

Effects of ocean acidification (pH_{total}~7.8) on calcification, photosynthesis, carbon and nitrogen contents and carbon isotopic signatures on *Halimeda opuntia* grown at tropical carbon dioxide seeps (NERP TE 5.2, AIMS)



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Title	Effects of ocean acidification (pH _{total} ~7.8) on calcification, photosynthesis, carbon and nitrogen contents and carbon isotopic signatures on <i>Halimeda opuntia</i> grown at tropical carbon dioxide seeps (NERP TE 5.2, AIMS)
Date	2015-09-15
Date type	Publication

Abstract

This dataset consists of one csv data file from field derived experiments at tropical carbon dioxide seeps in Papua New Guinea, measuring the response parameters: calcification, photosynthesis, carbon and nitrogen contents and carbon isotopic signatures on *Halimeda opuntia* grown under ocean acidification conditions.

The aim of this study was to investigate the effects of ocean acidification on *Halimeda opuntia* grown under ocean acidification conditions at tropical carbon dioxide seeps. Therefore we tested several response parameters to try to understand how the calcareous alga is capable of growing under ocean acidification conditions.

Method:

At several locations in Milne Bay Province, Papua New Guinea, volcanic CO₂ is seeping out of the seafloor (Fabricius et al. 2011). The seep sites are located at Dobu Island and Upa-Upasina (Normanby Island) close to the shore in shallow water of ~1–15 m depth and extend over an area of ~20 by 100 m with different intensities of bubble activity within this area. Control reefs were allocated several hundred meters away from the seep sites with no impact of the seep activity on their seawater carbonate system. The bubbles, which consist of pure CO₂, ascend to the surface and mix with the ambient seawater, changing the carbonate chemistry. This study was confined to areas where seawater chemistry was altered to levels projected for a vast part of the globe for the end of this century ('representative concentration pathway' RCP6.0 to RCP8.5 scenarios) (Moss et al. 2010).

Calcification rates in the light and dark, as well as net photosynthesis and respiration rates, were measured in-situ at control (pH_{total} = 8.17) and seep sites (pH_{total} = 7.77). Branches 5 – 8 cm in height and with ~20 phylloids of *H. opuntia* were collected and retained at the site of collection until incubations commenced. Light incubations were conducted in-situ at 5 m water depth at midday. Specimens were placed into 0.5 L clear Perspex chambers, simultaneously at control and seep sites, by two separate SCUBA diving teams. After ~3 h incubation under ambient light, incubation chambers were retrieved and a water subsample was directly analyzed for total alkalinity. Oxygen concentration was determined in each incubation chamber including two blank incubations per treatment (to correct for seawater production/ respiration) with a hand-held dissolved oxygen meter (HQ30d, Hach, USA). Light intensities of incubation conditions were recorded by two light loggers (Odyssey, New Zealand) each at control and seep site. Photosynthetically available radiations (PAR) was dependent on weather conditions and averaged 259 and 281 μmol photons m⁻² s⁻¹ for *H. opuntia* incubations. Dark incubations were conducted on board the research vessel for ~3 h in the evening. The incubation chambers were filled with water from the site of origin of the plants (control vs. seep site). Chambers were placed in black plastic bins (45 L) with lids for darkening and flow-through seawater for temperature control. Rates of calcification were determined with the

alkalinity anomaly technique (Chisholm and Gattuso 1991). Calcification rates (in $\mu\text{mol L}^{-1} \text{C h}^{-1} \text{gFW}^{-1}$) and oxygen fluxes (in $\mu\text{g O}_2 \text{h}^{-1} \text{gFW}^{-1}$) were calculated in relation to blank incubations and standardized to the fresh weight (FW) of the plants. Daily net calcification rates were calculated by 12h of daylight and 12h of darkness.

Apical phylloids of dried *Halimeda* spp. were crushed with mortar and pestle and the homogenate was analyzed for total carbon (C_{tot}) and total nitrogen (N) on a Flash EA 1112 elemental analyzer (Thermo Fisher Scientific, USA). In addition, organic carbon (C_{org}) contents were measured after acidifying the sample with 150 μL concentrated HCl to drive out C_{inorg}. Inorganic carbon content was calculated by subtracting C_{org} from C_{tot}. Stable isotope signatures were measured in a subset of these samples using a Delta S mass spectrometer (Thermo Fisher Scientific, USA) coupled with the elemental analyzer.

Further details can be found in the publication:

Vogel, N., Fabricius, K. E., Strahl, J., Noonan, S. H. C., Wild, C. and Uthicke, S. (2015), Calcareous green alga *Halimeda* tolerates ocean acidification conditions at tropical carbon dioxide seeps. *Limnology and Oceanography*, 60: 263–275. doi: 10.1002/lno.10021

Format:

This dataset comprises a single csv file, `Vogel_acid_opuntia.csv`.

