Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2363

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **4 (4):** 8-14 (2016)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Diatom Species in Lake Batur, Bali Province, Indonesia As Supporting Data for Forensic Analysis of Drowned Victim

Ni Made Suartini* and I Ketut Junitha

Biology Department, Faculty of Mathematic and Natural Sciences, Udayana University, Bukit Jimbaran-Badung, Bali-Indonesia

*Corresponding Author E-mail: made_suartini@unud.ac.id

Received: 20.08.2016 | Revised: 28.08.2016 | Accepted: 30.08.2016

ABSTRACT

Diagnosis of death drowned people can be done by observanting the diatoms in the body of the victim. Diatoms can get into human body through the respiratory tract. This could happen because someone who was still alive will be tried to breathe in the water, and diatoms in the water will be sucked into the respiratory tract following the water movement. This study was conducted to determine diatoms species in lake Batur as an effort of making diatoms species database on waters of Bali island for forensic interest. Water sample was taken by purposive sampling method in fifthteen sampling stations in the lake. There were 12 diatom species found in this study. Species Fragilaria sp. and Nitzschia palea were found in every sampling stations. Fragilaria sp. was found as the highest percentage of diatom species in the lake.

Keywords*: species, diatom, lake Batur, Bali, forensic*

INTRODUCTION

Diatoms are very wide spread organisms, they can be found not only in marine waters but also in fresh water in the mountains[8]. Diatoms are a group of single-celled organisms and sometimes colonized. Diatom cell size was generally about 10-200µm and it cell wall composed of silica which distinguishes it from other unicellular organisms[17]. The cell wall of templated silica called frustul consists of two valves which are similar to a petridish or shaped like a box. Both valves are sticking together and wrap around the cell contents[5,9]. Sunlight is a source of energy for the diatoms to conduct the process of photosynthesis. Water turbidity can interfere with the penetration of light into the water so that it will disrupt diatoms life[10]. Benthic diatoms mostly belong to the order Pennales while pelagic belong to the order Centrales[7].

Diatoms have been used in forensic analysis for determine of death by drowning. If drowned person is still alive in the water as along as the respiratory system is still working, the diatoms in the water will be inhaled and entered along the respiratory tract. Thus, the diatoms will enter into the body of the victim[11].

Cite this article:, Suartini, N.M. and Junitha, I.K., Diatom Species in Lake Batur, Bali Province, Indonesia As Supporting Data for Forensic Analysis of Drowned Victim, *Int. J. Pure App. Biosci.* **4(4):** 8-14 (2016). doi: http://dx.doi.org/10.18782/2320-7051.2363

Copyright © August, 2016; IJPAB

Rohn and Frade[14] and Gunatilake & Gooneratne[6] mentioned that diatom in the body of the victim can be found in the lungs, heart, bone marrow, liver, spleen, kidneys, and even brain tissue.

Diatoms found inside the body of a drowned victim may serve as evidence in the diagnosis of cause of death[13]. If diatoms were found in the bone marrow, it can be ascertained that the victim was still alive when he drowned in the water. Diatoms entered the lungs by the inhalation of the water then followed the flow of blood into the bone marrow. Conversely, diatoms will not be found in the body of the victim if he entered the water after death. If diatoms found in the water where the victim was found are similiar with diatoms found in the part of the victim's body, it can be used as an indication that the victim dead by drowning[19].

Diatoms analysis needs to be done to determine the actual scene process of the drowning victim. If diatoms found in the victim's body are not same as diatoms in the water where he was found, it showed that the victim's location of death should be elsewhere. Data on diatoms in the water will greatly assist the forensic analysis. For these reasons, the study was conducted. This study aimed to identify the diatoms in the water of Lake Batur in Bali Island, Indonesia, to provide database of diatoms species in Bali.

MATERIALS AND METHODS

Water Sampling

Water samplings were taken at Lake Batur, Bali Island, Indonesia on August 2015. Lake Batur is located in the district of Kintamani Bangli at an altitude of 1,050m above of sea level. The surface area of water is about 16:05 km^2 with average depth of 50.8m. There are agricultural lands and settlements around the lake[2]. Water samples were taken by a purposive sampling method. Surface water was taken 2-3 m from the outer edge of the lake by using a bucket. Water sample were also taken in the middle of the lake as much as 50 liters. Plankton net with a bottle at the end was used to filter the water sample. The volume of bottle used for water sample was 25 ml. Ten drops of Lugol (fixative reagen) were added into the filtered water, then further observations were done in the laboratory. Data of water temperature, air temperature, brightness, pH and water dissolved oxygen are recorded in each sampling station.

