Endolithic Tissue Aids Rapid Recover from Wounds in Porites Cylindrica: the 'Phoenix Effect' in Action

REEF ENCOUNTER

The news magazine of the International Coral Reef Society

GLASGOW COP26 SPECIAL EDITION

REEF PERSPECTIVES

Rupert Ormond: COP26 The ICRS Delegation - Impressions of the COP

REEF CURRENTS

Alan White: Lessons from Indonesia

REEF LIVES

Daphne Fautin
Walter Jaap
Jeremy Woodley
Paul Yoshioka

REEF EDGE

Sponge Necrosis
The Phoenix Effect
Sclerobionts

ICRS International Coral Reef Society

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Reef Encounter is the Magazine Style Newsletter of the International Coral Reef Society. It was first published in 1983. Following a short break in production it was re-launched in electronic (pdf) form. Contributions are welcome, especially from members.

INTERNATIONAL CORAL REEF SOCIETY
The International Coral Reef Society was founded (as the International Society for Reef Studies) in 1980, at a meeting in Cambridge, UK. Its mission is to promote the acquisition and dissemination of scientific knowledge to secure coral reefs for future generations.

CORAL REEFS - THE JOURNAL
The International Coral Reef Society also publishes through Springer its premier scientific journal entitled “CORAL REEFS”. The Journal publishes high quality scientific papers concerning the broad range of fields relevant to both modern and ancient reefs. For further details, including the list of editors see here.

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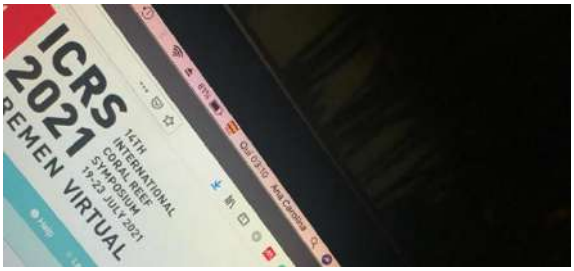

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EDITORIAL & OFFICERS' REPORTS

PRESIDENT'S WELCOME

Andréa Grottoli, ICRS President

Dear International Coral Reef Society (ICRS) Colleagues:

The International Coral Reef Society is a scientifically and culturally rich organization and I am proud and honored to serve as its President. Despite the setbacks and difficulties due to the pandemic, we have accomplished so much over the past six months and have great plans for the coming year.

One of the goals of the ICRS Plan of Action is to promote science-based decision making for coral reefs. We are meeting that goal with engagement and action in four areas:

1. **Science-to-Policy Paper:** During the 14th virtual International Coral Reef Symposium, we launched the science-to-policy paper "Rebuilding Coral Reefs: a Decadal Grand Challenge" that was the inspiration of Dr. Sebastian Ferse and lead by our newest ICRS Darwin Medalist Dr. Nancy Knowlton. The paper provides a path forward to protect and restore coral reefs with three target actions: 1) **Reduce global climate change threats** by establishing and following through on commitments, 2) **Improve local conditions to build resilience** through active coordination among agencies at all levels of government, and 3**) Invest in active restoration to enhance recovery** coupled with support for innovation. Many thanks to the team of authors, advisors, reviewers, and translators. The executive summary is available in English, German, French, Spanish, Portuguese, Chinese, Indonesian, and Arabic.

2. **CoP Meeting Observer Status:** We have observer status in the upcoming Convention of the Parties (CoP) on Climate Change (October 2022, Glasgow) and will be co-hosting a side event with other organizations. The contents of the science-to-policy paper form the central message to our presentation. Thank you to the ICRS Conservation Committee co-chairs Rachel Peixoto and Simon Harding for leading the ICRS efforts at the recent CoP26 meeting and to Rupert Ormond for securing the observer status for the Society.

3. **G20 International Coral R&D Accelerator Platform**: ICRS is a voting member of the Initiative Governing Committee of the G20 International Coral R&D Accelerator Platform. We have also nominated several researchers to serve on the Scientific Advisory Panel for the platform.

4. **International Coral Reef Initiative:** ICRS has members sitting on the three ad hoc committees (CBD Post-2020 Global Biodiversity Framework, Resilience Based Management for coral reefs, Reef Restoration) and co-authors on a white paper on coral reefs and human health. Thank you to Simon Harding, Sue Wells, Ania Banaszak, Rupert Ormond, Morgan Pratchett, Ranjeet Bhagooli, Michael Sweet, and Valerie Paul for their contributions to these efforts.

We are also in the final stages of establishing a new three-year contract with Springer for the publication of our journal Coral Reefs. Under our new agreement, authors will be able to submit abstracts in Spanish, Portuguese, French, Mandarin, and German in addition to the required English version. The journal will transition to an online-only publication, and we will receive 10% royalties as payment to the Society.

Finally, the 14th International Coral Reef Symposium was the first virtual conference for the Society. With 1100 registered participants, 900 presenters, 4 concurrent live streams, e-posters, workshops, and virtual social events, the symposium was a great success. For all those who registered, the archive of all presentations and posters is accessible until next summer. My deepest thanks to the symposium organizing committee chair Dr. Christian Wild and all the members of the organizing committee for their tireless work in making the meeting a success. Please mark your calendars for the 15th International Coral Reef Symposium to be held in-person in Bremen, Germany 3-8 July 2022.

Moving forward, one of my main goals is to develop a stable financial plan for the Society. The royalties from Springer publishing and the return on the financial investment we made in 2020 serve as first steps in building financial stability for the Society. We are looking to decrease registration costs at the 2026 conference and increase support for students and early career scientists, while at the same time recalibrating our balance sheet in response to the pandemic. We continue to depend entirely on membership dues to support the Society operation and existing programs in ICRS such as student fellowships, awards, local and regional meetings, and support of our chapter organizations.

As you can see, the ICRS has been busy. As President of the Society, I am incredibly grateful to the Officers and Council members who voluntarily work tirelessly for the Society, and to all ICRS Members for your continued support of the Society. Your dedication and commitment to reefs makes the above accomplishments possible.

Sincerely,

President, International Coral Reef Society
Professor, Ohio State University

ICRS GENERAL MEETING

Record of the General Meeting of the society

Held on-line 14th July 2021

The International Coral Reef Society General Meeting was held on the **14th of July 2021** using a virtual format for the first time in ICRS history. Two meetings were scheduled to accommodate all time zones. The first meeting was recorded and replayed at the second session to ensure the same information was relayed at both meetings. The following are the reports presented by the President, officers and committee chairs:

President's Report

The ICRS President, Dr. Andrea Grottoli, welcomed the attendees and presented the State of the Society report

The mission of ICRS is to promote the acquisition and dissemination of scientific knowledge to secure coral reefs for future generations. The vision is to be a leader in coral reef scientific discovery, to contribute to the education of future coral reef scientists, and to be a strong voice for science-informed policies that protect coral reefs. The ICRS Plan of Action, which laid out the goals we had as a society for the coming four years, was launched last year; some of these goals have already been implemented, others are in progress. The first goal, to promote science-based decision making for coral reefs, was advanced with the publishing of the ICRS Science to Policy document. The three main messages of this paper are: we need to reduce global climate change threats by establishing and following through on commitments such as those made in the Paris agreement, as well as other innovations having to do with blue carbon. Second, we need to improve local conditions, mostly through MPA management of both coasts and reefs, through active coordination among agencies at all levels of government. Third, we need to invest in active reef restoration to enhance recovery. One of the points the paper makes is that the latter two projects will be most effective and have the highest degree of probable success if climate change is mitigated. This paper will serve as a cornerstone for the discussion and for our interventions at the CoP in Glasgow and other meetings that are coming in the next year. We are launching this document now to make sure coral reefs are taken into consideration in these international agreements. The second goal was to reduce the carbon footprint of the Society, and with the virtual ICRS meeting and virtual General Meeting we are already reducing our carbon footprint.

Otherwise ICRS has formalized partnerships with other societies to create a larger umbrella association that can encompass all the voices that represent coral reef science. Our newest chapters are the Mexican Coral Reef Society, the Mid-East Coral Reef Society, and the European Chapter; they join the Coral Restoration Consortium and the Student Chapter. We also now support two science communication fellowships. We have also launched The Pledge for Corals Reefs, which is a series of actions that any individual can take to be part of the solution for coral reefs.

Meanwhile we are in the final stages of renegotiating our contract with Springer for the journal Coral Reefs. For the first time the Society will be receiving 10% royalty payments from Springer, and it is agreed that we will now publish abstracts in multiple languages, in addition to the required English; we will start with Spanish, Portuguese, Mandarin, French, and German. We will no longer be publishing the hard copy versions of the journal which will save money. Lastly, the Table of Contents will now include sub-headings, so that you can quickly find papers and subjects that you are interested in and to illustrate the diversity of papers being published in the journal.

We also want to start developing a strategic sustainable financial plan for the money we are earning; this will determine how we invest the money and how we allocate it. One goal will be to reduce the

cost of symposium registration for the 2026 meeting. We would also like to have targeted fundraising activities to support specific goals. In addition, we will continue to work closely with colleagues in Germany who have continued working to implement both the virtual 14th ICRS and the in-person 15th Symposium in 2021 and 2022. I would especially like to thank Dr. Christian Wild, who has been working tirelessly with his team to make this happen, despite the challenges of the pandemic. By the time all is done, he will have been planning the symposium for four or five years. At the same time we will be working with the team in New Zealand who will be hosting the 16th ICRS in 2026. Thanks to all of you for your dedication and commitment to coral reefs and to the Society.

We have also been busy at the international level promoting science-based policy by:

- *collaborating with the American Fisheries Society on the World Climate Statement and acting as co-authors of the Correspondence in the journal Nature that highlighted this statement,*
- *serving on the scientific advisory committee for the G20 Global Coral Reef R&D Accelerator Initiative,*
- *securing observer status at the United Nations Climate Change Conference and working with partner organizations including UNEP and the World Wildlife Fund to coordinate a side event to highlight the need to reduce greenhouse gas emissions and regulate climate change in order to save coral reefs,*
- *becoming a signatory to a letter to UNESCO calling for expanded protection of the Great Barrier Reef,*
- *intensifying our relationship with the International Coral Reef Initiative, working with them on a paper on Coral Reefs and Human Health, and serving on three ad hoc committees: a CBD Post-2020 Global Biodiversity Framework committee, a committee for Resilience Based Management of Coral Reefs and a committee for Reef Restoration.*

ICRS currently has 1,242 members (450 of whom are students) from 75 countries. ICRS is an all-volunteer organization and over the past two years has made great strides by defining who we are as a Society and what we want to do, thanks to a large number of people working together; special thanks are extended to all Officers, Council members, Committee chairs and members, Chapter organizations, and the Coral Reefs and Reef Encounter teams, and all members for their support.

The President's report was followed by update reports from each of the Society's committees, presented by the respective chairperson(s).


Conservation Committee Report

by Co-chairs Raquel Peixoto and Simon Harding

1. The ICRS Conservation Committee's new Terms of Reference were finalised in May 2021. "The purpose of the International Coral Reef Society (ICRS) (the "Society") Conservation Committee is to consider coral reef conservation and management related activities of interest to the Society and, subject to approval by the ICRS President and/or ICRS Council, pursue those activities as energetically as is practicable".

2. The committee has been doing a lot of work with the ICRI ad hoc committee on the inclusion of a coral reef-related target in the Post-2020 Global Biodiversity Framework. A new version of the framework has just been released this week.

3. Members of the committee were involved in the review of the ICRS Policy Paper.

4. The committee is planning the Coral Reef Side Event at the UNFCCC COP26 in the EU Pavilion together with a number of partner organizations.

5. Ongoing activities include input to the ICRI Resilience-based Management AHC, input to the ICRI Restoration AHC and closer interaction with ICRI e.g. attendance at its Annual Meeting, responding to surveys / requests, and supporting communications work.

6. The committee has also been undertaking evaluation of the Conservation Awards, developing a working arrangement with the ICRS Communications and Education Committees, and liaising with the UNEP coral reef team.

Communications Committee Report

by Chair Michael Sweet

We have the new website in full swing and looking "swanky" (thanks to Joanie Kleypas, Liz Drenkard, and the website design company and its CEO Frank Farris). We have the Society's Facebook site, managed by former committee member David Baker, with 9.3K members, although we would welcome more ICRS specific content. We also have a Twitter account started relatively recently but that already has 982 members. Do follow us: @ICRSCoralReefs. The YouTube channel created during the Hawaii conference is currently inactive, but there are plans to bring it back to life. We have an open call for content for any social media channels. Members are asked to please email me with content in a suitable format and video/pictures as relevant; but note that submissions go through a series of checks to ensure that content is appropriate. We have also developed a new concept, appointing two new ICRS Science Communication Fellows: Denise Danielle Alcantara and Tory Chase. Fellows are provided with a training budget enabling them to train themselves or attend relevant courses and workshops. For more information please consult: coralreefs.org/awards-and-honors/science-communication-fellowship/. New applications are due on 15th March 2022.

Equity, Diversity, and Inclusion Committee Report by Chair Joanie Kleypas

The aim of the Equity, Diversity and Inclusion (EDI) committee is to help the Society become more inclusive and engage more with our very diverse community. We want to attract more diversity amongst our leadership, and amongst our active membership. Our challenge is to understand what further actions we can take to become more inclusive.

We have created an ICRS Diversity Statement, which is "Coral reefs are diverse. ICRS should be too". On the Society's website you can find more information about this. We have also completed the ICRS Code of Conduct (initiated when Ruth Gates was President) incorporating a clear, strong message promoting fair, equitable treatment and behaviour of everyone within ICRS and at all ICRS functions.

We also have a new proposal to help us address how we are progressing with EDI. This proposal was submitted to the (US) National Science Foundation (NSF) LEAPS (LEAding cultural change through Professional Societies) program. The title is "Collaborative Research: LEAPS: Assessing and broadening diversity, equity, and inclusion, leading to cultural change in the International Coral Reef Society". The proposal was led by Tammy Goulet with co-PIs Andrea Grottoli, Nikki Traylor-Knowles and many other ICRS members as collaborators. It is a very exciting proposal, which we hope gets funded. Proposed actions are to evaluate the composition of the ICRS membership, to evaluate how we can eliminate any bias in the awards process and to evaluate representation within coral reef publications to make them more inclusive.

A series of problems & solutions have been identified and discussed by the EDI committee. These have included (with possible solutions indicated):

- *Language is a huge barrier – provide abstracts in other languages*
- *Invisible science is great science that is being undertaken but not being published in journals and reaching the rest of the community – a platform for making publications in other journals more visible to the ICRS community*
- *"Parachute science" where researchers from advanced countries work in another country, complete their science, but leave without proper engagement – criteria for reef scientists working in countries other than their own*
- *Limited access to publishing – a no-cost fee in Coral Reefs to support those with limited funding and keep people publishing there*
- *Limited access to funding by researchers in less wealthy countries – develop ways to partner low-funded researchers with high-funded researchers.*

Awards Committee Report

by Chair Carly Randall

The aim of the awards committee is to recognize and honour Society members for their excellence in research, and for their scientific, conservation and management contributions. ICRS offers a suite of awards, fellowships and grants (14 in total). We are always looking to increase the number of awards. The goal of these 14 different awards is to span different career stages and disciplines. Please visit https://coralreefs.org/awards-and-honors/ for a complete list of the opportunities available. Another aim is to maintain diversity (gender, cultural, age, socio-economic, field of study) within the committee itself that judges the nominations. Current committee members include: 10 ICRS Councillors & 2 ICRS Officers, 3 members of the Conservation Committee, and 2 members of the Equity, Diversity, and Inclusion Committee.

In the last two years, the committee evaluated 246 student travel grant applications, 40 graduate fellowship applications, and 47 other ICRS awards and fellow applications. This is an extensive amount of work and we really appreciate both those who have put effort into nominations and the members of the awards committee who have undertaken the evaluations. We granted 30 Student travel grants for ICRS2021 virtual registration, 12 Graduate fellowships and 27 Society awards including to Dr. Nancy Knowlton as our 2020 Darwin Medallist. Visit the ICRS website http://coralreefs.org/awards-and-honors/recipients/ for a complete list of recipients. The ICRS2020 Student travel grants were carried over to ICRS2021. A new call for ICRS2022 will be announced later this year.

Recent changes have been made to improve efficiency, flexibility, and objectivity. There is a new on-line application submission system implemented using Google Forms and also a new instructions document (thanks to Lisa Rodrigues who trialled and finalized the system over the past few years). The Awards and Honours Committee and Graduate Fellowship Committee were merged to form one Awards Committee, and more committee members included to help with the evaluation process. Application deadlines have been consolidated to two specific dates each year: December 15th for the Darwin Award and Student/Communications Fellowships and February 15th for the remaining awards (i.e., Eminence, Mid-career, ICRS Fellow). Finally, 2021 marked the first year that current ICRS Fellows were included in the selection and endorsement of new Fellows; Fellows will be asked to help with award evaluations in coming years.

Education Committee Report

by Chair Luis Calderon-Aguilera

The vision of the Education Committee is to promote knowledge and awareness of the nature of coral reefs and the threats to them, from a broadly inclusive perspective, fostering the participation of under-represented groups, in line with the Society's EDI policies. The Education Committee's objectives are to consider what environmental education and public awareness activities are appropriate for the Society to undertake, considering its character and constitution, and to prioritize those activities as energetically as is practicable. The intention is to make as much use as is practicable of the Society's website and of its news journal Reef Encounter and to coordinate with other committees to pursue joint actions.

To accomplish these goals we plan to call for new members committed to education. The committee will stay involved with selecting the Science Communication Fellows, and will seek to work with other Society members in their formal (academic) and informal reef-related teaching activities, including by sharing teaching experience and materials (lecture notes, field and lab exercises, references, and book lists). We also intend to create an ICRS EC twitter handle #ReefEducation and promote online courses in different languages.

Financial Report

by Treasurer Anderson Mayfield

I will briefly explain ICRS's financial structure, status, spending and future. ICRS receives 97% of its money from membership dues and 3% from donations. About $115,000 to $120,000 USD comes in per year. After renegotiation of our contract with Springer (the publishers of the Society's journal Coral Reefs*) rather than the Society paying them $3,000 to $4,000 per year, starting in 2022, approximately $20,000 per year in royalties will be earned by the Society. Operating costs run at about $75,000-$80,000. Of this $15,000 goes to SG Meet to maintain compliancy, banking fees, credit card fees, and the Member Clicks feature for making payments; $15,000 goes to student fellowships and student travel; $15,000 goes towards sponsorships (and other awards); and $10,500 to the individual chapters payments to support regional conferences etc.*

Our earnings were used to triple travel grants for students to attend upcoming symposia, and to fund the new science communication fellowships. The net balance of $35,000-$50,000 has been invested to underpin the Society´s financial health and stability.

Other recent improvements have include diversifying the means of paying for membership (e.g. by wire transfer), modifying the membership registration process to be more inclusive, and improving the donation structure so that individuals can donate to specific areas or awards (e.g. the conservation award or student fellowships).

Looking forward, the hope is to develop a strategic, sustainable financial plan. Goals will be to help offset conference costs for members (not exclusively students), to continue increasing the number and size of awards, and to develop a path for assisting with open access publications. On the fundraising side, we have been looking for ways to grow the donations we receive, currently several thousand US$/year (including several hundred dollars per year via Amazon Smile). We are exploring ways to reach out to celebrities and charitable foundations, to facilitate monthly donations through payroll deductions and to market Society branded merchandise. Please feel free to offer further suggestions.

Coral Reefs Report

by Editor-In-Chief Morgan Pratchett

First, I should acknowledge the Topic Editors at Coral Reefs*, who do most of the handling of new submissions: Anastazia Banaszak, Simon Davy, Alastair Harborne, Andrew Hoey, Stuart Sandin, Lauren Toth, Mark Vermeij, Steven Vollmer. Special mention should also be made of newly appointed Editorial Board members, who help to shape the direction and scope of the journal, and who are increasingly involved in completing timely reviews, as it becomes ever more challenging to find reviewers. These are: Rebecca Albright, Lorenzo Alvarez-Filip, Serge Andréfouët, Michael Berumen, Simon Brandl, Terry Done, Peter Edmunds, James Guest, Dennis Hubbard, Kiho Kim, Haruko Kurihara, Harilaos Lessios, Valerie Paul, Chiara Pisapia, James Reimer, Miriam Reverter, Kimberly Ritchie, James Robinson, Verena Schoepf, Shaun Wilson, Maren Ziegler. Special thanks to Terry Done for managing the* Coral Reefs *Annual Best Paper Award, which comes with a financial prize provided by Springer. The winners are acknowledged in Reef Encounter and recent winners listed in each issue of Coral Reefs.*

Despite recent challenges, the number of submissions has remained close to normal (about 1 submission per day) and similar to previous years (2019:331 and 2020:346). 307 final decisions were made in both years (117 and 154 accepted and 176 and 129 rejected in 2019 and 2020, respectively). Acceptance rates were 38% and 50%, respectively. The average number of days to first decision did increase slightly from 56 (2019) to 67 (2020). The increase is mostly due to waiting ever longer to get responses from potential reviewers.

Coral Reefs is the official and only journal of the ICRS, publishing papers that are focused on understanding and managing coral reef systems and

organisms. The journal publishes original research articles (longer reports and shorter notes) and would like to publish more reviews (synthetic or systematic). The impact and standing of Coral Reefs *continues to increase. The 2020 Cite Score (which captures metrics over a 5 year period) and 2 year Impact Factors (number of citations in 2020 to papers that were published in 2018 and 2019) were recently released and are currently 5.8 and 3.982 respectively. The journal is ever evolving to provide better services to the Society. Some fundamental changes include accepting submission of articles in any format, to expedite the process, although closer to acceptance the paper still needs to be formatted. The journal is not currently an Open Access journal, but mechanisms are in place to allow for free sharing (e.g., using Springer´s ShareIt). Thanks to all who have contributed manuscripts and reviews; we look forward to receiving more contributions.*

Reef Encounter Report
by Coordinating Editor Rupert Ormond

Reef Encounter is the magazine style newsletter of the ICRS. It was first published in 1983 and relaunched in electronic form (as a pdf) in 2014. The editorial panel is thanked for their assistance and for reviewing contributions. Particular thanks are due to the Deputy Editor, Caroline Rogers, for her considerable assistance in getting issues finalized. The number of items in successive issues since the previous ICRS general meeting has varied between 27 and 41 items per issue. The frequency of issues has normally been one per year, but during conference years two issues have been published, one before and one after the conference. Contributions to the newsletter are officers´ reports, announcements, review articles, project descriptions, conference reports, short overviews of topic areas, book reviews and obituaries. Moving forward, we intend to move to two smaller issues per year, although that is something which is easier said than done.

Recently, the editorial panel has been working to improve the appearance of Reef Encounter and adopted a more magazine-style format in the most recent issue (March 2021). This new design and page layout was the work of Silas Principe, a Brazilian PhD student who has recently joined the panel. The panel always welcomes feedback, suggestions, and contributions. Please don´t hesitate to contact us if you are interested in contributing in any way, either as an author or an editor.

