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Density and habitat preference of *Telescopium telescopium* (Gastropoda: Potamididae) population in mangrove forest of likupang waters, North Sulawesi, Indonesia

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Key words: *Telescopium telescopium*, Density, Preferency, Environmental physical-chemical factors.

Abstract

This study was carried out in September, 2013 to August, 2014 in mangrove forest of Likupang waters. It was aimed to know the p[opulation density of *Telescopium telescopium*, habitat preference and influencing environmental physico-chemical factors. The study used survey method, and the study sites consisted of 2 stations, submerged and dry areas. The former was set 5 points each of which was placed 5 quadrats of 1×1m² for organism sampling. The latter was put 3 transect lines each of which was placed 5 quadrats of 1×1 m². Results found that the highest *T. telescopium* density occurred in the dry area with an average of 41.83m² and the lowest in the submerged area with an average of 10.58 m². The habitat preference was higher in the dry area than the submerged area based on the population density. Environmental physico-chemical factors affecting *T. telescopium* density in both areas were nitrate, phosphate, ammonia, pH, temperature, and salinity.

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Introduction

Class Gastropod is one of the most members of phyllum Mollusc that are mostly successful to do the environmental adaptation. About 55,000 species inhabit marine habitats distributed from coast to deep sea. *Telescopium telescopium* is one of gastropods found around the mangrove ecosytem (Kartawinata *et al*, 1979) and fish pond area near rivermouth with mud substrate of rich organic matters (Radjasa, *et al.*, 2012). Potamididae snails, including *T. telescopium,* are native residentsi of mangrove forest and live in intertidal and prefer muddy area (Heryanto *et.*, 1989 and Heryanto, 2009). The occurrence of *T. telescopium* in mangrove forest has sufficiently ecologically and economically important roles.

Ecologically, *T. telescopium* acts as food chain component, organic matter utilizer from decomposition of mangrove litters falling to the soil and waters (Kusrini, 1988). Economically, Potamididae, particularly *T. telescopium,* has been largely utilized by human, such as in Asia, Philippine and Indonesia (Houbrick, 1991), because its size is big, has sufficient nutrition based on dry weight, such as protein 43.38% - 73%, carbohydrate 3.09% - 5.8%, and inorganic substance about 16% (Alexander *et al*, 1979), and its shell is used as lime-making materials**.**
In Likupang waters, local communities have taken *T. telescopium* for either family consumption or sale outside Likupang (interviews and field observation). High human exploitation activities could cause population density decline, so that conservation management needs to be done.

Different habitat selection is effect of internal and external factors. According to Lee and Shin (2013), beside genetic factor, occurrence and adaptabity of certain species in one or more habitats are dependent upon the habitat carrying capacity. The presence of an organism in aquatic habitats possesses very important meaning due to their reciprocal relationship affecting the environment. Indirectly, this relationship can indicate the current water conditions, since organisms and habitats are subject of material and energy flows.

Specific habitat recognition of an organism will ease finding and utilizing the resource**.** On the other hand, habitat characteristics are one of the information useful for evaluating the body shape and function of the organisms (Gaffar *et al*, 2014). Thus, the role and benefit of the organisms in their habitat can be maximized when some basic aspects of the habitat preference, such as characteristic, distribution patterns**,** organism density, are known**.** Based on informatiion above, this study was done to know the population density of *Telescopium telescopium*, habitat preference, and the environmental physical-chemical factors affecting them.

Methods

This tudy was carried out from September 2013 to August 2014 in mangrove forest of Likupang waters, North Sulawesi (Fig. 1). Physical and chemical parameters of the environment were analyzed in Research and Industrial Standardization Center, Manado.

Method used in this study was survey method. Data sources were physical and chemical parameters measured in situ and laboratory and processed data of *Telescopium telescopium* density. These data were tabulated and then descriptively described. To know the relationship between the density of *T. telescopium* and the environmental physico-chemical factors, a multivariate statistical analysis was applied based on principal component analysis (PCA) (Legendre and Legendre, 1983).

