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Composition and Abundance of Aquatic Insects in Jurang Susuh Stream, Batu City, Indonesia

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ABSTRACT: The aims of this study are to determine and identify the aquatic insects in the Jurang Susuh Stream well as to determine its composition and abundance. This study was studied in 13 sampling stations along the Jurang Susuh Stream, Batu City, Indonesia during June to July 2014. A sampling technique was used to collect aquatic insect by stirring the substrate using a feet to steer the aquatic insects, then they were collected at the end of the drag net. A total of 11482 insects representing 28 families from 7 orders were recorded: Coleoptera (5 Families), Diptera (8 Families), Ephemeroptera (2 Families), Hemiptera (5 families), Lepidoptera (2 Families), Odonata (3 Families) and Trichoptera (3 Families). The highest number of aquatic insect was in station 3 (2115 individuals) and the lowest number was in station 5 (300 individuals). We conclude that the water quality of Jurang Susuh Stream influenced the habitat of aquatic insects, especially its composition and abundance. In the stream, the representatives of the orders Diptera and Ephemeroptera were the most abundant groups. Moreover, we suggest that the further studies should be conducted annually in order to determine the composition and abundance of aquatic insect influenced by the seasons.

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INTRODUCTION

Aquatic insects are the most diverse group of freshwater organisms. The main groups of aquatic insects are an important part of freshwater biota community and also become important organisms in freshwater ecosystem function [1]. Many species of aquatic insects living in certain seasons and prefers on single condition habitat only [2]. Aquatic insects have also proven to be a useful tool for testing the ecological paradigm [3]. They are an important component of the collection of invertebrates in aquatic ecosystems, where they are the majority in the food web. In the larval stage, they constitute the main food for fish [3]. According to Bouchard [5], water insects were able to break down and process the organic material and provide food for invertebrates and vertebrates (such as fish, birds).

In addition to the functions of ecosystems, aquatic insects can be used as an indicator of human impact on freshwater ecosystems. The study on aquatic insects of freshwater ecosystems in the river has been widely demonstrated relationships between species and habitats associated with water quality [6,7]. Some studies show that aquatic insects can be a good indicator in terms of anthropogenic disturbance and environmental quality [8, 9]. Some species have been known to require certain requirements relating to nutrition, water quality, substrate components and structure of vegetation. At a certain species in a habitat indicate that the given determinants or parameters would be the tolerance limits of some species of the aquatic insects [10].

This study was observed benthic macroinvertebrates, especially aquatic insect, in the Jurang Susuh Stream. Jurang Susuh Stream, belonging to the Brantas River, is part of upstream section of the Brantas catchment located in Batu City, East Java Province, Indonesia. This study aims to determine and identify the macroinvertebrates, especially aquatic insects, in the Jurang Susuh Stream well as to determine its composition and abundance.

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MATERIAL AND METHODS

Study area and sampling station

This study was conducted in 13 sampling stations along the Jurang Susuh Stream, Batu City, Indonesia (Figure 1). The sampling stations were chosen based their different land uses along the stream, natural and impaired condition, and accessibility. Samplings were done once in June to July 2014.

Sampling of Aquatic insects

The specimen collection was conducted by using the method of Sudaryanti et al. [11] with slightly modification. The collection was done in each station along the stream by using kicking method, a sampling technique to collect aquatic insect by stirring the substrate using a feet to steer the aquatic insects collected at the end of the drag net. The specimen collected could be combined into a single sample at each station and were individually taken in plastic jars. Aquatic insects were sorted from the detritus and kept in separate labeled plastic jars containing stream water and then taken to the laboratory, whereby, the specimens were preserved in 96% alcohol in separate labeled plastic jars.

Identification of Aquatic insects

The aquatic insects so collected were sorted on petri dish and identified to possible taxonomic level, i.e up to family level, using identification keys in the laboratory for identifying the insects [12]. Large aquatic insects were sorted by naked eyes whereas the sorting of the smaller ones was done under a dissecting microscope. All samples identified stored on properly-labeled glass vials. The abundance and relative abundance (%) were calculated for each sampling station.

Water Quality Assessment

Physicochemical parameters were measured at each sampling station. The dissolved oxygen (DO, mg/l), water temperature (°C), and pH were measured in situ by using a Dissolved Oxygen meter (Cyberscan DO 300, Eutech Instruments) and pH test strips (pH-indicator strips, MERCK), respectively. The ammonia (mg/L NH3) and Hardness (mg/L) were measured by method of APHA [13], using the Nessler method and EDTA Titrimetric method, respectively.