The 14th virtual ICRS2021 and in-person 15th ICRS2022 Report by Conference Chair Christian Wild

At the end of 2016, ICRS assigned the 14th ICRS 2020 to Bremen, Germany, the first European host of ICRS, for which we acknowledge the help of the Bremen government in providing staff and secretariat. By February 2020, preparation and registration were well underway, the budget was balanced, big sponsors were on board and about 3,000 participants were expected (1,400 talks and 1,200 posters). In March 2020 however, COVID-19 became a pandemic and in April 2020 it was decided, together with ICRS leadership, to postpone the 14th ICRS from July 2020 to July 2021, hoping that by then the pandemic situation would have eased. But by September 2020 it had become obvious that this was not the case, so a hybrid strategy was announced, combining an on-line conference with an in-person meeting. By October 2020, close to 2,200 abstracts had been re-submitted or newly submitted, with only 7% submitters choosing "on-line only". By December 2020, the evaluation of abstracts was completed, but the secretariat was hesitant to announce the outcome, since the epidemic situation had become even worse.

Further challenges appeared early in 2021. The conference venue became a vaccination centre. There were long-lasting travel restrictions imposed by many countries, especially Australia (one of the main target groups for ICRS events). Distancing rules were expected to last until autumn. Our budget was now deeply in the red due to Covid-related postponement costs (many expenses but no income). Key sponsors were questionable due to lack of clarity on what would happen. Staff contracts in the ICRS secretariat could not be renewed; we continued with a small team, though some have still not been paid. Finally, a new dual strategy was agreed - for the 14th ICRS 2021 Bremen to be virtual (19th to 23rd July) and a 15th ICRS 2022 Bremen (3rd to 8th July) to be in-person, in Bremen. Both formats have advantages and disadvantages. Further, with two such events organised in two successive years there is the likelihood that they may compete with each other, so different target groups are being addressed with the two formats.

During the 14th ICRS, the focus is on scientific exchange and early career researchers. There are 1,100 registered participants and 900 presenters, 4 live streams, pre-recorded talks and e-poster sessions, workshops, a policy event, and social/break program (e.g., pub night, mentoring, yoga, karaoke). The archive option was accepted by more than 95% of presenters and presentations will remain available for viewing for a whole year. An added value of the virtual format is that you need not miss presentations or posters.

The budget deficit and Covid-induced postponement costs have been partly compensated. But: there are no new supporters on board (an important exception is UNEP giving $50,000 USD to cover the green format) and no return of previous sponsors, in part because of the virtual format. But overall, there is more good news than bad news.

The focus of the 15th ICRS will be on in-person events, with lots of networking opportunities. Some virtual elements will be included, that worked at the 14th ICRS, provided they are affordable. Already accepted abstracts will keep their status, with an option to update or submit new abstracts linked to registration in January 2022. The sponsorship situation will likely stay problematic and financial support for secretariat staff is much needed. Nevertheless, we welcome everyone at the first virtual ICRS event and very much look forward to next year seeing everyone in person for the 15th ICRS in Bremen.

The meeting was followed by an open discussion before adjournment.

Anastazia Banaszak
ICRS Recording Secretary

SOCIETY ANNOUNCEMENTS

ICRS Awards and Honors 2022

Please consider nominating your ICRS colleagues for their research and conservation accomplishments! Colleagues at all career levels are eligible for the following annual awards. **Nominations for all awards listed below close on February 15, 2022.** Complete nomination criteria, information, and award descriptions can be found online at http://coralreefs.org/awards-and-honors/.

- **Eminence in Research Award**
- **Mid-Career Award**
- **Early-Career Award**
- **World Reef Award**
- **Coral Reef Conservation Award**
- **ICRS Fellows**

Nominations should be submitted online (email nominations are no longer accepted). Directions for the online form can be found at icrs.memberclicks.net/message2/link/fe3db319-28db-418b-a91d-9ad20133c261/4. Questions about ICRS honors and awards can be addressed to Dr. Carly Randall (c.randall@aims.gov.au).

Carly Randall
Chair ICRS Honors & Awards Committee

ICRS Awards and Honors **2021**

Earlier this year ICRS Officers and Council announced the 2021 award of the following honors to the following members:

- Eminence in Research Award – **Helmut Schuhmacher**, University of Duisburg-Essen, Germany
- Eminence in Research Award – **Jorge Cortés-Núñez**, University of Costa Rica, Costa Rica
- Mid-Career Award – **Luiz Rocha**, California Academy of Sciences, USA
- Early Career Award – **Nyssa Silbinger**, California State University, Northridge, California, USA
- Coral Reef Conservation Award – **Melanie McField**, Healthy Reefs for Healthy People Initiative / Smithsonian Institution, Fort Lauderdale, Florida, USA

The winners listed above automatically received ICRS Fellow status.

The following nominees also received ICRS Fellow status:

- **Anastazia Banaszak**, National Autonomous University of Mexico, Puerto Morales, Mexico
- **Howard Lasker**, University at Buffalo, New York, USA

ICRS Graduate **Fellowships**

ICRS Officers and Council have announced the award of the 2021 Graduate Fellowships to:

- **Natalie Anderson**, University of Exeter, Exeter, UK
- **Emily Chei**, University of Hong Kong, Hong Kong
- **Benjamin Farmer**, Louisiana State University, USA
- **Akacia Halliday-Isaac**, University of Mississippi, USA
- **Katherine Lawson**, State University of New York, USA
- **Clayton Vondriska**, Arkansas State University, USA

Thanks to all nominees, nominators, and writers of letters of support. You all help to make the ICRS a thriving Society. The ICRS supports diversity and inclusivity, and we are happy to be able to award scientists and students from across the globe. We encourage all ICRS members to nominate candidates for awards in the coming years that will continue building this esteemed and globally diverse group of awardees. We note that Graduate Fellowship Applications were only received from 3 nations this year and we aim to increase this diversity in the coming years. Thank you for all that you do to investigate, protect, and conserve coral reef ecosystems.

Best Paper for **Coral Reefs** Volume 39, 2020

From a total of 150 articles published in six issues, the twenty-nine members of the Coral Reefs editorial team nominated 39 papers for consideration for 2020's Best Paper. The criteria for inclusion were both the quality of the research reported, and the quality of the presentation as published. From a short list of six papers that were nominated by several board members, the winner was a paper by Georgina Nicholson and Kendall Clements that addressed the role of parrotfishes as ecosystem engineers in coral reef ecosystems. The authors undertook a detailed field study of parrotfish's dietary targets at a microscopic scale, affirming the minor contribution of macroalgae and linking diet to the successional stages through which microscopic photoautotrophs and reef substrata transition during a reef's damage and recovery cycles. Congratulations to Georgina and Kendall for producing a quality paper that gained such recognition by your peers.

The lead authors and titles of the other five papers that received multiple nominations for this year's award are listed below. Congratulations to you all!

The Winner

Resolving resource partitioning in parrotfishes (Scarini) using microhistology of feeding substrata

Georgina M. Nicholson and Kendall D. Clements

Abstract: Parrotfishes (Scarini) are considered key agents in coral reef health and recovery, but the drivers of parrotfish–coral dynamics remain contentious. The prevailing view of parrotfishes as ecosystem engineers is based on the perceived removal of algal turf, macroalgae and sediment, but these are effects of feeding, not causes. The recent proposal that most parrotfishes are 'microphages' that target microscopic photoautotrophs (particularly cyanobacteria) identifies the need to resolve dietary targets at a microscopic scale. Here, we investigate parrotfish dietary targets by posing the following two questions: (1) are microscopic photoautotrophs the most consistent and dominant elements of the prey community, and (2) do the prey community and substratum taphonomy vary between parrotfish species? In order to identify and quantify dietary targets, five parrotfish species were followed until focused feeding was observed at Lizard Island on the Great Barrier Reef, Australia. Feeding sites were photographed in situ and extracted as substratum bite cores. Cores were analysed microscopically to identify and quantify all epilithic photoautotrophs. Endolithic photoautotrophs accessible to excavating parrotfish were also investigated by vacuum-embedding cores with epoxy resin followed by decalcification to expose endolith microborings. The dominant functional groups of epilithic biota on the cores were tufted cyanobacteria, turfing algae and crustose coralline algae (CCA). The only consistent feature across all cores was the high density of filamentous cyanobacteria, supporting the view that these parrotfishes target microphotoautotrophs. Macroalgae was absent or a minor component on cores, supporting the hypothesis that parrotfishes avoid larger algae. The microchlorophyte *Ostreobium* was the dominant photoautotrophic euendolith (true borer) in the cores of the excavating parrotfish *Chlorurus microrhinos*. Significant differences in CCA coverage, turf height and substrate taphonomy were found among the five parrotfish species, suggesting that interspecific resource partitioning is based on successional stage of feeding substrata.

Honorable mentions

Congratulations also to all authors of these other shortlisted papers.

Anna K. Cresswell, Damian P. Thomson, Michael D. E. Haywood & Michael Renton (2020) Frequent hydrodynamic disturbances decrease the morphological diversity and structural complexity of 3D simulated coral communities. Coral Reefs 39: 1147–1161

Rowan H. McLachlan, James T. Price, Sarah L. Solomon & Andréa G. Grottoli (2020) Thirty years of coral heat-stress experiments: a review of methods. Coral Reefs 39: 885–902

Renato A. Morais & David R. Bellwood (2020) Principles for estimating fish productivity on coral reefs. Coral Reefs 39: 1221–1231

Hannah G. Reich, Irene B. Rodriguez, Todd C. LaJeunesse & Tung-Yuan Ho (2020) Endosymbiotic dinoflagellates pump iron: differences in iron and other trace metal needs among the Symbiodiniaceae. Coral Reefs 39: 915–927

Sterling B. Tebbett, Andrew S. Hoey, Martial Depczynski, Sharon Wismer & David R. Bellwood (2020) Macroalgae removal on coral reefs: realised ecosystem functions transcend biogeographic locations. Coral Reefs 39: 203–214

Terry Done
Convener of Coral Reefs Best Paper Award

CONFERENCES

15th ICRS, 3rd – 8th July, 2022

Bremen, Germany

Prof. Dr. Christian Wild | Universität Bremen - christian.wild@uni-bremen.de

Our third attempt to hold a traditional-style International Coral Reef Symposium, in Bremen, will take place, as an in-person event, from July 3rd to 8th, 2022. This time the event will primarily consist of personal presentations of talks in the normal way. There will also be evening poster sessions with finger food and drinks provided. We also aim to stream and archive all in-person oral presentations on the virtual conference platform, so that they can be viewed and discussed more widely.

In addition, the 15th ICRS 2022 will provide remote virtual participation opportunities, with pre-recorded talks and e-posters linked to speed talks being made available on the virtual conference platform and archived as successfully carried out for the 14th ICRS 2021 Virtual Conference. Exchange and discussion will be possible via related chats on the platform, not only during the 15th ICRS 2022, but for months afterwards via the archive. However, there will be no moderated on-line discussions, and while virtual contributions will be included in the scientific program, they will not be in the schedule during the conference week.

All previously accepted abstracts will keep their status as pre-approved oral or poster presentations; but it will be possible to update these during the re-submission process in early 2022. In addition, we encourage the submission of completely new abstracts, so that we can include fresh research findings in the scientific program. While these new abstract submissions will need to be evaluated, we intend to carry out this evaluation as rapidly as possible. As previously, we expect to accept more than 98% of submitted abstracts, rejecting only those written in poor language that heavily impedes their understandability being rejected.

Because of this strategy, coupled with time constraints, we will need to link each delegate's registration with their abstract (re-) submission. That means that you will need to register before you can submit or resubmit your abstract. At the point of registration, you will be able to decide whether you want to participate in-person in Bremen or to do so remotely via the virtual conference platform. Further detailed information about what is included in each type of registration and about the registration fees will be announced when registration opens. We anticipate the fees will be similar to those announced for in-person and virtual attendance at the 2020 and 2021 events, but active participants at the 14th ICRS 2021 will be offered a discount for the 15th ICRS 2022.

We will open registration by mid-January 2022, with the following fixed (i.e. no extension possible) deadlines for each stage:

- February 23 for all in-person and virtual participants to submit **new abstracts** that will need to be evaluated
- March 16 for all in-person and virtual participants to **re-submit abstracts** that have already been evaluated
- April 27 end of **early-bird registration** for all non-presenting in-person and virtual participants
- June 15 end of **standard registration** for all non-presenting in-person and virtual participants

We look forward to receiving your registration and welcoming you at last to the charming historical city that is Bremen.

CONFERENCES

14th ICRS (VIRTUAL), 19th – 23rd July, 2021

Bremen, Germany

The 14th International Coral Reef Symposium (ICRS 2021) – hosted by **University of Bremen**, Germany, and organized together with the **Bremen Convention Bureau** (WFB), in close partnership with the **International Coral Reef Society (ICRS)** – **took place, because of the global covid epidemic, between 19th and 23rd July, as an entirely virtual event.** There were more than **1300 participants** coming **from all continents (except Antarctica!) and 80 countries**. More than 500 of the participants were students.

While, in contrast to the previous ICRS events, the 14th ICRS 2021 VIRTUAL took place on-line, nevertheless both oral and poster presentations were available and will remain so, in the **conference archive**, for about a year, until the start of 15th ICRS in early July next year (2022). The archive includes **595 pre-recorded oral presentations** and **265 electronic posters** (ePosters), plus several **workshops**. Many of the ePosters in the gallery are linked to **speed talks** prepared by the authors, with the symposium program embedded with brief opening and closing events.

Notably the 14th ICRS 2021 VIRTUAL Symposium combined both synchronous and asynchronous exchange elements. The **synchronous elements** included the real-time and moderated discussions that took place after the oral presentations in four parallel live streams plus the two real-time poster sessions. The long-lasting **asynchronous elements** are reflected by the chat opportunities linked to each oral and poster presentation. Via these chats, you could ask questions or add comments so as to start an exchange with the author, not only before and during the symposium week, but also far beyond.

The scientific program was supported by a **social program** developed by **University of Bremen students**. It provided many opportunities to get to know, meet, and exchange ideas with other participants during mentoring, yoga, pub night, karaoke, and other activities.

The Virtual Conference Archive can be accessed by registered delegates at:
https://app.icrs2021.smart-abstract.com/shell/home

For impressions of the VIRTUAL CONFERENCE see the CONFERENCE REPORTS Section, pages 56 – 62.

ICRS Bremen: Second Special Volume

Publication by the journal Oceans

Christian Wild (Chair ICRS2021/22 Organising Committee)

In connection with the 14th International Coral Reef Symposium (ICRS 2020, https://www.icrs2020.de/), originally planned to be held in Bremen, Germany, in July 2020, arrangements were made with the journal ***Oceans*** to produce a Special Issue associated with the conference, to which conference delegates could submit papers based on their oral presentations or posters. However, due to the coronavirus epidemic, the conference was postponed. A virtual conference was held as the 14th ICRS online in July 2021, while an in-person meeting (15th ICRS) is expected to take place in July 2022.

Nevertheless, to provide attending delegates with an appropriate outlet for their material, a first Special Issue (entitled "The Future of Coral Reefs: Research Submitted to ICRS 2020/21") based on papers submitted by July 2021 is in the process of publication in the journal "***Oceans***". Twelve manuscripts had been published online (https://www.mdpi.com/journal/oceans/special_issues/coral_reefs) by November 2021, and more will come later, ensuring publication of 2020/21 manuscripts in the near future.

However, since the follow-up in-person meeting is now to take place in July 2022, *Oceans* have agreed that **a second Special Issue will be published in 2021/22.** This sister volume will retain the same name and continue to reflect the conference themes. **Manuscripts for this volume will need to be submitted by 30 September 2022.** For details see: (https://www.mdpi.com/journal/oceans/special_issues/coral_reefs2).

Oceans is an open access journal that normally charges a fee (https://www.mdpi.com/journal/oceans). However, MDPI have agreed with the organizers of the 14th and 15th ICRS to publish papers related to accepted presentations or posters **free of any charge or fee**. This is a **unique and valuable opportunity for participants** of the 14th and 15th ICRS to publish their work in an **international, open access, and peer-reviewed journal** without any associated costs.

Instructions for submission may be found at https://www.mdpi.com/journal/oceans/instructions. To ensure quality standards of writing and accuracy, all submissions will be subject to standard reviewing procedures. ***Oceans*** has no restrictions on the length of manuscripts, and hence short papers based on either oral presentations or posters will be considered.

This second volume will be edited by ***Oceans*** editors in cooperation with an editorial support team, led by Prof. Dr. Christian Wild, chair of 14th and 15th ICRS. Other editors will include: **Peter Schupp, Rupert Ormond, Sebastian Ferse and Leila Chapron.**

Authors whose first language is not English are encouraged to submit manuscripts, but it is essential they have their text checked by a native English speaker or make use of MDPI's English editing service (https://www.mdpi.com/authors/english). Only manuscripts which are well written in quality scientific English will be considered and sent out for review.

CONFERENCES

16th ICRS, Auckland, New Zealand

19th-24th July 2026

As announced in the Spring edition of Reef Encounter, **New Zealand** was selected to host the International Coral Reef Symposium. At that point, the date for the conference had yet to be decided. We can now confirm that the dates for ICRS16 will be **19th-24th July 2026** (that is four years after the upcoming 15th ICRS in Bremen).

the first time, an area that, due to its remoteness, is often forgotten, despite the fact that its reefs are under considerable threat. We will ensure a unique and diverse programme, covering all the normal aspects of the symposium, but giving a localised flavour, and offering delegates a unique opportunity to learn from Pacific Island knowledge

The ICRS will be held at the brand-new Conference Centre (pictured above) in Auckland, New Zealand's largest, most multicultural city, which is near the north end of the country's North Island. The Centre is surrounded by hotels to fit all budgets within an easy walking distance and, on completion, will be the only carbon neutral venue in the Asia-Pacific region. Pre- and post-symposium field trips will be offered to Fiji, just a 3-hour flight from Auckland, while participants will also be able to visit NZ's stunning Fiordland (pictured right), a UNESCO World Heritage Site, as well as New Zealand's numerous other natural wonders.

Bringing the conference to New Zealand will allow a focus on the plight of the South Pacific Islands for

and traditions. For advance information contact **Professor Simon K. Davy,** Victoria University of Wellington, Wellington, New Zealand (simon.davy@vuw.ac.nz).

REEF PERSPECTIVES

COP26

The big problem is this. Even if, magically, we could halt the on-going rise in atmospheric carbon dioxide and keep it at the level it is today, global temperatures would continue to rise for another 50 years or more, until we experience a further 3 or 4°C of warming.

21 **Will Coral Reefs COP it?**

COP 26 was critical for the future of coral reefs - but did it achieve enough?

By Rupert Ormond

26 **Good-COP, Bad-COP**

The varied experiences of the ICRS observer delegation at the Glasgow COP.

By the ICRS delegation

Will Coral Reefs COP it?

Rupert Ormond
Heriot-Watt University, Edinburgh, and Editor, Reef Encounter

In 2015 ICRS lobbied key delegations attending the Paris COP21 of the Climate Change Convention, urging nations to limit global warming to well below 2°C in the short-term, and 1.5°C in the long-term, if functional coral reefs were to survive. The wording was very close to the target adopted in the Paris agreement. This year the subsequent key COP took place in Glasgow to consider whether greenhouse gas emission reduction targets should be further tightened. An ICRS delegation attended to make sure that coral reefs were not forgotten and to support the move to "keep one point five alive". In the event, the new commitments, although promising, seem insufficient to save reefs as we know them. But a further review of commitments is now promised for COP27 in 2022.

I return to putting this latest edition of Reef Encounter to bed not long after assisting the team (led by ICRS Conservation Committee co-chairs Simon Harding and Raquel Peixoto) that made up the ICRS delegation to COP26, in Glasgow (Scotland). COP26 is, of course, the 26th "Conference of the Parties" (i.e. of the participating national governments) to the United Nations Framework Climate Change Convention (UNFCCC). Undoubtedly it was an interesting experience (see Good COP, Bad COP pp 26-33); but was it important we attend? Or were we wasting our time? In my estimation COP26 was the last best hope for corals. Possibly (as Spock would have said) for "life as we know it".

One would assume that by now anyone with any interest in coral reefs knows that there is a "Coral Reef Crisis". Coral reefs are in serious decline. While there are many factors that have caused local change, by far the largest impact is now the widespread effect of global warming, caused by the global-scale emission of greenhouse gases, principally carbon dioxide (CO_2), resulting from the universal use of fossil fuels (oil, gas and coal). With increasing atmospheric levels of CO_2 (see Fig. 1), temperatures in tropical seas are reaching levels above those which corals can tolerate. At sea surface temperatures much above 30°C corals lose their intracellular symbiotic microalgae (zooxanthellae) and as a result appear white – an effect known as coral bleaching. If elevated temperatures persist then, without their symbiotic algae, the corals die. Widespread or "mass" coral bleaching was recorded for the first time in the 1980s, during an exceptionally strong warming event (El Niño) in the Eastern Pacific. Since then, the scale of bleaching has been rising steadily with the global proportion of coral being hit by bleaching per year rising from 8% in the 1980s to 31% in 2016 (Hughes et al. 2017). During the warmest years there have been three global mass bleaching events affecting all coral reef regions, the most recent in 2014-2017 (Eakin et al. 2019), while the iconic Great Barrier Reef of Australia experienced mass bleaching five times, in 1998, 2002, 2016, 2017 and 2020.

The 2010s were the hottest decade on record globally, and the past seven years have been the warmest seven on record (World Meteorological Organisation 2021). Yet to date we have experienced on average only 1.2°C of global warming. This has been sufficient to have triggered numerous one-in-a-hundred-years type local weather-related disasters (droughts, forest fires, and flash floods) and to have bleached or killed perhaps as much as 50% of the world's corals (depending on how this is measured). Indeed, a recent study has concluded that global coverage of living coral has already declined by 50% since the 1950s (Eddy et al. 2021). Worse, it appears (with a

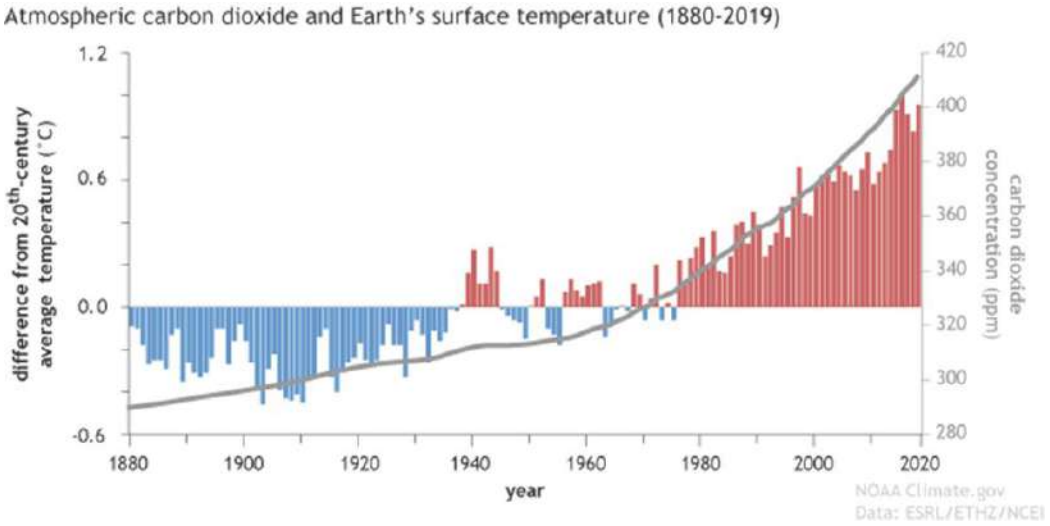


Figure 1. The well-known graph showing both the difference between the mean global temperature each year and the twentieth-century average (red bar = above average, blue bar = below average) (based on data from NOAA NCEI), and the rise in atmospheric carbon dioxide concentrations (grey line) going back to at least 1880 (1880-1958 from IAC, 1959-2019 from NOAA ESRL). Original graph by Dr. Howard Diamond (NOAA ARL), adapted from NOAA Climate.gov. (https://www.climate.gov/news-features/climate-qa/what-evidence-exists-earth-warming-and-humans-are-main-cause.)

very high degree of confidence) that 70-90% of coral reef ecosystems will face long-term degradation even at 1.5oC of global mean warming, and >99% at 2oC of global warming (assuming no change in thermal tolerance) (Frieler at al. 2013, Bindoff et al. 2019). Under pre-Glasgow emission reduction commitments (NDCs) annual severe bleaching was expected to occur on 100% of the world's coral reefs before the end of the century, with the average year for the beginning of annual severe bleaching being as early as 2034 (UNEP 2020).

