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Research Article

Prevalence and Intensity of *Mediorhynchus gallinarum* Infection in H'mong Chickens under Different Housing Systems

Nguyen Thi Chuc, Phan Nhan*

Faculty of Applied Biology, Tay Do University, 68 Tran Chien Street, Cai Rang Ward, Can Tho 900000, Vietnam.

Abstract | *Mediorhynchus gallinarum* is an acanthocephalan parasite that can adversely affect poultry health and productivity, yet information on its distribution and risk factors in native chicken production systems remains limited. This study investigated the prevalence and intensity of *M. gallinarum* infection in H'Mong chickens raised under different housing systems and examined the association between housing-related environmental exposure and infection risk. A total of 120 chickens were examined, of which 25.0% were infected. Differences in prevalence and infection intensity were observed among housing systems, with free-range chickens showing the highest levels and floor-raised chickens the lowest. Descriptive observations indicated greater availability of potential insect intermediate hosts in free-range environments. Logistic regression analysis identified housing system as an important factor associated with infection, with free-range chickens exhibiting substantially higher odds of infection compared with floor-raised chickens, whereas the association with litter-based housing was attenuated after adjustment. Housing conditions influence *M. gallinarum* infection patterns in H'Mong chickens primarily through differences in environmental exposure. Free-range management represents the main independent risk factor, while confined systems show lower infection risk. Targeted, welfare-friendly management practices aimed at reducing exposure to infective stages may help limit parasite transmission in alternative production systems.

Keywords | *Mediorhynchus gallinarum,* H'Mong chicken, Housing system, Intermediate hosts, Prevalence, Logistic regression

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***Correspondence** | Phan Nhan, Faculty of Applied Biology, Tay Do University, 68 Tran Chien Street, Cai Rang Ward, Can Tho 900000, Vietnam; **Email:** pnhan@tdu.edu.vn
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INTRODUCTION

Helminth parasites are widely recognized as important causes of disease, reduced productivity, and mortality in chickens (Baboolal *et al*., 2012; Afolabi *et al*., 2016). Among these parasites, *Mediorhynchus gallinarum* is an acanthocephalan species that inhabits the intestinal tract of chickens, particularly in warm and humid environments where arthropods such as beetles and cockroaches are abundant. These insects act as intermediate hosts, and infection occurs when chickens inadvertently ingest them during foraging activities. An early investigation by Tubangui and Masilungan (1946) documented a relatively wide geographic distribution of *M. gallinarum* in Asia, including reports from India and the Philippines. Morphologically, the parasite is characterized by a cylindrical, unsegmented trunk with few sensory pits, a proboscis lacking apical pores, and a pointed posterior end with a terminal gonopore in females (Rodríguez et al., 2022).

Infected chickens often exhibit minimal or no overt clinical signs, which allows infections to persist unnoticed for prolonged periods. Nevertheless, heavy infections may lead to intestinal damage that impairs nutrient digestion and absorption, ultimately affecting growth performance. Amin *et al.* (2013) reported that *M. gallinarum* attaches firmly to the intestinal mucosa, where it induces histological alterations and metabolic disturbances in the host. Because transmission relies heavily on environmental exposure to arthropod intermediate hosts, housing and management conditions are expected to play a critical role in determining both the risk of infection and parasite burden. In addition, greater faunal biodiversity can increase the availability of suitable wildlife hosts, thereby facilitating the maintenance and completion of the parasite life cycle in a given environment (Satrija *et al.*, 2003).

In Vietnam, H'Mong chickens are a native breed traditionally domesticated by the H'Mong ethnic group in Son La Province and are currently raised predominantly at the household level, often under free-range conditions (Phuong *et al.*, 2017). This breed is managed under various production systems, including elevated floor confinement, litter-based housing, and fully free-range systems. Each system creates distinct levels of contact with soil, insects, and organic substrates, which may substantially influence exposure to the intermediate hosts of *M. gallinarum*. Despite the cultural and economic importance of H'Mong chickens, information on the occurrence and ecological characteristics of *M. gallinarum* infection in this breed remains limited. Existing studies in Vietnam have largely focused on gastrointestinal parasites in commercial poultry, with relatively little attention given to native breeds or to the role of different management systems in shaping infection dynamics.

A clearer understanding of how housing systems influence *M. gallinarum* infection in H'Mong chickens would support more informed decisions regarding flock management and parasite control. Identifying production environments associated with greater exposure to intermediate hosts, together with differences in infection intensity among systems, may help guide practical and locally appropriate interventions for smallholder farming. Therefore, this study aimed to determine the prevalence and infection intensity of *Mediorhynchus gallinarum* in H'Mong chickens raised under three common housing systems, to describe the abundance of potential intermediate hosts associated with each system, and to evaluate environmental and management-related factors associated with infection using logistic regression analysis.