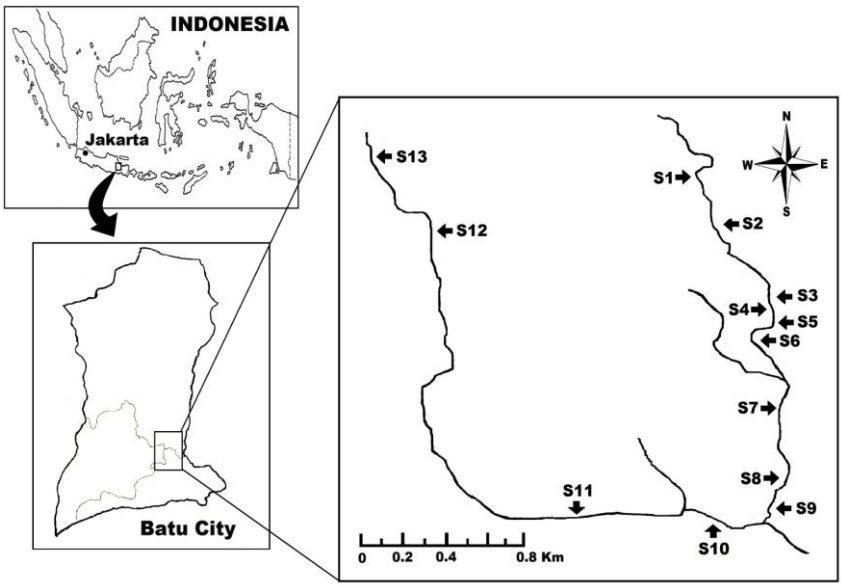

Figure 1. Location of study area and sampling stations (S1–S13) (Direction of stream flow is east to west).

RESULTS AND DISCUSSION

A total of 11482 individuals of aquatic insects representing 28 families from 7 orders (Coleoptera, Diptera, Ephemeroptera, Hemiptera, Lepidoptera, Odonata, and Trichoptera) were successfully collected and identified from the Jurang Susuh Stream, from June until July 2014. Table 1 shows the overall composition and abundance of aquatic insect communities in the stream. The highest number of aquatic insect was in station 3 (2115 individuals) and the lowest number was in station 5 (300 individuals). Order Diptera, Ephemeroptera, and Trichoptera were found in all stations of Jurang Susuh Stream.

In the range of 300 to 2115 individuals of aquatic insects, Diptera was dominated quantitatively in the station 1, 4, 5, 6, 10, 11, and 13 with the highest number of individuals (with relative abundance of 94.91%, 91.40%, 75.67%, 45.20%, 58.78%, 51.95% and 48.38%, respectively).

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Table 1. Composition and Abundance of aquatic insects identified in the sampling stations

Taxa		Station 1		Station 2		Station 3		Station 4		Station 5		Station 6		Station 7	
Order	**Family**	**A**	**RA**	**A**	**RA**	**A**	**RA**	**A**	**RA**	**A**	**RA**	**A**	**RA**	**A**	**RA**
Coleoptera	Elmiidae	1	0.2	7	1.89	11	0.52	-	-	-	-	1	0.08	6	0.42
	Psephenidae	-	-	-	-	3	0.14	-	-	-	-	-	-	-	-
	Lampyridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Dytiscidae	2	0.41	-	-	-	-	-	-	-	-	-	-	-	-
	Dryopidae	-	-	-	-	-	-	-	-	-	-	-	-	1	0.07
Diptera	Simuliidae	13	2.65	1	0.27	215	10.17	-	-	21	7	34	2.63	57	3.96
	Culicidae	3	0.61	2	0.54	-	-	-	-	-	-	-	-	-	-
	Tipulidae	3	0.61	11	2.97	21	0.99	1	0.32	21	7	12	0.93	9	0.62
	Tabanidae	-	-	-	-	-	-	-	-	1	0.33	-	-	-	-
	Empididae	-	-	-	-	2	0.09	-	-	-	-	1	0.08	-	-
	Ceratopogonidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Psychodidae	2	0.41	-	-	-	-	5	1.61	2	0.67	2	0.15	-	-
	Chironomidae	445	90.63	133	35.95	182	8.61	277	89.35	182	60.67	535	41.41	275	19.08
Ephemeroptera	Baetidae	14	2.85	154	41.62	1348	63.74	21	6.77	53	17.67	565	43.73	783	54.34
	Caenidae	1	0.2	20	5.41	19	0.9	-	-	5	1.67	18	1.39	38	2.64
Hemiptera	Gerridae	1	0.2	-	-	-	-	-	-	-	-	-	-	-	-
	Naucoridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Hydrometridae	1	0.2	-	-	-	-	-	-	-	-	-	-	-	-
	Nepidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Veliidae	-	-	15	4.05	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Noctuidae	-	-	2	0.54	-	-	1	0.32	-	-	1	0.08	-	-
	Pyralidae	-	-	2	0.54	-	-	1	0.32	-	-	1	0.08	-	-
Odonata	Amphipterygidae	-	-	-	-	-	-	-	-	-	-	1	0.08	-	-
	Platycnemididae	-	-	7	1.89	-	-	3	0.97	11	3.67	1	0.08	-	-
	Gomphiidae	-	-	3	0.81	-	-	-	-	-	-	-	-	-	-
Trichoptera	Glossosomatidae	-	-	-	-	-	-	-	-	-	-	-	-	1	0.07
	Ecnomidae	-	-	5	1.35	-	-	-	-	-	-	-	-	-	-
	Hydropsychidae	5	1.02	8	2.16	314	14.85	1	0.32	4	1.33	120	9.29	271	18.81
Total		491	100	370	100	2115	100	310	100	300	100	1292	100	1441	100

