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Life Cycle and Larval Feeding Habits of *Macrostemum indistinctum* Banks 1911 (Trichoptera: Hydropsychidae) in the Stream Flows into Krasiow Reservoir, Thailand

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Abstract

The aim of this work was to determine the feeding habits of *Macrostemum indistinctum* larvae using gut content analysis. The study was carried out in the stream flows into the Krasiow dam. A total of 126 larvae were captured and had the head capsule width measured. The gut content was analyzed under microscope. Seven categories of food items were determined: arthropod fragment, blue green algae, diatoms, gastropods, green algae, protozoa and rotifers. When comparing both populations in two seasons, statistically significant differences ($P<0.05$) were found for gastropods and protozoa. The food items, arthropods, blue green algae, diatoms, green algae and rotifers showed no difference between both populations. *Macrostemum indistinctum* was found to be an omnivorous collector organism. The similarities in the seasonal trophic structure might indicate the constant availability of food.

Introduction

Aquatic insects are one of the most dominant elements in freshwater ecosystem trophic webs, participating in energy flow and nutrient cycling (Whiles & Wallace, 1997). They are also important food resources for fish (Wallace & Webster, 1996) and some insectivorous birds (Ward et al., 1995). The distribution and abundance of insects in freshwater systems is the result of complex interactions between their ecological roles and the physicochemical conditions that characterize the habitat, and food availability (Merritt & Cummins, 1996). Thus, the community structure depends on a number of factors, such as water quality, type of substrate, particle size of sediment, water flow, available of sediment organic matter, oxygen concentration as well as environmental conditions surrounding the watercourse (Ward et al., 1995; Buss et al., 2004). They reflect environmental changes, aquatic insects are often used as indicators of the effects of human activity on water systems, providing information on habitat and water quality (Woodcock & Huryn, 2007). Amongst the aquatic insects, order Trichoptera (or caddisflies) are the most widely distributed; their larvae are common in running water (Ward, 1992) and they are one of the relatively well-studied orders of aquatic insects in South East Asia (Malicky, 2010; Morse, 2017). The larvae of many species coexist in running waters and are known to have specific habitat and environmental requirements (de Moor, 2007).

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The filter-feeding caddisflies of Hydropsychidae comprise one of the largest families of Trichoptera, with about 1,756 described adult species worldwide (Morse, 2011). Larvae of hydropsychids live in running waters and are generally collectors-filterers. Hydropsychidae larvae use nets spun with their silk glands to capture drifting food materials in stream (Merritt & Cummins, 1996). They usually construct a silken filter net at the entrance to their fixed tubular retreat (Wiggins, 1996). Larvae present a high ecological diversity and display a wide range of tolerance to different levels of pollution, which makes them very useful organisms in biological water quality monitoring programs (Resh, 1995). The species *Macrostemum indistinctum* Banks 1911 from the Thai basin constructs a tube of sand grains (Fig. 2) on the sandy bottom of streams and utilizes an extremely fine meshed net that captures food. However, it is not known on the trophic behavior of this species in the study area during a year sampled, the aim of the present paper was to determine the feeding habits of *M. indistinctum* larval stages using gut analysis from the two seasons collected in corresponding on water quality measurement.

Materials and methods

1. Study area

The study was conducted in the stream flows into the Kasiow reservoir, Dan Chang district, Suphan Buri Province, Thailand (14°56.859´N, 099°38.118´E) (Fig. 1). This stream is part of the Tha Chin River, and is 140 km long. The stream watershed is located between Khao La and Khao Yai, north of Ban Rai district, Uthai Thani Province. The study site is located at an elevation of 81 m and the stream is on average 2.0 m wide and 0.6 m deep. It presented clear water, gravel, a sandy muddy bottom, and marginal herbaceous vegetation. The collecting sites are located in the extensive areas with the sugar cane cultivation.

