PAPER • OPEN ACCESS

Dietary preference of key microhabitat *Diadema setosum*: a step towards holistic Banggai cardinalfish conservation

To cite this article: A Moore *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **235** 012054

IOP Conf. Series: Earth and Environmental Science **235** (2019) 012054 doi:10.1088/1755-1315/235/1/012054

Dietary preference of key microhabitat *Diadema setosum*: a step towards holistic Banggai cardinalfish conservation

A Moore [1,5], S Ndobe [2], R Ambo-Rappe[3], J Jompa[3,4,5] I Yasir [3,6]

[1] Doctoral Program, Faculty of Marine Science and Fisheries, Universitas Hasanuddin, Makassar, Indonesia
[2] Aquaculture Study Program, Faculty of Animal Husbandry and Fisheries, Tadulako University, Palu, Indonesia
[3] Marine Science Department, Faculty of Marine Science and Fisheries, Universitas Hasanuddin, Makassar, Indonesia
[4] Post-Graduate School, Universitas Hasanuddin, Makassar, Indonesia
[5] Marine Resilience and Sustainable Development Centre of Excellence, Faculty of Marine Science and Fisheries, Universitas Hasanuddin, Makassar, Indonesia
[6] Center of Excellence for Development and Utilization of Seaweed, Universitas Hasanuddin, Makassar, Indonesia

E-mail: *jjompa@unhas.ac.id*

Abstract. The sea urchins *Diadema setosum* and *D. savignyi* are key symbionts of the Banggai cardinalfish *Pterapogon kauderni*, a species of global and national conservation concern. There is growing interest in *Diadema* propagation for conservation and human consumption; however little is known about the dietary preferences of Indo Pacific *Diadema* species. This study explored the feeding preference of *Diadema setosum* offered a choice of two macroalgae (*Ulva reticulata*, *Gracilaria* sp.) and two seagrasses (*Thalassia hemprichii, Enhalus acoroides*). Portions (5g) of the four feeds were attached to the corners of rectangular plastic cages and one *D. setosum* released in the centre of each cage. Uneaten feed was weighed after 24 hours. This procedure was repeated for 5 days with 8 replicates. Mean daily feed consumption/urchin was 4.31g,. All urchins ate a varied diet comprising all four feed types, with a significant preference ($p < 0.01$) for macroalgae (on average 80%). Our results point to an important role of *D. setosum* in macroalgal control; however this urchin might graze on cultivated seaweeds. Further research avenues include the use of macroalgae in prepared feeds for *Diadema* culture, including in the context of *P. kauderni* microhabitat rehabilitation.

1. Introduction

Sea urchins of the genus *Diadema* play important ecological roles as herbivores [1,2,3] and as symbionts of other organisms [4]. In particular, Diadematid urchins are key symbionts of the Banggai cardinalfish *Pterapogon kauderni* [5,6,7,8], in particular *Diadema setosum* and *D. savignyi* [9]. A species of global and national conservation concern, *P. kauderni* is threatened by overexploitation and habitat degradation [8,9,10,11,12,13,14]. The Banggai cardinalfish is one of four conservation management priorities of the recently declared Banggai Dalaka MPA [15], which comprises over 90% of endemic *P. kauderni* populations and habitat [7,15]. While sea anemones are considered important as microhabitat for juvenile *P. kauderni* and hard corals provide habitat for many adult *P. kauderni,* all over half of all *P.*

kauderni (including all age/size classes) associate with *Diadema* urchins as microhabitat [6,7,8,9.12.13,16,17]. However, at many *P. kauderni* population sites within the MPA, the abundance of *Diadema* urchins has declined drastically (by an order of magnitude) over the past decade, largely due to overharvesting for human consumption [12,13,14,15].

Restoring *Diadema* populations is a key factor in rebuilding *P. kauderni* populations [6,9,12,13,14,15]. However, although *D. setosum* is known to eat a variety of seagrasses and algae [18,19], there are still many gaps in our knowledge regarding the ecology, and in particular the dietary preference, of this Indo Pacific *Diadema* species.

