Species composition and density of sea cucumbers in Buru Regency, Maluku Province, Indonesia

Species composition and density of sea cucumbers in Buru Regency, Maluku Province, Indonesia

Mariyati[1], J Tresnati[2,4] and A Tuwo[3, 4]

[1] Fishery Resources Utilization Study Program, Faculty of Fisheries and Marine Science, Universitas Iqra Buru, Namlea, Buru Regency, Maluku Province, Indonesia
[2]Fisheries Department, Faculty of Marine Science and Fisheries, Universitas Hasanuddin, Makassar, Indonesia
[3]Marine Science Department, Faculty of Marine Science and Fisheries, Universitas Hasanuddin, Makassar, Indonesia
[4]Multitrophic Research Group, Universitas Hasanuddin, Makassar, Indonesia

E-mail: ambotuwo62@gmail.com

Abstract. Species composition and density are a feature of the biological adaptation of organisms to their habitat conditions. Composition and density need to be known because it is related to resource exploitation. Sea cucumber is a marine resource that is exploited intensively. Sea cucumbers are marine benthic organisms with important economic values found largely in Indonesian waters, especially in Kayeli Bay. Although sea cucumbers have high economic value, there was no information regarding the species and distribution of sea cucumbers in Kayeli Bay. This study aims to assess the species composition and density of sea cucumbers in Kayeli Bay, Buru Regency, Maluku Province, Indonesia. This study used method line transects and plots. Sampling was done at four stations with different habitat characteristics. Sampling was carried out at night when the tide was lowest. Sea cucumbers tend to be on the surface of the substrate at night. The species composition was presented in percentage, and density was presented in the number per unit space. The composition of sea cucumbers in Kayeli Bay was *Holothuria scabra* (25%), *H. scabra var. versicolor* (19%), *H. argus* (8%), *H. edulis* (12%), *H. atra* (3%), *H. vacabunda* (2%), *Actinopyga lecanora* (4%), *Bochasdchia marmorata* (7%), *Stichopus variegatus* (17%), *Thelenota ananas* (3%). Species composition and density of sea cucumber in the waters of Buru Regency are closely related to the bottom substrate. *H. scabra* and *S. variegatus* preferred muddy substrate. The density of *H. scabra* was 41 ± 9, and *S. variegatus* was 31 ± 8 per 25 m^2. More species of sea cucumber inhabit the sand substrate in the coastal area adjacent to the coral ecosystem with low density.

1. Introduction

Worldwide, there are 1762 species of sea cucumber [1], Most of these species live in Asia Pacific waters [2, 3]. Yamana et al. (2006). Previous research results indicate that the number of sea cucumber species in Asia Pacific waters is relatively high. In the waters of the South China Sea, the Sulu Sea, and Sulawesi Sea, 12 species were found divided into four families, namely *Colochirus robustus* (Family Cucumariidae), *Euapta godeffroyi*, *Synaptula lamperti*, *Synapta maculate* (Family Synaptidae), *Bohadscia argus*, *B. marmorata*, *Holothuria leucospilota*, *H. edulis*, *Pearsonothuria graffei* (Family Holothuriidae), *Stichopus vastus*, *Thelenota ananas*, and *T. anax* (Family Stichopodidae) [4]. In Indonesian waters, at least 54 species are found, namely *Actinopyga*