2. Sampling and laboratory analyses

Nine water physicochemical variables were measured once a month during January to December 2019. The physicochemical water quality parameters were recorded directly at the sampling site and included pH (measured by a pH-meter Waterproof Model Testr30), water temperature (measured by a hand-held thermometer), and dissolved oxygen (DO, measured by a HACH® Model sensION 6 DO meter), total dissolved solid (TDS) and electrical conductivity (EC) (measured by a EURECH CyberScan CON110 conductivity/TDS meter). Water samples from each collecting period were stored in polyethylene bottles (500 mL). Ammonia nitrogen (NH_3-N), sulfate (SO_4^{2-}), nitrate-nitrogen (NO_3^--N), orthophosphate (PO_4^{3-}), and turbidity were determined in accordance with standard procedures (American Public Health Association (APHA), 1992).

Aquatic insects were collected during the wet season (July to October 2019) and cold-dry season (November to April 2019), along with 50 m stretch of the stream. Samplings were collected with a D-frame kick net with 250 μm mesh size, including by hand picking. The caddisflies larvae, *M. indistinctunm* (Fig. 2) were taken together with other aquatic insects and preserved in 70% ethanol.

All the organisms were sorted and kept its in 70% ethanol. For the *M. indistinctum,* head capsule width was use to classified into the larval instar, following the method described by MacKay (1978). Head capsule width was measured using an ocular micrometer. The numbers of larval instars were determined by analyzing the frequency distributions of head capsule widths, following which the width ranges for instars were determined for each month.

For a qualitative assessment of the chief food item of *M. indistinctum,* a total of 50 larvae of the cold-dry season and 66 larvae of the wet season were dissected under a stereomicroscope (Olympus SZ51). The whole digestive tracts were removed to a glass slide with water, shredded, and examined under dissecting and compound microscopes (Olympus CX31). Gut contents were separated into arthropod fragment, blue green algae, diatoms, gastropods, green algae, protozoa, and rotifers.

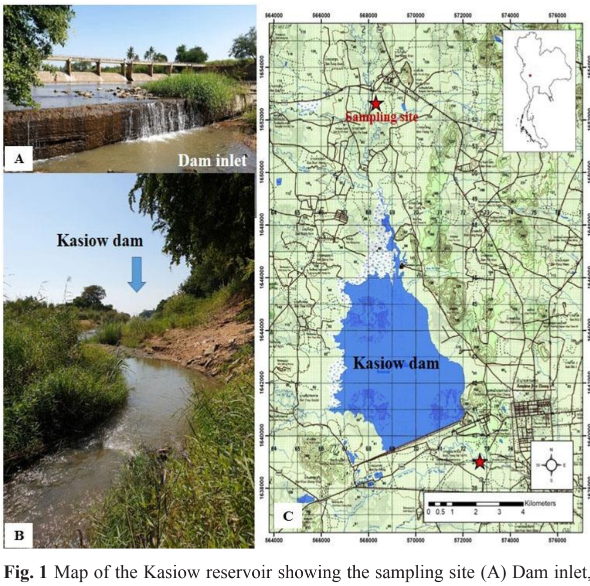

Fig. 1 Map of the Kasiow reservoir showing the sampling site (A) Dam inlet, (B) the collecting sites, and (C) Map of the Kasiow reservoir

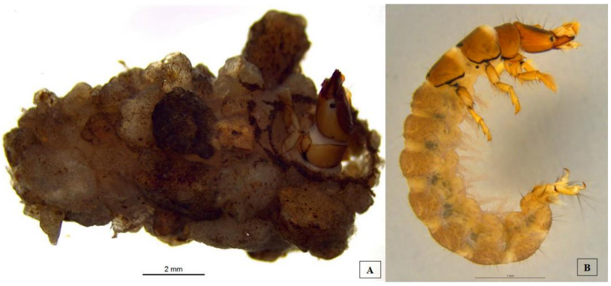

Fig. 2 The characteristics of larva with case (A) and larva of *Macrostemum indistinctum* (B)

3. Data analysis

The SPSS v. 13.0 (http://www.spss.com/) was used to perform the statistical analyses. Mean, standard deviation, maximum and minimum values of prey (as the maximum and minimum number of individuals identified) were calculated for the percentage of each item of gut content. The ontogenetic shift on diet was assessed by means of a correlation (Gamma correlation test) between larval size (measured as head width) and percentage of the different items in the larval gut. To compare the food items in gut contents between populations in cold dry and wet season, Mann-Whitney *U*-test was used.

