Daytime habitat use and abundance of a freshwater shrimp *Macrobrachium yui* Holthuis, 1950 (Decapoda: Palaemonidae) in tropical forest stream, northern Laos

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**Abstract.**— From 2008 to 2014, we monitored the abundance and daytime habitat use of the freshwater shrimp *Macrobrachium yui* at a fixed site on a tributary of the Xuang River in northern Laos. Throughout the monitoring period, the shrimp *M. yui* showed strong preference for cobble and small boulder substrates, as well as moderate preferences for 21–30 cm depth and the midstream (251–350 cm distance from the bank) as daytime habitat factors. The shrimp *M. yui*, on the other hand, exhibited intense avoidance for shallower water depths (less than 10 cm), stagnant (0 cm s\(^{-1}\)) and faster water velocity (greater than 60 cm s\(^{-1}\)), finer substrates (from silt to gravel), and stream margin (less than 50 cm from the bank). During the day, the habitat with the cobble and small boulder in the midstream is probably the best place for the shrimp *M. yui* to hide from predators. The abundance of the shrimp *M. yui* had positive and negative correlations with water depth and sand percentage in the bottom sediment, respectively. It suggests that a decrease in water depth caused by increased deposition of fine sediment from the catchment has a negative impact on the shrimp abundance.

**Key words:** freshwater prawn, life history, habitat preference, predation risk, sediment deposition, migration

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**Introduction**

Freshwater shrimps, which often dominate the biomass in tropical streams, play an important role as major faunal components in the tropical stream ecosystem (Iwata *et al.*, 2003a; Mantel & Dudgeon, 2004; Soomro *et al.*, 2016). Their foraging activities can influence the distribution and abundance of benthic organisms such as algae and aquatic insects, as well as convert detritus into fine particles and nutrients that can be consumed by other macroconsumers, bacteria, and primary producers (Crowl *et al.*, 2001; Iwata *et al.*, 2003a; Moulton *et al.*, 2004; Macías *et al.*, 2014). The shrimps, on the other hand, are utilized as prey by various aquatic and riparian predatory animals such as carnivorous and omnivorous fishes, snakes, and birds depending on their ontogenetic growth (see. March & Pringle, 2003; Mantel *et al.*, 2004; Coat *et al.*, 2009). The shrimps often become key aquatic animals in the tropical stream ecosystem, acting as a link between lower and higher trophic levels (Iwata *et al.*, 2003a; Soomro *et al.*, 2016).

Many freshwater shrimps migrate to obtain resources necessary for growth and reproduction, as represented by amphidromous species.
(Shokita, 1985; Fièvet et al., 2001; Bauer & Delahoussaye, 2008; Bauer, 2013; Kounthongbang et al., 2015). Their migratory activities are often influenced by biological and physical factors in the streams (March et al., 1998; Hein & Crowl, 2010; Bauer, 2018; Hongjamrassilp et al., 2021). The presence of predators, in particular, has a great impact on their activities. To avoid predation, freshwater shrimps often alter their migratory patterns and develop specific traits (Covich et al., 2009; Hein & Crowl, 2010; Ocasio-Torres et al., 2014). The habitat use of the shrimp would also be closely associated to their predator-avoidance behavior (Leberer & Nelson, 2001). For example, nocturnal shrimps hide underneath or behind substrates such as stone and vegetation in water during the day to secure their survival (Pringle & Hamazaki, 1998; Mariappan & Balasundaram, 2003; Lammers et al., 2009; Moreira-Ferreira et al., 2020). The distribution of the shrimp would then be concentrated in shelter-rich habitats. Thus, predation risk often determines the biological characteristics of the shrimps through predatory avoidance behavior.

*Macrobrachium yui* is found in river basins running across the Indochina Peninsula’s karst mountainous regions (Hanamura et al., 2011; Kounthongbang et al., 2015). The shrimp larvae require cave water for normal development (Kounthongbang et al., 2015; Okutsu et al., 2018). The ecological characteristics that depend strongly on cave water in the early life cycle have caused the species-specific migration pattern, greatly influencing the aquatic ecosystem around the river system where the shrimp massively migrates through the food web.