bannwarthi, *A. caerula*, *A. echinites*, *A. lecanora*, *A. mauritiana*, *A. miliaris*, *Bohadschia* sp.1, *Bohadschia* sp.2, *Bohadschia* sp. 3, *B. Bargus*, *B. marmorata*, *B. similis*, *B. subrubra*, *B. tenuissima*, *B. vitiensis*, *Holothuria cf. albiventer*, *H. atra*, *H. coluber*, *H. conusalba*, *H, edulis*, *H. excellens*, *H. fuscocinerea*, *H. fuscogilva*, *H. fuscopunctata*, *H. hilla*, *H. cf. imitans*, *H. impatiens*, *H. lesson*, *H. leucospilota*, *H. nobilis*, *H. ocellata*, *H. pardalis*, *H. perficax*, *H. rigida*, *H. scabra*, *H. scabra versicolor*, *H. similis*, *H. turriscelsa*, *H. vagabunda*, *H. vatiensis*, *H. whithei*, *P. graeffei*, *S. chloronotus*, *S. herrmanni*, *S. horrens*, *S. monotuberculatus*, *S. noctivagus*, *S. pseudohorrens*, *S. quadrifasciatus*, *S. variegatus*, *S. vastus*, *T. ananas*, *T. anax*, and *T. rubralineata* [5]. Fishers on Barrang Lompo Island, South Sulawesi process at least nine species of sea cucumber, namely: *Actinopyga sp*., *B. vitiensis*, *H. coluber*, *H. fuscogilva*, *H. fuscopunctata*, *H. scabra var. versicolor*, *Stichopus sp*., *Thelenota ananas*, and *T. anax* [6]. And fishermen in Lampung waters, Indonesia catch at least eight species at the intertidal site: *Actinopyga echinites*, *Actinopyga mauritiana*, *H. atra*, *H. impatiens*, *H. coluber*, *P. graeffei*, *S. ocellatus*, and *S. vastus* [7].

Indonesian waters are one of the natural habitats where sea cucumber has been used since hundreds of years ago and has placed Indonesia as the leading exporting country of Japan to the world [8]. In some cases, sea cucumber fishing is carried out in ways that are not environmentally friendly, such as the operation of bottom nets in muddy waters, which can cause habitat destruction and overfishing sea cucumber. The capture of sea cucumber, which is not environmentally friendly, is thought to be one of the causes of the decline in trepang production in Indonesia. This decline in production can be seen in Indonesia's trepang production, which began to decline in 1987 [9]. Other signs of overfishing are fishing areas farther and deeper into the sea [10], and the smaller size of the early maturity of the gonad sea cucumber [11].

The decline in the catch of sea cucumber is a common symptom that occurs in various waters in Indonesia. Signs of overfishing sea cucumber can also be seen in the decreasing size and quality of trepang [12-14], as well as fishers starting to catch and dry species that used to is an aquarium species [15]. If the overfishing continues, it can cause the loss of sea cucumber species of high economic value in Indonesian waters, especially in Buru Regency.

Buru Regency is one of the archipelagic regions of Maluku Province. The waters of the Buru Regency have productive marine ecosystems such as estuaries, mangroves, seagrass, and coral reefs. These four ecosystems have great fishery potential. This ecosystem is a natural habitat for sea cucumber. The species composition and density of sea cucumbers in the Buru Regency waters have never been studied. Species composition and density study are needed to determine the condition of the presence of a species in certain waters. This study aims to identify species and densities in the waters of Buru Regency, Maluku Province, Indonesia.

2. Materials and methods

The study was done in the waters of the Buru Regency. The research location was located in the intertidal area of Waplau District, Namlea District, Waeapo District, and Batabual District. Observation stations were determined by purposive sampling [16] based on the habitat characteristics in the intertidal area. The species composition and density of sea cucumber were observed in four habitat characteristics, namely: (1) Seagrass sand substrate in coastal areas adjacent to coral reefs (Station 1), (2) Sandy substrate overgrown with seagrass near the mouth of Kayeli Bay (estuary).) (Station 2), (3) The muddy sand substrate near the river mouth, which is overgrown with seagrass near the mangrove forest in Kayeli Bay (Station 3), and (4) Coral reef area (Station 4). At the station, three observation sub-stations were made as replications (Figure 1).

Sampling was carried out at night during the lowest tide until just before high tide. Sea cucumber is a nocturnal organism, which is active at night so that it is on the surface of the substrate at night. Data collection was done at the station using the transect method [17] using a quadrant (plot) measuring 5 x 5 m. Repeat position at each station is perpendicular to the coastline outwards.