Results and discussion

1. Physicochemical parameters of water quality

Mean values of selected physicochemical parameters of water quality at the stream flows into Kasiow dam during this study are presented in Table 1. All water parameters such as water temperature, dissolved oxygen (DO), pH, total dissolved solids (TDS), electrical conductivity (EC), nitrate-nitrogen (NO_3^--N), ammonia-nitrogen (NH_3-N), orthophosphate (PO_4^{2-}) and turbidity varied significantly during the sampling periods ($p<0.05$), using ANOVA (Table 1).

Water temperature greatly varied from 22.37± 0.21 to 39.50±1.15°C. Temperature is one of the most important physical parameter in the biosphere, partly because it affects the movement of saturation constants of dissolved gasses in water, metabolic rate of organisms and other factors that directly or indirectly affect life on earth (Hauer & Hill, 1996). In tropical streams, the mean annual temperature generally exceed 20°C (Dudgeon, 1999). This average temperature is similar to the average result in this study.

The mean value of pH ranged from 7.47±0.15 to 9.30±0.44. The pH is parameter concerned with the concentration of carbon fractions and hydrogen ions (Goldman & Horne, 1983), which shows a similarly trend of local and seasonal difference to the previous ions mentioned (i.e. EC and TDS). However the result of pH showed significant differences.

The mean value of dissolved oxygen ranged from 6.13±0.16 to 8.63±0.50 mg/L. Beside the ions concentration, dissolved oxygen is the most widely studied chemical in aquatic environment. Dissolved oxygen greatly affects aquatic life as well as biochemical processes. Nearly all stream organisms are sensitive to DO. Organic pollution may significantly reduce DO concentration in entire stream reaches as microbial processes consume the oxygen from the water (Hauer & Hill, 1996). The fact that DO saturation mixed well at above 80% at the unpolluted stream, which is greatly replenished from the air, supports that DO concentrations of each month showed significant differences with excessive concentration.

The mean electrical conductivity values ranged from 202.73±0.59 to 602.33±0.58 µS/cm. Within the water column, conductivity, which indicates the ability of

Table 1 Physicochemical parameters of the sampling site during January to December 2019*

Parameter/month	Jan	Feb	Mar	Apr	Jul	Aug	Sep	Oct	Nov	Dec
Water temp. (°C)	27.67 ± 0.3^{bc}	30.13 ± 1.18^{de}	31.30 ± 0.53^{e}	39.50 ± 1.15^{f}	29.13 ± 0.06^{cd}	29.87 ± 0.06^{de}	29.10 ± 0.53^{cd}	31.60 ± 1.08^{e}	22.37 ± 0.21^{a}	26.80 ± 0.17^{b}
DO (mg/L)	8.21 ± 0.13^{c}	7.21 ± 0.13^{b}	8.63 ± 0.50^{c}	6.88 ± 0.65^{ab}	6.13 ± 0.16^{a}	6.65 ± 0.07^{ab}	7.07 ± 0.03^{b}	6.89 ± 0.07^{ab}	6.99 ± 0.02^{b}	7.06 ± 0.04^{c}
pH	8.20 ± 0.10^{bc}	7.97 ± 0.40^{abc}	8.53 ± 0.06^{c}	7.87 ± 0.12^{ab}	8.03 ± 0.06^{abc}	8.17 ± 0.06^{bc}	7.47 ± 0.15^{a}	8.30 ± 0.00^{bc}	9.30 ± 0.44^{d}	8.43 ± 0.06^{bc}
TDS (mg/L)	228.67 ± 0.58^{f}	111.67 ± 11.50^{b}	134.10 ± 0.75^{c}	95.93 ± 1.05^{a}	136.70 ± 3.91^{c}	162.57 ± 0.41^{d}	175.00 ± 0.26^{e}	245.67 ± 2.52^{g}	385.50 ± 0.35^{i}	359.00 ± 1.00^{h}
EC (uS/cm)	457.00 ± 1.00^{g}	216.00 ± 2.00^{b}	283.33 ± 1.53^{c}	202.73 ± 0.59^{a}	289.00 ± 0.00^{d}	372.67 ± 1.53^{e}	393.33 ± 1.53^{f}	569.33 ± 1.53^{h}	602.33 ± 0.58^{i}	762.33 ± 4.04^{j}
NH_3-N (mg/L)	0.08 ± 0.04^{a}	0.69 ± 0.34^{c}	0.23 ± 0.01^{ab}	0.72 ± 0.04^{c}	0.22 ± 0.13^{ab}	0.20 ± 0.03^{ab}	0.48 ± 0.30^{bc}	0.26 ± 0.01^{ab}	0.15 ± 0.03^{a}	0.24 ± 0.02^{ab}
NO_3-N (mg/L)	4.13 ± 0.06^{bcd}	7.20 ± 0.17^{d}	4.10 ± 0.17^{bcd}	NA	1.77 ± 0.15^{abc}	1.57 ± 0.46^{ab}	5.63 ± 4.21^{cd}	2.93 ± 0.06^{abc}	3.70 ± 0.00^{abcd}	4.40 ± 0.62^{bcd}
PO_4^{3-} (mg/L)	1.18 ± 0.08^{d}	2.25 ± 0.15^{ef}	0.84 ± 0.04^{cd}	0.76 ± 0.25^{bcd}	0.26 ± 0.27^{ab}	0.17 ± 0.07^{a}	0.40 ± 0.19^{abc}	0.67 ± 0.10^{abcd}	1.82 ± 0.39^{e}	2.43 ± 0.06^{f}
Turbidity (NTU)	7.39 ± 1.72^{a}	10.55 ± 3.36^{a}	4.96 ± 2.96^{a}	1.87 ± 0.75^{a}	127.33 ± 13.65^{c}	41.63 ± 4.97^{b}	364.33 ± 16.50^{d}	7.39 ± 1.72^{a}	10.55 ± 3.36^{a}	4.96 ± 2.96^{a}

