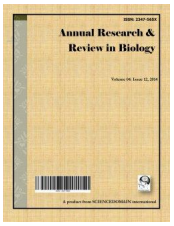

Annual Research & Review in Biology

13(3): 1-7, 2017; Article no.ARRB.33487
ISSN: 2347-565X, NLM ID: 101632869

A Century of Change in an Indonesian Coral Reef: Sluiter's Brandewijnsbaai (1890) Revisited

Andreas Kunzmann[1*] and Samsuardi[2]

[1]Leibniz-Center for Tropical Marine Research (ZMT), Fahrenheitstr. 6, 28359 Bremen, Germany.
[2]CV Sanari, Jl. Pekanbaru 11, 25115 Padang, Indonesia.

Authors' contributions

This work was carried out in collaboration between both authors. Author AK designed the study, wrote the protocol and wrote the first draft of the manuscript. Author Samsuardi supported the fieldwork and helped with the literature searches. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/ARRB/2017/33487
Editor(s):
(1) George Perry, Dean and Professor of Biology, University of Texas at San Antonio, USA.
Reviewers:
(1) Natan Silva Pereira, University of Bahia State, Brazil.
(2) Angelo Paone, Pusan National University, Busan, South Korea.
Complete Peer review History: http://www.sciencedomain.org/review-history/19428

Short Research Article

Received 17th April 2017
Accepted 31st May 2017
Published 9th June 2017

ABSTRACT

Corals of Terlena Island were first mentioned more than 125 years ago, when Sluiter in 1890 came up with a new theory of initial reef development. Our aim was to re-visit the reef, investigate the coral community and environmental conditions, identify dominating species and compare the present and past situation. Today the island is part of the international port Teluk Bayur and hosts only few, but unique assemblages of corals, including the first record of *Oulastrea crispata* from West Sumatra. This localized coral community is due to special environmental and anthropological conditions, with low light conditions and sediment input through rivers and excavations on one hand and protection from wind, waves, red tides and destructive fishing through proximity to the harbour on the other hand. We conclude that only extremely tolerant coral species will survive.

Keywords: Coral community; Padang; Oulastrea; Emmahaven; Pulau Pieh MPA; local stressors.

**Corresponding author: E-mail: akunzmann@zmt-bremen.de, akunzmann@leibniz-zmt.de;*

1. INTRODUCTION

The first record of corals of Terlena Island in West Sumatra, Indonesia (Fig. 1) goes back to 1890, when Sluiter [1] reports about a small sandy island (at that time called Pasir Ketjil) in the harbour of the Brandewijnsbaai. For the corals no species names were recorded, but members of the genus *Acropora*, *Montipora* and *Porites* are referred to. Sluiter comes up with a new theory about the initial stages of many reefs in the Java Sea and other areas by citing the example from Brandewijnsbaai near Padang [1].

Sluiters report was picked up by Umbgrove [2,3], when the Brandewijnsbaai was renamed Emmahaven. Umbgrove explains in great detail the origin and geomorphology of the reefs around the small island Pasir Ketjil (today Pulau Terlena). He provides hand-drawn maps, both of the island and harbour constructions, including the first publication of three b/w photos of Emmahaven and surroundings (Fig. 2a). His major contribution is the explanation of the change from sand to mud bottom and consequently of major reef parts of the bay through the influence of wind and river input.

The stepwise development of the bay to the important harbour of Bungus Bay and to an international port, named Teluk Bayur since the eighties, resulted in building of numerous brick walls, piers etc. and deepening of harbour basins (Fig. 2b). These major construction works changed the small-scale hydrography and physical conditions of the bay. In addition to global stressors such as temperature and CO_2 increase, numerous local stressors are affecting the corals of Bungus, Teluk Bayur and Terlena. Apart from heavy fishing, including destructive methods [4,5], numerous households and several industries in the bay (incl. an oil terminal) produces harmful effluents. Teluk Bayur Port receives regular large traffic, particularly for shipping coal. Therefore, we were interested in recording the effects of all these local stressors on the coral community. Our aim was to re-visit the reef, investigate the coral community and environmental conditions, identify dominating species and compare the present and past situation. Our hypothesis is that only very few corals can survive the stressful environmental conditions of Terlena Island.