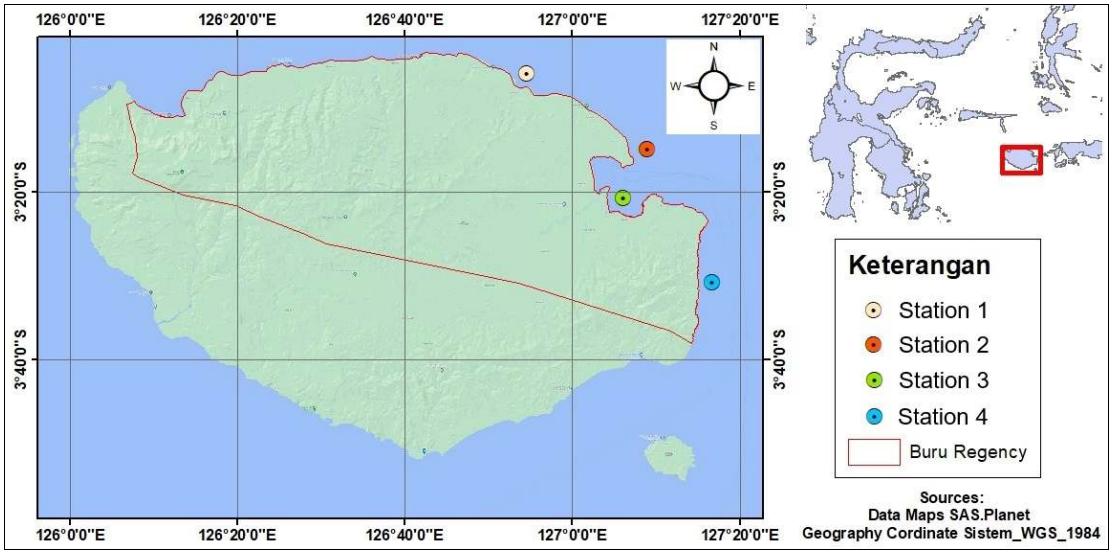

Figure 1. Research stations in the intertidal area of Waplau District (Station 1), Namlea District (Station 2), Waeapo District (Station 3), and Batabual District (Station 3) in Buru Regency, Maluku Province, Indonesia.

The number of sea cucumber found in each sub-station is counted for each species. Species that cannot be identified directly in the field are taken and then stored in labeled plastic bags, then preserved with 70% alcohol, and taken to the laboratory for identification.

The composition of the sea cucumber species is calculated according to the equation:

$$Ci = \frac{ni}{N} \; x \; 100\%$$

where Ci are the percentage of species to-i, ni was the number of individuals at certain species to-i, N was the number of individuals in all species [18].

Kepadatan sea cucumber dihitung sesuai persamaan:

$$X = \frac{\sum_{i=1}^{s} xi}{n}$$

where X was the average number of individuals on the observation n times, ni was number of observations to-i, n was the number of observations [19].

3. Results

3.1. Species composition

During the study, 589 individuals were found consisting of 10 species, namely *A. lecanora*, *B. marmorata*, *H. argus*, *H. atra*, *H. Edulis*, *H. scabra*, *H. scabra var. versicolor*, *H. vacabunda*, *S. variegatus*, and *T. ananas*. The most significant percentage of the species was *H. scabra*, and the smallest was *H. Vacabunda*. The composition of sea cucumbers in Kayeli Bay was *H. scabra* (25%), *H. scabra var. versicolor* (19%), *H. argus* (8%), *H. edulis* (12%), *H. atra* (3%), *H. vacabunda* (2%), *A. lecanora* (4%), *B. marmorata* (7%), *S. variegatus* (17%), *T. ananas* (3%) (Figure 2).