Remarks: *The heavy rains occur in the month of May and June, environmental variables were no measured. Values with different letters indicate significant mean difference following Turkey post hoc tests ($P<0.05$).

solution to carry on an electric current, is related to the water fertility (Mustow, 1997). Conductivity was found as the gradual built-up along a downstream progression, which was clearly shown in high values in stream flow in to the Kasiow reservoir. This may be explained by the dissolution of rocks and soil nearby stream, which was high up at the lower altitude. Conductivity, moreover, showed evidence of seasonal pattern, which indicated a high value in hot-dry season and less value in cold-dry season and wet season, respectively. This pattern was explained by the theory of Bishop (1973). In hot-dry season, the amount of the falling leaves or leaf litters were high. Leaves were quickly decomposed by high temperature and then, the soluble nutrients were released into the water.

The mean total dissolved solids values ranged from 95.93±1.05 mg/L to 385.50±0.35 mg/L. Total dissolved solids is another parameter, which indicates the materials that are chemically dissolved in water. This includes materials such as calcium, chloride, sodium, magnesium, silicate and carbonate. The TDS enters the stream from three natural sources; (1) atmosphere (i.e. rainfall), (2) soil and rock weathering and (3) biological process (Webster & Ehrman, 1996). Seasonal pattern of TDS indicates that a high concentration of TDS appears in hot-dry season and is less concentration in cold-dry season. This shows a similar trend to electrical conductivity parameter and can be explained by the same explanation.

The mean turbidity values ranged from 1.87±0.75 to 364.33±16.50 NTU. The high turbidity was recorded during the wet season due to heavy rainfall. Turbidity of the water is caused by suspended solids and any coloration produced by dissolved substance. The source of suspended solids and dissolved substance can be inorganic particles and organic debris from soil erosion in the agricultural areas, with high erosion during the flood (Bisson & Montgomery, 1996). As results of this study indicated the turbidity of all month were different, especially in the month of rainy season. The adverse effects of turbidity on freshwater system included; low penetration of light which then reduces primary and secondary production, high adsorption of nutrient molecules to suspended materials making the nutrients unavailable for plankton production, decreased oxygen concentration, and clogged filter-feeding apparatus, and digestive organs of planktonic organisms, which may adversely affect the production of larvae (Gupta & Gupta, 2006).

