Occurrence of macro-epiphyte on *Eucheuma spinosum* cultivated on floating cages

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Abstract. The occurrence of macro-epiphyte is one of the main problems on seaweed cultivation. The occurrence of macro-epiphyte has negative impact on seaweed growth rate. This study tries to clarified the occurrence of macro-epiphyte on the thallus of the *Eucheuma spinosum*. This study clarified that the high species occurrence of macro-epiphyte on thallus of *E. spinosum* during 10 days, 20 and 30 days are 3, 2 and 2 ind/m^3/day respectively. The occurrence of *Ulva lactuca* during 20 days was 21, 16 ind/m^3/day. Environmental variable such as temperature 28–29^{0}C, current 0.05–0.15 m/s, radiance waters 11.59–12.71 m, salinity 32–36$^0/_{00,}$ nitrate 0.0012–0.0043 mg/L, phosphate 0.006–0.0018 mg/L, DO 5–6.6 mg/L and pH 6.

Key Words: environmental, seaweed, attachment, thallus, dominant.

Introduction. *Eucheuma spinosum* is one of the most cultivated seaweed commodities in Indonesia and in some of South East Asia region because it is the primary sources of iota caragenan (Trono & Lluisma 1992). In eastern Indonesia, *E. spinosum* was called as *E. denticulatum*. This species becomes most popular at eastern Indonesia due to its rapid growth and less preference by herbivorous (Kasim et al 2016). Unfortunately, recently, most of euchematoids cultivated in Eastern areas become low in production since 2016. One of the main problem with the seaweed cultivation is the decreased number of seaweed production caused by a harmful epiphyte. Epiphytes are one interesting phenomenon that spread across marine benhic communities at several coastal and marine areas (Kraberg & Norton 2007). Epiphytes are generally attached to other plants and are not part of the parent plant (Wahl & Mark 1999). Epiphyte can cause a disturbance on a photosynthesis process which can result in less optimal growth of seaweed (Buschmann & Gómez 1993). Epiphyte belongs to seaweeds which usually attach to other seaweed or other submerged plant and causes the main problem in cultivation. Thus phenomenon is recognized since the beginning of seaweed cultivation. In some of the cultivation area, epiphyte occurrence becomes a serious concern for seaweed farmers. Epiphyte can occur anywhere as long as there is an optimal substrate as place to attach. The growth of Epiphyte highly depends on environmental condition such as temperature, density, salinity and availability of nitrate and phosphate (El-Din et al 2015; Buschmann & Gómez 1993). Scientific information related to the growth of epiphyte on a seaweed thallus is still lacking. The information is very crucial to understand the case of seaweed resource development.

This research aims to analyze the growth of a harmful macro-epiphyte on thallus of *E. spinosum.*

Material and Method

Time and location. This research was conducted from May to December 2015, and took place at coastal area of Pantai Lakeba Kota Baubau, Province of South East Sulawesi, Indonesia. The observation of water quality sample was conducted at the laboratory of the Faculty of Fishery and Marine Science, Universitas Halu Oleo and the research location is determined into two observatory station which coordinates are 05^0 29'16.2"S and 122^0 33'47.0"E and 05^0 29'18.8"S and 122^0 33'48.9"E.

Research design framework. Seaweed *E. spinosum* was cultivated within floating cages. The size of floating cages was 400 x 100 x 60 cm. To simplify the observation and reconstruct the observation, a 100 cm plots was made in one unit of floating cage (Kasim et al 2016). The total of plots in one unit of floating cage was four plots. A 1.5 cm diameter of nets covers the outside part the floating cage as a wrapper. In field observation, the researcher distinguished one plot by another with a marker (sign), cage A and plot 1 (A1), cage A plot 2 (A2), cage A plot 3 (A3), cage A plot 4 (A4), while for cage B plot 1 (B1), cage B plot 2 (B2), cage B plot 3 (B3), cage B plot 4 (B4). Each plot has seed of seaweed in total of 20 thallus and weight 100 g for each thallus. The seaweeds that are being observed have a various colored rope to help the process of observation and the seaweeds are cultivated during the research. To clarify the impact of epiphyte parasitism towards the growth of seaweed, every 10 days there was performed weight measurements of the seaweed.

Macro-epiphyte sample collection. To know the occurrence of macro-epiphyte on seaweed thallus, visual observation is required and samples were taken 3 times with 10 days of interval. The sample of macro-epiphyte which attaches to seaweed thallus inside the cage was taken randomly from each cage. Samples were stored in labeled plastic bottles. The type of macro-epipyte was identified based on morphological characteristic.

