INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 6, No. 6, p. 356-369, 2015
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Biology and blooms of the edible jellyfish (*Crambione mastigophora*) in the Saleh Bay, Indonesia

Evron Asrial[1,2*], Arief Prajitno[3], Edi Susilo[3], Gatut Bintoro[3]

[1]*Fisheries and Marine Science Faculty, University of Brawijaya, Malang, East Java, Indonesia*

[2]*Fisheries Faculty, University of 45, Mataram, West Nusa Tenggara, Indonesia*

[3]*Fisheries and Marine Science Faculty, University of Brawijaya, Malang, East Java, Indonesia*

Article published on June 24, 2015

Key words: Scyphozoan, Temperature, Hydrological system, Pond, Fishing.

Abstract

Edible jellyfish (scyphozoan) is one of coastal fishery resources in Indonesia that has economic value because has been exported to some countries in eastern Asia. Research concerning in scyphozoan resources in Saleh Bay waters has been carried out in 01st September 2014 - 15th December 2014. The research aimed is to know causes of blooming phenomenon of the scyphozoan who living and growing up in Saleh Bay. The authors visited the research location four times in order to get data and information of scyphozoan, and to interview local fishermen. This research uses survey method, and also using sampling, dialogue, and documentation methods for data collecting. Primary data was collected with simple random sampling. For data analysis, used quantitative and qualitative methods. The scyphozoan (104 ind) and time series data were used as the main research materials. The main equipments are pair of scales, ruler and camera. The scyphozoan classification is class Scyphozoa, species *Crambione mastigophora* MAAS 1903. Up till now, blooming scene of *C. mastigophora* was one time in a year usually go on five months on period September-January, it is affected by disparity of waters temperature (SST, SBT). Whereas the scyphozoan proliferation is influenced by hydrological system, shrimp pond, illegal fishing, overfishing and catch-ability of scyphozoan fishing gear. For muffle of bloom rate, admissible action is mangrove reforestation, coral reef transplantation, shrimp culture restriction and intensive sea patrol to take action against the actors of illegal fishing and destructive fishing.

***Corresponding Author:** Evron Asrial ✉ asrialevron80@gmail.com

Background

Edible jellyfish is one of the Indonesia fishery resources with economic value that has been exported to China, Japan, Hong Kong, Taiwan, and Korea (Mujiono, 2010). This fishery resource has become popular not only in Southeast Asia countries is such as Indonesia, Vietnam, Malaysia, Philippine and Myanmar, but also in Australia, India, Mexico, Turkey and the U.S.A (Omori and Nakano, 2001). In Indonesia sea waters, there is eight species of edible jellyfish who can be found in the Malacca Strait, Karimata Strait, Java Sea (northern Java Island, southern of South Borneo), Hindia Ocean (southern of Java Island), Macassar Strait (southeastern of East Borneo), and Bacan Island waters (North Molucca) (Omori and Nakano, 2001; Kitamura and Omori, 2010) and Saleh Bay in West Nusa Tenggara (FMA-WNT, 2009).

The Saleh Bay is a big bay (2,123 km^2) with many socio-economics activities every day and night. Its waters constitute the habitat of edible jellyfish that is known its existence to 2003. Coastal community and fishermen around Saleh Bay call it as *ubur-ubur merah* (red jellyfish) that has exploited since 2003. The fishermen catch the edible jellyfish when blooming that goes on every year until 2014.

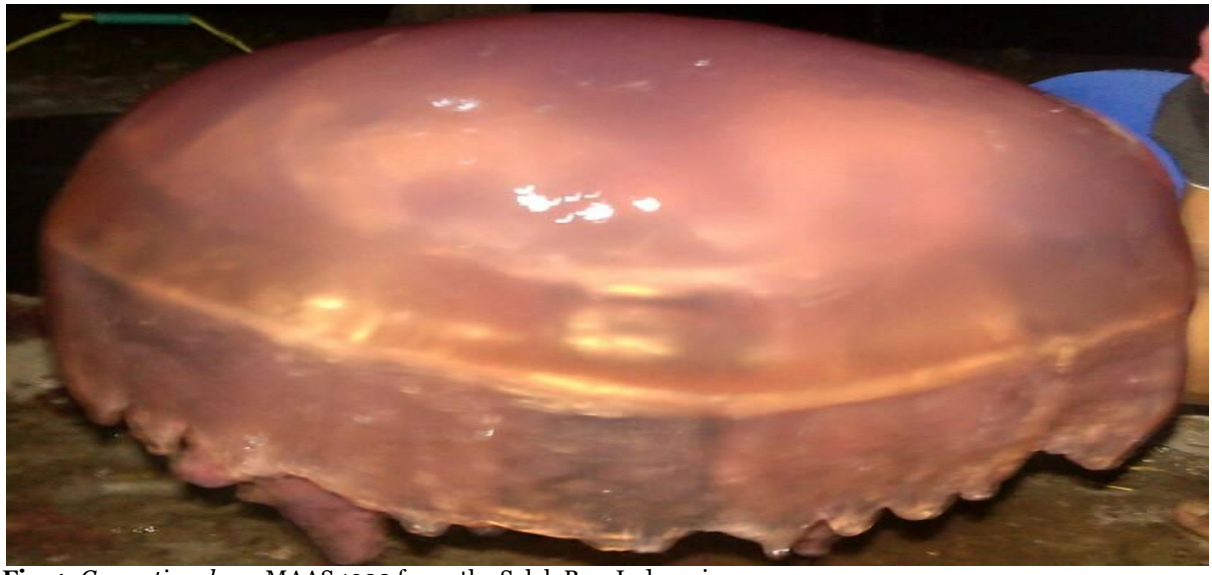

Fig. 1. *C. mastigophora* MAAS 1903 from the Saleh Bay, Indonesia.

