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AQUATIC INSECTS AND THE RELATIONSHIP TO WATER QUALITY OF WATER BODIES IN HAI VAN AREA, THUA THIEN HUE PROVINCE

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ABSTRACT

In Vietnam, the supervisory biology of water quality has been mentioned many times in the last 10 years. However, in the 2000s, when Nguyen Xuan Quynh and coworkers built the BMWPViet calculation system, the key to identifying macroinvertebrate animals in freshwater (Nguyen Xuan Quynh, 2001, 2004) began to apply the process of supervisory water quality in freshwater water areas of Viet Nam. One problem in relying solely on chemical and physical measurements to evaluate water quality is that they provide data that primarily reflect conditions when the sample is taken. Chemical measurements must be repeated many times because they vary widely in response to short-term fluctuations in water flow and position in the stream. Furthermore, chemical analysis relates only to sampling; organisms integrate effects over a relatively long period and intermittent pulses of pollution that are difficult to detect by chemical analysis. A physical-chemical approach provides a "snapshot" of water quality conditions. In contrast, biological monitoring provides a "moving picture" of past and present conditions and a more spatially and temporally integrated measure of ecosystem health. The study aimed to study the diversity of the aquatic insects and bioindicators of water in the Hai Van area. The result showed that eight orders and 37 families of aquatic insects were found. We are using aquatic insects to estimate the water quality of collected samples in the Hai Van area of Thua Thien Hue province using the BMWPVietcalculation system and ASPT biological index. It shows that the water supply in the researched places can be used for life, industrial branches, agriculture, tourist activities, and entertainment.

Keywords: Aquatic insects, Hai Van area, water quality

1. Introduction

Hai Van area has an extraordinarily high biodiversity, and it is 65 km away from Hue City. Insects represent the most diverse group of organisms, not only terrestrial but also aquatic, especially freshwater, habitats. In which the most diverse aquatic insect orders are the Mayfly (Ephemeroptera), Caddisfly (Trichoptera), Stonefly (Plecoptera), Dragonfly (Odonata),… Nowadays, bioindicators are a method usually used to evaluate water quality; in aquatic insects, they are one of the priorities because of their sensitivity to the water environment.

Aquatic insects play an essential role in the ecosystem of which they are a part. Not only do they serve as food for fish and amphibians, but they are also involved in the breakdown of organic matter and nutrients. Aquatic insects are used as indicator organisms to identify the ecological characteristics of streams. Aquatic insects are frequently used as bioindicators and biomonitors in various aquatic systems. One reason is that they are a very successful group of animals distributed in several habitats, including streams, lakes, rivers, and ponds… Due to the importance of aquatic organisms in environmental impact studies and biomonitoring of freshwater habitats, there is an urgent need for comprehensive studies and publications that are locally available.

The objective of this study was a preliminary survey of the effect of anthropogenic activity on aquatic insect diversity in the Hai Van area. Furthermore, the study aimed to investigate the relationship between physicochemical water and aquatic insect families from 07 sampling sites belonging to the Hai Van area.

2. Materials and methods

2.1. Sampling sites

Seven sampling sites belonging to the Hai Van area were selected. The collection places were chosen carefully so that we could collect representative samples for those places and conform to the process; the recommended methods of sampling procedures are based on studies by the State Committee for Science and Technology, now the Science and Technology Department, which was promulgated in 1981. The nature of the stream is described in Table 1.

Table 1. *Studying site collecting of aquatic insects in Hai Van mountain*

Order	Water bodies	Character water body	Mark
1	Bach Xa stream	- Depth 30cm, width 6m, a nearly small village, water somewhat polluted with organic matter.	M1
2	Ong Huy stream	- Depth 36cm, width 4m. The foundation of the bottom is sand, which mixes rocks and pebbles, accumulating organic substances. Fallen leaves	M2
3	Hai Van Mountain Pass stream	- Depth 42cm, width 7m. The foundation of the bottom has many large rocks. Beside traffic road	M3
4	Hoi Dua hamlet	- Depth 28 cm, width 4m. Waterfall. The foundation of the bottom has many large rocks.	M4
5	Hoi Mit hamlet	- Depth 37 cm, width 6m. The foundation of the bottom is medium-sized rock that mixes large rock.	M5