It would be nice to think that 1.2^{o}C of global warming will be about as bad as it will get. But I remember when I first began lecturing on climate change at the University of York in the 1980s. At that time there were only some hundreds of papers published on the topic and the upward trend in global temperatures was not quite statistically significant. But soon the evidence both for pre-historic and current climate change became increasingly convincing. Even so, I comforted myself "Thank goodness we have discovered this now, and that we live in a world of national and international law - so that there is still plenty of time for mankind to avoid this disaster." Subsequently, I was amused to contrast our situation with that of the vanished societies described by Jared Diamond in his book Collapse (2011), where he puzzles that the last men to cut down the last trees on Easter Island could not see that they were triggering their own destruction. Of course, my previous confidence was misplaced. The climate crisis is upon us, yet the great majority of mankind, and even numerous reef scientists, have little appreciation of just how serious the situation has become.

The big problem is this. Even if, magically, we could halt the ongoing rise in atmospheric carbon dioxide and keep it at the level it is today, global temperatures would continue to rise for another 50 years or more, until we experience a further 3 or 4^{o}C of warming. The reason is that, because of the slow turnover of the oceans (via widely separated major downwellings and upwelling areas), it will take that long for the oceans to come into thermal equilibrium with the atmosphere. Meanwhile the oceans are actually keeping the planet cooler than it would otherwise be.

Probably most voters imagine that should global warming really begin to become unpleasant for them, then at that point they can agree to make the necessary sacrifice and put on the carbon emission breaks. Unfortunately, by that time we will already be heading unavoidably for levels of warming that will make large swathes of the planet uninhabitable (see the graphic presentation in the Guardian of 14th October 2021 by Millman et al.), and likely end human civilisation "as we know it". I imagine a much larger scale replay of the disaster (most probably a large-scale epidemic) that led, in or about 1177 BC, to the widespread collapse and disappearance of the sophisticated Bronze Age civilisations of the Eastern Mediterranean and adjacent Africa and Asia (Cline 2021).

Nevertheless, in 1992, sufficient wise statesmen and scientists, aware of the issue, assembled at the

much anticipated "Earth Summit" in Rio de Janeiro, and were able to secure the coming into force (legal effect) of the UNFCCC. The treaty also established the Intergovernmental Panel on Climate Change (IPCC), the United Nations (UN) body responsible for assessing climate change science. But the success of the UNFCCC, being a framework convention, is by its nature dependent on the voluntary commitments (Nationally Determined Contributions or NDCs) of, in particular, the major polluters, and the leaders of many countries have either found it difficult to convince enough of their electorates of the need for action, or in some cases are themselves unreformed climate change sceptics. Thus, until now, progress has been far too slow. Despite the pressure from developing countries already affected by climate change, such as Tuvalu (Fig. 2) and Bangladesh, NDCs have only gradually been negotiated upwards at the key target-setting COPs that take place every five years. Hence the need for climate activists and NGOs to campaign, both to raise awareness among the wider population, and to put pressure on the negotiating governments.

So, the Climate Change COPS are not just talking shops about an issue of minor importance. They are meetings at which, albeit after long drawn-out negotiations, vital agreements are made, or not made, that will determine whether the environment we live in continues much as before, or begins to change beyond recognition. Of all environments, the one most sensitive to change, as luck would have it, are the coral reefs that are for many of us, not just a focus of interest, but a passion. Polar ecology also is beginning to suffer severely, since the polar regions evidently experience greater temperature change than lower latitudes. But coral reefs would seem to be "the canary in the coal mine", i.e. an early indicator of potential danger[1]. For corals, despite their capacity to build structures visible from space, seem to be exceptionally sensitive to above normal temperatures, doubtless the result of their very simple nature (lacking any temperature control mechanisms) and, for most species, total dependence on a profound symbiosis with their microalgae. Yet coral reefs were hardly mentioned in the early bulky scientific reports prepared by the IPCC. Hence the move by ICRS to lobby, both in 2015, at COP21 in Paris, the previous meeting at which NDCs were negotiated, and this year at COP26 in Glasgow, at which stricter NDCs were to be considered.

At Paris, 196 countries reached an internationally binding agreement to seek to limit global warming to well below 2°C in the short-term, and 1.5°C in the long-term, compared to pre-industrial levels. On behalf of ICRS, Sue Wells and several dedicated French ICRS members campaigned at the COP, lobbying delegates and distributing leaflets. For this purpose a group of us (including in particular Ove Hoegh-Guldberg and Mark Eakin) had developed a Consensus Statement (ICRS 2015)[2] which both alerted readers to the emerging fate of coral reefs and urged the COP to adopt a very similarly worded target, selected because it was estimated that 1.5°C was the degree of warming at which perhaps 50% of coral reefs might escape serious loss of function and biodiversity as a result of regular bleaching events. We emphasised the economic value of coral reefs, estimated at US$ 11.9 trillion per year (Constanza et al. 2014). Fortuitously ICRS may have

Figure 2. One of the memorable images from the COP's first few days - Tuvalu's Foreign Minister, Simon Kofe, delivering the nation's statement, from amid the rising waters that threaten his islands.

[1] referring to the former practice of taking live canaries into coal mines to test for the presence of toxic gases, shown to be present if the canary dies.

[2] ICRS (then ISRS) previously lobbied at the Copenhagen COP15, having produced its first statement on climate change as far back as 1988.

had a significant influence on events for, perhaps thanks to selected lobbying through the previous year, the same target was adopted by the alliance of Small Island Developing States (SIDS), the countries most threatened by climate change, and by at least some western governments.

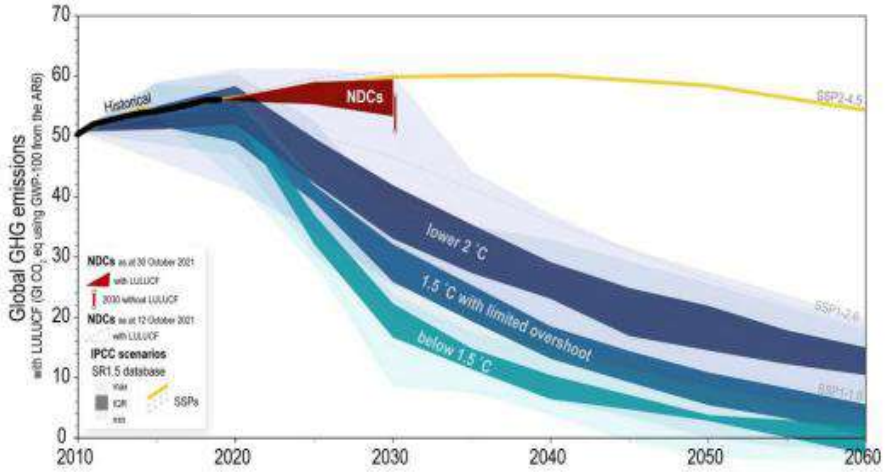
The fear was that at Glasgow, given the recent divisive trends in modern politics, especially in the US, coral reefs would be forgotten and the 1.5°C target abandoned. Hence the move by ICRS to attend the Glasgow COP, having obtained official observer status, permitting attendance at some if not all of the proceedings. ICRS, like many other observer NGOs, was allowed four delegates during each of the two weeks of the COP. We selected nine members to attend (four each week plus one reserve), half based in UK, but including members from US, Brazil, Germany and Saudi Arabia.

So, did we and the other international organisations campaigning for coral reefs (WWF, WCS, and the Commonwealth Secretariat) make a difference? Well, on the positive side, there was among the thousands of attendees a much greater awareness of the threat to coral reefs. They were regularly mentioned by different speakers, both during the formal debates and at so-called side-events, including one organised by Simon Harding and ICRS in the EU Pavilion (viewable at https://www.youtube.com/watch?v=adCZVV1Bis0). There was also a huge sense of common purpose, even of camaraderie, among the great majority of the diverse array of national delegates and NGO representatives. Above all, it quickly became clear that both the UK hosts, and most developed and developing countries, were strongly committed to the 1.5 degree target. “Keep alive one point five” was the oft repeat mantra.

On the other hand, there was great frustration at the problems in gaining entry into sessions within the central “Blue Zone” of the COP. The Blue Zone was managed by the UN (and for the duration of the COP was legally United Nations territory), while the surrounding area was managed, in a welcoming style, by the City authorities and squadrons of cheery Glasgow police. The difficulty was getting into the Blue Zone for which only an inadequate number of turn-style gates had been provided. Attendance at many of the key sessions was also heavily restricted, in part due to the need for social spacing. The salvation was that there was excellent live on-line coverage of most events, so that proceedings could be followed from adjacent foyers or even one’s hotel room or home.

The NDCs agreed to in Paris had only been enough to restrict global warming to around 2.7°C degrees above pre-industrial levels (UNEP 2021). According to a recent in-depth assessment (Quiggin et al. 2021), based on those commitments, there was a less than 5% chance of keeping temperature rise well below 2°C above pre-industrial levels, and a less than 1% chance of reaching the 1.5°C target. So, the key issue was whether new stricter NDCs could be agreed upon which could restrict temperature increases to the 1.5°C target from Paris. In addition, there was uncertainty whether all nations were really limiting their greenhouse gas emissions to the extent promised. Many had achieved much of their commitments. Scotland, the host, now generates all of its electricity from renewable sources on most days of the year.

As negotiations proceeded and more commitments to reduce emissions were announced (Fig. 3) the hoped-for global temperature increase, if all commitments are honoured, fell to as low as 1.8°C (International Energy Agency 2021). But even so, with not all nations able to meet their commitments, best estimates published during the COP were still predicting an actual global temperature rise of up to 2.4°C by the end of the century (Climate Action Tracker 2021). There was also great unhappiness among developing nations that promises of climate finance and compensation to help them tackle climate mitigation were falling well short of what had been promised. Small island states will still suffer, and some drown, and some continental countries will have their living space greatly reduced, as a result of sea-level rise and flooding. And coral reefs, as we have known them, will more or less vanish.



◂ Figure 3. An updated comparison of the reductions in global emissions expected given the latest NDCs (brown area) with the projections of the Intergovernmental Panel on Climate Change of the reductions necessary to restrict global warming to different levels (blue and green bands). (Circulated to delegates at COP 26 by the UNFCCC Secretariat 4 November 2021.)

But there may still be some hope. As we know, reef scientists are making progress in selecting corals that can withstand marginally higher temperatures, and the UNEP Projections Report estimates that corals could receive a 30-year reprieve from severe bleaching if they can adapt to 1°C of warming, though even such super-corals would not allow reefs to survive 2°C of global warming (UNEP 2020). Much greater attention is being paid to protecting or enhancing the array of environments, not least the oceans, that take up and sequester carbon. More than 100 world leaders, responsible for about 85% of the world's forests, promised to end and reverse deforestation by 2030. And, by the end of the COP, it was agreed that the question of the NDCs should be revisited, not in five years' time as expected, but at the next COP due to take place in Egypt in 2022. If, and it's a big if, even more ambitious emission targets (NDCs) can be agreed upon, if we can hit net zero and begin actually removing CO_2 from the atmosphere, there is still, just, according to the models, a small possibility of limiting climate change to 1.5°C, and of keeping "one point five alive".

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Good-COP, Bad-COP

Impressions of the UNFCCC COP26 in Glasgow from members of the ICRS observer delegation

The ICRS Delegation (led by Simon Harding and Raquel Peixoto). Left: the week one team, Mike Sweet, Jenny Mallon, Jens Zinke and Simon Harding. Right: the week two team, Nadia Jogee, Sue Wells, Raquel Peixoto and Mike Berumen.

Nadia Jogee (University of Edinburgh)

I was so pleased to be asked to represent ICRS at COP26, but, once I said Yes to going, I quickly realised I didn't actually know much about what happens at COP meetings. In fact, at that point, I didn't even know what COP stood for. Several google searches and rabbit holes later I was much more informed… yet still, I didn't really know what to expect.

The first day I felt an adrenaline rush that no other conference has ever given me. The venue felt like being in a very large, and very busy airport, but where everyone felt guilty about taking their flight. Thousands of people were rushing to be places, whilst many people had seemingly given up and were watching events on their laptops in the corridors. At that point I felt like I was going to have very little to offer COP26. This overwhelming

sense of being out of my depth quickly dissipated when I started talking to people. Everyone I encountered was warm, bright and, most importantly, keen to hear about coral reefs and our campaign to save them. I had wonderful conversations with everyone from fellow PhD students from the USA, to indigenous peoples from Panama, to Stewart Maginnis, IUCN's Global Director of the Nature-based Solutions Group.

Global Responsibility: Nadia Jogee from the week 2 team, holding up the planet (or appearing to) hung in the centre of the venue.

I attended several talks about nature-based solutions where blue carbon was a main feature – even the food hall had an animated video about blue carbon on loop. It was wonderful to see the ocean front and centre. I did wonder however whether our plan of targeting people at ocean related events was the most effective. Were we just preaching to the choir? I certainly saw some very inspirational talks from advocates for the ocean, such as the charismatic Peter Thomson, the United Nations Secretary-General's Special Envoy for the Ocean, and Rashid Sumaila, a professor of ocean and fisheries economics at the University of British Columbia. This made me feel really positive that we were going to achieve our goal of limiting global warming to 1.5 °C.

Therefore, the final outcome of COP26 was a real shock and my heart broke, especially for the small island states, whom I saw fighting to save their nations, not just from disaster, but in some cases total eradication. Two weeks later and I'm able to reflect more on my experience. I can safely say that attending COP26 was not only a pleasure but a great learning experience. I saw some wonderful talks and, as an early career researcher, I can start to see more clearly what policy makers are interested in. I can now start to think about how I can translate my own research for policy makers more effectively. So, after attending COP26, am I more clued up on what happens at COP than I was before? Maybe. I certainly have a better sense of what 99% of people at COP do, but it's the 1% behind closed doors doing the negotiating that really matter. ICRS now has the challenge of making sure our message crosses that threshold.

Jens Zinke (University of Leicester)

For me, the most important outcome of COP26 was that this was the first COP where climate mitigation by oceans and coastal ecosystems, including coral reefs, was included in the subsequent agreement – the Glasgow Climate Pact (article 38;

◂ Jens Zinke: Saving the world's coral reefs

https://unfccc.int/sites/default/files/resource/cma2021_L16_adv.pdf). It had seemed incomprehensible that the largest carbon sink and lifeline for our planet, the oceans, were so neglected in climate mitigation actions and nationally determined contributions (NDCs) before COP26. The two sessions, in the EU Pavilion (https://www.youtube.com/watch?v=adCZVV1Bis0) and Commonwealth Pavilion (https://www.youtube.com/watch?v=5McAWovwJ6w&t=7385s), co-hosted by ICRS or with ICRS members in the panel (David Obura), attracted a lot of attention and contributed to the raised awareness of ocean solutions. On-line, the YouTube recording of the Commonwealth session was the most viewed of all their sessions during COP26 (>1300 views). ICRS should keep organising these sessions at the upcoming COPs; they were our strongest 'weapon'.

My most interesting encounter was with the Belize delegation, including the Hon. Andre Perez, Minister of Blue Economy and Beverly Wade, Director of Blue Economy Belize, whom I won over to attending our EU Pavilion session on November 3rd (https://www.youtube.com/watch?v=adCZVV1Bis0). All of the ICRS delegation quickly learned how to engage with delegates and policy makers, so as to bring our message across "to keep 1.5C alive", pointing to solutions already on the table that would help reach that goal. Another lively conversation followed at an evening reception that the Blue Marine Foundation (https://www.bluemarinefoundation.com/) held in a Glasgow venue outside COP26 to launch their Blue Carbon project (under lead of the University of Exeter). During the panel discussion that followed, my raising awareness of interdisciplinarity with the Blue Marine team (Prof. Callum Roberts and Prof. Carlos Duarte) was well received by the audience.

The Presidents of Colombia, Ecuador, Costa Rica and Panama signing documents declaring the new Eastern Tropical Pacific Marine Corridor (CMAR), which would join and increase the size of their protected territorial waters to create a fishing-free corridor covering more than 500,000 sq km.

Mike Sweet (University of Derby)

As an ICRS representative at COP26 we went armed with a heap of information. Our aim? To highlight the plight of reefs under the current climate and how they would fare in the not-too-distant future. We had our policy paper and a beautiful leaflet designed by the student chapter of the society. We were ready. But as soon as we arrived there was something different in the air. And the more we talked to people, especially those who had been before, we kept hearing the same thing; 'this is a COP like no other'. This was soon followed by a statement that; 'this is a good thing'. They meant that at COP26 the writing was on the wall; most (if not all) who were in attendance, knew something needed to be done and so I certainly felt that maybe our science was not really needed here.

That said, we still talked to party members, presidents, and prime ministers, even the odd princess and celebrity when our paths crossed. Everyone was happy to talk about corals. Our community's science education efforts seemed on point, as people knew about bleaching and the other threats faced by them. In my opinion, this was as much down to the Attenborough documentaries and Netflix's Chasing Coral, as much as our science papers. It was also undoubtedly helped by the recent success of CoralVita winning the Earth Shot Prize. What many now wanted to hear, was what can we do to save them? Well, the obvious was lowering our carbon footprint and keeping warming to 1.5. This was our main message, but discussion also went in the direction of short to medium term intervention strategies, including reef restoration, the use of probiotics to fight disease, and the creation of Marine Protected Areas.

In this connection, one of my most memorable moments at COP was when the Presidents of Colombia, Ecuador, Costa Rica and Panama were together in a room and signed documents declaring a new trans-country reserve in the Pacific. I was lucky enough to be standing next to ICRS delegate and early career researcher Jenny Mallon who translated the event for me in real time. The fact that these four countries, who as far as I know have probably not always seen eye to eye, joined forces, shook hands and pledged protection of our ocean filled me with optimism. I then saw more and more signs that we were going to make it, we were seeing history in the making. Deforestation stopped by 2030, the phase 'out' of coal and a lot of talk about finance. Yet alas, when things came to a close, the protestors outside the event, who had been saying COP had failed right from the onset, seemed to be right or at least a little right. A few last-minute changes to some of the wording or phrases used in the official text meant we were 'phasing down' coal not 'out' as originally degreed.

So, where does that leave us? Well, sadly, it looks like a warming world above our 1.5^{o}C goal, maybe it's 2, maybe it's more, but it doesn't look great for our beloved reefs. But let us end on a bright spot, let us bring back a little ocean optimism. So many people are fighting for the survival of these amazing ecosystems, they are trying so many different techniques, different tools, different methods, will they all work? No. Is it worth a shot? Absolutely. We all have the same goal – save our reefs. After all, saving the reefs means we save our world! So, we must continue to fight, continue to educate, and continue to conduct the science which supports policy and allows our elected leaders to make those all-important decisions. I think COP did a lot, we moved in the right direction – maybe we acted a little too late, but we ARE acting, and you should too. **Don't sit and wait for politics to catch up – you can make massive changes and do your bit from home.**

Mike Sweet and friends: with Frank Bainimarama, the Prime Minister of Fiji (left), Nicola Sturgeon, the First Minister of Scotland, plus Jenny Mallon (centre), and Peter Thomson, the UN Secretary-General's Special Envoy for the Oceans.

Raquel Peixoto (King Abdullah University of Science & Technology)

Like Mike (Sweet), I too experienced the relief of realizing the overall awareness of the current science addressing our climate situation. Most of the delegations were discussing high-level science-based data and solutions, and all attendees were very keen to brainstorm and access our society's policy paper. I was surprised to see a massive interest from stakeholders in learning details of innovative scientific solutions focused on coral reef restoration (something we have not really prepared specific material for). Mitigation of CO_2 emissions and local pollution are, unquestionably, a top priority, especially since the carbon reduction commitments were not always necessarily as ambitious as they should have been. Most delegates were very curious to hear more about methods of active restoration that can be applied to threatened or already damaged areas. In several cases, attendees (especially government delegates) specifically asked whether science can be used to accelerate coral adaptation to this new world and future climate scenarios.

My feeling was that these solutions build on people's hope and that it should indeed be possible to minimize the impacts we have already begun to witness, a belief that in any case encourages more action on the actual solutions. Interestingly, as I

Raquel Peixoto with James Green, NASA's Chief Scientist

realised during discussions, ICRS' three pillars (i.e. mitigate CO_2 emissions, mitigate local impacts and invest in active restoration) can be extrapolated to provide a perfect summary of the main topics discussed at COP26, but we will need to think of active restoration in broader terms, promoting science innovation to accelerate adaptation of communities, societies and ecosystems.

Michael Berumen (King Abdullah University of Science & Technology)

I was happy to see the amount of science represented at COP26. All the delegations that we spoke with understood the need for data-driven decisions. (We might even add that this generally applies to the (unnamed) countries with not-the-greatest recent reputations for environmental policies.) It's possible that we have a biased view since our target interactions were with countries that have reefs in their territories, but everyone was happy to hear about the Society's work towards science for the long-term benefit and protection of coral reefs. It was, indeed, a "Blue COP" and ocean science featured prominently alongside the previous 'poster children' of climate work, such as the rainforests and polar bears.

It was very exciting to hear about the technological developments that will continue to benefit our knowledge and understanding of ocean (and reef) health. For example, we were fortunate to meet NASA's Chief Scientist (James Green), who happily pointed out that much of the remote sensing data many of us rely on (through NOAA products, etc.) come from sensors and satellites built by NASA. He presented an overview of how new NASA technologies are improving our ability to study wide areas of the ocean.

◂ Session personalities: Left, the giant puppet, Little Amal, depicting a 9-year-old Syrian refugee, arrived at COP26 from Turkey, to help lead a session on the plight of refugees. Right, Mike Berumen and Sue Wells at one of the scientific sessions.

Simon Harding (University of the South Pacific)

Much of my time allocated to COP26 was spent organising our side event in the EU Pavilion. ICRS put this together along with two other organisations, Friendship, an NGO involved in mangrove restoration, and GEOMAR, a German Marine Research Institute, working on seagrass ecosystems. Setting up the event started in June when we contacted a number of organisations about collaborating on a coral reef focussed event at the COP. Subsequently we were encouraged by the EU to develop a joint event with Friendship and GEOMAR to present and discuss these three closely-linked ecosystems: coral reefs, mangroves and seagrass beds.