Blooms of jellyfish has become the problem for in part of communities. Jellyfish bloom scene has been unsettle of the activities of tourism, sea transportation, power plant/station and small-scale fishing. Whereas blooming of the edible jellyfish has given a better income for small-scale fishermen.

Blooming of jellyfish has happened since hundreds of million years ago. According to Brotz *et al*. (2012), blooming of jellyfish population in an entire ecosystem coastal waters and the world marine allegedly happened in 2010. The small-scale fisherman in Saleh Bay always catches the edible jellyfish when blooming season occurs from September to January (FMA-WNT, 2009).

Materials and methods

The research was done by taking four times visitation in Saleh Bay lasted from 01st September 2014 to 15th December 2014 to investigate and gain the biology edible jellyfish primary data, and blooming scene of edible jellyfish secondary data were obtained from Fisheries and Marine Affairs of Sumbawa District, Dompu District and West Nusa Tenggara Province while the phenomenon of blooming edible jellyfish. The method of this research is survey method, and also using sampling, dialogue, and documentation methods for data collecting. Primary data was

collected with simple random sampling. The data were analyzed with quantitative (regression and comparative) and qualitative methods (the problem tree method).The aims of this research were to know the factors causing of edible jellyfish blooming scene in Saleh Bay waters.

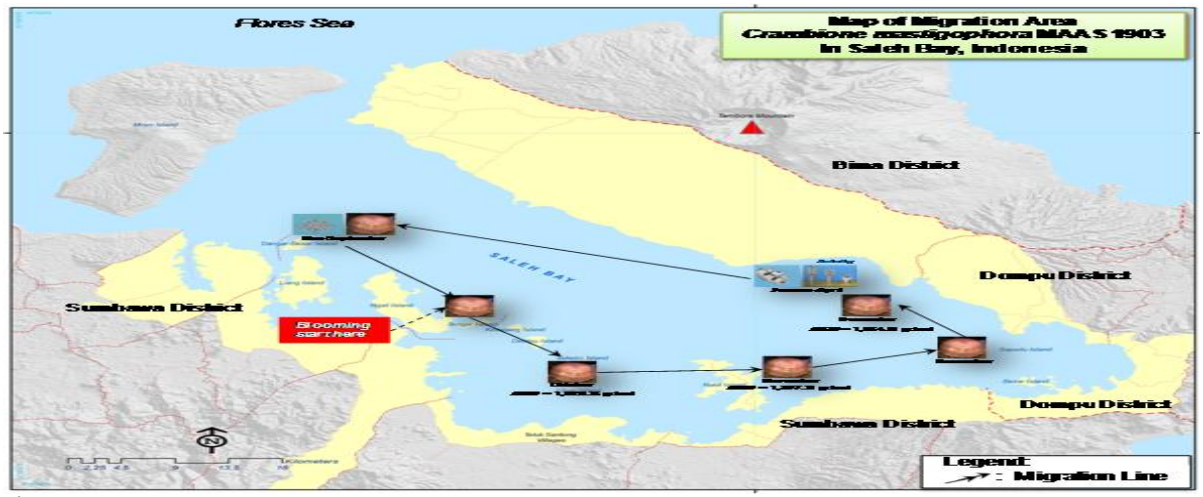

Fig. 2. Map of *C. mastigophora* migration area in the Saleh Bay, Indonesia, 2014.

The edible jellyfish data (cross section data) and time series data were used as the main research materials. Whereas the main research equipments is the pair of scales, the ruler and the camera.

For knowing correlation and determination of all variables, also level of data precision or accuracy, the authors analyzed data using the simple regression method ($Y = \alpha + \beta X + \varepsilon$) between edible jellyfish yield (dependent variable) with some variables individually (independent variable). In the mean time, multiple regression analysis ($Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$) was also used among edible jellyfish yield (dependent variable) with yield of medusivores (red snapper, grouper, rabbit fish) coincide as independent variables. Analysis of variance (ANOVA) is applied to take equation that can be a math model.

Result and discussion

Edible Jellyfish

Species

Jellyfish has a lot of name or terminology by experts. Some of them called jellyfish as gelatinous, gelatinous plankton, gelatinous zooplankton, or jellyfish plankton (Brotz *et al.*, 2012; Brotz and Pauly, 2012; Condon *et al.*, 2012; Miranda *et al.*, 2012; Boero, 2013), or gelatinous macrozooplankton (Boero, 2013). Other names are medusae, medusa, or plural medusa (Ohtsuka *et al.*, 2010; Miranda *et al.*, 2012), and scyphozoan (Bayha *et al.*, 2010; Perissinotto *et al.*, 2013). True jellyfish is macrozooplankton group wich has the quality of plankton from the class of Scyphozoa, the body consist of umbrella, mouth-arms, and mucous. In this report, we called edible jellyfish with the terminology of "Scyphozoan".