Physical and chemical parameters observation. Physical parameters were measured directly from the field observation and particular tools were used for water temperature measurement (thermometer), current flow measurement (current meter), and water transparency measurement (Secchi disk). While chemical parameter were directly measured on site, tools that are utilized such as refractometer for salinity measurement. For DO, nitrate and phosphate parameter, attained sample from the field is analyses at the laboratory of Faculty of Fishery and Marine Science, Halu Oleo University, Indonesia.

Parasitism growth data on each plot inside the cage was processed statistically with One Way ANOVA examination (Analysis of Variance), if there are significant diversion of the growth in each plot therefore a further Duncan examination is used and LSD with a significance level of 0.05 by using SPSS 16.0 software.

Results and Discussion

Macro-epihyte attach on E. speinosum. During our research, there are up to 7 species of macro-epipyte attached on *E. spinosum* which are shown in Table 1.

Table 1

Macroepiphyte species attached on thallus of *Eucheuma spinosum*

No.	*Macro-epiphyte species*	*Stations*					
		Station A			*Station B*		
		Days					
		10	*20*	*30*	*10*	*20*	*30*
1	*Acanthophora spicifera*	-	√	-	√	√	-
2	*Chondrophycus papillosus*	-	√	-	-	-	-
3	*Chaetomorpha crassa*	√	√	-	-	-	-
4	*Jania longifurca*	√	√	√	√	-	√
5	*Pomatoceros triqueter*	-	√	√	√	√	-
6	*Ulva lactuca*	√	√	√	√	√	-
7	*Turbunaria ornata*	-	√	-	-	-	-

(√) - present, (-) - not present.

The result of observation during this research has found that seven types of macro-epiphytes attached to *E. spinosum*, namely: *A. spicifera, C. papillosus, C. crassa, J. longifucra, P. triqueter, U. lactuca,* and *T. ornata*. Most dominant macro-epiphyte which attached to *E. spinosum* in the station A during the observation was *J. longifurca,* and *U. lactuca,* and the least dominant macro-epiphytee were *T. ornata, C. papillosus,* and *A. spicifera.* While the most dominant macro-epiphyte found in the cage B is only one type which is *J. longifurca* (Figure 1). Hamsia (2014) stated that the types of macro-epiphyte which attached to the thallus of seaweed *E. spinosum* during February to April 2014 in same areas are *C. crassa, U. lactuca, T. ornata,* and *A. spicifera.* Those types of macro-epiphytes were also found by Yulianto & Hatta (1996) in Tual Maluku Tenggara water, which are the followings: *Codium* sp., *Enteromorpha clathrata, Acanthophora dendroides, A. spicifera, Dictyota dichotoma, Padina* sp., and *blue green algae.*