3.2. Density

Density varies widely among species and habitat types (Table 1). *H. scabra* and *H. scabra var. versicolor* were very abundant in waters with a muddy sand substrate near the river's mouth, which is overgrown with seagrass near the mangrove forests (Station 3). *H. scabra* was also relatively abundant in sandy, seagrass-covered waters near the mouth of Kayeli Bay (estuary) (Station 2). *H. atra* (Figure

4a) was found in sandy substrate waters with seagrass-covered in coastal areas near coral reefs and far from estuary areas. *B. marmorata* (Figure 4b) and other species are generally found in all water types, except in estuaries or estuaries.

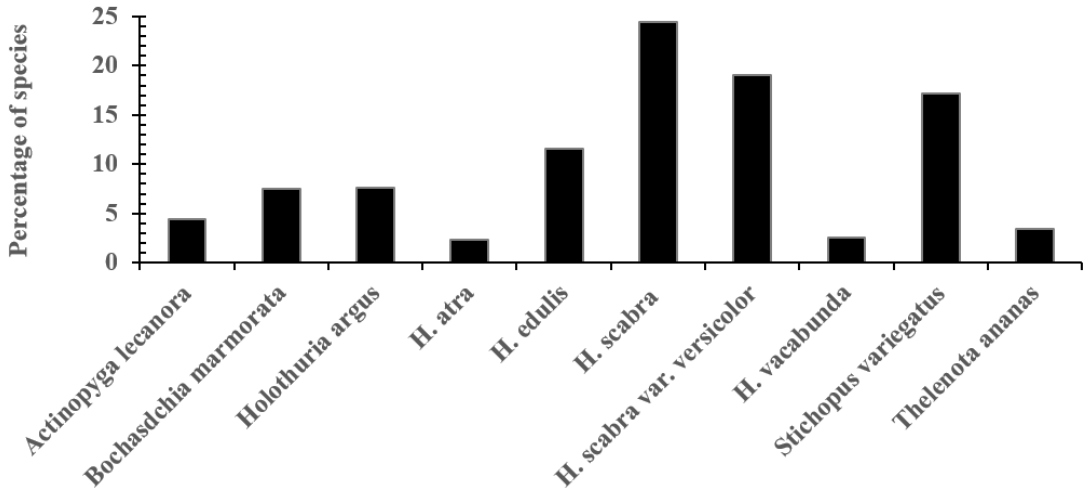

Figure 2. Persentage of species of sea cucumber in Buru Regency, Maluku Province, Indonesia.

Table 1. The density of sea cucumber per 25 m^2 at each station in Buru Regency, Maluku Province, Indonesia.

	Station 1. Waplau				Station 2. Namlea				Station 3. Waeapo				Station 4. Batabual			
	A	B	C	Mean ± STD	A	B	C	Mean ± STD	A	B	C	Mean ± STD	A	B	C	Mean ± STD
Actinopyga lecanora	3	12	0	5.00±6.24	0	8	0	2.67±4.62	0	0	0	0.00±0.00	0	3	0	1.00±1.73
Bochasdchia marmorata	16	9	0	8.33±8.02	0	12	0	4.00±6.93	0	0	0	0.00±0.00	0	4	3	2.33±2.08
Holothuria argus	10	15	0	8.33±7.64	6	14	0	6.67±7.02	0	0	0	0.00±0.00	0	0	0	0.00±0.00
H. atra	9	6	0	5.00±4.58	0	0	0	0.00±0.00	0	0	0	0.00±0.00	0	0	0	0.00±0.00
H. edulis	21	18	0	13.00±11.36	0	17	0	5.67±9.81	0	0	0	0.00±0.00	9	3	0	4.00±4.58
H. scabra	0	0	0	0.00±0.00	22	0	0	7.33±12.70	51	33	38	40.67±9.29	0	0	0	0.00±0.00
H. scabra var. versicolor	0	0	0	0.00±0.00	0	0	0	0.00±0.00	47	30	35	37.33±8.74	0	0	0	0.00±0.00
H. vacabunda	0	0	0	0.00±0.00	0	9	5	4.67±4.51	0	0	0	0.00±0.00	0	0	0	0.00±0.00
Stichopus variegatus	0	3	3	2.00±1.73	0	0	3	1.00±1.73	23	31	38	30.67±7.51	0	0	0	0.00±0.00
Thelenota ananas	0	8	0	2.67±4.62	0	7	5	4.00±3.61	0	0	0	0.00±0.00	0	0	0	0.00±0.00