Table 1. Size of *C. mastigophora* during fishing season in Saleh Bay, 2014.

Month	ABW (g/ind)	AUD (cm/pc)	AUW (g/pc)	AMW (g/pc)
October 2014	500 - 1,860	14.50 - 24.50	360 - 1,260	100 - 600
November 2014	740 - 2,240	17.00 - 24.00	520 - 1,400	200 - 840
December 2014	1,100 - 2,800	18.50 - 27.00	740 - 1,820	300 - 1,000

Note: ABW = Average Body Weight; AUD = Average Umbrella Diameter;
AUW = Average Umbrella Weight; AMW = Average Mouth-arms Weight.

Number of samples has been identified 104 scyphozoan as sample with the total weight is 145.53 kg. The body weight range from 500 g/ind to 2,800 g/ind, and average body weight (ABW) is 1,400 g/ind. The diameter of umbrella between 14.50-27.00 cm/umbrella and average umbrella diameter (AUD) is 20.60 cm/umbrella. The marginal lappet rounds the umbrella (exumbrella) amounted to 70-95 lappet/umbrella, and had 8, 9, 10 and 11 lappet/octant. It was found that based on morphological characteristic of the scyphozoan in Saleh Bay was classified as *Crambione mastigophora* MAAS 1903 from the phillum of Cnidaria and the class of Scyphozoa. Common name of *C. mastigophora* is "Tomato Jellyfish". (Figure 1).

Table 2. Scyphozoan yield in the Saleh Baleh, 2009-2013.

No.	Year	Yield	Rise/Down	
		(ton)	Ton/Year	%/Year
1	2009	7,200.00		-
2	2010	30,519.14	23,319.14	323.88
3	2011	34,566.79	4,047.65	13.26
4	2012	32,115.26	(2,451.53)	(7.09)
5	2013	30,817.87	(1,297.39)	(4.04)

Source: FMA District of Sumbawa, 2013; FMA District of Dompu, 2013.

In the international market, product of *C. mastigophora* (salted jellyfish) sold with trade-mark or label name is "Prigi Type". Prigi is the name of little bay in Trenggalek District (West Java Province). In Indonesia, the similar jellyfish species can be found in southern East Java waters (Hindia Ocean) in two places are Muncar (Banyuwangi District) and Prigi Bay (Trenggalek District).

Table 3. Sum of a rain day and rainfall in Sumbawa District, 2009-2013.

No.	Year	2009		2010		2011		2012	
	Month	RD	RF	RD	RF	RD	RF	RD	RF
1	January	14	149.0	15	490.4	21	248.0	26	174.0
2	February	19	300.0	24	169.2	15	316.0	24	134.0
3	March	14	103.0	10	101.3	14	171.0	24	108.0
4	April	7	116.0	8	62.3	19	247.0	21	75.0
5	May	2	36.0	7	131.5	22	230.0	7	50.0
6	June	2	0.0	0	1	1	0.0	0	42.0
7	July	1	17.0	2	91.5	7	0.0	0	5.0
8	August	0	0.0	0	4.5	2	0.0	0	0.0
9	September	1	0.0	0	156.9	13	0.1	1	0.0
10	October	6	2.0	4	91	14	15.0	5	5.0
11	November	18	186.0	6	230.9	17	228.0	22	32.0
12	December	18	61.0	14	287.6	24	176.0	18	168.0
Total		102	970.0	90	1818.1	169	1631.1	148	793.0

Source: BSC WNT, 2013

Note: RD = Rainy Day (day); RF = Rainfall (mm).

Habitat

The habitat of jellyfish widespread throughout the sea waters ranging from shallow waters in tropics and sub-tropical regions until deep waters. Several species of jellyfish prefer to live in warm waters such as tropical waters, while other species tended to live in colder waters such as sub-tropic and arctic waters. In

addition, the jellyfish is called as scyphozoan is Cœlenterata which live in the sea in the form of polyp that stick on the bottom of the sea (Manuputty, 1988). Parameter of pH in Saleh Bay waters ranged from 7.9 to 8.3, in October to December 2014. According to Manuputty (1988), the tolerances range of pH water which had to get away of the umbrella contraction from 8.0 to 8.2. However, pH less than 7.2 or more than 9.5 the umbrella contraction will run down. Doyl *et al.* (2007) argued that jellyfish life tolerance against that sea surface temperature (SST) ranging -0.6^{O}C to 31.0^{O}C, with optimal temperature of 9^{O} to 19^{O}C. SST changes affect at the sequence of umbrella contraction and oxygen consumption. The SST of the Saleh Bay ranged from 24.1^{O}C to 25.6^{O}C. It was higher than the optimal temperature tolerance. However the duration of this SST didn't have negative impacts toward the jellyfish life.

Table 4. Addition of shrimp pond area in the Saleh Bay coastal.

No.	Sub-district	Pond Area (hectars)			
		2009	2010	2011	2012
1	Lape	398.00	398.00	398.00	398.00
2	Plampang	520.00	552.10	609.00	609.00
3	Maronge	164.50	164.50	164.50	164.50
4	Empang	72.00	72.00	72.00	72.00
5	Tarano	252.45	252.45	256.45	256.45
Saleh Bay Area		1,406.95	1,439.05	1,499.95	1,499.95

Source: FMA District of Sumbawa, 2013.

