TẠP CHÍ KHOA HỌC
TRƯỜNG ĐẠI HỌC SƯ PHẠM TP HỒ CHÍ MINH
Tập 23, Số 6 (2026): 1542-1552
Website: https://journal.hcmue.edu.vn
ISSN: 2734-9918

HO CHI MINH CITY UNIVERSITY OF EDUCATION
JOURNAL OF SCIENCE
Vol. 23, No. 6 (2026): 1542-1552
https://doi.org/10.54607/hcmue.js.23.6.5572(2026)

Research Article

TREMATODE INFECTIONS IN SNAILS FROM SMALL CANALS SUPPLYING WATER TO BLACK-SPOTTED CATFISH PONDS IN HUNG LONG COMMUNE, HO CHI MINH CITY, VIETNAM

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Received: February 03, 2026; Revised: March 16, 2026; Accepted: May 07, 2026

ABSTRACT

Foodborne zoonotic trematodes are an important public health concern in many countries, particularly in Southeast Asia. Previous studies have shown that black-spotted cultured catfish (Pangasius larnaudii) in cultured ponds in Hung Long commune, Ho Chi Minh City, are infected with fish-borne zoonotic trematodes (FZT). This study investigated whether water-supply canals contribute to transmission by carrying infected intermediate hosts and/or cercariae into black-spotted catfish ponds. Snails were collected from 16 small canals supplying water directly to black-spotted catfish ponds in Hung Long commune in January 2023 (dry season) and June 2023 (wet season) and examined for trematode larvae. A total of 2,065 snails representing nine species were examined. Four species—Indoplanorbis exustus, Lymnaea viridis, Bithynia siamensis, and Melanoides tuberculata—were infected with cercariae. Four cercarial morphotypes were identified: furcocercous, pleurolophocercous, xiphidio, and echinostome cercariae. Further studies should examine all water sources and seasonal patterns to inform trematode control, support the production of cercaria-free black-spotted catfish, and promote sustainable aquaculture and food safety.

Keywords: canals; catfish; cercariae; fish-borne zoonotic trematodes; snails

1. Introduction

Foodborne zoonotic trematodes (FZT) are an important public health concern in many countries (Chai et al., 2005; Chai & Lee, 2002), particularly in Southeast Asia (Keiser & Utzinger, 2005; WHO, 1995, 2002). Their distribution depends on interactions among hosts, parasites, environmental conditions, and food-consumption practices (WHO, 1995).

Snails serve as the first intermediate hosts in trematode transmission cycles (Thai, 2022). In northern Vietnam, trematode infections have been reported in eight snail species

Cite this article as: Ho, T. M., & Pham, C. T. (2026). Trematode infections in snails from small canals supplying water to black-spotted catfish ponds in Hung Long commune, Ho Chi Minh City, Vietnam. *Ho Chi Minh City University of Education Journal of Science, 23*(6), 1542-1552. https://doi.org/10.54607/hcmue.js.23.6.5572(2026)

in Nam Dinh Province (Bui et al., 2010). Besprozvannykh et al. (2013) detected cercariae in three snail species—*Bithynia fuchsiana* and *Parafossarulus striatulus* (Bithyniidae) and *Melanoides tuberculata* (Thiaridae)—and recorded 12 cercarial species from eight families. Nguyen et al. (2014) identified five cercarial groups in 11 snail species. In 2015, three cercarial groups were recovered from seven snail species, with *Melanoides tuberculata* showing the highest prevalence (Nguyen et al., 2015). Pham et al. (2019) reported cercarial infections in nine snail species.

Fish serve as second intermediate hosts for several FZT species in Vietnam. The most frequently reported species is *Haplorchis pumilio* (Dinh et al., 2010; Nguyen et al., 2007; Pham et al., 2007; Pham et al., 2009; Phan et al., 2010; Trinh et al., 2008). Other reported intestinal flukes include *Haplorchis taichui* and *Centrocestus formosanus* (Dinh et al., 2010; Pham et al., 2007; Pham et al., 2009; Phan et al., 2010; Trinh et al., 2008), *Haplorchis yokogawai* (Phan et al., 2010; Trinh et al., 2008), *Procerovum* sp. (Dinh et al., 2010; Nguyen et al., 2007; Phan et al., 2010), *Stellantchasmus falcatus*, and *Echinochasmus japonicus* (Trinh et al., 2008).

