



Tubastrea micranthus

Black sun coral, Green sun coral

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Maldives National Red List Assessment: *Tubastrea micranthus*

A. Background Information

1. Assessment Information

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2. Taxonomic Information

Scientific Name	<i>Tubastrea micranthus</i> (Ehrenberg, 1834)	
Common Name (English)	Black sun coral, Green sun coral	
Common Name (Dhivehi)	-	
Taxonomy	Order	Scleractinia
	Sub-order	
	Family	Dendrophylliidae
Taxonomic Notes	Originally <i>Oculina micranthus</i> (Ehrenberg, 1834)	

3. Geographic Range

3.1 Summary of Global Distribution

Records of the species indicate distribution spreading from the Red Sea to throughout the Indian Ocean and along the Indo-Pacific region, Australia, and the Pacific.

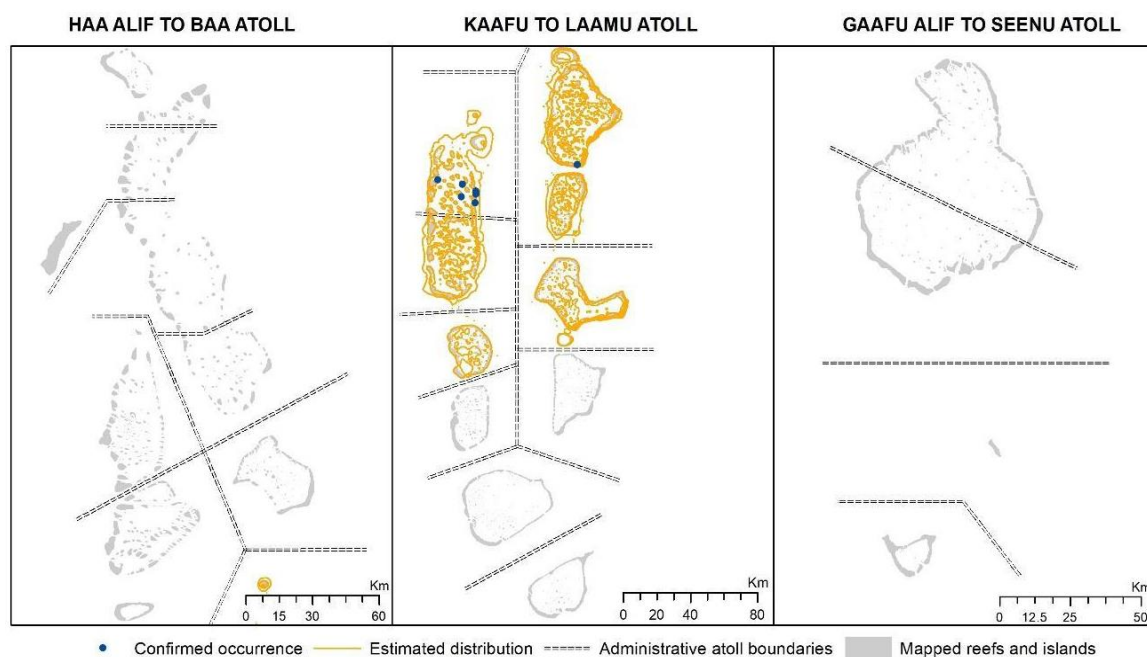
3.2 Countries of Occurrence

Australia, British Indian Ocean Territory, Comoros, Fiji Islands, Madagascar, Maldives, Mexico, Philippines, Puerto Rico

3.3 National distribution

The species has been reported in literature (e.g., Bigot and Amir 2012). Data confirmed occurrences are available from Kaafu, Ari, Vaavu and Faafu atoll and therefore it is estimated that species could be found at appropriate depths and habitats throughout these atolls.

Additionally, the species is often at locations and depths missed in surveys and there is a possibility for the species to be found in all atolls at the appropriate depths. However, without confirmed observations or data, these regions are not included in the distribution.



4. Population

4.1 Summary

Species specific population information is not available. Population estimates are derived based on best available generic information.

4.2 Population Size

Global populations are not known; however, they are recognized invasive at locations in the Pacific (Creed et al., 2017; Kolian et al. 2013; Sammarco et al., 2010, 2013)

A ten-year generic mean, the mean percent cover of the genus over a ten year period of time, was calculated for each genus. This was used as a proxy for the potential species population size.

The ten-year species mean derived from available data is $0.19 \pm 0.64\%$ (\pm S.E). Therefore, based on these estimates the species population may vary between $0.35 \pm 0.19\%$ within atolls where they are found. However, there is potential for the population to be much higher as the available data records for this calculation is less than 10 records from restricted locations.

4.3 Population Trend

Global and national past population trends are unknown. Future population trend is likely to be decreasing.

