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Using Macro-invertebrates as Bio-indicator for Assessment Water Quality of Bodies in Ngoc Thanh Commune, Phuc Yen District, Vinh Phuc Province

Nguyen Van Hieu[1,*], Bui Thuy Lien[2], Nguyen Van Vinh[3]

[1]*Faculty of Biology - Agricultural Technology,*
Hanoi Pedagogical University 2, 32 Nguyen Van Linh, Vinh Phuc, Vietnam
[2]*Faculty of Agriculture-Forestry, Hoa Lu University, Ninh Binh, Vietnam*
[3]*Faculty of Biology, VNU University of Science,*
334 Nguyen Trai, Thanh Xuan, Hanoi, Vietnam

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Abstract: This study aims to assess the environmental condition of selected water bodies in Ngọc Thanh commune, Phuc Yen district, Vinh Phuc province. Water quality was assessed by using macro-invertebrates as bio-indicators. Field collection from 20 sampling sites in December 2015 has yielded 71 aquatic macro-invertebrates families, 64 of which were included in the $BMWP^{VIET}$ scoring system. Among 20 sampling sites, eleven sites (from site S10 to site S20) were classified at the α-Mesosaprobe level (quite polluted), with ASPT scores ranging from 3.0 to 4.9; two sites (S7 and S8) with ASPT scores 5.5 and 5.7 respectively, were classified at the β-Mesosaprobe (quite polluted); seven sites (from site S1 to S6 and site S9) with ASPT scores ranging from 6.0 to 7.9, were classified at the Oligosaprobe level (fairly clean). Mostly of sampling sites in the study area with human activities (construction, tourism, agriculture…), negatively affected the water quality, with pollution level at these sites classified at α- and β-Mesosaprobe levels.

Keywords: Macro-invertebrates, bio-indicator, BMWP, water quality, Ngoc Thanh commune.

1. Introduction

There are several methods to monitor and evaluate the quality of the water environment, including the use of macro-invertebrates as bio-indicators to assess water quality based on the scoring system BMWP (Biological Monitoring Working Party) and biological index ASPT (Average Score Per Taxon). This scoring system has some advantages and has been widely used in Europe. In recent years, the application of this organism group to monitor and assess water quality has been adjusted for use in some countries in Southeast Asia, including Vietnam.

* Corresponding author. Tel.: 84-987508243
Email: nguyenvanhieusp2@gmail.com

Ngoc Thanh commune with total natural land area of over 7500ha and a part of Ngoc Thanh commune belonging to buffer zone of the Tam Dao National Park, Vinh Phuc province. In Ngoc Thanh commune, there are some several streams, which are suitable for the survival and growth of freshwater organisms, especially the macro-invertebrates. However, in recent years, under the influence of economic development, various human activities have certain impacts on the environmental of the area, especially the water environment.

Based on the analysis of the samples was collected in Ngoc Thanh and using macro-invertebrates as bio-indicators to assess the quality of the water environment, this article provides the data on current status of the water environment in the studied area.

2. Materials and methods

Materials: Samples of macro-invertebrates were collected in 20 sampling sites in December 2015 in Ngoc Thanh commune, as Table 1 and Figure 1.

Table 1. Environmental data of 20 sampling sites in the studied area

Site	Name	Width of stream (m)	Depth of stream (cm)	Coverage (%)	Landscape
S1	Dong Tam 1	3-4	10-20	50-60	Forest
S2	Dong Tam 2	3-5	15-30	85-95	Forest
S3	Dong Tam 3	2-3	10-20	80-90	Forest
S4	Dong Tam 4	2-4	10-30	35-55	Forest
S5	Tan An	1-1.5	5-10	0-5	Paddy field
S6	Dong Cham 1	2-3	10-15	30-50	Forest
S7	Dong Cham 2	2-3	15-20	0-5	Village
S8	Tan Binh	1-2	10-12	5-10	Village
S9	Thanh Cao 1	2-4	20-30	0-10	Paddy field
S10	Thanh Cao 2	2-3.5	5-15	10-20	Paddy field
S11	Thanh Cao 3	2-4	10-20	0-5	Paddy field
S12	Thanh Cao 4	1.5-3.5	10-15	0-10	Paddy field
S13	Lung Va	2-3	15-20	0-5	Paddy field
S14	Dong Cau	2-3	10-15	0-5	Paddy field
S15	Dong De	1-2	10-15	10-15	Paddy field
S16	Ngoc Quang	2-3	20-25	0-10	Village
S17	Lap Dinh 1	2-4	15-30	0-5	Village
S18	Lap Dinh 2	2-4.5	20-30	5-10	Village
S19	Lap Dinh 3	2.5-4.5	15-30	0-5	Paddy field
S20	Lap Dinh 4	3-5	15-30	0-5	Paddy field