Station determination and sampling proceedure

Study site consisted of 2 stations, submerged area and dry area. The former was set 5 points each of which was put 5 quadrats of $1\times1m^2$ for organism sampling. The latter was put 3 transect lines and each of which was put one quadrat of $1\times1m^2$ for organism sampling and a 10x10m2 quadrat for environmental physico-chemical parameter measurements. Organisms collected from each station were counted and recorded, then analyzed based on each station. This study also collected water sample. Water was put into sample bottle for further analysis in the laboratory.

Fig. 1. Study site Map of Mangrove forest in Likupang waters.

Calculation of T. telescopium density

Population density of *T. telescopium* was calculated using the formula of Krebs (1989) as follows:

Density/m^2 = No. of individuals/ No. of plots inhabited by all individuals

Analysis of Variance (ANOVA) was used to test the significance of density difference among the station points. To know which stations were different, Tukey test (Steel and Torrie, 1989) was applied.

Results and discussion

T. telescopium density in submerged area

Density condition in the submerged is presented in Table 1.

Table 1. Density condition of *Telescopium telescopium* in the submerged area.

Points	Submerged area			
	Mean	Sd	Minimum	Maximum
I	12.08	3.655	8	18
II	11.5	3.896	6	19
III	10.58	2.539	7	16
IV	9.42	2.906	5	14
V	10	3.191	5	16
VI	8.08	2.037	4	13

Table 1 shows that the largest mean density occurs in point II, but the difference is not too big. The difference of *T. telescopium* density among points were determined through ANOVA (Table 2).

Table 2. ANOVA for comparison test.

Variance	Sum of Squares	df	Mean of Squares	F	Sig.	F tab.
Point	125.778	5	25.156	2.42490	0.044	2.3538
Between points	684.667	66	10.374			
Total	810.444	71				

Based on ANOVA, there is significant difference in *T. telescopium* density among observational points at 0.05 confidence level ($F_{cal.}>F_{tab.}$). To determine which points are different, Tukey test was used (Table 3).

Table 3. Tukey test for *T. telescopium* for density difference.

		Sub set for Alpha = 0.05%	
Location	N	1	2
Point VI	12	8.08	
Point IV	12	9.42	9.42
Point V	12	10.00	10.00
Point III	12	10.58	10.58
Point II	12	11.50	11.50
Point I	12		12.08
Sig.		.112	.338

Tukey test shows that *T. telescopium* densitt in point I is significantly different from that in point VI at 5% significance level, but not different from that in point II, III, IV, and V.

T. telescopium in dry area

The density of *T. telescopium* in the dry area during the study is presented in Table. 4.

Table 4. *T. telescopium* density in dry area.

Transect	Dry area			
	Mean	Sd	Minimum	Maximum
I	48.5	12.99301	25	71
II	44.5	14.25419	25	71
III	32.5833	11.94273	14	50

In September 2013 to August 2014, *T. telescopium* density in transect I ranged from 25 to 71 ind/m^2 with mean density of 48.5 ind /m^2, transect II from 25 to 71 ind/ m^2 with mean density of 44.5 ind/ m^2, and transect III from 14 to 50 ind/m^2 with mean density of 32.5 ind/m^2. From Table 4, it is apparent that the highest density occurs in transect II. Difference in *T. telescopium* density among transects was pursued with ANOVA as presented in Table 5.

Table 5. ANOVA for comparison test.

Variance	Sum of Squares	Df	Mean of Squares	F	Sig.	F_{tab}
POINT	1645.389	2	822.6945	4.795852	0.015	3.284918
Among points	5660.917	33	171.54293			
Total	7306.306	35				

Table 5 reveals that *T. telescopium* density among transects is significantly different indicated with F_{calc}. bigger than F_{tab}. To know which transects are different, Tukey test is applied (Table 6).

Table 6. Tukey test for *T. telescopium* for density difference.

