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Chemosensory-Driven Foraging and Nocturnal Activity in the Freshwater Snail *Rivomarginella morrisoni* (Gastropoda, Marginellidae): A Laboratory-Based Study

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Abstract

Rivomarginella morrisoni is a freshwater snail endemic to Thailand, yet its behavioral ecology remains poorly understood. This study described the feeding behavior of *R. morrisoni*, focusing on its foraging activity, behavioral patterns, and food detection mechanisms under laboratory conditions using specimens collected from four river basins in central Thailand. Daily monitoring revealed nocturnal emergence, peaking between 21:00 and 22:00 h, with stable rhythms established 72 h post-feeding. Feeding trials revealed a preference for aged shrimp over fresh or decayed ones. Behavioral observations confirmed that food localization in *R. morrisoni* was mediated by chemical cues. Light–dark tests indicated a slight tendency toward darkness, but no significant phototactic response was observed. These findings suggest that *R. morrisoni* is a generalist scavenger with chemosensory-driven foraging and nocturnal activity. Its apparent sensitivity to habitat disturbance underscores the relevance of behavioral studies for informing future conservation and captive breeding efforts.

Keywords: circadian rhythms; food detection; snail behavior

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1. Introduction

Rivomarginella morrisoni Brandt, 1968 is a freshwater gastropod endemic to Thailand and one of only two freshwater representatives of the predominantly marine family Marginellidae [1,2]. Found in several major river basins in central, eastern, and southern Thailand, the species inhabits sandy, flowing freshwater environments. Despite its distinct taxonomic status and restricted distribution, this species' basic biology, ecological role, and behavioral adaptations remain poorly understood. The species is listed as Data Deficient on the IUCN Red List [3], highlighting the need for foundational ecological research to support future conservation and management efforts.

Urban development and constructing concrete embankments for flood control have increasingly altered freshwater habitats in Thailand and Southeast Asia [4]. These changes may threaten *R. morrisoni*, which relies on natural sandy substrates. Understanding its behavioral ecology, particularly foraging patterns and activity rhythms, can inform conservation strategies, including ex situ cultivation and potential restocking in suitable environments [5]. In many freshwater gastropods, behavioral rhythms are closely tied to diel cycles, with nocturnal activity being common in benthic habitats [6,7]. Direct observation

of *R. morrisoni* in situ is difficult due to its small size, benthic habit, and sand-burrowing behavior. Laboratory-based experiments conducted under ex situ conditions thus provide a practical approach to obtain detailed ecological and behavioral data. These controlled studies enable detailed investigation of behavior and ecology under standardized conditions, offering critical insights that form a scientific basis for conservation-oriented research [8].

Among aquatic gastropods, foraging behavior is primarily guided by chemosensory input, which enables organisms to detect food sources, avoid predators, and navigate their environment. Sensory organs such as tentacles and the osphradium play critical roles in these processes [9,10]. Feeding strategies in gastropods are diverse, ranging from herbivory and scavenging to active predation, depending on their ecological role [11]. Like other neogastropods, members of the family Marginellidae are generally carnivorous [12], possessing a rachiglossate radula adapted for consuming animal tissue [1,2]. Although morphological characteristics of *R. morrisoni* are consistent with this feeding mode, few studies have directly examined its feeding behavior or trophic strategy under experimental conditions.

Therefore, this study provides laboratory-based insights into the behavioral responses of *R. morrisoni* to food-related sensory cues and its diel activity under laboratory conditions. Specifically, we evaluate (1) the role of chemosensory versus visual cues in food detection, (2) food preference across fresh, aged, and decayed food, and (3) the snail's nocturnal emergence pattern as an indicator of circadian foraging behavior. The findings are expected to deliver baseline data directly applicable to ex situ conservation planning and to guide the development of laboratory-based breeding protocols for population reinforcement and future reintroduction.

2. Materials and Methods

2.1. Sample Collection

R. morrisoni specimens were collected from four river basins in Central Thailand, Bang Pakong (Kabinburi District, Prachin Buri Province; 13°59′07.5″ N, 101°42′30.8″ E), Pa Sak (Raphiphat Canal, Phra Nakhon Si Ayutthaya Province; 14°32′08.5″ N, 100°45′01.8″ E), Tha Chin (Sam Chuk District, Suphan Buri Province; 14°46′23.9″ N, 100°05′19.8″ E), and Mae Klong (Khlong Khoi Subdistrict, Ratchaburi Province; 13°40′10.3″ N, 99°49′00.5″ E), between 26 and 29 March 2023. Sampling was conducted during daylight using a randomized sand-sieving technique (mesh size < 10 mm). To characterize habitat conditions, basic water quality parameters, including pH, conductivity, total dissolved solids (TDS), and salinity, were measured in situ at each site using a SeaSun Multi Tester (Sea & Sun Technology, Germany). Specimens were transported in 5 L plastic containers filled with site water and maintained under continuous aeration.

Only mature individuals, identified by a thickened outer lip, indicative of adulthood in *R. morrisoni*, were selected for this study. Juveniles were excluded to minimize ontogenetic variation. Due to the absence of external sexual dimorphism, individuals were not sexed. Specimens were morphologically verified according to Brandt (1968) [1], with expert confirmation by Asst. Prof. Pongrat Dumrongrojwattana. Diagnostic features included a thick, smooth outer lip with a columella bearing four oblique folds, the soft body is whitish with black spots, paired elongate tentacles with basal eyes, and a long siphon positioned between the tentacles (Figure 1a,b), which are key characteristics of *R. morrisoni* as previously described in earlier taxonomic studies [1,2].