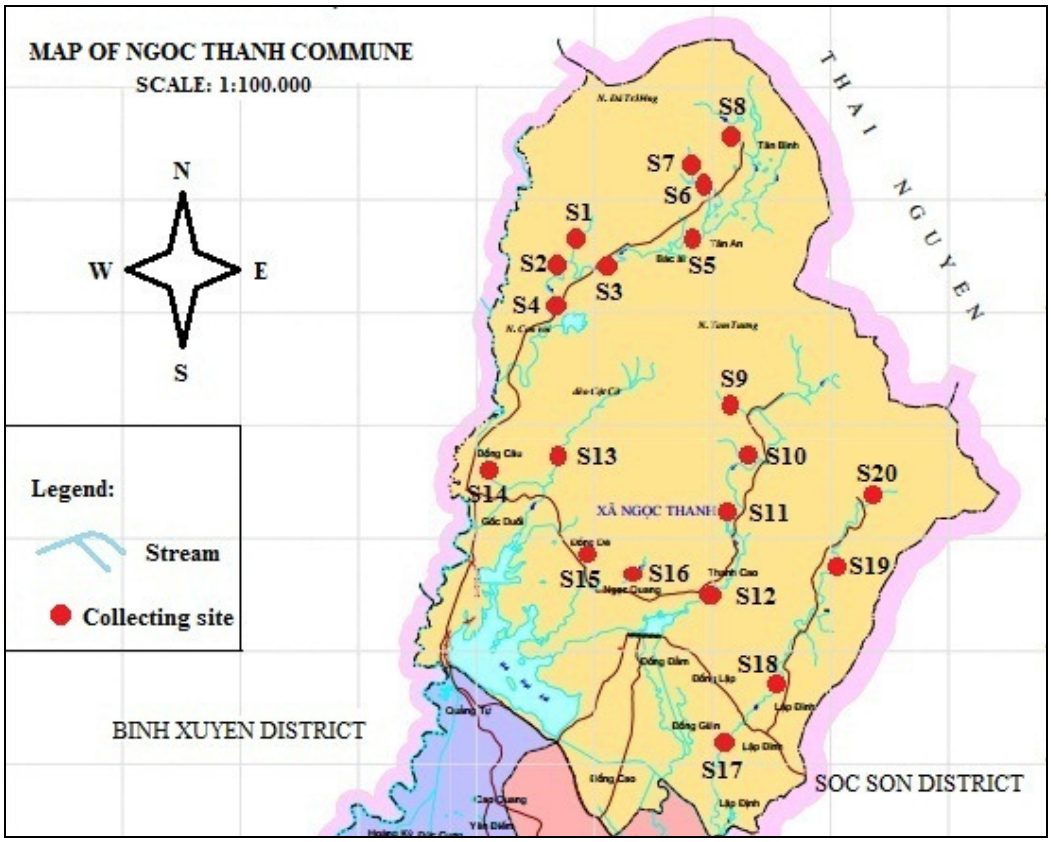

Figure 1. Map of aquatic macro-invertebrate sampling sites in Ngoc Thanh commune.

Methods: Aquatic macro-invertebrates were collected using pond nets and hand nets, according to methods illustrated by Nguyen *et al.* (2004) [1]. Then, samples were preserved in 80% ethanol and deposited in the Lab of Zoology, Faculty of Biology - Agricultural Technology, Hanoi Pedagogical University 2. The protocols of water quality assessment using macro-invertebrates as bio-indicators followed Nguyen *et al.* (2004) [1], De Pauw *et al.* (1993) [2], and Mustow (2002) [3] respectively.

Macro-invertebrates were identified to family level, based on published identification keys by Dang *et al.* (1980) [4], Dudgeon (1999) [5], Nguyen *et al.* (2001) [6], Narumon and Boonsoong (2004) [7]. BMWP scores were calculated according to the $BMWP^{VIET}$ scoring system. The total BMWP score of each sampling site was the total sum of BMWP score of each family found in the sample of that site. The ASPT (Average Score Per Taxon) score was calculated by the total BMWP score of the sampling site divided by the number of scored families found in that site.