		Subs*et alpha* = 0.05	
Transect	N	1	2
III	12	32.5833	
II	12	44.5000	44.5000
I	12		48.5000
Sig		.081	.737

Based on Table 6, it is found that the density of *T. telescopium* in transect I is significantly different from that in transect III at 5% confidence level. However, the density of *T. telescopium* in transect I is not significantly different from that in transect II and the density of *T. telescopium* in transect II and III is not significantly different.

T. telescopium density comparison between submerged and dry area

Density comparison of *T. telescopium* in the submerged area and dry area showed that mean density in the submerged area was 10.58/m² and in the dry area 41.83/m². To know whether there was difference in *T. telescopium* density between both areas, t-test was used. The t-test showed that $t_{calc.} > t_{tab.}$ (39.509 > 2.405473) indicating that there was significant difference in *T. telescopium* density between submerged area and dry area, in which the dry area had higher density than the submerged area. Monthly observations shows similar conditions in both areas (Fig. 2).

A study conducted by Rahmawati (2013) in Mayangan beach, West Java, found abundant snails, *T. telescopium,* in open area of former fish pond. Similar situation was recorded by Budiman (2009) that *T. telescopium* was found in higher number in open area of middle part of mangrove forest, while Sihombing (2014) found that in Dumai rivermouth, *T. telescopium* was recorded more in the area of low mangrove density level. Low mangrove density causes the area open to more sunlight intensity. Smith, *et al.* (2004) further uttered that Potamididae snails in dry area have earlier gonad maturity, faster growth, and possessed bigger shells than those in mangrove forest.

Environmentalphysico-chemical characteristics

The environmental physico-chemical parameters in each study site are presented in Table 7.

Table 7. Distribution of mean environmental physico-chemical parameters.

			Submerged Area				
	Organic matters	Ammonia	Nitrate	Phosphate	Temp. (°C)	Salinity (‰)	pH
Mean	23.22	0.02	1.89	0.003	32.60	29.24	7.34
SD	1.88	0.01	0.33	0.01	1.33	1.37	0.11
Minimum	21.17	0.01	1.55	0.01	30.10	27.00	7.10
Maximum	25.91	0.04	2.32	0.02	36.20	34.00	7.85
			Dry Area				
	Organic matters	Amonia	Nitrate	Phosphate	Temp (°C)	Salinity (‰)	pH
Mean	25.56	0.54	0.002	0.0117	34.62	28.67	7.38
SD	3.36	1.02	0.0008	0.0257	1.63	1.69	0.24
Minimum	20.54	0.05	0.001	0.001	31.5	25.0	6.5
Maximum	30.02	3.26	0.004	0.08	39	32	7.85

Organic matters in the submerged area ranged from 21.17 to 25.91% with an average of 23.22%, in the dry area from 20.54 to 30.02% with mean of 25.56%, and in mangrove area from 19.75 to 22.91% with an average of 21.78%. Organic matter concentrations in the water will rise from domestic disposals, agriculture, industries, rainfalls and runoff. In dry season, the increased organic matter concentration will raise the water nutrients and conversely in rainy season, decline in organic matters occurs because of dilution process (Hadinafta, 2009). The concentration of organic matters in the water ranged from 1.00 to 30.00 mg/l .Our study in both study sites found high concentration of the organic matters. It could result from the presence of mangrove ecosystem around the study site. It is in agreement with Sukardjo (2002) that mangrove forest is nutrient contributor to the organisms living in and around it where the extent of the litter biomass on the forest bottom becomes an indication of mangrove forest importance as source of organic matters.

Ammonia in the submerged area ranged from 0.01 to 0.04 mg/l with an average of 0.02 mg/l and in the dry area from 0.05 to 3.26 mg/l. According to Silvester (1958), ammonia concentration in the water should not reach 1.5 mg/l. Nitrate in the submerged area ranged from 1.55 mg/l to 2.32 mg/l with an average of 1.89 mg/l and in the dry area from 0.001 mg/l to 0.004 mg/l with an average of 0.0023 mg/l. From mean nitrate concentration in both sites, it is apparent that nitrate content in the submerged area be higher than that in dry and mangrove areas.