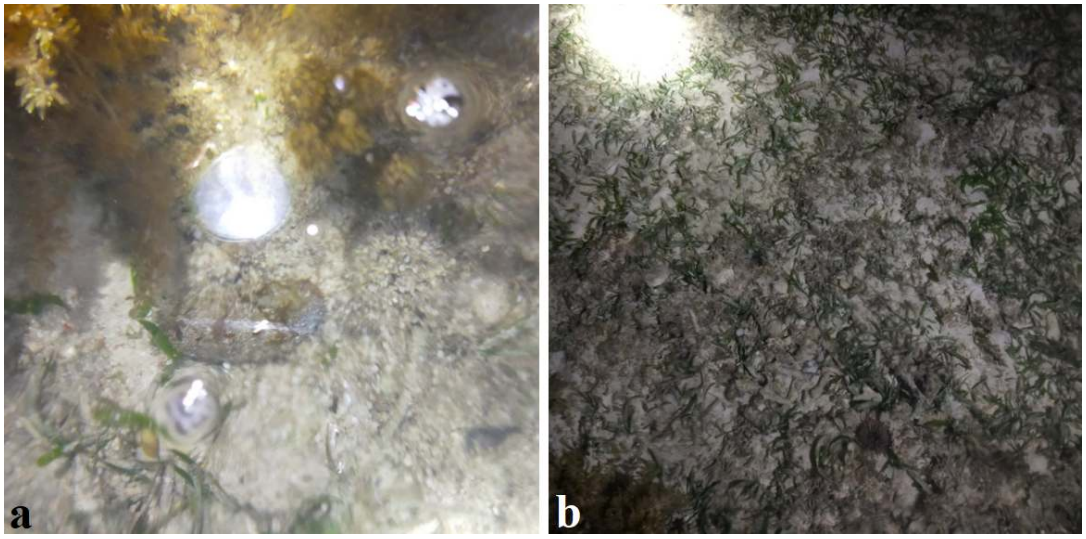

Figure 3. *Holothuria scabra* (a) in its natural habitat (b) in the waters of Buru Regency, Maluku Province, Indonesia.