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

(Nguyen Xuan Quynh, Mai Dinh Yen, Clive Pinder and Steve Tilling (2004) [1]).

Explication: N: the number of scored families found in the site.

The water quality and pollution levels of each sampling site was assessed by matching the BMWP and ASPT scores with the scale presented in Table 2.

Data processing: The data were processed by using Microsoft Office Excel® 2007 software.

Table 2. Evaluation of water quality using the ASPT score

ASPT score	Pollution level
0	Extremely polluted (non macro-invertebrates found)
1.0 - 2.9	Polysaprobe (very polluted)
3.0 - 4.9	α-Mesosaprobe (quite polluted)
5.0 - 5.9	β- Mesosaprobe (quite polluted)
6.0 - 7.9	Oligosaprobe (fairly clean)
8.0 - 10	Clean water

(Environment Agency, Bristol, UK, 1997 [8])

3. Results and discussion

Basing on samples collected at 20 sites in Ngoc Thanh commune, Phuc Yen distict, Vinh Phuc province, we have identified a total of 71 families of 16 orders, seven classes belonging to three phyla of invertebrates (Table 3), including:

- Four families belonging to four orders, three classes (Polychaeta, Oligochaeta and Hirudinae) of the of phylum Annelida (individuals of Polychaeta and Oligochaeta could only be identified to class, and each class was counted as one family, presumably).
- Fifty seven families belonging to ten orders, two classes of the phylum Arthropoda.
- Ten families belonging to two orders,two classes of phylum the Mollusca.

Among 71 families of aquatic macro-invertebrates found, 64 families (Oligochaeta was counted as one family) were included in the $BMWP^{VIET}$ scoring system. Among them, the majority were aquatic insects, e.g, the order Odonata with ten families, Hemiptera with nine families, Trichoptera with nine families, Ephemeroptera with six families, Coleoptera with six families, etc Besides, the class Gastropoda was represented by seven families.

Table 3. Number of aquatic macro-invertebrate families collected from the studied area and those included in the $BMWP^{VIET}$ scoring system

Taxon	Number of families	Number of families in the $BMWP^{VIET}$
ANNELIDA		
HIRUDINEA	2	2
OLIGOCHAETA	1	1
POLYCHAETA	1	0
ARTHROPODA		
CRUSTACEA		
Decapoda	4	4
INSECTA		
Coleoptera	6	6
Diptera	6	4
Ephemeroptera	9	6
Hemiptera	9	9
Lepidoptera	1	0
Megaloptera	1	1
Odonata	10	10
Plecoptera	2	2
Trichoptera	9	9
MOLLUSCA		
GASTROPODA	8	8
BIVALVIA	2	2
Total	71	64

The BMWP and ASPT scores for each sampling site are presented in Table 4.

Table 4. BMWP and ASPT scores and assessment of pollution level in each sampling site

Site	No. of families	BMWP scores	ASPT scores	Pollution level
S1	22	143	6.5	Oligosaprobe
S2	26	166	6.4	Oligosaprobe
S3	18	119	6.6	Oligosaprobe
S4	22	145	6.6	Oligosaprobe
S5	18	122	6.8	Oligosaprobe
S6	14	98	7.0	Oligosaprobe
S7	15	83	5.5	β-Mesosaprobe
S8	15	85	5.7	β-Mesosaprobe
S9	18	115	6.4	Oligosaprobe
S10	7	26	3.7	α-Mesosaprobe
S11	11	44	4.0	α-Mesosaprobe
S12	18	66	3.7	α-Mesosaprobe
S13	19	84	4.4	α-Mesosaprobe
S14	10	48	4.8	α-Mesosaprobe
S15	11	43	3.9	α-Mesosaprobe
S16	14	67	4.8	α-Mesosaprobe
S17	15	60	4.0	α-Mesosaprobe
S18	15	68	4.5	α-Mesosaprobe
S19	8	30	3.8	α-Mesosaprobe
S20	9	41	4.6	α-Mesosaprobe

Based on ASPT score, eleven sites (from S10 to S20) were classified at the α-Mesosaprobe level (quite polluted), with ASPT scores ranging from 3.0 to 4.9; two sites (S7 and S8), with ASPT scores 5.5 and 5.7 respectively, were classified at the β-Mesosaprobe (quite polluted); seven sites (from site S1 to S6 and site S9), with ASPT scores ranging from 6.0 to 7.9, were classified at the Oligosaprobe level (fairly clean).