2. METHODS

In cooperation with the Leibniz Centre for Tropical Marine Research (ZMT), the coral reef team of Bung Hatta University carried out several reef surveys [5,6] along the West Sumatra coast including Terlena Island (01° 00.04' S/ 100° 22,66' E) in 1997 and 2001/2. A description of the reef of Pulau Terlena (formerly Pasir Ketjil) in the Teluk Bayur Bay (formerly Brandewinsbaai and Emmahaven) including coral cover and species checklist was prepared. More recently short visits to the island were part of surveys of the Pulau Pieh MPA (http://scorpionfish.zmt-bremen.de) and surrounding islands, in 2012 and 2016, more than 125 years after Sluiter.

Methods for Manta tow assessment and subsequent line transects, as described in English et al. [7] and UNEP [8], were used. Water quality parameters (temperature, salinity, pH, visibility) were taken using Refractometer, Secchi Disc and WTW-Multisensors. During the recent visits physico-chemical data were taken with a Manta (Eureka, USA) multisensor.

3. RESULTS AND DISCUSSION

Fig. 3a shows the extension of the live reef area of Pulau Terlena in 1931 [2], which remained almost the same until 2001 (Fig. 3b). The north-western area of the island is now part of the harbour, where only mud without corals occurs. The east and west are entry points for large ships, where excavation resulted in short but steep slopes and only moderate coral growth in the upper 5 m. The average visibility was low, Secchi disc measurement was 2.9 m in the south, 2.5 m in the west and less than 2 m in the north (at 27°C, 33 PSU and pH 8.2 in August 2012).

Two transects on the **southern** part of the island revealed an extensive reef flat, the largest coral area of Terlena with a percentage cover of up to 30%. In the upper 5 m of the reef flat branching *Acropora* and *Pocillopora* mixed with large *Montipora* and very few massive *Favia* and mushroom corals occur. Few *Porites* were counted. Other fauna was comparatively rich, with anemones, seastars, sea urchins and giant clams, alternating with small fields of red macroalgae (*Gelidium spec.*). The percentage cover with live coral was about 10-30% in 2001 and less than 10% in 2012.

The base of the reef was reached in 8-10 m depth, where many dead corals, coral rubble and accumulations of river sediment or sand are encountered. These accumulations were already reported by Sluiter in 1890 [1], who undertook several drilling operations. One of his most

interesting conclusions is that the reef is fairly young and must have developed on the muddy ground by a complicated mechanism of foundation forming [1].

At the **western** end of Terlena (01° 00.05' S/ 100° 22,54' E), where the main harbour entry is, the reef has a small vertical wall and mainly encrusting and massive corals are found. Here, at least for small stretches of 10-30 m length, the percentage cover can reach 60-70% and most common genera are: *Hydnophora, Merulina, Favia, Pectinia, Physogyra, Platygyra, Leptoria, Pocillopora and Stylophora*. At this location we also *found Oulastrea crispata*, also called Zebra coral (Fig. 4). For our team in 1997 this was the first record of this species in western Sumatra [9] and therefore most likely for the entire eastern Indian Ocean area of Indonesia. According to the IUCN red list it is reported from the northern Indian Ocean and the Indo-Pacific [10], emphasising that it is one of the very few corals remaining in the Jakarta Bay. *Oulastrea crispata* is known to be a very solid encrusting species, preferring shallow water and wave-washed rock [11]. According to Ditlev [12] it prefers turbid waters and rocky, intertidal reef flats. *Oulastrea* is even found in muddy areas on the shallow back reef and seldom occurs among dense corals on the fore reef. It may be more abundant in degraded habitats, where other coral species have disappeared [13].

