Abundance of Aquatic Insects in Spatial Variation of Two Rivers in Perak, Malaysia

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Abstract. The effect of physical factors on the abundance of aquatic insects has been studied in Kuala Woh and Lata Kinjang Rivers, Perak, Malaysia. The focuses are to identify the aquatic insect families, to compare the abundance of aquatic insects in both sampling areas and to investigate the effect of physical factors (water temperature, depth of water, canopy, and water velocity) of both places on the abundance of aquatic insects. The samples were collected by using aquatic net. Physical parameters; water velocity, water temperature, depth and canopy cover have been measured in situ and recorded. A total of 278 individuals classified into 6 orders and 9 families of aquatic insects were identified from two sampling sites. The largest percentage of samples collected is from order Plecoptera 62.6%, followed by Trichoptera 15.8%, Hemiptera 10.8%, Ephemeroptera 7.9%, Odonata 1.4% and Coleoptera 1.4%. The aquatic insects collected from Kuala Woh have the highest abundance of 214 individuals from 6 orders and 9 families compared to Lata Kinjang which only have 64 individuals from 5 orders and 6 families. Chi-square test value (23.494) indicated significant association between different sampling areas and abundance of aquatic insects, P value=0.003 (p<0.05). Kuala Woh has a moderate stream flow (0.17 m/s) of warm water (27°C), with 0.85 m depth and not covered by canopy. Lata Kinjang has faster stream flow (0.84 m/s) with the temperature of 24°C, 0.36 m depth and covered by canopy. The results reveal that the abundance of aquatic insects is high when water temperature increases, low water velocity, deeper water and the area that is not covered by canopy.

Keywords: Physical factor, Aquatic insect, River.

1. Introduction
Aquatic insects spent most of their life cycle in water, living under the water or on water surface. Physical parameters such as water depth, water temperature, canopy cover and water velocity are often used in studying the diversity of aquatic insects. This study shows the physical environments do give an impact to the abundance and diversity of aquatic insects. The objectives of this research are to study the composition of aquatic insects’ families in Kuala Woh and Lata Kinjang Rivers, to compare the abundance of aquatic insects in both sampling areas and to investigate the influence of physical factors (water temperature, canopy, water velocity and depth of water) of both places on the abundance of...
aquatic insects. Any changes in water quality due to physical environment can affect the aquatic insect’s assemblages or richness. The methods include sampling of the aquatic insects, identification of aquatic insect collected, record physical parameter of rivers, statistical analysis, and report. A total of 278 individuals classified into 6 orders and 9 families of aquatic insects were identified from two sampling sites. The order with the highest abundance is Plecoptera which is 174 individuals, followed by Trichoptera (44), Hemiptera (30), Ephemeroptera (22), Odonata (4) and Coleoptera (4). The aquatic insects collected from Kuala Woh have the highest abundance of 214 individuals from 6 orders and 9 families compared to Lata Kinjang which only have 64 individuals from 5 orders and 6 families. Kuala Woh has a moderate stream flow (0.17 m/s) of warm water (27°C), with 0.85 m depth and not covered by canopy. Lata Kinjang has faster stream flow (0.84 m/s) with the temperature of 24°C, 0.36 m depth and covered by canopy.

1.1. Literature review
In Malaysia, few studies had highlighted application of benthic macroinvertebrates including aquatic insects as bioindicators to assess the condition and water quality of the river and waterfall [1][2]. There is always growing interest among the aquatic ecologists to understand the relationship between river water quality and the diversity of aquatic insects as bioindicators for stream water quality and ecosystem condition [3]. Ephemeroptera, Plecoptera and Tricoptera (EPT) abundance were high in wet season while it was higher during dry season (27°C) in Tupah River, Kedah [4]. In dry season, the suitable temperature that causing the high abundance were recorded as the factor that increase the abundance of the aquatic insects in that area. The abundance of insects per unit area was correspondingly high in dry season. The accomplishment of various species and the pattern of abundance, diversity and distribution are completely correlated and influenced by the canopy cover [5]. For another example, Stephenson [6] wrote that cover being important as prey protection while closure directly influences understory light and temperature at a given point. The ecological relevance of each measurement is needed to interpret their biological importance. The environment with densely packed canopy will prevent the penetration of sunlight to the water thus making the water temperature decrease. A cool environment does not promote growth for the aquatic insects as they can die from over-cooling. Canopy cover of trees is among the main factor in aquatic insects’ distribution and process of ecosystem in aquatic habitats [7].