I managed to line up a good selection of speakers in addition to the contributions from the co-organisers, so that we had both high-level speakers from other parts of the UN system and marine leads for key global conservation organisations as well as ICRS's own David Obura. Nicely moderated by Mike Sweet the side event went very smoothly. There was, however, quite a crowd outside the EU Pavilion trying to get one of

▲ Speakers at the ICRS-led side event in the EU Pavilion. From left to right: Simon Cripps (WCS), David Obura (ICRS), Stephane van Haute (Friendship), Minna Epps (IUCN).

▲ Sam Teicher (Coral Vita) promoting the ICRS flyer during the Commonwealth Pavilion side event on coral reefs.

the limited seats in the room and many had to watch online. Nevertheless, we did have attending the Belize Minister for the Blue Economy (thanks to Jens Zinke's earlier connection with him).

Once the side event was done and dusted, I could spend more time contacting country delegations to push for 1.5°C. In particular, through the Fiji delegation I was introduced to the Pacific SIDS group, coordinated by SPREP, that is an active part of the Alliance of Small Island States (AOSIS). They welcomed the full ICRS Science-to-Policy paper as well as the ICRS flyers developed for the COP. Although in many cases we were 'preaching to the converted' , the provision of up-to-date scientific and policy advice focused on coral reefs does provide parties to the UNFCCC with the latest information to support their statements and arguments at the COP. Next time it would perhaps be more productive to target early those delegations less committed to ensuring that "one point five is kept alive".

Overall, it was a relief to find that at the COP there was broad consensus on the need to act urgently to tackle the very real threat of climate change - quite different from the feeling at the previous COP that I had attended, in Copenhagen. There was also much more recognition of the role of the oceans in influencing climate, including a UN Ocean Action Day, on the first Friday (Dec 5th) of the two-week conference.

Sue Wells (Independent Consultant, Cambridge, UK)

ICRS has long played an important role in the climate change debate by highlighting the scientific evidence of the impact of global warming on reefs, but it was not until the late ICRS President Ruth Gates championed the Society's attendance at the 2016 Paris COP that the potential role we could play became clear. Thanks to the efforts of Rupert Ormond and support of current President Andrea Grottoli, this year ICRS became registered as an official observer to the UNFCCC process (no mean feat given the amount of "paper" work involved), which will make participation in future COPs much easier.

While we waited to hear if our observer application was successful, the Conservation Committee started to make plans. The COP aimed to be largely "paperless", but we felt that a leaflet would be useful. Jenny Mallon led a group (Paige Strudwick, Julia Briana and Emma Strand) from the ICRS student chapter to produce this. It proved an invaluable tool for both the ICRS delegation, and other ICRS members, in particular David Obura

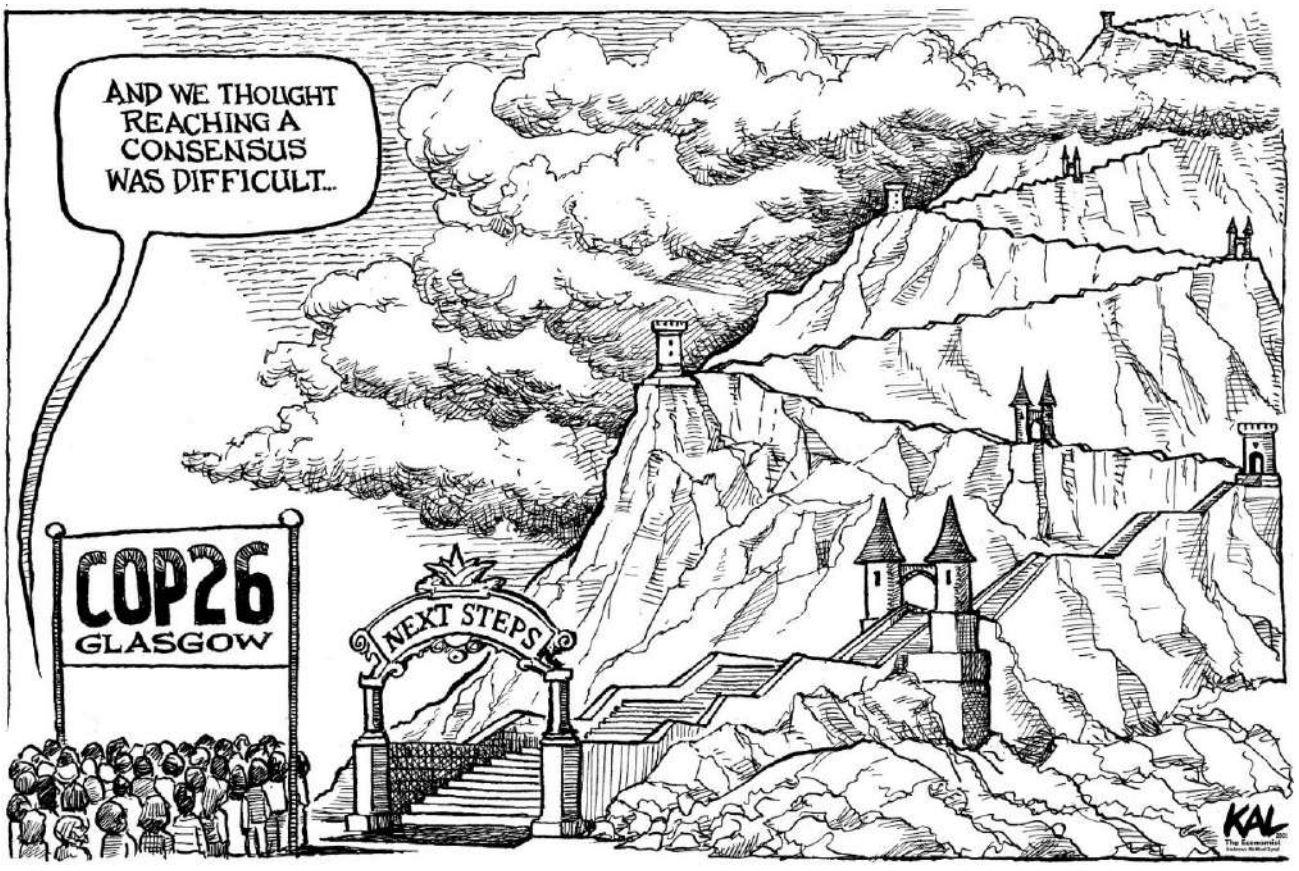
(Kenya), Marcia Ford (Jamaica) and Diane Thompson (University of Arizona), when initiating conversations with national delegates (contact was made with over 30 countries), representatives from NGOs and key international and regional bodies.

The side events mentioned in the other contributions above took considerable planning and we are very grateful in particular to the ICRI Secretariat for its help and introductions to high level speakers. We encourage you to watch the videos of the events held in the EU and the Commonwealth Secretariat pavilions. The ICRS policy document was a key focus for lobbying, and the team also promoted it widely through social media. It was also available on the ICRS "booth" at the Virtual Ocean Platform (VOP) - an imaginative virtual alternative to COP26 with exhibits, on-demand videos, reports and side events, hosted by the Global Ocean Forum. ICRS was involved at an early stage of developing the VOP, with key input provided by Simon Harding, Tory Chase and Nadia Jogee. The final VOP side event included a presentation by me, looking back on the history of climate change and reef science, and the roles of ICRS and ICRI.

As Jens Zinke mentions, the efforts of many organisations including ICRS, combined with hard negotiation by the parties, resulted in the Glasgow Climate Pact officially integrating the ocean across all the UNFCCC areas of work for the first time. The Pact recognises the need for "protecting, conserving and restoring nature and ecosystems, including … marine ecosystems" and establishes an annual "ocean-climate" dialogue, starting in June 2022. The role of science, evidence-based action and technology was firmly recognised, making ICRS's presence very relevant. Financing was a major area of discussion throughout the fortnight, with the Global Coral Reef Fund being presented on many occasions as an example of the kind of initiative needed.

The image of Simon Kofé, Tuvalu's Minister of Foreign Affairs, speaking knee-deep in the sea to highlight sea level rise, helped to make adaptation, along with mitigation, one of the two "hot topics". As an immediate follow-up, ICRS has suggested to ICRI that its revised Plan of Action could include an activity to provide UNFCCC parties with guidance on how coral reefs can contribute to Nationally Determined Contributions, for example through shoreline protection. ▸

CREDIT: Kevin KAL Kallaugher, The Economist, Kaltoons.com (with thanks to KAL for waiving the usual fee)



REEF CURRENTS

Integrated Marine Conservation and Fisheries Management Approaches are Prerequisites for Reef Protection in Eastern Indonesia

Alan White and Tiene Gunawan

Formerly Chief and Deputy Chief of Party for USAID Sustainable Ecosystems Advanced Project, Indonesia (2016-2021) - alanwhite1@hawaiiantel.net

Preface

This article synthesizes some of the many lessons learned during the implementation of the USAID supported **Sustainable Ecosystem Advanced (SEA)** Project (2016-2021) in Indonesia that pertain to coral reef conservation. In many ways, this large project, that had excellent financial support, provided an experiment in how to improve marine conservation outcomes that are increasingly difficult to achieve in our complex modern world. The Indonesian government and people understand the need to conserve and sustain their marine resources and to invest heavily in this outcome, but the solutions as to how to achieve these results effectively and efficiently are not easy to find. This paper, initially for presentation in the ICRS of 2020, highlights insights from the SEA Project. The material herein is largely drawn from the project report: *Ministry of Marine Affairs and Fisheries (MMAF), Republic of Indonesia and USAID Sustainable Ecosystems Advanced (SEA) Project (2021). Sustaining Indonesia's Marine Environment: Lessons Learned from the USAID Sustainable Ecosystems Advanced Project. Jakarta, pp. 135* (www.oneocean.org).

Indonesian context

Indonesia is at the center of the world's tropical marine biodiversity; it possesses 76% of the world's coral reef species and 17% of the world's coral reef area. This biodiversity is critical to support the healthy functioning of Indonesia's marine ecosystems, so that they are resilient to adapt to ecological changes from climate and human impacts. Indonesia is also the world's second largest fish producer.

However, Indonesian seas are not limitless and show many signs of overfishing. Thousands of fisheries in vast fishing grounds require collection of data and effective fisheries management, and, most importantly, governance to mitigate coastal development, land-based and marine pollution, as well as destructive fishing practices. Poor management and lack of governance often lead to losses in food resources, social-economic benefits, and livelihood for people. The condition of coral reefs is often the initial indicator of these changes.

To sustain fish production for Indonesia's food security and economy without damaging the marine ecosystem, the government and private sector stakeholders are working together to increase ecosystem-based management of fisheries and critical habitats. Such interventions to improve management are only effective if they address small-scale fishers and industrial fleets together, which in Indonesia implies both provincial and national waters, and the fisheries resources that have direct links to marine biodiversity.

The SEA Project

The Sustainable Ecosystems Advanced (SEA) Project, starting in 2016, was designed to address a multitude of threats to the coastal and marine habitats and fisheries resources in eastern Indonesia, and was comprised of 4 strategic technical approaches: 1) Improve and enhance the ecosystem approach for fisheries management, 2) Improve the management of marine protected areas (MPAs) and expand MPA coverage, 3)

Strengthen marine spatial planning, and 4) Promote law enforcement to strengthen species and ecosystem conservation in support of sustainable fisheries. These core technical approaches were supported by four overarching strategies: Communication and Outreach; Incentive Mechanisms; Policies and Regulations; and, Capacity Building including community empowerment (Fig. 1).

The SEA Project aimed to: a) Improve conservation and sustainable use of marine resources by reforming fisheries management and promoting marine protected areas (MPAs) to enhance fisheries productivity and sustainable livelihoods, and b) Strengthen the leadership role and capacity of the national and local governments to promote conservation and sustainable fishing. To accomplish these outcomes, SEA engaged multiple partners and counterparts, both to enhance Indonesia's ecological, social, and economic knowledge of focal areas through detailed baseline assessments, and to build awareness through robust communication plans and messaging. It also developed incentives for marine stewardship through transparent policies, while also creating coastal champions to strengthen the capacity of stakeholders and institutions to implement marine and fisheries management action plans.

The targets set by USAID and the Indonesian Government for SEA were, by 2021, to bring at least six million hectares in the three eastern provinces of Indonesia (Fig. 2) under improved fisheries management, measured through impacts including 1.1 million hectares of new or improved MPAs; have in place improved policies and protocols in support of marine conservation and sustainable fisheries; and to have reduced destructive and over-fishing. While the targets were daunting, the SEA Project was able to surpass these targets with:

- Improved fisheries management addressed through small pelagic and reef fisheries harvest strategies that covered 22.5 million ha;
- The design, development and establishment of 14 MPAs across North Maluku, Maluku and West Papua, covering a combined area of 1,630,106 ha;
- Completing marine spatial plans for the provincial waters (to 12 nm) of the three provinces (Maluku, North Maluku and West Papua), thus outlining a range of utilization zones and providing spatial planning for the management of 17,312,391 ha;
- Formal recognition of 324 local community and government champions who demonstrated measurable leadership and the ability to successfully influence their societies to adopt interventions for marine and coastal sustainability; and,
- Enabling the development, drafting, or revision of 58 legal statutes, 42 of which successfully reached 'stage 2' of being 'endorsed' for implementation.

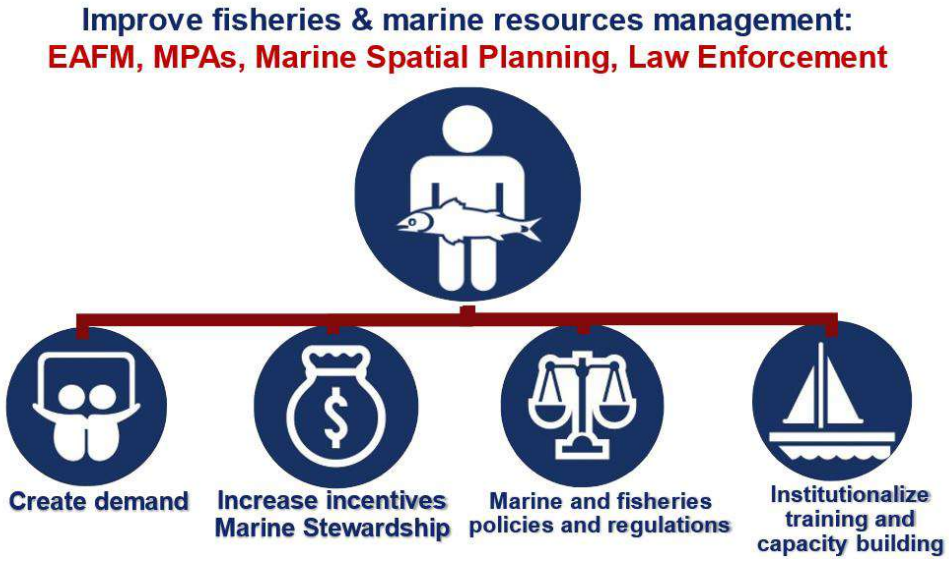


Figure 1. Technical approaches and strategies in SEA Project design and structure

The SEA Project is an example of the type of integrated resources management that is essential if we are to protect critical coastal habitats in complex management situations such as found in Indonesia (Fig. 2). But, how were these objectives to be achieved? And what were the key lessons learned from the project?

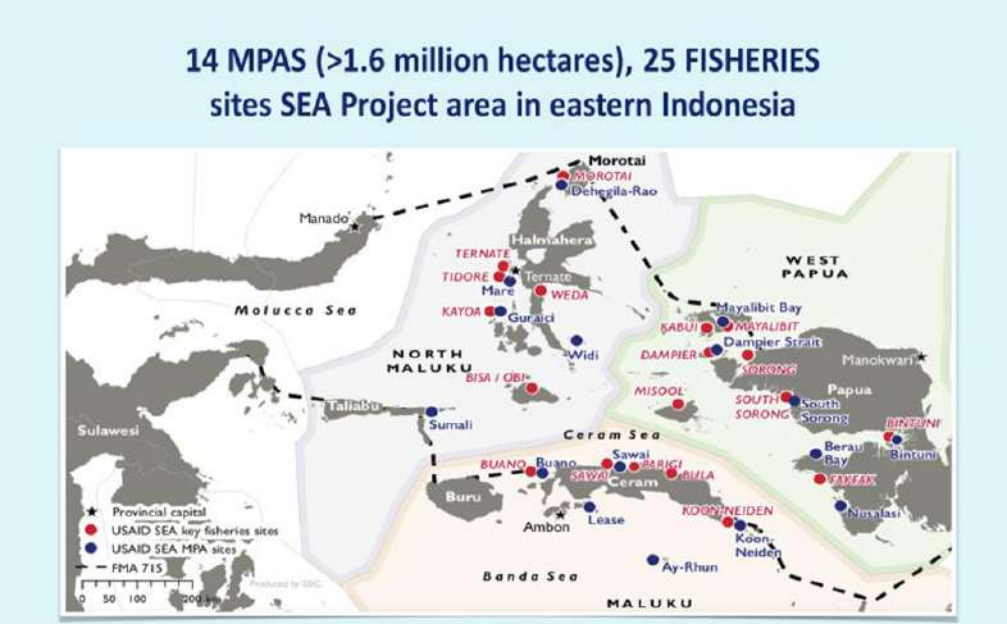


Figure 2. Geographic area of operation of the USAID SEA Project in eastern Indonesia

Importance of an Ecosystem Approach to Fisheries Management (EAFM)

The Ecosystem Approach to Fisheries Management (EAFM) was a guiding principle of the Project; fundamentally it forces integration of project components to achieve long term outcomes because EAFM links ecological and human factors into a coherent framework. An issue that arose is that the definition of EAFM among partners in government and the private sector was not commonly understood, and rather, was defined somewhat differently be each party. Thus, the project had to define EAFM in practical and easy to understand terms so that all participants were moving in the same direction. Points that helped define EAFM for all were to focus on small scale fisheries that comprise about 90% of the fish catch in Indonesia, focus on fisheries dependent on critical habitats (e.g., on reefs and mangroves) and to fully consider the role of coastal communities as stakeholders and as resource stewards. It was also important that we consider the impact of all management actions on local communities (socio-economic, cultural, and livelihood).

A key aspect of EAFM was to account realistically for fish resource status by establishing robust systems for data analysis, vessel registration and logbook keeping; also to develop stock assessment for certain fisheries important to local stakeholders. The project focused management and fisheries policies on a rights-based fisheries system, institutions, and local enforcement involving community level stakeholders as supported by Indonesian law. Finally, incentives depended on good

Figure 3. Many fishers participated in the SEA Project through Fair Trade agreements, or as local "sea champions" for marine conservation

communications, capacity building and mechanisms for changing human behavior.

Lessons for integration and EAFM

In the SEA Project, marine spatial planning (MSP) helped set the stage for broad area planning and management by the Provincial governments, required under national law to accomplish MSP plans. MSP is an important aspect of integrated coastal management of fisheries and marine biodiversity protection but not an end in itself.

In the field-experience of the SEA Project it was soon realized that for EAFM to take effect it is important not to wait for perfect data sets and information before applying management measures. But at the same time a standardized regional system for data collection is crucial to allow for scalable analysis, as well as for training and continuous mentoring of enumerators to ensure robust data collection.

Fishery stock assessments required a diversity of skills unique to each fishery and location. Training and continued mentoring of assessors in diverse techniques relevant for different stock types and data levels ensured that skills continued to build, and managers had confidence in their management interventions. Despite the improved capacity of government researchers and partners under the SEA Project, Indonesia's pool of expertise remains insufficient to meet the extensive stock assessment needs across the country's vast fisheries. A few key lessons on fisheries management are:

- Systematic data verification systems and processes are vital, as is regular contact, in order to ensure learning, review, and improvements (adaptive management) throughout EAFM planning and implementation.
- With the right engagement and incentives, communities can become effectively involved in EAFM monitoring, which can in turn lead to improved data collection and coverage, management involvement, and compliance benefits.
- In partnership with provincial governments and communities, local universities have an important scientific role to play in supporting data collection and interpretation.
- Adequate scientific monitoring enables managers to experiment with targeted interventions, to quickly see the impacts on the stocks, and to adjust accordingly. Use of limited data approaches was important to overcome significant gaps in data.
- While globally recognized science and management tools are already in use across multiple fisheries in Indonesia, including onboard observer programs, logbooks, e-logbooks, catch per unit effort (CPUE) standards and vessel trackers, the fairly well-developed data-limited stock assessments and credible assessment of Indonesia's fisheries' overexploitation needs to be translated into management actions.
- Local customary practices such as *sasi*[1] offer great potential as fisheries solutions.
- Although the Project experienced some successes, the provincial licensing and classification of boats requires continued attention, simplification, and clarification. A lack of small boat registration, together with complications around licensing, inhibit authorities, managers and enforcers from managing the majority of small-scale fisheries.

Effective MPAs are essential for reef conservation and fisheries

One of the measures of success of the SEA Project was the level of reef health in the MPAs supported by the Project, as determined by the percent hard coral cover observed during transect surveys. In the Project portfolio of MPAs, eight sites were selected for baseline surveys between 2016–18 and surveyed again in 2020, in order to assess reef health over time. All the surveys were conducted in the planned 'no-take' zones of the MPAs. The SEA Project worked with provincial and local governments and communities in order to establish fully protected areas that were off-limits to fishing, coral gleaning and other extractive practices. The surveys revealed that nearly all the sites had managed to maintain stable reef health through MPA protection, with two sites showing increases in

[1]Sasi Laut is a traditional Eastern Indonesian conservation system involving closed areas that are occasionally opened to fishing.

hard coral cover through this time. Lessons from the MPA interventions were:

- A clear vision, robust planning and extensive experience, backed by a suite of standardized capacity-building tools, a national effectiveness rating system, and ample successful working models, have together enabled Indonesia to make great strides towards its goal of 30 plus million ha of MPAs by 2030.
- Of the 23 million hectares of legally declared MPAs at present in Indonesia, only about 15 percent are meeting their management and conservation objectives, with the percent coverage of no-take zones within MPAs remaining well below the targets set in order to build resilience in critical habitats and sustain fisheries.
- MPAs are an essential buffer for reducing the risks of ecological system failures and strengthening other management interventions; they also provide opportunities to build on fisheries management, enhance tourism, and create other social, economic, and ecological benefits.
- A network of smaller MPAs fits well with the scale of provincial management planning.
- Communities and district governments can play a major role in supporting environmental improvement; thus, government can be harnessed by advancing creative enabling policies at both the national and provincial levels in order to support the establishment and management of MPA networks.
- Even when data is limited and not standardized, pooling data sets allows for a better understanding of the situation and identifies priority interventions for management.
- Multiple engagement with stakeholders and provincial government leadership is vital to secure the long-term success of MPAs within provincial waters.
- The allocation of adequate human and financial resources to MPA management is essential for long-term success, but is not sufficient on its own.
- While MPAs do not always lead to immediate improvements in biophysical conditions, due to the broader fluctuations in ocean health, MPAs are a sound local solution for reef conservation and fisheries management.
- MSP is essential for Indonesia, where the sea covers about 75 percent of the total geographical area. With the importance given by national government to having multi-stakeholder MSPs legally approved, MSP helps to guarantee that designated MPAs are honoured at all levels of government. In Indonesia the MSP is often a pre-requisite for internal zoning plans for each MPA.
- The MSP process also provides an opportunity for provincial leaders, policymakers, government departments, and other stakeholders, to work together so as to resolve conflicts between development and conservation objectives.
- Finally, a legally adopted and enforced MSP system creates an enabling environment that facilitates the success of MPA, fishery and other environmental management initiatives.