Identification of diatoms

Observation of water samples to identify the diatoms was done in the Animal Taxonomy Laboratory of Biology Department, Faculty of Mathematic and Natural Sciences, Udayana University. Observation was done by taking 0,04ml water samples, dropped on an object glass and covered it with a cover glass. The water samples on the slide was observed as a whole. Observation of each water sample from each station (each sample bottle) was repeated 10 times. Diatoms were identified based on morphological characters, the determination of diatom species refered to Taylor *et al*[18]., Bellinger and Sigee[3] and Al-Yamani and Saburova[1]. Calculation of the number of each diatom species in each sampling station refered to the formula of Purnomo[12]:

$$\frac{\frac{\text{water volume in the bottle collection}}{\text{water volume was observed}} \times \text{number of diatom}}{\text{water volume was taken}}$$

RESULT AND DISCUSSION

Diatoms species were determined from water samples taken from 15 stations around Lake Batur, as shown in Figure 1. Environmental factors measured in each sampling stations are listed in Table 1.

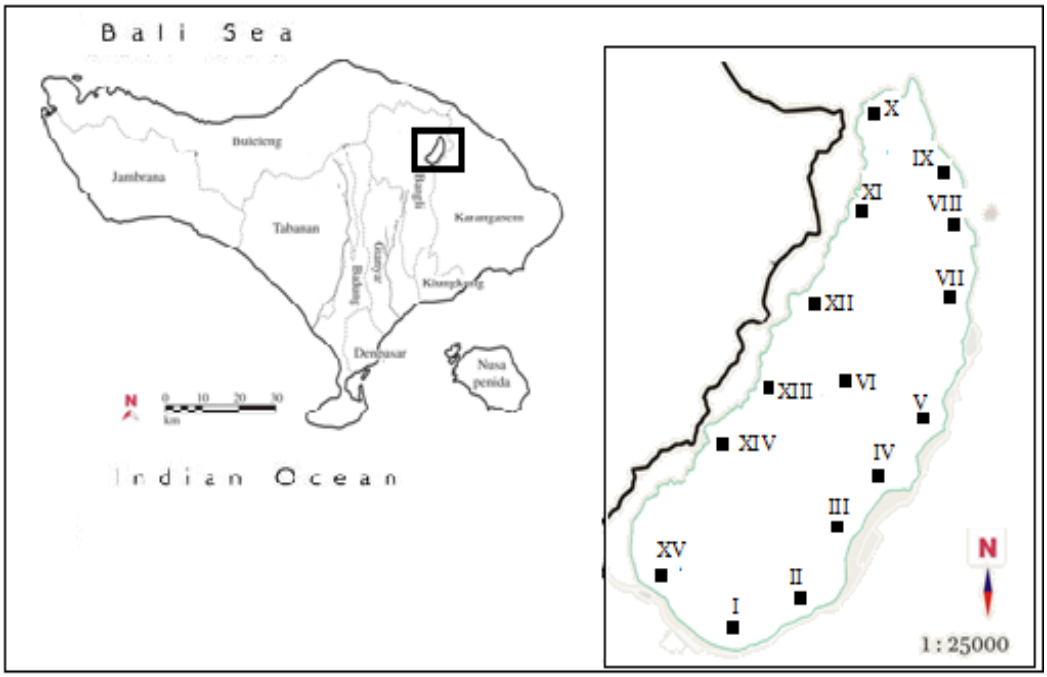

Fig. 1: Sampling stations in lake Batur

Table 1: Environmental parameter of each sampling station

Sampling Station	Environmental parameter					
	Water temperature (°C)	Water pH	Water dissolved oxygen (mg/L)	Water transparency (cm)	Air temperature (°C)	Air humidity (%)
I	25.0	8.0	8.3	190	23.0	51
II	23.0	8.5	8.2	250	23.5	49
III	23.0	8.5	8.6	210	26.9	45
IV	23.0	8.5	8.0	280	25.3	49
V	21.5	8.0	7.8	190	25.7	52
VI	23.0	8.5	7.6	220	24.5	63
VII	23.0	8.5	7.4	190	23.5	67
VIII	23.0	8.5	7.4	200	23.5	66
IX	23.0	8.0	7.8	190	25.7	57
X	23.0	8.0	7.6	200	24.9	59
XI	23.0	8.0	7.2	190	24.9	55
XII	23.5	8.5	7.6	190	25.3	54
XIII	23.5	8.0	7.8	190	26.2	57
XIV	23.5	8.0	7.1	200	26.8	55
XV	23.5	8.0	7.7	200	28.5	59
Average	23.2	8.2	7.7	206.0	25.2	55.9

Twelve diatom species were identified in this study and the number of each species per liters of water in each station were varied (Table 2). Percentage based on the number of species of each station listed in Figure 2. Percentage of each diatom species found in lake Batur are listed in Figure 3.