2. Methodology
Any changes in water quality due to physical and chemical environment can affect the aquatic insect’s assemblages or richness. The water quality of a river can be determined by carrying out study on aquatic insect’s assemblages and richness to examine the species-habitat relationship. Aquatic insects have been widely used as indicators for monitoring river quality [8] due to continuous response to a variety of perturbations, present in a wide array of aquatic habitats, relatively easy to sample and process and standardized methods of collection and analysis have been greatly progressed [1]. The degree of environmental impact can be determined using the data provided by these indicator organisms. Indicator organisms refer to those taxa known to have their own sensitivity towards environmental changes. Changes of abundance of an organism can reflect the environmental condition. The differences in physical environments were the reason for the chosen of those study areas. Description of methodology as follows:

2.1. Sampling of the aquatic insect
The study was conducted between January and May 2019 at Lata Kinjang (N04° 18.14', E101° 15.38') and Kuala Woh (N04° 14.657', E101° 19.317') rivers as in Figure 1 and Figure 2, which are in Perak state, with three replicates were done at each site. Macroinvertebrate sampling was most useful for comparisons between local sites, or a series of different times at a single site. These two rivers were identified to have different canopy cover, water temperature, water velocity and depth of water and were chosen in the study. This is because macroinvertebrate numbers and variety will probably differ not only between streams but also between different sections of the same stream. The aquatic insects were
sampled at riffle habitats using kick sampling technique, aquatic D-net. This method is suited for qualitative sampling, has the advantage of being potentially a one-person job, and is good for any type of substrate. Standing facing downstream, the net held upright with the bag resting on the bottom and open upstream. The feet shuffled vigorously along the bottom while moving sideways across the stream, keeping the net in front to catch dislodged organisms. In soft substrates, the net run repeatedly along the bottom, washing excess mud and organic material from the net. Collected organisms transferred to a wide-mouth jar containing 70% ethanol.

2.2. Identification of aquatic insects collected
In the laboratory, the aquatic insects were sorted on a tray and identified to the family level using taxonomic keys. Small aquatic insects were sorted by using light microscope while the larger one were identified using naked eyes. The sorted specimens are kept in properly labeled universal bottles containing 70% ethanol.

2.3. Physical parameter of rivers
Physical parameters such as water velocity, water temperature, depth and canopy cover have been measured in situ and recorded.

2.4. Statistical analysis
The association between different sampling areas and abundance of aquatic insects was tested using Chi-Square test. P-value of less than 0.05 was taken as significant. Pearson Correlation analysis also being used to measure the association between physical parameters and the abundance of aquatic insect communities.

3. Findings
Table 1 shows the result for the total number of aquatic insects collected in Kuala Woh River and Lata Kinjang River. The total number of individual in both sampling areas was 278 with 214 individuals in Kuala Woh River and 64 individuals in Lata Kinjang River (see Table 1). In Kuala Woh, the total number of orders was 6 which were Ephemeroptera, Plecoptera, Odonata, Trichoptera, Coleoptera and Hemiptera while Lata Kinjang only have 5 total number of orders which were Ephemeroptera, Plecoptera, Odonata, Trichoptera and Hemiptera. The largest percentage of samples collected was from order Plecoptera 62.6% (174), followed by Trichoptera 15.8% (44), Hemiptera 10.8% (30), Ephemeroptera 7.9% (22), Odonata 1.4% (4) and Coleoptera 1.4% (4). Chi-square test value (23.494) indicated significant association between different sampling areas and abundance of aquatic insects, P value=0.003 (p<0.05). Figures of some aquatic insects’ orders have shown in Figure 3 until Figure 6.
Table 1. Numbers of Aquatic Insects Collected In Kuala Woh and Lata Kinjang.