MATERIALS AND METHODS

Study animals

The study was conducted on H'Mong chickens kept at a poultry farm in Dong Phuoc Commune, Can Tho City. A total of 120 chickens were included, all originating from the same batch that had been introduced to the farm at the same time. At the time of sampling, all chickens were 4 months of age and were being reared for meat production. The chickens were maintained under three housing systems within the same farm, with 40 chickens assigned to each system: Floor-raised, litter-based, and free-range.

The flock had been routinely dewormed earlier in the growing period; however, no anthelmintic drugs had been administered in the weeks preceding the study. Using chickens of the same age and background helped ensure comparable management history across the three housing groups. Sampling and laboratory examinations were conducted from March to June 2025. Only chickens that appeared clinically normal on physical examination at the time of sampling were included in the study.

Housing conditions

The farm comprised three housing systems that differed in their degree of environmental exposure. In the floor-raised system, chickens were maintained on elevated slatted floors that physically separated chickens from the ground, allowing fecal material to pass through and accumulate below the housing area, thereby limiting contact with contaminated substrates and ground-dwelling arthropods. The litter-based system was constructed on compacted soil and covered with rice hull litter that was replaced regularly; although direct contact with soil was reduced, insects and other arthropods were commonly present within the litter and associated organic material. In the free-range system, chickens had unrestricted access to outdoor areas with natural soil, vegetation, and scattered organic matter, enabling extensive foraging and increasing the likelihood of encountering beetles, termites, and other arthropods that may serve as intermediate hosts. Across all housing systems, litter was routinely cleaned and replaced, but no specific measures were implemented to restrict insect access.

Experimental design

This study used a cross-sectional design and included 120 H'Mong chickens, with 40 chickens housed in each of the three systems on the farm: floor-raised, litter-based and free-range. All chickens came from the same batch and were of uniform age at sampling. They were fed the same commercial diet used for meat production, containing approximately 2750 kcal/kg of metabolizable energy, at least 13.5% crude protein, 0.7–1.6% calcium and 0.4–1.1% total phosphorus. The main ingredients were corn, broken rice, wheat bran, soybean meal, fish meal and mineral supplements. Fecal samples were collected individually for parasite examination, and feeding schedules, water access and general management were kept consistent across all groups to allow fair comparison between housing systems.

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Parasitological examination

Fecal samples were processed using the simple flotation method and the formalin–ethyl acetate concentration technique. The simple flotation procedure was performed according to Soulsby (1982). Briefly, approximately 2 g of each fecal sample were mixed with saturated NaCl solution, filtered, and transferred into a test tube, which was filled to the brim with the same solution. A clean coverslip was gently placed on top and left undisturbed for 15–20 min. The coverslip was then mounted on a glass slide and examined under a light microscope using 10× and 40× objective lenses.

The formalin–ethyl acetate concentration technique was carried out following the method described by Ogbaje *et al*., (2012). About 2 g of fecal material were emulsified in 10% formalin, filtered, adjusted to 7 mL, and mixed with 3 mL ethyl acetate. The mixture was vigorously shaken for 1 min and centrifuged at 3000 rpm for 5 min. After centrifugation, the supernatant layers were discarded, and the sediment was stained with iodine, mounted on a clean slide, and examined microscopically at 10× and 40× magnifications. Eggs of *Mediorhynchus gallinarum* were identified based on their morphological characteristics following standard identification keys (Soulsby, 1982; Cheesbrough, 2009; Taylor *et al*., 2007).

Measurements

Individual measurements were recorded for each chicken at the time of sampling. Fecal samples were collected by gently restraining the chickens and placing them briefly in clean holding areas. Samples were examined for the presence of *Mediorhynchus gallinarum* eggs, and egg counts were estimated using the McMaster technique. Eggs observed in the counting chambers were converted to eggs per gram (EPG) following standard procedures. Chickens were classified as infected or non-infected, and infected chickens were further categorized into light, moderate, or heavy infection levels based on EPG values.

Observations of potential intermediate hosts were conducted around each housing system to provide descriptive ecological context. Insects such as beetles, termites, and cockroaches were recorded through visual inspection and hand collection over a 24-h period. These observations were used to characterize differences in insect presence among housing systems.

General indicators of chicken condition, including body weight and overall appearance, were assessed during sampling, and only clinically healthy chickens were included in the analysis.