Order	Water bodies	Character water body	Mark
6	Loc Thuy village 1 stream	- Depth 35 cm, width 11m. The foundation of the bottom has many large rocks. Preserved	M6
7	Loc Thuy village 2 stream	- Depth 23cm, width 9m. The foundation of bottom has many large rocks. Preserved	M7

Figure 1. *Aquatic insect sampling points in the Hai Van area, Thua Thien Hue province*

2.2. Aquatic insect sampling

The aquatic insects were collected using a hand net (0.5 mm, mesh size 1mm) and suber net (50cm × 50cm, mesh size 0.2mm) from 07 study sites from February 2023 to May 2023 [1]. The hand net, kicking, and picking sample method collected aquatic insects from several habitats. The hand and super net was put on the bottom against the stream current, and the foot and hand disturbed the area in front of the net. The insects, which live in the gravel and sand, drifted into the sub net. During aquatic insect collection, stones were removed from the stream, and their undersurface was searched carefully. The larvae and nymphs were lifted with the help of forceps and brushes and then washed in a collecting jar [2], [3]. The nets were swept along the bottom or through stagnant waterweeds. All samples were preserved in 80% ethanol for sorting and identification in the laboratory. Physicochemical values of water pH and DO were measured. Water collection: with the aquatic insect collection, we studied some environmental parameters by collecting samples and preservation methods of Water and Wastewater (TCVN 5993 – 1995).

2.3. Laboratory procedures

After samples have been sorted, organisms must be identified and counted. By following simple keys based on distinguishing morphological characteristics, it is relatively easy to identify aquatic insects to the family level. Use the key provided to identify the most commonly occurring taxa to the family level for insects. The numbers of individuals in each family were counted and identified by using a taxonomical key to the family level or to the lowest possible level. Identification was done using Quynh N. X, (2000) [4]; McCafferty (1983) [1]; Huy, H. D. (2005) [5]; Michael Quigley (1993) [6]; ; Thu, C. T. K. (2002) [7]; Sangradub and Boonsoong (2004) [8]; Vinh, N. V. (2003) [9]; Ward (1992) [10]. Physicochemical parameters of the study sites were collected on sites, including pH, using a pH meter, dissolved oxygen (DO) and biochemical oxygen demand (BOD_5) by the aside modification method [11], [12]. These were determined by the standard method procedures (Vietnam standard 08/2008/Resources and Environment Department) [13]. All the materials are preserved in the Department of Environment Laboratory, Faculty of Biology, Hue University of Science.

2.4. Using a method of BMWP calculation system and ASPT index

The ASPT index (Average Scores Per Taxon) is a method that uses an observing calculation system to evaluate sum marks of the size of invertebrate families. The samples were classified and named taxon in families. BMWP (*Biological Monitoring Working Party, 2004*) is used to monitor the condition of Vietnam [14].

Table 2. *The relationship between biological index (ASPT) and pollution level*

Rank	Biological index ASPT	Pollution level
I	10 - 8	No pollution, fresh water
II	7.9 – 6.0	Fairy fresh water (Oligosaprobe), or a little fresh
III	5.9 – 5.0	The water is a little dirty (β - Mesosaprobe)
IV	4.9 – 3.0	Water is pretty dirty (α - Mesosaprobe)
V	2.9 – 1.0	Water is foul (Polysaprobe)
VI	0	Water is foul (absent the big size invertebrate)

(Source: Environmental Agency, UK, 1997)

The ASPT index ranges from 1 to 10. Based on the ASPT index, we can evaluate the quality of environmental water in each research place, following the classification table (Table 2).

$$ASPT = \frac{\sum_{i=1}^{n} BMWP}{N}$$

N: amount families take part in calculation mark; BMWP: *the sum mark of BMWP; ASPT: Average score per taxon*

3. RESULTS AND DISCUSSION

3.1. Aquatic insect diversity of Hai Van area

The analysis is based on 07 sampling sites. A total number of 37 aquatic insect families under 8 orders were collected from Hai Van. The highest number of aquatic insects were from the families Ephemeroptera and Odonata. Among them were 8 (Ephemeroptera), 8 (Odonata), 7 (Trichoptera), 4 (Hemiptera), 4 (Plecoptera), 3 (Coleoptera), 2 (Diptera), and 1 (Megaloptera) (Table 3).

