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SHORT COMMUNICATION

First Report of Morphological Identification and Prevalence of *Eimeria* Species in Japanese Quails (*Coturnix coturnix japonica*) in Mekong Delta of Vietnam

Tran Nguyen-Ho-Bao[1]*, Nguyen Thi Kim Khang[2], Lu Ai Tien [1], Nguyen Thi My Tien [1], Nguyen Thi Chuc [3] and Nguyen Huu Hung [1]

[1]Faculty of Veterinary Medicine, Can Tho University, Ninh Kieu, Can Tho 900000, Viet Nam: [2]Faculty of Animal Sciences, Can Tho University, Ninh Kieu, Can Tho 900000, Vietnam: [3]Applied Biology Faculty, Tay Do University, Cai Rang, Can Tho 900000, Vietnam
*Corresponding author: nhbtran@ctu.edu.vn

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A B S T R A C T

Quails are susceptible to avian coccidiosis, which causes significant economic loss to the quail industry worldwide. However, the morphological comprehension of *Eimeria* species in quails in Vietnam remains inadequate. The study aimed to identify *Eimeria* species in infected quails and to survey the prevalence of *Eimeria* species in Japanese quails in the Mekong Delta, Vietnam by using the flotation technique. Identification of *Eimeria* species was conducted based on morphological indices of oocysts and sporocysts, combined with sporulation time observation by using a light microscope. The infected quails were highlighted at 46.10% positive with coccidiosis. The prevalent species were morphologically characterized as *Eimeria bateri, E. tsunodai, E. uzura,* and *E. fluminensis*. Young chicks were easily infected with *Eimeria* at early development from the second week to the fourth week of age reaching the highest rate of infection 77.33%. *Eimeria bateri* was identified as the most predominant species, but *E. tsunodai* was the most pathogenic in surveyed quails, accounting for 67.95% and 46.67% of coccidiosis infection, respectively. These results indicated that quails were highly susceptible to coccidiosis, highlighting the urgent need to implement effective prophylaxis in quail farms.

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INTRODUCTION

Quails (*Coturnix coturnix*), extensively reared worldwide, is an important sector of the poultry industry. Quail farming is preferred by small-scale and household farmers because of its rapid growth, high feed conversion efficiency, valuable nutrients and relatively low investment costs. As a result, quail production provides substantial economic returns and becomes a notable contributor to rural areas. Besides, quail farming ensures the food security by providing sustainable protein source, particularly in regions where protein deficiencies are a major concern (Mulaudzi *et al*., 2022). Moreover, quails require low maintenance and insusceptible to diseases compared to chicken (Alam *et al*., 2023). However, they remain susceptible to coccidiosis which is ubiquitous disease in birds and poultry. It is caused by a genus of *Eimeria*, an intracellular protozoan parasite. In quails, the symptoms of coccidiosis have been well described as anorexia, weight loss, diarrhea, and dehydration, impaired reproduction and enteropathy, resulting in high mortality in young quails (Elmorsy *et al*., 2020; ElDeen *et al*., 2021; ElBakrey *et al*., 2025). During the invasion and replication of *Eimeria* species, *Eimeria* species invade and damage intestinal epithelium cells, resulting in reducing growth and intestinal lesions such as hemorrhage and necrosis. *E. tsunodai*, *E. bateri*, and *E. uzura* have been identified as common *Eimeria* species in Japanese quails (Zoroaster A *et al*., 2024). Interestingly, each *Eimeria* species possesses various pathogenicity to its own host. Therefore, accurate *Eimeria* species identification is necessary for implementing effective prophylaxis for coccidiosis in quails.

MATERIALS AND METHODS

Research site and sampling: The study was conducted in three areas, including Can Tho City, Vinh Long, and Tien Giang provinces in the Mekong Delta of Vietnam. Fresh fecal samples were collected weekly from the first week to the seventh week in small-scale quail farms from February

2022 to February 2023. The collected samples were carefully stored in zip-lock plastic bags and refrigerated at 4ºC until further examination. To ensure the precision of *Eimeria* species identification, the samples were examined within two days of collection.