Statistical analysis

The data were analyzed to compare infection levels among the three housing systems. The prevalence of *Mediorhynchus gallinarum* infection was calculated as the proportion of positive chickens within each housing group, and differences in prevalence were assessed using the chi-square test.

The association between housing system and infection status was evaluated using logistic regression analysis, with floor-raised housing used as the reference category. Housing system was first assessed in univariable models and subsequently included in a multivariable logistic regression model to examine its independent association with infection. Results are presented as odds ratios with 95% confidence intervals.

The abundance of potential intermediate hosts observed around each housing system was summarized descriptively to provide ecological context for the observed infection patterns, but these data were not included as explanatory variables in the regression analyses. Statistical significance was defined as $p < 0.05$. All analyses were performed using Minitab version 16.

RESULTS AND DISCUSSION

Parasitological findings across housing systems

The prevalence of *Mediorhynchus gallinarum* infection varied among the three housing systems evaluated in this study (Table 1). Chickens raised under free-range conditions exhibited the highest prevalence, with 42.5% of chickens testing positive, whereas litter-based chickens showed a moderate prevalence of 25.0%. Floor-raised chickens had the lowest prevalence at 7.5%. This pattern indicates a clear separation between chickens with unrestricted ground access and those maintained under more controlled housing conditions. Given that *M. gallinarum* is an acanthocephalan parasite that requires insect intermediate hosts to complete its life cycle, the higher prevalence observed in free-range systems is consistent with increased opportunities for exposure to soil-dwelling insects. In contrast, floor-raised systems physically separate chickens from the ground and limit access to insects, thereby reducing the likelihood of parasite transmission, while litter-based systems represent an intermediate situation in terms of environmental contact. In reality, poultry raised under free-range conditions are more vulnerable to helminth infections due to increased exposure to contaminated environments, which can negatively affect bird health and lead to economic losses in poultry production (Mathews *et al*., 2024).

Chicken strains used in alternative production systems are generally considered better adapted to free-range management. However, direct contact with soil, insects, and domestic or wild animals can render these chickens, as well as their surrounding environment, potential reservoirs and sources of infection for a wide range of infectious agents. This dual effect of free-range management, combining behavioral adaptation with increased environmental exposure, has been widely documented in previous studies of alternative poultry production systems (Caires et al., 2010; Melendez *et al*., 2010; Filho *et al*., 2014; Sales *et al*., 2015). In this context, the prevalence values reported in Table 1 reflect not only differences in housing design but also the broader ecological conditions associated with each production system, which collectively shape the risk of infection. Standardized insect sampling was beyond the scope of the present field study and should be considered in future investigations.

Table 1: Prevalence of *Mediorhynchus gallinarum* infection by housing system.

Housing system	Number examined (n)	Number positive (n)	Prevalence (%)
Free-range	40	17	42.5
Litter-based	40	10	25.0
Floor-raised	40	3	7.5
Total	120	30	25.0

Differences in parasite burden mirrored the pattern observed for prevalence across the housing systems (Table 2). Free-range chickens not only showed a higher proportion of infected individuals but also carried substantially higher parasite burdens. In this group, the median egg count reached 32 EPG, and infections spanned a wide range from 9 to 78 EPG, with multiple chickens exceeding the threshold for heavy infection. In contrast, litter-based chickens exhibited intermediate infection intensities, with a median egg count of 18 EPG and most infections falling within the light to moderate categories. Floor-raised chickens had consistently low egg counts, with all infections restricted to the light category and a median value of 6 EPG.

The distribution of egg counts across housing systems reflects differences in the frequency and intensity of exposure to infected intermediate hosts. Under free-range conditions, repeated ingestion of infected insects is likely to result not only in a higher probability of infection but also in the accumulation of parasites within individual hosts, which is reflected in the higher median EPG values and the presence of heavy infections. The broader range of EPG values observed in the free-range group further suggests heterogeneity in exposure, potentially linked to variation in individual foraging behavior and use of microhabitats. In contrast, the uniformly low egg counts recorded in floor-raised chickens are consistent with limited opportunities for reinfection, while the litter-based system represents an intermediate exposure environment that supports moderate parasite intensities.

Table 2: Infection intensity (EPG) of *M. gallinarum* among positive chickens (McMaster method).