Hyman (1940) has been illustrated that tolerance live of jellyfish against that the lowest salinity waters was about 30% fresh water and 70% saltwater, or about 6 ppt. It was called brackish water. According to Manuputty (1988) that salinity of jellyfish tolerance was between 12 to 65 ppt. Salinity in Saleh Bay waters during the scyphozoan fishing season in 2014 ranged from 28.2 to 28.4 ppt.

Scyphozoan moved in the form of solitary or clustered in coastal waters on all waters column, and swam freely in a horizontal and vertical with the assistance of umbrella contraction (Hyman, 1940).

Table 5. Yield of jellyfish and medusivores in the Saleh Bay, 2008-2012.

No.	Year	Jellyfish	Red Snapper	Grouper	Rabbitfish
1	2008	55.20	4,057.35	3,417.44	119.17
2	2009	7,200.00	5,020.10	3,705.63	124.59
3	2010	30,519.14	4,822.29	3,470.76	136.10
4	2011	34,566.79	2,305.52	3,387.15	147.94
5	2012	30,817.87	2,730.58	2,616.77	186.83

Source: FMA District of Sumbawa, 2013.

Migration Area

Wootton (1990) *in* Bintoro (2005) said, that based on the direction of the movement (migration), migratory fish was divided in two group namely horizontal and vertical migrations. The late movement was mostly caused by searching for food in short periods (daily). While the former movement was longer time and distance.

The scyphozoan in Saleh Bay moved horizontally accending to waters current direction that influenced by direction and velocity of wind. Whereas

scyphozoan horizontal migration cycle each years in teh Saleh Bay as follows: (Table 1, Figure 2).

a. January-April: Scyphozoan (medusa, polyp, ephyra) lives in Hodo Bay (a little bay in eastern of Saleh Bay) for survival, reproduction process and growth.

b. May-September: The young and adult scyphozoan that have a big and small size horizontal migrating from Hodo Bay to eastern waters of Dangar Besar Island following sea waters current and east wind on May. They became medusa (adult scyphozoan), but not for repoduction process. The bloom of scyphozoan starts in eastern Ngali Island on September when they swim for horizontal migration to the south caused aeolian west Monsoon. The fishermen saw some schooling scyphozoan in big size on the surface waters. Nontheless, they didn't catch scyphozoan because still small size.

c. October: Following sea waters current and aeolian west Monsoon, the scyphozoan move and migrate horizontally to Kebo Island waters and other small islands near and arround Kebo Island, in southern Ngali Island. On this period, medusa dominantly develop to be bigger size. The fishermen start catching the scyphozoan on October (ABW = 1,020.38 g/ind).

d. November: Medusa move and migrate horizontaly to the waters of Rakit Island, eastwards from Kebo Island. In this period, medusa size is bigger than last period. (ABW = 1,207.31 g/ind).

e. December: Adult medusa move horizontaly to Hodo Bay waters, following sea waters current and south wind. Its size reaches the biggest size that is ABW 1,684.81 g/ind. On the end of this month, the adult medusa swim and migrate vertically until attained to the depth of waters more than 10 meters from sea surface. On this situasion, the fishermen stopped catching scypozoan because their jellyfish fishing gear (scoop net) can not reach out the scyphozoan position in the waters. Whereas as compared to along October and November, the scyphozoan on December is the biggest size with the best price. The fishermen have to wait a year later for catching scyphozoan.

Based on migration data and size distribution (weight & diameter) of scyphozoan as mentioned above it can be concluded that scyphozoan size reaches the biggest size on December (end of fishing season). This indicates that the scyphozoans source comes from same cohort namely the result from reproduction process in the same time during January-April in Hodo Bay waters.

Blooming

Scene

Blooming of scyphozoan is when the scyphozoan in much number put in an appearance on the sea surface over a particular period that can repeated periodically each year, un-periodically, and/or unpredictable. According to the opinion of international jellyfish experts, jellyfish blooming scene in the world waters has been achieve of feel concerned. In 2010, blooms of jellyfish scene until the waters of north pole and south pole (Brotz *et al.*, 2012).

The blooming can be caused by aquaculture system (Dong *et al.*, 2010; Baxter *et al.*, 2011; Brotz *et al.*, 2012; Boero, 2013), overfishing (Boero *et al.*, 2008; Dong *et al.*, 2010; Bortz *et al.*, 2012; Schrope, 2012; Sahu and Panigrahy, 2013), catching of jellyfish predators (Pauly *et al.*, 1998), the decline in the catch fish and damage of fishing gear (Daryanabarda and Dawson, 2008), ecosystem/habitat modification (Dong *et al.*, 2010; Brotz *et al.*, 2012; Carrasco and Perissinotto, 2012; Schrope, 2012), changes in water quality condition (Shoji *et al.*, 2010; Brotz *et al.*, 2012; Schrope, 2012), water temperature and salinity [Brotz *et al.*, 2012; Sahu and Panigrahy, 2013) and hypoxia condition (Purcell, 2007).