At present, approximately 240 *Macrobrachium* species have been reported worldwide, adapting to a variety of environments ranging from mountain streams to estuaries and expanding their distribution (Murphy & Austin, 2005; Wowor et al., 2009; De Grave & Fransen, 2011). *Macrobrachium* species, therefore, have high potential as fishery products for the local people (Anger, 2013; Phone et al., 2005). *M. yui* also has a relatively large body size among landlocked *Macrobrachium* species and is easily captured in large quantities in cave streams due to mass migration for reproduction. The shrimp *M. yui*, which is a very cost-effective living aquatic resource for the local people, is very important as a source of financial income for the rural communities. Therefore, in a few river basins where *M. yui* inhabits, stock management has already been carried out to ensure sustainable use of the shrimp resource (Kounthongbang et al., 2013). However, in the areas where *M. yui* inhabits, river basin development, such as riparian deforestation, gold dust mining, and dam construction, has been actively promoted in recent years. It has been reported that habitat modification by sedimentation caused by human activities, such as riparian deforestation, negatively influence the abundance of *Macrobrachium* species (Iwata et al., 2003a, b). The reduction in the abundance of the shrimp *M. yui*, which possibly functions as a key species in the river system, would have a significant impact on the aquatic ecosystem. Furthermore, the impact would spread to the rural communities that rely on animals in the river basins for a living. To our knowledge, no research has been done on the effects of environmental factors on *M. yui* habitat use and abundance. We therefore conducted field research on habitat of the shrimp *M. yui* in a forest stream of northern Laos.

The goal of this study is to clarify (1) daytime habitat use and (2) determinants of abundance for the freshwater shrimp *M. yui*. We also discussed the relevance of *M. yui* juveniles migrating to forest streams. These findings will provide useful information for river environmental management in the future.

**Materials and Methods**

**Study site and study shrimp**

In northern Laos, we investigated the habitat
use and abundance of the freshwater shrimp *Macrobrachium yui* in a fixed reach of the Pho Stream, a tributary of the Xuang River (Fig. 1). The Pho Stream (forest stream), having a width of approximately 2–8 m, drains into the Xuang River (main river) through the forest, slash and burn shifting cultivation and paddy field areas. The Xuang River, known as one of the three major tributaries of the Mekong River in Luang-Prabang province, flows into the Mekong River through the mountainous area of northeastern Laos, and harbors a few *Macrobrachium* species, including *M. yui*, *M. amplimanus*, *M. eriocheirum*, *M. dienbienphuense*, and *M. mieni* (see Hanamura et al., 2011). Despite the presence of *M. yui* and *M. lanchesteri* in the Pho Stream, *M. yui* is found only in the study reach. The potential predatory fish of *M. yui* in the Pho Stream (i.e., *Channa gachua*) are considerably lower than those in the Xuang River (i.e., *Bagarius bagarius*, *Hemibagrus filamentosus*, *Channa gachua*, *Luciocyprinus striolatus*, *Hemibarbus labeo*, *Hampala macrolepidota*, *Tor tambroides*), but snakes and birds may also be predators (personal observation, S. Ito).

The freshwater shrimp *M. yui* lives in rivers and streams that run through the karst mountainous regions in southern China, northern Vietnam, northern Thailand, and northern Laos (Liu et al., 1990, 2007; Cai & Dai, 1999; Cai et al., 2004; Hanamura et al., 2011). The shrimp *M. yui* migrates in large numbers to cave streams to reproduce, and its females remain in the cave streams to spawn and incubate eggs as cave water is essential for the hatched larvae to successfully develop (Kounthongbang et al., 2015; Okatsu et al., 2018). The hatched larvae spend about a month in the cave streams as free-swimming larvae before settling to the bottom as post-larvae. After undergoing migratory drift to the main river and developing into juveniles, they massively migrate to the forest streams (Ito et al., 2011; Kounthongbang et al., 2015; Suppl. Fig. 1). The juveniles spend

![Fig. 1. Location map of the study reach in the village of Na-Pho, Luang Prabang Province, Laos. Star and dotted lines represent survey points and cave streams, respectively.](image-url)
Around one and a half years in forest streams before they mature based on estimates from rearing in an aquarium (personal observation, S. Ito).