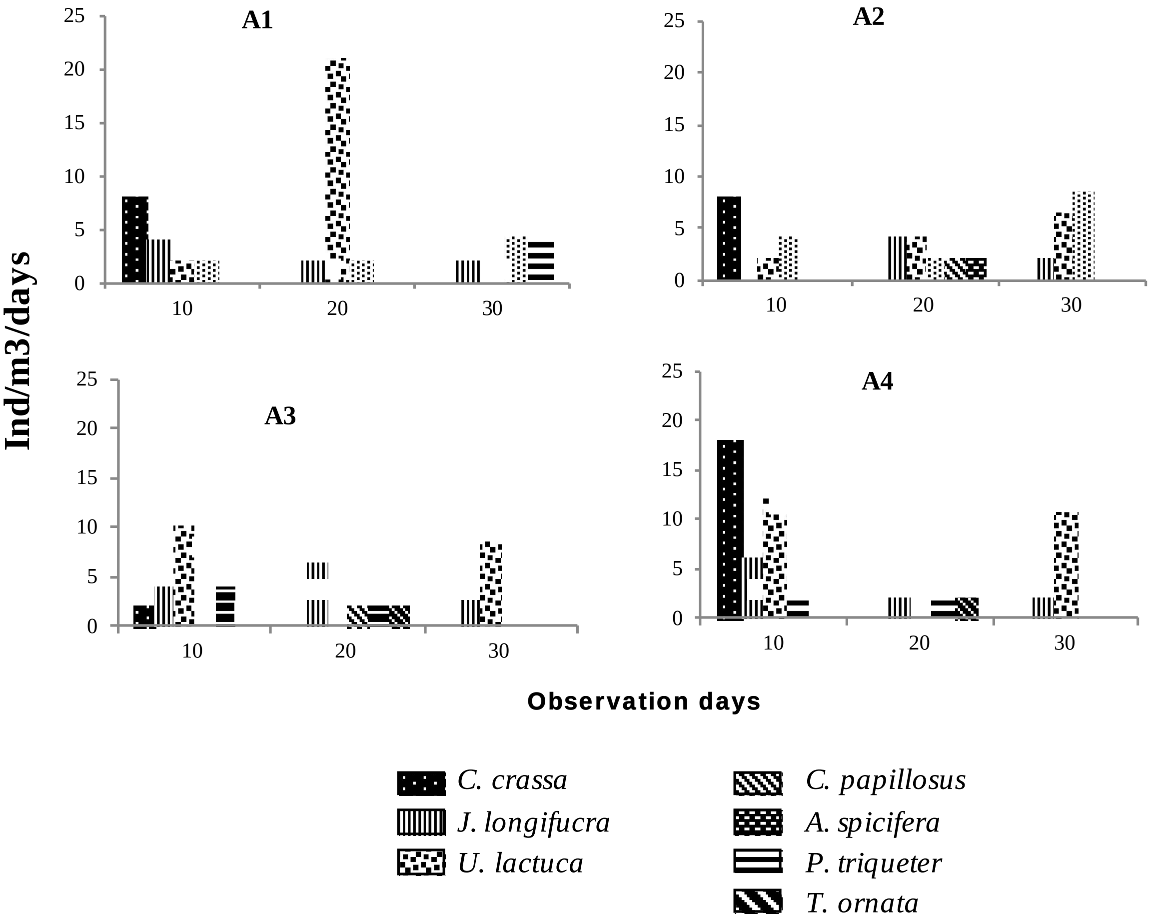

Figure 1. Attachment rate of epiphyte on thallus of *Eucheuma spinosum* at station A.

During our research, attachment rate of *U. lactuca* on thallus of *E. spinosum* found the highest occurred in Station A at the 20^{th} day with the value of 21 ind/m^3/day. Furthermore, the lowest attachment rate of this species occurs on the 10^{th} day, with the average value of 2 ind/m^3/day. While in cage B the highest attachment rate occurred on the 20^{th} day the value of 12 ind/m^3/day (Figure 2). The types and amount of macro-epiphyte which attached to the *E. spinosum* thallus during the research inside each station in the cage A and cage B caused crop failures to the seaweed. This situation occurred because the thallus becomes thin and fragile due to the macro-epiphtye parasitism. The variety of numbers and types of macro-epiphyte which attached to the *E. spinosum* thallus inside each plots and cage during the research was caused by the drastic change of water abiotic factor (salinity) which was approximately around 32-36 ‰. Vairappan et al (2008) argues that epiphyte disease is a seaweed parasite disease which fails crops on cultivation activity. Thus disease is caused by the *Neosiphonia* *apiculata* parasite and Vairappan (2006), also claimed that the occurrence of macro-epiphyte on seaweed thallus is caused by significant change of salinity and water temperature.