Fig. 1. Teluk Bayur Port, Padang, Indonesia with the protected Terlena Island (Google Maps, 11/08)

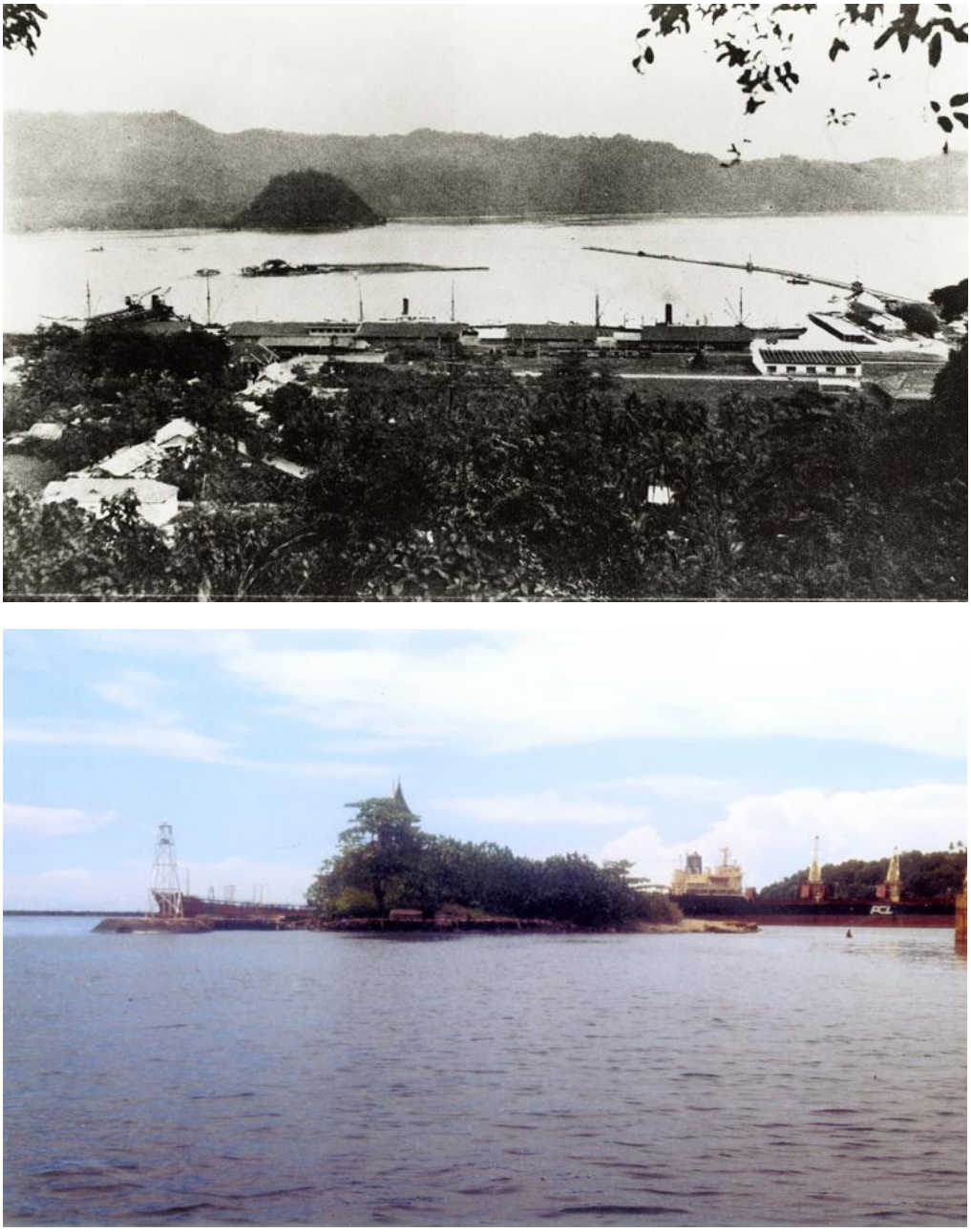

Fig. 2a, b. Picture of Pasir Ketjil / Terlena Island from 1931 [2] and 2000, a: from NW, overlooking T. Bayur with island in center, b: from E, with port facilities to the right

The reefs of West Sumatra in general are endangered through increasing fishing pressure with destructive methods (explosives and poison [4]). Due to the proximity of Terlena Island to the harbour, where also the Navy is situated, no destructive fishing, no anchoring, no tourists are encountered here. This unique situation seems to enable and favour the settlement of slow growing and sensitive corals, which cannot compete at other locations. On the other hand, increasing siltation rates and turbid waters due to river input and continuous harbour activities have reduced the photic zone to only a few meters. Only very few coral species are able to develop in this environment [12]. In addition the construction and deepening of the harbour entrance provided a kind of rocky drop-off, which otherwise would not be available for