**Shrimp abundance and habitat use**

In the middle reaches of the Pho Stream, the starting point of the survey was decided (20.134444 N, 102.537305 E), and a 42–75 m long reach including a riffle-pool sequence upstream from that point, was set up as the survey reach for each survey. From 2008 to 2014, field research on shrimp habitat and abundance was conducted five times throughout the dry season (December to March) (Table 1). The five surveys were assigned with survey codes in chronological order as S1, S2, S3, S4, and S5. However, because *M. yui* moves around actively at night, quantifying nighttime microhabitat use was difficult. Therefore, observations were implemented during the day as an assessment of daytime microhabitat use. The observers laid at the downstream end of the observation reach and work their way upstream in a zigzag pattern to observe nearshore and midstream areas equally. Then, stones larger than 5 cm in diameter were flipped over gently to find the shrimp hiding underneath them. When we came across large rocks we cannot flip over, we looked into the dents and holes underneath.

### Table 1. Comparisons of habitat availability for the four variables and shrimp abundance among the five surveys. Mean depth, mean current velocity, and mean substrate coarseness score were calculated for each survey using measured data from the measurement points on the transects, and mean river width was determined from the number of the measurement points and transects. Shrimp abundance was expressed as the number of individuals per unit area (m²) of the survey reach.

| (Date)       | S1          | n    | S2          | n    | S3          | n    |
|--------------|-------------|------|-------------|------|-------------|------|
| (27. Jan. 2008) | 22.6 (12.8)  | 136  | 24.2 (8.3)  | 95   | 19.1 (9.4)  | 97   |
| Mean depth (cm) (SD) | 8.9 (9.0)  | 136  | 19.2 (15.6) | 95   | 23.5 (20.5) | 98   |
| Mean current velocity (cm s⁻¹) (SD) | 4.7 (1.2)  | 26   | 3.9 (1.4)  | 21   | 6.3 (1.1)  | 15   |
| Mean substrate coarseness score (SD) | 2.8 (1.7)  | 136  | 3.8 (1.5)  | 95   | 3.5 (1.7)  | 102  |
| Substrate constitution | Silt (%)  | 36.0 | 12.6 | 10.8 | 35.0 | 12.6 | 10.8 |
| | Sand (%)   | 14.0 | 7.4  | 23.5 | 16.0 | 7.4  | 23.5 |
| | Gravel (%) | 11.0 | 16.8 | 16.7 | 11.0 | 16.8 | 16.7 |
| | Pebble (%) | 11.8 | 20.0 | 15.7 | 11.8 | 20.0 | 15.7 |
| | Cobble/small Boluder (%) | 25.7 | 40.0 | 21.6 | 25.7 | 40.0 | 21.6 |
| | Bolder (%) | 0.0  | 0.0  | 5.9  | 0.0  | 0.0  | 5.9  |
| | Rock (%)   | 1.5  | 3.2  | 5.9  | 1.5  | 3.2  | 5.9  |
| Shrimp abundance (inds m⁻²) | 0.14 | 0.21 | 0.11 |

