

SCOR Working Group Proposal

Title: BIOgeochemistry of COral REef systems (BIOCORE)

Summary/Abstract

Coral reefs are home to more than 25% of all marine species, making them the most diverse marine ecosystem. However, globally coral reefs are threatened by human activities at both large- (ocean warming and acidification) and local-scales (e.g. pollution, overfishing). The impact and extent of these disturbances vary between ocean regions, due to factors such as proximity to land and local human activity. While some anthropogenic activities have been clearly demonstrated to cause decline of dominant reef taxa, it is currently unclear how such changes impact the overall biogeochemistry and function of these ecosystems. This is caused by the fragmented knowledge of impacts, derived from observations from relatively few locations. Because many anthropogenic impacts are fundamentally chemical in nature, understanding the biogeochemical context of coral reefs in a changing world is critical to improve preservation efforts and enhance the health quality of these endangered ecosystems. Therefore, a coordinated international effort is needed to obtain a global understanding of biogeochemical processes in coral reef systems.

The **BIOCORE** working group would take a major step towards understanding the global variability in coral reef system biogeochemistry by 1) creating an accessible internet-enabled data platform, 2) summarizing the latest scientific insights by publishing a series of open access manuscripts, 3) hosting international workshops geared toward identifying gaps in our understanding of coral reef biogeochemistry, and 4) pursue capacity building in the research field for scientist from developing countries. The **BIOCORE** working group would thereby not only advance our understanding of coral reefs, but also provide knowledge of crucial importance for predicting how future changes will impact these unique ecosystems.

Scientific Background and Rationale

Coral reefs are vibrant, living assemblies which are amongst the most impressive and varied ecosystems on the planet. They are primarily found in tropical and semitropical waters (between 30°N and 30° S), where they provide food and income and a variety of services to hundreds of millions of people, mainly from tourism and fisheries (Moberg and Folke 1999), and are home to a myriad of marine species that are dependent on coral reefs to feed, reproduce, and obtain shelter. Globally, coral reefs are threatened by a combination of local (e.g. pollution, overfishing, growing coastal populations) and global stressors (ocean warming, acidification)(e.g. Cyronak et al. 2013), which, across large parts of the ocean have caused the steady decline of dominant coral communities (Burke et al. 2011; Fabricius 2011; Hughes et al. 2010). Corals are ecosystem engineers and thus play a crucial role in physically shaping the ecosystems they live in, mainly by their ability to produce large calcium carbonate structures. In order for corals to calcify and grow, they need stable environmental conditions, temperatures typically around 25°C, and oligotrophic, sunlit, and alkaline waters (Atkinson & Falter 2003; Uthicke et al. 2014). Understanding the interactions of biological, chemical, and geochemical fluxes and processes, that is the biogeochemistry, that control environmental conditions and the response of coral ecosystems to change is therefore crucial. However, much of the research on coral reefs to-date has been biological, with some geological and geochemical work.

We propose to form a SCOR Working Group which would focus on the biogeochemistry of coral reef systems (**BIOCORE**) across global and local scales to determine how coral reef systems have been and are being altered by environmental change. As coral reefs are globally spread over large geographical areas, the work we propose, naturally includes a strong international element, providing a unique framework to link existing information. Human pressures on coral reefs are increasing globally in both developed and developing countries. But the impact and extent of these disturbances varies between regions due to factors such as proximity to land, coral reef community composition, local human activities and the extent to which strategies for coral reef management are followed. The **BIOCORE** working group would provide the first step towards a more complete understanding of global variability in the biogeochemistry of coral reef systems. Many relevant data sets have been collected by independent researchers, agencies and nations, but comparing and synthesising this data from different reef systems, is a huge task, which requires sustained activity of a co-ordinated group of researchers. One example of such an analysis would be to summarize and understand why the daily and seasonal patterns in the partial pressure of carbon dioxide ($p\text{CO}_2$) are different between coral reef systems globally. It can easily be visualized using the NOAA Coral Reef Moorings data (<http://www.pmel.noaa.gov/co2/story/Coral+Reef+Moorings>), that the amplitude and patterns in the $p\text{CO}_2$ varies between systems, but understanding why this is the case would be one of the questions addressed by the **BIOCORE** working group. Another example of a detailed analysis would be to review and comprehend why the limiting nutrients for primary production varies between systems. While primary productivity in some coral reef systems is suggested to be limited by phosphorus (e.g. Florida Keys) others are limited by nitrogen (e.g. Great Barrier Reef) when assuming a Redfield Nitrogen: Phosphorus ratio of 16:1 (Redfield et al. 1963). This points to the nutrient biogeochemistry of these systems being different. Understanding the causes of these fundamental differences would be another valuable endeavour for the **BIOCORE** working group. As international efforts requiring prolonged activities are rarely funded by national research agencies a SCOR Working group would be an ideal platform to gather experts from key coral reef areas from around the world.