Figure 4. Reef surveys were used to validate the status of reefs and of biophysical change with local NGO and stakeholder participation - Image ©USAID SEA / Irwan Hermawan

Multi-scaled approach to law enforcement

Law enforcement is a critical component of effective marine and coastal management. The SEA Project supported advances in law enforcement at the national, provincial, and site levels. Focusing on the Provincial and site level interventions, key lessons were:

- The SEA Project made strides in strengthening law enforcement in its operational provinces by synergy building among all relevant agencies. But there remains a need to use the Project's lessons learned to further promote an enabling environment for marine and coastal law enforcement.
- Marine and coastal law enforcement in Indonesia is hampered by a lack of resources and human capacity, by complex policy frameworks, by numerous agencies having intersecting responsibilities, and by the enforcement agencies' generally poor recognition of the urgency of combating fisheries and habitat damaging crimes.
- In the development of new policies or local regulations that impact resource use, stakeholder ownership and compliance can be fostered through engagement between policymakers and their constituents, and early community involvement in policy discussions. Policies and regulations that incorporate local contexts and take into account fishing communities' need for viable livelihood alternatives are more likely to achieve local buy-in, and be more self-enforceable.
- Trust, engagement, and local leadership from the community, local and provincial government, and civil society organizations are key to success in policy and law implementation. Community engagement, through local institutions and the establishment of community surveillance groups (as is allowed by law), can be instrumental in ensuring enforcement and compliance.
- The effectiveness of Indonesia's localized enforcement systems relies on district and community involvement, which depends on provincial government delegating authority to district fisheries agencies, integrating the interventions into village governance, and ensuring all parties have access to resources for long-term enforcement through regular allocations.
- Enforcement work requires interventions right across the law enforcement continuum, from promoting local policing through to working with regional judiciary and national policy makers. To have any meaningful impact, the effort to address the problem of illegal fishing must be a collaborative and integrated undertaking across multiple agencies operating at all levels of government; it must involve both government and all those working in, or dependent on, the marine sector.

Figure 5. Law enforcement capacity building was mostly for local surveillance groups to watch for illegal activities that were then reported to the formal police units

Changing behavior for a sustainable future

Implementing EAFM, establishing MPAs, preparing marine spatial plans, and promoting law enforcement - the four pillars of the SEA Project (and almost all marine and coastal management projects) - have one thing in common: They are about managing people. They are about adjusting individual and organizational behaviour patterns to achieve a sustainable future. They are about

people taking responsibility for and amending their actions that undermine the viability of the marine environment. Whether you are trying to improve fisheries by getting fishers to use environmentally friendly techniques, or working to protect marine habitat by closing access to an area of the sea, what you are really trying to do is change people's behavior. This is a slow, transformative process, and requires a multi-faceted approach. Therefore, the SEA Project embedded behavior change communication (BCC) techniques across the four pillars of work. BCC techniques involved: a) identifying and mapping target audiences; b) identifying, recruiting, and training champions for change; c) developing and distributing tailored messaging to target audiences; and d) building coalitions for change.

Figure 6. The "sea champion" activity attracted many young men and woman who were keen to protect their reefs and threatened species, and to reduce ocean waste dumping

Lessons drawn from SEA Project efforts regarding behavior change are:

- Behavior change takes time, is complicated, and needs to be tied in with management interventions; it is also important to ensure that incentives for sustaining positive behaviour (e.g. increased fish catch, more revenues from tourism) are seen and felt quickly by the community.
- Catalysing behavior change at scale requires interventions to engage fishers, resource users, their families and the broader community.
- The presence of local champions and community leaders (change agents) from the beginning ensures that behavior change occurs and is sustained.
- Training content for champions and communities is best tailored to local context.
- Opportunities to engage and work with community-led institutions can greatly support compliance and enforcement.
- Successful approaches to behavior change rely heavily on four intertwined components: (1) involving facilitators with social skills that local stakeholders will relate to, (2) integration within the wider program design, (3) utilizing peers to accelerate the adoption of the new behaviors, and (4) promoting the influence of the project through outreach activities and the example of influential individuals.
- Behavior change interventions and techniques can accelerate stakeholder engagement and improve the management effectiveness of fisheries and MPAs.

Creating incentives for behavior change

A key ingredient of success at the local level (to protect reefs and endangered species and to curtail illegal and destructive activities) was to build incentives for people to change their habits and beliefs, so leading to behavior change. Such change requires incentives; a few key insights from the SEA Project about how to facilitate behavioural change to achieve marine conservation objectives are:

- With the right engagement and incentives, communities can be effectively involved in EAFM monitoring, improved data collection, management and compliance.
- Traditional marine management approaches tend to focus on disincentives (e.g., arrests, seizures, prosecutions, penalties and fines); these remain necessary for severe crimes, but tend not to work for fisheries and environmental infractions that require widespread compliance.
- Strategic use of positive economic incentives (through e.g. tourism, Fair Trade premiums) can encourage the local adoption of MPA and fishery management measures.
- Incentives were most successful when affected resource users were consulted well before management measures were introduced.
- Public recognition of positive actors, enforcers, and local champions generates significant positive incentive that helps create a network of supportive actors.
- Public-Private Partnerships can be a useful tool at the right time and in the right place; but it is not a universal tool that works in every situation.
- Tourism development works well with resource management, but it requires full engagement of stakeholders, and it is vulnerable to externalities that cannot be mitigated at the local level (such as Covid-19 or cultural influences).
- The choice of who leads the different stakeholders' engagement is critical; establishing trust and rapport with the communities first, before embarking on interventions, is important, because incentive mechanisms require a long planning and engagement process to ensure that the interventions are trusted by local adopters.

New or refined policies and laws are often needed

The SEA Project worked closely with the provincial agencies and staff so as to build leadership and assist them in overcoming the fragmented roles and responsibilities of different agencies involved in ocean governance. It was important to develop mutual understanding among the many actors of their individual and collective roles in policy implementation, since existing policies and legislation are not always understood. An example of this was the new law (No. 23/2014) that reduced the district government's authority over fisheries and MPAs. However, district governments and village governments both still have significant fishery and coastal management roles. Thus, cooperative agreements and the development of plans (such as a village master plan) effectively engaged site-based participation in marine and MPA management.

Capacity building is paramount to support behavior change for conservation

It was found that in the Project's work areas of eastern Indonesia promoting stakeholder ownership proved invaluable in encouraging capacity development. This observation highlighted an opportunity for local universities and academic institutions to play a larger role in the project. By sitting in on the scientific panels of fishery management areas and MPAs they were able to enrich the scientific processes involved in fisheries analysis and stock assessment, the design of MPAs and the development of appropriate site level plans. In addition, the engagement of stakeholders outside of primary government was needed in order to help mitigate the frequent changes in government staff, and to sustain the ongoing need for capacity building of those playing key roles. Thus, the Project looked for opportunities to institutionalize capacity building into project objectives and strategies, so as to ensure their long-term continuation. Measures included training cadres of future trainers to ensure continuity, and institutionalizing capacity development programs and processes within the government priorities.

It was apparent that collaborative multi-agency / multi-disciplinary and multi-sectoral working arrangements tended to have the most significant long-term impact in enhancing capacity. And ensuring that training programs always had a gender lens was very important, since the role of women in many rural areas was still severely underutilized.

To make capacity building efforts more comprehensive, the SEA Project noted the value of coordinating donor investments across diverse implementers (including international, national, and community-based organizations). Coordinating these investments is vital, since donors often tend to work separately on their "own" turf, a tendency which undermines long term sustainability. While in recent years we have seen improvements in donor coordination in Indonesia, gaps remain to ensure priority themes and geographies have technical support.

Conclusion

The Indonesian SEA Project tested multiple mechanisms for streamlining planning for and implementation of improved fisheries and of MPAs in the three eastern provinces of Indonesia (Maluku, North Maluku and West Papua). If there was one major lesson learned, it is that fisheries management and MPAs operate in a complex coastal environment - they must be part of integrated management systems with interventions tailored to local needs and conditions within existing jurisdictions. So often we think at the national, regional (e.g. Coral Triangle) or global level. But the reality is that almost all actions undertaken to conserve coral reefs and manage nearshore fisheries in tropical countries are achieved at the local scale, within local government jurisdictions and with a multitude of local stakeholders and countervailing forces to plan for and mitigate. In addition, most local government agencies at either provincial or district level in Indonesia are not yet capable of integrating all the current design science, stock assessment and planning tools or of using the most effective and efficient implementation methods. While the road to build the needed capacity may seem long, the three provinces, and multiple district and village governments within the SEA Project areas of work, have made progress, and are on a path to more sustainable fisheries and MPA management. Such lessons can be applied in future similar projects.

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Additional reading

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REEF EDGE

Lenz & Edmunds

Sponge necrosis in the U.S. Virgin Islands

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Sponges on tropical reefs have long been recognized as critical components of the ecosystem (Reiswig 1973) because they enhance seawater quality through filtration, transfer dissolved organic carbon to higher trophic levels, immobilize rubble, and increase benthic rugosity (Diaz and Rützler 2001; Wulff 2016). However, challenges in identifying and quantifying sponges have led to them being overlooked in many coral reef monitoring programs (Wulff 2001). Scarce historical records of sponge abundance have made it difficult to evaluate long-term population dynamics of sponges on present day reefs (Webster 2007; Edmunds et al. 2020), particularly since dead sponges leave little evidence of their previous existence.

Disease is a leading cause of sponge mortality, and reports of necrotic sponges have become common in the Mediterranean, on the Great Barrier Reef, and throughout the Caribbean (Luter and Webster 2017). While the etiology of most sponge diseases remains poorly understood, perturbed environmental conditions (e.g., rising temperature and high nutrient concentrations) are thought to disrupt sponge-associated microbial communities (Pita et al. 2018). Common signs of disease in sponges are lesions, the rapid "wasting away" of whole organisms, and high rates of infection (Luter and Webster 2017).

The Caribbean sponge fauna is diverse (Diaz and Rützler 2001) and consists of many conspicuous species that produce dense populations on shallow reefs. These include the giant barrel sponges (*Xestospongia muta*), vase sponges (e.g., *Callyspongia plicifera*), rope sponges (e.g., *Aplysina insularis*), the bell sponges (*Ircinia campana*), the loggerhead sponges (*Spheciospongia vesparium*), and the black ball sponges (*Ircinia strobilina*). Thirty years ago, on the shallow reefs (7–9 m depth) of St. John, U.S. Virgin Islands, the mean density of *I. strobilina* was 0.47 ± 0.14 sponges m^{-2} (± SE, n = 6 sites), but between 1992 and July 2017 the mean density of this species declined by 53% (Edmunds et al. 2020). By November 2017, two months after two hurricanes impacted the island, the density of *I. strobilina* on the same reefs had declined by a further 74% (relative to July 2017) (Edmunds et al. 2020). Despite these losses, a simple approximation based on sponge density in November 2017 at reef sites (at 7–9 m depth) between White Point and Cabritte Horn, suggested there were ~ 26,400 *I. strobilina* on the shallow reefs extending between these points.

In January 2021 we encountered a high number of necrotic *Ircinia strobilina* (Fig. 1) while conducting scleractinian and octocoral surveys at 13 different sites along the north and south shores of St. John and St. Thomas, US Virgin Islands (as in Edmunds et al., 2016). These surveys were conducted at Cocoloba Cay, Booby Rock, Leduck Island, Haulover Bay, Leinster Bay, Whistling Cay, and six sites between White Point and Cabritte Horn in St. John, and at Magens Bay, Inner Brass Cay, Botany Bay,

Figure 1. Necrotic *Ircinia strobilina* sponge (~ 30 cm in diameter) on a shallow reef (9 m depth) off St. Thomas, US Virgin Islands, in January 2021. Extensive necrosis reveals spongin fibres within the mesohyl (the middle layer of the sponge composing the majority of the biomass).

Fortuna Bay, Flat Cay, and Cow and Calf rocks in St. Thomas. At the six sites off St. Thomas, and three sites off St. John, individual *I. strobilina* were qualitatively inspected for necrosis. At Leduck Island, Booby Rock, Cocoloba Cay, East Tektite, and Little Lameshur on St. John, the number of visually healthy and necrotic *I. strobilina* were quantified in 30 × 2 m band transects. Additional surveys were completed on the Tektite reef between White Point and Cabritte Horn to assess the effects of depth (5, 7, and 8-m depths) on the abundance of necrotic sponges. When the surveys were completed, seawater temperature was ~26.7°C, which is close to the mean winter low temperature of 26.0°C that occurs in late February and early March (Edmunds 2021).

Necrotic *Ircinia strobilina* were found at all sites visited around St. Thomas and St. John. Affected individuals had lost portions of their biomass to create lacunae in which spongin fibres were visible (Fig. 2). The size of the lesions was variable and consumed ~ 5–100 % of the volume of individual sponges, often leaving only a small patch of living biomass. In severe cases, dead sponges were detached from the benthos leaving a mobile ball of spongin fibres. In partially affected sponges, necroses deeply penetrated each sponge, sometimes creating a void in which juvenile wrasses were seen (e.g., *Thalassoma bifasciatum*), with irregular margins separating the necrosis from apparently healthy sponge biomass. Most of the diseased sponges were 10–20 cm in diameter, and therefore inferred to be between 14 and 28 years old assuming *I. strobilina* grows at 0.7 cm y^{-1} (Hoppe 1988). At the four sites around St. John where quantitative surveys (n = 4 band transects) were completed, the mean (± SE) density of *I. strobilina* was 0.11 ± 0.06 sponges m^{-2}, of which 74 ± 11% were necrotic. Surveys of *I. strobilina* on the Tektite reef suggested the number of necrotic sponges did not vary with depth (4–9 m) (r = 0.01, *P* = 0.88).

As the density of *Ircinia strobilina* on shallow reefs along the south shore of St. John overall has declined since 1992 (Edmunds et al. 2020), the high prevalence of necrosis (i.e., ≥ 50% of sponges by site) suggests the population size may decline further. Necrosis with visually similar signs reported here for *I. strobilina* has also been reported on the shallow reefs of Belize (in 2011, Wulff 2011), Curaçao, Panama (in the mid-to-late 1980s, Wulff, 2006), and Puerto Rico (in 2021 J. Wulff pers. comm. to EA Lenz). Without knowing the causes of these cases of sponge necrosis, or the etiology of the condition if it is a disease, it is impossible to project sponge population and community dynamics into the future, especially as current and future environmental conditions rapidly change. Major outbreaks of sponge necrosis have the potential to dramatically alter the structure and function of coral reef communities. There is a risk, however, that these effects will remain under-reported unless coral reef monitoring projects report holistic changes in benthic communities and in abundance of sponges with species resolution.

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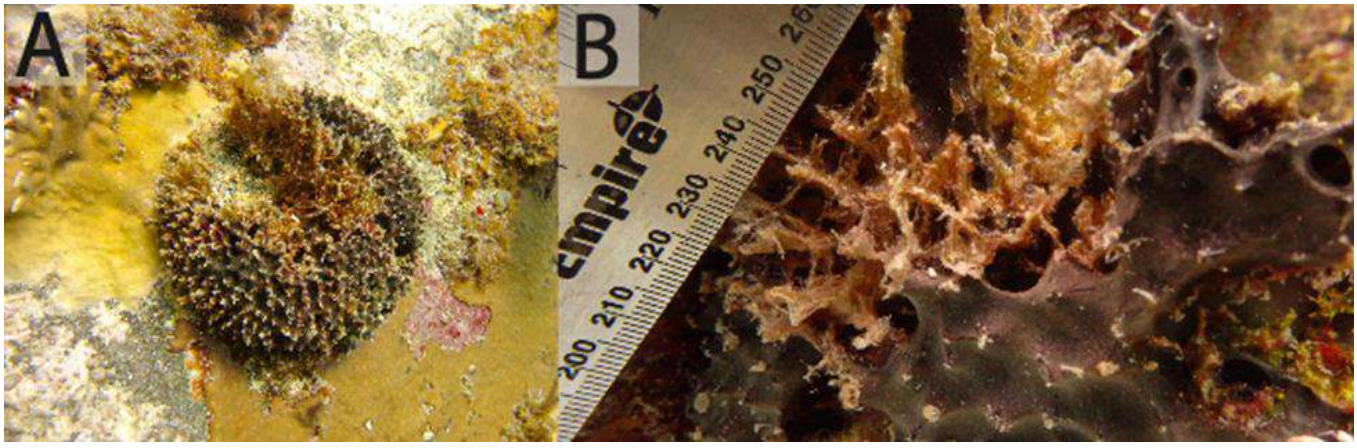

Figure 2. Photographs of necrotic *Ircinia strobilina* at 9 m depth off St. John in January 2021. A) A sponge (~ 20 cm diameter) with a conspicuous lesion extending through the height of the organism to expose the substratum beneath, and B) close-up of a necrotic area showing exposed spongin fibres adjacent to intact sponge biomass.

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Jogee et al.

Endolithic Tissue Aids Rapid Recovery from Wounds in *Porites cylindrica*: the 'Phoenix Effect' in Action

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Scleractinian corals are frequently fragmented via wave action and animal interactions. For many coral species, including members of the *Acropora*, *Pocillopora* and *Goniopora* genera, these fragments form a natural part of their reproductive strategy. For a handful of massive or sub-massive species, these fragments can remain free-living growing in an almost spheroidal morphology, and have been termed coralliths. However, fragmentation causes wounds, creating three major challenges for the newly fragmented coral. First, energy is diverted away from growth and reproduction in order to heal the wound (Burmester et al. 2017). Secondly, the fracture generates a point of entry for competing or damaging organisms, such as pathogens (Traylor-Knowles, 2016). Finally, the smaller fragment has a reduced available surface area for photosynthesis. The rate at which the coral can recover from the wounds caused by fragmentation will contribute to the fragment's survival.

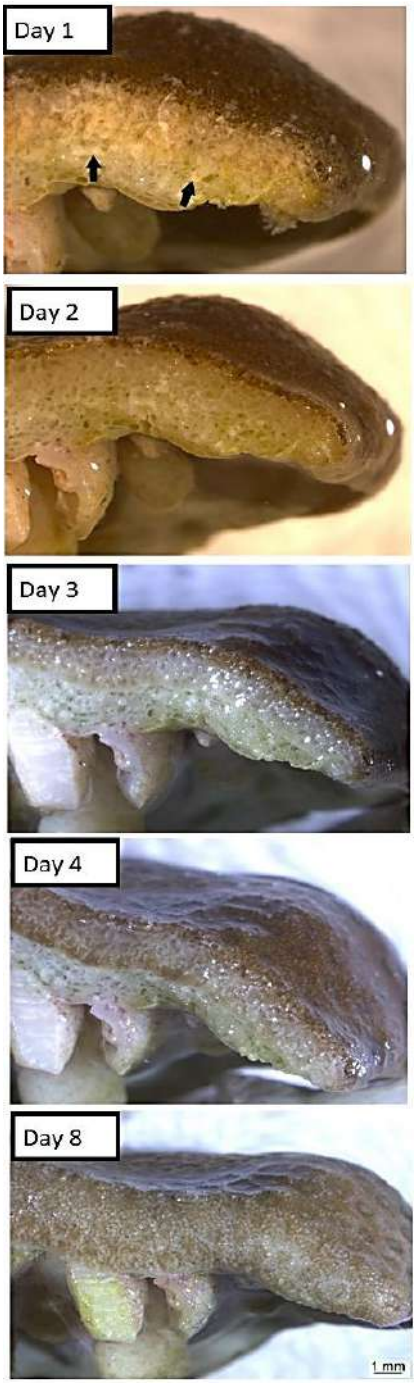
Three major hypotheses describe wound recovery patterns in corals: localised regeneration, colony integration and the "phoenix effect". The phoenix effect is a phenomenon whereby seemingly dead coral has the ability to regenerate from remnant tissue existing either on the surface or, in more notable cases, deeper within the coral's skeleton (Krupp, 1992; Roff et al. 2014). Some small polyp corals with deep tissue matrices, like *Porites* spp. are known to have sometimes recovered from various stressors, including physical damage, bleaching and grazing, after appearing completely dead. The phoenix effect has been credited with permitting recovery of *Porites* spp. colonies after non-fatal mass bleaching events (Roff et al. 2014), and could aid in their recovery from other forms of stress, such as predation or physical damage following rolling of coralliths by wave action.

To date, the phoenix effect has been observed in very few species, mainly from the genera *Fungia*, *Astrangia* and *Porites*. Using microscopy, we present photographic evidence of *Porites cylindrica* exhibiting endolithic tissue that, post-fragmentation, aids in the healing of the wound along the fracture point and grows out towards this newly exposed surface, allowing for re-sheeting of the newly exposed skeleton.

From corals that were housed in aquaria at the University of Edinburgh, we cut five coral fragments from three larger colonies of *Porites cylindrica*, and, for comparison, five fragments from four colonies of *Platygyra* sp., to a size of approximately 3 cm at their widest point. Corals were then photographed at the same point along the fractured edge at 8 x magnification daily for 20

days. Tissue extension rate over the newly exposed coral skeleton was measured in mm day-1. The rate of recovery across the 20 days was not significantly greater in *P. cylindrica* (mean ± S.E. = 0.12 mm day-1 ± 0.02) than *Platygyra* sp. (0.08 mm day-1 ± 0.01). Paired t-test: t78 = 1.528, p = 0.131. However, the initial rate of recovery between days 0-3, was 79% greater in *P. cylindrica* (0.34 mm day-1 ± 0.04) than in *Platygyra* sp. (0.19 mm day-1 ± 0.01). Paired t-test: t8 = 4.012, p= 0.004.

The initial rapid rate of recovery was observed via microscopy to be due to the endolithic tissue within the upper layer of the *P. cylindrica* skeleton (see Figure 1). Once the coral was cut and a newly exposed surface was receiving suitable levels of PAR for symbiont colonisation, we observed increasing colouration of this endolithic tissue over the first four days (see Fig. 1). This colouration was due to the migration, and then proliferation, of algal symbiont cells (see Fig. 2). It appeared that by providing resources to the coral host, these newly established symbiont cells then aided in the regeneration of upper tissue layers. By Day 8 we could see new coral polyps beginning to form (see Fig 1). This was in contrast to the behaviour of tissue in *Platygyra* sp. which appeared to seal the edge of the wound and then slowly grow tissue down the newly cut face. The ability of endolithic tissue to quickly establish on the surface of the skeleton after fragmentation would increase the survival rate of *P. cylindrica* post-fragmentation by avoiding the complications that arise once the exposed skeleton is colonised by biofilm microorganisms and the larvae of other invertebrate.



◂ Figure 1. A) Photographs of the cut edge of the coral fragment at 8 x magnification. From day one (top) to day 9 (bottom). Day 1 black arrows indicate the deepest layer of endolithic tissue. As the days progress we see the colouration of this tissue as symbionts colonise the tissue. By Day 9 we see polyp corallite formation occurring.