The mean dissolved nutrients, NH_3-N, NO_3^--N, and PO_4^{3-} concentrations varied from 0.08± 0.04 to 0.72±0.04 mg/L, 1.57±0.46 to 7.20±0.17 mg/L, and 0.17±0.07 to 2.43±0.06 mg/L, respectively. Nitrates are the most oxidized forms of nitrogen and the end product of aerobic decomposition of organic nitrogenous matter (Qadri et al., 2020). Nitrogen is always present in aquatic ecosystems and is as abundant as gas in the atmosphere. Relatively small quantities of nitrogen exist in the combined forms of ammonia, nitrate, nitrite, urea, and dissolved organic compounds. Nitrate is usually the most important nutrient. Natural changes in the vegetation of the drainage basin caused by fire, floods, or artificial clearing usually results in an increase of nitrate in streams. Even moderate environmental disturbances, such as sensible farming or logging without severe erosion, release a higher quantity of nitrate more than ammonia or phosphate (Goldman & Horne, 1983). Therefore nitrate concentration also reflects the range of pollution or disturbances, while ammonium concentration indicates a metabolic waste product of animals. At the time of this study nitrate concentrations were found to be slightly low. Although it should be noted that according to Goldman & Horne (1983) indicated that the concentration of most nitrogen compounds in lake and stream tended to follow regular seasonal pattern. The extreme values in this study in wet and hot-dry season, respectively, coincide with the recorded heavy rain before collecting began the same as the value of turbidity and others. The result of ammonia was also similar to nitrate concentration. Phosphate, in contrast to nitrate, is readily adsorbed to soil particles and does not move easily in groundwater. High flows of total phosphorus is due to erosion of particles from steep slopes with easily erodible soils. Agricultural, domestic and industrial wastes are the major sources of soluble phosphate. Phosphate containing detergents, for example, commonly contribute about half the phosphorus contained in domestic sewage. Here the detected phosphorus is treated as the reflection of waste within water column and hill-slope. The amounts of phosphorus concentration has significant seasonal pattern similarly to the results of the nitrate and ammonia.

2. Larval instars of *Macrostemum indistinctum*

From the specimens collected on all occasions during the wet season (July to October 2019) and cold-dry season (November to April 2019), a total of 5,583 individual of hydropsychid larvae were found. 126 larvae of *M. indistinctum* were identified and measured of head capsule width.

Larval head width ranged from 0.13 to 1.98 mm, which all developmental stages of larvae were present in our analysis (Table 2). The larvae were classified into five instars using 126 specimens. Head widths of first instars ranged from 0.13-0.18 mm (n = 8). Head widths of second instars ranged from 0.26 to 0.44 mm (n = 18). The third instars ranged from 0.50 to 0.81 mm (n = 30). The fourth instars ranged from 0.83 to 1.36 mm (n = 34) and the fifth instars ranged from 1.38 to 1.98 mm (n = 34) (Fig. 3 and Table 2).

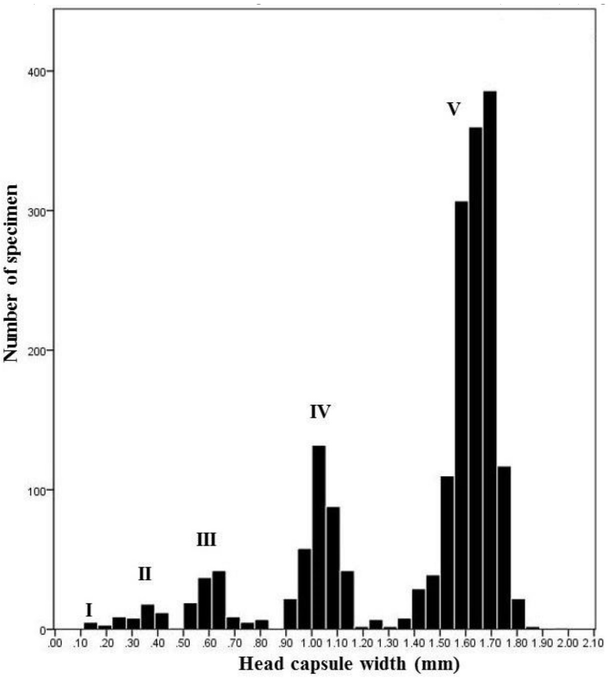

Fig. 3 The frequency distribution of larval instars of *M. indistinctum* at all sampling sites, based on head capsule width

Table 2 Median and range of head capsule width (mm) for larval instars of *M. indistinctum* during study period