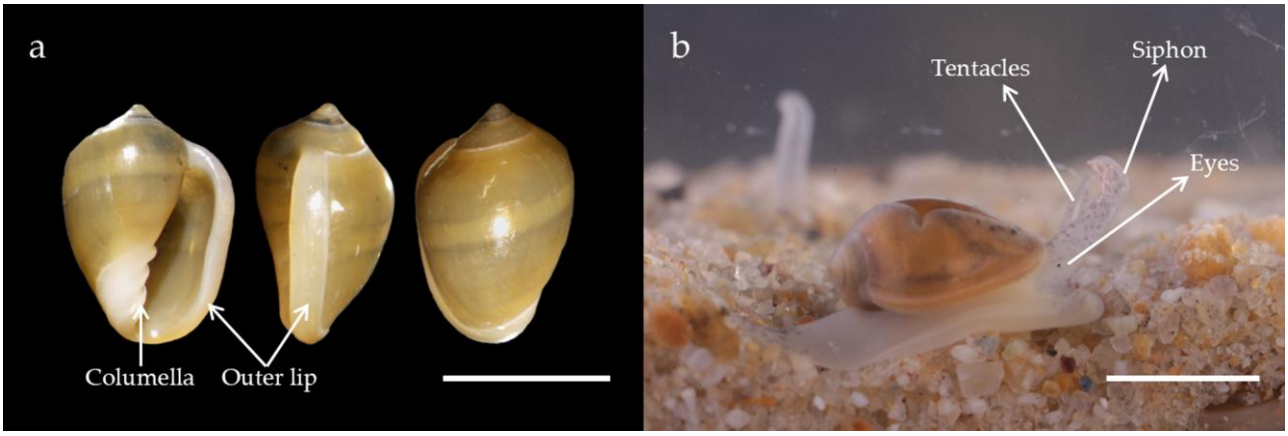


Figure 1. The morphological diagnostic features of *R. morrisoni* (Brandt, 1968) used in this study: (**a**) the shell exhibited a thick, smooth outer lip with the columella, (**b**) live specimens displayed tentacles with eyes positioned and a siphon photographed under laboratory conditions—scale bar: 5 mm.

Individuals from all locations were pooled before experimentation to reduce potential maternal or site-specific effects. One hundred adults (25 per site) were housed in aerated glass tanks (13 × 39 × 20 cm) with a sandy substrate at 25 °C. All snails underwent a 3-day food deprivation period for acclimation, following the protocol of Kimberly and Salice (2012) [13], to standardize their physiological states before behavioral trials.

2.2. Daily Foraging Behavior Observation

Twenty adult *R. morrisoni* individuals, randomly collected from the pooled collection, were housed in a transparent glass tank (13 × 39 × 20 cm) (Figure 2a) containing a fine sand substrate suitable for burrowing (grain size < 0.5 mm; approximately 3–5 cm depth). The substrate used in all tanks consisted of sand collected from the same locality where *R. morrisoni* specimens were obtained. The sand was thoroughly rinsed with clean freshwater to remove debris and fine sediment. Aeration was provided using a single air stone positioned centrally at the rear corner of each tank to ensure uniform circulation and prevent direct disturbance to the snails. The air flow rate was maintained at approximately 3 L/min, using an SOBO SB-228 air pump (Zhongshan SOBO Electric Appliance, Guangdong, China), which kept the water well-oxygenated throughout the experiment. The tank was maintained at 25 °C under controlled laboratory conditions. Live *Macrobrachium lanchesteri* (De Man, 1911) (freshwater shrimp) and *Filopaludina martensi* (Frauenfeld, 1864) (freshwater snail) were introduced, but no predation or feeding responses were observed, indicating scavenging tendencies. Consequently, all subsequent feeding trials used only dead shrimp. Snails were fed once at 21:00 h on the first day of observation, based on prior trials showing peak emergence between 18:00 and 22:00 h. Uneaten food was removed the following morning to prevent water deterioration and residual chemical cues that could influence subsequent behavior. No additional feeding was provided during the 7-day observation period to ensure consistent hunger levels and to avoid the confounding effects of repeated food stimuli. Hourly observations were conducted for seven consecutive days to monitor activity. The active proportion was calculated as the number of emerged snails divided by the total number per replicate (20 individuals; three replicates) and expressed as a percentage, following and modified from the methods of Lombardo et al. (2010) [14] and Ng et al. (2021) [15].

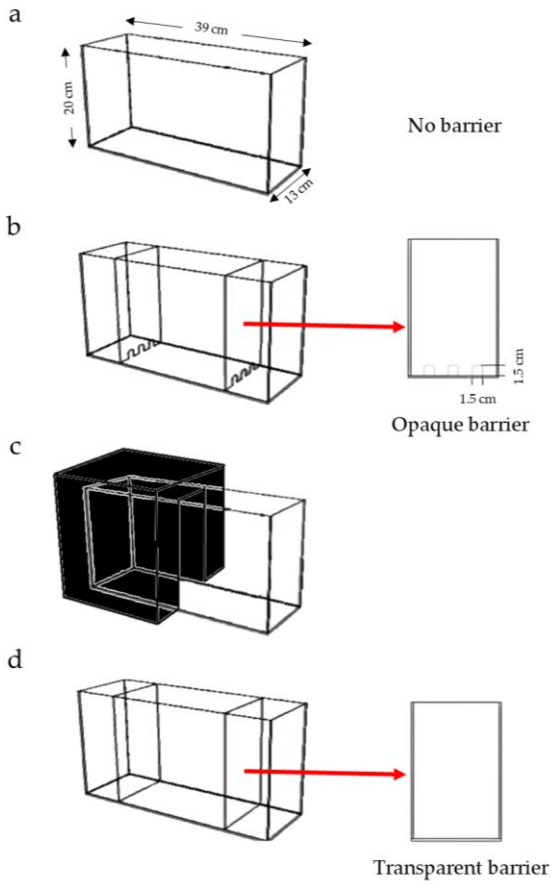


Figure 2. Experimental tank setups: (**a**) transparent glass tank for daily foraging observation; (**b**) tank with opaque barrier and base perforations for chemosensory detection; (**c**) tank partially covered with a black box for light/dark locomotion test; (**d**) tank with transparent barrier (no perforations) for visual cue detection.