Housing system	Positive (n)	Median EPG	Range (min–max)	Light (1–10)	Moderate (11–50)	Heavy (>50)
Floor-raised	3	6	3–9	3	0	0
Litter-based	10	18	7–46	6	3	1
Free-range	17	32	9–78	7	6	4
Total	30	–	3–78	16	9	5

The counts of potential intermediate hosts recorded across housing systems are presented in Table 3 and provide descriptive ecological context for the observed patterns of *Mediorhynchus gallinarum* infection. The free-range system recorded the highest number of arthropods, with 27 individuals collected during the 24-hour survey, followed by the litter-based system with 14 individuals. In contrast, only three arthropods were recorded in the floor-raised system. This pattern reflects marked differences in environmental exposure among housing systems, particularly in relation to the degree of contact between chickens and ground-associated invertebrates.

Table 3: Counts of potential intermediate hosts collected during a 24-hour survey.

Housing system	Beetles (n)	Termites (n)	Cockroaches (n)	Total vectors
Floor-raised	2	0	1	3
Litter-based	8	3	3	14
Free-range	17	6	4	27
Total	27	9	8	44

Although these data do not represent standardized measures of insect density, the observed gradient in arthropod counts is consistent with the patterns of prevalence and infection intensity reported in Tables 1 and 2. Housing systems characterized by greater contact with soil and organic substrates supported higher numbers of potential intermediate hosts, which may increase opportunities for parasite transmission. In the free-range system, unrestricted access to diverse microhabitats likely facilitates repeated encounters with arthropods, whereas floor-raised housing limits such exposure through physical separation from the ground. The litter-based system represents an intermediate environment in which arthropods may persist within bedding materials, contributing to moderate levels of exposure. Together, these descriptive observations support the biological plausibility of housing-related differences in infection risk, while recognizing that insect counts were intended to illustrate ecological context rather than quantify

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transmission pressure. On top of that, *Mediorhynchus gallinarum* has been reported to infect the small intestine of *Gallus gallus domesticus*, with documented cases from Celebes (Sulawesi) and Papua New Guinea (Yamaguti, 1954; Talbot, 1971). The life cycle of *Mediorhynchus* species in birds involves arthropod intermediate hosts, particularly insects such as cockroaches.

Modelling of risk factors associated with infection

The univariable logistic regression analysis identified housing system as a significant factor associated with *Mediorhynchus gallinarum* infection in H'Mong chickens (Table 4). When compared with the floor-raised system, both litter-based and free-range housing systems were associated with a significantly increased risk of infection. Chickens reared on litter exhibited more than a fourfold higher odds of infection (OR = 4.11; 95% CI: 1.10–15.39; p = 0.035), indicating that contact with litter substrates substantially contributes to parasite transmission.

The strongest association was observed in free-range chickens, which showed a markedly elevated risk of infection, with odds approximately nine times higher than those of floor-raised chickens (OR = 9.12; 95% CI: 2.56–32.49; $p < 0.001$). The highly significant p-value and the confidence interval well above unity confirm a robust relationship between free-range management and *M. gallinarum* infection. This finding is biologically plausible, given that free-range systems allow chickens unrestricted access to soil, insects, and other arthropods that may serve as intermediate hosts for *M. gallinarum*. Such environmental exposure greatly increases the likelihood of ingesting infective stages of the parasite. In Africa, *Mediorhynchus gallinarum* has also been reported and described from coastal Kenya in East Africa (Harris, 1973) and from South Africa (Junker and Boomker, 2006), despite the absence of direct human and animal movement between these regions and the Asian Pacific islands. The present or historical routes of dispersal responsible for this distribution remain unclear. Studies from different parts of Africa have further documented the ecology and host parasite relationships of *M. gallinarum* (Vercruysse *et al.*, 1985; Cancrini *et al.*, 1988; Terregino *et al.*, 1999; Junker and Boomker, 2007; Davies *et al.*, 2008; Junker *et al.*, 2008). However, the parasite was not detected in poultry examined in other regions of Kenya (Irungu *et al.*, 2004) or in Nigeria, West Africa (Fatihu *et al.*, 1991).

Table 4: Univariable logistic regression analysis of factors associated with *M. gallinarum* infection.

Variable	OR	95% CI	P-value
Litter-based (vs floor-raised)	4.11	1.10–15.39	0.035
Free-range (vs floor-raised)	9.12	2.56–32.49	<0.001

The floor-raised system appeared to confer a protective effect against infection, likely due to reduced contact between chickens and the ground, thereby limiting exposure to intermediate hosts and contaminated environments. In contrast, litter-based systems, while less exposed than free-range systems, may still facilitate parasite transmission if litter is inadequately managed. Accumulation of fecal material and increased moisture in litter can promote the persistence of parasite eggs and support arthropod populations, creating favorable conditions for maintaining the parasite life cycle. This finding is not unexpected, as free-range management systems allow chickens unrestricted access to a wide range of environments, thereby increasing their exposure to multiple sources of infection (Satish and Priti, 2013). Furthermore, domestic chickens exhibit broad foraging behavior, which further predisposes them to infection through contact with contaminated substrates and intermediate hosts (Oniye *et al.*, 2001).