Larval instar	Number measured	Mean head width (mm)	Range of head width (mm)
I	8	0.16±0.02	0.13-0.18
II	18	0.34±0.05	0.26-0.44
III	30	0.62±0.07	0.50-0.81
IV	34	1.06±0.08	0.83-1.36
V	34	1.63±0.09	1.38-1.98

3. Larval gut contents in Macrostemum indistinctum

Larval gut contents were assessed qualitatively. Gut contents were separated into arthropod fragments, blue green algae, diatoms, gastropods, green algae, protozoa and rotifers. Gut content analysis indicated that larvae are omnivorous filterers. The major resource items used by *M. indistinctum* larvae were diatoms, green algae and blue green algae (Tables 3-4 and Fig. 4).

In the cold-dry season, 50 larvae were analyzed gut content. The most abundant trophic resource was diatoms followed by green algae, blue green algae, gastropods, arthropods, rotifers and protozoa (Table 3 and Fig. 4). Significant positive correlations (P<0.05) was found between head width and percentage of arthropods (Gamma correlation = 0.707), blue green algae (Gamma correlation = 0.352), diatoms (Gamma correlation = 0.587), green algae (Gamma correlation = 0.563), and rotifers (Gamma correlation = 1.000). No significant positive correlations was found between larval stages and percentage of gastropods (Gamma correlation = –0.034) and protozoa (Gamma correlation = –1.000). The example of food items in the gut of *M. indistinctum* was shown in Fig. 5.

Table 3 Gut contents of the larvae of *Macrostemum indistinctum** in the dry season

Food item/ individual	Instar II		Instar III		Instar IV		Instar V	
	N	Mean	N	Mean	N	Mean	N	Mean
Arthropods	6	1.2±0.4 (1-2)	15	1.5± 0.9 (1-4)	14	3.9±6.8 (1-24)	15	5.6±3.3 (1-13)
Blue green algae	6	9.6±13.2 (1-39)	15	9.2± 8.5 (1-33)	14	11.6±10.2 (1-34)	15	32.6±45.2 (1-176)
Diatoms	6	45.3±65.2 (9-211)	15	64.5±11 (11-155)	14	165.9±113.1 (13-415)	15	218.5±142.9 (26-573)
Gastropods	6	15.7±16.0 (1-34)	15	9.1± 8.6 (2-29)	14	9.2±6.1 (2-20)	15	8.5±6.7 (3-20)
Green algae	6	6.7±6.5 (1-35)	15	10.0±5.2 (1-17)	14	20.4±9.8 (3-32)	15	37.4±25.2 (1-74)
Protozoas	NA	NA	15	1.3± 0.6 (1-2)	14	1.0±00 (1)	15	1.0±00 (1)
Rotifers	NA	NA	15	1.0± 0.0 (1)	14	1.0±00 (1)	15	13.6±14.0 (3-38)

Remarks: *Gut content of first instar was not dissected for qualitative assessment

In the wet season, 66 larval analyzed in this study had gut content, and they ingested mainly diatoms followed by green algae, blue green algae, gastropods, arthropods, rotifers and protozoa (Table 4 and Fig. 4). A significant positive correlation (P<0.05) was found between head width and percentage of arthropods (Gamma correlation =0.635), blue green algae (Gamma correlation = 0.660), diatoms (Gamma correlation = 0.594), green algae (Gamma correlation = 0.589), and protozoa (Gamma correlation = 0.280). No significant correlations was found between head width and percentage of gastropods (Gamma correlation = 0.103) and rotifers (Gamma correlation = –0.600).

Comparing populations in two seasons, statistically significant differences (P<0.05) were found for gastropods (Mann-Whitney U = 0.021) and protozoa (Mann-Whitney U = 0.043). The food items, arthropods (Mann–Whitney U test, P = 0.564), blue green algae (Mann–Whitney U test, P = 0.773), diatoms (Mann–Whitney U test, P = 1.000), green algae (Mann–Whitney U test, P = 0.386) and rotifers (Mann–Whitney U test, P = 0.796) showed no difference between both populations.