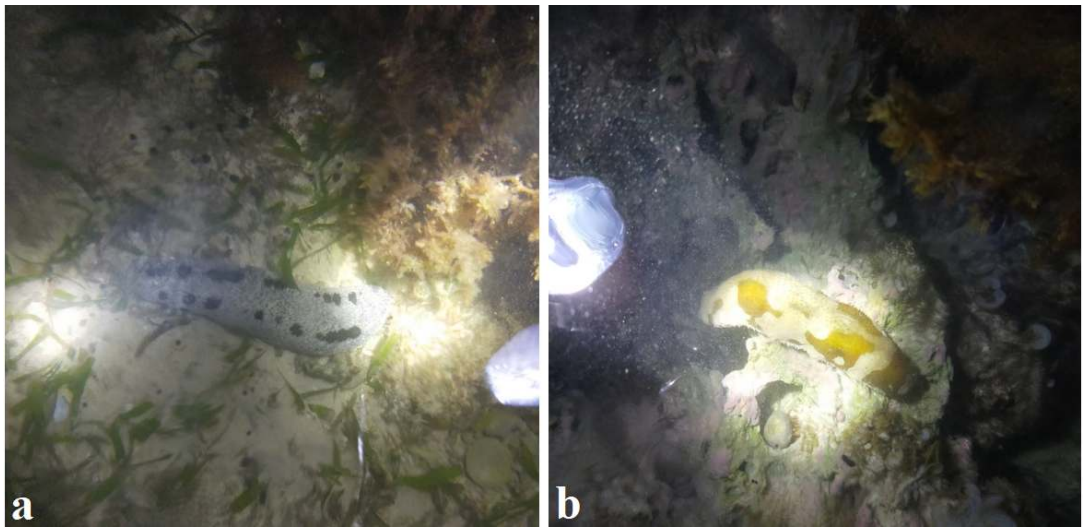

Figure 4. *Holothuria atra* (a) and *Bochasdchia marmorata* (b) in their natural habitat in the waters of Buru Regency, Maluku Province, Indonesia.

4. Discussion

The species composition describes the species richness found in waters [18]. All species of sea cucumber found during the study belonged to the Aspidochirotida order, which is a tropical species of Bakus [20], and is of crucial economic value.

Holothuria scabra, which dominates the estuary area in Kayeli Bay, indicates that this species is a species that can tolerate fluctuating salinity. Holothura scabra is a species most often found in estuarine waters and muddy or sandy coastal waters close to estuarine areas. Holothura scabra can tolerate a decrease in salinity to levels close to the concentration of body fluids [21].

The presence of sea cucumber species is closely related to the bottom substrate. Sea cucumber is a macrodetritus that likes sandy or muddy waters covered with seagrass [22]. Sea cucumber is a benthic

organism that engulfs living microorganisms and organic materials attached to sand or mud. The existence of sea cucumber in waters in the bottom water ecosystem is vital because it is bioremediation [23] that consumes various organic materials that fall to the bottom. Sea cucumber intestines are sand, mud, delicate pieces of coral, and other animal shells or skeletons.

The high *H. Scabra* density was thought to be related to limiting factors. In transitional or ecotone ecosystems, such as estuaries, not many species can permanently live; only species with a high tolerance for environmental changes can survive. The combination of the influence of seawater and fresh water on estuary waters, for example, bays, which are connected to the sea, will result in fewer communities of organisms with high density [24]. The condition of the muddy sand substrate overgrown with seagrass near the mangrove forests in Kayeli Bay is an area that is very suitable for the life of *H. scabra*. Kayeli Bay is very suitable for developing *H. scabra* cultivation, which has a very high salinity tolerance range [25]. Better adaptability makes *H. scabra* the most widely cultivated species [8].

H. vacabunda tends to occupy coastal areas close to land influences, but sea influences are still dominant. In this study, *H. vacabunda* was only found in coastal areas with a sandy substrate overgrown with seagrass near the mouth of Kayeli Bay.

H. atra tends to occupy waters with a sandy substrate overgrown with seagrass in coastal areas close to coral reefs and far from the influence of rivers (Station 1). The results of previous research also show that *H. atra* likes delicate sandy areas that are overgrown with seagrass [26, 27].

A. lecanora, *B. marmorata*, and *H. edulis* have relatively high densities at stations dominated by the influence of the sea or in coral reef areas. These three species are thought to like waters that do not experience physical stress. In populations that do not experience physical stress, population density tends to be regulated by biological factors, such as food availability and competition[28].

Sea cucumber density is closely related to the bottom substrate. The muddy sand substrate near the river mouth where seagrass is growing near the mangrove forest (Station 3) is very popular with H. Scabra because it is thought to be richer in organic matter and relatively calm because it is in Kayeli Bay. H. Scabra likes waters that are rich in organic and protected matter.

The low density of sea cucumber in coral areas (Stasium 4) is thought to be related to hydrodynamic conditions. The large waves cause organic matter and fine sediment to be carried by water to other areas, causing larger sediment grains with low organic matter content. The low organic matter content and the size of coarse to very coarse sand at the bottom of the waters are less favored by sea cucumber. The grain size of the bottom substrate is a transparent barrier to the spread of macrofauna organisms in the intertidal area [29].