The “**BIOCORE**” working group would be comprised of an international consortium of coral reef researchers. Our major focus would be on increasing knowledge of coral reef biogeochemical processes that can be utilised for scientific, management and public outreach activities. This would be accomplished through; 1) providing a synthesis and review of coral biogeochemical processes by publishing a special issue in an open-access journal, 2) developing a strategic plan to fill in gaps in our knowledge, 3) pursuing capacity building for developing country scientists and 4) improving access to information by creating online databases and use other available communication tools.

Terms of Reference

The working group on “**BIO**geochemistry of **CO**ral **RE**ef systems (**BIOCORE**)” would:

1. **Identify and combine datasets** of key biogeochemical measurements in coral reefs to centralize the information and improve accessibility;

2. Write a **short perspectives paper** after the first meeting, to be submitted to an open-access journal (PeerJ or Frontiers in Marine Science), highlighting the importance and knowledge gaps in coral reef biogeochemistry;
3. Identify gaps in scientific knowledge and **develop priorities and recommendations** for future efforts within coral reef biogeochemistry studies;
4. Organize a **series of invited, peer-reviewed manuscripts** as a special issue in an open-access journal to enhance our understanding of coral reef processes;
5. **Conduct active outreach to coral reef researchers in developing countries** to build capacity through participation in the working group activities;
6. **Engage with the wider scientific and management coral reef community** by inviting them to the regular working group meetings.

These actions would be achieved during the working group meetings (annually for three years), building web-based resources and publishing of scientific manuscripts. This would establish the platform for the coral reef science community to build an international programme on coral reef biogeochemistry similar to existing international oceanic programs such as “GEOTRACES”.

Working plan/Timeline

Year 1 In order to provide high international visibility the first working group meeting would piggyback on the 13th International Coral Reef Symposium (ICRS: Hawaii, USA, June 19-24, 2016). The meeting would consist of an organized presentation session and subsequent 2-day workshop after the symposium so that participants from the symposium would be able to attend. Local coral reef authorities (e.g. NOAA-CRED and OAP) would also be invited to attend the workshop in order to provide end-user inputs and perspectives on the working program. This would ensure that the coral reef community is well informed of the working group objectives and targets. Other goals for the first working group meeting would specifically include the following:

- Inform the coral reef community of working group goals and targets;
- Obtain input from the coral reef research community and authorities on priorities and targets for future studies;
- Identify and distribute specific tasks to working group participants and set targets for deliverables, to ensure that all of the terms of reference would be covered during the 3-year period;
- Present the outline of the working group database and facilitate discussion for improvement;
- Launch social media platforms (e.g. Facebook, Twitter) which would be updated during the meeting and over the following 3 years;
- Draft a brief perspectives paper to be submitted to open-access journal highlighting the importance and research needs;
- Coordinate a special issue of an open-access journal (e.g. PeerJ or Frontiers in Marine Science) using papers presented in the special session at ICRS to report the current state of reef biogeochemistry and future research goals.

Year 2 Working group meeting 2. We would apply for a topical session at the aquatic science Meeting 2017 (Hawaii, USA; February 26 – March 3) and furthermore organize a 2-day

workshop following the meeting. This would ensure participation and input from the wider oceanographic community. Goals of the meeting would include the following:

- Focus progress on database synthesis and get the data webpage operational;
- Publish special issue in open-access research (PeerJ or Frontiers);
- Inform oceanographic community of working group goals and targets and discuss with the ASLO community the major goals and knowledge gaps;
- Develop final list of future challenges and research needs.

Year 3 Working group meeting 3 would be a 4 days meeting hosted by the Australian Institute of Marine Science, Townsville (AIMS) in 2018, with venue and accommodation costs covered as an in-kind contribution from AIMS. Representatives from the Great Barrier Reef Marine park authority would also be invited to this meeting to provide end-user inputs. Goals for the meeting would include the following:

- Finalize data access portal;
- Produce working group outcome document as open-access perspectives article in the journal "Coral Reefs";
- Discuss future plans for continuing working group efforts to build a robust platform for an international programme similar to the "GEOTRACES" program.