Flocks of *D. setosum* feeding on a seasonal bloom of *Ulva reticulata* were observed on the reef flat of Barrangcadi Island, Spermonde Archipelago, while collecting seagrasses as feed for *D. setosum* kept in the laboratory during a study on the symbiosis between *P. kauderni* and *Diadema* urchins and the possible effects of climate change on these organisms. This observation prompted opportunistic harvesting of *Ulva*, which proved palatable as an alternative feed for *D. setosum*, as did several other macroalgae entangled in the *Ulva* thalli collected. However these qualitative (unquantified) field and laboratory observations of *D. setosum* feeding on macroalgae (seaweeds) and seagrasses did not provide information on feeding rates or preference. To further elucidate *D. setosum* feeding patterns and preferences, this study used a quantitative experimental approach to explore the dietary preferences of *Diadema setosum* offered a choice of four feeds, all of which had been observed to be palatable to (consumed by) *D. setosum*, comprising two macroalgae (Ulva *reticulata* and *Gracilaria* sp.) and two seagrasses (*Thalassia hemprichii* and *Enhalus acoroides*).

2. Methods

The experimental research (feed preference trials) took place at the Multitrophic Research Group (MTRG) Laboratory of the Center of Excellence for Development and Utilization of Seaweed (CEDUS), Universitas Hasanuddin, Makassar, Indonesia. With the exception of *Gracilaria* sp., which was sourced from Ujung Baji village in the Takalar District of South Sulawesi, experimental organisms were collected from the Spermonde Archipelago, South Sulawesi, Indonesia. *Diadema setosum* sea urchins (test diameter close to 5 cm) were obtained from Barranglompo Island. The two seagrass species *Thalassia hemprichii* and *Enhalus acoroides* were collected from seagrass meadows on the east side of Barranglompo Island, Spermonde Archipelago The seaweed *Ulva reticulata* was collected from the reef flat of Barangcadi Island, Spermonde Archipelago. Eight *D. setosum* urchins were acclimated to conditions similar to the feed preference trial tank for 5 days. Seaweeds and seagrasses were kept in aerated seawater, confined to floating cages in a tank similar to the trial tank.

The trial comprised eight experimental units (replicates), each consisting of a rectangular plastic cage (50 x 30cm2, depth 15cm), floated in a 100cm x 200cm tank filled with clean, filtered seawater (Figure 1). To prevent the egress of feed, the exterior of each cage was covered with fine mesh netting. An aliquot of 5g of each feed (digital scales, precision 0.01g) was attached to each unit using plastic coated ties. The position of the feeds within each unit on each day was random. One *Diadema setosum* was carefully placed in the centre of each unit (cage). Initial action was observed and recorded (photographed). After 24 hours the feed remaining in each unit was removed and weighed using the same scales. The process was repeated for 5 x 24 hour cycles, providing 5 observations for each of the 8 replicates (cage and individual *D. setosum*).

The difference between initial (5g) and final weight of each feed was calculated for each trial and considered to have been consumed by the urchin. For each replicate (urchin) the mean weight of each feed consumed was calculated by adding the total weight consumed over 5 days and dividing by 5. The mean, standard deviation, and standard error were calculated using the mean daily values for each of the 8 replicates (cage/urchin).

The linear model (Lm) function in R version 3.4.2 (implemented in the RStudio Version 1.1.456 environment) was applied to evaluate the effect of day and urchin on diet composition. Analysis of variance (ANOVA) was implemented to evaluate the significance level of the difference in feed weight consumed between the feed types at 95% and 99% confidence levels ($\alpha = 0.05$ and $\alpha = 0.01$).

IOP Conf. Series: Earth and Environmental Science **235** (2019) 012054 doi:10.1088/1755-1315/235/1/012054