A study in Ho Chi Minh City detected *Haplorchis pumilio* and reported that 20.0% of ponds raising black-spotted catfish (*Pangasius larnaudii*) contained FZT-infected fish, primarily in Hung Long commune (Pham & Murrell, 2020). Catfish farmers obtain juveniles from hatcheries, where the fish appear to be free of trematode infection (Madsen et al., 2015b). Black-spotted catfish may therefore become infected during the grow-out phase through cercariae produced within ponds or introduced via water from external habitats, including small canals. However, the role of these canals in introducing infected snails or cercariae into ponds has not been investigated. This study therefore aimed to determine the species composition of snail communities and the prevalence of trematode infection in snails from small canals supplying water directly to black-spotted catfish ponds in Hung Long commune, Ho Chi Minh City.

2. Materials and methods

Study area and design

Hung Long commune is a suburban area of Ho Chi Minh City with extensive freshwater aquaculture. A cross-sectional survey of FZT infection in snails was conducted in 16 small canals in Hung Long area. Snails were collected in January 2023 (dry season) and June 2023 (wet season).

Snail collection

In each canal, snails were sampled using a 25-cm-wide dredge to scrape the canal bottom from the bank to a distance of 1.0 m. Three samples were collected per canal at points 100 m apart. The first sampling point was located at the water-supply inlet to the pond, and the other two points were located 100 m to either side of the inlet. Each sample was washed,

and the collected snails were placed in cloth bags and transported to the laboratory for examination. Snails were identified to species using the keys of Dang et al. (1979).

Examination for cercarial shedding

Snails were examined for cercarial shedding following Bui et al. (2010). Each snail was placed individually in a 100-mL plastic beaker and left for 12 h to allow shedding. The water in each beaker was examined for cercariae twice daily, at 08:00 and 14:00, for two days. Cercarial morphotypes were identified using the keys of Frandsen and Christensen (1984) and Schell (1985).

Data analysis

Data were entered in Microsoft Excel 2010 and analyzed using SPSS version 20 (SPSS Inc., Chicago, IL, USA). Chi-square tests were used to compare prevalence between seasons. A p value < 0.05 was considered statistically significant.

3. Results and discussion

Snail species composition in the 16 study canals

Nine snail species representing eight genera and six families were collected from the 16 small canals supplying water directly to back-spotted catfish ponds in Hung Long area. All species were found in both seasons. The total number of snails collected was slightly higher in the wet season (June; n = 1,050) than in the dry season (January; n = 1,015). *Pomacea canaliculata* was the dominant species in both seasons, accounting for 34.7% of specimens in the dry season and 23.2% in the wet season. Each of the other species accounted for less than 17.0% of the sample (Table 1).

Table 1. *Snail species composition in 16 canals supplying water directly to black-spotted catfish ponds in Hung Long commune, Ho Chi Minh City, Vietnam, in 2023*

Family	Genus	Species	In canals	
			Jan 2023 (n/%)	**June 2023 (n/%)**
Thiaridae	*Melanoides*	*Melanoides tuberculata* (Müller, 1774)	52/5.1	21/2.0
	Thiara	*Thiara scabra* (Müller, 1774)	59/5.8	77/7.3
Viviparidae	*Filopaludina*	*Filopaludina sumatrensis* (Dunker, 1852)	154/15.2	170/16.2
		Filopaludina martensi martensi (Frauenfeld, 1865)	105/10.3	164/15.6
Ampulariidae	*Pomacea*	*Pomacea canaliculata* (Lamarck, 1828)	352/34.7	244/23.2
	Pila	*Pila ampullacea* (Linnaeus, 1758)	89/8.8	145/13.8
Bithyniidae	*Bithynia*	*Bithynia siamensis* (Lea, 1856)	65/6.4	112/10.7
Bulinidae	*Indoplanorbis*	*Indoplanorbis exustus* (Deshayes, 1833)	75/7.4	55/5.2
Lymnaeidae	*Lymnaea*	*Lymnaea viridis* (Quoy & Gaimard, 1832)	64/6.3	62/5.9
		Total	1015/100	1050/100