2.3. Food Type and Freshness Preference Experiments

Feeding preference trials were conducted using a modified design based on Will (2009) [16], employing a tank fitted with an opaque barrier containing three 1.5 cm diameter perforations at its base (Figure 2b). Two experimental factors were tested: (1) food type, *M. lanchesteri* (shrimp), *Pangasius pangasius* (Hamilton, 1822) (fish), and *F. martensi* (snail); and (2) food freshness, fresh (immediately prepared), aged (stored at room temperature for 6 h), and decayed (stored for 12 h). All bait species used in the feeding experiments are naturally found in Thai freshwater river systems, representing ecologically relevant food sources available within the natural habitat of *R. morrisoni*. Food items (~400 mg each) were blotted dry with tissue paper before weighing to minimize variation due to water content, and were randomly assigned to perforation sites to avoid positional bias in each replicate. Ten adult *R. morrisoni*, randomly selected from a group not previously exposed to food cues, were released at the tank center. Snail responses were recorded every 15 min for 3 h by counting the number of individuals in contact with each food source. The remaining food was weighed after each trial to estimate consumption. Bait was blotted dry with tissue paper before weighing, following the same procedure used during the initial preparation. All experiments were conducted at 25 °C with continuous aeration.

2.4. Locomotion Under Light and Dark Conditions

A transparent glass tank was partially covered with an opaque black box to assess light sensitivity and create distinct light and dark zones (Figure 2c). Light intensity was measured using a FLUKE 941 light meter (FLUKE, Everett, WA, USA). Ten adult *R. morrisoni*

individuals were randomly selected and released at the center of the tank without food. Snail positions were recorded every 15 min over 3 h, noting the number of individuals in each zone to evaluate locomotor preference.

2.5. Chemosensory Food Detection

This experiment excluded visual stimuli to isolate chemical cues. The tank was divided by an opaque barrier containing three perforations at its base, allowing the diffusion of chemical cues and the passage of snails (Figure 2b). Before use, the barrier's permeability was tested by adding potassium permanganate crystals to one side to confirm gradual diffusion of the colored solution through the perforations. A food item (~400 mg) was placed near the perforations on one side (bait-present). In contrast, the opposite side remained food-free (bait-absent). Ten adult *R. morrisoni* individuals were randomly selected and released at the center of the tank. Snail positions were recorded every 15 min for 3 h to assess directional movement. All trials were video-recorded using a camera mounted above the tank.

2.6. Visual Food Detection

This experiment replicated the design of the chemosensory detection trial, using the same number of snails, observation protocol, and recording method. However, a transparent barrier without perforations (Figure 2d) allowed visual access to the food while preventing chemical diffusion. Before the experiment, the barrier's watertightness was verified by adding colored water to one side and observing for 30 min; no leakage or diffusion was detected across compartments. This setup ensured that only visual cues were available for food detection.

2.7. Statistical Analysis

All experiments were performed in three independent replicates (n = 3), with each replicate consisting of a separate tank containing 10 individuals (for daily foraging behavior, 20 individuals per replicate). Each tank was considered an independent experimental unit to ensure statistical independence. Repeated observations within the same tank (e.g., hourly records) were used solely for descriptive purposes and were not treated as independent data points in hypothesis testing. Data on daily foraging behavior and the weight of remaining food are expressed as mean ± standard deviation (SD). For preference experiments, data were aggregated over time for each tank, and Chi-square tests were used to assess associations between food type, food freshness, light/dark locomotion, chemosensory responses, and visual food detection. Statistical significance was determined at $p < 0.05$. All analyses were conducted using IBM SPSS Statistics version 29.

3. Results

3.1. Specimen Information

One hundred adult *R. morrisoni* specimens (25 from each of the four river basins: Mae Klong, Pa Sak, Tha Chin, and Bang Pakong) were collected and pooled for laboratory experiments. All individuals were morphologically consistent across sampling sites. To minimize environmental variation, snails were acclimated under identical conditions for 3 days without feeding before behavioral assays, thereby standardizing physiological states across populations. Water quality at all sites was consistent and typical of freshwater habitats, with a pH range of 7.80 to 7.85, conductivity between 175 and 249 µS/cm, total dissolved solids ranging from 86 to 124 ppm, and no detectable salinity. Water temperatures ranged from 24 °C to 28 °C.

3.2. Feeding Behavior and Daily Activity

Twenty *R. morrisoni* were housed in a transparent glass tank (13 × 39 × 20 cm) with a fine sand substrate. Upon introduction, individuals burrowed into the sand, exposing only the siphonal tip. Preliminary trials with live *M. lanchesteri* and *F. martensi* elicited no predatory or feeding responses. These results suggest that the species is not an active predator but instead functions as a scavenger with a strong preference for animal-based material. Accordingly, subsequent trials focused exclusively on scavenging behavior, using dead shrimp as bait. Following a single feeding at 21:00 h on day 1, snails consistently emerged from the substrate and aggregated around the food source, demonstrating clear group feeding behavior (Figure 3a). Individuals approached the bait by extending the siphon and elongated proboscis; rasping movements of the mouth on the food surface were observed (Figure 3b). Feeding lasted approximately 30–60 min, after which individuals gradually reburied. Hourly observations over 7 days (n = 3 independent replicates) revealed distinct nocturnal emergence patterns in *R. morrisoni*. Activity typically began around 18:00 h, with most individuals emerging between 20:00 and 22:00 h. Peak emergence was recorded at 21:00 h on days 4, 5, and 7, but shifted to 22:00 h on day 6 (Figure 4). The proportion of active individuals declined after 22:00 h each night. Behavioral rhythms stabilized approximately 72 h after feeding, suggesting an endogenous circadian pattern consistent with nocturnal foraging.