Table 4 Gut contents of the larvae of *Macrostemum indistinctum** in the wet season

Food item/ individual	Instar II		Instar III		Instar IV		Instar V	
	N	Mean	N	Mean	N	Mean	N	Mean
Arthropods	12	1.0±0.0 (1)	15	1.4±0.5 (1-2)	20	1.6±1.3 (1-6)	19	4.4±4.1 (1-15)
Blue green algae	12	3.2±1.3 (1-4)	15	8.8±7.7 (1-27)	20	20.5±28.5 (2-119)	19	43.8±19.7 (10-77)
Diatoms	12	11.4 ±10.8 (1-38)	15	86.6 ±65.3 (1-223)	20	126.1±115.8 (1-386)	19	269.2±166.0 (7-659)
Gastropods	12	4.2± 3.2 (1-10)	15	6.7 ±6.1 (1-20)	20	3.0±2.9 (1-11)	19	8.1±6.3 (1-24)
Green algae	12	2.7± 2.2 (1-7)	15	28.9±25.1 (2-82)	20	52.8±68.9 (2-254)	19	113.3±102.6 (4-363)
Protozoa	NA	NA	15	2.0±1.4 (1-3)	20	2.0±1.7 (1-4)	19	3.2±2.8 (1-8)
Rotifers	NA	NA	15	1.0±00 (1)	20	2.0±00 (2)	19	1.0±00 (1)

Remarks: *Gut content of first instar was not dissected for qualitative assessment

The feeding habits of *M. indistinctum* populations in the stream flows into Kasiow reservoir widely coincided with that observed in other species of Hydropsychidae larvae populations in Thailand (Maneechan et al., 2018; Thamsenanupap & Prommi, 2020). They are mainly filtering-collectors, but detritus is also an important component of their smaller larvae diet. Among the food items, diatoms, green algae and blue green algae are also the major resources for most of the studied Hydropsychidae species (Maneechan et al., 2018; Thamsenanupap & Prommi, 2020). When analyzing changes in diet with growth, apart from a general decrease in detritus intake, they seemed to be a significant trend to ingest higher size prey (as gastropods, protozoa and rotifers) by bigger larvae. This was the result of different conditions and environmental parameters at the sampling site (Table 1). The same result was published by Gil et al. (2008). During both periods the most representative items were invertebrates and amorphous substance constituting about 70% of the diet. Hydropsychidae, *Smicridea (Rhyacophylax) dithyra* Flint, 1974 between both periods preferred amorphous material (37.4%), invertebrate remains (32.6%), filamentous algae (11.5%), leaves fragments (6.3%), inorganic matter (5.9%) and unicellular algae (4.8%). Hyphae, fine sediment and pollen were found in small percentages between 0 and 0.7%. Chaetas of oligochaeta, eggs, legs and tegument of mayflies and antennas, among others, were observed in the invertebrate remains.

Hydropsychidae larvae are described as filterer collectors (Merritt & Cummins, 1984). A filterer collector is classified by the way that they eat: those which feed on seston moved by a current, using silk nets or body parts (passive), and those which resuspension deposits which are filtered using silk nets or body parts (active) Palmer & O´Keefe (1992). Gallardo-Mayenco et al. (1998) described the feeding habits of Hydropsychidae in relation to the different net sizes which can be related to the larvae development stage.

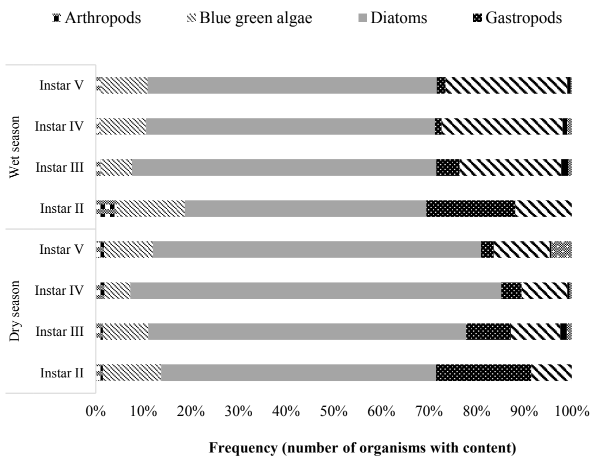

Fig. 4 Frequency of food items in the gut of *Macrostemum indistinctum*

The food item composition in larval gut observed in *M. indistinctum* obtained from the stream flows into the Kasiow reservoir was in agreement with the genus description due to the variety of ingested food items. Considering the size of the items found in the digestive tracts of *M. indistinctum* larvae, the definition given for omnivorous collectors might be extended since they have been traditionally described as processors of fine particulate organic matter (FPOM) and coarse particulate organic matter (CPOM). However, some cases, coarse particulate organic matter (CPOM), such as complete preys or fragments of big filamentous algae, were found.