Phosphate in the submerged area ranged from 0 mg/l to 0.02 mg/l with an average of 0.0035 mg/l and in dry area from 0.001 mg/l to 0.08 mg/l with an average of 0.0117 mg/l. Based on mean phosphate concentration in both study sites, phosphate concentration in the submerged area wass lower than that in the dry area. Environmental temperature in the submerged area ranged from 30.1 to 36.2°C with an average of 32.6°C and in the dry area from 31.5 to 39°C with an average of 34.62°C. Based on mean temperature in these locations, the dry area had higher temperature than that in the submerged area. Salinity in the submerged area ranged from 27 to 34 ‰ with an average of 29.24 ‰ and in the dry area from 25 to 32 ‰ with an average of 28.67‰. From mean salinity, both locations have nearly similar salinity concentration reflecting that salinity of the study site, both dry and submerged areas, had good salinity for the growth of the biota. Faisal (2010) stated that pH could promote the decomposition process of the litters, in which the higher the pH the better the decomposition to produce the organic matters. Microorganisms can quickly break down the litters to organic matters at pH of 5.5 or higher. At water pH below 5,5, microbial growth will be inhibited so that the decomposition process will also decline. In the submerged area, pH ranged from 7.1 to 7.85 with an average of 7.34, while in the dry area, pH ranged from 6.5 to 7.85 with an average of 7.38. Thus, mean pH in both study sites was nearly similar.

Relationship between environmental physico-chemical parameters and T. telescopium density in the submerged and dry areas

To assess the water physico-chemical characteristics in the submerged and dry areas with density as complementary variable, a principal component analysis-based mutlivariate statistical analysis was used (Table 8 and 9).

Table 8. Correlation matrix among environmental parameters in the submerged area.

Variables	Organic matters	Amonia	Nitrate	Phosphate	Temp.	salinity	pH	Density	density
Organic matters	1	-0.560	-0.515	-0.107	-0.310	0.091	-0.129	-0.418	-0.418
Amonia	-0.560	1	0.351	0.229	0.314	0.110	0.298	0.522	0.522
Nitrate	-0.515	0.351	1	0.870	0.950	0.760	0.630	0.847	0.847
Phosphate	-0.107	0.229	0.870	1	0.947	0.954	0.676	0.776	0.776
Temp.	-0.310	0.314	0.950	0.947	1	0.828	0.805	0.918	0.918
Salinity	0.091	0.110	0.760	0.954	0.828	1	0.483	0.585	0.585
pH	-0.129	0.298	0.630	0.676	0.805	0.483	1	0.917	0.917
Density	-0.418	0.522	0.847	0.776	0.918	0.585	0.917	1	1.000
Density	-0.418	0.522	0.847	0.776	0.918	0.585	0.917	1.000	1

Table 9. Correlation matrix among environmental parameters in the dry area.

Variables	Organic matters	Ammonia	Nitrate	Phosphate	Temp.	salinity	pH	Density	Density
Organic matters	1	0.177	0.385	0.113	-0.366	-0.021	-0.223	0.102	0.102
Ammonia	0.177	1	0.717	0.995	0.300	0.600	0.186	-0.531	-0.531
Nitrate	0.385	0.717	1	0.723	0.160	0.194	-0.369	-0.174	-0.174
Phosphate	0.113	0.995	0.723	1	0.300	0.555	0.196	-0.487	-0.487
Temp.	-0.366	0.300	0.160	0.300	1	0.488	0.104	-0.636	-0.636
Salinity	-0.021	0.600	0.194	0.555	0.488	1	0.251	-0.918	-0.918
pH	-0.223	0.186	-0.369	0.196	0.104	0.251	1	-0.307	-0.307
Density	0.102	-0.531	-0.174	-0.487	-0.636	-0.918	-0.307	1	1.000
Density	0.102	-0.531	-0.174	-0.487	-0.636	-0.918	-0.307	1.000	1

In the submerged area, sufficiently close correlation matrix was found between nitrate and phosphate (0.87), temperature and nitrate (0.95), density and nitrate (0.847), temperature and phosphate (0.947), salinity and phosphate (0.955), temperature and salinity (0.83), density and temperature (0.918), and pH and temperature (0.917). Environmental physico-chemical parameters in the submerged area are being positively correlated. It reflects that increase in one parameter will be followed with increase in other parameters.