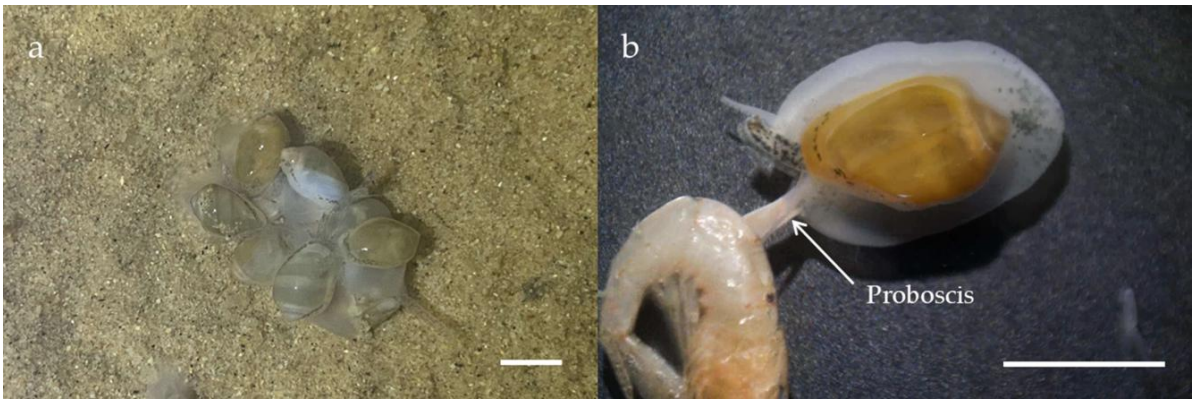


Figure 3. The feeding behavior of *R. morrisoni*: (**a**) group feeding behavior and (**b**) an individual extending its cylindrical proboscis to rasp the food surface. Scale bars: 5 mm.

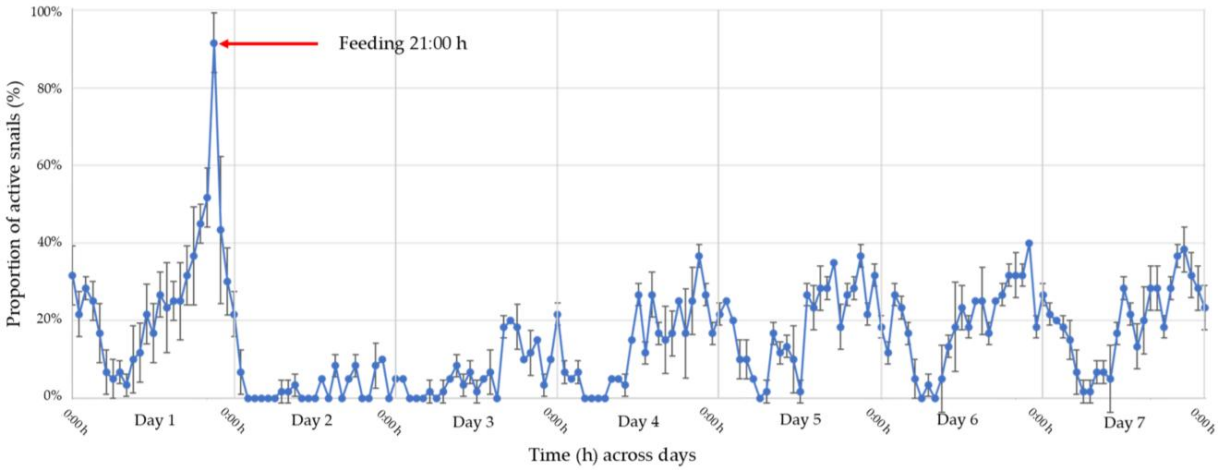


Figure 4. The hourly emergence patterns of *R. morrisoni* over 7 days. Snails were fed once on day 1 at 21:00 h, and the proportion of individuals visible above the sand was recorded hourly and expressed as a percentage. Peak emergence occurred at 21:00 h on days 4, 5, and 7, but shifted to 22:00 h on day 6. Error bars represent SD (n = 3 independent tanks, each with 20 individuals).

3.3. The Food Type and Food Freshness Preferences

A limitation encountered during the feeding preference experiments was that it was impossible to control or force the snails to choose specific food types or freshness levels at a given time, which affected the applicability of the Chi-square test. Therefore, the number of individuals attached to the bait at each observation interval was used to calculate the proportion of active responses. Each trial consisted of 10 individuals per replicate, with three replicates (30 snails total) observed over 12 time intervals, resulting in a maximum of 360 potential bait contacts. However, the actual number of bait contacts was lower because not all individuals were active at every interval. This reduction was likely due to asynchronous feeding behavior among individuals, including differences in the timing of feeding initiation, pauses, and repeated feeding events. As a result, 195 bait contacts were recorded for the food type preference test and 199 for the food freshness preference test.

The food type and freshness preferences of *R. morrisoni* were observed for 3 h using a tank with three perforations at its base. The snails' responses to different food types (shrimp, fish, and snails) (Figure 5) and food freshness conditions (fresh, aged, and decayed shrimp) were recorded every 15 min. Chi-square analysis was performed using data aggregated across time (three independent tanks per treatment), as repeated observations within the same tank were not considered independent. The results revealed a significant preference for shrimp (83.59%) over snail (14.87%) and fish (1.54%) ($p < 0.05$). Similarly, shrimp consumption (35.67 ± 5.91 mg) was markedly higher than that of fish (2.00 ± 2.83 mg) and snails (4.33 ± 3.00 mg).

