Diversity of aquatic insects in water hyacinth (*Eichhornia crassipes*) leaf litter in aquaculture experiment ponds

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ABSTRACT

Aquatic insects are known as insects that spend part of their lives in water. Water insects are very important for ecological systems because they are often used as indicators of pollution levels in waters. The purpose of this study was to determine the types of aquatic insects and how the level of diversity, evenness and dominance of aquatic insects in the Aquaculture Experimental Pond. Five orders and seven families of aquatic insects were found in water hyacinth leaf litter. The results of the calculation of the diversity index in water hyacinth leaf litter are in the low and medium categories, for the evenness index in the low category and for the dominance index in the low to high category.

INTRODUCTION

Aquatic insects are water-dwelling organisms that inhabit water bodies for part or all of their life cycle. The population of aquatic insects is influenced by changes in water quality, as they are aquatic organisms that live in and occupy water bodies. Aquatic insects are often used as indicators of pollution levels in water because the composition or abundance of these organisms depends on their sensitivity or tolerance to environmental changes. Many species of aquatic insects are frequently used as markers of water health because they can provide a more accurate picture than physical and chemical studies (Hynes, 1978). Besides being used for water biomonitoring, aquatic insects also play a role in helping the rate of plant decomposition, such as leaf litter found in water bodies.

Thaiutsa and Granger (1979) stated that litter is a source of organic soil material obtained through decomposition, which occurs when litter falls to the ground and is broken down into smaller particles by organisms and microorganisms into dissolved nutrients. In aquatic environments, one component of litter is leaves that fall into the water and act as a substrate.

Research on the colonization of aquatic insects on various types of substrates has not been widely conducted, especially in tropical lentic systems. It is not yet known for certain how aquatic insects prefer different types of leaf litter as a habitat substrate, particularly aquatic plant litter substrates. Considering that water hyacinth (known as eceng gondok) is a plant commonly found around us, this research will observe how the litter of this plant provides habitat for aquatic insects.

METHODOLOGY

Research Time and Location

This research was conducted from October 2023 to December 2022 at the Aquaculture Experimental Pond, Faculty of Fisheries and Marine Science, Mulawarman University. The identification of aquatic insects was carried out in the Experimental Pond Laboratory.

Research Procedure

Nets were filled with water hyacinth leaves, each weighing 20 grams, and then placed in the Aquaculture Pond containing 6 buoys tied to the nets. Each buoy held 2 types of plants, including water hyacinth, with each type having 3 replication bags. Aquatic insect collection was performed on days 7, 14, 28, 42, 56, and 70 (Reddy and DeBusk, 1991). The collection involved filtering the leaf litter in the pond, rinsing several times to ensure no aquatic insects remained attached to the leaf litter and net. The filtered insects were placed in plastic jars containing 70% alcohol according to the identification book (Borror et al, 1992). The collected aquatic insects were then sorted using a dissecting microscope with 10-40x magnification. After sorting, the insects were identified following the "Aquatic Insects of North America" by R.W. Merritt and K.W. Cummins.

Data Analysis

The collected and identified aquatic insects were tabulated into a database using Microsoft Excel and analyzed using diversity index, evenness index, and dominance index with the following formulas:

Diversity Index

The diversity of aquatic insects was calculated using the Shannon-Wiener index (Brower et al., 1998):

$$H' = - \Sigma ((ni)/N) \ln ((ni)/(N))$$

Explanation:
H’ = Diversity index
Pi = Number of individual per order (i=1,2,3…n)
Ln = Natural logarithm
Pi = Proportion of individuals of an order to the total number of individuals
H’ > 3 = High diversity
1 < H’ < 3 = Moderate diversity
H’ < 1 = Low diversity

Evenness Index

The evenness index of aquatic insects can be calculated using the Evenness Index formula (Odum, 1993):

$$E = H'/\ln S$$

Explanation:
E = Species evenness index
H’ = Shannon diversity index value

S = Number of order found
E < 0,4 = Uneven distribution
0,4 > E < 0,6 = Moderately even distribution
E > 0,6 = Even distribution

Dominance Index

The dominance index is calculated using Simpson's Dominance Index formula (Odum, 1971):

$$C = \Sigma[(ni/N)]^2$$

Explanation:
C = Simpson's dominance index
N = Total number of individuals
ni = Number of individuals of each order
$0 < C \leq 0,5$ = Low dominance
$0,5 < C \leq 0,75$ = Moderate dominance
$0,75 < C \leq 1$ = High dominance