| Order       | Family            | Abundance of aquatic insects | Kuala Woh | Lata Kinjang | Total |
|-------------|-------------------|------------------------------|-----------|--------------|-------|
| Ephemeroptera | Heptageniidae     | 13                           | 9         | 22           |
| Plecoptera  | Pteronarcyidae    | 101                          | 25        | 126          |
|             | Chloropelidae     | 33                           | 15        | 48           |
| Odonata     | Libellulidae      | 1                            | 3         | 4            |
| Trichoptera | Polycentropodidae | 27                           | 0         | 27           |
|             | Philopotamidae    | 11                           | 6         | 17           |
| Coleoptera  | Gyrinidae         | 3                            | 0         | 3            |
|             | Haliplidae        | 1                            | 0         | 1            |
| Hemiptera   | Gerridae          | 24                           | 6         | 30           |
| Total No. of Individual |                 |                              | 214       | 64           | 278   |
| Total No. of Order  |                  |                              | 6         | 5            |
| Total No. of Family |                 |                              | 9         | 6            |

3.1. Physical parameters of sampling areas
Four physical factors that were recorded are water temperature, water velocity, depth of water and canopy cover (see Table 2).

Table 2. Mean (± SE) of physical parameters in Kuala Woh and Lata Kinjang and Pearson Correlation value

| Parameters | Temperature (°C) | Velocity (m/s) | Depth (m) | Canopy cover (%) |
|------------|------------------|----------------|-----------|------------------|
| Kuala Woh  | 27.2 ± 0.04      | 0.17 ± 0.56   | 0.85 ± 0.02 | 0 (Open)        |
| Lata Kinjang | 24.4 ± 0.08      | 0.84 ± 0.78   | 0.36 ± 0.03 | 50 (Closed)     |
| Correlation value, r | 0.842 | -0.819 | 0.889 | -0.927 |

The environmental effect which is water temperature influences the abundance of aquatic insects. From the result, there was a strong, positive correlation between water temperature and diversity of aquatic insects, r =0.842. Warmer temperature in Kuala Woh with average temperature of 27°C increases
the metabolism of aquatic insects. The emergence of many aquatic insect is influenced by water temperature [9] and thus warmer temperature leads to earlier emergence of insects for example, egg may hatch when temperature reaches a certain level.

Water velocity is one of the factors that effect on the abundance of aquatic insects. The result shows that there was a strong, negative correlation between water velocity and aquatic insects diversity, \( r = -0.819 \). Rock, rubble, and sand offer different types of niches for aquatic insects in fast flowing stream of Lata Kinjang. Leaf litters, algae, and aquatic plant are a suitable habitat for macroinvertebrates in slow moving stream. Macroinvertebrates have developed adaptations to live in these environments. Sudden increase in water flow causes streambed translocation with the consequence removal of insect and reduction in their local abundance [10]. Moreover, aquatic invertebrates rely on the current of the stream to bring nutrient down from the upstream.

Aquatic mite and insect distributions in Lake Moaralmsee, Austria were strongly related to water depth, which mostly determines in-lake variability in temperature, substrate, and water chemistry [11]. This statement supports the result where water depth has strong, positive correlation with diversity of aquatic insects \((r=0.889)\).

Canopy cover has strong, negative correlation with aquatic insects diversity, \( r = -0.927 \). Aquatic insect prefers a place that is less densely packed with canopy as shown in Kuala Woh. In other words, aquatic insects prefer environment that has a direct penetration of sunlight to the water. Canopy cover also influences the water temperature. If the canopy cover is partly open, the temperature of water might be increase due to the penetration of light. High richness and abundance of aquatic insects happen in more open canopy ponds [12] [13].

The results reveal that the abundance of aquatic insects depends on the physical factors in Kuala Woh and Lata Kinjang rivers which is high when water temperature increases, low water velocity, deeper water and the area that is not covered by canopy.

4. Conclusions
Based on this study, it can be concluded that the physical parameters of Kuala Woh and Lata Kinjang Rivers which are water temperature, water velocity, water depth and canopy cover strongly influence the abundance of aquatic insects in the water. Thus, we can develop the alternative bioindicator for water condition by using aquatic insects. By studying their diversity, population, behavior and taxonomy of species, estimation of the current degradation rate and future consequences can be assumed.

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