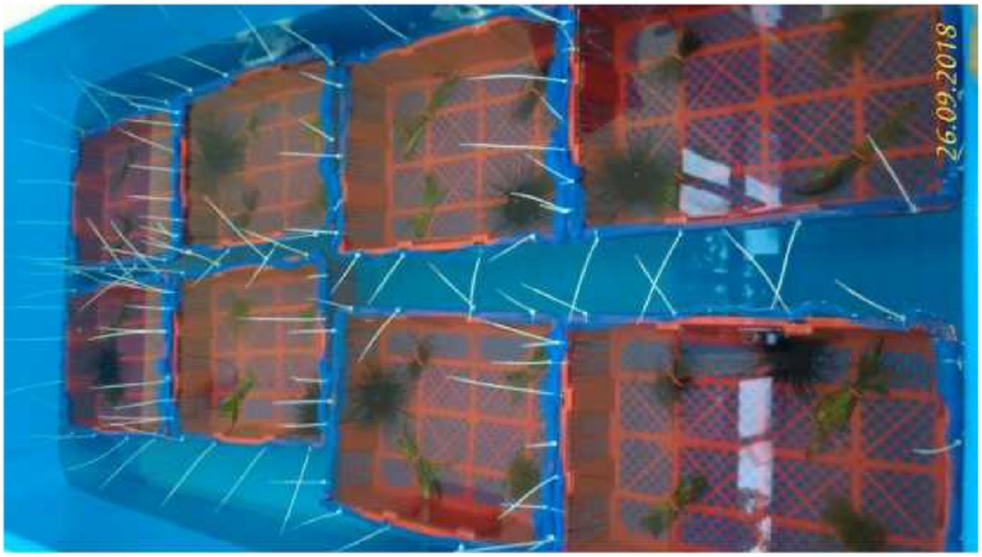

Figure 1. Experimental set-up on Day 1: one *D. setosum* was released in the centre of each cage (experimental unit) containing four feeds (*Thalassia hemprichii, Enhalus acoroides, Ulva reticulata*, *Gracilaria* sp.) attached to the corners of each cage in a random sequence

3. Results and Discussion

The mean daily feed consumption (N = 8) was 4.45 g/urchin/day (Table 1). There was, however, considerable variation in mean feed volume (wet weight) and composition between replicates (urchins) and between days, as reflected in the standard deviation (SD) values.

Table 1. Mean daily diet composition and volume of 8 *Diadema setosum* over 5 days

Replicate (urchin)	Mean daily feed volume (g/day)				
	Gracilaria	*Ulva*	*Thalassia*	*Enhalus*	Total
1	1.45	0.44	0.32	0.32	2.54
2	3.53	0.90	0.76	0.68	5.87
3	1.30	0.98	0.19	0.58	3.06
4	4.56	1.43	0.53	0.85	7.37
5	3.25	0.78	0.38	0.65	5.05
6	3.21	1.32	0.56	0.42	5.51
7	1.28	0.71	0.42	0.21	2.61
8	2.20	1.15	0.08	0.15	3.58
Average	2.60	0.96	0.41	0.48	4.45
SD	1.22	0.33	0.22	0.25	1.76

The overall mean feed consumed (Figure 2) reflects the predominance of macroalgae in the diet of most urchins on most days. The preference for macroalgae, which comprised on average 80.1% of diet by weight, was significant at the 99% confidence level ($p < 0.01$). In terms of percentage, *Gracilaria* sp. accounted for 58.4% of all feed consumed, followed by *Ulva reticulata* (21.7%), while the two seagrass species each contributed around 10% (*E. acoroides* 10.8% and *T. hemprichii* 9.1%) by weight.

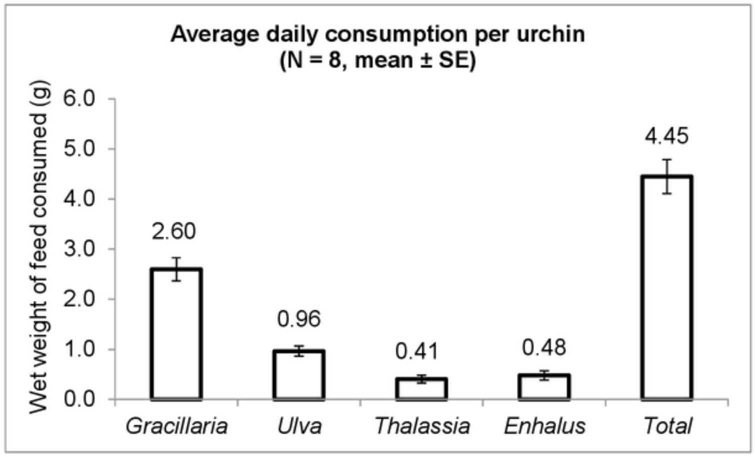

Figure 2. Feed consumption of *Diadema setosum* during the 5 day trial (g/urchin/day)

There was some variation in mean feed volume (wet weight) and composition between days, as reflected in the standard error (SE) values in Figure 2. Each urchin tended to vary its diet between days, as can be seen in the boxplots for consumption of the four feed types (Figure 3). Figure 4 shows the initial choices of two out of the 8 urchins on day 2, one immediately feeding on *Gracilaria* sp. the other on *T. hemprichii*.

