1st International Conference on Multiple-governance in Islam, Environmental Development, and Conservation. Johor, Malaysia, Nov. 20-21, 2012, Water Research Alliance, Universiti Teknologi Malaysia. ISBN 978-983-44826-4-0.
http://ienv.web.fc2.com/env.islam/hp2012.html

Communications:

Diversity of Aquatic Biota as Bioindicator for Water Quality of Ranu Pani and Ranu Regulo

*Dwi Suheriyanto, Liliek Harianie A.R., and Suyono

Biology Department, Faculty of Science,
Universitas Islam Negeri Maulana Malik Ibrahim Malang, Indonesia.

Abstract: Changes in water conditions greatly affect the presence and ability of aquatic biota to survive in their habitat. The presence of these biota are largely determined by the physical and chemical conditions of water, so that the community structure of aquatic biota will vary according to the conditions of physical and chemical parameters of water. It allows aquatic biota to serve as bioindicator of water quality changes. The study aims to determine the abundance and diversity of phytoplankton, zooplankton and benthos in Ranu Pani and Ranu Regulo, to know the physical and chemical properties of water and to obtain bioindicator of the phytoplankton, zooplankton and benthos in order to assess water quality in both Ranu. Research using quantitative descriptive method to describe about the diversity index and abundance of phytoplankton, zooplankton and benthos related to water quality in Ranu Pani and Ranu Regulo. Samples were taken at 7:00 until 10:00 am on 5 station observations. Physical and chemical factors measured were temperature, pH, and brightness, DO, BOD, OD, TDS, TSS, Phosphate and Nitrate. The results showed that there are 17 phytoplanktons genera were found in Ranu Pani, while in Ranu Regulo there are 16 genera with the highest abundance of the genus Dictyosphaerium. There are 13 and 10 genera of Zooplankton found in Ranu Pani and Ranu Regulo row, with the highest abundance of genus Arcella. Benthos are found in Ranu Pani consisting of 7 families with the highest abundance of the family Bulimidae and there are 3 families in Ranu Regulo, with the highest abundance of family Coenagrionidae. Diversity of phytoplankton and zooplankton in Ranu Pani is lower than Ranu Regulo, while benthos biodiversity in Ranu Pani is higher than Ranu Regulo. Water quality in Ranu Pani is lower than Ranu Regulo and based on Government Regulation No. 82/2001, generally water of Ranu Pani can be categorized as water quality class II and Ranu Regulo can be categorized as water quality class I. Genus Dictyosphaerium (phytoplankton), genus Arcella (zooplankton) and family Bulimidae (benthos) can be used as bioindicator for water quality class II. Family Coenagrionidae can be used as bioindicator for water quality class I.

Keywords: *Aquatic biota, Bioindicator, Diversity, Ranu, Water quality*

1. Introduction

Water is a chemical compound that essential for human life and other living creatures. The function of water for life cannot be replaced by other compounds and almost all human activities require water, ranging from personal and shelter hygiene, preparing food and beverages and other activities. The source of water mostly comes from groundwater, ranu (lakes) and rivers. Therefore, the quantity and quality of water resources must be maintained (Achmad 2004).

Good or bad the water was due to activities in the vicinity. Often times there are activities that can degrade water quality, which in turn would disrupt the lives of aquatic biota. Changes in water conditions greatly affect the presence and ability of aquatic biota to survive in their habitat. The presence of the biota is largely determined by the physical and chemical conditions of the water, so that the community structure of aquatic biota will vary according to the conditions of physical and chemical parameters of water. It allows aquatic biota to serve as bioindicator of water quality changes (Wijaya 2009).

*: Corresponding author: dsuheriyanto@yahoo.com, Gajayana 50, 65144-Malang, East Java, Indonesia.

Ranu Pani and Ranu Regulo are lakes located in the Bromo Tengger Semeru National Park, East Java - Indonesia. This park is a conservation area and tourist destination. Ranu Pani is located close to population centers, so it is often used as a venue for various community activities, such as bathing, washing, bathing livestock, irrigate the fields and estuaries channel of household waste. While Ranu Regulo is located in a very remote area from residential so it is natural and beautiful. The behavior of the visitors, especially those camping at Ranu Regulo plays an important role in keeping it clean (Department of Forestry 2009).