Data Dictionary:

The columns of the `Vogel_acid_opuntia.csv` are described below:

- Species: *Halimeda opuntia*
- Treatment: Site of collection/ measurement, seep site or control reef
- Light calcification: calcification in light, given in $\mu\text{mol L}^{-1} \text{C h}^{-1} \text{gFW}^{-1}$
- Dark calcification: calcification in darkness, given in $\mu\text{mol L}^{-1} \text{C h}^{-1} \text{gFW}^{-1}$
- Net calcification: $12 \times \text{light} + 12 \times \text{dark}$ calcification, given in $\mu\text{mol L}^{-1} \text{C d}^{-1} \text{gFW}^{-1}$
- Net photosynthesis: oxygen production in light, given in $\mu\text{mol L}^{-1} \text{O}_2 \text{h}^{-1} \text{gFW}^{-1}$
- Dark respiration: oxygen respiration in darkness, given in $\mu\text{mol L}^{-1} \text{O}_2 \text{h}^{-1} \text{gFW}^{-1}$
- Gross photosynthesis: oxygen production – dark respiration, given in $\mu\text{mol L}^{-1} \text{O}_2 \text{h}^{-1} \text{gFW}^{-1}$
- C_{tot}: total carbon content, given in molar %
- C_{org}: organic carbon content, given in molar %
- C_{inorg}: inorganic carbon content (C_{tot}-C_{org}), given in molar %
- N: total nitrogen content, given in molar %

References:

Chisholm JRM, Gattuso JP (1991) Validation of the alkalinity anomaly technique for investigating calcification and photosynthesis in coral-reef communities. *Limnol Oceanogr* 36:1232-1239

Fabricius KE, Langdon C, Uthicke S, Humphrey C, Noonan S, De'ath G, Okazaki R, Muehlehner N, Glas MS, Lough JM (2011) Losers and winners in coral reefs acclimatized to elevated carbon dioxide concentrations. *Nature Climate Change* 1:165 - 169

Moss RH, Edmonds JA, Hibbard KA, Manning MR, Rose SK, van Vuuren DP, Carter TR, Emori S, Kainuma M, Kram T (2010) The next generation of scenarios for climate change research and assessment. *Nature* 463:747-756

Metadata language	eng
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Character set	UTF8
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Hierarchy level	Dataset
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OnLine resource

Linkage	https://eatlas.org.au/data/uuid/e95796dd-08dd-4a0c-b81c-230bf244c56a
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Protocol	WWW:LINK-1.0-http--metadata-URL
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Linkage	https://eatlas.org.au/nerp-te/gbr-aims-combined-water-quality-climate-effects-5-2
Protocol	WWW:LINK-1.0-http--related
Linkage	http://onlinelibrary.wiley.com/doi/10.1002/Ino.10021/abstract
Protocol	WWW:LINK-1.0-http--link
Linkage	https://eatlas.org.au/pydio/data/public/nerp-te-5-2_aims_vogel_acid_opuntia_2013-zip.php
Protocol	WWW:LINK-1.0-http--downloaddata

Point of contact

Individual name	Uthicke, Sven, Dr
Organisation name	Australian Institute of Marine Science (AIMS)
Role	Point of contact
Topic category	Biota

Keyword

Keyword	ocean acidification
Keyword	Halimeda opuntia
Keyword	calcification
Type	
Keyword	marine
Type	Theme

Extent

Description	Dobu Island, Milne Bay Province, Papua New Guinea Control Site
Description	Dobu Island, Milne Bay Province, Papua New Guinea Seep Site
Description	Upa-Upasina, , Milne Bay Province, Papua New Guinea Control Site
Description	Upa-Upasina, , Milne Bay Province, Papua New Guinea Seep Site

Geographic bounding box

West bound	150.8541
East bound	150.8541
South bound	-9.75208
North bound	-9.75208
West bound	150.8677
East bound	150.8677
South bound	-9.73665
North bound	-9.73665
West bound	150.8205
East bound	150.8205
South bound	-9.82822
North bound	-9.82822

West bound	150.8176
East bound	150.8176
South bound	-9.8241
North bound	-9.8241

File identifier	e95796dd-08dd-4a0c-b81c-230bf244c56a
Metadata language	eng
Character set	UTF8

Metadata author

Individual name	eAtlas Data Manager
Organisation name	Australian Institute of Marine Science (AIMS)
Role	metadataContact
Date stamp	2015-12-09T16:43:32