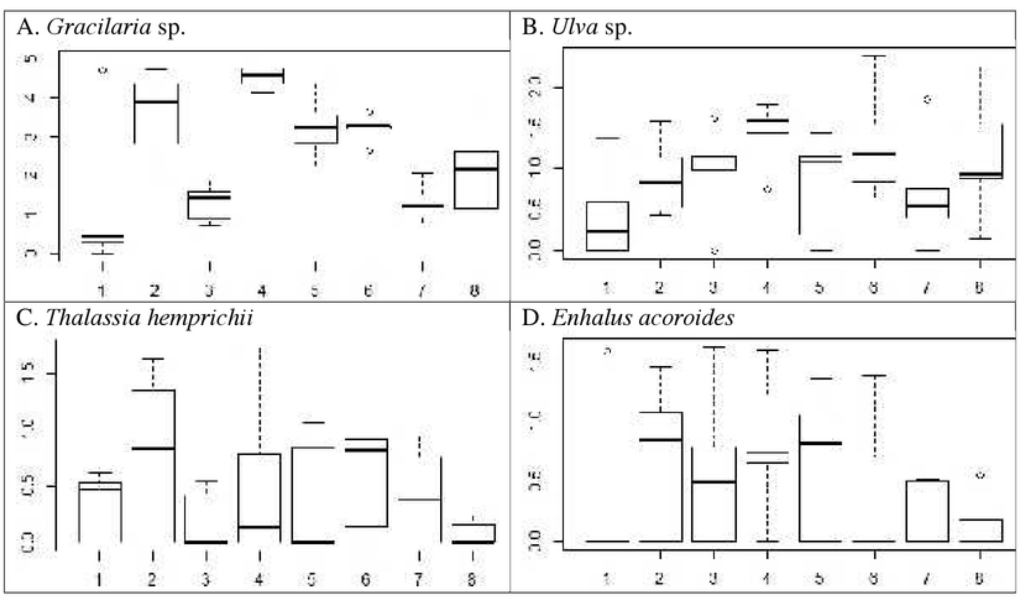

Figure 3. Box plots of four feed types consumed by each of the 8 urchins over 5 days (in grams/urchin/day). Vertical axes: weight consumed (g); horizontal axes: urchin (replicate) number; box: interquartile range; bold lines: median values, whiskers: most extreme values not more than 1.5 x interquartile range outside the box; circles: extreme outlier values.