Parasitological examination: The flotation method using a saturated solution of sodium chloride (NaCl d=1.2) was applied to screen for the presence of *Eimeria* species in fresh fecal samples. Thereafter, oocysts were collected and rinsed 3 times with tap water to eliminate excess saturated NaCl solution. Clean oocysts were sporulated in a solution containing 2.5% potassium dichromate ($K_2Cr_2O_7$) and incubated at room temperature. The number of coccidial oocysts in 1g of feces (OPG) was quantified by the McMaster method. The intensity of infection was categorized into four levels based on OPG, namely 1+ (fewer than 1,000 oocysts), 2+ (1,000-5,000 oocysts), 3+ (5,000-20,000 oocysts), and 4+ (more than 20,000 oocysts) (Jordan *et al.,* 2011).

Morphological identification of *Eimeria* species in quails: The morphological identification was based on parasitological criteria, including the shape, length, and width of oocysts and sporocysts, the presence or absence of micropyle, polar granule, Steida body, and sporulation time of 50 oocysts/ species. The morphological features and measurements of unsporulated and sporulated oocysts/ sporozoites were observed using a digital microscope (ECLIPSE Nikon 200) with software (DS-L4) to measure the two dimensions of the oocysts. The *Eimeria* species differentiation was established as compared to these morphological characteristics with previously published descriptions of *Eimeria* infecting quails.

Statistical analysis: The average measurements of oocyst and sporocysts, along with the differences in infection prevalence and infection intensity, were analyzed by descriptive statistics and the Chi-Square (χ^2) test using Minitab software (version 16). A $P<0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

The global quail population has been consistently grown due to its high-value nutrients and economic profitability; therefore, the quail farming in the Mekong Delta of Vietnam requires synchronization with veterinary measures to prevent poultry diseases, including coccidiosis.

However, sustainable farming is hindered by limited research on coccidiosis in quails, especially in *Eimeria* species identification. Thus, investigating the prevalence of infection rates as well as the circulation of *Eimeria* species is necessary. In this study, the overall infection rate of coccidiosis was 46.10% of all surveyed quails in the Mekong Delta. Our finding was consistent with the study in Iraq with 41.78%. However, the prevalence of our study was significantly lower than the studies in quail farms in Thi-Qar province (64.54%) (AL-Zarkoushi and AL-Zubaidi, 2022), and in El-Behera governorate, Egypt with 94.28% (Waheeb *et al*., 2022). The difference in infection rate of coccidiosis in quails may be influenced by geographical areas, the situation of farm management practices and using anticoccidial agents. Quail farming in Mekong Delta of Vietnam predominant conducted in small-scale, resulting insufficient attention to hygienic measures. The routine disinfection of husbandry facilities was rarely performed; consequently rising the risk of *Eimeria* transmission in quail flocks.

Young quails were highly susceptibility to coccidiosis infection during the third and fourth week of their development, which is intensively challenging for quail growth, particularly with the high infection intensities of the scale of 3+ and 4+ (Table 1). Therefore, it is necessity for quail farmers and health authorities to apply appropriate

Table 1: The prevalence of coccidiosis in quails in the Mekong Delta

Age (week)	Infection rate			Intensive infection							
				1+		2+		3+		4+	
	No. of surveyed quails	No. Infected quails	Infection rate (%)	No. infected quails	Infection rate (%)	No. infected quails	Infection rate (%)	No. infected quails	Infection rate (%)	No. infected quails	Infection rate (%)
1	150	0	0	-	-	-	-	-	-	-	-
2	150	27	18.00[a]	20	74.07	7	25.92	-	-	-	-
3	150	96	64.00[b]	46	47.92	10	10.42	16	16.67	24	25.00
4	150	116	77.33[c]	21	18.10	30	25.86	50	43.10	13	11.21
5	150	97	64.67[b]	23	23.71	43	44.33	31	31.96	2	2.06
6	150	89	59.33[b]	18	20.22	33	37.08	37	41.57	1	1.12
7	150	59	39.33[d]	24	40.68	21	35.59	14	23.73	-	-
Total	1050	484	46.10	152	31.40	144	29.75	148	30.58	40	8.26

a, b, c, d Values in the same column with different superscripts differ significantly ($P<0.05$).