The blooming scene of scyphozoan can occurs whenever and wherever in each coastal and bay

waters in the world, also in the Saleh Bay waters. Brotz *et al.* (2012) indicated that there has been jellyfish population in coastal waters all over the world in 2010. The highest jellyfish population is occured in coastal waters along the South Pole, the southwestern Africa and the eastern Asia (Japan, China). Meanwhile, low level population increased widespread in many coastal waters area wich was in the northeastern Australia, the middle eastern and southern Asia, the Mediterranean, the western Europe, the western Africa, the side of southern U.S.A, the Gulf of Mexico, the eastern of south America continent and the northern of south America continent. Whereas, decreasing level of the jellyfish population occurred in western coastal region of the southern part from the America continent.

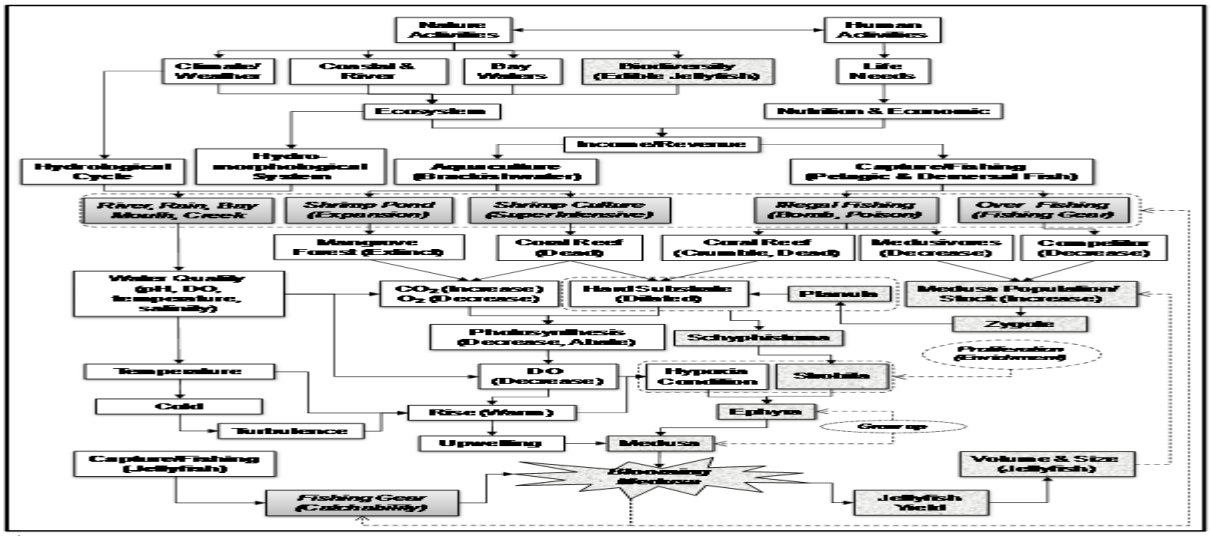

Fig. 3. Blooming causes of scyphozoan in the Saleh Bay.

Generically, activities of edible jellyfish fisheries in the world lasted during the period of blooming. Blooming is a population increase that last some times periodically in each a year, or unpredictable as was the case for blooming the green scyphozoan in Jogjakarta (Indonesia). When blooming season, the fishermen fishing the scyphozoan as the main income source of fishermen family. So it is with *C. mastigophora* in the Saleh Bay, had been around of blooming phase.

In Saleh Bay, the scyphozoan blooming scene is known since 2006 (FMA-WNT, 2009). On 2014, blooming occurred once in each year that usually begins on September and ends on January. Whereas fishing season of *C. mastigophora* which only in three months that is during October to December.

Causes

Blooming of scyphozoan in Saleh Bay is indicated by fluctuation of its production. Since 2009, scyphozoan yield from Saleh Bay waters rise 380.09% until 2011. But, the production got down to 10.85% for two years end in period 2011-2013. The top-level production is in 2011 amount to 34,566.79 ton of scyphozoan , and the lowest as many 7,200.00 ton in 2009. The biggest production increment between 2009 and 2010 i.e. 23,319.14 ton (323.88%), and the biggest production descent is 2,451.53 ton (-7.09%) on period 2011-2012. (Table 2).

Main causes of the scyphozoan blooming in Saleh Bay is estimated to concerned with (1) nature activities namely hydrological system of the bay and (2) human activities i.e. aquaculture and capture/fishing. The Saleh Bay hydrological system is to do with river type, creek, bay mouth (size) and rain (rain day and rainfall). Brackish-water aquaculture activities (shrimp culture) closely related to shrimp pond expansion and operational of intensive shrimp

culture. Whereas fishing activities on occasion of illegal fishing and overfishing, and fishing of scyphozoan is catch-ability of fishing gear. (Figure 3).

Hydrological System

The Saleh Bay waters constitute well habitat for scyphozoan *C. mastigophora* reasoned by the waters suited for scyphozoan life. The bay who is located in the northern part of Sumbawa Island related directly with Flores Sea, classified of semi-closed bay category. The bay water derived from saltwater and fresh water. Saltwater has a source from the Flores Sea (northern of Saleh Bay), flows into the bay through the mouth of the bay. In the mean time, fresh water that goes to the bay almost entirely sourced/derived from the rains which go straight into the bay and through the river and the creek. It is concomitance in a hydrological cycle. Thus, hydrological system is available in the Saleh Bay consisting of the mouth of the bay, the river, and the creek. This means, the hydrological system of the bay affects the condition of water quality of the Saleh Bay waters.