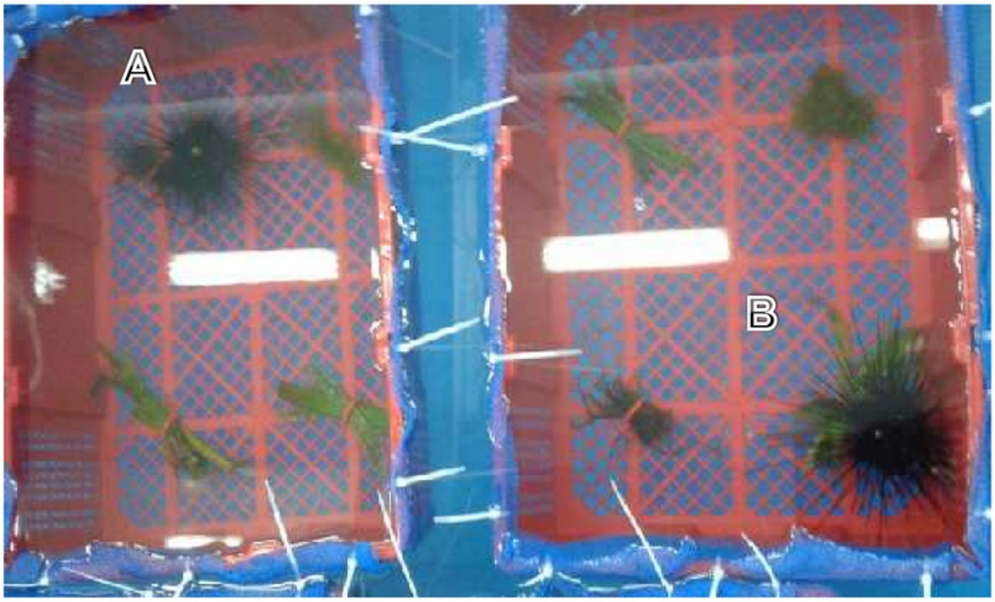

Figure 4. Initial feed choices of two urchins on day 2; A. *Gracilaria* sp; B. *T. hemprichii*

3.1. Feeding rate

The comparison between our data and that from other studies in which feeding rates of *D. setosum* and/or related species are reported (Table 2) indicates that the urchins in our trials had a highly variable (0.45-8.74 g/day) but on average relatively high daily feed consumption compared to the only published study found from Indonesia [19] and a study in Kenya [20], but much lower than the rates reported from Fiji [18]. It is interesting to note that [19] found that *D. setosum* which had been fasted before trials had considerably higher feeding rates than non-fasted individuals in the laboratory but that under field conditions (in the wild) there was no significant difference.

Table 2. Comparison of some published feeding rates of Indo-Pacific *Diadema* urchins

Species	Mean rate (g/day)	Feed type	Remarks	Reference
D. setosum	4.45	algae and seagrass	laboratory (range 0.45-8.74 g/day)	This study
D. setosum	2.32	unknown (multispecies seagrass bed)	Barranglompo Island, field conditions (fasted/non-fasted)	[19]
	≈ 3	7 species of seagrass	laboratory; fasted	
	< 0.5		laboratory; non-fasted	
	1.52		laboratory (mean, all trials)	
D. setosum	19.6	algae and seagrasses	Fiji, field conditions	[18]
D. savignyi	24.8	algae and seagrasses		
D. setosum	1.1	herbivory	Kenya, field conditions	[20]
D. savignyi	0.4	herbivory		

IOP Conf. Series: Earth and Environmental Science **235** (2019) 012054 doi:10.1088/1755-1315/235/1/012054

3.2. Diet composition and feeding preference

As in this study, Diadema urchins in Fiji [18] were found to favour macroalgae rather than seagrasses, and to select a varied diet rather than concentrating their efforts on one favoured food species. The macroalgae and one seagrass species, in order of preference, were: *Codium geppiorum*; *Hydroclathrus clathratus*; green filamentous algae; *Padina pavonica*; *Halophila ovalis*; brown filamentous algae; *Amphiroa foliacea*; *Caulerpa racemosa*; and *Galaxaura marginata*.

A study from Zanzibar [21] reports the following order of feed preference for *D. setosum*: *Galaxaura oblongata, Padina gymnospora, Halymenia venusta, Dictyota* sp., *Eucheuma striatum, Gracilaria crassa,* and *Cystoseira trinodis*. The authors also note a "sustained avoidance" of the macroalgae *Sargassum* sp. and *Turbinaria* sp. even after prolonged fasting with no other feed choices. *Sargassum* sp. and *Turbinaria* sp, were among the algae presented to *D. setosum* and *D. savignyi* held in aquaria prior to this study. Both urchin species appeared to avoid *Turbinaria*; however, neither *Diadema* species appeared to exhibit any reluctance to consume *Sargassum* when provided alone (Figure 5A) or together with *E. acoroides* and/or *T. hemprichii*, although *Ulva* was consumed first when present. However, unlike *Ulva* and *Gracilaria* which could be kept for several weeks, *Sargassum* quickly began to decompose under holding conditions in the laboratory, emitting unpleasant odours after 2-4 days.