The similarities found in the seasonal trophic structure might indicate the constant availability of the food resource. This possibility was reinforced by some studies carried out with coleopterans and dipterans, which showed that a change in the trophic group involved a change in the proportion of items consumed during the dry and wet seasons (Motta & Uieda, 2004).

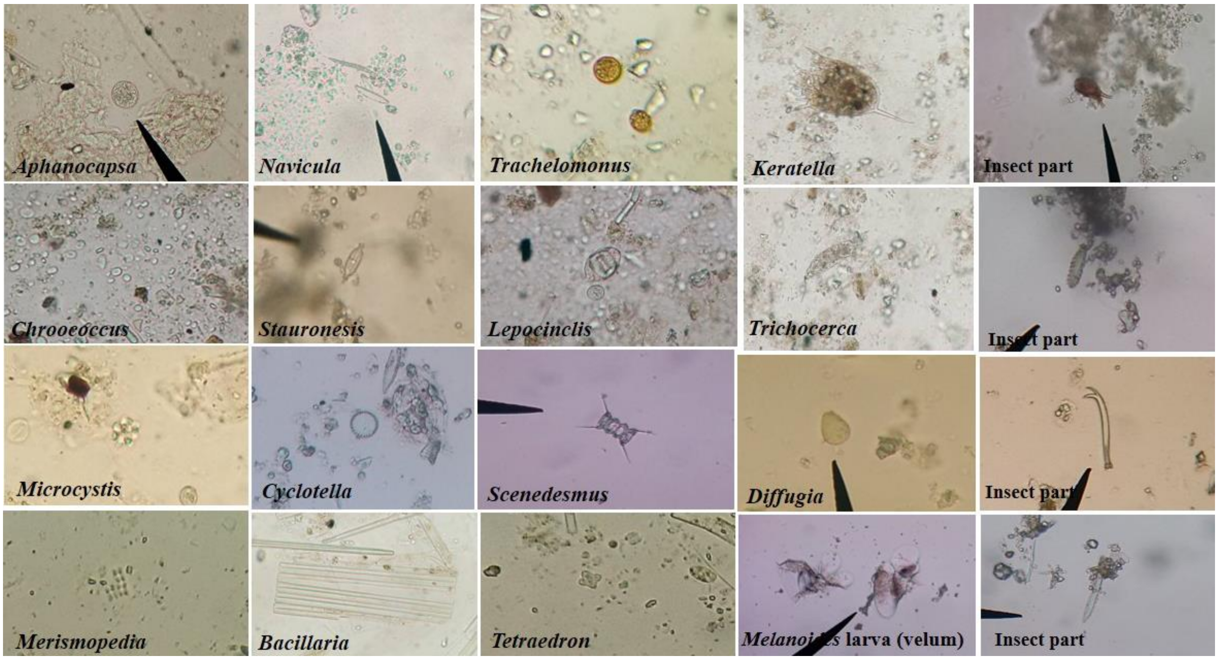

Fig. 5 Food items in the gut of *M. indistinctum* under bright field microscope (magnification x40)

Conclusion

Most of *M. indistinctum* consumed diatoms, blue green algae, and green algae as the main food source. The small larval of *M. indistinctum* consumed detritus as part of their diet, whereas the larger larval consumed larger food items. *M. indistinctum* is not exclusively herbivorous, but rather omnivorous species with flexible feeding habits. The physico-chemical of water quality parameters such as electrical conductivity, total dissolved solids, water turbidity, orthophosphate, pH, water temperature, dissolved oxygen, ammonia-nitrogen, and nitrate-nitrogen are currently affecting on the life stages of *M. indistinctum* in Kasiow reservoir, Thailand. Hydropsychidae are richly diverse in Thai streams and other species can be expected to be affected in the same way.

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