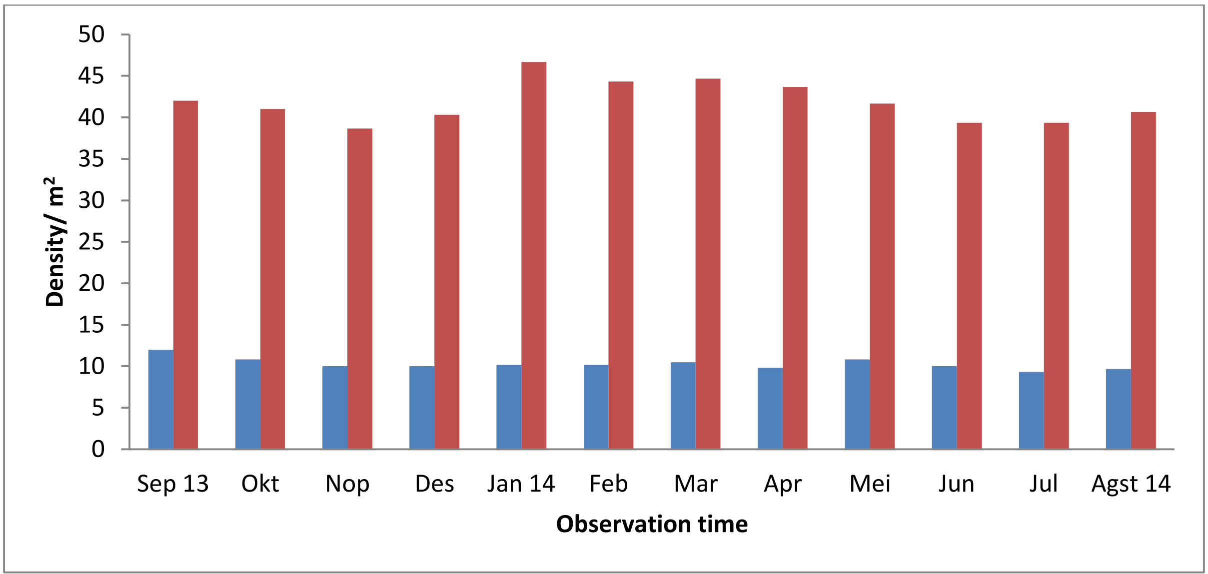

Fig. 2. Comparison between density in submerged and dry area.

To assess the role of points on the location against the axes, the extent of squared cosinus angle is obtained determining the goodness of fit of the observational points. Based on the analysis in the submerged area, it is apparent that there be 3 location point groups where the contribution of water physo-chemical parameters and density as supplementary variables is high, group 1, T1 and T2, group 2, T3 dan T4, and group 3, T5, respectively. Group 1 is characterized with high phosphate, temperature, salinity, pH, nitrate and *T. telescopium* density. Group 2 is characterized with sufficiently high organic matters and salinity, and group 3 is characterized with high organic matters and pH (Fig. 3).

Based on PCA analysis, the highest *T. telescopium* density in the submerged area is found in points T1 and T2, where the site is characterized with high phosphate, temperature, salinity, pH, and nitrate. These parameters are sufficiently highly correlated with density.