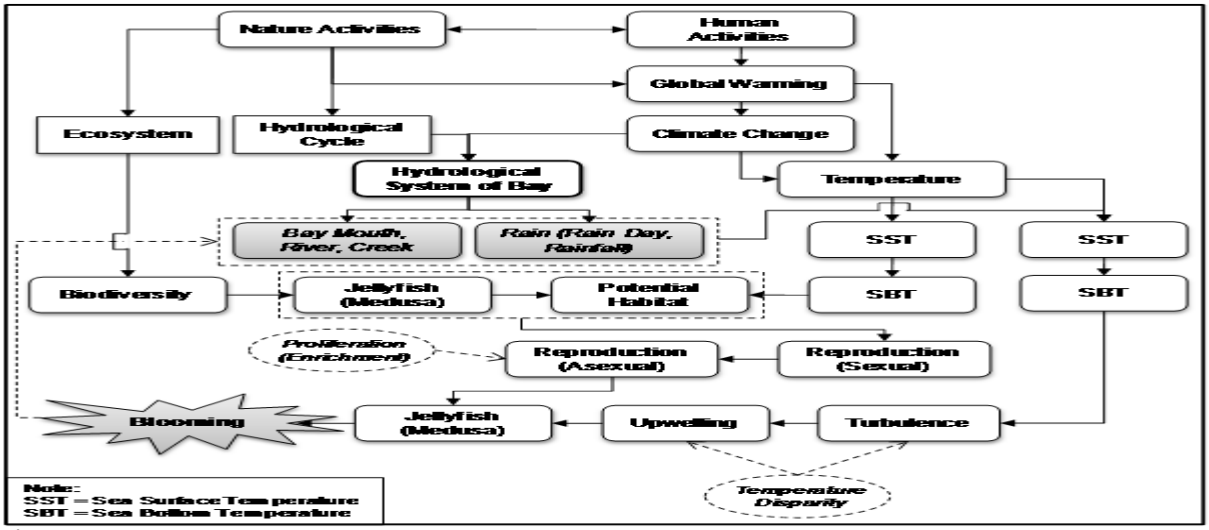

Fig. 4. Correlation between hydrological systems with blooming in the Saleh Bay.

Morphologically, the Saleh Bay shaped like a tube of erlenmeyer that is foreshortened in the mouth parts with wide the mouth of the bay is 23.5 km (12.71 nautical miles). The flow of saltwater from the Flores Sea into the Saleh Bay waters in trouble because in front of the mouth of the outer Saleh Bay there is Moyo Island covering almost all of the mouth of the bay. Nevertheless, there are two slits each to $\pm$6 km on the northeastern side and southwestern side of the southern of Moyo Island which connects the Saleh Bay waters with the Flores Sea. (Figure 4).

Salinity in the Saleh Bay waters wholly derived only from the Flores Sea, flowing into the bay through the bay mouth. The position of the Moyo Island is impeding this process, velocity of watercourse and speed of water change for flushing the Saleh Bay waters using the water from the Flores Sea. The state of had managed to the difficulty of increasing the water quality of the Saleh Bay waters.

Based on Figure 4, variable of rain has a significant effect on the condition of water quality in the river, the creek, and the bay waters. The river that rises in the Saleh Bay waters is mostly intermitten type and creek. The intermitten river namely the water brooks when heavy rains fall and still watery than an hour after the rain stop. Only a few the rivers are annual and perennial type. The both of those rivers type number in the Saleh Bay is scantly, namely six rivers. So that, almost of all of the rivers in the Saleh Bay was very dependent on rain water. Finally, the waters of

Saleh Bay depend on the rain water either because all the rivers water stream continuously to the bay. Broadly speaking that the water quality and quantity of Saleh Bay is determined by single factor only namely rain water. In the aftermath is the water quality almost homogeneous in the all of part of bay waters so scyphozoan can live on the safe side (safely) and increase its population (blooming) through all the waters.

The Saleh Bay hydrological system is influenced by the form of bay morphology, a small island in front of the bay mouth, the river type, the creek and rain (season and pattern). . The bad hydrological system is believed to be one of the causes of scyphozoan blooming in the Saleh Bay. The allegation evidenced by simple regression analysis between variables of the scyphozoan yield with the rain day and rainfall that affects the Saleh Bay water quality.