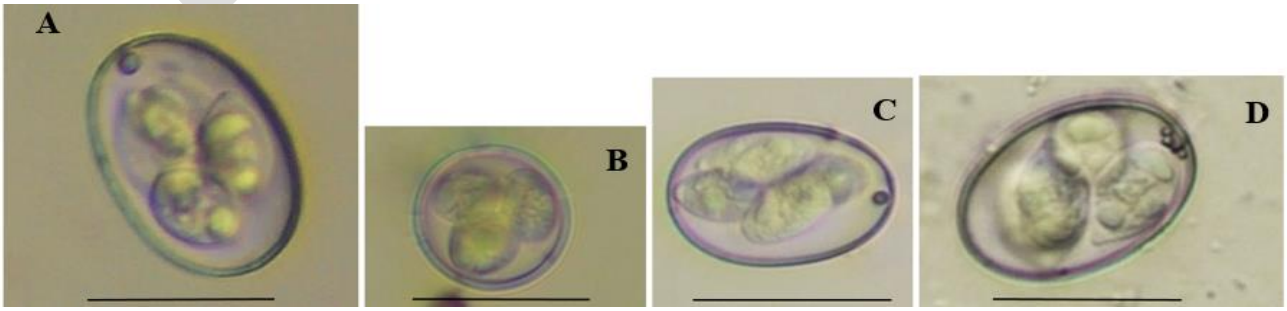

Fig 1: Typical micrographs of *Eimeria* species isolated from infected Japanese quails. Images were visualized under microscope x40, bar scale 20µm A. *E. bateri*, B. *E. fluminensis*, C. *E. tsunodai*, D. *E. uzura.*

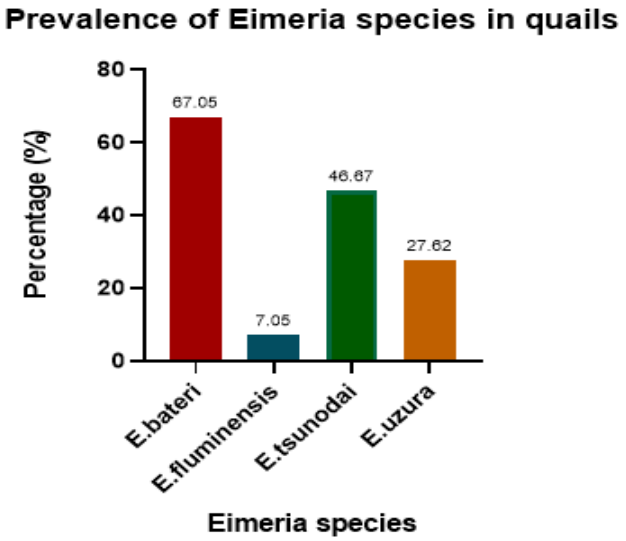

Fig 2: The prevalence of *Eimeria* species recovered from Japanese quail in Mekong Delta of Vietnam.