Lakes generally have high biodiversity, which include phytoplankton, zooplankton, benthos, fish and plants. Various human activities around the lake directly or indirectly will lead to changes in the quality of the aquatic environment. Damages and changes in the aquatic environment caused by human activity can be determined by looking at the existing aquatic biota. Good quality of water usually have many kind of aquatic biota and polluted waters with little aquatic biota (Fachrul 2007). Odum (1993) explains that the biotic components can provide an overview of the physical, chemical and biological waters. The study aims to determine the abundance and diversity of

phytoplankton, zooplankton and benthos in Ranu Pani and Ranu Regulo, to know the physical and chemical properties of water and to obtain bioindicator of the phytoplankton, zooplankton and benthos in order to assess water quality in both Ranu.

2. Methods

2.1. Materials

The materials used in this study were 4% Formalin, 70% alcohol, $CuSO_4$, substrate soil, water samples Ranu Pani and Ranu Regulo, samples of phytoplankton, zooplankton and benthos.

2.2. Methods

Preliminary study was conducted in June 2011. This activity aims to determine the location of which will be used to observe the abundance and diversity of phytoplankton, zooplankton and benthos and physical and chemical properties of water Ranu Pani and Ranu Regulo.

Table 1. Description of observation stations

Stations	Ranu Pani	Ranu Regulo
I	The dock area and close to the Inns and office	The dock area and campground
II	Siltation and trash piles	The fishing
III	The dock area and close to the forest	Near the forest
IV	Near the farm and temple	Near the forest
V	Siltation and household sewerage	Near the shelter

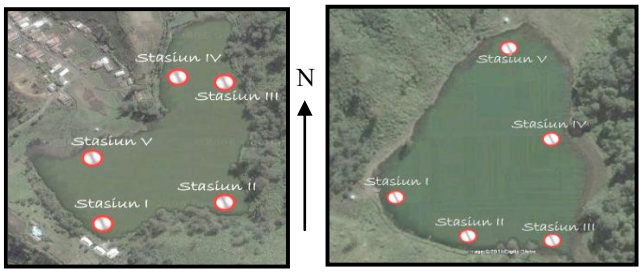
2.3. Sampling

Samples were taken at 7:00 until 10:00 am on 5 station observations. Phytoplankton and zooplankton were taken with 40 µm pore size plankton net. Withdrawals were made horizontally under the surface of the water as far as 2 meters at a constant speed of 10 cm/sec. Samples were obtained, poured into a 25 ml sample bottle and preserved with 4 drops of 4% formalin and 5 drops of $CuSO_4$, labeled and sent to the laboratory for identification.

Benthos samples were taken with Ekman Dredge. The samples contained in each substrate was poured into a bucket of water, then filtered with a filter that has a hole of 0.5 mm wide. Remained materials were sorted by hand and kept in a bottle. Samples were preserved in a bottle with 4% formalin or 70% alcohol, labeled and transported to the laboratory for identification.

2.4. Measurement of Physical and Chemical Water

Measurements of water temperature, acidity (pH) and brightness were conducted at the sites. Analysis of Dissolved Oxygen (DO), Biochemical Oxygen Demad (BOD), Chemycal Oxygen Demand (COD), TDS, TSS, Phosphate and Nitrate were performed in the Laboratory.



Ranu Pani Ranu Regulo

Fig. 1. Study site and detalils of sampling location (Modified from Google Maps, 2011)

2.5. Identification of Aquatic Biota

Water and substrate samples obtained from the field were brought to the laboratory in order to identify the type of phytoplankton, zooplankton and benthos. Phytoplankton specimens were identified using the books written by Edmonson (1959), Mizumoto (2001), Davis (1955), Silva (1999), Loch (2003), Bold and Wyne (1985) and John *et al.* (2005). Zooplankton specimens were identified using the books written by Edmonson (1959), Davis (1955), James and Alan (2001), Work (2005) and Shiroza (2006). Benthos specimens were identified using the books written by Edmonson (1959) and Zwart *et al.* (1995).