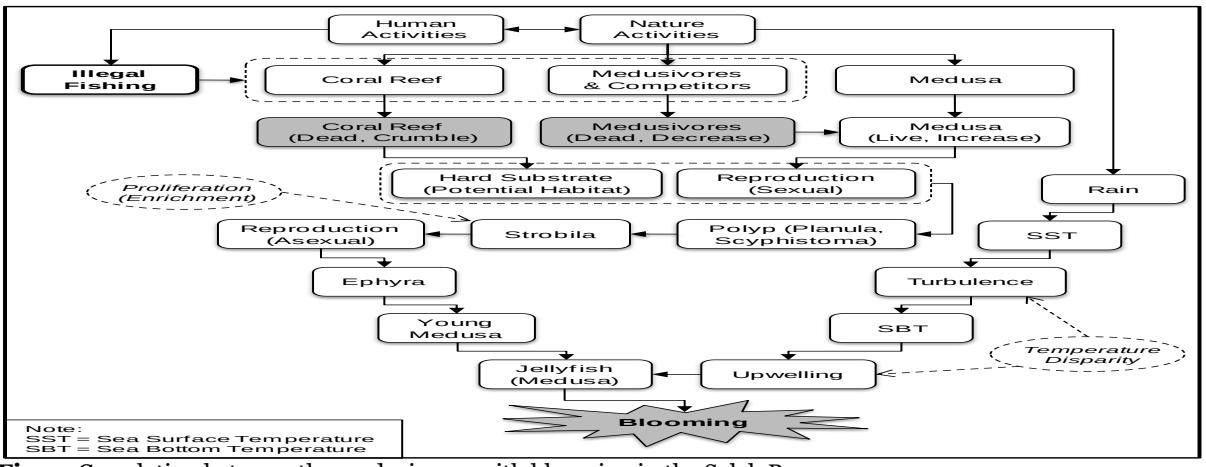

Fig. 5. Correlation between the medusivores with blooming in the Saleh Bay.

Rain

The number of rain days and rainfall are not supporting to increase water quality of the bay waters. In accordance with the Schmidt-Ferguson Classifications, so climate type in the coastal areas of Saleh Bay zone is appertain as "type F" namely climate type of "Dry". This climate type is caused the number of dry months (DM) reach the number of more than twice compared in wet months (WM).The rainy season is held twice a year namely January-March and November-December (Table 3).

During 2010-2013, rain day in region of Sumbawa District (include Saleh Bay) was around 90-169 days/year or average 134 days/year. Every month, rain fell ranged from 0 to 29 days or average 11-12 days/month. At the same period, average of monthly a rain day most in January i.e. 15-25 days (average 21-22 days) and the least number in June and August i.e. 0-2 day (1 day). The most of rain day as long as 2010-2013 scene on March 2013 that is 29 days (Table 4).

Result analysis between variable of scyphozoan yield (J) and variable of rain day (D) obtain an equation is J = 9,515 + 0,176 D, and values of r = 84.52%, R^2 = 71.43% and Adjusted R^2 = 57.14%. The equations meaningful, the more a rain day that occurring were increasing the scyphozoan yield. The value of "r" means the both of variables having very strong correlation. The value R^2 meaningful as variable a rain day that used in the equation is a dominant influence variation to production variable (28.57% equation determined by another variables that were not included in this study) and most of the data (71.43%) able to explain the equation. While the value of Adjusted R^2 described that sample capable of finding an answer that needed from the population, which means the sample has the high precision/accuracy level.

Whereas the regression analysis result with variable of scyphozoan yield (J) and rainfall variable (F) making a formula J = 9,489 + 0,130 F, and another values as r = 79.74%, R^2 = 63.58%, and Adjusted R^2 = 45.37%. The formula above meaningful, if occur of the rainfall therefore estimated the yield of scyphozoan will increase either. The value of r is meaningful that the both of variables having strong correlation. Value of R^2 means as rainfall variable is used in the equation a dominant influence variation of production variable (36.42% equation determined by other variables that is not included in this study) and 63.58% data capable to explain the formula. While the value of Adjusted R^2 described that sample capable of finding an answer that needed from the population, which means the sample has the enough precision/accuracy level.

The quality of Saleh Bay waters is fit for meet the needs of viability of scyphozoan *C. mastigophora*, especially for life and reproduction process. Caused of suitably of water condition so the production process can produce many strobila and ephyra (proliferation/enrichment) that grow become adult medusa in waters of Saleh Bay. Coincide with increment of rain day and rainfall number then scene of scyphozoan bloom on September to January. So to speak, blooming of scyphozoan in the Saleh Bay waters when the sea surface temperature (SST) moves down at the height of rain intensity (rain day and rainfall).

In the Saleh Bay waters, the blooming scene to begin with movement of temperature namely the water of sea surface flows down to the bottom of the sea (turbulence) that is aided by the wave energy. This movement of temperature transfers SST to the sea bottom with the result that sea bottom temperature (SBT) moves up to the sea surface. The movement of temperature from the sea bottom to the sea surface - also called with upwelling - carried out the planktons, the nutrition, the small fishes, the jellyfishes, etc., and also the schooling of scyphozoan *C. mastigophora* in the multitudes. So when finally the schooling of scyphozoan attained to the sea surface will it do blooming scene of scyphozoan.

Scyphozoan blooms in Saleh Bay get started on September each year. On that month, take its rise the rain which the SST changes to the lower level. Furthermore, occurring concurrently sober reality those are turbulence, upwelling and blooming.

Expansion of Shrimp Pond Area

International price and demand improvement of shrimp commodity in era 2000's has impacted development and expansion of shrimp pond area in through all Indonesia coastal. Initially, the shrimp pond area is jerry-built in low-land coastal by felling of mangrove forest until getting deforestation of mangrove. The cost benefit analysis result makes the point that the shrimp culture business can create big profit.

And so it is with brackishwater aquaculture in coastal zone of Saleh Bay is rapidly developed and uncontrolled, especially shrimp culture in the pond. During 2009-2012, shrimp pond area grew fast come out at 21.75%. Shrimp farming area in Plampang Sub-district grew 45.00% and Maronge Sub-district grew 40.12% (Table 5).