interventions such as diagnosis, and epidemiological surveillance to prevent coccidiosis. Due to the high host specificity of *Eimeria* species, the vaccine for broiler coccidiosis is not suitable for quails. Therefore, precise identification of *Eimeria* species plays a crucial role in predicting the pathogenicity of coccidiosis and in developing effective prophylaxis. Based on the morphological characteristics (Fig 1, Table 2 and 3) as well as the sporulation time of *Eimeria* species (Table 2), four various of *Eimeria* species were identified in infected quails, including *E. bateri*, E. *fluminensis, E. tsunodai*, and *E. uzura*. Those *Eimeria* species were frequently identified in Japanese quails (*Coturnix japonica*) in previous studies (Zoroaster *et al*., 2024). Among identified *Eimeria* species, *E. bateri* was the most dominant species, accounting for 67.05% of all infected quails (Fig 2). The *E. bateri* oocysts were ellipsoidal, smooth and bilayered, measured as 25.04±0.31µm in length and width, respectively. A single polar granule was present, whereas the micropyle and residual body were absent. The sporocyst body exhibited a prominent nipple-like structure. Although *E. bateri* was prevalent in quails, it has been considered moderately pathogenic, typically associated with mild clinical symptoms such as growth retardation and reduce the reproduction (Waheeb *et al*., 2022). *E. tsunodai* was the second dominant species among the sampled quails (46.67%); however, its pathogenicity has been considered as the highest one among *Eimeria* species in quails. Morphologically, *E. tsunodai* oocyst was sub-spheroidal to ellipsoidal (20.23±0.46µm x 14.92±0.33µm), with smooth and bilayered oocyst walls, and a shape index of 1.36. Both micropyle and residuum of oocysts were absent. Sporocysts were ovoidal, measuring 10.47±0.14µm x 6.29±0.12µm, and having a Steida body ranging from nipple-like to triangular shape. The residual body of sporocysts was present and composed of several granules. *E. tsunodai* poses a significant threat to quail farmers because it causes water diarrhea, bloody caecal lesion, cecal ballooning, and high mortality rates (Elmorsy *et al*., 2020, ElBakrey *et al*., 2025), which leads to economic loss of intensive quail farms. The other species found in the collected samples are *E. uzura* and *E. fluminensis,* with infection rates of 27.62% and 7.05% (Fig 2), respectively. In some documents, *E. uruza* was reported as having the presence of micropyle; however, the presence or absence of micropyle is still being discussed. The main distinct of this species is that there is agreement among scientists that it has many polar granules, which are 1 to 5 polar granules detected in sporulated oocysts (Waheeb *et al*., 2022; Zoroaster *et al*., 2024). Compared to the pathogenicity of *E. tsunodai*, *E. uzura* is considered to have mild pathogenicity which caused of inflammatory infiltrates, and villous erosion in the small intestine, along with diarrhea, emaciation and anemia, appearing 5 to 8 day post infection (Ramadan *et al*., 2021). *E. fluminensis* possesses a spherical or subspherical shape (Zoroaster *et al*., 2024), a characteristic distinction that facilitates the accurate identification of this species. Currently, there are no detailed studies about individual pathogenicity of *E. fluminensis* on quails. Therefore, the pathogenic role of this species remains unclear.

In conclusion, this current study is a pioneer in morphological identification of *Eimeria* species infected quails in the Mekong Delta of Vietnam, contributing updated information of the prevalence of *Eimeria* spp. in farm-raised quail populations across the surveyed areas. To strengthen species identification and ensure greater diagnostic precision, further studies are recommended to use molecular biological techniques in addition to morphological approaches.

Table 2: Observation of sporulation of *Eimeria* species recovered from quails *(Cortunix japonica)*

Species	Oocyst shape	Sporulation (Hours) in this study	Sporulation (Hours) References
Eimeria bateri	Subspheric to ellipsoidal	28-48	48-72 (Berto *et al*., 2008)
Eimeria fluminensis	Subspheric	48-70	48-72 (Bashtar *et al*., 2010)
Eimeria tsunodai	Subspheric to ellipsoidal	24-48	24-48 (Tsutsumi, 1972)
Eimeria uzura	Ovoidal	20-24	21-24 Tsunoda and Muraki, 1971)

Table 3: Morphological characteristics of *Eimeria* species recovered from quails (*Cortunix japonica*) in the Mekong Delta.

Species	Oocysts				Sporozoites				
	Morphology	Length $\bar{x}$ ± SEM (µm)	Width $\bar{x}$ ± SEM (µm)	Shape index	Polar granule	Shape	Length $\bar{x}$ ± SEM (µm)	Width $\bar{x}$ ± SEM (µm)	Shape index	Stieda body
Eimeria bateri	Subspheric to ellipsoidal	25.04±0.31	18.62 ± 0.27	1.35	Present	Ovoid	11.68±0.28	7.53±0.12	1.55	Nipple-like
Eimeria fluminensis	Subspherical	18.71±0.35	17.45±0.35	1.08	Absent	Ovoid	9.81±0.22	6.63±0.14	1.49	Piriform
Eimeria tsunodai	Subspheric to ellipsoidal	20.23±0.46	14.92±0.33	1.36	1-2	Ovoid	10.47±0.14	6.29±0.12	1.68	Nipple-like to triangular
Eimeria uzura	Ovoidal	22.06±0.40	16.02±0.41	1.4	2-5	Elongate	11.35±0.18	5.97±0.10	1.91	Knob-like

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Conflicts of interest: The authors declare no conflicts of interest.

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