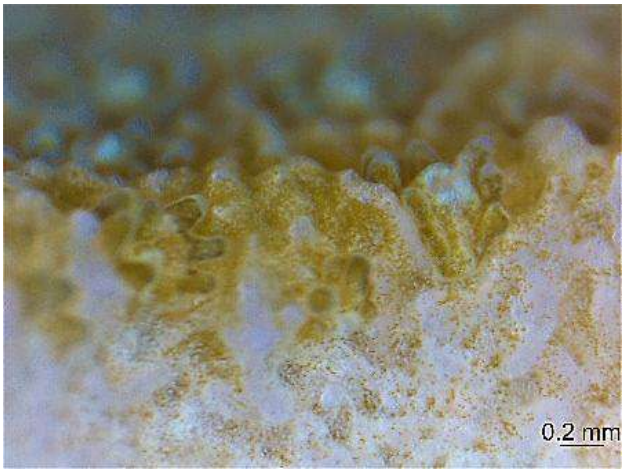


Fig. 2 Image taken at 40 x magnification on Day 3, shows the migration of algal symbiont cells through the newly exposed endolithic tissue.

Considering that many *Porites* species have large, massive and sub-massive morphologies, their fragments are likely to have relatively large surface areas of exposed skeleton. By endolithic tissue rising to the surface and then 're-sheeting' this skeleton with new soft tissue the coral fragment can re-establish a large surface area for photosynthesis with minimal energy being diverted to calcification. This is unlike other species of coral, such as those with branching morphologies, which need to invest in skeletal growth to maximise tissue surface area. We also propose that endolithic tissue could contribute to the phoenix effect. Whilst Sheppard (2020) described how massive corals recovered from shaded wreaths of surviving

polyps, we suggest that corals may also be able to recover from surface-colonising endolithic tissues. Thus, partially killed *Porites* colonies and smaller unattached fragments, such as coralliths, may have a higher survival rate and be more successful at re-establishing themselves than many other genera. We suggest investigating whether other species can recover via the phoenix effect driven by endolithic tissue, since this may explain their increased dominance in the community post-disturbance.

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The despised role of sclerobionts in a coral community from the eastern tropical Pacific

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Introduction

Cementation is a crucial process for the permanence of reef structures since it precipitates secondary $CaCO^3$ binding framework components and occludes porosity (Perry and Hepburn 2008). In the absence of reef cementation, the rigid structures that characterize reefs become fragile and vulnerable to physical and biological erosion (Perry 1999). In the eastern Pacific (EP), coral reefs are small, have a simple physical structure, discontinuous distribution, and low diversity (Cortés 2003). Usually, coral reefs from the EP are built by few species, including both branching (*Pocillopora*) and massive species (*Porites*, *Pavona*). The EP's coastal reefs show little or no cementation, and consequently, they do not consolidate as large and biodiverse reefs as in other ecoregions (Manzello et al. 2008; Toth et al. 2017).

The organisms which colonize hard substrates have been named encrusting, fouling, or boring. Here, we adopted the term sclerobiont, as proposed by Taylor and Wilson (2002), who define them as "any organism (plant or animal) fouling any hard substrate." In this work, we observed the colonization by sclerobionts in experimental Calcification/Accretion Units (CAU) during 15 months to estimate the calcification rate in a small coral community from the west coast of Mexico in the tropical Pacific subject to anthropogenic impact. We found that the calcification rate peaks at six months and then decreases slowly afterwards.

Methods

The study site was at Las Gatas, in the Bay of Zihuatanejo, where there is a rocky reef colonised by scattered small *Pocillopora* colonies (Fig. 1). In the bay sea temperature fluctuates between 31°C in the summer and 27°C in the winter.

To assess the calcification rate of sclerobionts we used square (10 x 10 cm) PVC tiles coupled in CAUs (Price et al. 2012), overlapped to emulate four micro-habitats: Exposed Upper Surface (EUS), facing upwards, exposed to light and sedimentation; Cryptic Upper Surface (CUS) facing downwards and protected from light and sedimentation; Cryptic Bottom Surface (CBS), facing upwards, protected from direct light but exposed to sedimentation, and Exposed Bottom Surface (EBS) facing downwards and protected from light and sedimentation (Fig. 1). This kind of structure has been used before to assess recruitment and calcification on coral reefs (Price et al. 2012; Vargas-Ángel et al. 2015; Reis et al. 2016; Alvarado-Rodríguez et al. 2019) and currently by NOAA in its Pacific Reef Assessment and Monitoring Program.

CAUs were deployed on April 2019 and collected six months (October 2019) and 15 months (July 2020) (4 CAUs x 4 surfaces, n=16) after the beginning of the experiment. Once in the lab, tiles were immersed in

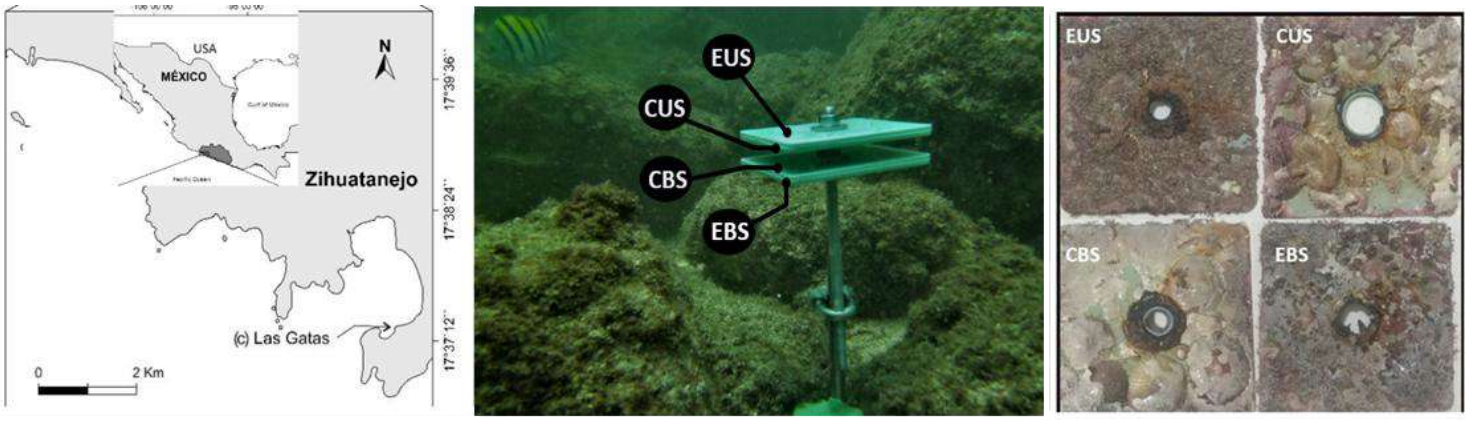

Figure 1. Study site (left), artificial fouling structure in situ (middle) and four micro-habitat tiles colonized by encrusting calcifiers after six months (right). EUS = Exposed Upper Surface, CUS = Cryptic Upper Surface, CBS = Cryptic Bottom Surface, and EBS = Exposed Bottom Surface

hypochlorite (4%) and then oven-dried at 70°C for 48 h. Calcifiers were classified into seven groups: Crustose Calcareous Algae (CCA), Polychaete tubeworms (Po, serpulid and spirorbid worms), Sessile molluscs (Mo, Vermetidae and Calypraeidae family), Bryozoans (Br), *Balanus* (Ba), Limpets (Li, Patellidae), and Miscellaneous (Ms, included small unidentified fragments). The gross calcification rate (GC) was calculated as: GC = 〖SC〗_dw/(a·t), where SCdw is the dry weight of the sclerobiont calcifiers found in the structure, a is the area of the tile (0.01 m^2) and t is the time immersed.

Results

Calcification rate (mean ± SD) decreased from 1.37 ± 0.46 kg CaCO3 m-2y-1 at six months to 1.01 ± 0.29 kg CaCO3 m-2y-1 at 15 months, but this difference was not statistically significant (t0.05, 22= 1.468, p= 0.156). A two-factor ANOVA test indicated that the interaction of the sampling period with the surface (EUS, CUS, CBS, and EBS) was significant ($p< 0.05$). A Tukey post-hoc test revealed that calcification rate was similar between sampling periods ($p> 0.05$) on the four surfaces, but significantly higher ($p< 0.05$) on cryptic (range: 1.15-2.79 kg $CaCO^3$ $m^{-2}yr^{-1}$) than on exposed surfaces (range: 0.32- 1.31 kg $CaCO^3$ $m^{-2}yr^{-1}$) during the six months study period (Fig. 2). On the other hand, the calcification rate was similar ($p> 0.05$) between surfaces during the 15 months study period (range: 0.23-1.74 kg $CaCO^3$ $m^{-2}yr^{-1}$; Fig. 2).

The limpets (Patellidae) had the highest calcification rate (mean ± SD, kg $CaCO^3$ $m^{-2}yr^{-1}$) through the study period (0.65 ± 0.16, at 6 mo, 0.51 ± 0.36, at 15 mo) followed by Balanus (0.29 ± 0.33, 6 mo) and sessile mollusks (0.17 ± 0.13, at 15 mo). Polychaete tube worms (0.01 ± 0.01) and crustose calcareous algae (0.05 ± 0.04) recorded the lowest calcification rate (Table 1).

Figure 2. Box plots of calcification rate at exposed (EUS and EBS) and cryptic (CUS and CBS) surface of experimental units at 6 months (white boxes) and 15 months (black boxes). Boxes represent the inter-quartile range (25th to 75th percentile), and whiskers indicate the 5th and 95th percentiles for unadjusted data. The notch in each box represents confidence intervals about the median, shown by a horizontal line at the middle of the notch

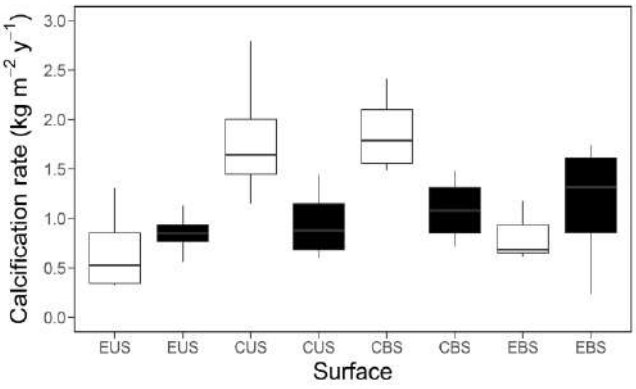

Table 1. Calcification rate (kg $CaCO^3$ m^{-2} yr^{-1}, mean ±SD) of the sclerobionts found in four experimental units after six and 15 months.

	6 months	15 months
CCA	0.09 ± 0.07	0.05 ± 0.04
Polychaetes	0.01 ± 0.01	0.05 ± 0.04
Mollusks	0.12 ± 0.14	0.17 ± 0.13
Bryozoans	0.17 ± 0.02	0.05 ± 0.02
Balanus	0.29 ± 0.33	0.04 ± 0.04
Limpets	0.65 ± 0.16	0.51 ± 0.36
Miscellaneous	0.04 ± 0.03	0.14 ± 0.04
Total	1.37	1.01

Discussion

Binding by sclerobionts in a coral reef is critical. However, their contribution to the carbon budget is usually overlooked because most of the attention has been focused on the main calcifying organisms, in particular hermatypic corals. In this study, we found that sclerobionts contribute around 1.4 kg $CaCO^3$ $m^{-2}yr^{-1}$; in the same area, Medellín-Maldonado et al. (2016) found a calcification rate of 7.2 kg $CaCO^3$ $m^{-2}yr^{-1}$ for the massive coral Pavona gigantea. In the Cabo Pulmo reef (23°50'N - 109°27' W) Norzagaray-López et al. (2015) reported a calcification rate of 10.1 kg $CaCO^3$ $m^{-2}yr^{-1}$ for Porites panamensis. Across Heron Reef, Brown et al. (2020) reported sediment budgets of 2.8 kg $CaCO^3$ $m^{-2}yr^{-1}$ and emphasized the spatial variability of calcification rates.

Unlike other sites where CCA is a principal component of the carbon budget (Vargas-Ángel et al. 2015 and references within), in Playa Las Gatas their contribution was just 7% (0.09 kg $CaCO^3$ m^{-2} yr^{-1}). This low contribution may be due to multiple human activities that generate chronic environmental stress on the reef (i.e., sewage outlets, anchoring, fishing, and recreational snorkeling). Also, intense runoff carries sediments from the land due to deforestation (Nava and Ramírez-Herrera, 2012), so that sedimentation rates can exceed 2 kg $m^{-2}d^{-1}$ (Alvarado-Rodríguez et al. 2019). On the other hand, as hypothesized by Mallela (2013), filter-feeder sclerobionts (i.e., Balanus, bryozoans, and sessile mollusks) contributed 80% (Table 1) to the calcium carbonate production, due to eutrophication of the site.

In the Eastern Tropical Pacific, the increase of surface nutrients associated with upwelling water, together with the low pH levels and concentration of Ωar, limits the early cementation of reef structures and promotes their bioerosion (Manzello et al. 2008). The role of sclerobionts in reef growth goes beyond just the contribution of new calcium carbonate; with their extensive growth, they bind and stabilize the fragments and loose sediments (Fagerstrom, 1991; Rasser and Riegl, 2002) and, at the same time, they occlude the pores and cavities of the primary matrix, filling them with calcium carbonate and promoting the precipitation and preservation of carbonate cements (Scoffin, 1992). Sclerobionts contribute to the preservation of the scarce coral structures (living and dead) present in the coral community of Playa Las Gatas, and at the same time, continue the calcification process in a significant way.

Acknowledgments

We are grateful to H. Nava and MA Cárdenas-Alvarado for their valuable help in the field and G. Fernández for lab assistance.

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The Blue Center:

a Coral Guardian program supporting coral conservation from the Flores Sea, Indonesia, to the Mediterranean Sea, Spain

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Overall Context and the Blue Center

Coral ecosystems around the world have faced rapid degradation over the last several decades. The combination of global and local stressors has led to a decrease in coral cover and a shift in biological community composition and diversity (Kubicek et al. 2019). The fast decline of these ecosystems endangers the support of millions of people who directly depend on them for their livelihoods through fisheries, tourism activities and coastal protection (Woodhead et al. 2019).

Local pressures such as destructive fishing, coastal pollution or mass tourism can make coral ecosystems less resilient to global stressors like climate change (Hein et al. 2020). Therefore, management and conservation strategies should respond to the specific problems, avoiding silver bullet solutions.

The NGO Coral Guardian was founded in France in 2012 to protect and restore coral reefs around the world, through involving both local and international communities. For this purpose, Coral Guardian created the Blue Center, a program aimed at training and supporting local actors (NGOs, governments, communities) in the development of their own coral protection and conservation projects. This formation program has both a theoretical and practical training. The theoretical part is addressed with a manual regrouping key notions for the creation of a coral restoration

Figure 1. (above) General view of the coral restoration area at Hatamin Island, Indonesia. Photo: © Coral Guardian - M. Colognoli; (right) two kinds of coral restoration structures used in Hatamin. (upper right) metal tables, and (lower right) bamboo / metal table. Photos: © Coral Guardian.

project, which will be soon published, while the practical training is made in the field with the guidance of a local trainer. Currently, the only practical training center is based in Indonesia.

Depending on the needs of the particular projects, the Blue Center offers two kinds of support. The first consists of punctual assistance for "Consultancy Projects", based on advising local structures on a specific technical, scientific, or administrative matter. The second one involves regular support for "Core Projects" from Coral Guardian, which can include technical, scientific, administrative, and financial help.

Thanks to the Blue Center, several projects have been developed. Currently, Coral Guardian provides support for two coral conservation programs on a regular basis, within two very different contexts.

The first program is based in Indonesia, in the Flores Sea, where shallow-water corals have been protected and restored by the local community since 2015 after destruction from blast fishing. The second one is based in Spain, off the Mediterranean coast, where cold-water coral communities have been restored through waste recovery actions from the sea bottom and coral transplantation, following degradation due to coastal pollution, abandoned fishing gear and mass tourism.

In both projects, coral reef protection, restoration and monitoring are used as tools to involve the local community in coral conservation and to raise awareness locally and internationally around the importance of coral ecosystems.

The Pilot Project: Hatamin Island (Indonesia)

The pilot project takes place in Indonesia, in the heart of the Coral Triangle, one of the regions with the highest diversity of corals. The project started in 2015 with the aim of counteracting reef degradation off Flores Island, in the region of East Nusa Tenggara. Here, blast and cyanide fishing have destroyed the structure and diversity of reefs, hindering recovery, and threatening the livelihoods of local communities.

Coral Guardian and the Indonesian NGO Waka Eling Semeton combined their efforts to establish the coral conservation project at Hatamin Island, in close collaboration with the inhabitants of the surrounding village of Seraya Besar and the town of Labuan Bajo. The major goals of the project are: (1) to protect and restore the coral reef ecosystem around Hatamin Island, (2) to increase social benefits derived from coral reef protection, and (3) to contribute to the scientific knowledge of coral reefs and coral restoration. Monitoring and other actions are carried out by a local team of 8 people who are inhabitants of the surrounding villages.

Since 2019, a 1.2 ha marine protected area (MPA) has been implemented (Pulau Hatamin Island Sanctuary), where the fringing coral reefs are protected from the direct impact of fishing and tourism thanks to the surveillance of the local team. Coral restoration takes place here through coral gardening, by fragmenting corals from previously restored areas and transplanting them onto metal structures (tables). These metal structures are used to stabilize the substrate and support coral growth (Fig. 1).

To date, more than 40 000 corals have been transplanted in the MPA by the local team. The impact on the fish community, assessed by yearly monitoring, has shown that from 2015 to 2019, 30 times more fish abundance and 4 times more fish species were present in the restored area, compared to the unrestored control site (Coral Guardian 2020).

In addition, an experimental area has been established in the MPA, aimed at developing the scientific curiosity of the local team through experiments on coral restoration. For instance, during 2020, experiments to test new restoration tables and coral attachments were made here using bamboo and metal structures. The objective was to

Figure 2. Community associated with chandelier corals (*Dendrophyllia ramea*) in Punta de la Mona. Photo: © M. Colognoli – Coral Guardian.

Figure 3. Partial mortality of chandelier coral colonies (*D. ramea*) entangled with abandoned fishing nets. Photo: © Javier Sánchez – SOS Corales.

compare the growth of the corals between the bamboo/metal structure and the conventional one (100% metal structure) (Fig. 1). After 6 months of study and numerous trials, the results showed no difference in the coral growth rate between the two types of structures (41% in average for corals in both bamboo/metal and metal tables), meaning that the material does not seem to affect corals' growth. However, due to the natural degradation of bamboo in the marine environment, the attachment of coral to bamboo is not stable. After one year in the field, 44% of the corals had detached from the bamboo structures, reducing the success of the transplantation.

Restoring Cold-Water Coral Communities in the Mediterranean Sea: SOS Corales

In the Mediterranean coast of La Herradura village in Spain, the protected area of Punta de la Mona is locally known for its abundance of cold-water corals at unusual shallow depths. Colonies of orange coral (*Astroides calycularis*) can be found at 5 m deep, and chandelier corals (*Dendrophyllia ramea*) from 30 m, while in other parts of the Mediterranean, the latter species can only be found 70 m deep (Barea-Azcon 2008). As a consequence, the area holds a remarkable marine biodiversity, supporting tourism and fishing activities by offering aesthetic value and habitat for marine organisms. Therefore, La Herradura economy is based on these two activities, benefitting the local human communities.

However, despite the government's efforts to protect the area, coral communities are being degraded by coastal pollution and abandoned fishing gear - fishing nets getting entangled around coral colonies, breaking them, and detaching them from the sea bottom (Fig. 3). In addition, unorganized anchoring and the action of divers' fins have an impact on coral bottoms, breaking coral colonies and putting at risk the foraging and breeding habitat they make availability for marine organisms, and the long-term sustainability of local communities' livelihoods.

In this context, the project SOS Corales was launched in 2020 in collaboration between the Spanish NGO Equilibrio Marino and Coral Guardian, to act for the protection and recovery of cold-water corals in Punta de la Mona. The objectives of the project are (1) to accelerate the recovery of the coral bottoms in the area working closely with local stakeholders, (2) to raise awareness locally and globally about cold-water corals, their importance and the threats to them; and finally (3) to contribute to the scientific knowledge of these ecosystems in collaboration with local universities. Therefore, the project has both a biological and a social dimension.

In the field, actions have started with underwater waste removal from the sea bottom, following specific protocols. In 2021 alone, 241 kg of marine debris have been removed by the local team with the contribution of diving centers and trained volunteers. In order to raise awareness, exhibitions of the debris and workshops have been held in the surrounding villages.

During the clean-up phase, coral fragments and colonies are gathered by the team. Depending on their condition (presence of epibionts, proportion of dead coral), they can be carefully cleaned and transplanted directly back onto the rocky substrate using bioepoxy (Fig. 4). However, if they are in poor condition (Fig. 3), meaning they are covered by epibionts and with low amounts of living tissue, they will first be transferred to the coral nurseries. In fact, SOS Corales is one of the few Mediterranean coral restoration projects with a coral nursery in the field (Fig. 4). It acts as a "coral recovery center", where the favorable environmental conditions and the regular maintenance accelerate coral recovery, so that when they are transplanted back into the substrate, they have the best chances of survival.

Figure 4. Top and centre: Direct transplantation of an orange coral colony (*A. calycularis*) (top) and of a chandelier coral (*D. ramea*) (centre) at Punta de la Mona. Bottom: Divers monitoring the chandelier coral nursery in Punta de la Mona. Photos: top & centre © Javier Sánchez – SOS Corales; bottom © M. Colognoli – Coral Guardian.

Until summer 2021, 311 corals of both orange and chandelier coral species have been transplanted in the area, ranging from 5 to 35 meters deep. In the meantime, 37 corals are being treated in the nursery.

In parallel with the coral conservation actions, awareness programs are ongoing, with a special focus on informing government officials, and helping them make progress with the enforcement of the protected area, but also in diving centers and schools, for which communication tools have been created.

Finally, several partnerships with local universities (University of Seville, University of Cadiz, University of Malaga) have been put in place to increase the knowledge about the species' habitats, populations' structure and genetics, and the presence of pollutants in the area.

What's next?

We can summarise our plans as follows :

- **Current projects**: to strengthen and create new partnerships with local stakeholders to continue protecting and restoring coral ecosystems in both Indonesia and Spain.
- **New projects**: to support new projects through the Blue Center, in order to expand the benefits of its coral protection and restoration efforts.
- **Blue Center Training Manual**: the publication of the Training Manual we have been working on with our scientific team will be made soon. It will contain key information to help and guide the teams of our associated projects in the steps towards building their own project.
- **Raising awareness**: to explore new tools to reach different audiences, both locally and globally on the importance of tropical coral reefs and cold-water coral ecosystems around the world.

If you want to know more about any of these projects, or about the Blue Center, you can follow Coral Guardian on social media (Facebook, Instagram, Linkedin) or please contact Florina Jacob-Lozano by email (f.jacob@coralguardian.org).

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14th ICRS (VIRTUAL)
July, 2021, Bremen, Germany

We invited four delegates attending on-line the VIRTUAL ICRS to give an account of their impressions of the Conference - a professor, a mid-career researcher, a post-doc and a PhD student. Did they think the virtual organisation a success? READ ON!

Chris Perry
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Not quite a tropical venue (and not even northern Germany) but, as the first virtual ICRS started, the UK was certainly basking in a summer heatwave. After some deliberations I had decided to keep my registration and try the virtual format – partly because it seemed like a good opportunity to see how such formats might work, but also because I felt I was starting to miss the opportunity to think about reef science more widely. Ongoing lockdowns and a restricted travel environment inevitably seem to lead to some degree of insularity. One of the major problems of course of not actually being away for a meeting is that it is far harder to shut out all the day-to-day admin and management emails coming in, and despite my best attempts on Day 1 various departmental distractions arose. However, I tapped into some great talks on ecosystem function changes and on research aimed at better constraining our understanding of past reef growth responses to sea level and environmental change – topics of course close to my own research interests.