| (Date)       | S4          | n    | S5          | n    |
|--------------|-------------|------|-------------|------|
| (20. Dec. 2012) | 16.0 (8.2)  | 103  | 13.7 (7.6)  | 103  |
| Mean depth (cm) (SD) | 24.1 (20.5) | 99   | 18.5 (16.4) | 92   |
| Mean current velocity (cm s⁻¹) (SD) | 5.1 (1.0)  | 19   | 4.9 (0.9)  | 19   |
| Mean substrate coarseness score (SD) | 3.8 (1.8)  | 108  | 3.3 (1.7)  | 104  |
| Substrate constitution | Silt (%)  | 19.4 | 20.2 | 19.4 | 20.2 |
| | Sand (%)   | 9.3  | 18.3 | 9.3  | 18.3 |
| | Gravel (%) | 8.3  | 12.5 | 8.3  | 12.5 |
| | Pebble (%) | 19.4 | 14.4 | 19.4 | 14.4 |
| | Cobble/small Boluder (%) | 26.9 | 29.8 | 26.9 | 29.8 |
| | Bolder (%) | 11.1 | 1.9  | 11.1 | 1.9  |
| | Rock (%)   | 5.6  | 2.9  | 5.6  | 2.9  |
| Shrimp abundance (inds m⁻²) | 0.12 | 0.09 |

Different letters indicate significant differences (Tukey-Kramer’s multiple comparison test, *P* < 0.05).
them using a flashlight to see if there was any shrimp. Since the light from a flashlight causes the shrimp's eyes to glow, we can confirm the presence of the shrimp. If present, the shrimp was captured with a dip net, and its carapace length (CL) was measured after sex identification. A piece of colorful tile was used to mark the position where the shrimp was found. At each marked position, water depth and distance to the nearest bank (spaced 20 cm from the shoreline) were measured with a ruler, and current velocity was measured at mid-depth (0.5 of the depth) using a portable water current meter (CR-7WP; Cosumo-Riken Inc., Kashihara, Japan). The dominant substrate coarseness in a 25 × 25 cm quadrat around each marked position was classified and coded in order of coarseness using the modified Udden-Wentworth grain-size scale (Blair & McPherson, 1999) as follows: 1, silt (particle size < 0.06 mm); 2, sand (0.06–2 mm); 3, gravel (2–16 mm); 4, pebble (17–64 mm); 5, cobble and small boulder (65–512 mm); 6, boulder (513–1024 mm); 7, rock (>1024 mm).

To quantify habitat availability in the study reach, 15–26 transects were established at 3-m intervals upstream from the fixed starting point (the bedrock marked with paint), and measurement points were set on each transect at 1-m intervals from the left bank by placing the colored tiles (95–136 points in total). Water depth, water current velocity, and substrate coarseness score, and wetted river width (m) at the habitat availability measurement points were also compared throughout the five surveys using the Tukey–Kramer multiple comparison test following one-way ANOVA to examine changes in habitat availability.

The effect of physical habitat factors on the shrimp abundance was determined using a stepwise multiple regression analysis with the shrimp abundance as the dependent variable and mean water depth (cm), mean water current velocity (cm s⁻¹), mean wetted river width (m), and relative frequencies of silt (%), sand (%), gravel (%), pebble (%), cobble and small boulder (%), boulder (%) and rock (%) as independent variables.

To standardize variances and improve normality, all variables in the statistical analyses were converted into log₁₀( x ) or log₁₀( x + 1) for exact values and into arcsine ( p ¹⁄₂ ) for percentage values.

All analyses were conducted using JMP 8.0.2 (SAS Institute Inc., 2009).

The habitat preferences of *M. yui* were examined using Jacobs' formula (1974) as follows:

\[ D_{sa} = \frac{(r_{sa} - p_{sa})}{(r_{sa} + p_{sa} - 2 r_{sa} p_{sa})} \]

where \( D_{sa} \) is the preference value for range \( a \) of variable \( s \), \( r_{sa} \) is the proportion of the shrimp using range \( a \) of variable \( s \), and \( p_{sa} \) is the proportion of measurement points within range \( a \) of variable \( s \) in the total available habitat. \( D_{sa} \) values range from –1 (never used) to +1 (only one range used). Preferences for habitat variables vary from –1 (never used) to +1 (only one range used), with 0 indicating that a given habitat is used in proportion to its
availability. When the availability was zero, the preference value was not calculated. With reference to Matthews (1996) and Wissmar & Craig (2004), the preference value for habitat variables in this study was defined as $-1.0$ to $-0.5$ in avoidance and $0.5$ to $1.0$ in selection.