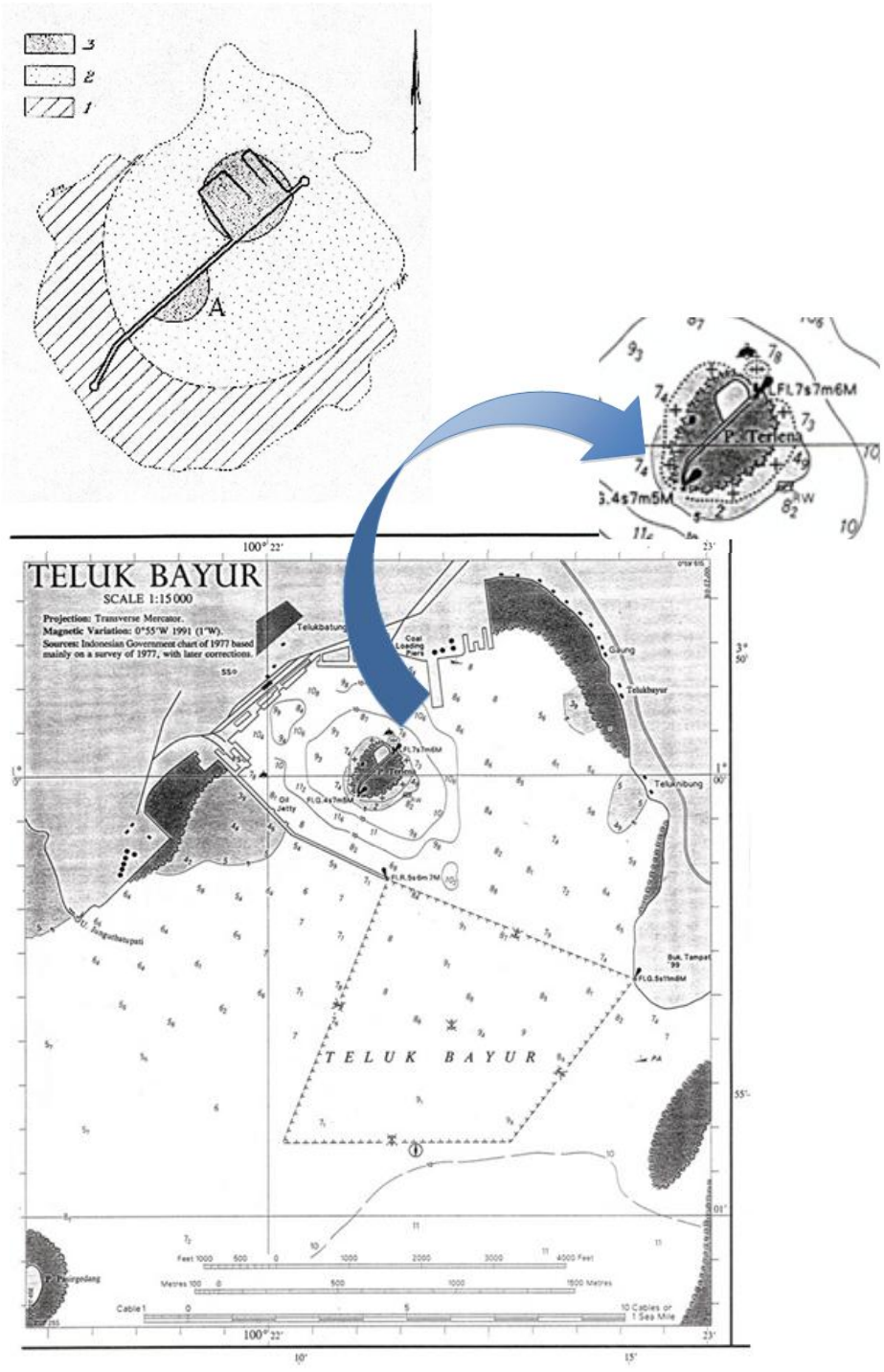

Fig. 3a, b. Coral area of Terlena Island, a: drawing from Umbgrove [2] 1= live coral reef, 2 = submerged coral sand, 3 = coral sand island, b: sea chart, revealing deeper parts in the southwest after excavation (Admirality Charts 1991) – see also enlarged part of 3b

corals. These combinations of factors have provided the necessary physical and biological environment for a localized "coral community" of Pulau Terlena, unique for West Sumatra. Special