Table 3. *List of aquatic insects in water bodies of Hai Van area, Thua Thien Hue province*

Order	Scientific name	Sampling point						
		M1	M2	M3	M4	M5	M6	M7
I	**Ephemeroptera**							
1	Baetidae	-	++	-	+	++	++	++
2	Ephemeridae	+	++	++	++	++	++	++
3	Heptagenidae	+ +	+	+	++	++	+++	+++
4	Leptophlebiidae	-	+	-	+	++	+	-
5	Neophemeridae*	+	+	-	+	++	++	+
6	Potamanthidae	++	++	+++	++	++	+++	+++
7	Polymitarcryidae*	+	+	+	++	++	++	+
8	Prosopistomatidae*	++	+	++	+++	+++	++	++
II	**Plecoptera**							
9	Chloroperlidae*	-	-	+	+	-	++	++
10	Leuctridae	+	+	++	+	++	+++	+++
11	Nemouridae	++	+	++	+++	+	+	+
12	Perlidae	+	+	++	++	++	++	+++
III	**Trichoptera**							
13	Brachycentridae	++	++	+	+++	++	-	++
14	Hydropsychidae	+	++	++	-	-	-	+
15	Leptoceridae	++	++	++	+	+	+	++
16	Polycentropodidae	+	++	+	+++	+	++	+
17	Philopotamidae	+	++	+	+	-	+	+
18	Rhyacophilidae	+	+	-	+	+	-	++
19	Stenopsychidae *	+	++	++	+	-	-	+
IV	**Odonata**							
20	Aeshnidae	-	-	+	+	++	+	+

Order	Scientific name	Sampling point						
		M1	M2	M3	M4	M5	M6	M7
21	Amphipterygidae	+	++	+	++	+	++	++
22	Coenagrionidae	+	+	++	++	++	+++	++
23	Corduliidae	+	+	++	+	++	+	-
24	Gomphidae	+	-	-	++	+	++	+
25	Lestidae	-	-	+	-	+	+	+
26	Libellulidae	+	+	+	++	+	++	-
27	Macromidae	+	+	+	-	+	+	-
V	**Hemiptera**							
28	Aphelocheiridae	-	-	-	+	-	+	+
29	Gerridae	-	-	+	++	+	+	+
30	Naucoridae	-	+	-	+	+	+	++
31	Notonectidae	+	-	+	+	+	+	+
VI	**Megaloptera**							
32	Corydalidae	-	-	+	+	+	+	+
VII	**Coleoptera**							
33	Colymbetidae*	-	+	+	+	+	+	+
34	Psephenidae	+	+	+	+	+	-	-
35	Ptilodactylidae	+	+	+	++	+	+	+
VIII	**Diptera**							
36	Simuliidae	++	++	+	+	-	-	-
37	Tipulidae	++	+	-	+	+	+	-

Note: (-): *Absen*t (+) *Present;* (++): < 5 inds/sample (+++): > 5 inds/sample

(*) *is present but absent in table mark BMWP^{Viet}*

After four months of studying seven places in the Hai Van area, we found 31 families of aquatic insects in the BMWP^{Viet} calculation system. Ephemeroptera and Odonata oder are the predomination with 8 families (21.62%); the second is Trichoptera oder, which has 7 families (18.92%). The third are Plecoptera and Hemiptera, oder each of which has 4 families (10.81%); the Coleoptera oder with 3 families (8.10%); the Diptera oder with 2 families (5.41%) and Megaloptera only 1 family (2.71%).