4.3 Generation length

Estimates for coral generation lengths are based on Carpenter *et al.* 2008, as follows. The coral colony is considered to be the mature individual, as it typically lives, is injured, or dies as a unit. The average age of natural survival of a coral colony was defined as the average age of a mature individual, or one generation length. Based on available knowledge

of coral species' biology and life history, this was determined to be 10 years. Therefore, population reductions are estimated over 30 years, representing three generation lengths.

4.4 Continuing Decline in Number of Mature Individuals?

Unknown.

4. Extreme Fluctuations?

No

5. Severely Fragmented?

Degree of fragmentation is unknown. However, it is assumed to be minimal or limited based on observations indicating there could be connectivity between islands and atolls.

5. Habitat and Ecology:

5.1 Summary

The species can be found on mid-slopes and have been known to colonize artificial structures. While native to the Indian ocean, it is considered invasive at some locations in the Pacific. Generally, they can be found between 5 m and 50 m though they have recorded at depths up to 130m. However, none of these records are from the Indian Ocean. The species is azooxanthellate (Schuhmacher 1984).

5.2 Systems (terrestrial / freshwater / marine)

Marine

5.3 Continuing Decline in Area, Extent, and/or Quality of Habitat?

Yes. Shallow habitats decline in area, extent, and quality due to coastal developments. Deeper habitats may remain intact and act as a refuge for the species.

5.4 A Migratory Species?

No.

6. Use and Trade

6.1 Is the species used or traded?

Yes.

6.2 Summary

Small colonies or fragments of the species are collected for use in aquariums. This harvesting may represent a threat to the species.

7. Threats

7.1 Summary

The coral is an azooxanthellate coral, making it relatively resilient to bleaching. Members of this genus have also been found to be more resilient to the effects of climate change (Strychar et al 2021). However, it is still vulnerable to sedimentation and predation. Its vulnerability to sedimentation can make it vulnerable to sedimentation from unmanaged or unmitigated coastal development projects like reclamation or dredging. This can affect its capacity to recover from stressors like bleaching once affecting such areas. The members of species at the shallow would be vulnerable to the impacts of coastal development. The species can also be located close to human habitation, either island communities or resorts, they are subject to stressors in the form of untreated sewage (where infrastructure is lacking), agricultural runoff and domestic waste.

The projected date of onset of Annual Severe Bleaching (ASB) is the date after which the capacity of coral reefs to recover from repeated bleaching events is expected to significantly reduce - resulting in fundamental, permanent population changes (UNEP 2017). The calculation of ASB by UNEP (2020) is restricted to a 30 m depth, due to the dataset used for the spatial analysis.

We calculated the mean year of ASB onset, assuming 0° coral adaptation (UNEP 2020) to climate change, for areas occupied by the genus. A 0° adaptation (i.e. no adaptation) to climate change was applied as a precautionary approach:

- as the capacity of coral to adapt to climate change is not yet well understood
- as there are other climate change impacts that may compound population decline and affect population refuges, and
- to account for impacts from coastal development that could potentially exacerbate the effect of bleaching prompted by climate change.

7.2 Major Threats to the Species (using IUCN Threat Classification Scheme)

1. Residential & commercial development:

1.1. Housing & urban areas

Timing: Ongoing

Stresses:

1. Ecosystem/Community stresses

1.1. Ecosystem conversion

1.2. Ecosystem degradation

1.3. Indirect ecosystem effects

2. Species stresses

2.2. Species disturbance

2.3. Indirect species effects

2.3.7. Reduced reproductive success

1.2. Commercial & industrial areas

Timing: Ongoing

Stresses:

1. *Ecosystem/Community stresses*

1.1. *Ecosystem conversion*

1.2. *Ecosystem degradation*

1.3. *Indirect ecosystem effects*

2. *Species stresses*

2.2. *Species disturbance*

2.3. *Indirect species effects*

2.3.7. *Reduced reproductive success*

1.3. *Tourism & recreational areas*

Timing: Ongoing

Stresses:

1. *Ecosystem/Community stresses*

1.1. *Ecosystem conversion*

1.2. *Ecosystem degradation*

1.3. *Indirect ecosystem effects*

2. *Species stresses*

2.2. *Species disturbance*

2.3. *Indirect species effects*

2.3.7. *Reduced reproductive success*

5. Biological resource use:

5.4. *Fishing & harvesting aquatic resource*

5.4.3. *Unintentional effects: subsistence/small scale*

Timing: Ongoing

Stresses:

1. *Ecosystem/Community stresses*

1.2. *Ecosystem degradation*

7. Natural system modifications:

7.3. *Other ecosystem modifications*

Timing: Ongoing

Stresses:

1. *Ecosystem/Community stresses*

1.1. *Ecosystem conversion*

1.2. *Ecosystem degradation*

1.3. *Indirect ecosystem effects*

2. *Species stresses*

2.2. *Species disturbance*

2.3. *Indirect species effects*

2.3.7. *Reduced reproductive success*

8. Invasive & other problematic species, genes & disease:

8.2. Problematic native species/diseases

8.2.1. Unspecified species/disease

2. *Species stresses*

2.1. *Species mortality*

2.2. *Species disturbance*

2.3. *Indirect species effects*

2.3.2. *Competition*

2.3.7. *Reduced reproductive success*

9. Pollution:

9.1. Domestic & urban wastewater

9.1.1. Sewage

Timing: Ongoing

Stresses:

1. *Ecosystem/Community stresses*

1.2. *Ecosystem degradation*

9.1.2. Run-off

Timing: Ongoing

Stresses:

1. *Ecosystem/Community stresses*

1.2. *Ecosystem degradation*

9.4. Garbage and solid waste

Timing: Ongoing

Stresses:

1. *Ecosystem/Community stresses*

1.2. *Ecosystem degradation*

Species vulnerability modifiers

Coral abundance and distribution data is only available at the genus level. Species characteristics were used to evaluate how susceptible each species is to treats. This data was gathered from the IUCN SSC Coral Working Group's Global

Traits Database, and available literature. Each species was assigned a vulnerability score for each trait (3 = high vulnerability; 2 = medium vulnerability; 1 = low vulnerability). This species was scored as follows.

Trait	Vulnerability score
Susceptibility to bleaching	1
Resistance to bleaching	1
Recovery from bleaching or disease	2
Resistance to disease	2
Susceptibility to predation	2
Recovery from sedimentation	2
Resistance to sedimentation	2
Susceptibility to sedimentation	2
<i>Average</i>	2

8. Conservation and Research

8.1 Summary

The species is included in CITES Appendix II. Collection, killing and export of live and dead scleractinian corals is illegal under Maldivian fisheries law. Distribution of the species falls under multiple national MPAs though not all the MPAs are properly managed. Species distribution and population information would be required to better manage and protect the species especially as it is a popular target for propagation products and for aquaria. Further species-specific research for threats would support development and implementation of necessary legislation.

8.2 Conservation Actions/Research in Place

Globally, as a coral the species is included within CITES Appendix II.

Nationally, collection, killing, and export of both live and dead scleractinian corals (under phylum Cnidaria) are illegal in the Maldives under the Maldives Fisheries Law 2020/R-75. The distribution of the genus, and likely the species, overlaps multiple MPAs including Baa atoll biosphere reserve SAMPA.

8.3 Conservation Actions Needed

Despite laws and regulations protecting coral species within the country, implementation of such laws and regulations are a challenge. There is a need to create infrastructure and capacity that would enable relevant laws and regulations to be enforced whilst educating the general public that they exist. Educational and training needs extend to more

educational opportunities in the marine field as well as skill training opportunities that can support research, further education, institutional development, awareness and communication efforts. Moreover, with the spatial distribution of maldivian reefs and the corals that are found within them, there is an urgent need to foster intra-governmental as well as inter-agency and inter-organizational cooperation and partnerships to mediate limitations related to capacity and resources. Areas of high abundance of specific species along with areas of high coral cover and resilience need to be identified and managed if not fully protected to ensure sustainable use and longevity. Management includes mitigating impacts from coastal development and resolving conflict of multi-use resources. Further, with increasing interest in restoration of reefs, there is a need to properly manage species harvest for projects to ensure that wild stocks are not decimated and species are able to recover.

1. Land/water protection

1.1. Site/area protection

1.2. Resource & habitat protection

2. Land/water management

2.1. Site/area management

2.3. Habitat & natural process restoration

3. Species management

3.1. Species management

3.1.1. Harvest management

3.2. Species recovery

3.4. *Ex situ* conservation

3.4.1. Captive breeding/artificial propagation

3.4.2. Genome resource bank

4. Education & awareness

4.1. Formal education

4.2. Training

4.3. Awareness & communications

5. Law & policy

5.3. Private sector standards & codes

5.4. Compliance & enforcement

5.4.1. Scale unspecified

7. External capacity building

7.1. Institutional & civil society development

7.2. Alliance & partnership development

7.3. Conservation finance

Research Needed

1. Research

1.1. Taxonomy

1.2. Population size, distribution and past trends

1.3. Life history and ecology

1.5. Threats

1.6. Conservation actions

3. Monitoring

3.1. Population trends

3.3. Trade trends

3.4. Habitat trends

B. Assessment

9. CRITERION A

Criterion A

Generation Length		10 years
3 Generations		30 years
Reduction in population size?		Yes
Start Date of Reduction		2022
End Date of Reduction		2052
Rate of Reduction (%)		20-30%
Meets Criteria Thresholds?	A1	-
	A2	-
	A3	Projected reduction of 20-30% over the next three generations. Nearly meets VU A3
	A4	-
Reduction Based on Which Sub-criteria?	a	-
	b	-
	c	Decline in habitat quality associated with climate change
	d	-
	e	-

Assessment Under Criterion A NT (nearly meets VU A3c)

Reasoning Our assessment of future population reduction is based on the projected date of onset of ASB. *T. micranthus* is expected to experience ASB starting in 2042.