The low density of sea cucumber in the coral area (Station 4) is also thought to be related to the condition of the coral reefs at the station that has been damaged due to fishing gear that is not environmentally friendly. Fishing that is not environmentally friendly causes the sea cucumber habitat to be disturbed. The fishing gear that is not environmentally friendly can cause habitat destruction and reduce the diversity of sea cucumber species [30].

5. Conclusion

The type of substrate dramatically influences the species composition and density of sea cucumber in the waters of Buru Regency. The muddy substrate has a low percentage of species composition with a high density. H. scabra and S. variegatus highly favored the muddy substrate. On muddy substrates, the average density of H. scabra can be as high as 41 ± 9 per 25m2. S. variegatus can reach 31 ± 8. Some species characterize the type of sand substrate in areas directly facing coral ecosystems or in coral ecosystems with low density.

Acknowledgment

The author would like to thank all those who have helped in carrying out research, both in the field and in the laboratory, especially Risal Aprianto for improving the research map.

References

[1] WoRMS 2014 World register of marine species. In: *WoRMS Taxon list,* (Belgium: WoRMS)
[2] Du H, Bao Z, Hou R, Wang S, Su H, Yan J, Tian M, Li Y, Wei W and Lu W 2012 Transcriptome sequencing and characterization for the sea cucumber Apostichopus japonicus (Selenka, 1867) *PloS one* **7** e33311
[3] Yamana Y, Hamano T and Miki K 2006 Distribution of the Japanese sea cucumber Apostichopus japonicus in the intertidal zone of Hirao Bay, Eastern Yamaguchi Pref., Japan: suitable environmental factors for juvenile habitats *Journal of National Fisheries University (Japan)* **53** 111-20
[4] Woo S P, Yasin Z, Ismail S H and Tan S H 2013 The distribution and diversity of sea cucumbers in the coral reefs of the South China Sea, Sulu Sea and Sulawesi Sea *Deep Sea Research Part II: Topical Studies in Oceanography* **96** 13-8
[5] Setyastuti A and Purwati P 2015 Species list of Indonesian trepang *SPC Beche-de-mer Information Bulletin* **35** 19-25
[6] Conand C and Tuwo A 1996 Commercial holothurians in South Sulawesi, Indonesia: fisheries and mariculture *SPC Beche-de-mer Information Bulletin* 17-44
[7] Setyastuti A, Wirawati I and Iswari M Y 2018 Identification and distribution of sea cucumber exploited in Lampung, Indonesia *Biodiversitas* **19** 726-32
[8] Tuwo A 2005 Status of sea cucumber fisheries and farming in Indonesia *FAO fisheries Technical Paper* 49-56
[9] Suwignyo S, Widigdo B, Wardiatno Y and Krisanti M 2005 *Aquatic invertebrates* vol II: Penerbit Penebar Swadaya, Jakarta. 204 p. [in Indonesia])
[10] Yusuf S, Tuwo A, Tresnati J, Moore A M and Conand C 2017 Teripang fishing activities at Barang Lompo Island, Sulawesi, Indonesia: An update 20 years after a visit in 1996 *SPC Beche-de-mer Information Bulletin* **37** 99-102
[11] Yanti A, Tresnati J, Yasir I, Rahmani P Y, Aprianto R and Tuwo A 2020 Size at the maturity of sea cucumber Holothuria scabra. Is it an overfishing sign in Wallacea Region? In: *IOP Conference Series: Earth and Environmental Science. 473: 012056. doi:10.1088/1755-1315/473/1/012056*: IOP Publishing) p 012056
[12] Amir N, Aprianto R, Tuwo A and Tresnati J 2020 Processing and quality characteristics sea cucumber Bohadschia vitiensis at Kambuno Island in Sembilan Islands, Bone Gulf, South Sulawesi, Indonesia. In: *IOP Conference Series: Earth and Environmental Science, 564: 012047. doi:10.1088/1755-1315/564/1/012047*: IOP Publishing) p 012047
[13] Aprianto R, Amir N, Tresnati J and Tuwo A 2020 Bycatch sea cucumber Holothuria scabra processing and the quality characteristics. In: *IOP Conference Series: Earth and Environmental Science. 473:012001. doi:10.1088/1755-1315/473/1/012001*: IOP Publishing) p 012001
[14] Aprianto R, Amir N, Tresnati J, Tuwo A and Nakajima M 2019 Economically important sea cucumber processing techniques in South Sulawesi, Indonesia. In: *IOP Conference Series: Earth and Environmental Science. 370: 012089. doi:10.1088/1755-1315/370/1/012082*: IOP Publishing) p 012082
[15] Yusuf S, Tuwo A, Tresnati J and Conand C 2017 An aquarium trade dendrochirotid holothurian, *Pseudocolochirus* sp. processed into teripang in Sulawesi, Indonesia *SPC Beche-de-mer Information Bulletin* 116
[16] Gillison A N 1985 Transects or Gradsects in *Journal of Environmental Managemenl* **20** 103-27
[17] Loya Y 1978 *Plotless and transect methods* (Paris: UNESCO, Paris. p. 197-217)
[18] Burges W G H R and Huniziker R E 1990 *Atlas of Marine Akuarium Fishes Second Edition* (New Jersey, United States of America. 768 p.: T.F.H. Publication, Inc. New Jersey, United States of America. 768 p)
[19] Dahuri R, Putera N S, Zairion and Sulistino 1993 Methods and Techniques for Analysis of Aquatic Biota. (Bogor. 6 p. [In Indonesia]: Pusat Penelitian Lingkungan Hidup, Lembaga Penelitian Institut Pertanian Bogor)