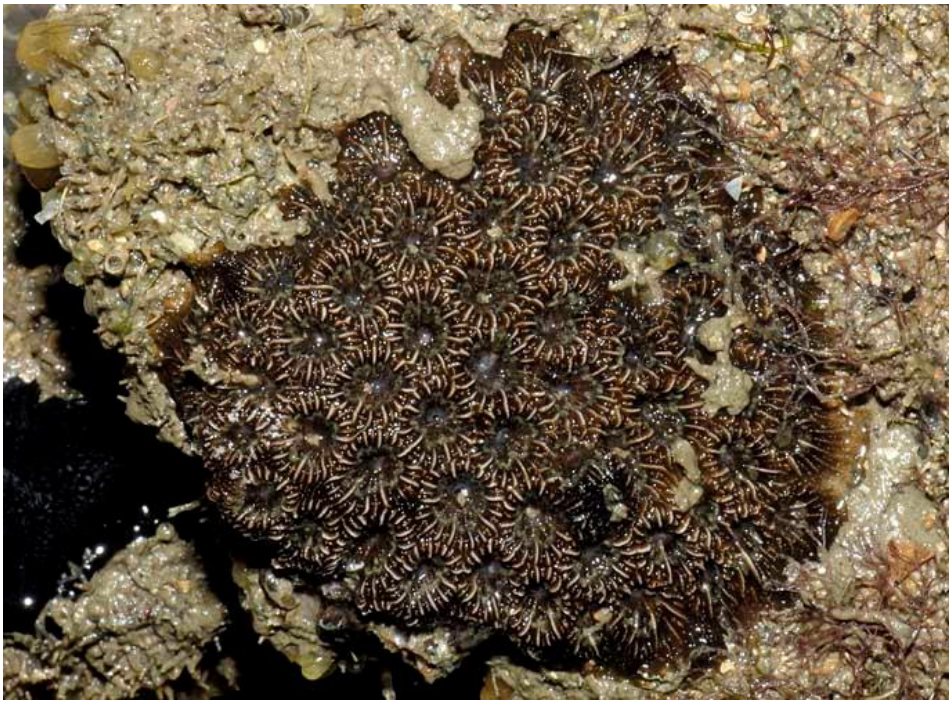

Fig. 4. Picture of *Oulastrea crispata* from Terlena Island

environmental conditions in West Sumatra in general also lead to the report of a new coral species [14], a number of new fish species [15] and numerous first records of species (corals: [16]; fish: [17]).

In addition the occurrence of a severe red-tide with temperature anomalies in 1998 [18] killed numerous corals along the entire coastline, favoured by a rapid exchange of water masses in the western area of the Padang islands and bays. Due to the protected location, it seems that Terlena Island was not reached and served as a retreat for a number of coral species of Western Sumatra. However, the extremely low visibility (Secchi disc 2 m) restricts coral growth to the upper few meters and the increasing coastal population and industrial use of the bay will further decrease visibility and pollution load with very low chances for coral survival at Terlena and in the entire Bungus Bay. As it has been shown by Denis et al. [19] that *Oulastrea* can survive in the dark, we are confident that it can outcompete other coral species also in the near future.

4. CONCLUSION

We conclude that because of increasing local stressors, such as increased turbidity and pollution load, reduced water exchange, sediment input through rivers and excavations, amongst others caused by the expansion of the International Port Teluk Bayur and increasing coastal population, only very few corals can survive the stressful environmental conditions of Terlena island. Therefore we find a species-poor, very localized coral community adapted to low light conditions and increased turbidity on the one hand, and protected from wind, waves, red tides and destructive fishing through the proximity to the harbour on the other hand. In the long run only extremely tolerant coral species such as *O. crispata* will survive.