2.6. Data Analysis

Determination of the abundance of plankton (phytoplankton and zooplankton) done by segwick rafter. Plankton abundance was calculated using the following formula:

$N = nx\ (V_r / V_o)\ x\ (1/V_s)$ [1]

N : Number of individuals per liter
n : Number of individuals observed
V_r : Volume of water filtered
V_o : Volume of water was observed (at segwick rafter 1 ml)
V_s : Volume of filtered water

Diversity of aquatic biota analyzed with Shannon-Weaver diversity index (*H'*).

$H' = - \sum p_i \ln p_i$ [2]

H' : Shannon-Weaver diversity index
p_i : the proportion of the i species in the total sample

3. Results and Discussion

According to Table 1, it can be known that 17 genera of phytoplankton was found in Ranu Pani while 16 genera of phytoplankton was found in Ranu Regulo, with the highest abundance was occupied by genus Dictyosphaerium. Genus Dictyosphaerium abundance in Ranu Pani is higher (11.002 individuals/l) than in Ranu Regulo (454 individuals/l). There are 13 genera of Zooplanktons were found in Ranu Pani while 10 genera was found in Ranu Regulo. Highest zooplankton abundance in both Ranu were occupied by genus Arcella. Abundance of genus Arcella in Ranu Pani is 384 individuals/l higher than in Ranu Regulo with 31 individuals/l. Benthos that were caught in Ranu Pani consisting of 7 families, with the highest abundance is from family Bulimidae. Benthos

found in Ranu Regulo consists of 3 families, with the highest abundance is Coenagrionidae.

Table 1. Abundance of aquatic biota

No.	Genus	Ranu Pani	Ranu Regulo
A.	Phytoplankton	(individu/l)	(individu/l)
1.	Anabaena	50	27
2.	Chroococcus	53	27
3.	Closterium	0	9
4.	Cosmarium	7	16
5.	Crucigeniella	73	0
6.	Cylindrotheca	43	0
7.	Cymbella	109	125
8.	Diatomella	0	2
9.	Dictyosphaerium	11.002	454
10.	Fragilaria	64	19
11.	Frustulia	12	14
12.	Microcystis	465	0
13.	Navicula	74	93
14.	Oscillatoria	65	35
15.	Peridinium	0	10
16.	Pinnularia	9	4
17.	Selenastrum	6	0
18.	Spirogyra	48	19
19.	Staurastrum	6	59
20.	Staurodesmus	11	19
B.	Zooplankton	(individu/l)	(individu/l)
1.	Anuraeopsis	0	1
2.	Arcella	384	31
3.	Branchionus	49	0
4.	Chaetonotus	10	9
5.	Chollotheca	25	0
6.	Ciclopoid	17	0
7.	Floscularia	0	14
8.	Keratella	51	0
9.	Lepadella	1	6
10.	Monostyla	0	10
11.	Nauplius	28	2
12.	Paramecium	4	5
13.	Polyarthra	10	0
14.	Trichocherca	72	4
15.	Tropocylops	4	0
16.	Undinula	5	2
C.	Benthos	(individu)	(individu)
1.	Aeshnidae	0	5
2.	Asselidae	0	5
3.	Bulimidae	93	0
4.	Coenagrionidae	3	50
5.	Gammaridae	1	0
6.	Glossiphoniidae	22	0
7.	Gomphidae	1	0
8.	Hirudidae	14	0
9.	Syrphidae	1	0

Table 2. Diversity index of aquatic biota

No.	Aquatic Biota	Diversity Index	
		Ranu Pani	Ranu Regulo
1.	Phytoplankton	0.55	1.87
2.	Zooplankton	1.54	1.89
3.	Benthos	0.96	0.57