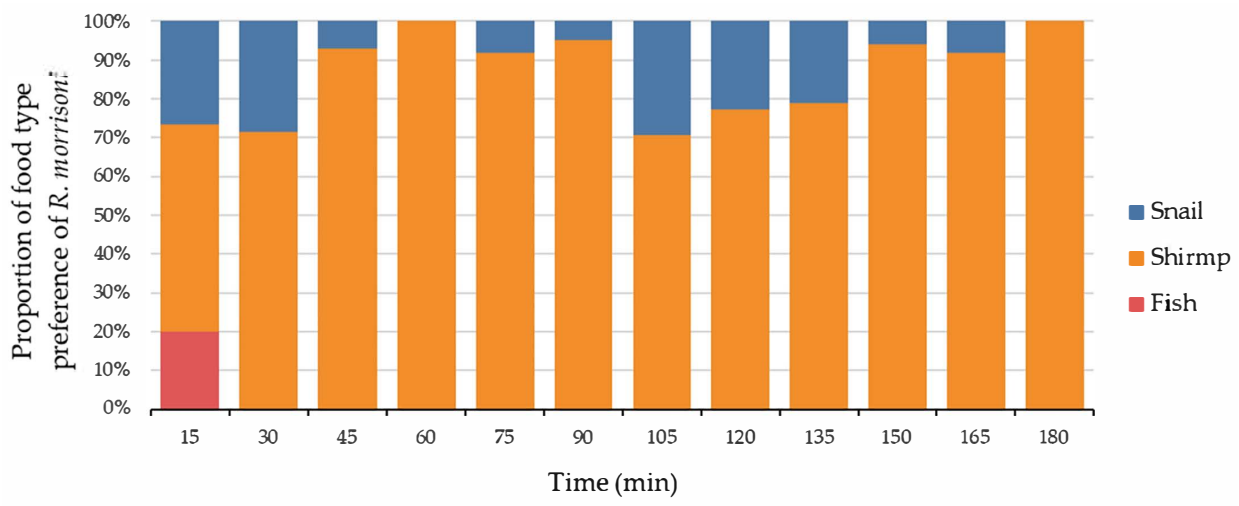


Figure 5. The proportion of food type preference of *R. morrisoni* among shrimp, fish, and snail, based on trials with 10 individuals per replicate and three independent replicates ($n = 3$ tanks) recorded over 3 h.

The food freshness preference experiment and the food type preference experiment revealed that *R. morrisoni* significantly preferred shrimp. To explore this preference, shrimp were prepared under three conditions (fresh, aged, and decayed). During the first 15 min, *R. morrisoni* exhibited no movement toward fresh shrimp. The highest preference for fresh shrimp was observed at 60 min, exceeding 66.67% (Figure 6). Based on the Chi-square analysis using three independent replicates, and excluding temporal dependence within tanks, the results indicated no significant preference among fresh (44.22%), aged (37.19%), and decayed shrimp (18.59%) ($p > 0.05$). Although the association proportion was similar between fresh and aged shrimp during most observation periods, as shown in Figure 6. However, throughout the experiment, *R. morrisoni* showed a preference for aged shrimp, with aged shrimp consumption (29.33 ± 5.56 mg) higher than that of fresh shrimp

(16.00 ± 4.32 mg), and decayed shrimp were consistently less preferred (10.67 ± 7.32 mg). The results highlight *R. morrisoni*'s strong preference for aged shrimp.

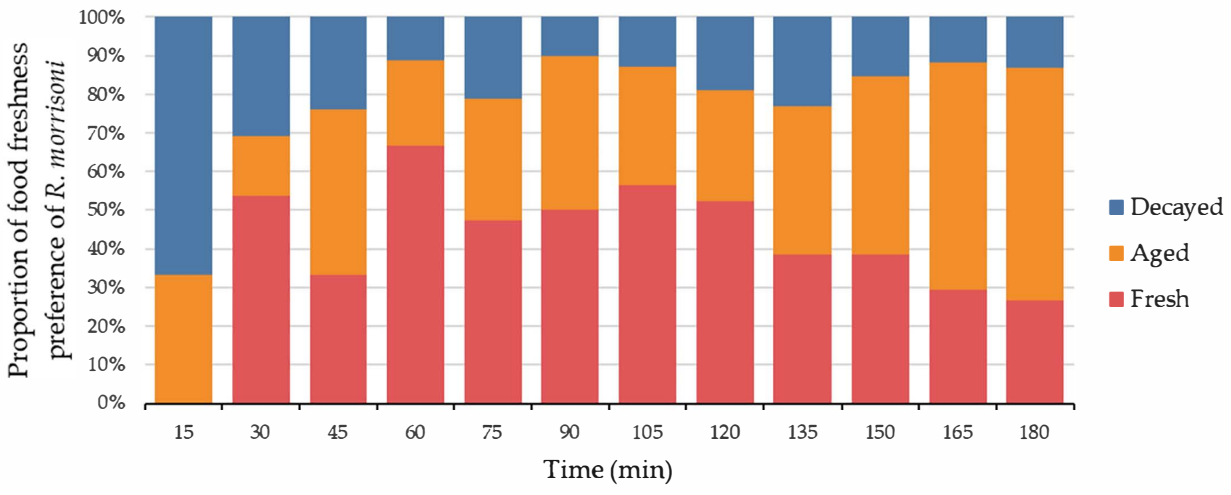


Figure 6. The proportion of food freshness preference of *R. morrisoni* among fresh, aged, and decayed shrimp, based on trials with 10 individuals per replicate and 3 independent replicates (n = 3 tanks) recorded over 3 h.

3.4. Light and Dark Locomotion Behavior

The locomotion of *R. morrisoni* was observed over 3 h, with recordings taken every 15 min (resulting in 12 observations per experiment). Light intensity was 0 lux in the dark and 300 lux in the light areas. The snails exhibited random movement with no significant preference for either area (Figure 7). Although the dark area showed a slightly higher proportion at certain intervals, the overall distribution fluctuated. Snails were more frequently observed in the dark area seven times and in the light area four times, with an equal distribution at 135 min. Peak proportion occurred 60 min in the dark and 120 min in the light areas. Chi-square analysis, performed using time-aggregated data to avoid temporal dependence, confirmed no significant preference between dark (51.67%) and light (48.33%) areas ($p > 0.05$).