A = Abundance (Individual/5m2); RA = Relative Abundance (%)

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Table 1. Composition and abundance of aquatic insects identified in the sampling stations (*Extended*)

Taxa		Station 8		Station 9		Station 10		Station 11		Station 12		Station 13	
Order	**Family**	**A**	**RA**	**A**	**RA**	**A**	**RA**	**A**	**RA**	**A**	**RA**	**A**	**RA**
Coleoptera	Elmiidae	2	0.26	1	0.16	5	0.36	-	-	5	0.29	9	3.63
	Psephenidae	-	-	-	-	-	-	-	-		-	-	-
	Lampyridae	-	-	-	-	-	-	-	-	1	0.06	-	-
	Dytiscidae	-	-	-	-	2	0.14	-	-	-	-	-	-
	Dryopidae	-	-	-	-	-	0	-	-	-	-	-	-
Diptera	Simuliidae	8	1.05	3	0.47	-	-	-	-	21	1.2	1	0.4
	Culicidae	-	-	-	-	-	-	-	-	-	-	-	-
	Tipulidae	28	3.68	4	0.63	6	0.43	1	0.28	8	0.46	3	1.21
	Tabanidae	-	-	-	-	-	-	-	-	-	-	-	-
	Empididae	21	2.76	4	0.63	4	0.28	1	0.28	1	0.06	-	-
	Ceratopogonidae	-	-	-	-	-	-	-	-	1	0.06	-	-
	Psychodidae	-	-	-	-	-	-	-	-	-	-	-	-
	Chironomidae	234	30.75	96	15.05	817	58.07	185	51.39	78	4.46	116	46.77
Ephemeroptera	Baetidae	320	42.05	358	56.11	19	1.35	67	18.61	1525	87.19	108	43.55
	Caenidae	87	11.43	29	4.55	8	0.57	1	0.28	5	0.29	6	2.42
Hemiptera	Gerridae	3	0.39	1	0.16	-	-	-	-	1	0.06	-	-
	Naucoridae	-	-	-	-	-	-	-	-	1	0.06	-	-
	Hydrometridae	-	-	-	-	-	-	-	-	-	-	-	-
	Nepidae	-	-	-	-	-	-	-	-	-	-	1	0.4
	Veliidae	-	-	-	-	-	-	1	0.28	3	0.17	1	0.4
Lepidoptera	Noctuidae	-	-	-	-	-	-	-	-	-	-	-	-
	Pyralidae	1	0.13	-	-	1	0.07	5	1.39	-	-	-	-
Odonata	Amphipterygidae	1	0.13	-	-	-	-	-	-	-	-	-	-
	Platycnemididae	-	-	-	-	-	-	-	-	-	-	1	0.4
	Gomphiidae	-	-	-	-	-	-	-	-	-	-	-	-
Trichoptera	Glossosomatidae	-	-	-	-	-	-	-	-	-	-	-	-
	Ecnomidae	-	-	-	-	-	-	-	-	3	0.17	2	0.81
	Hydropsychidae	56	7.36	142	22.26	545	38.73	99	27.5	96	5.49	-	-
Total		761	100	638	100	1407	100	360	100	1749	100	248	100