## Results

In terms of the shrimp habitat, water depth and water current velocity differed significantly among the five surveys, but substrate coarseness score and distance to the nearest bank did not (water depth: $F_{4,183} = 12.4, P < 0.001$; current velocity: $F_{4,183} = 11.4, P < 0.001$; substrate coarseness: $F_{4,183} = 0.9, P = 0.492$; distance to the bank: $F_{4,183} = 1.8, P = 0.138$). For water depth, S1 and S5 were shallower than S2, S3, and S4, but there was no difference between S1 and S5; and between S2, S3, and S4 (Fig. 2). For water current velocity, S4 was faster than S1 and S5, while S1 was slower than S2 and S3, but with no difference between S2, S3, and S5 (Fig. 2). During the five surveys, the carapace length (CL) of the shrimp was 19.9 mm ± 2.3 SD in males, 21.7 mm ± 3.1 SD in females and 13.2 mm ± 2.4 SD in juveniles or unknown.

In terms of habitat availability, water depth, current velocity, wetted river width, and substrate coarseness score differed significantly among the five surveys (Table 1). For water depth, S1 and S2 were deeper than S4 and S5, while S3 was shallower than S2 but deeper than S5 (Table 1). For water current velocity, S1 was the slowest and there were no differences between S2, S3, S4, and S5 (Table 1). For wetted river width, S3 was wider than S1 and S2, while S2 was narrower than S4 and S5; but with no difference between S1, S4, and S5 (Table 1). For substrate coarseness score, S2, S3, and S4 were higher than S1, but there were no differences between S2, S3, S4, and S5 (Table 1).

According to stepwise multiple regression (Table 2), the abundance of the shrimp *M. yui* was best explained by a combination of water depth and percentage sand, with the former having a positive effect and the latter having a negative influence. The effect of water depth was greater than that of sand percentage (Table 2). This result indicates that the shrimp abun-

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Table 2. Results of stepwise multiple regression analysis using shrimp abundance (inds m$^{-2}$) as a dependent variables and the ten habitat variables as independent variables for the five survey

| Response variable   | Explanatory variables | Estimate | Standard regression coefficient | $P$ | Model | $R^2$ | $F$   | $P$   |
|---------------------|-----------------------|----------|--------------------------------|-----|-------|-------|-------|-------|
| Shrimp abundance    | Mean depth            | 0.87     | 0.73                           | 0.01| 0.98  | 105.4 | <0.01 |
|                     | Percentage of sand    | -0.98    | -0.46                          | 0.03|       |       |       |       |
dance decreases as water depth becomes shallower and the percentage of sand in the bottom substrate increases.

Throughout the five surveys, the shrimp *M. yui* showed an intense avoidance to shallower water depths (less than 10 cm), stagnant (0 \( \text{cm s}^{-1} \)) and faster water velocity (greater than 60 \( \text{cm s}^{-1} \)), finer substrates (from silt to gravel), and stream margins (less than 50 cm from the bank) as habitat factors (Fig. 3A–D). At the same time, the shrimp exhibited a strong preference for cobble and small boulder substrate as habitat factor (Fig. 3C), as well as moderate preferences for 21–30 cm depth and the midstream (251–350 cm distance from the bank) (Fig. 3A, D).