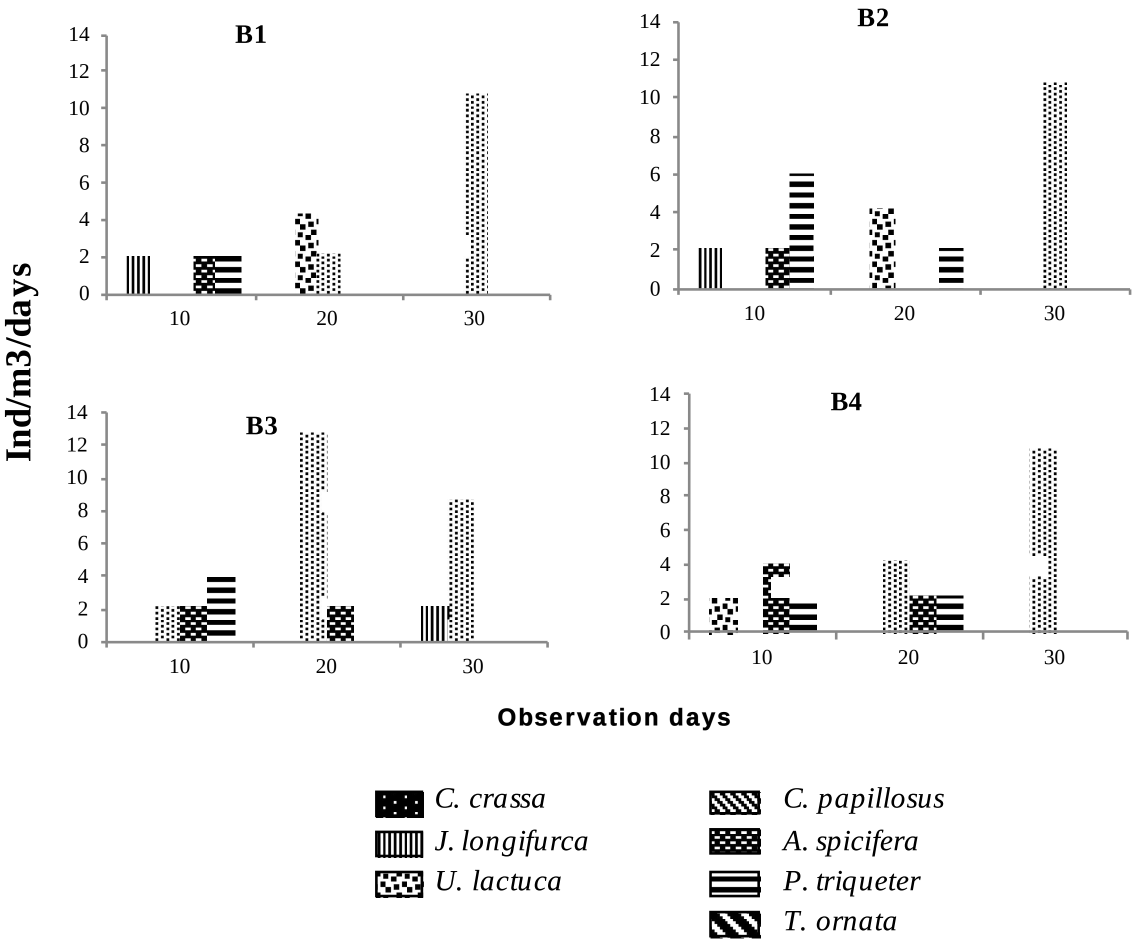

Figure 2. Attachment rate of epiphyte on thallus od *Eucheuma spinosum* at station B.

Macro-epiphyte attachment rate in every station was different. During our research attachment rate of macro-epiphyte in station A was higher that of station B in most cages (Figure 3). The rapid growth of macro-epiphyte on each plot of *E. spinosum* thallus inside cage A and cage B was caused by water current velocity. During our observation current velocity in all stations was very slow and calm with the value of 0.005-0.15 m/s. The current velocity was low, which triggered the growth of macro-epiphyte on seaweed and also on the floating cages. Slow current velocity was stimulating the growth of epiphyte and dominates the light, space, and sustenance take up process from the seaweed Rombe et al (2013). Sunlight will be absorbed more by the macroalgae than the cultivated seaweed. In contrast, if the current velocity is too fast, it can cause negative affects on the seaweed such as a broken thallus. According to Dubost et al (1996), the ideal water current velocity for macroalgae growth is around 0.10-0.50 m/s.

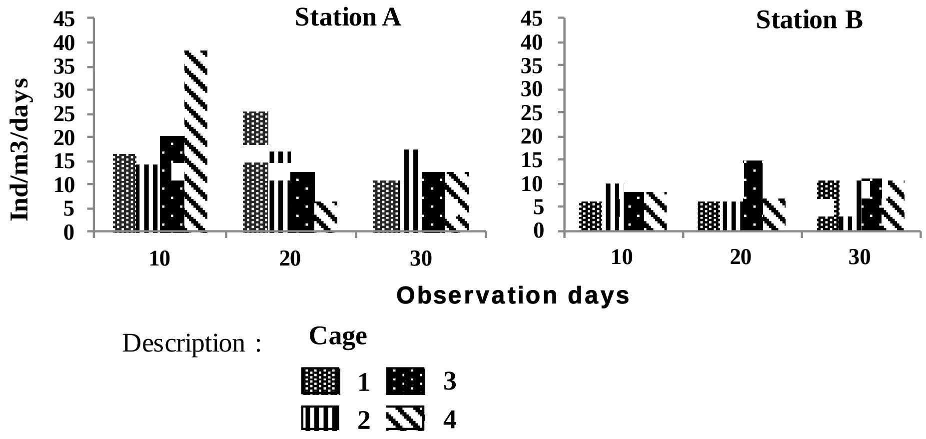

Figure 3. Comparison attachment rate of epiphyte in every cage at every station.