Copyright © August, 2016; IJPAB

Table 2: Diatom species in each sampling station

Sampling station	Species (cell/L)												
	A. inflata	*A. coarcata*	*A. ovalis*	*C. placentula*	*Cymbella* sp.	*Cyclotela* sp.	*Diatoma* sp.	*E. adnata*	*Fragilaria* sp.	*G. pseudoaugur*	*N. palea*	*Stauroneis* sp.	Total
I	10	4	3	4	9	2	13	11	228	2	15	3	304
II	3	4	0	2	3	5	3	2	172	0	19	2	215
III	0	0	0	2	0	3	0	0	128	0	13	0	146
IV	0	0	0	3	0	5	0	0	82	0	28	0	118
V	0	0	2	3	0	5	0	0	92	3	35	0	140
VI	2	0	3	0	2	7	0	0	74	4	34	0	126
VII	0	0	0	3	0	2	0	0	73	3	30	0	111
VIII	0	0	0	4	0	2	0	0	45	4	20	4	79
IX	0	0	2	2	0	3	2	0	19	2	17	2	49
X	0	0	0	2	0	2	0	0	37	2	22	4	69
XI	0	0	4	0	0	0	0	0	2	0	7	0	13
XII	0	0	0	3	0	0	0	2	29	2	19	2	57
XIII	2	0	0	2	2	2	0	0	22	0	3	2	35
XIV	0	0	0	2	0	0	0	0	5	2	4	0	13
XV	0	0	2	2	0	0	0	0	23	0	19	2	48
Total	17	8	16	34	16	38	18	15	1031	24	285	21	1523