A = Abundance (Individual/5m²); RA = Relative Abundance (%)

Table 2. Physico-chemical properties for each station of Jurang Susuh Stream

Parameters	**Station**												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Velocity (cm/s)	41	47	66	12	41	43	33	37	26	29	32	87	44
Temperature (°C)	23	26	19	21	21	20	19	24	20	19	23	22	23
pH	7	8	7	8	8	7	7	7	7	7	7	8	8
Dissolved Oxygen (mg/L)	6.35	6.21	7.61	6.02	6.61	6.82	7.31	6.48	6.73	7.03	6.46	7.71	7.32
Hardness (mg/L)	26	18	38	32	32	30	38	18	20	18	28	14	14
Ammonia (mg/L)	0.02	0.42	0.08	0.14	0.002	0.08	0.01	0.04	0.02	0.05	0.04	0.45	0.24

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The contribution of the family Chironomidae to total abundance in 9 families was considerably higher in Station 1 (465 individual/5m^2), Station 4 (277 individual/5m^2), Station 5 (182 individual/5m^2), Station 6 (535 individual/5m^2), Station 10 (817 individual/5m^2), Station 11 (185 individual/5m^2), and Station 13 (116 individual/5m^2). In the other hand, Ephemeroptera was dominant order of aquatic insect in the station 2, 7, 8, 9 and 12 with the highest number of individuals (with relative abundance of 47.03%, 64.64%, 56.98%, 53.48%, 60.66% and 87.48%, respectively). There are only 2 families found in Order Ephemeroptera, namely Baetidae and Caenidae. Baetidae gave the highest contribution to total abundance with number of individual in station 2 (154 individual/5m^2), station 7 (783 individual/5m^2), station 8 (320 individual/5m^2), station 9 (358 individual/ 5m^2), and station 12 (1525 individual/5m^2).

The present study showed that insect fauna of stream was dominated by Diptera that are typical of many freshwater systems [14]. The same results were shown by Azrina et al. [15], who observed Langat River, Malaysia, and showed that the abundance of aquatic insect in the upper reaches of the river was dominated by Chironomidae and Ephemeroptera. Most of these larval fauna are reported to be tolerant to varied aquatic environments [16]. Morse et al. [17] found that urbanized catchment gave the highest abundance in the family Chironomidae, because some species of the family Chironomidae has tolerance to live in the silt. Aquatic insect observations had also been made by Guimaraes et al. [18] at 4 Rivers in Brazil, namely Cabeceira do Lageado River, Buritizinho River, Lobo River, and Bons Olhos River. The result showed that Chironomidae became the most dominant group in the aquatic insect community in the 4 Rivers, with the highest percentage of the value indicated in all rivers. Other studies also reported the dominance of Chironomidae [19, 20] in the community of aquatic insect. Then, Wahizatul et al. [21] found that Diptera (primarily Chironomidae) were the most abundant at the two freshwater streams of Hulu Terengganu, Malaysia and was found in all stations, followed by Tipulidae. They showed no habitat restriction as they exhibit a great variety of feeding types.

Moreover, some environmental variables such as temperature, pH, and dissolved oxygen are important regarding the composition and abundance of aquatic insect. Moreover, some of biological fluctuations exhibit the combination of natural and anthropogenic influences such as food availability, hydraulic conditions, substrate composition, nutrient loads and water quality variations [22]. In this study, the water-quality data of Jurang Susuh Stream collected during the survey is summarized in Table 2. Also, this study found that the stream still has reasonable riparian vegetation, a substratum consisting of cobble, pebble, gravel, sand and silt. The main land use is a combination of natural forest, forestry activities and dry cropping. The study indicates that the some insects have the capability to adapt in varied aquatic environments due to their structural organization and physiology [23, 24]. According to Ross et al. [25], temperature is one of the most important environmental factors controlling aquatic insect density. Also, Standing and slow-flowing streams and muddy or sandy areas, with high fine-sediment particles are known to support higher diversity and abundance of some aquatic insects [26]. This study can be explained that some family members have the capability of tolerance to extreme hypoxia and rapid growth rate [18]. According to Anbuchezhian et al. [27], the distribution of benthic macro invertebrates, including aquatic insects, depend on the physical condition of the substrate, nutrient content, and the level of stability, oxygen, and hydrogen sulfide levels. Small changes in the environment habitat will greatly affect macro invertebrate community and this can be used to measure the level of pollution in the waters [28, 29], where the impact of anthropogenic activities on the water quality and distribution of aquatic insects were clearly associated.

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