Correlation between scyphozoan yield (J) and shrimp pond area (P) agree with equation is J = -8,454 + 2,526 P. That equation means in each addition of shrimp pond area will increase jellyfish yield. One of the causes of the number of jellyfish yield is availability the scyphozoan in the waters in multitudes. It means, scyphozoan stock in the waters increased when the area of shrimp pond grow broad. Another values from simple regression analysis result namely values of r = 82.10%, R^2 = 67.40% and Adjusted R^2 = 51.10%. The value of r means the both of variables having very strong correlation. The value R^2 meaningful as variable a shrimp pond area used in the equation is a dominant influence variation of production variable (32.60% equation determined by other variables that are not included in this study)

and 7.40% data able to explain the equation. While the value of Adjusted R^2 described as much as 51.10% sample capable of finding an answer that needed from the population, which means the sample has the high precision/accuracy level.

All of the analysis results above indicating that increase in yield of the scyphozoan in the Saleh Bay are directly proportional to the increased extent of coastal land that was built for shrimp ponds area. Increased yield of jellyfish indicates the growing of amount or reserves of scyphozoan population in the waters. This means, a minimum of mangrove forest in consequence of shrimp ponds expansion area in jerry built had reduce photosynthesis process that have on decreasing of the production of oxygen (O_2) and leave behind carbon dioxide (CO_2) in multitudes. The carbon who is not absorbed will increase the air-temperature cap it all rise SST and SBT. This condition (high SBT) makes it worth a while the reproduction of scyphozoan so it will support to proliferation process. Finally did enrichment the polyp of scyphozoan more of the last years.

Yield of Medusivores

Other causes of scyphozoan bloom in the Saleh Bay thought to be caused by the yield of medusivores, should be called as the jellyfish predator is like fishes, turtles, birds, etc. The main medusivores in Saleh Bay waters are the red snapper (S), the grouper (G) and the rabbitfish (R).

Grouper tends to decrease the volume of yield since 2009 to 2012.The red snapper declined since 2009 until 2011 and then increased in 2011-2012. Meanwhile, the rabbitfish yield tends to increase since 2008 till 2012. If the trend is associated with the medusivores yield so the red snapper and the rabbitfish area likely to be a lever of the blooms of scyphozoan in Saleh Bay. (Table 6).

Meanwhile, medusivores influence to edible jellyfish yield (J) shown by equation is J = -494.91 + 2.61 S + 36.26 G + 38.12 R. This equation means, if more medusivores caught by the fishermen, the scyphozoan are caught by fishermen also increase in volume, and thus the stock/population of the scyphozoan in the Saleh Bay waters increase either. Value of Multi R = 99.73% showed a very strong correlation among all variables in that analyzed. While the value of R^2 = 99.47% is defined as all of the variables used in the call now medusivores a dominant influence variation of equation of scyphozoan yield variable (0:27% equation determined by other variables who are not included in this study) and almost all of data (99.47%) able to explain the equation. The value of Adjusted R^2 described as much as 97.88% sample capable of finding the answer that needed from the population, which means the sample has the high precision/accuracy level.

Yield increase of scyphozoan in Saleh Bay since 2009 in line with increase of medusivores yield especially the rabbitfish as a main medusivores. Shrinkage of stocks of medusivores the living around the coral reef had increasing the stock of adult scyphozoan. With many more the adult scyphozoan in the waters so many scyphozoan can do the reproduction, notably sexual reproduction. So it will tend potentially to multiply of zygote, polyp and planula until become the scyphistoma. Proliferation of scyphistoma will produce innumerable strobila that will be become ephyra in multitudes through asexual reproduction process that swimming in the waters as called as the young scyphozoan. Thereby, the existence of medusivores be direct cause for enrichment/proliferation of scyphozoan, in this case is bloom of scyphozoan in the Saleh Bay.

Conclusion

In Saleh Bay, living and growing a type of edible jellyfish from class Scyphozoa, species *Crambione mastigophora* MAAS 1903. Blooming of scyphozoan in Saleh Bay caused by disparity of temperature in the waters (SST and SBT), it is a trigger to strung out turbulence and upwelling in the waters. Blooming in the Saleh Bay always occurred from first to last of rainy season (September-January) each year.

Whereas the hydrological system (hydrological cycle), shrimp pond expansion, illegal fishing, over-fishing and catch-ability of scyphozoan fishing gear gave occasion to increase of the scyphozoan reproduction, proliferation and enrichment. As for the main medusivores in Saleh Bay waters are the grouper, the snapper, and the rabbit fish. The suggestion for minimizing of jellyfish blooming are (1) mangrove reforestation (in tidal zone and forest in up land), (2) coral reef transplantation (around Dangar Besar Island waters), (3) shrimp culture restriction (pond area expansion and carrying capacity), and (4) intensive sea patrol for watching and take action against of the actors of illegal fishing and destructive fishing (especially around the waters of the Dangar Besar, the Liang, the Ngali and the Rakit, and also in the another small islands).

Acknowledgement

Mr. Junaedi (Sumbawa Besar), Mr. Edi Susilo (Dompu), Mr. Sunardi Harjo (Mataram), Mr. Sasi Rustandi (Mataram), Mr. Jamhuri (Saleh Bay) and Mr. Supardi (Saleh Bay) gave us much information and data about edibe jellyfish fisheries in Saleh Bay waters. We greatly appreciate their assistance.

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