According to Table 2, diversity index of phytoplankton and zooplankton in Ranu Pani is lower than diversity index of phytoplankton and zooplankton in Ranu Regulo. Diversity index of benthos in Ranu Pani is higher than Ranu Regulo. The low value of diversity index of phytoplankton and zooplankton in Ranu Pani and high value of diversity of benthos in Ranu Pani may be caused by the condition of areas that were close to human settlements and agricultural lands, where the domestic and agricultural waste are directly discharged into Ranu Pani causing the water of Ranu Pani to contain many organic ingredients higher than in Ranu Regulo. Analysis of physical and chemical factor indicates that all parameters of physical and chemical except DO in Ranu Pani is higher than Ranu Regulo (Table 3). Generally, water of Ranu Pani can be categorized as water quality class II and Ranu Regulo water can be categorized as water quality class I based on Government Regulation No. 82/2001.

Table 3. Comparison of Physical and Chemical Factors with Water Quality Standards

Parameters	Unit	Maximum allowable (*)			Result	
		I	II	III	Ranu Pani	Ranu Regulo
Temperature	^{0}C	-	-	-	18.36	17.76
TDS	mg/l	1000	1000	1000	176.5	54.9
TSS	mg/l	50	50	400	56.5	22.5
pH	mg/l	-	6-9	6-9	6.51	6.45
BOD_5	mg/l	2	3	6	2.62	2.05
COD	mg/l	10	25	50	10.68	7.13
DO	mg/l	6	4	3	5.23	5.49
PO_4	mg/l	0.2	0.2	1	0.71	0.40
NO_3	mg/l	10	10	20	1.14	0.55
Brightness	Cm	-	-	-	54.8	108.6

* : Water quality standards based on Government Regulation Number 82 Year 2001

\- : Parameter is not required

Dictyosphaerium abundance in Ranu Pani is 11.002 individu/l with phosphate levels 0.71 mg/l and nitrate levels 1.14 mg/l higher than Dictyosphaerium abundance in Ranu Regulo, ie 454 individu/l with phosphate levels 0.40 mg/l and nitrate levels 0.55 mg/l. Results of research conducted by Prihantini *et al.* (2008), showed that the average number of abundance genus Dictyosphaerium in several lakes in Jakarta, Depok and Bogor are quite high. Total abundance of Dictyosphaerium in Babakan Lake is 82.197 individu/l with phosphate levels 0.28 mg/l and nitrate 12.75 mg/l.

Dictyosphaerium abundance in Ulin-Salam lake is 60.101 individu/l with phosphate levels 0.16 mg/l and nitrate 16.94 mg/l. Lindo Lake is 6187 individu/l with phosphate levels 0.17 mg/l and nitrate 21.24 mg/l.

Arcella abundance in Ranu Pani is 384 individuals/l higher than in Ranu Regulo, which is 31 individuals/l. The high abundance of zooplankton in the waters of Ranu Pani may be caused by the high abundance of phytoplankton in the waters. Phytoplankton in the trophic structure acts as primary producer. Phytoplankton use light energy to synthesize sugars and other organic compounds, which are then used by the primary consumer. Primary consumers in aquatic form of zooplankton that eat phytoplankton (Campbell *et al*. 2004).

Highest abundance of benthos in Ranu Pani is Bulimidae. The high abundance may be due to the availability of food in this water. Organic materials such as household waste and manure can get into Ranu alongside with rain water and water from houses. In Ranu Regulo, highest abundance of benthos is Coenagrionidae. Edmondson (1959) states that Coenagrionidae can live in warm water and even in very cold water but they cannot live in water that is very dirty. According to Government Regulation No. 82/2001, Ranu Regulo water can be categorized as water quality class I (Table 3).