It is also of interest that [21] reports *D. setosum* as feeding on two species from genera widely used in mariculture, *Eucheuma* and *Gracilaria*. In our study, *Gracilaria* sp. was the preferred feed. Neither of the two species which dominate mariculture in Indonesia (Kappaphycus alvarezii and *Eucheuma spinosum*) was included in the feeding trials under this study. However, the authors have observed that *D. setosum* and *D. savignyi* will consume fragments of eucheumatoid algae entangled in (and thus collected together with) *U. reticulata* blooms. The unusually high density of *D. setosum* observed feeding on a *U. reticulata* bloom before and during feed collection for this study (Figure 5B) indicates a possible role for *Diadema* urchins in the control of such macroalgal blooms.

Figure 5. *Diadema setosum* feeding on: A. *Sargassum* sp. (Marine Environmental Quality Laboratory, Universitas Hasanuddin); B. *Ulva reticulata* bloom on Barrangcadi reef flat, Spermonde Archipelago

Of the seven seagrass species found around Barranglompo Island by [19] (*Enhalus acoroides*, *Thalassia hemprichii*, *Cymodocea rotundata*, *Syringodium isoetifolium*, *Halodule uninervis*, *Halophila ovalis* and *Halodule pinifolia*), *D. setosum* is reported as consistently preferring *E. acoroides*. One reason put forward for this preference is the relatively high protein content of *E. acoroides* compared to the other seagrass species. In our study, the urchins did consume slightly more *E. acoroides* than T. *hemprichii*, but the difference in preference was not significant ($p > 0.05$). However, the consumption of both seagrasses did exhibit an increasing trend over the 5-day study period. One reason for this trend could be the reduced toughness of the seagrass leaves over time, due to decomposition processes. Nutrient content (e.g. protein and lipid), as well as texture and palatability, might influence *D. setosum* dietary choices. Somatic growth and gonad development of sea urchins, including *Paracentrotus lividus* [22] and *Tripneustes gratilla* [23], can be promoted through the addition of algae to feeds, especially *Ulva* sp.

3.3. *Potential implications and future directions*

Our data point to a potentially important role of *D. setosum* in macroalgal control in tropical coastal ecosystems. With respect to aquaculture, it has been suggested that *D. setosum* may have potential in multi-trophic context. However the preference for *Gracilaria* in this study and the reports of *Diadema* urchins feeding on Eucheumatoid algae mean that (like *Tripneustes* sp. [24]) these urchins could potentially become pests in the context of seaweed farming.

There is considerable interest in sea urchin culture [25], including *Diadema* propagation, mostly for conservation [26], including in the context of *P. kauderni* population and habitat management [12,13,14,15], and as an alternative to unsustainable harvest practices [9,13,14]. The varied diet of urchins in our study indicates that formulations of feed for captive *D. setosum* could be flexible. For example, while seagrasses could be used when leaves are abundant and can be harvested without undue damage to seagrass ecosystems, care should be taken not to degrade these highly productive ecosystems, under threat across much of Indonesia [27].

4. Conclusion

Our study contributes to the body of knowledge on the dietary preferences of *Diadema setosum,* and tends to support the ecological importance of this tropical shallow-water invertebrate which is also of socio-economic importance. Results indicate that feed to support the development of culture of Inod-Pacific *Diadema* urchins could make use of a variety of red and green algae, including *Ulva reticulata* blooms (with potentially beneficial impacts on the harvested areas). In the context of the threatened endemic Banggai cardinalfish *P. kauderni,* the identification of potential feeds for *Diadema* culture is one small step towards a wider strategy of recovery through habitat and microhabitat rehabilitation.