The species mainly ranges between 4-50 m, though it has been recorded as deep as below 130 m.

Depth and depth range is considered in our assessment, as populations at depths shallower than 30 m are expected to experience greater temperature fluctuations and extreme temperatures (Riegl and Piller 2003), and therefore decline more quickly.

While part of this species' depth range will be affected by ASB, at least 40% of its depth range is likely to be less impacted.

The species is azooxanthellate (lacking symbiodinium) which may make it relatively resilient to climate change induced bleaching. This has been recorded previously in the Maldives along with a capacity to take over spaces left by scleractinian corals affected by bleaching (Loch et al 2002, 2004).

Additionally, the species and genus have the capacity to become invasive which may be indicative of its capacity to adapt to new environments (Creed et al., 2017; Kolian et al. 2013; Sammarco et al., 2010, 2013).

As such, while the species is projected to undergo a significant reduction in population size associated with the impacts of climate change, it is unlikely that the reduction over the next three generations will be greater than 30%. A reduction of 20-30% is considered more likely.

10. CRITERION B

Criterion B

AOO		-
EOO		-
Meets Criteria Thresholds?	B1	-
	B2	-
Severely Fragmented?		-
No. Locations		-
Threat used to calculate locations		-
Continuing Decline?	(i) EOO	-
	(ii) AOO	-

	(iii) Habitat	-
	(iv) Locations / Subpopulations	--
	(v) Mature Individuals	-
Extreme Fluctuations?	(i) EOO	-
	(ii) AOO	-
	(iii) Locations / Subpopulations	-
	(iv)Mature Individuals	-

Assessment Under Criterion B DD

11. CRITERION C

Criterion C

No. Mature Individuals		Unknown
Continuing Decline in Population Size?		-
Is Rate of Decline Known?		-
Generation Length		-
C1	Meets Thresholds for Rate of Decline?	-
	Rate of Decline (%)	-
	Time Period of Decline	-
C2	(a) (i) No. Mature Individuals in Each Subpopulation	-
	(a) (ii) % Mature Individuals in one Sub-population	-
	(b) Extreme Fluctuations in No. Mature Individuals?	-

Assessment Under Criterion C DD

12. CRITERION D

Criterion D

No. Mature Individuals	Unknown	
Meets Criteria Thresholds?	-	
VUD2	AOO	-
	No. Locations	-
	Plausible Future Threat That Would Quickly Drive Taxon to CR or EX	-
	Plausible Future Threat That Would Quickly Drive Taxon to VU or EN	-

Assessment Under Criterion D DD

13. CRITERION E

Criterion E

Has a Quantitative Analysis Been Conducted?	No
Type of Quantitative Analysis	-
Generation Length	-
Probability of Extinction within 100 Years	-
Probability of Extinction within 20 Years / 5 Generations (whichever is longer)	-
Probability of Extinction within 10 Years / 3 Generations (whichever is longer)	-

Assessment Under Criterion E DD

14. Preliminary and Final Assessment

Preliminary Assessment NT (nearly meets VU A3c)

Regional Adjustment	Up-list, Down-list, or No Change?	No change
	Justification for Regional Adjustment	No likely interaction with individuals outside the region

Final Assessment NT (nearly meets VU A3c)

Narrative Justification for Assessment:

Although *Tubastrea micranthus* is only known from a few atolls of the Maldives, it is possible that it is more widespread. It has a recorded depth range of 5-50 m, with potential for it to go far into the mesophotic regions.

Although the current population size and past rate of decline are not known, it is anticipated that the species will undergo a population reduction in the future based on the impacts of climate change on its local range. Based on published climate model-based bleaching assessments published by UNEP (2017, 2020), it is projected that Annual Severe Bleaching (ASB) will commence in the year 2041 over this species' distribution, affecting approximately 60% of its main depth range.

However, with its capacity to exist at even deeper depths, and its known capacity to withstand climate change induced bleaching events and colonize in new spaces, it is expected that the species' decline in population size will be limited. As an azooxanthellate coral, the species is expected to be relatively resilient to the impacts of climate change, though there is still much to be understood about its capacity to adapt. Nevertheless, the species has been locally recorded to readily survive bleaching events replacing, even if briefly, space occupied by zooxanthellate corals.

Therefore, based on the best available data, we project a 20-30% reduction in population size over the next three generations (2022-52), prompted by degradation in habitat quality associated with the impacts of climate change. It is assessed as Near Threatened (nearly meeting VU A3c).

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