As I felt my way into this virtual format, I decided to shift tack a little, listening live to those talks most closely aligned to my own research interests, and then watching on demand (in blocks) a selection of other talks that attracted my interest from across a wide spectrum of the discipline. I enjoyed an awful lot of these and selecting just a few highlights seems unfair, but here are several that span a broad research spectrum. Julia Baum gave a great talk on her group's long-term monitoring in Kiritimati, highlighting the very different responses to recent bleaching depending on magnitudes of pre-existing local stresses and the emergence of different "winner" and "loser" taxa across sites. Chris Jury also gave a very interesting talk showing the results of long term mesocosm experiments measuring coral calcification rates – the key finding being a potentially more positive prognosis for the persistence of, albeit altered, coral communities under future SST and OA scenarios. Violeta Martínez Castillo gave another talk providing some optimism for the future, her work showing quite good recovery of coral communities, including the locally important *Pocillopora* taxa, at sites in the Eastern Tropical Pacific.

I also tapped into a few talks on the, currently much debated, topic of coral restoration, these variously illustrating examples based on coral out-planting, and on deployments of different types of artificial reef structures, including 3D printed tiles mimicking coral surfaces. The talk by Lisa Carne I felt was important because it showed that out-planted *Acropora* had been spawning, viably settling and thus increasing coral cover in shallow reef settings in Belize, the key habitats and depths that will be most important for coastal protection gains as the talk by Curt Storlazzi demonstrated. On the related theme of future reef persistence Madeleine van Oppen's overview talk highlighted the amazing work now being done in the field of assisted evolution to identify and produce thermally tolerant coral taxa. Finally, and on a completely different topic, I found the talk by Jessica Reichert on long term accumulation of microplastics in corals really interesting. Her work clearly showed high inclusion rates in coral skeletons with incorporation positively correlated with skeletal extension rates. This raises interesting

ideas about long-term sinks for microplastics in accumulating reef frameworks.

The on-demand approach to viewing talks had the disadvantage of not being able to ask questions live, although of course it proved simple enough to email speakers afterwards on the Q&A platform – which I found worked very well. I also had a look through quite a few of the posters and especially enjoyed some of these where speed talks were embedded – that might be a good format for any hybrid conference model going forwards (more on that below). EGU have been running what they call PICO talks for a few years where you get 2 minutes to highlight the key findings of your work based around an interactive Powerpoint or similar format slide/poster; once all the speakers have talked there is an opportunity for people to chat with the presenters live (of late in break-out rooms of course). I have found that a pretty good way to get an update from across a large number of presentations.

I felt that the recorded delivery platform worked really well, and actually was a great benefit in terms of time keeping. I didn't see any talks run up to the 15-minute deadline; in fact all the speakers had left 2-3 mins for live Q&A. So, I could certainly see this format working in the future, and I think that a hybrid approach could be very good, with some people delivering in person and some via pre-recorded talks. Indeed, if we are to think seriously about what we do in terms of travel from a personal carbon footprint perspective these mixed or virtual models are probably what we need to learn to accept. Session Q&A was interesting, sometimes of course one wants to wait to the end of a talk before formulating a question and so actually getting that question down on the chat (by the time you've corrected for typos!) in time for it to be picked up by the Chair in the time available is not always easy, and I saw a lot of questions appearing sometimes just before the next talk auto-started.

The session I was presenting in seemed to run well. One suggestion is to think a bit about how that interaction for the speakers works. As a speaker you disappear off into a live Zoom call with the other presenters and the session Chair, which is fine, but that means (maybe this was just me) you cannot then see the questions being posed live on the video feed channel that everyone else is using, or at least you can't without hearing an overlap in the talk (again, maybe that was my system). We did end up having quite a lot of inter-speaker discussion in our own mini Q&A – which was interesting but not ideal. This discussion was of course also time limited, and here one of the major virtual conference limitations appears – you get on a train of thought and discussion with someone and then people have to disappear, depending on global location, to go sleep, get something to eat, pick the kids up etc. So that more prolonged and informal discussion of emerging ideas over coffee or drinks is inevitably lost. Hopefully, we'll follow up on some of these by email/Zoom but that's not quite the same.

Due to my own pre-conference dis-organisation I missed out on registering for a couple of participant-limited workshops, but I did attend the public presentation on 'Rebuilding Coral Reefs: A Decadal Grand Challenge'. Ambassador Peter Thomson and then Nancy Knowlton and David Obura presented clear and strong messages on climate change, and the critical need for urgent action. Even with all the local actions that we know can make a difference, curbing emissions is of course the fundamental challenge of our time (indeed a multi-decadal challenge). At the global scale we are of course strongly dependant on governmental actions and the changes coming from the energy generation sector and (vehicular) manufacturing sectors. Different countries are clearly at very different points along the road (no pun intended) on this topic, but the magnitude of the task involved in driving transition is huge, and this technology is of course already far ahead of major emitting sectors like aviation and shipping. I doubt anyone listening would disagree with anything being said in this public meeting about both local and global solutions, but as a community who inherently travel widely (often by air) for fieldwork etc we also need to start to reflect on what is perhaps desirable and what is essential in what we do. Transitioning to hybrid meeting models or future virtual only models may be a path we need to embrace (for all the limitations) to start to limit, in some small way, our collective carbon footprints.

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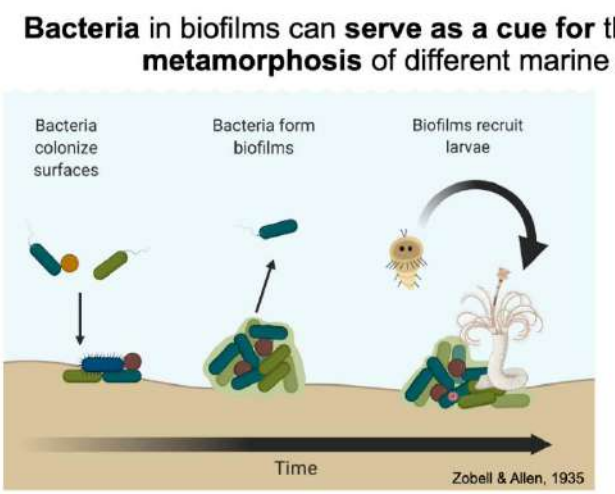
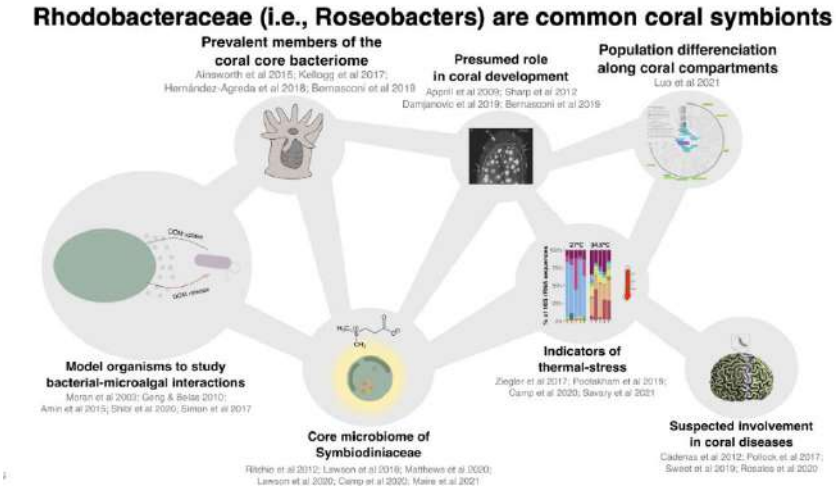


Since, as I write this, the 14th ICRS has only just drawn to an end, I am taking time to process the unique experience of this meeting – the very first held in virtual format that I have attended. To be perfectly frank, while it was the sensible decision to organize the event online, I had been concerned about the quality of the networking experience for early career researchers and the potential problems in the interaction between the presenters, chairs, and the audience during the sessions. It turned out that I need not have worried, since the ICRS student moderators efficiently and competently guided us chairs through our sessions. Moreover, I was pleasantly surprised by the numbers of questions from the audience, which were comparable to any meeting I attended in person in the past. The online live chat feature was so well received (and in fact running hot with questions!), I barely had to resort to my own little pool of 'emergency' backup questions. This I attribute in part to the high quality of research presented, and in part to the truly enthusiastic and engaging audience, who fully and whole-heartedly embraced the online format. Overall, both my co-chair Dr. Anny Cárdenas and I considered our session 4H a delightful experience and a great success, and we hope our speakers and audience enjoyed it as much as we did. The experience of chairing such an enjoyable online session certainly gives food for thought for future considerations to fully replace in person events with online symposia instead (perhaps the time is finally ripe to embrace the use of avatars to meet with friends and peers over a pint in the virtual 'Coral Garden'?).

In the original format, our session 4H 'Beyond diversity: What can we learn from exploring microbial function in coral reef holobionts?' aimed to attract functional approaches to coral reef microbiology research. The contributions we had the honor of chairing included very exciting work on a broad diversity of topics, ranging from applied coral probiotic applications, and nutrient cycling and metabolomic studies in holobiont-bacteria interactions, to bacterial genomics and genetic manipulation. Unfortunately, I cannot highlight every single one of these excellent presentations in this report, but I am delighted to take the opportunity to feature 'teasers' of some of my personal favorite contributions by Early Career Researchers in reef microbiology research. For further exciting reef (microbiology) research, please do watch the recordings of the remaining contributions in Theme 4 (and others).

The opening talk of session 4H was delivered by Amanda Alker (Shikuma Lab, San Diego State University, US), presenting results from her ongoing PhD work on the Proteobacterium *Pseudoalteromonas luteoviolacea*. *P. luteoviolacea* is commonly associated with marine animal hosts, and is known to produce a diverse range of bioactive compounds including metamorphosis-inducing factors. Amanda investigated the effect of such metamorphosis-inducing factors, in particular metamorphosis-associated contractile structures and tetrabromopyrrole, and performed manipulative experiments using *P. luteoviolacea* mutants deficient of gene clusters encoding for these factors, to assess their effects on different marine animal larvae. If you are curious about her exciting work, visit Amanda's presentation in the ICRS21 archive (Session 4H-1; Screenshot 1), or have a look at her recent publication in *Environmental Microbiology* (Alker et al. 2020).

Dr. Anny Cárdenas (Voolstra Lab, University of Konstanz, Germany) presented her work on a diverse group of Symbiodiniaceae-associated

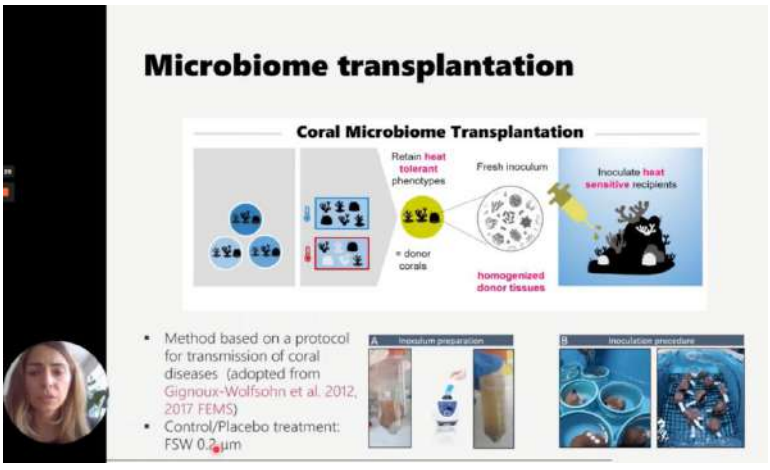


bacteria, the Rhodobacteraceae. Rhodobacters are metabolically highly versatile, and many of them possess the genetic machinery to break down dimethyl-sulfoniopropinate (DMSP), a compatible solute doubling as antioxidant and osmolyte that is abundantly produced by various algae, including the Symbiodiniaceae. Building methodologically on her recent PhD work (Cárdenas et al. 2018) combining state-of-the-art sequencing and bioinformatics tools, Cárdenas is currently investigating the interactions of Rhodobacters and coral-associated Symbiodiniaceae, in which she employs clever microbial co-culturing approaches to further our understanding of the underlying metabolic currencies of this intriguing partnership. For more details and preliminary results, visit her presentation in Session 4H-2 (Screenshot 2).

Maggie Hudspith (de Goej Lab, University of Amsterdam, the Netherlands) presented recent work from her ongoing PhD on metabolic interactions in complex sponge-prokaryote systems combining isotopic labelling techniques with Nanoscale Secondary Ion Mass Spectroscopy (NanoSIMS). In her work, she demonstrated the subcellular uptake and processing of food by the filtering cells (choanocytes) of low and high microbial abundance (LMA and HMA) sponges. Maggie's work showed that the choanocytes constitute the primary site of organic matter uptake, while the later enrichment of microbial symbionts over time suggests translocation of carbon and nitrogen via the uptake and recycling of host-derived waste products by the associated prokaryotes. Overall, this work supports the notion that sponge-associated prokaryotes gain nutritional benefits from symbiosis. More on her work can be found in Session 4H-3, or recently published in BMC *Microbiome* (Hudspith et al. 2021).

In her recent work, Dr. Anna Roik (Hentschel Lab, GEOMAR; current affiliation: Schupp Lab, University of Oldenburg; Germany) employed a radically different approach to microbiome manipulation in scleractinian corals using transplants of whole coral tissue homogenates as donors, a microbial culture-independent approach inspired by the application of fecal transplants in humans. Her work used tissue homogenate of heat stress resistant donor colonies to inoculate heat-sensitive recipient colonies. Not only was transmission of bacteria from heat resistant donors observed, but also beneficial effects on bleaching susceptibility in recipients. Her work can be found as a presentation in Session 13H-1 (Screenshot 3), or recently published in BMC *Microbiome* (Doering et al. 2021).

Finally, I would like to take the opportunity to highlight two poster contributions by PhD students. Adam Barno (Peixoto Lab, King Abdullah University of Science and Technology, Saudi Arabia) presented preliminary findings of his ongoing project on phenotypic and epigenetic responses of corals to microbiome manipulation (Poster ID 1957). Ms Nan Xiang presented her results on the effects of experimental manipulation of temperature and addition of sugar on bacterial community dynamics, with particular focus on the functional group of denitrifying microbes (Gärdes Lab, Alfred-Wegener Institute, Germany; Poster ID 1799). Watching their speed presentations is warmly recommended!



Overall, I was very impressed by the high level of reef microbiology research presented at this year's online symposium, as well as by the significant advances in the field since the last meeting. The 2016 meeting in Hawaii was dominated by microbiome characterization and biodiversity studies – which are essential to our efforts for a better understanding of the composition and community dynamics of microbiomes associated with reef holobionts. For a more functional understanding of the roles associated microbes may play in the stress response, acclimatization, and potentially even adaptation of holobionts however, it is indispensable that we go beyond biodiversity studies. I am thrilled to say that there has been a welcome increase in and diversification of studies employing a variety of functional approaches to tackle the roles of microbes play in coral reef holobionts over the past five years. Many of these involve highly creative and innovative novel efforts combining traditional coral reef ecology and bacteriology with state-of-the-art -omics applications, and I have a feeling there is even more yet to come. I very much look forward to the research presented at the next ICRS meetings – in eager anticipation of more truly exciting work!

References cited:
Alker AT, Delherbe N, Purdy TN, Moore BS, Shikuma NJ (2020) Genetic examination of the marine bacterium Pseudoalteromonas luteoviolacea *and effects of its metamorphosis-inducing factors. Environ Microbiol 22: 4689-4701; Cárdenas A, Neave MJ, Haroon MF, Pogoreutz C et al. (2018) Excess labile carbon promotes the expression of virulence factors in coral reef bacterioplankton. ISME J 12: 59-76; Doering T, Wall M, Putchim L, Rattanawongwan T et al. (2021) Towards enhancing coral heat tolerance: a 'microbiome transplantation' treatment using inoculations of homogenized coral tissues. Microbiome 9: 1-16; Hudspith M, Rix L, Achlatis M, Bougoure J et al. (2021) Subcellular view of host–microbiome nutrient exchange in sponges: insights into the ecological success of an early metazoan–microbe symbiosis. Microbiome 9: 1-15*

Jessica Bellworthy

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Under circumstances that were more typical, I might now be traveling through German cities, toasting local beers with close friends whom I see only on a multi-year timescale or hiking through green countryside feeling a cool breeze on my skin. Instead, I am in my office in the Israeli desert with air conditioning working overtime in attempt to combat the 45°C temperatures outside, reflecting on having seen ICRS unfold from this very same spot. So, whilst a virtual conference has the climate benefit of reducing travel (though I am very much aware of the high demand of air conditioning), I also really missed the exploration element that inherently comes with international conferences. After Hawaii in 2016, I was lucky enough to spend time exploring the islands. Had the conference not been there, it is highly unlikely I would have visited Hawaii and had the wonderful experiences I did.

We all know that having a virtual event has both positive and negative attributes in comparison to in-person events. For starters, I found pre-recording my oral presentation infinitely more painful. For live talks, I complete the physical presentation, talk over the slides a few times to make a coherent story, but not so much that the speech becomes over-rehearsed, get appropriately nervous and excited before the talk, and deliver the presentation. Pre-recording a talk made me overly critical of every "umm", "errrr", and stutter. Stop. Start again. And again. And again. Until I understood that, as my frustration grew, every iteration was worse than the previous one. I finally convinced myself (with the help of some honest Twitter posts) that many people faced the same issues and that most will never record that aspirational faultless presentation. I hit the 'submit' button. Some of the most engaging talks I saw broke this PowerPoint presentation default, such as Isla Keesje Davidson, who took us on a walk through the British countryside whilst discussing her work on cleaner wrasse. Virtual conferences certainly are a new playground for creative minds to break the mould.

As the conference drew closer, as both a session chair and a speaker, I became anxious to understand exactly how the format functioned, technically. Thankfully, ICRS had an incredible "behind-the-scenes" crew who quickly reassured

me. In particular, I would like to highlight the student helpers; all of those I had contact with were polite and super helpful. No doubt, the conference hugely benefited from their collective work. What's more, personally, I really enjoyed the student-mentoring event organised by Bremen student Selma Mezger - so much so, I did it twice. I remember the value of these events when I was a student. I really hope I provided similar benefit to the students I spoke to; I believe mentoring both in-person and on Zoom can achieve similar, worthwhile results.

Listening to presentations on-line, I really appreciated the ability to pause a talk to get a better look at the graphics or to write down a particular reference. Further, having talks and posters archived for a year will allow us to revisit ones we have viewed before, or catch up on those we could not attend live, which ultimately may lead to greater engagement and scientific benefit. It was also much more convenient to jump between talks in different sessions by simply clicking between live streams than it ever is at a live conference. In previous ICRS conferences, even the smaller ECRS, I have been seen literally running between rooms, missing the end of the questions to see the next talk on my schedule.

Even with these benefits, one joy of conferences just cannot be adequately simulated in a virtual event. Despite the introverted nature of many scientists, including myself, I really feel the absence of real human contact. The 'Gather' platform just cannot replace the excitement of seeing a past colleague/ friend from across the room and sitting down together. Going forward, I believe hybrid events will be the most equitable and productive model.

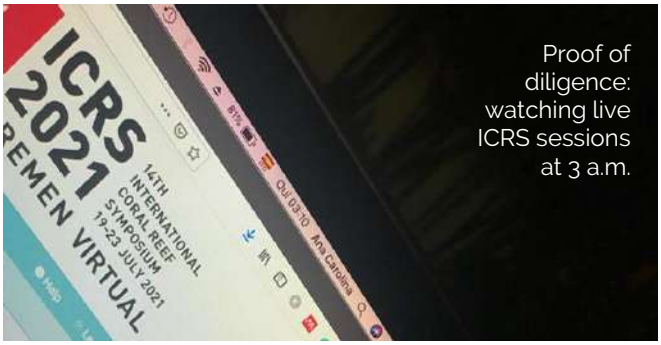
Ana Carolina Grillo

Marine Ecology Laboratory @MarineEcoBR, Federal University of Rio Grande do Norte, Brazil (mailto:a.grillomonteiro@gmail.com)

The first Virtual International Coral Reef Symposium was also my first ICRS, at which I'd been planning to participate since I first heard it was going to take place in Germany. As the pandemic forced many of us to change personal and professional plans, it also meant that the most awaited conference in my scientific area would be entirely in a virtual format. As a result, I wasn't really excited about it, not having many expectations of this type of event. But, amazingly, by the end of the first day, I was so impressed, and absolutely convinced that I was participating in an incredible scientific gathering. It completely changed my mind about the value of virtual events.

The main advantage of this shift from personal to virtual gatherings is that it boosts participation from across the world, promoting the geographical diversity that is so important for scientific progress. However, unfortunately, science faces huge barriers in many countries, and normal conference fees are still prohibitive for a large part of the scientific community. Although the virtual format permitted a slightly reduced conference fee, if my registration fee hadn't been covered by my Postgraduate Program, I wouldn't have been able to participate. Indeed, that's the reason why I couldn't attend the last ICRS in Hawaii. It is a real necessity to make these events, whether in-person or virtual, accessible to all scientists, regardless of their country of origin, to enhance scientific representation.

Another disadvantage of not having everyone reunited in the same location was that it resulted in crazy timings for participants outside Europe, but, to an extent, the availability of recorded presentations solved this difficulty. This proved that watching the presentations again, in a calmer environment, and being able to pause so as to better comprehend the material, is such a good way to absorb scientific content! Further, with the use of recordings, we were able to watch every presentation that interested us – regardless of whether they were occurring at the same time during the live event. This for me was such an



Proof of diligence: watching live ICRS sessions at 3 a.m.

advantage, because at in-person events one always has to choose one among several simultaneous sessions.

The virtual platform was great; after a few practicing hours it was easy to move from one session to another with one click, and given the enforced punctuality of all presentations, it was possible to maintain the schedule as originally planned, and hence to switch between sessions more easily. The time available for questions and discussion was necessarily short, but this also happens at in-person conferences, and with the online chat facility it was still possible (and really nice) to be able keep the conversation flowing and promote contacts.

The supporting programs were also very pleasant. In particular, I was overwhelmed by the mentoring events! At first, I wasn't really sure how this would work, and I was a little nervous to chat with any well-known scientists, but we ended up having an inspiring conversation about scientific careers and scientific communication, women in science, and how to achieve our personal and professional goals, among other curiosities. I would like to thank all the scientists who were willing to spend their time talking to us, and especially Dr. Verena Schoepf and Dr. Emma Camp for being so open and sharing their amazing experiences and opinions with our small group.

In general, the scientific content of the conference was diverse, but there was a noticeably high representation of coral microbiome and microbial ecology research. The development of novel molecular tools now allow genome sequencing of corals, algal symbionts, bacteria, and viruses, and also permit identification of proteins and metabolites. This can help us better understand coral's resistance to impacts and better predict their response to changing environmental conditions. Another emerging study area that captured my attention concerned the *tough corals*, found to thrive in unexpected environments such as in mangroves and urban bays, that have turbid waters and high loads of nutrients. These so-called *extreme habitats* are natural laboratories and can give us both insight into and hope for the corals that have been so devastated in recent years. This expansion of scientific research beyond the well-known coral reef areas was also demonstrated by reports of work in less recognized shallow coralline environments in for example Brazil, South Africa, and India, and on cold-water corals from the Mediterranean, Norway, and Ireland. It seems we are only just learning about a new suite of environments where corals can be found, corroborating their outstanding diversity and their relative resilience.