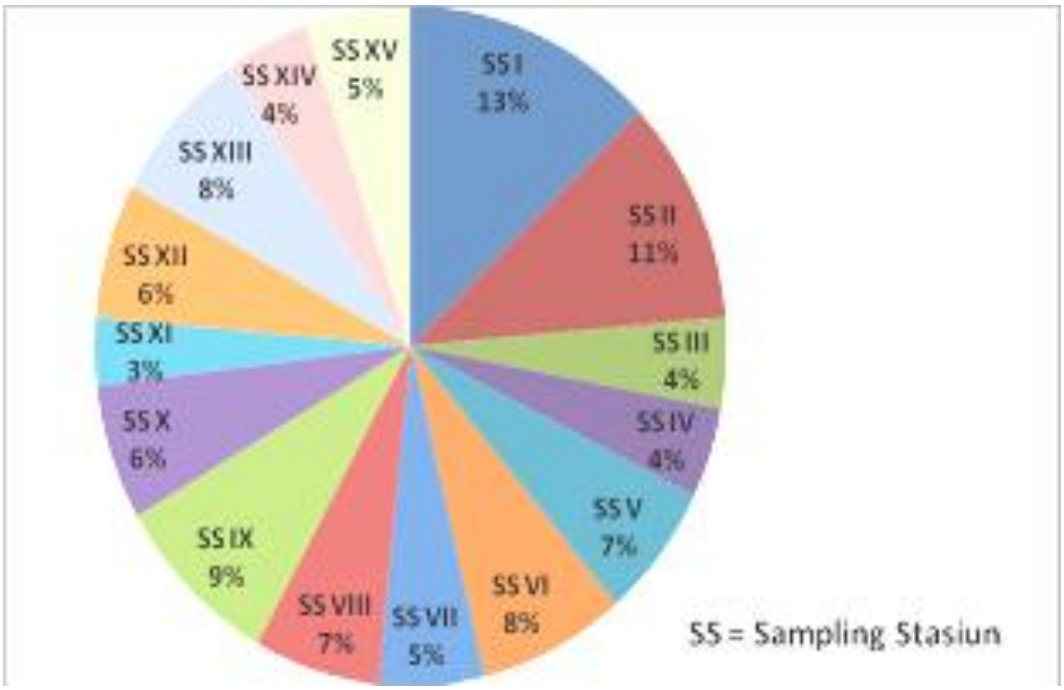

Fig. 2: Percentage based on the number of species in each sampling station

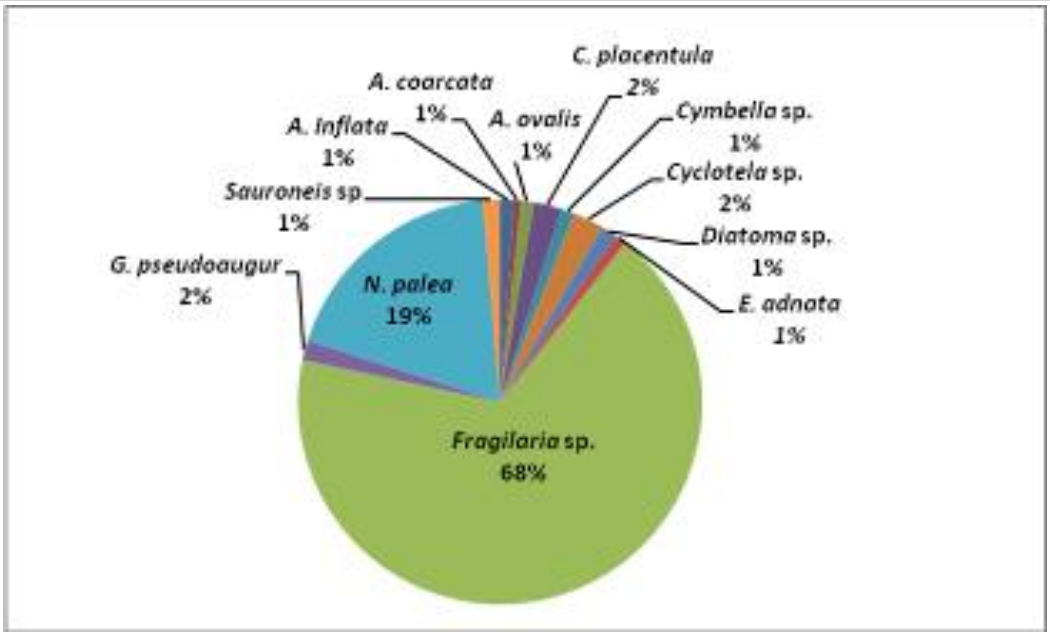

Fig. 3: Percentage of each diatom species found in lake Batur

Diatoms have an ability to live in a certain range of environmental parameter. The measurement results of environmental parameter from this study were still in the range of diatoms life. The measured temperature of Lake Batur was 21.5-25.0 ^{o}C. Effendi[4] stated that the range of temperatures where diatoms can grow well is 20-30^{o}C. The content of hydrogen ions (pH) in lake Batur was quite high. Probably because of the existence of many rocks and the natural forest on the edge of the lake. So, when the rains, will occur entry of rainwater from the forest into the lake. The water pH of lake Batur was 8.0 to 8.5. According to Welch[20] , water pH which aquatic organisms can live are 6.6-8,5. Diatoms need oxygen for their respiration process. Water dissolved oxygen in Lake Batur still supported diatoms life. The range of water dissolved oxygen in Lake Batur was 7.1 to 8.6 mg/L (Table 1). Soeprobowati and Hadisusanto[17] mentioned that dissolved oxygen content required by diatom was 7-12 mg/L, however, some species were able to live in dissolved oxygen content below 6.5 mg/L.

The numbers of diatoms species found in each sampling station in Lake Batur were varied. Sampling stations with the highest number of diatom species was on sampling stations I (12 species of diatoms). Sampling station with the lowest number of diatoms species was sampling station XI (3 species of diatoms). *Fragilaria* sp. and *Nitzschia palea* were found in every sampling station (Table 2). *Fragilaria* sp. was the highest percentage species (68%) which found in Lake Batur (Figure 3). Round[15] stated that the Fragilaria is prefer neutral and alkali water. The water pH of lake Batur was 8.0 to 8.5 with an average 8.2. The range of water pH on the lake supports the life of Fragillaria. The condition causes Fragilaria found in all sampling station with the highest persentage.

Examination of diatoms found in a drowned person conducted to clarify the diagnosis of the cause of death of the victim. The discovery of diatoms in organs of the victims will explain whether someone drown at the time of antemortem or postmortem. The examination of cases of drowning are not always found diatoms, but if found diatom in organs in large quantities it will clarify the diagnosis antemortem drowning[16]. Further study of the morphology and the presence of diatoms in the water bodies will help in investigating the cause of death by drowning.

Associated with the interests of forensics as an indicator of death due to drowning, several genera of diatoms found in this study are often found on the examination

of organs samples of drowning victims, some of them mentioned in Wilianto[21], i.e. *Cocconeis placentula* which is often found in the liver samples, Nitszchia and Gomphonema in the duodenum, Diatoma in the bone marrow, Fragilaria in the hepar samples.