The nine snail species recorded in this study are consistent with the nine species reported by Pham and Nguyen (2023) from rice fields in Binh Chanh, but slightly fewer than the 10 species recorded in sixth-order canals in the same area. These sixth-order canals connect rivers to the smaller canals examined in this study. The broadly similar species richness across small canals, sixth-order canals, and rice fields may reflect the relatively uniform environmental conditions within the study area. *Melanoides tuberculata*, an important first intermediate host of heterophyid FZT, was particularly abundant in small canals in Nam Dinh Province, northern Vietnam (Madsen et al., 2015b), and was the dominant snail species in canals in Cu Chi, Ho Chi Minh City (Pham et al., 2022). In the present study, however, the golden apple snail (*Pomacea canaliculata)* was the most abundant species. This invasive snail damages rice crops (de Brito & Joshi, 2016), adversely affects the growth and survival of *Pila polita* (Ngo & Tran, 2016), and may also affect other snail species. Controlling *Pomacea canaliculata* may therefore help protect local biodiversity.

Cercarial morphotypes

Four snail species collected from the small canals were infected with trematode cercariae: *Indoplanorbis exustus, Lymnaea viridis, Bithynia siamensis,* and *Melanoides tuberculata* (Figure 1). Prevalence was higher in the wet season than in the dry season for *Indoplanorbis exustus* (12.7% vs. 1.3%, $p < 0.05$), *Bithynia siamensis* (4.5% vs. 1.5%, $p > 0.05$), and *Melanoides tuberculata* (4.8% vs. 1.9%, $p > 0.05$). In contrast, prevalence in *Lymnaea viridis* was higher in the dry season (9.4%) than in the wet season (1.6%; $p > 0.05$) (Table 2).

Table 2. *Prevalence of trematode infection in snails collected from 16 canals supplying water directly to black-spotted catfish ponds in Hung Long commune, Ho Chi Minh City, Vietnam, in 2023*

Snail species	**In canals (Jan 2023 and June 2023) Infected/ Collected snails**			
	Jan (N)	**%**	**Jun (N)**	**%**
Indoplanorbis exustus	1/75	1.3	7/55	12.7
Lymnaea viridis	6/64	9.4	1/62	1.6
Bithynia siamensis	1/65	1.5	5/112	4.5
Melanoides tuberculata	1/52	1.9	1/21	4.8