Table 4. *Composition of the enormous size of invertebrate in BMWP^{Viet} calculation system*

Order	Orders	Amount of orders	Ratio %
1	Ephemeroptera	8	21.62

Order	Orders	Amount of orders	Ratio %
2	Odonata	8	21.62
3	Trichoptera	7	18.92
4	Plecoptera	4	10.81
5	Hemiptera	4	10.81
6	Coleoptera	3	8.10
7	Diptera	2	5.41
8	Megaloptera	1	2.71
Sum	**8**	**37**	**100**

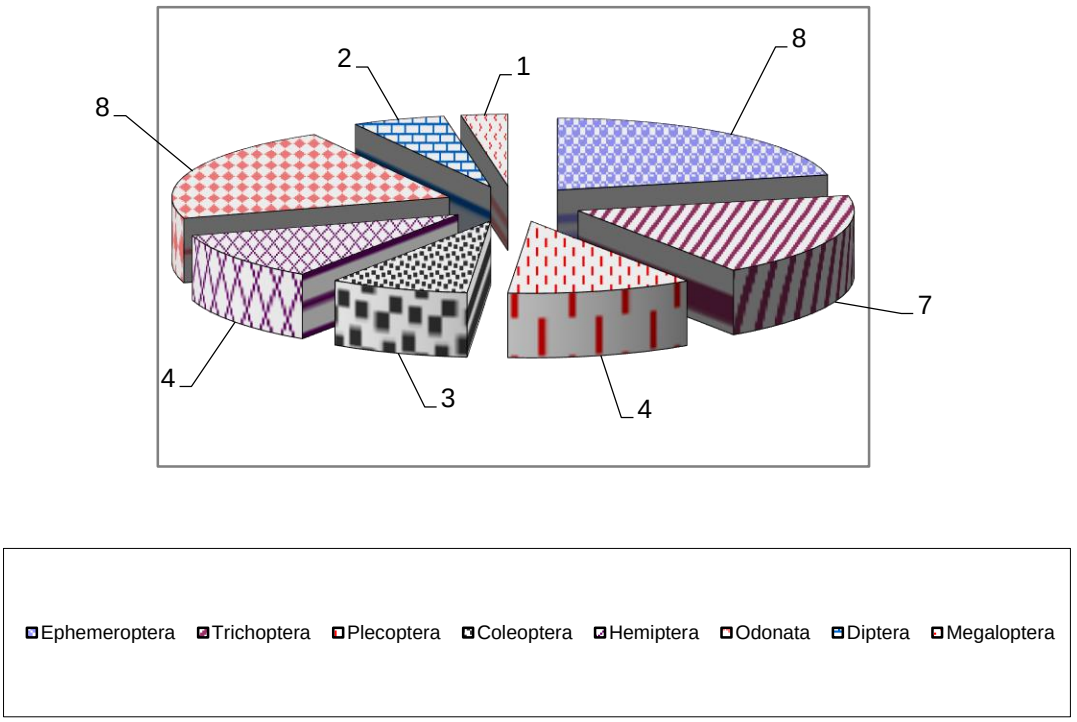

Figure 2. *The rate composition of the number of aquatic insects in the Hai Van area*

From the biological index ASPT, which we have and combine with "the relationship between biological index (ASPT) and pollution level" (table 2), we have pollution level correlative with research places through studying courses (table 5). Table 5 shows that generally, water quality in the areas where we collected samples over four months is quite good; it fluctuates from fresh to fresh. All of them can be allocated for life, industry branches, agriculture, and entertainment. The ASPT fluctuates from about 7.60 to 8.80. In May, the water quality in places from M1 to M4 slightly changed; the minimum index of ASPT this month is 7.60 in M1, and the maximum is 8.80 in M7. In the last four months, water quality in most places in February is the best, always maintained at the freshwater level.