Capacity Building

Understanding coral reef biogeochemistry is essential for our understanding and capability to predict how coral reefs will respond to environmental changes and to develop and test strategies for coral reef management. Currently, this knowledge is often restricted to single locations and individual research groups. Many coral reef systems are located in developing nations with growing, but limited, research capacity. **The BIOCORE working group would therefore link key geographical areas and experts to enhance our understanding and develop new capability in coral reef biogeochemistry.** To ensure that these links are created, we would have full participation from Full Members in the meetings to be held in 2016, 2017 and 2018. We would also identify important knowledge gaps which would encourage new research efforts in this area. All working group members would furthermore participate individually and collectively in efforts to increase public and scientific understanding of coral reef biogeochemistry. Specifically we would develop capacity on several levels by:

- Creating a Facebook page and a Twitter account to promote public interaction. Activities of outreach are also anticipated through national and regional user groups and media.
- Including experts from around the globe to increase interactions, knowledge transfer, student exchanges and mentoring. The inclusion of scientists from developing nations provide links to ecosystems and research institutions in their respective regions and this ensure capacity building for developing country scientists through participation in the working group meetings and sessions hosted at international conferences, otherwise difficult to archive.
- Publishing of the working group outcomes in an open-access journal to provide a new resource to help expand the field and provide information to policy makers and managers. To build new capacity and sustain young researcher we would encourage all

working group members to involve early career scientist in the writing of these open-access publications.

- Invite end-user groups to attend and contribute to working group meetings (e.g. Great Barrier Reef Park Authority, NOAA).

Start and End Date

July 2016 to September 2018

Deliverables

If approved, this working group would:

1. Establish a database, hosted at AIMS, to connect available data of reef biogeochemical measurements.
2. Publish a scientific perspectives manuscript in an open-access journal, highlighting the importance and knowledge gaps in coral reef biogeochemistry.
3. Produce a series of publications to be included in a special issue of an open-access journal to enhance our understanding of coral reef processes. The papers would summarize current knowledge and identify gaps in our scientific knowledge and help us prioritise and make recommendations for future efforts within the research area.
4. Build and maintain at AIMS a support network for coral reef researchers in developing countries, including resources for grants, supplies, data repositories, and management guidelines.

Working Group Members

Full members of this Working Group were selected to assemble the appropriate scientific expertise and to span over the different geographical areas where coral reefs exist, including developing countries where a large fraction of the world's coral reefs are found.

Associate Members were chosen to expand the scientific and geographical working area, and they would assist with specific working group deliverables. As costs of attending the 3 working group meetings won't be covered for these members, we have mainly chosen associate members from countries where funding is likely to be available to cover such expenses in order to maximize meeting attendance.

The researchers included represent a broad geographical spread, from Asia, Australia, Europe, Middle East, North and South America. The working group members also span from early to mid-career international researchers to international leading experts in coral reef biogeochemistry.

Full members			
Name	Gender	Place of work	Expertise
Nicholas Bates	M	BIOS, Bermuda	Coral biogeochemistry
Beatriz Casareto	F	Shizuoka University, Japan	Microbial ecology and biogeochemistry
Ruy Kenji Kikuchi	M	Universidade Federal da Bahia, Brazil	Coral biogeochemistry
Christian Lønborg*	M	AIMS, Australia	Microbial ecology and biogeochemistry
Craig E. Nelson*	M	CMORE, USA	Microbial ecology and biogeochemistry
Xosé Anxelu G. Morán	M	Kaust, Saudi Arabia	Microbial ecology and biogeochemistry
Aazani Mujahid	F	University Malaysia Sarawak, Malaysia	Physical oceanography
Anond Snidvongs	M	Phuket Marine Biological Center, Thailand	Coral biogeochemistry
Adrienne J. Sutton	F	NOAA, USA	Ocean acidification
Aline Tribollet	F	IRD, France	Coral ecology and biogeochemistry

* = co-chairs

Associate members			
Name	Gender	Place of work	Expertise
Eric De Carlo	M	University of Hawaii, USA	Coral biogeochemistry and acidification
Henrieta Dulaiova	F	University of Hawaii, USA	Coral geochemistry
Bradley D. Eyre	M	Southern cross University, Australia	Coral biogeochemistry
Andréa G. Grotto	F	The Ohio State University, USA	Coral and isotope biogeochemistry
Joanie Kleypas	F	CGD/NCAR, USA	Ocean acidification
Nichole Price	F	Bigelow, USA	Ocean acidification
Jing Zhang	M	State Key Laboratory, China	Coral biogeochemistry

Funding

In order to reduce overall costs and ensure sufficient funding is available for all full members to attend all meetings we have 1) arranged that the Australian Institute of Marine Science, Townsville would cover the venue and accommodation costs for the third meeting in 2018 and 2) agreed that full members from developed countries, where possible, would cover parts of the cost of their own travel and accommodation from other sources.

References

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