a. Bithynia siamensis *b. Melanoides tuberculata*

c. Lymnaea viridis *d. Indoplanorbis exustus*

Figure 1. *Snail species infected with trematode cercariae*

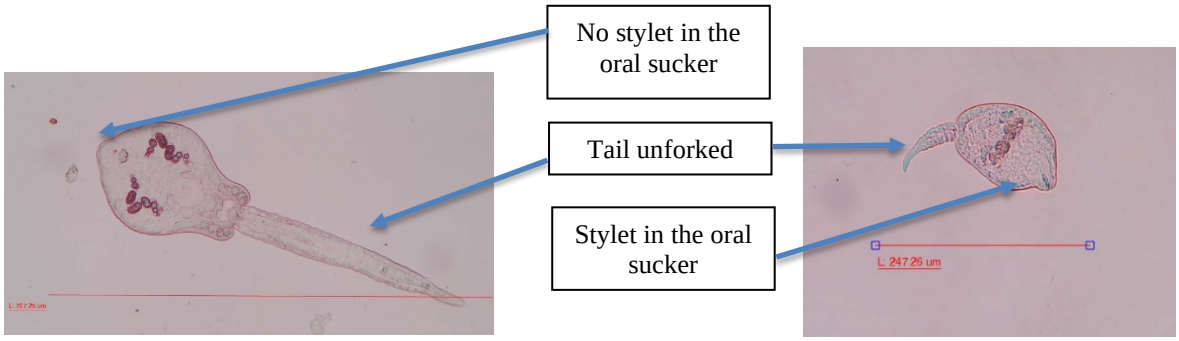
Across both seasons, the combined prevalence of FZT infection was highest in *Indoplanorbis exustus* (6.2%), followed by *Lymnaea viridis* (5.6%), *Bithynia siamensis* (3.4%), and *Melanoides tuberculata* (2.7%). *Indoplanorbis exustus* has also been reported with an infection prevalence of 11.1% in Phu Yen, central Vietnam (Nguyen et al., 2014); however, the present study is the first to record infected Indoplanorbis exustus in Ho Chi Minh City. *Lymnaea viridis* was not infected with FZT in Cu Chi (Pham & Duong, 2023) or Nha Be (Pham, 2023), whereas infected Lymnaea viridis has been reported from rice fields in Binh Chanh (Pham et al., 2023). This result suggests that *Lymnaea viridis* in Hung Long commune may be more likely to harbor FZT than populations in other parts of Ho Chi Minh City. *Bithynia siamensis* and *Melanoides tuberculata* were also infected, although their prevalence was lower than that reported in other areas (Madsen et al., 2015a; Nguyen et al., 2014) and lower than that of Indoplanorbis exustus and Lymnaea viridis in the present study. Nevertheless, these findings confirm that Bithynia siamensis and Melanoides tuberculata are commonly infected across different types of water bodies. In Nam Dinh Province, *Melanoides tuberculata* had the highest overall prevalence, while *Melanoides tuberculata* and *Bithynia* spp. harbored the greatest diversity of trematodes (Bui et al., 2010). These were also the only two snail taxa infected with FZT in rice fields in Can Gio, Ho Chi Minh City (Nguyen & Pham, 2022).

Seasonal patterns of FZT infection varied among snail species. Prevalence was significantly higher in the wet season than in the dry season for *Indoplanorbis exustus* ($p < 0.05$), *whereas the wet-season increases for Bithynia siamensis* and *Melanoides tuberculata* were not statistically significant ($p > 0.05$). This result is consistent with findings from Can Gio, Ho Chi Minh City, where prevalence was substantially higher in the wet season (Nguyen & Pham, 2022). Conversely, Lymnaea viridis showed a higher prevalence in the dry season, although the difference was not statistically significant ($p > 0.05$). This result is consistent with Nguyen et al. (2014), who reported higher trematode larval infection in snails during the dry season, possibly because of temperature, and with Nkwengulila and Kigadye (2005), who found that cercarial prevalence peaked during the dry season and declined during the wet season. The effects of season on FZT prevalence in snails, therefore, remain uncertain and warrant further investigation.