### Discussion

The post-larvae of the freshwater shrimp *M. yui*, which have settled at the bottom in the cave stream, undergo migratory drift to the Xuang River at night during the dry season (Kounthongbang et al., 2015). The nocturnal drifting pattern of the larvae is probably attributed to the high richness of fishes at the confluence of the Xuang River and cave stream (Kounthongbang et al., 2015). After the post-larvae which undergone migratory drift have developed into juveniles in the river, they mas-

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Fig. 3. Microhabitat availability (upper) and habitat preference (lower) for (A) water depth, (B) water current velocity, (C) substrate coarseness and (D) bank distance in the five surveys. Substrate coarseness classification: Si = silt, Sa = sand, Gr = gravel, Pe = pebble, Co/sBo = cobble and small boulder, Bo = boulder, and Ro = rock. Preference values revealed by Jacobs index \( (D) \) were defined as \(-1.0\) to \(-0.5\) in avoidance and \(0.5\) to \(1.0\) in selection.
sively migrate to the forest streams by walking along the riverbank at night before the rainy season begins (Ito et al., 2011; Kounthongbang et al., 2015; Supplementary Fig. 1). This migratory behavior of the juveniles is gradually becoming common in freshwater shrimps (Bauer, 2018; Hongjamrassilp et al., 2021). Of course, nocturnal predators exist, however nighttime migration during the primary life cycle of this species helps to reduce predation risk, which is an adaptive behavior to avoid predators such as carnivorous and omnivorous fishes (Kikkert et al., 2009; Bauer, 2018). Thus, the migratory behavior of the freshwater shrimps is often affected by the presence of predators (Covich et al., 2009; Hein & Crowl, 2010).

The migration of aquatic animals occurs to acquire the necessary resources depending on their ontogenetic growth (McDowall, 2007; Fièvet et al., 2001; Kounthongbang et al., 2015). Therefore, the Pho Stream (forest stream) may have some important resources for the juvenile growth of the shrimp *M. yui*. Although the shrimp *M. yui* and *M. lanchesteri* are found in the Pho stream, *M. lanchesteri*, which inhabits a fluvial environment with paddy fields, is found only in a very short reach of the Pho stream through the paddy field. Therefore, *M. yui* can almost exclusively exploit the ecological niche of *Macrobrachium* species in the Pho stream. On the other hand, the predation risk is also a critical problem for survival of the juveniles, not only during the nocturnal mass migrations, but also during their life in the Pho Stream. Compared to the Xuang River (main river), the Pho Stream contained considerably less predatory fishes. It indicates that the shrimp *M. yui* shifted water depth and current velocity which it uses as habitat according to the habitat availability; however, substrate coarseness and distance to the nearest bank remained unchanged despite the fluctuation in habitat availability. It may be attributed that the shrimp *M. yui* strongly preferred habitat with cobble and small boulder substrates and avoided habitat near stream margins with shallower water depth, stagnant flow, and fine substrates. If the shrimp *M. yui* uses a stream margin with a few hiding places as its habitat, the shrimps are potentially vulnerable to predation by riparian animals such as birds and snakes. In addition, the rocky habitat may not be also safe enough for the shrimp observed in the Pho Stream ranged in size from juvenile to mature adult, similar to Kounthongbang et al. (2015). Ultimately, *M. yui* that has reached sexual maturity in the Pho Stream would migrate into the cave streams through the Xuang River to reproduce (see Fig. 1, Kounthongbang et al., 2015).