[20] Bakus G J 1973 *Biology and Geology of Coral Reefs,* ed O A Jones and R Endean (New York: Academic Press) pp 325-67
[21] Tuwo A, Yasir I, Aprianto R, Yanti A, Bestari A D and Tresnati J 2020 Low salinity reduces survival rate of a commercially important sea cucumber (Sandfish: Holothuria scabra). In: *IOP Conference Series: Earth and Environmental Science*: IOP Publishing) p 012088
[22] Sutaman S 1993 *Practical Instructions for Cultivating Sea Cucumbers* (Yogyakarta. 68 p. [In Indonesia]: Kanisius)
[23] Chary K, Aubin J, Sadoul B, Fiandrino A, Covès D and Callier M D 2020 Integrated multi-trophic aquaculture of red drum (Sciaenops ocellatus) and sea cucumber (Holothuria scabra): assessing bioremediation and life-cycle impacts *Aquaculture* **516** 734621
[24] Supriharyono 2020 *Conservation and Management of Natural Resources in Tropical Coastal Areas* (Jakarta. 118 p: P.T. Gramedia Pustaka Utama. [In Indonesia])
[25] Tuwo A and Tresnati J 2015 *Echinoderm Aquaculture,* ed N P Brown and S D Eddy pp 331-52
[26] Mercier A, Battaglene S C and Hamel J-F 2000 Settlement preferences and early migration of the tropical sea cucumber Holothuria scabra *Journal of Experimental Marine Biology and Ecology* **249** 89-110
[27] Hair C, Mills D J, McIntyre R and Southgate P C 2016 Optimising methods for community-based sea cucumber ranching: experimental releases of cultured juvenile Holothuria scabra into seagrass meadows in Papua New Guinea *Aquaculture Reports* **3** 198-208
[28] Odum E P 1993 *Fundamentals of ecology*: Gadjah Mada University Press. Yogyakarta. 697. [In Indonesia])
[29] Nybakken J W 1992 Marine Biology: An Ecological Approach *Subarjo. PT. Gramedia Pustaka Utama. Jakarta. 459 p.* [In Indonesia]
[30] Gamboa R, Gomez A L and Nievales M F 2005 The status of sea cucumber fishery and mariculture in the Philippines *FAO Fisheries Technical Paper* 69-78