CONCLUSION

Twelve diatom species were identified in this study i.e. *Achnanthes inflata*, *Achnanthes coarcata*, *Amphora ovalis*, *Cocconeis placentula*, *Cymbella* sp., *Cyclotela* sp., *Diatoma* sp., *Epithemia adnata*, *Fragilaria* sp., *Gomphonema pseudoaugur*, *Nitzschia palea* and *Stauroneis* sp. The species *Fragilaria* sp. and *Nitzschia palea* were found in every sampling station. *Fragilaria* sp. was also found with the highest percentage.

Acknowledgements

Authors thank to the Faculty of Mathematics and Natural Science, Udayana University for providing the opportunity to undertaken this research by a Research Grant Program in 2015 (number of agreement 1314/UN14.1.28.I/PP/2015).

REFERENCES

1. Al-Yamani, F.Y. and Saburova, M.A., Illustrated Guide On The Benthic Diatoms of Kuwait's Marine Environment. 1st Edition. Kuwait Institute for Scientific Research (2011)..
2. Bappedalwil II, Badan Pengendalian Dampak Lingkungan Wilayah II. Norma dan Program Danau Lestari Provinsi Dati I Bali (1998).
3. Bellinger, E.G. and Sigee, D.C., *Freshwater Algae: Identification and Use as Bioindicators*. Wiley-Blackwell. United Kingdom. London (2010).
4. Effendi, H., *Telaah Kualitas Air. Bagi Pengelolaan Sumber Daya Alam dan Lingkungan Perairan*. Kanisius. Yogyakarta. (2003).
5. Gunn, A., Essential Forensic Biology. Second Edition. Wiley-Blackwell. West Sussex (2009).
6. Gunatilake, P.G.L., and Gooneratne, I., Drowning Associated Diatoms in Sri Lanka. Sri Lanka. Journal of Forensic Medicine, Science, and Law. **1(2):** 23-24 (2010).
7. Hasrun, L.O., Kasim, M. and Salwiyah, Studi Biodiversitas Diatom Bentik Pada Areal mangrove di Perairan Kecamatan Kolono Kabupaten Kolowae Selatan. *Jurnal Mina Laut Indonesia*. **2(6):** 35-47 (2013).
8. McLaughlin, R.B., An Introduction to Microscopic Study of Diatom. Available at:http://www.modernmicroscopy.com./article_pix/130107_McLaubhlinDiatomBook/rbmbook.pdf. (2012).
9. Nontji, A., *Plankton Laut*. LIPI Press. Jakarta (2008).
10. Nybakken, J.W., *Biologi Laut*. Suatu Pendekatan Ekologis. Edisi Kedua. Penerjemah Eidman dkk. PT. Gramedia. Jakarta (1992).
11. Peabody A.J. Cameron, N.G., The *Diatom: Application for The Enveronmental Sciences*. Second Edition. Cambirdge University Press. United Kingdom. (2010).
12. Purnomo, A.D., Variasi Spesies Diatom Pada Berbagai Perairan Untuk Kepentingan Forensik Sebagai Petunjuk Kematian Akibat Tenggelam. *jurnal Simbiosis*. **3(1):** 247-257 (2015).
13. Punia, R.K., Case Report Diatoms: Role in Drowning. *J Indian Acad Forensic Med*., **33(2):** (2011).
14. Rohn, E.J. and Frade, P.D., The role of Diatoms in medico-legal investigations II: a case for the development and testing of new modalities applicable to the diatom test for drowning. *American College of Forensic Examiners*. **15(4):** (2006).
15. Round, F.E., The Biology of Algae, 2nd. Ed., Edward Arnold, London, (1973).
16. Singh, R., Singh, R., Kumar, S. and Thakar, M.K., Forensic Analysis of Diatoms- A Review. *Journal of Forensic Medicine and Toxicology*, **7(2):** (2006).
17. Soeprobowati, T.R. and Hadisusanto, S., Diatom dan Paleolimnologi: Studi

Komparasi Perjalanan danau Lac Saint-Augustine Quebeq-City, Caanada dan Danau Rawa Pening Salatiga, Indonesia. *Biota*.**14(1):** 60-68 (2009).

18. Tyalor, J.C., Harding, W.R. and Archibald, C.G.M., *An Ilustrated Guide to Some Common Diatom Species from South Africa*. Water Research Comission South Africa (2007).
19. Verma, K., Roel of Diatom in the World of Forensic Science. *J.Forensic. Res*. **4(2):** (2013).
20. Welch, E., Limnology. Mc. Growhill Book Company. New York (1980).
21. Wilianto, W., Pemeriksaan Diatom Pada Korban Diduga Tenggelam (Review). *Jurnal Kedokteran Forensik Indonesia*. **14(3):** 39-46 (2012).