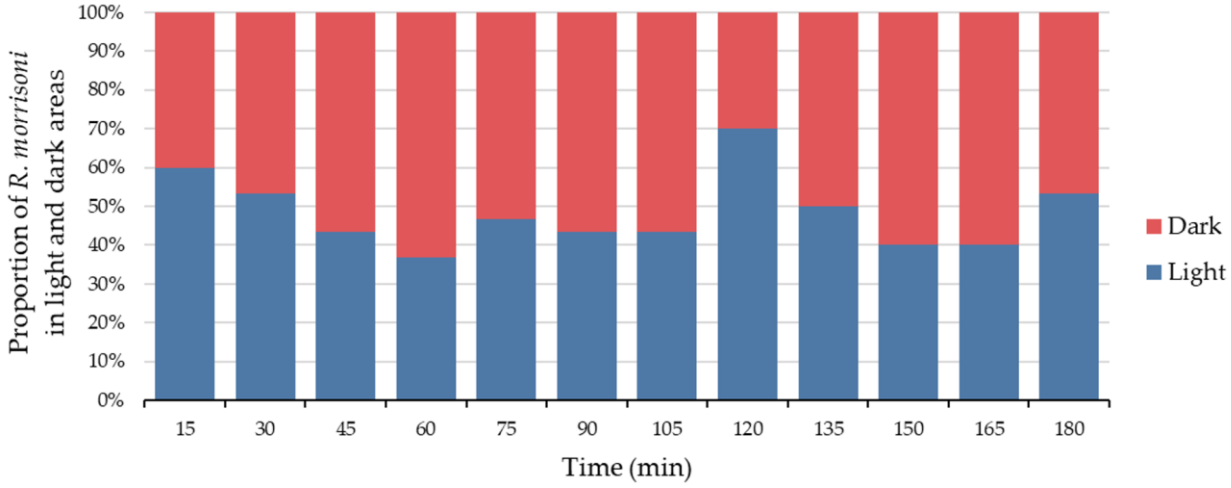


Figure 7. The proportion of *R. morrisoni* in light and dark areas for a 3 h observation period. Snail proportions were recorded every 15 min, resulting in 12 time points per replicate. Data represent proportion from three independent replicates (n = 3 tanks, each with 10 individuals).

3.5. Feeding Behavior and Chemosensory Response

To assess food chemosensory detection, visual cues were eliminated using an opaque barrier with three perforations at its base (Figure 2b). Shrimp, the preferred food source, was placed on one side of the tank (the bait-present side). In contrast, the opposite side remained empty (bait-absent side). Ten *R. morrisoni* snails were introduced at the tank's center, and their spatial distribution was recorded every 15 min for 3 h. The snails exhibited a strong preference for the bait-present side (98.06%) over the bait-absent side (1.94%) (Chi-square, $p < 0.05$). The Chi-square test was based on time-aggregated data to avoid temporal dependence. Their presence on the bait-present side consistently exceeded that on the bait-absent side throughout the experiment (Figure 8).

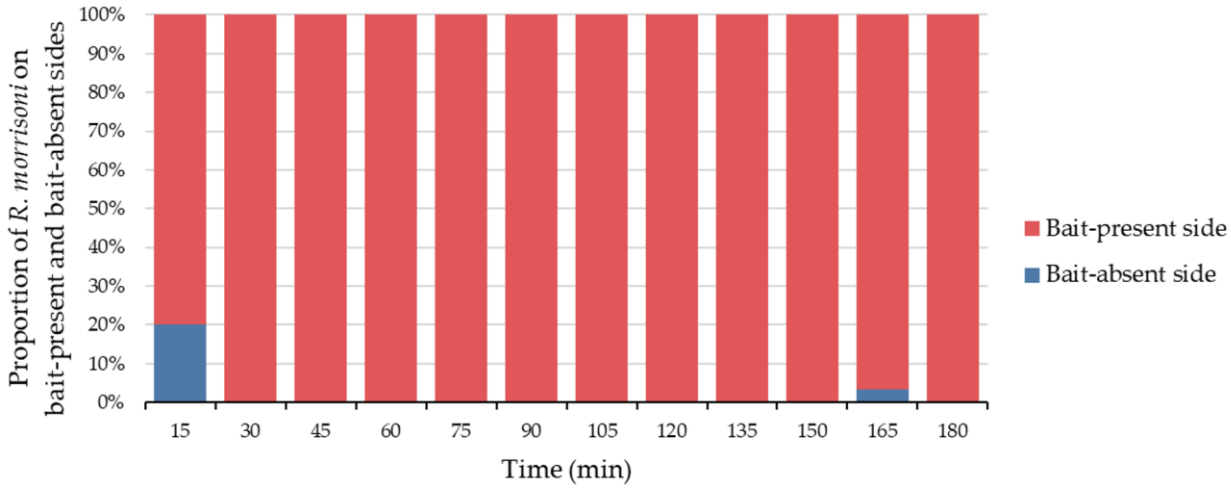


Figure 8. The proportion of *R. morrisoni* observed on the bait-present and bait-absent sides in the food chemosensory experiment was recorded at 15 min intervals for 3 h. Data represent proportion from three independent replicates (n = 3 tanks, each with 10 individuals).

A camera positioned above the tank continuously recorded snail movements to analyze their movement patterns. Most snails gradually moved from the central release point (gray diamond) toward the shrimp location (red circle) on the bait-present side. While initial movement directions varied, especially within the first 15 min, all individuals were ultimately oriented toward the food. Individual movement trajectories were tracked and plotted, with Figure 9 illustrating the detailed movement patterns of 10 snails for the first 30 min.

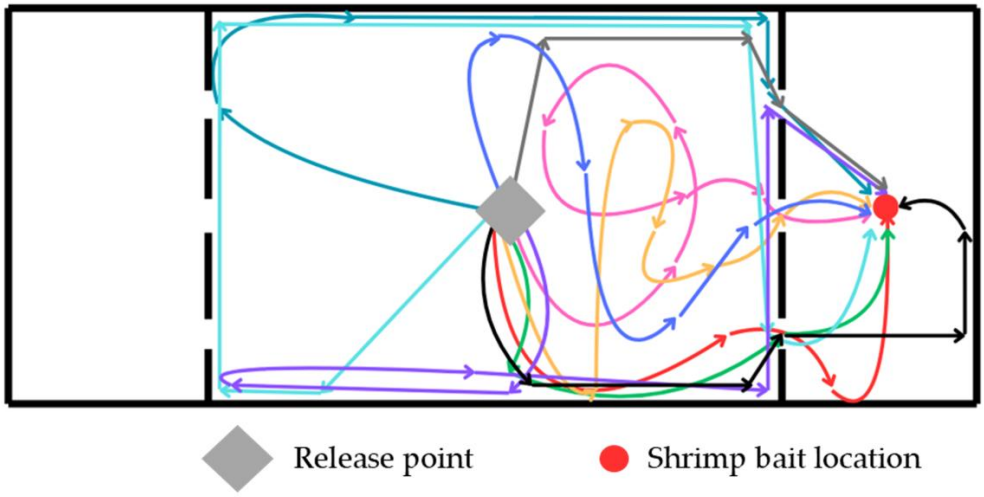


Figure 9. The movement patterns of 10 individual snails during the first 30 min of chemosensory food detection, with each colored arrow representing the movement of an individual *R. morrisoni.*