3.2. Using insects in water to evaluate quality water in studying places

Table 5. *ASPT index and pollution level in places collected sample*

Sampl epoint	Basing on BMWP^{Viet} system							
	February		March		April		May	
	ASPT	Pollution level	ASPT	Pollution level	ASPT	Pollution level	ASPT	Pollution level
M1	7.80	Fairy fresh water	7.90	Fairy fresh water	7.70	Fairy fresh water	7.60	Fairy fresh water
M2	8.0	No pollution (freshwater)	7.90	Fairy fresh water	8.0	No pollution (freshwater)	7.80	Fairy fresh water
M3	8.20	No pollution (freshwater)	8.0	No pollution (freshwater)	8.10	No pollution (freshwater)	8.0	No pollution (freshwater)
M4	8.10	No pollution (freshwater)	8.25	No pollution (freshwater)	8.0	No pollution (freshwater)	8.30	No pollution (freshwater)
M5	8.33	No pollution (freshwater)	8.28	No pollution (freshwater)	8.33	No pollution (freshwater)	8.40	No pollution (freshwater)
M6	8.50	No pollution (freshwater)	8.25	No pollution (freshwater)	8.71	No pollution (freshwater)	8.36	No pollution (freshwater)
M7	8.80	No pollution (freshwater)	8.40	No pollution (freshwater)	8.60	No pollution (freshwater)	8.50	No pollution (freshwater)

The result of analytic water quality by chemical method shows that water quality in the Hai Van area belonging to Thua Thien Hue provinces is outstanding. Most water environmental parameters are within the running water supply limit (columns A1 and A2: Vietnam standard 08/2008/Resources and Environment Department). When we contrast the results of the water environmental analysis by chemical method, we find that the water environmental quality determined by biological method gives similar results to the results obtained by chemical method. This fact demonstrated that using the bioindicator method has high fidelity (table 6). The ASPT index is relatively equitable, with less fluctuation; the minimum is in M1, and the maximum is 8.80 in M7. Based on the calculation system BMWPViet and ASPT index, the quality of collected streams in the Hai Van area is mainly from relatively fresh water (olygosaprobe) to fresh water. All of them can be used to allocate for life, industry branches, agriculture, and entertainment, and create good conditions for the development of tourists and the ecology of the Hai Van area.

Table 6. *The water quality in water bodies of Hai Van area by time*

Sampling point	Chemical parameters											
	February			March			April			May		
	COD (mg/l)	DO (mg/l)	BOD_5 (mg/l)	COD (mg/l)	DO (mg/l)	BOD_5 (mg/l)	COD (mg/l)	DO (mg/l)	BOD_5 (mg/l)	COD (mg/l)	DO (mg/l)	BOD_5 (mg/l)
M1	30	8.75	2.35	30	8.10	2.42	30	8.16	2.62	30	8.23	2.36
M2	30	9.40	2.30	20	10.05	2.26	20	10.05	2.03	20	8.75	2.12
M3	20	8.43	2.82	20	8.77	1.31	10	10.32	1.70	20	9.40	1.50
M4	10	8.10	1.62	10	10.20	2.42	10	9.30	1.03	10	9.65	1.12
M5	10	9.73	2.60	10	8.20	2.56	10	9.50	1.40	10	9.50	1.30
M6	10	8.43	1.94	10	9.30	1.35	10	8.60	2.12	10	8.20	2.16
M7	10	8.23	0.77	10	10.10	1.24	10	8.20	1.47	10	8.24	1.56

4. Conclusions

1) Consequently, 37 families of aquatic insects belonging to eight orders were recorded in the Hai Van area. Among these families, 31 belong to the BMWPViet scoring system list. Aquatic insects about the water quality of water bodies in the Hai Van area of Thua Thien Hue province, by using the $BMWP^{Viet}$ calculation system and ASPT biological index. It shows that the water supply in the researched places can be used for life, industrial branches, agriculture, tourist activities, and entertainment).

2) The ASPT biological index, which uses aquatic insects to evaluate surface water quality of water bodies in the Hai Van region, Thua Thien Hue province, shows that water quality at the research sites is good to very good. Water environment chemical parameters (DO, BOD5, COD) are all within the allowable limits for domestic water supply (Column A1, A2: National technical regulation of Vietnam 08:2008/Minister of Natural Resources and Environment).

3) Compared with the results of water environment evaluation using aquatic insects with chemical parameters, determining water environment quality using biological methods gives equivalent results. This proves that the use of biological indicator methods is highly accurate and very useful in practical applications.

One of the best methods of assessing water quality by bioindicators, especially aquatic insects, has played a part in the unshakeable development of the ecological environment. Therefore, this method needs to be studied in other water areas of Thua Thien Hue province and expanded to other aquatic creatures to build a biological index table for evaluating water quality that can apply to the country.

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