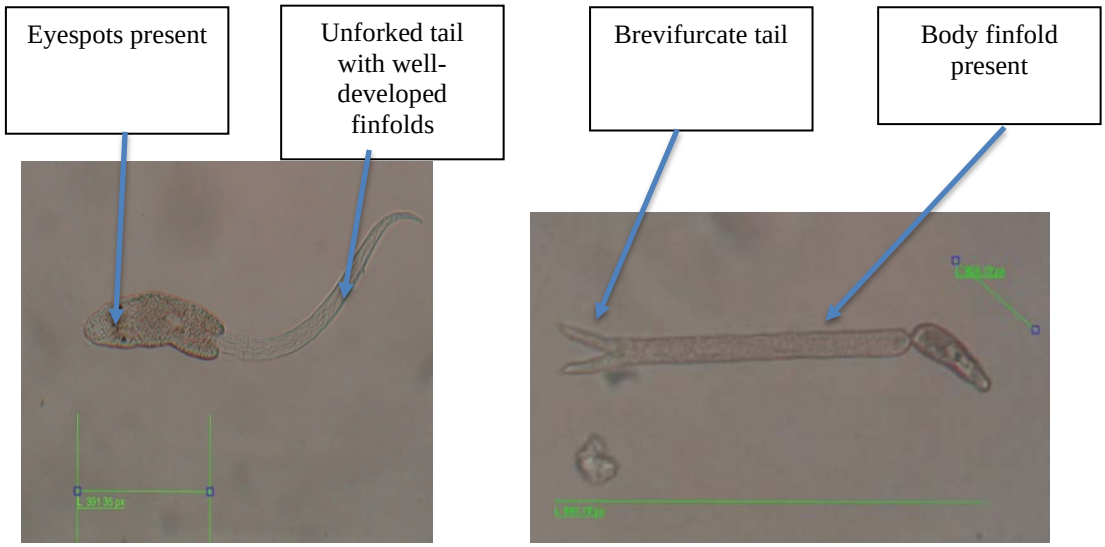
Four cercarial morphotypes were recovered from the collected snails: furcocercous, pleurolophocercous, xiphidio, and echinostome cercariae (Figure 2). *Indoplanorbis exustus* and *Melanoides tuberculata* were infected with echinostome cercariae. *Lymnaea viridis* harbored both furcocercous and echinostome cercariae, whereas *Bithynia siamensis* harbored pleurolophocercous and xiphidio cercariae (Table 3).

Table 3. *Numbers of snails infected with different cercarial morphotypes in 16 canals supplying water directly to black-spotted catfish ponds in Hung Long commune, Ho Chi Minh City, Vietnam, in 2023*

Infected snail species	Jan 2023	Jun 2023
Indoplanorbis exustus (N=8)	Echinostome cercariae	Echinostome cercariae
Lymnaea viridis (N=7)	Furcocercous cercariae, Echinostome cercariae	Echinostome cercariae
Bithynia siamensis (N=6)	Pleurolophocercous cercariae	Xiphidio cercariae
Melanoides tuberculata (N=2)	Echinostome cercariae	Echinostome cercariae



a. Echinostome cercariae *b. Xiphidio cercariae*



c. Pleurolophocercous cercariae *d. Furcocercous cercariae*

Figure 2. *Cercarial morphotypes identified in the study*

Xiphidio cercariae were the most prevalent morphotype in the study by Nkwengulila and Kigadye (2005), as well as in the Kenh Lang–Ben Muong Canal in Cu Chi (Pham et al., 2022) and in Can Gio (Nguyen & Pham, 2022). In the present study, however, only four snails were infected with xiphidio cercariae. Furcocercous cercariae were also rare, occurring in only one snail, whereas echinostome cercariae were the most common morphotype, occurring in 15 of the 23 infected snails. This finding is consistent with Nguyen et al. (2014), who reported echinostome cercariae in five of eight infected snail species in Phu Yen. Echinostome cercariae were also detected in nine snails in Nam Dinh Province (Madsen et al., 2015a), but in only one snail from a rice field in Nha Be (Pham, 2023) and two snails from a rice field in Binh Chanh (Pham et al., 2023). Another notable finding was the detection of pleurolophocercous cercariae in *Bithynia siamensis*. Pham and Murrell (2020) reported metacercariae of *Haplorchis pumilio*, a species in the family Heterophyidae (Chai et al., 2005), in black-spotted catfish from Hung Long commune. Pham and Nguyen (2005) identified pleurolophocercous cercariae as belonging to Heterophyidae. The presence of these cercariae in *Bithynia siamensis* suggests that infected snails in water-supply canals may contribute to trematode transmission to pond-raised black-spotted catfish in Hung Long commune. This finding helps address the previously unresolved source of FZT infection in local catfish and may inform control measures for a commercially important freshwater fish. Further monthly sampling of canal snails is needed to identify seasonal peaks in FZT infection and develop strategies to reduce transmission to fish, thereby supporting more sustainable aquaculture.