3.6. Visual Food Detection Experiment

This experiment investigated whether *R. morrisoni* could detect food using visual cues, with shrimp as the food source. The setup was similar to the chemosensory detection experiment. Still, it used a transparent barrier without perforations (Figure 2d). Snails moved randomly at several intervals with a slightly higher proportion on the bait-present side. They were observed more frequently on the bait-present side, six times versus four times on the bait-absent side, with equal distribution at 150 and 180 min. The highest proportion on the bait-present and bait-absent sides occurred at 15 and 90 min and 135 min, respectively (Figure 10). Snail distribution fluctuated throughout, and Chi-square analysis, based on time-aggregated data to avoid temporal dependence, showed no significant preference for either side (bait-present: 51.39%, bait-absent: 48.61%; $p > 0.05$).

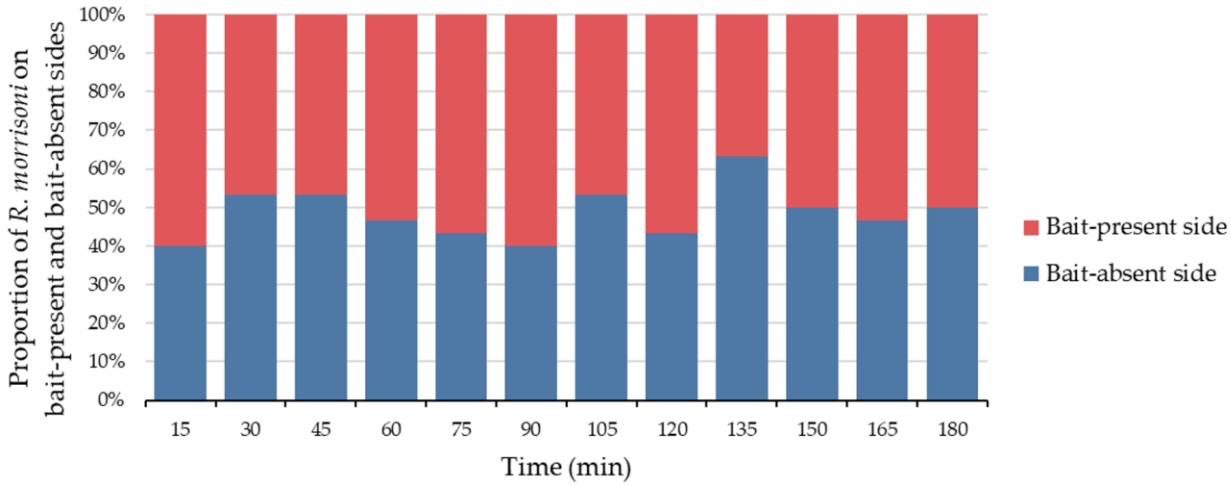


Figure 10. The proportion of *R. morrisoni* observed on the bait-present and bait-absent sides in the visual food detection experiment was recorded at 15 min intervals for 3 h. Data represent proportion from three independent replicates (n = 3 tanks, each with 10 individuals).

4. Discussion

R. morrisoni was more abundant at the Mae Klong and Pa Sak sites than in the Tha Chin and Bang Pakong basins, suggesting sensitivity to anthropogenic disturbance. Urbanized areas with altered substrates or potential pollution may reduce the suitability of habitats, which is consistent with documented impacts of urban development on tropical Asian river systems [4]. Similar patterns have also been observed where embankment construction and river engineering significantly altered benthic invertebrate diversity and habitat conditions [17]. Although shell abundance varied, all sites shared similar physicochemical water conditions (neutral pH, low conductivity, and zero salinity), consistent with natural freshwater habitats [18]. These findings indicate that *R. morrisoni* prefers undisturbed, well-oxygenated sandy or muddy substrates, consistent with studies highlighting how substrate composition and environmental quality are key determinants of freshwater gastropod diversity and distribution [19].

Foraging behavior observations required specimens with intact diagnostic features, including siphon length, eyes, tentacle structure, proboscis, and normal mantle retraction. A preliminary experiment using live shrimp and snails as prey showed no predatory behavior, indicating that *R. morrisoni* likely functions as a scavenger. When dead shrimp were provided at 21:00 h, individuals emerged, aggregated, and fed for 30–60 min before reburying. Based on the peak proportion of active individuals at 21:00 h on days 4, 5 and 7, feeding was scheduled to align with the snails' highest foraging activity. Activity declined

after 22:00 h, and rhythmic patterns stabilized by 72 h post-feeding, indicating a circadian rhythm likely regulated by endogenous cues.

A limitation of the feeding preference experiments was the inability to control the exact timing of feeding initiation and cessation among individuals. Snails did not begin or stop feeding simultaneously, resulting in some individuals not attaching to the bait during certain observation intervals. Including these inactive individuals in the analysis would have biased the Chi-square test, as it assumes all observations represent independent feeding choices. Therefore, only the proportion of individuals actively attached to the bait during the experiment was used in the analysis. This approach better reflects the true feeding dynamics and avoids temporal dependence, providing a more realistic interpretation of feeding behavior under laboratory conditions.