RESULTS AND DISCUSSION

Types of Aquatic Insects

Aquatic insect sampling was conducted six times at different observation periods in the Aquaculture Experimental Pond. After collection, the insects were sorted and identified, resulting in the following list of aquatic insects found in the experimental pond:

Table 1. List of Aquatic Insects on Water Hyacinth Leaf Litter

Leaf Litter	Order	Family	Observation Day						Total
			7	14	28	42	56	70	
Water Hyacinth	Ephemeroptera	Baetidae	31	11	2	1	-	-	45
	Coleoptera	Dytiscidae	2	3	-	-	-	-	5
		Gyrinidae	1	1	-	-	-	-	2
	Diptera	Chironomidae	29	2	15	7	-	-	53
	Hemiptera	Pleidae	1	-	-	-	-	-	1
		Corixidae	108	14	18	5	-	-	145
	Odonata	Libellulidae	1	6	-	-	-	-	7
Total			173	37	35	13	-	-	258

Based on the table, the results showed that aquatic insects found in the experimental pond on water hyacinth leaf litter from day 7 to day 70 included 5 orders and 7 families. The order Ephemeroptera included the family Baetidae, order Coleoptera included families Dytiscidae and Gyrinidae, order Diptera included family Chironomidae, order Hemiptera included families Pleidae and Corixidae, and order Odonata included family Libellulidae, with a total of 258 individual aquatic insects found.

The most abundant aquatic insect found on the water hyacinth leaf litter was the family Corixidae, known for its tolerance to environmental changes and being cosmopolitan, meaning it has a wide distribution and can be found everywhere. The least abundant was the family Pleidae, with only one individual found during the observation period, likely due to its small group living and sensitivity to movement, making it swim quickly and hard to find.

Diversity Index, Evenness Index, and Dominance Index of Aquatic Insects

Based on the research results, the diversity index, evenness index, and dominance index of aquatic insects on water hyacinth leaf litter at different collection times are as follows:

Table 2. Diversity Index, Evenness Index, and Dominance Index of Aquatic Insects on Water Hyacinth Leaf Litter

Leaf Litter	Observation Day	H'	E	C
Water Hyacinth	7	1,043	0,149	0,45
	14	1,482	0,247	0,268
	28	0,869	0,29	0,451
	42	0,898	0,299	0,444

Diversity Index

Based on the calculations using the Shannon-Wiener diversity index (Brower et al., 1998), the water hyacinth leaf litter on days 7 and 14 had diversity index values of 1.043 and 1.482, respectively, falling into the moderate category ($1 < H' < 3$). In contrast, days 28 and 42 fell into the low category ($H' < 1$). The average diversity index found was in the low to moderate category due to the small number of individuals for each type. Krebs (1985) stated that a low diversity index usually results in a low evenness index.

Evenness Index

The evenness index, calculated using the Evenness Index formula (Odum, 1993), showed that aquatic insects found on water hyacinth leaf litter on different observation days all had values below 0.4, indicating uneven distribution. This was due to the unequal number of individuals in each order and the significant differences in the number of individuals among the orders. The evenness index is a good predictor of the dominance level of aquatic insects; if the evenness index is low, the dominance index will be high.

Dominance Index

The dominance index values calculated using Simpson's formula (Odum, 1971) indicated that on days 7, 14, 28, and 42, the water hyacinth leaf litter had low dominance index values ($C \leq 0.5$). The varying dominance index values found in each observation period were due to the uneven diversity of aquatic insects.

CONCLUSION

1. The aquatic insects found on water hyacinth leaf litter included 5 orders and 7 families: order Ephemeroptera (family Baetidae), order Coleoptera (families Dytiscidae and Gyrinidae), order Diptera (family Chironomidae), order Hemiptera (families Pleidae and Corixidae), and order Odonata (family Libellulidae), with a total of 258 individual insects over 70 days.

2. The diversity index of aquatic insects on water hyacinth leaf litter in the Aquaculture Experimental Pond ranged from 0.869 to 1.482. The evenness index ranged from 0.149 to 0.299, indicating a low category. The dominance index ranged from 0.268 to 0.451, indicating a range from low to high dominance.

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