4. Conclusions

1. There are 17 genera of phytoplanktons were found in Ranu Pani, while 16 genera were found in Ranu Regulo with the highest abundance of genus Dictyosphaerium. There are 13 and 10 genera of zooplankton were found in Ranu Pani and Ranu Regulo row, with the highest abundance of genus Arcella. Benthos are found in Ranu Pani consisting of 7 families with the highest abundance of family Bulimidae and there are 3 families in Ranu Regulo with highest abundance of family Coenagrionidae.
2. Diversity of phytoplankton and zooplankton in Ranu Pani is lower than Ranu Regulo, while benthos biodiversity in Ranu Pani is higher than Ranu Regulo.
3. Water quality in Ranu Pani is lower than Ranu Regulo based on Government Regulation No. 82/2001. Generally water of Ranu Pani can be categorized as water quality class II and Ranu Regulo can be categorized as water quality class I.
4. Genus Dictyosphaerium (phytoplankton), genus Arcella (zooplankton) and family Bulimidae (benthos) can be used as bioindicator for water quality class II. Family Coenagrionidae can be used as bioindicator for water quality class I.

5. Acknowledgments

I would like to convey to the Research and Development of the State Islamic University Maulana Malik Ibrahim Malang which has provided research grants, Forestry Ministry Bromo Tengger Semeru National Park that has provided research permit and to Ahmad Gazali, Sutaji and Yudo Hanggo P. who have assisted this research.

6. References

Achmad, R. (2004) *Kimia Lingkungan*. Andi,Yogyakarta.

Bold, H.C., and Wyne M.J. (1985) *Introduction to the Algae. Structure and Reproduction.* 2nd Edition, Prentice-Hall, Englewood Cliffs, New Jersey.

Campbell, N.A., Reece, J.B., and Mithchell, L.G. (2004) *Biology,* Trans. Manalu, W., 5th Edition, Erlangga, Jakarta.

Davis, C.C. (1955) *The Marine and Fresh-water Plankton*. The Michigan State University Press, Amerika.

Department of Forestry (2009) *Profil Balai Besar Taman Nasional Bromo Tengger Semeru*. BB TN-BTS, Malang.

de Zwart, D. and Trivedi, R.C. (1995) *Taxonomical Key for Biological Water Quality Determination.* RIVM, Bilthoven, The Netherlands and CPCB, Delhi, India.

Edmonson, W.T. (1959) *Freshwater Biology*. John Wiley and Sons, Inc., 2nd Edition, New York, pp124.

Fachrul, M.F. (2007) *Metode Sampling Ekologi*. Bumi Aksara, Jakarta.

James, P.T. and Alan, P.C. (2001) *Ecology and Classification of North American Freshwater invertebrates*. Academic Press, Florida.

John, D.M, Whitton B.A and Brook A.J. (2005) *The Freshwater Algal Frola of the British Isles*. Cambridge Press, New York.

Loch (2003) Alga Base. Source: *www.lifesciences.napier.ac.uk*. Accessed June 8th 2011.

Mizumoto (2001) Alga Base. Source: *www.lifesciences.napier.ac.uk*. Accessed June 8th 2011.

Odum, E.P. (1993) *Dasar-Dasar Ekologi*. UGM Press, Yogyakarta.

Prihantini, N.B. (2008) Biodiversitas Cyanobacteria dari Beberapa Situ/Danau Di Kawasan Jakarta-Depok-Bogor, Indonesia. *Makara Sains,* 12 (1):44-54.

Shiroza (2006) Copepods (*Undinula vulgaris*) in the Straits of Florida. Source: *http://homepage.mac.com/a.shiroza/ plankton/ ssf/u_vulgaris_mf_e.html,* Accessed July 13th, 2011.

Silva, L.H.S. (1999) Fitoplankton in Reservatório Utrófico (Lago Monte Alegre). Ribeirão Preto, São Paulo, *Rev. Bras. Biol*, Brasil, 59(2).

Wijaya, H.K. (2009) *Komunitas Perifiton Dan Fitoplankton Serta Parameter Fisika-Kimia Perairan Sebagai Penentu Kualitas Air Di Bagian Hulu Sungai Cisadane Jawa Barat*. IPB, Bogor.

Work, K. (2005) Lake Ochee Chobee Plankton. Source: *http:// www2.stetson.edu/~kwork/lake_okee_ plankton.htm,* Accessed July 13th, 2011.