Table 2

Average of physical and chemical parameters during research observation

Parameters	*Observation day*		
	10	*20*	*30*
Physical			
Temperature (°C)	28	29	29
Current velocity (m/s)	0.15	0.05	0.15
Water transparency (m)	11.59	12.71	11.65
Chemical			
Salinity (‰)	36	35	32
Nitrate (mg/L)	0.0043	0.0012	0.029
Ortho phosphate (mg/L)	0.0018	0.0007	0.006
Dissolved oxygen (mg/L)	5	6.6	6.6
pH	6	6	6

Water transparency and dissolved oxygen (DO) is also impactful towards the growth and macro-epiphyte parasitism. During research the water transparency level was 11.59-12.71 m; that water transparency level is very good for the growth of macro-epiphyte. Hodson et al (2000) stated that transparency level for macroalgae parasite growth and biofauling is 5-8 m. The DO level during the research was marked at around 5-6.6 mg/L, level which is optimal for macro-epiphyte growth, therefore the parameter also affects macro-epiphyte parasitism enhancement during the research. Mejia (2005) stated that the DO level for the growth of macro-epiphyte is around 4.54-5.88 mg/L. Besides current velocity, water transparency and DO triggers the growth of macro-epiphyte in each plot on *E. spinosum* thallus inside cage A and cage B. Other environment parameter which affects the growth of macro-epiphyte is water temperature and salinity. On the research area during observation the water temperature level was around 28-29°C and the salinity level is around 32-36 ‰, increasing or decreasing water temperature and salinity drastically caused the dominance and infection on seaweed thallus towards macro-epiphyte. Vairappan et al (2013) stated that drastic change of abiotic factors such as temperature and salinity can act as trigger mechanism or signage for infection with macro-epiphyte. Kasim et al (2016) also stated that normal temperature for the growth of macroalgae is around 25-35°C. Optimal temperature that is suitable with the macroalgae growth in tropical sea water is 25°C and water transparency also affects photosynthesis process of macrolgae.

The lack of macro-epiphyte parasitism growth in each plot on *E. spinosum* thallus in the case of cage A and cage B it is due to the very low concentration of phosphate and nitrate (0.0007-0.0018 mg/L and 0.0012-0.029) during the research. This values shows the lack of phosphate which it is not enough for macro-epiphyte growth, therefore macro-epiphyte parasitism growth is low. According to Patadjai (2007), phosphate necessity to fulfill the optimal growth of macroalgae is affected by the form of nitrogen compounds. Highest boundaries of phosphate concentrate will be lower if the nitrogen comes in the form of ammonium salt. In contrast, if the nitrogen is in the form of nitrate, the phosphate concentrate that is required will be higher. The lowest boundaries of phosphate concentrate for optimal growth of macroalgae is around 0.18-0.90 mg/L, and highest boundaries between 8.90-17.8 mg/L. While nitrate content during the research was around 0.0012-0.0043 mg/L, which is relatively low for macroalgae growth, therefore the macro-epiphyte parasitism was registered at a low level. According to Railkin (2004), the range of nitrate content for macroalgae growth is around 0.001-0.012 mg/L. Furthermore, besides phosphate and nitrate which affects the lack of macro-epiphyte parasitism growth, water pH is also impactful which affects the macro-epiphyte parasitism growth. During the research the pH level was 6 units, value which is not quite optimal for macroalgae growth therefore the macro-epiphyte parasitism remained low. Dawson (1966) stated that the optimal pH level range of water for macroalgae growth is between 7.75 and 8.26.

Conclusions. The amount of macro-epiphyte types which attacked *E. spinosum* thallus during present research include 7 types, which are *U. lactuca, C. crassa, P. triqueter, J. longifurca, C. papillosus, T. ornata,* and *A. spicifera.* In average the growth of macro-epiphyte parasitism on *E. spinosum* thallus at the 10^{th} day was found 3 ind/m^3, at the 20^{th} day was 2 ind/m^3, and at the 30^{th} day was 2 ind/m^3. The highest level of macro-epiphyte parasitism with *U. lactuca* was found at the 20^{th} day; with value of growth of 21 ind/m^3. Statistically there was not found significant difference between experimental plots of the floating cages

Acknowledgements. The aithors are grateful to the Directorate General of Higher Education, Ministry of Culture and Education of Indonesia for the Full Research Funding of this research project, gratitude for Fishery Laboratory, Faculty of Fishery and Marine Science Halu Oleo University for their assistance in sample analysis.

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Received: 04 May 2017. Accepted: 20 June 2017. Published online: 25 June 2017.

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How to cite this article:
Kasim M., Jamil M. R., Irawati N., 2017 Occurrence of macro-epiphyte on *Eucheuma spinosum* cultivated on floating cages. AACL Bioflux 10(3):633-639.