References

[1] Mumby P J, Hastings A and Edwards H J 2007 Thresholds and the resilience of Caribbean coral reefs *Nature* **450** 98-101
[2] Maciá S, Robinson M P, Nalevanko A (2007) Experimental dispersal of recovering *Diadema antillarum* increases grazing intensity and reduces macroalgal abundance on a coral reef. *Mar Ecol Prog Ser* **348**173-182
[3] Carpenter R C and Edmunds P J 2006 Local and regional scale recovery of *Diadema* promotes recruitment of scleractinian corals *Ecol Lett* **9** 268–77
[4] Coppard S E and Campbell C 2004 Organisms associated with diadematid echinoids in Fiji *Proc 11th Int Echinoderm Conf (Munich)* (Boca Raton: CRC Press) 171-75
[5] Kolm N, Berglund A 200) Wild populations of a reef fish suffer from the "nondestructive" aquarium trade fishery *Cons Biol* **17** 910-14
[6] Moore A, Ndobe S, Salanggon A I M, Ederyan and Rahman A 2012 Banggai Cardinalfish Ornamental Fishery: The Importance of Microhabitat *Proc 12th Int Coral Reef Symp (Townsville)* (Townsville: James Cook University) 13C
[7] Vagelli A A 2011 *The Banggai Cardinalfish: Natural History, Conservation, and Culture of Pterapogon kauderni* (Chichester: John Wiley & Sons, Ltd.)
[8] Ndobe S, Setyohadi D, Herawati E Y, Soemarno, Moore A, Palomares M D and Pauly D 2013 Life History of Banggai Cardinalfish (*Pterapogon kauderni*; Pisces, Apogonidae) in Banggai Islands and Palu Bay, Sulawesi, Indonesia. *Acta Ichthyol Piscat* **43** 237–50

[9] Ndobe S, Moore A and Jompa J A 2018 Tale of two Urchins - Implications for *in-situ* breeding of the endangered Banggai cardinalfish (*Pterapogon kauderni*) *Aquacultura Indonesiana* **19** 65-75
[10] Allen G R and Donaldson T J 2007 *Pterapogon kauderni* The IUCN Red List of Threatened Species e.T63572A12692964
[11] Moore A M, Ndobe S and Jompa J 2017 Fingerprints of the Anthropocene: the 2016 Coral Bleaching Event in an Equatorial Archipelago *Proc 4th Int Mar Fish Symp* (Makassar: Universitas Hasanuddin) 66–86
[12] Ndobe S, Moore A, Salanggon A I M and Muslihuddin 2013 Banggai cardinalfish (*Pterapogon kauderni*) Management: an Ecosystem-Based Approach *Mar Fish* **4** 115–26
[13] Ndobe S, Moore A M and Jompa J 2017 Status of and threats to microhabitats of the endangered endemic Banggai Cardinalfish *Pterapogon kauderni Coast Ocean J* **1** 73–82
[14] Moore A, Ndobe S and Jompa J 2017 A site-based conservation approach to promote the recovery of Banggai cardinalfish (*Pterapogon kauderni*) endemic populations. *Coast Ocean J* **1** 63-72
[15] Ndobe S, Yasir I, Moore A, Biondo M and Foster S 2018 A study to assess the impact of international trade on the conservation status of *Pterapogon kauderni* (Banggai cardinalfish) Report (Gland: International Union for Conservation of Nature)
[16] Moore A, Ndobe S and Zamrud M 2011 Monitoring the Banggai cardinalfish, an endangered restricted range endemic species *J Indonesia Coral Reefs* **1** 99–113
[17] Ndobe S, Widiastuti I and Moore A 2013 Sex ratio dan pemangsaan terhadap rekrut pada ikan hias Banggai cardinalfish *Pterapogon kauderni Prosiding Konferensi Akuakultur Indonesia 2013* (Masyarakat Aquaculture Indonesia) 9–20
[18] Coppard S E and Campbell A C 2007 Grazing preferences of diadematid echinoids in Fiji *Aquat Bot* **86** 204–12
[19] Haerul A, Yasir I and Supriadi 2011 Grazing activity and food preference of sea urchins to Seagrass species found in coastal area of Barrang Lompo Island, Makassar *Prosiding Pertemuan Ilmiah Nasional Tahunan VIII ISOI 2011* (Jakarta: Ikatan Sarjana Oseanologi Indonesia) 26-36
[20] Carreiro-Silva M and McClanahan TR 2001 Echinoid bioerosion and herbivory on Kenyan coral reefs: the role of protection from fishing *J Exp Mar Biol and Ecol* **262** 133-53
[21] Shunula J P and Ndibalema V 1986 Grazing preferences of *Diadema setosum* and *Heliocidaris erythrogramma* (Echinoderms) on an assortment of marine algae. *Aquat Bot* **25** 91–95
[22] Fabbrocini A, Volpe M G, Di Stasio M, D'Adamo R, Maurizio D, Coccia E and Paolucci M 2012 Agar-based pellets as feed for sea urchins (*Paracentrotus lividus*): rheological behaviour, digestive enzymes and gonad growth *Aquacult Res* **43**: 321–331
[23] Cyrus M D Bolton J J, Scholtz R and Macey B M 2015 The advantages of using *Ulva* (Chlorophyta) as an additive in sea urchin formulated feed: Effects on consumption and digestibility *Aquacult Nutr* **21** 578–591
[24] Neish I C 2008 *Good agronomy practices for Kappaphycus and Eucheuma including an overview of basic biology* SEAPlant.net Monograph HB2F 1008 V3
[25] Kelly M S 2005 Echinoderms: their culture and bioactive compounds. Matranga V. (ed.) *Echinodermata. Progress in Molecular and Subcellular Biology* **39** (Berlin, Heidelberg: Springer) 139-65
[26] Sharp W C, Delgado G A, Hart J E and Hunt J H 2018 Comparing the behavior and morphology of wild-collected and hatchery-propagated long-spined urchins (*Diadema antillarum*): implications for coral reef ecosystem restoration *Bull Mar Sci* **94** 103-22
[27] Unsworth R K F, Ambo-Rappe R, Jones B L, La Nafie Y A, Irawan A, Hernawan U E, Moore A M and Cullen-Unsworth L C 2018 Indonesia's globally significant seagrass meadows are under widespread threat. *Sci Tot Env* **634** 279–286