Overall, based on the BMWP scoring system, the water quality in Ngọc Thanh commune at 20 sampling sites was considered from fairly clean to quite polluted. At sites in forests (e.g., sites S1, S2, S3, S4, S6), which were less affected by humans, the water quality was considered fairly clean. At sampling sites in area of villages and paddy fields, the water quality was considered quite polluted. This could be due to the influence of human activities, such as construction (e.g., site S17), tourism activities (e.g., site S7), agricultural actitivies and waste from villages, (e.g., sites S8, S16). At sampling sites in paddy fields area (S10, S12 and S15), the pollution level was considered even higher, with lower ASPT scores (ranging from 3.7-3.9, corresponding to the α-Mesosaprobe level). We observed that the pollution in these sites could be due to fertilizers and pesticides running with water directly from the paddy fieldsto the streams...

4. Conclusion

In the studied area, a total of 71 families of 16 orders, seven classes belonging to three phyla of aquatic macro-invertebrates was found from 20 sampling sites. Sixty four families of these were included in the $BMWP^{VIET}$ scoring system. Eleven of 20 sampling sites (from site S10 to site S20), were classified at the α-Mesosaprobe level (quite polluted). Two sites, S7 and S8, were classified at the β-Mesosaprobe (quite polluted). Sites S1, S2, S3, S4, S5, S6 and S9 were classified at the Oligosaprobe level (fairly clean). With growing demand for economic development and human activities (tourism, agriculture…) in the area, water pollution may become a more serious

issue, particularly in the villages, unless there is propermanagement of the environmental.

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Sử dụng động vật không xương sống cỡ lớn làm sinh vật chỉ thị đánh giá chất lượng nước ở xã Ngọc Thanh, thị xã Phúc Yên, tỉnh Vĩnh Phúc

Nguyễn Văn Hiếu[1], Bùi Thùy Liên[2], Nguyễn Văn Vịnh[3]

[1]Khoa Sinh - Kỹ thuật nông nghiệp, Trường Đại học Sư phạm Hà Nội 2, 32 Nguyễn Văn Linh, Vĩnh Phúc, Việt Nam
[2]Khoa Nông Lâm, Trường Đại học Hoa Lư, Ninh Bình, Việt Nam
[3]Khoa Sinh học, Trường Đại học Khoa học Tự nhiên, ĐHQGHN, 334 Nguyễn Trãi, Thanh Xuân, Hà Nội, Việt Nam

Tóm tắt: Nghiên cứu này sử dụng sinh vật chỉ thị là nhóm động vật không xương sống cỡ lớn nhằm đánh giá mức độ ô nhiễm môi trường nước tại xã Ngọc Thanh, thị xã Phúc Yên, tỉnh Vĩnh Phúc. Nghiên cứu được tiến hành vào tháng 12 năm 2015 với 20 điểm thu mẫu. Kết quả phân tích cho thấy, tại khu vực nghiên cứu đã xác định được 71 họ, 16 bộ, 7 lớp, 3 ngành (Ngành Giun đốt, ngành Thân mềm và ngành Chân khớp) thuộc nhóm động vật không xương sống cỡ lớn, trong đó có 64 họ thuộc hệ thống tính điểm $BMWP^{VIET}$. Kết quả nghiên cứu cũng chỉ ra rằng, có 11/20 điểm nghiên cứu với chỉ số ASPT dao động từ 3,0 đến 4,9; chất lượng nước ở các điểm này được đánh giá ở mức khá bẩn (α-Mesosaprobe). Hai điểm S7 và S8 có chỉ số ASPT tương ứng là 5,5 và 5,7; chất lượng nước được

đánh giá ở mức bẩn vừa (β- Mesosaprobe), có 7/20 điểm chất lượng nước được đánh giá ở mức tương đối sạch (Oligosaprobe) với chỉ số ASPT dao động từ 6,0 đến 7,9. Hầu hết các điểm nghiên cứu chịu tác động của con người (xây dựng, du lịch, nông nghiệp…), điều này đã ảnh hưởng tiêu cực đến môi trường nước với mức độ ô nhiễm tại đa số các điểm ở mức α- và β-Mesosaprobe (nước khá bẩn và bẩn vừa).

Từ khoá: Động vật không xương sống cỡ lớn, sinh vật chỉ thị, BMWP, chất lượng nước, xã Ngọc Thanh.