ACKNOWLEDGEMENTS

The authors thank the coral reef team (Pusat Studi and Minang Bahari Divers) of Bung Hatta University, Padang for support in the early studies, and the team of CV Sanari for the recent studies, the DAAD (German Academic Exchange Service) for funding and BW Hoeksema for help with identification.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sluiter CP. Einiges über die Entstehung der Korallenriffe in der Javasee und Branntweinsbai, und über neue Korallen-bildung bei Krakatau. Natuurkundig Tijdschrift voor Nederlandsch Indie, Batavia. 1890;49:361-580.
2. Umbgrove JHF. De koraalriffen van Emmahaven (W. Sumatra). Overdruck uit Leidsche geologische Mededeelingen 1931;4(1):9-24.
3. Umbgrove JHF. De Koraalriffen der Duizend-Eilanden (Java-see). Dienst van den Mijnbouw in Nederlandisch-Indie. Wetenschappelijke Mededeelingen. 1929; 12:47.
4. Kunzmann A. On the way to management of West Sumatra's coastal ecosystems. Naga. 2002;25(1):4-10.
5. Kunzmann A. Corals, fishermen and tourists. Naga. 2004;27(1-2):15-19.
6. Kunzmann A. The coral reefs of West Sumatra. In: Tomascik T, Mah AM, Nontji A, Kasim Moosa M (Eds.). The Ecology of the Indonesian Seas Part Two. Periplus Editions (HK) Ltd., Singapore. 1997;1249-1262.
7. English SA, Wilkinson C, Baker V. Survey manual for tropical marine resources, ASEAN-Australian Marine Science Project, AIMS, Townsville. 1994;368.
8. UNEP, AIMS. Monitoring coral reefs for global change. Regional Seas. Reference Methods for Marine Pollution Studies. 1993;61:72.
9. Jonker L, Johan O. Checklist of the scleractinian coral species from the waters of Padang (West Sumatra, Indonesia) held in the coral collection of Bung Hatta University. The Beagle. 1999; 15:47-54.
10. DeVantier L, Hodgson G, Huang D, Johan O, Licuanan A, Obura D, Sheppard C, Syahrir M, Turak E. *Oulastrea crispata*. The IUCN Red List of Threatened Species; 2008. DOI:10.2305/IUCN.UK.2008. RLTS.T132859A3465107.en
11. Veron JEN. Corals of Australia and the Indo-Pacific. University of Hawaii Press, Honolulu. 1986;644.
12. Ditlev H. A fieldguide to the reef-building corals of the Indopacific. Backhuys, Rotterdam. 1980;291.
13. IUCN. Available:http://www.iucnredlist.org/details/132859/0 (Accessed 13 November 2016)
14. Hoeksema BW. Attached mushroom corals (Scleractinia: Fungiidae) in sediment-stressed reef conditions at Singapore, including a new species and a new record. Raffles Bulletin of Zoology Supplement 2009;22:81-90.
15. Randall JE, Kunzmann A. Seven new records of fishes from Indonesia, with discussion of western Indian Ocean fishes in Southwestern Indonesia. Raffles Bulletin of Zoology. 1998;46(2):477-485.
16. Hoeksema BW. Generic diversity of Scleractinia in Indonesia. In: Tomascik T, Mah AM, Nontji A, Kasim-Moosa M (Eds.) The Ecology of the Indonesian Seas Part Two. Periplus Editions (HK) Ltd., Singapore. 1997;308-310.
17. Kunzmann A, Randall JE, Suprihanto I. Checklist of the shore fishes of the Mentawai Islands, Nias Island and the Padang region of West-Sumatra. Naga. 1999;22(1):4-10.
18. Hoeksema BW, Cleary DFR. Letter to: Abram NJ, Gagan MK, McCulloch MT, Chappell J, Hantoro WS. The Sudden Death of a Coral Reef. Science. 2004; 303(5662):1293–1294.
19. Denis V, Leung JKL, Hsu CM, Hsieh HJ, Tsai WS, Chen CA. Dark survival of *Oulastrea crispata*. Galaxea. 2012;14:117-118.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/19428