Moore_2019_IOP_Conf..pdf

ORIGINALITY REPORT

%13	%9	%9	%9
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.pmrslab.cn Internet Source	%3
2	elk.adalidda.com Internet Source	%2
3	aquasiana.org Internet Source	%1
4	pertambangan.fst.uinjkt.ac.id Internet Source	%1
5	Shunula, J.P.. "Grazing preferences of Diadema setosum and Heliocidaris erythrogramma (Echinoderms) on an assortment of marine algae", Aquatic Botany, 1986 Publication	<%1
6	Coppard, S.E.. "Grazing preferences of diadematid echinoids in Fiji", Aquatic Botany, 200704 Publication	<%1
7	repository.unhas.ac.id	

Internet Source

<%1

8 centaur.reading.ac.uk
Internet Source

<%1

9 Submitted to Universiti Malaysia Sarawak
Student Paper

<%1

10 coj.pksplipb.or.id
Internet Source

<%1

11 Submitted to Universitas Hasanuddin
Student Paper

<%1

12 "11th Congress of the International Society of Nutrigenetics/Nutrigenomics (ISNN) : Abstracts", Journal of Nutrigenetics and Nutrigenomics, 2017
Publication

<%1

13 Submitted to National Research University Higher School of Economics
Student Paper

<%1

14 Submitted to Southern Cross University
Student Paper

<%1

15 Submitted to University of Wales, Bangor
Student Paper

<%1

16 Palantei, Elyas, Syafruddin Syarif, Nadhifah Sakka, Andi Asmi Pratiwi, Bayu Topalaguna, and Zakiy Ubaid. "Lungs patch structures:

<%1

Numerical computation, testing and application", 2013 International Conference on QiR, 2013.
Publication

17	Siti Maryam Yaakub, Jillian Lean Sim Ooi, Pimchanok Buapet, Richard K.F. Unsworth. "Seagrass research in Southeast Asia", Botanica Marina, 2018 Publication	<%1
18	www.peertechz.com Internet Source	<%1
19	www.sons.ecu.edu.au Internet Source	<%1
20	cites.org Internet Source	<%1
21	Goh, Beverly P. L., and Dawn Y. F. Lim. "Distribution and abundance of sea urchins in Singapore reefs and their potential ecological impacts on macroalgae and coral communities", Ocean Science Journal, 2015. Publication	<%1
22	"6th European Federation for Primatology Meeting, XXII Italian Association of Primatology Congress Rome, Italy, August 25-28, 2015: Abstracts", Folia Primatologica, 2015 Publication	<%1

EXCLUDE QUOTES	ON	EXCLUDE MATCHES	< 5 WORDS
EXCLUDE BIBLIOGRAPHY	ON		