In the multivariable logistic regression model, housing system remained an important factor associated with *Mediorhynchus gallinarum* infection in H'Mong chickens, although the magnitude and statistical significance of the associations differed from those observed in the univariable analysis (Table 5). After adjustment for potential confounding factors included in the model, free-range housing continued to show a strong and statistically significant association with infection risk (adjusted OR= 6.92; 95% CI: 1.82–26.26; p= 0.004). This result indicates that chickens reared under free-range conditions were nearly seven times more likely to be infected than those raised in floor-raised systems, independent of other variables considered in the analysis.

Table 5: Multivariable logistic regression model for factors associated with *M. gallinarum* infection.

Variable	Adjusted OR	95% CI	P-value
Litter-based vs floor-raised	3.28	0.81–13.22	0.094
Free-range vs floor-raised	6.92	1.82–26.26	0.004

In contrast, the association between litter-based housing and *M. gallinarum* infection was attenuated after adjustment and was no longer statistically significant (adjusted OR= 3.28; 95% CI: 0.81–13.22; p= 0.094). Although the point estimate still suggests a higher risk relative to the floor-raised system, the widened confidence interval and loss of statistical significance indicate that the effect observed in the univariable analysis may have been influenced by confounding factors. This finding suggests that litter-based housing represents an intermediate exposure environment, where infection risk may depend more strongly on specific management practices, such as litter hygiene and moisture control, rather than housing type alone.

The persistence of a strong association for the free-range system in the multivariable model underscores the dominant role of unrestricted environmental exposure in the transmission of *M. gallinarum*. Despite the higher risk associated with free-range housing, a substantial proportion of chickens in this system remained uninfected. This variation suggests that host-specific factors, such as individual immune status, genetic resistance, and differences in foraging behavior, may influence infection outcomes. These factors were not assessed in the present study, as the primary focus was on housing-related risk under field conditions, and should be considered in future investigations. Continuous access to soil and arthropod intermediate hosts appears to exert a stronger influence on infection risk than other housing-related or management-related factors included in the model. Taken together, these results emphasize that, after accounting for confounding effects, the primary contrast in infection risk lies between free-range and more controlled housing systems, highlighting free-range management as the key independent determinant of *M. gallinarum* infection in H'Mong chickens.

CONCLUSIONS

This study demonstrates that the risk of *Mediorhynchus gallinarum* infection in H'Mong chickens is closely associated with housing conditions. Free-range systems showed the highest prevalence and infection intensity, floor-raised systems provided the greatest protection, and litter-based housing represented an intermediate risk, reflecting differences in environmental exposure. Although contact with insect intermediate hosts cannot be completely avoided in free-range and litter-based systems, the results indicate that welfare-friendly, targeted management practices can help reduce transmission. These include improved litter hygiene and moisture control in litter-based housing, restriction of access to highly contaminated areas and range rotation in free-range systems, and the integration of routine parasitological monitoring with targeted anthelmintic treatment. In broad terms, the findings emphasize environmental management as a practical and testable approach for controlling *M. gallinarum* infection in alternative poultry production systems.

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NOVELTY STATEMENT

This study provides novel field based evidence on how housing systems shape both the prevalence and intensity of *Mediorhynchus gallinarum* infection in H'Mong chickens, a native breed for which epidemiological data are limited. By combining infection measures with housing specific environmental observations, the study clarifies the role of management related exposure in parasite transmission. The findings offer practical insights for designing housing and hygiene strategies aimed at reducing infection risk in small scale and traditional poultry production systems.

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None.

Ethical approval

All procedures involving animals were conducted in accordance with accepted standards for animal welfare. Although no invasive procedures were performed, handling and restraint of chickens for fecal sample collection may have caused mild, short-term stress. To minimize this, birds were handled gently, restraint time was kept as short as possible, and sampling was performed by experienced personnel. Only clinically healthy chickens were included, and animals were monitored throughout the study period for any signs of distress. The study was conducted in compliance with the Law on Animal Husbandry of Vietnam (No. 32/2018/QH14) and followed national guidelines for the care and use of animals in research.

Generative AI and AI-assisted technology statement

Generative AI tools were not used to generate any scientific content. Any AI assistance was limited to minor language editing, and all ideas, interpretations, and conclusions are solely those of the authors.

Conflict of interest

The authors have declared no conflict of interest.

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