This study identified snail species and characterized their cercariae in small canals supplying water directly to black-spotted catfish ponds in Hung Long commune, Ho Chi

Minh City, Vietnam. However, it had four major limitations. First, some photographs of cercariae were of insufficient quality to show all morphological features clearly. Second, although associations between cercariae and metacercariae were considered, the two stages were collected from different water bodies and therefore could not be linked conclusively. Third, the life cycles of the detected cercariae were not completed experimentally, preventing identification of the corresponding adult trematodes. Finally, no molecular analyses were conducted to support morphological identification, which may be less precise. Future studies should combine improved imaging, life-cycle experiments, and molecular methods to achieve more accurate identification.

4. Conclusion

Nine snail species representing 8 genera and 6 families were identified in 16 canals supplying water directly to black-spotted catfish ponds in Hung Long commune, Ho Chi Minh City, Vietnam. Four species—*Indoplanorbis exustus, Lymnaea viridis, Bithynia siamensis,* and *Melanoides tuberculata*—were infected with trematode cercariae, whereas the other five species were uninfected. Four cercarial morphotypes were identified: furcocercous, pleurolophocercous, xiphidio, and echinostome. The detection of pleurolophocercous cercariae in *Bithynia siamensis* suggests that infected snails in water-supply canals may contribute to FZT transmission in pond-raised black-spotted catfish. Additional sampling across months and water bodies in Hung Long commune is needed to identify sources and seasonal patterns of FZT transmission and support the production of FZT-free fish.

❖ ***Conflict of Interest:*** *Authors have no conflict of interest to declare.*

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SÁN LÁ SONG CHỦ TRONG CÁC KÊNH NHỎ CUNG CẤP NƯỚC TRỰC TIẾP CHO AO NUÔI CÁ VỒ ĐÉM Ở XÃ HƯNG LONG, THÀNH PHỐ HỒ CHÍ MINH, VIỆT NAM

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Ngày nhận bài: 03-02-2026; Ngày nhận bài sửa: 16-3-2026; Ngày duyệt đăng: 07-5-2026

TÓM TẮT

Sán lá song chủ gây bệnh qua thức ăn là một vấn đề về y tế công cộng ở nhiều quốc gia, đặc biệt là ở Đông Nam Á. Các nghiên cứu trước đây đã chỉ ra rằng cá vồ đém (Pangasius larnaudii) nuôi trong ao tại xã Hưng Long, Thành phố Hồ Chí Minh bị nhiễm sán lá song chủ. Nghiên cứu này muốn tìm hiểu xem các nguồn nước cung cấp cho ao nuôi có thể góp phần vào quá trình truyền bệnh bằng cách đưa kí chủ trung gian và/hoặc ấu trùng sán lá giai đoạn cercariae vào ao hay không. Nghiên cứu về ấu trùng sán lá (giai đoạn cercariae) từ ốc thu thập trong 16 kênh nhỏ cung cấp nước trực tiếp cho ao nuôi cá vồ đém ở xã Hưng Long, Thành phố Hồ Chí Minh, Việt Nam đã được tiến hành vào tháng 1 (mùa khô) và tháng 6 (mùa mưa) năm 2023. Tổng cộng có 2065 con ốc thuộc 9 loài đã được kiểm tra. Bốn loài bị nhiễm sán lá (giai đoạn cercariae) là Indoplanorbis exustus, Lymnaea viridis, Bithynia siamensis và Melanoides tuberculata. Có bốn dạng hình thái cercariae, gồm furcocercous, pleurolophocercous, xiphidio và echinostome đã được phát hiện. Nghiên cứu thêm về tất cả nguồn nước cung cấp cho cá vồ đém nuôi trong ao để có thể kiểm soát sán lá song chủ và sản xuất cá không có cercariae cần được thực hiện nhằm góp phần vào phát triển nuôi trồng thủy sản bền vững và đảm bảo an toàn thực phẩm.

***Từ khóa*:** kênh; cá vồ đém; cercariae; sán lá song chủ; ốc