1964b. Life cycle of *Cotugnia digonopora* (Pasquale, 1890) Diamare, 1893 and role of ants in taeniasis in poultry. *J. Res. Punjab. Agric. Univer*., **1:** 93-100.

Dutt, S.C. and Sinha, P.K.1961. Studies on the life history of the fowl tapeworm *Choanotaenia infundibulum* (Bloch). *Indian J. Vet. Sci. Anim. Husb*. **31:** 121-31

Dutt, S.C., Sinha, P.K. and Mehra, K.N.1961. Studies on the life history and biology of the fowl cestode *Raillietina cesticillus* (Molin, 1858) Fuhrmann, 1920. *Indian J. Vet. Sci. Anim. Husb*. **31:** 108-120.

Gogoi, A.R. and Chaudhuri, R.P.1982a. Biology of fowl cestodes *Raillietina tetragona, Raillietina echinobothrida* and *Raillietina cesticillus*. *Indian J. Anim. Sci*. **52**: 246-253.

Gogoi, A.R. and Chaudhuri, R.P. 1982b. Infectivity of newly formed cysticercoids of *Raillietina tetragona, R. echinobothrida* and *R. cesticillus*

to chicks. *Indian J. Parasitol*. **6:** 51-52.

Gogoi, A.R. and Hazarika, R.N.1985. *Tetramorium tortosum* (Rog), an intermediate host of poultry tapeworms *Raillietina echinobothrida* and *Raillietina tetragona*. *Indian Vet. J*. **52:** 939-941.

Joseph, S.A., Krishnamoorthy, G. and Lalitha. C.M. 1987. *Pheidole* sp., a new intermediate host for the fowl tapeworm, *Cotugnia digonopora*. *Cheiron.* **16:** 275.

Mathur, S.C. and Pande, B.P.1969. *Raillietina cesticillus* and *R. tetragona* infections in chicks reared on normal and deficient feeds-an experimental study. *Indian J. Anim. Sci.* **39:** 115-134.

Nadakal, A.M., John, K.O., Muraleedharan, K. and Mohandas, A. 1970a. Resistance potential of certain breeds of domestic fowl exposed to *Raillietina tetragona* infection. 1. Contribution to the biology of *Raillietina tetragona* (Molin, 1858). *Proc. Helminth. Soc. Wash.* **37:** 141-143.

Nadakal, A.M., Muraleedharan, K., Mohandas, A. and John, K.O. 1970b. Observations on certain aspects of the biology of the fowl tapeworm *Cotugnia digonapora*. *Jap. J. Parasitol*. **19:** 196-198.

Nadakal, A.M., Mohandas, A., John, K.O. and Muraleedharan, K. 1971. Resistance potential of certain breeds of domestic fowl exposed to *Raillietina tetragona* infections: 3. Species of ants as intermediate hosts for certain fowl cestodes. *Poult. Sci.* **50:** 115-118.

Nadakal, A.M., Mohandas, A., John K.O. and Muraleedharan, K. 1973. Contribution to the Biology of the fowl cestode *Raillietina echinobothrida* with a note on its pathogenicity. *Trans. Amer. Micros. Soc*. **92:** 273-276.

Ponnudurai, G. and Chellappa, D.J. 2001. Observation on the biology of *Choanotaenia infundibulum* and *Raillietina cesticillus* and their natural intermediate hosts in Tamil Nadu. *J. Vet. Parasitol*. **15:**51-53

Reid, W.M.1962. *Chicken and Turkey Tapeworms. Handbook to aid in identification and control of tapeworms found in United States of America.* Univ. Ga. Coll. Agri., Athens, Georgia, 77p.

Saran, J.1968. Observations on the

cysticercoids and larval nematodes from some of the common insects of the deep litter and studies on the helminth parasites of fish-eating birds-King Fisher. *M. V. Sc thesis,* Agra University, India.

Velusamy, R., Abdul Basith, S., Harkrishnan, T.J., Ponnudurai, G. T. and Ramakrishnan, S. 2014. Ground beetle, *Opatroides frater* (Coleoptera) as natural intermediate host for the poultry tapeworm, *Raillietina cesticillus*. *J. Parasit. Dis*., **38:** 128-131.

Velusamy, R., Latchumikanthan, A. and Vijayasarathi, M. K. 2023.The lesser mealworm beetle (*Alphitobius diaperinus*) as an intermediate host for poultry tapeworm, *Raillietina cesticillus*. *Uttar Pradesh J. Zool*. **44:** 72-77.