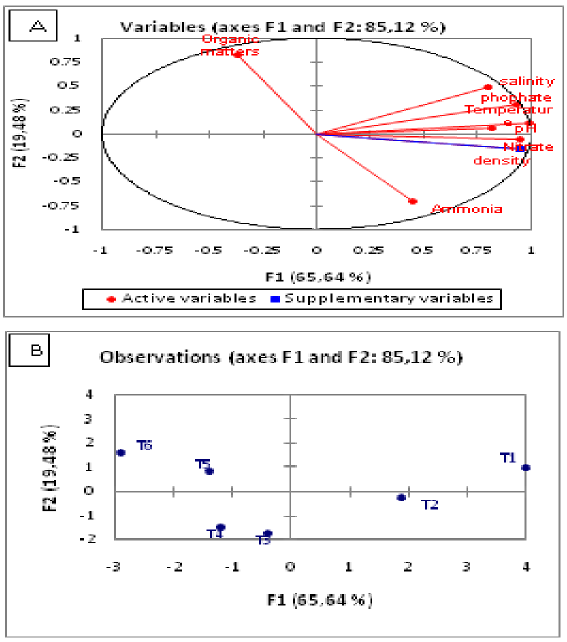

Fig. 3. PCA graph of water physico-chemical characteristics and as supplementary variables in the submerged area (A) Correlation of water physico-chemical variables in axis 1 and 2, (B). Observational point projectio n in axis 1 and 2.

In the dry area, correlation matrix shows sufficiently close correlation between nitrate and ammonia (0.717), phosphate dan ammonia (0.995), phosphate and nitrate (0.723), and density and salinity (-0.918). Environmental physico-chemical parameters observed in the dry area are generally positively correlated each other. It reflects that increase in one parameter is followed by the others. In the dry area, there is negative correlation between density and salinity (-0.918). This value indicates that the higher the density of *T. telescopium* the lower the salinity or whereas the higher the salinity the lower the density of *T. telescopium* (Table 10).

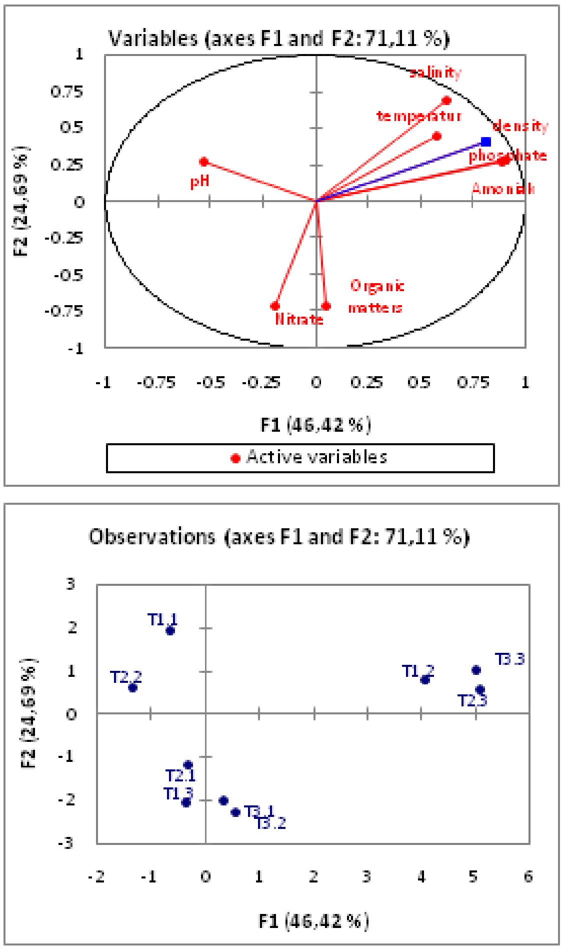

Fig. 4. PCA graph of water phisico-chemical characteristics and as supplementary variables in the dry area (A) Correlation of dry physico-chemical variables in axis 1 and 2, (B). Observational point projectio n in axis 1 and 2.

To assess the role of site points against the axes, the extent of squared cosinus angle is obtained determining the goodness of fit of the observational site points. For the dry area, it is apparent that there be 3 site point groups where the contribution of water physico-chemical parameters and density as supplementary variables is high enough, T1.2, T2.3, and T3.3 as group 1, T1.3, T2.1,T3.1 and T3.2 as group 2, and T2.2 and T1.1 as group 3, respectively.