The results indicate that *R. morrisoni* exhibits a scavenging feeding strategy, consistently preferring animal-based food—particularly shrimp—over live prey. This behavioral pattern, coupled with the absence of predatory activity, confirms that the species functions as a non-predatory scavenger that relies primarily on chemical cues to locate suitable food [20]. Although the statistical analysis showed no significant difference among food freshness ($p > 0.05$), the observed trend indicated a higher consumption of fresh (44.22%) and aged shrimp (37.19%) compared to decayed ones (18.59%). This pattern may reflect chemosensory-based discrimination, as moderately aged shrimp release stronger but non-putrid odor cues that can facilitate food localization. Such olfactory-driven selection for animal matter of intermediate freshness has been reported in other scavenging gastropods. This suggests an adaptive mechanism for maximizing nutrient intake while avoiding potentially harmful decomposition byproducts. Such opportunistic feeding behavior likely enhances survival under fluctuating freshwater conditions by allowing individuals to exploit available animal-derived detritus. This feeding strategy parallels that of other olfactory-driven scavengers, such as *Nassarius nitidus* (Jeffreys, 1867) and *Ilyanassa obsoleta* (Say, 1822) [21,22]. It provides insight into the ecological role of *R. morrisoni* as a benthic detritivore. These behavioral findings have practical relevance for laboratory maintenance and potential conservation applications, particularly in developing feeding protocols and understanding food-based motivation in captivity. However, since this study used only one type of animal-based food as bait, further research incorporating a broader range of potential food types—including aquatic invertebrates, biofilm, or detrital matter—would help clarify dietary flexibility. Complementary approaches, such as gut content examination or molecular dietary analysis, could also provide more comprehensive insights into the trophic ecology of *R. morrisoni* under natural conditions.

The locomotion experiment under light and dark conditions revealed no statistically significant difference in the proportion of snails occupying dark (51.7%) versus light (48.3%) areas ($p > 0.05$). Nevertheless, a slight, non-significant tendency toward darkness was observed, which may reflect a weak photophobic response rather than true nocturnal foraging behavior. The absence of strong phototaxis under laboratory conditions could be related to the relatively low light intensity (~300 lux) compared with natural daylight levels that may exceed 10,000 lux. Although an opaque box covered half of the tank, minor light leakage at the boundary between the light and dark compartments may have slightly affected illumination uniformity. These results suggest that the light–dark response of *R. morrisoni* is context-dependent and likely modulated by multiple environmental cues. Burrowing behavior observed in light and dark areas may serve as a general antipredator or microhabitat-maintenance strategy rather than a strictly diel rhythm [23].

The chemosensory detection experiment confirmed that *R. morrisoni* could locate food using chemical cues, demonstrating a well-developed chemosensory system. The lack of visually mediated food detection in *R. morrisoni* may reflect a reduced reliance on vision, con-

sistent with its sand-burrowing habit. Like other benthic or sediment-dwelling gastropods, this species likely depends primarily on chemosensory input rather than visual cues to locate food and navigate its environment. Individuals are consistently oriented toward the bait, often extending the siphon and tentacles, structures associated with chemoreception in gastropods. This behavior suggests directional tracking based on waterborne chemical gradients. Although *Buccinum undatum* (Linnaeus, 1758) is a marine species, its long-range chemosensory detection provides a useful comparative framework [24,25]. In contrast, *R. morrisoni* likely relies on similar mechanisms over shorter distances, adapted to benthic freshwater habitats where visibility is limited. These findings highlight chemoreception as a key foraging strategy in *R. morrisoni*, supporting its scavenging lifestyle in low-visibility environments. Such insights enhance our understanding of freshwater gastropod ecology and may inform future studies on habitat quality and the impacts of anthropogenic activities.

The visual food detection experiment indicated that *R. morrisoni* does not rely on visual cues for foraging, as individuals showed no significant directional response to visible food. This supports the chemosensory findings and suggests that chemical cues are the primary modality guiding food detection. The lack of visually mediated behavior likely reflects adaptations to a benthic lifestyle in turbid freshwater environments, where vision is limited. Unlike terrestrial gastropods with more developed visual systems for detecting shadows or motion [26], *R. morrisoni* relies predominantly on chemoreception, an efficient strategy in low-visibility habitats.

These findings provide critical insights into the behavioral ecology of *R. morrisoni* and have direct implications for conservation. Field surveys revealed evidence of population decline, with some previously documented sites yielding no live specimens. Habitat alterations from anthropogenic activities, such as watergate construction, urban expansion, and embankment development, likely contribute to habitat loss or degradation. Given the species' small body size and cryptic, sand-burrowing lifestyle, direct in situ behavioral observations are extremely difficult. Consequently, a laboratory-based approach was necessary, generating foundational knowledge on feeding ecology, sensory responses, and activity rhythms that can inform ex situ conservation planning. Such baseline data are essential for developing captive breeding protocols, optimizing feeding regimes, and identifying behavioral indicators of health and adaptation before potential reintroduction into restored or protected habitats, as emphasized in recent works highlighting the role of laboratory behavioral studies in ex situ strategies [5,8]. Nonetheless, these findings should be considered preliminary, derived entirely from controlled laboratory conditions. Future research should extend to in situ studies in natural river systems to confirm nocturnal foraging patterns, food preferences, and ecological roles. Additional investigations into life history traits, dietary breadth, and the application of field-based monitoring techniques (e.g., underwater video, gut content, etc.) will be essential to complement the present laboratory observations and build a more comprehensive understanding of the species' ecology and conservation needs.

5. Conclusions

This study provides the first detailed account of the foraging behavior and food detection mechanisms of *R. morrisoni*, a freshwater snail endemic to Thailand. The species is nocturnal, exhibits group scavenging behavior, and shows a marked preference for shrimp, relying primarily on chemosensory rather than visual cues. The absence of a phototactic response further emphasizes the dominance of chemical navigation in this species. Collectively, these findings define *R. morrisoni* as a generalist scavenger with potential roles in nutrient cycling within benthic freshwater habitats. Such baseline behavioral data are critical for informing ex situ conservation strategies, particularly in guiding captive mainte-

nance and breeding protocols to support population recovery and long-term management. This study represents an initial step in understanding *R. morrisoni*. Future work should prioritize field investigations to validate laboratory observations, alongside studies on life-history traits, ecological interactions, and captive-breeding protocols.

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Institutional Review Board Statement: This study was conducted strictly with ethical standards for the care and use of experimental animals. The Animal Care and Use Committee approved at King Mongkut's Institute of Technology Ladkrabang (Certificate No. ACUC-KMITL-RES/2022/009). All procedures were conducted according to the relevant institutional and international guidelines for animal welfare.

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