The preferences for habitats are often influenced by biological factors such as foraging and reproductive activities, as well as the presence of predators (Covich et al., 1991; Crowl & Covich, 1994; Iwata et al., 2003a). *Macrobrachium* species, in particular, are often preyed upon by higher trophic level animals such as carnivorous and omnivorous fishes and birds in the river ecosystem (Mantel et al., 2004; Huang et al., 2007; Coat et al., 2009). Therefore, it is very important for the shrimps to choose habitats that will allow them to avoid predators. It has been reported that the shrimp *M. yui* shows active nocturnal migration (Ito et al., 2011; Kounthongbang et al., 2015), implying that this species would require safe hiding places during the day. The shrimp habitat changed throughout the monitoring period of the study. The water depth and current velocity, in particular, were mainly related to the change in the shrimp habitat; but not its substrate coarseness and distance to the nearest bank. It indicates that the shrimp *M. yui* shifted water depth and current velocity which it uses as habitat according to the habitat availability; however, substrate coarseness and distance to the nearest bank remained unchanged despite the fluctuation in habitat availability. It may be attributed that the shrimp *M. yui* strongly preferred habitat with cobble and small boulder substrates and avoided habitat near stream margins with shallower water depth, stagnant flow, and fine substrates. If the shrimp *M. yui* uses a stream margin with a few hiding places as its habitat, the shrimps are potentially vulnerable to predation by riparian animals such as birds and snakes. In addition, the rocky habitat may not be also safe enough for the shrimp...
to avoid predation because the small snakehead species *Channa gachua*, a primary predator of the shrimp in the stream, often lurks there during the day. Intraspecific cannibalism has often been reported in *Macrobrachium* species (Kiran *et al.*, 2002; Mariappan & Balasundaram, 2003;). In particular, juvenile molting shrimp are easily preyed upon by conspecific shrimp (Opeh *et al.*, 2018). This indicates that conspecific shrimp can be a potential predator. The choice of the size of the stone for hiding may be important for the shrimp. As a result, the cobble and small boulder in the midstream would have been the best hiding place for the shrimp *M.yui* to reduce predation risk during the day. Of course, the shrimp habitat use may be influenced not only by the presence of predators, but also by their foraging activities. However, in the nocturnal shrimp *M.yui*, daytime habitat use would be determined for predator avoidance rather than foraging activities. Further studies on it are expected in the future.

Massive deforestation usually causes excessive sedimentation in forest streams (Benstead *et al.*, 2003; Iwata *et al.*, 2003a, b), which greatly impacts on aquatic animal dynamics and assemblages across the ecosystem (Jones *et al.*, 1999; Bojsen & Barriga, 2002). During the monitoring period from 2008 to 2014, the fluvial environment in the study reach fluctuated, with the water depth tending to be shallower year by year. It may be attributed to an increased deposition of sediments. In 2009, deforestation was permitted around the study site, and many trees were cleared. Although it is unknown if it had caused sediment deposition, the excessive supply of the sediments from deforestation and swidden cultivation areas around the study site probably explains the habitat change. The Pho stream, which is rich in forest-derived organic matter and has less predatory fishes, is probably very important for *M. yui* as a nursery habitat where the juveniles can reach maturity at high survival. Unfortunately, stepwise multiple regression analysis indicated that the decrease in water depth caused by increased deposition of fine sediment from the catchment has a negative impact on the abundance of the shrimp *M yui* in the Pho Stream. The decrease in water depth caused by fine sediment most likely reduces the habitat in which the shrimp hide, making them more vulnerable to predators. In addition, it may also reduce the abundance of aquatic insects, which are the main food resource for the shrimp. Depending on its ontogenetic developmental and migratory stages, the shrimp *M. yui* serves as prey for many carnivorous and omnivorous fishes in the Xuang River system and consumes a variety of foods such as detrital, algae, and aquatic insects (unpublished data, S. Ito), influencing the distribution and abundance of many aquatic organisms. Thus, the shrimp *M. yui* play an important role as an intermediate between lower trophic level and higher trophic level organisms in the food web and has the potential to become key species in the Xuang River system. When excessive fine sediment inputs reduce the shrimp abundance into the Pho stream, the ecosystem of the Xuang River system can be significantly affected through the food web. Then, the local people that rely on many living aquatic resources in the Xuang River system for livelihood would be severely affected. The shrimp *M. yui*, in particular, has been traded as a local delicacy for a high price, which sustains their livelihood in terms of financial income (Ito *et al.*, 2011; Kounthongbang *et al.*, 2013, 2015). To effectively maintain the shrimp *M. yui* stock, watershed management measures to avoid excessive fine sediment inputs would be necessary for the near future, along with the shrimp capture management measures. It would be one of the important steps to enable the local people to sustainably use many living aquatic resources in the Xuang River system.
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