In the dry area, T1.2, T2.3 and T3.3 are characterized with high phosphate, ammonia, temperature, salinity and density. T1.3, T2.1 ,T3.1 and T3.2 are characterized with high organic matters and nitrate, while T1.1 and T2.2 are characterized with pH (Figure 4).

PCA analysis showed that the highest density of *T. telescopium* in the dry area occurred at the point T1.2, T2.3 and T3.3 characterized with high phosphate, ammonia, temperature, and salinity. These parameters are sufficiently highly correlated with the density. The analysis revealed that the occurrence of *T. telescopium* was affected by certain parameters, such as nitrate, phosphate, ammonia, pH, temperature and salinity. Nitrate and phosphate in the water are micronutrient compounds controlling primary productivity in euphotic zone. Nitrate measurements were averagely 1.89 mg/l and 0.0023 mg/l in the submerged area and dry area, respectively. Based on Living Environmental Minister's decree no. 51/2014, nitrate concentration in the submerged area is relatively higher than recommended for aquatic biota (0.015 mg/l), but it has not caused eutrophication.

Phosphate in the submerged area was averagely 0.003 mg/l and in the dry area 0.011 mg/l. Standard criteria of phosphate concentration established in Indonesia Living Environmental Minister;s decree no. 51/2004 is 0.015 mg/l, while according to Arizuna *et al.* (2014), phosphate concentrations in the bottom ranged from 0.11 to 0.59 mg/l. Based on these criteria, our study found that phosphate concentration in the dry area approched to the established concentration. Mean ammonia concentrations in both dry and submerged area were 0.02 mg/l and 0.54 mg/l, respectively. According to Silvester (1958), ammonia concentration in the water should not reach 1.5 mg/l, while following the Living Environmental Minister's decree no. 51/MNLH/2004, the tolerable ammonia concentration is ≤ 0.3 mg/l. Our findings indicates that ammonia concentrations in both study sites are still in the recommended criteria.

Environmental temperature in the submerged area ranged from 30.1°C to 36.2 °C with an average of 32.6°C, while the temperature of the dry area ranged from 31.5°C to 39°C with an average of 34.62°C. Both mean temperatures show that the dry area is warmer than the submerged one. This condition is normal since it is related with difference in sunlight radiation on the water warming, in which both dry and submerged areas are open and warming process is not capped. Based on the mean temperature above, the temperature range of Likupang waters is normal and meets the seawater quality standard criteria for marine plants and biota (Menteri Lingkungan Hidup KEP No. 51/MNLH/2004).

Salinity in the submerged area ranged from 27 ‰ to 34 ‰ with an average of 29.24 ‰, while it ranged from 25 ‰ to 32 ‰ in the dry area with an average of 28.67‰. Based on the range, salinity in the study site, either dry and submerged areas were good for both mangrove growth and biota. Faisal (2010) uttered that pH could support the liiter decomposition process, in which the higher the pH the better the decomposition process of the microorganism to produce organic matters. Microorganisms can quickly break down the litters to be organic matters if pH is 5.5 or higher while pH below 5.5 will inhibit the microbial growth so that the litter decomposition process will also decline.

In the submerged area, water pH ranged from 7.1 to 7.85 with an average of 7.34, while the dry area had pH range of 6.5 to 7.85 with an average of 7.38.. Mean pH of both areas was slightly different and in normal pH range, 7.1 – 7.34, indicating that both flora and fauna could live in the pH condition. It is in line with quality standard issued by Living Environmental Minister Decree No. 51/MNLH/2004) that tolerable pH of the living is in the range of 7 – 8.5.

Conclusion

1. *T. telescopium* density in the dry area was higher than that in the submerged area. Mean density was 10.58/ m2 and 41.83/ m2 in the submerged and dry areas, respectively.

2. Habitat preference of *T. telescopium* based on population density, in general, occurred in both areas, but higher density was found in the dry area.

3. Environmental physico-chemical factors affecting the density of *T. telescopium* in either submerged area or dry area were nitrate, phosphate, ammonia, pH, temeprature and salinity.

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