Other emerging technologies also characterized the new era of coral reef science, providing new methods that may assist us in mapping unexplored reef habitats, quantifying and monitoring reef organisms, accessing their health, and improving restoration techniques. Nevertheless, as people are part of the system, effective coral reef conservation is only feasible where a just and inclusive management can be accomplished. Several studies exemplified the challenges and successes of local communities and of women's participation in the management of reef areas. Presentations also demonstrated that further acknowledgment of indigenous peoples for their knowledge of and links to their natural environment is still needed, and that the relationship between scientists and local people should always be a two-way street.

Overall, the 14th ICRS left me with a burst of hope and inspiration despite the difficult times that our world is going through. There is still much to fight for, and both early career and experienced scientists need to fulfil a role well beyond coral science if we truly want to embrace their conservation. We need to enhance all kinds of diversity – of reef organisms and reef scientists. And we need to take our scientific information to local communities on the one hand and to policymakers on the other, to improve their understanding of the corals, reefs, and the Ocean, on which we all depend.

Our exciting mentoring event with Dr. Emma Camp

REEF IMPRESSIONS | conference reports and impressions

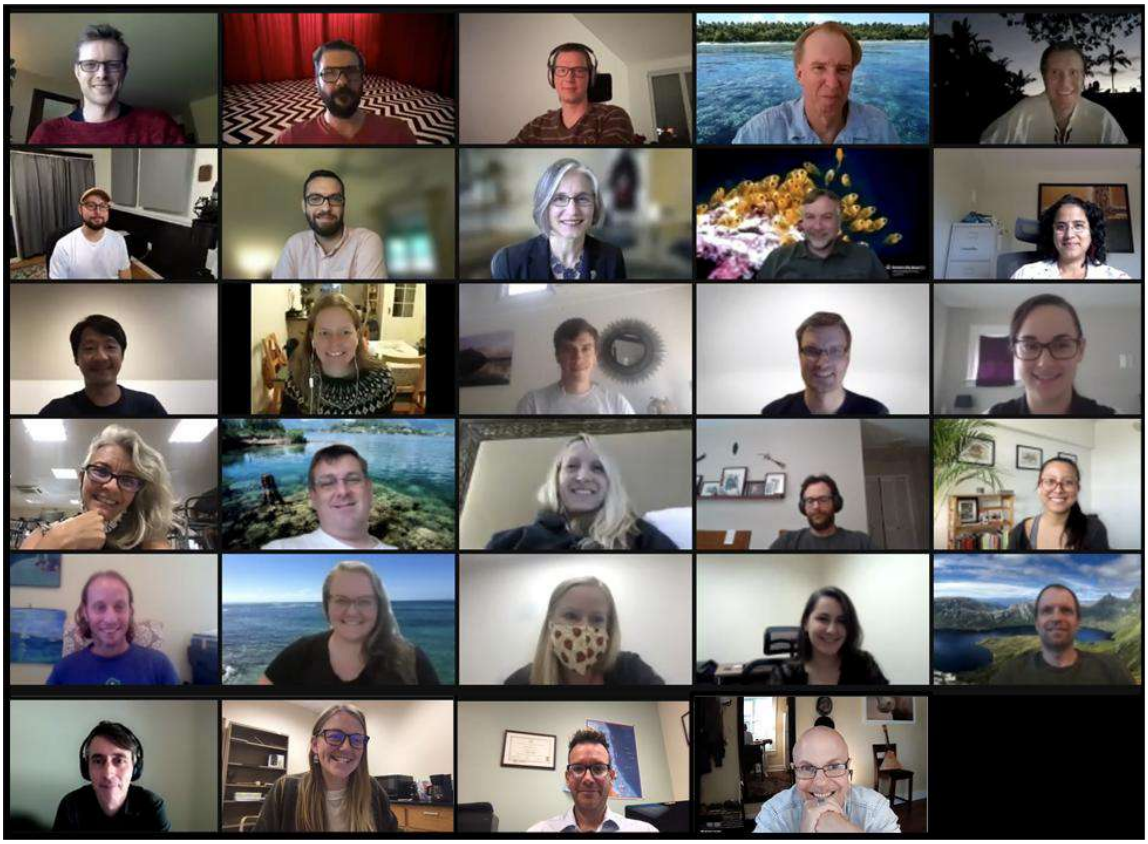
3rd Coral Bleaching Research Coordination Network Workshop

Temperature stress is the single largest threat to coral reefs globally and is also the focal topic of the newly established Coral Bleaching Research Coordination Network (CBRCN). The goal of the CBRCN is to work with the broader coral reef research community to develop a common framework for coral bleaching research, sample collection, and data collation to facilitate interdisciplinary collaborations. These goals are imperative given the ongoing global coral bleaching crisis. The framework has been developed over the course of three workshops to move the science of coral bleaching research forward.

The third workshop of the CBRCN was held, virtually, on 11-14 May 2021. The workshop was hosted by Dr. Andréa Grottoli, from the School of Earth Sciences at The Ohio State University, and led by Dr. Robert van Woesik, Institute of Global Ecology at the Florida Institute of Technology.

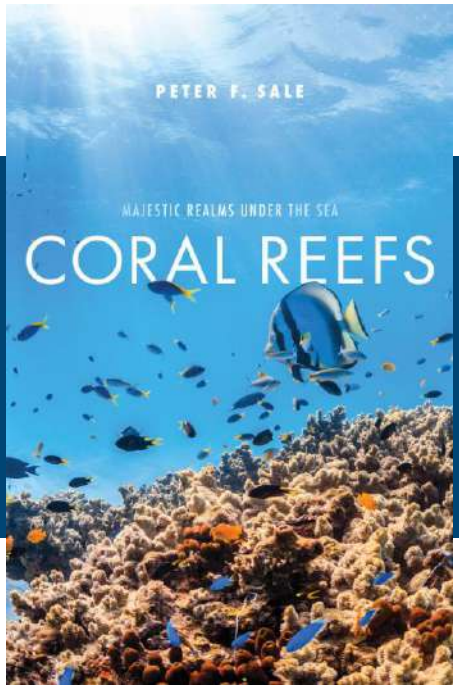
Twenty-nine investigators from the USA, Germany, the United Kingdom, Singapore, and Australia assembled to discuss the state of coral bleaching research, data, metadata, and modeling from a suite of disciplines, from the latest in –omics to regional and ocean-wide patterns of bleaching. The workshop was a success, and the participants are drafting up a manuscript to synthesize the major findings of the workshop. A webinar outlining the findings of the workshop will be presented mid-autumn 2021.

The Director of the CBRCN is Professor Andréa Grottoli. Steering committee members are Professors Robert Toonen, Robert van Woesik, Rebecca Vega Thurber, and Mark Warner. For additional information, you can visit the CBRCN website at http://u.osu.edu/grottoli.1/coral-bleaching-rcn/ or email Professor Grottoli directly at grottoli.1@osu.edu.



◂ Coral Bleaching Research Coordination Network virtual workshop participants (left to right, top row to bottom row): Jesse Zaneveld, Jose Eirin-Lopez, Christian Voolstra, Robert van Woesik, Scott Heron, Mark Warner, Hugo Harrison, Andrea Grottoli (Director), Eric Crandall, Maria Vega-Rodriguez, Danwei Huang, Adrianna Humanes Schumann, Thomas DeCarlo, Thomas Krueger, Rowan McLachlan, Rebecca Vega Thurber, Robert Toonen, Erinn Muller, Derek Manzello, Lisa McManus, Thomas Shlesinger, Mary Donovan, Rebecca Albright, Leila Chapron, Dan Thornhill, Josh Madin, Ann Marie Hulver, Mauricio Rodriguez-Lanetty, Mikhail Matz

REEF SHELF



Majestic Realms under the Sea: Coral Reefs

Peter Sale 2021

Publisher: Yale University Press (228 pages)
Hardback:
UK £20
USA $33.46

Peter Sale is doubtless well known to members of the ICRS, if not for his work on reef fishes, then from his later postings to coral-list or to his own blog. Sale does not take a rosy view of the future of reefs, as indeed few coral reef scientists of 'mature' years can do, we who have seen the relentless declines of coral reefs over our lifetimes.

This is a book in two almost separate parts, although the first part is intended to feed into the second. The first part is dominated by an account of several of the iconic associations that many reef fish have with other species of fish or invertebrate. These are all animal associations that are commonly featured and that are familiar to all of us who are interested in reefs: cleaning stations; groupers co-operatively hunting with eels; goby and shrimp sharing burrows; anemonefish and their host anemones, etc. It is told in an engaging way, enlivened with lots of digressions including numerous autobiographical stories gathered especially during his career in Hawaii, Heron and One Tree Islands, and tales about several other reef scientists with whom Sale has interacted over the years. Featuring importantly through this first half too is the story of fish recruitment: how fish (in particular) larvae disperse, survive and use cues to try and find a place to settle later. Their settlement and later residence on a patch of reef may of course have a large element of 'chance' in it - the lottery hypothesis, and much interesting discussion is devoted to this. This is followed by a section on corals, in particular their symbioses, and the coral microbiome. It makes for a pleasant read, set up to show the integrated nature and inter-connections of reef life.

The second part can be viewed as being in part a 'stream of consciousness' about the reef. Featuring strongly is the reefs' value, as viewed both by ecologists and also by accountants, considering what elements go into a valuation (such as tourism revenue, food, shore protection), as well as more fuzzy aspects, such as cultural, spiritual and aesthetic values. The need to obtain convincing values is illustrated by Sale's own work connected with conservation of the enormous Palm Islands and related constructions in the United Arab Emirates – conservation there was apparently an uphill effort! The fact is that, until relatively recently, valuation of habitats that are going to be destroyed during a coastal construction mega-project has never needed to be done. Indeed, historically, environmental assessments were never even considered until a high proportion of a coast was essentially dredged or buried. The need for proper environmental assessments is still not usually understood by the construction industry and others, unlike values of other mostly extractive uses that bring a profit.

Chapter 10 is called "Why don't we seem to care about coral reefs?" This discusses coral bleaching and mortality, and their causes, and puts forward views which might help answer the question in the chapter's title. On science journalism and in getting out the message that the situation is dire he notes: *"I'm not sure whether the science community deserves the greater part of the blame for the sorry state of science reporting or whether the journalists are primarily to blame for taking the bait we feed them hook, line, and sinker. Between us, we have made a mess of the reporting of science."* This is a good point. But, in my view, since journalists are

not expected to do the science, why should scientists be expected to do the journalism? Some scientists do, of course, and do it well, but rather few. This essay also brings in some politics, human behaviour, expedience, the media and other aspects.

In many ways I would agree with his views about the likely fate of coral reefs: "*The ecosystem to which I have devoted my career is very likely to disappear from the planet about the same time as I do. Dust to dust.*" I differ here only as far as noting that reefs are not in an 'all or nothing' state; nor are all following identical trajectories or rates of decline. Far from it. Some have turned to dust already – rubble anyway – while in some places they still look pretty good, damaged but still functioning as reefs. Forecasts show, however, that (as we know) the extent, spread and frequency of marine heatwaves are increasing in. This and the following chapter, discussing the law and possible reasons for inaction, were, I think, my favourite reads in this book.

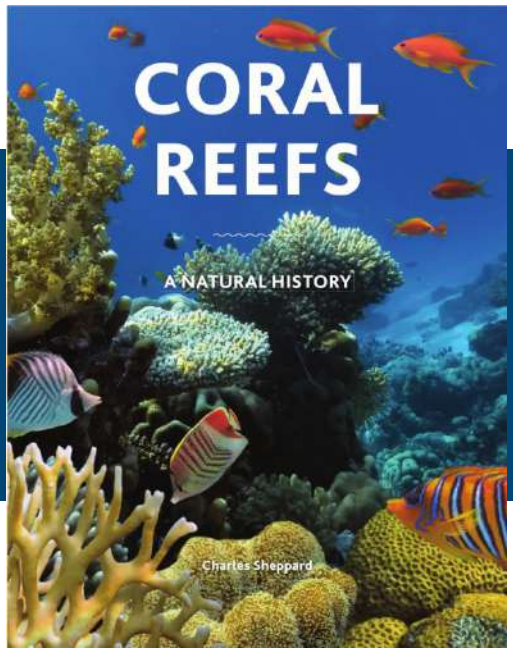
The book has a couple of dozen photos, which is adequate, though not really enough in a reef book in my view. In my copy, an advance pdf, they were in black and white – I hope colour is used in the 'real' version. It was an enjoyable read, and for those especially who have not yet discussed the questions of why we are all so slow, one might even say criminally negligent, about taking action, these final chapters are well worth reading. Throughout the book there are numerous anecdotes to enliven it and make you think. Some might be a bit of a stretch, but they do show that Sale is first and foremost a fishes enthusiast. I will end with a quote that seems to explain that we are all actually fish: "*The coelacanth and lungfishes, and their fossil relatives, and all the terrestrial vertebrates comprise one group of fishes (the lobe-fins, or subclass Sarcopterygii). There are three other subclasses with modern-day species [the ray-finned fishes, chimaeras and sharks with rays]...*" Well, you could have set the major bifurcation of groups a few hundreds of millions of years earlier or later, could you not? But his point is clear: "*Getting people to understand that we are one species of animal is a first step in building some humility in the face of nature.... and if there is one thing* Homo sapiens *needs, it is more humility.*"

Charles Sheppard (University of Warwick)

Coral Reefs: A Natural History

Charles Sheppard 2021

Publisher: Princeton University Press (240 pages)
Hardback:
UK £20.99
USA $20.24



This excellent book is the fifth popular text on coral reefs from the Sheppard stables, and I would suggest, the best for its target readership. It is, as its title suggests, a general but comprehensive account of the biology and ecology of coral reefs, ideal for interested students, divers, ocean managers and naturalists. Indeed, it could even make an excellent seasonal gift for recalcitrant friends and family, whom one wishes to persuade of the importance of our chosen ecosystem. It is not directed at research

scientists, (it contains no citations), but its clear explanations of almost every aspect of the subject are such that the book could well be used as required reading ahead of any more scientific final year undergraduate or first year post graduate lecture or field course.

Charles Sheppard's first general book was the somewhat similarly titled "A Natural History of the Coral Reef", published as long ago as 1983, by Little Hampton Book Services. Before opening, I assumed this volume might be just an update of the older material. But no, it is instead a cleverly organised and very nicely illustrated mini-encyclopaedia of matters coral reef. It consists of 120 or so double-page spreads each dealing with a separate topic, ranging from the obvious basic information like the nature of the coral animal and the role of the symbiotic zooxanthellae, to much more recent areas of research such as the significance of the microbiome, the impact of climate change, and the breeding of super-corals. These double page spreads are organised into six chapters or themes (The coral animal; Different kinds of reef; How a coral reef works; Local and regional disturbances; Climate change and reefs; People and reefs), and within the chapters series of complementary spreads are used to explore topics in greater breadth, with for example, seven double-page spreads on different coral growth forms and their occurrence on the reefs and advantages, and five spreads on selected contrasting coral reef realms (the Pacific, the Caribbean, the Red Sea, the coral triangle and the Great Barrier Reef). Each double page spread maintains a nice balance between text that is neither too brief nor too tedious, and typically two to four illustrations, either well-prepared diagrams or quality reef-related images secured from an impressive array of underwater photographers and scientists. The net result is a volume which is as suitable for selective browsing on such topics as appeal of an evening, as well as for reading from cover to cover.

Two features I might particularly praise before mentioning a couple of aspects I found a touch less than perfect. The text is beautifully written in a clear concise style, that I would love to be able to emulate. And, for the most part, the figures are nicely drawn, with enough but not too much detail, making them easy to understand. I would pick out the diagram on p. 17 of the coral polyp (see this page) which I rate as clearer than any I have used in teaching to date, and that on p. 191, which clearly illustrates how rising sea-level quickly pollutes the freshwater lens (and water supply) of low-lying coral islands, as well as promoting erosion. Figures and images clearly show, for example, the distinction between intra- and inter-tentacular budding and the character of the palliform lobes, without overwhelming the reader with all those other technical terms (like "dis-peppermints" was it?) so beloved of coral taxonomists.

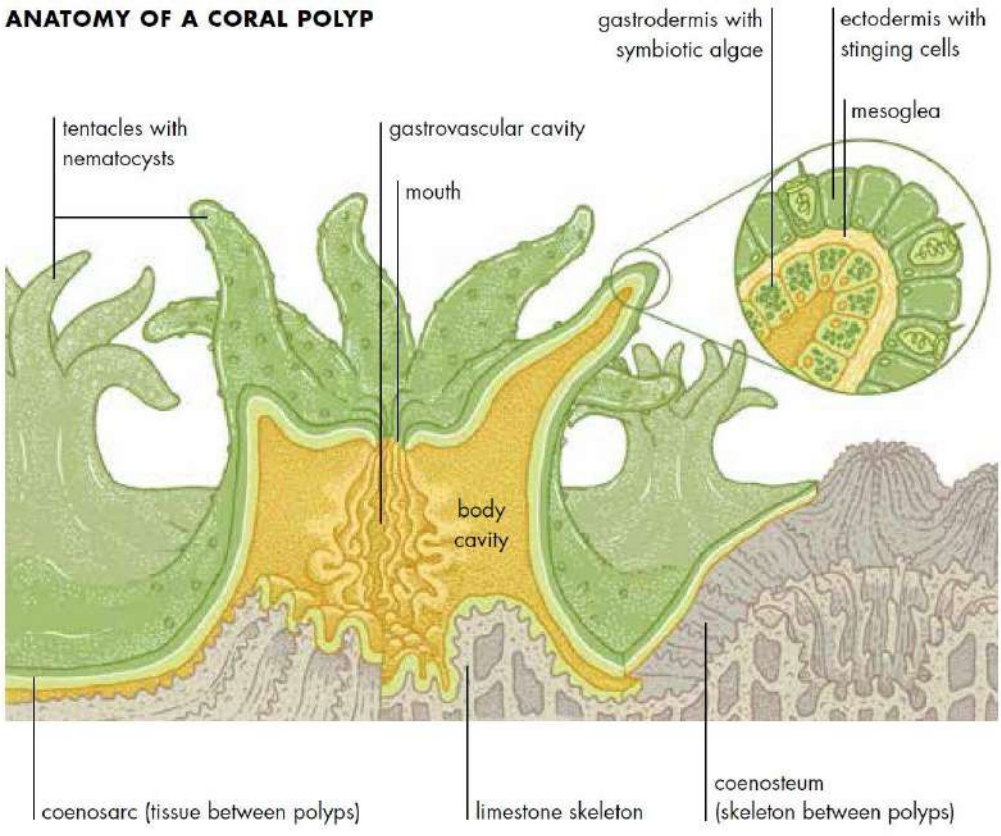
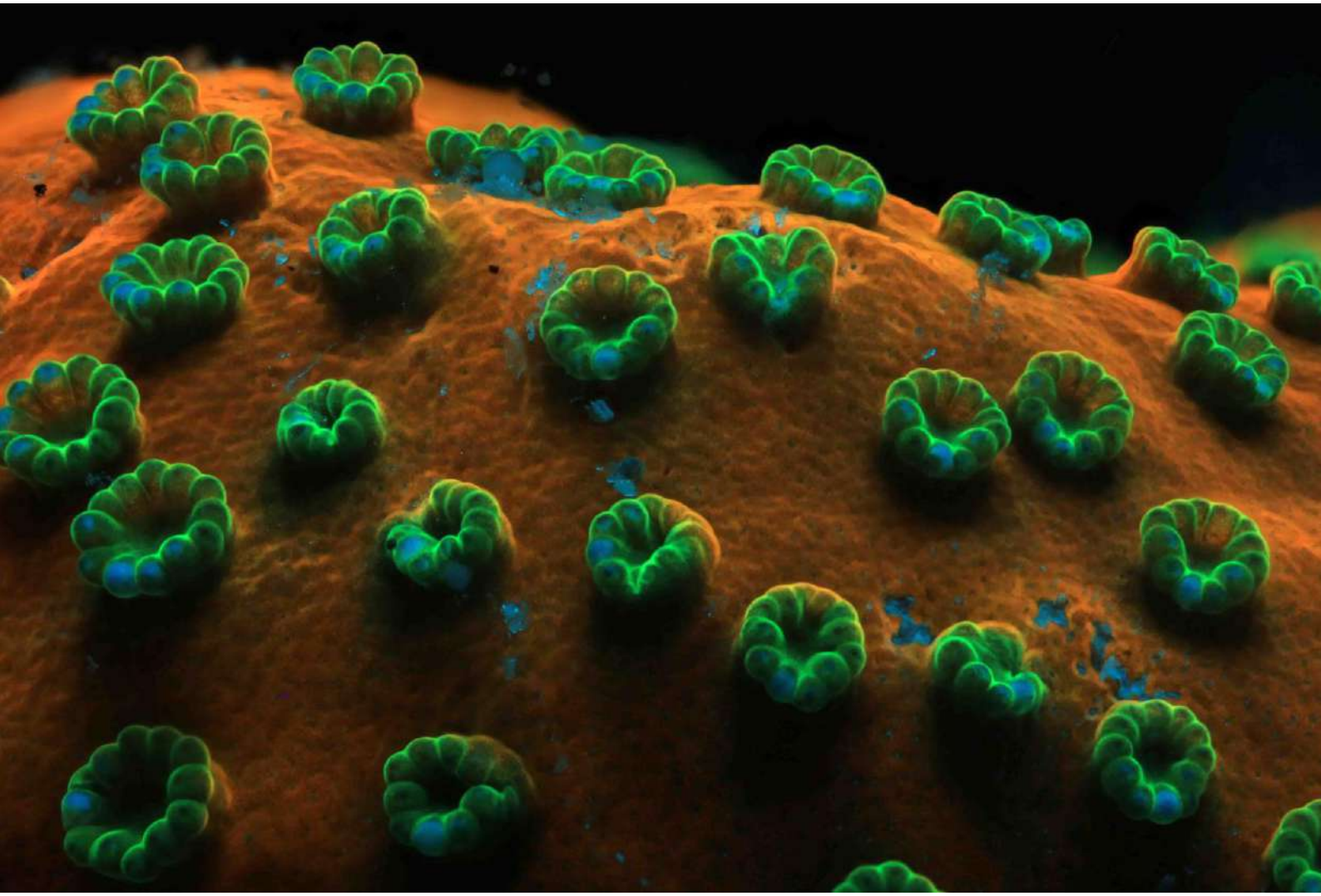


Figure from page 17 showing the structure of the coral polyp and relationship to the limestone skeleton.

In contrast, the resolution of many of the coral reef images is not as high as one might perhaps have



Polyps of sunset *Montipora* (*nodosa?*) fluorescing under far-blue / ultraviolet light, from page 55.
Photo by Jamie Craggs.

expected, but clearly this is not intended as a coffee-table book, and higher quality printing would have presumably upped the price significantly. My other quibble is that often the fish in images are not identified, even to genus; when this could probably have been easily done in consultation with more fish-orientated colleagues. In fact, in one or two places the wrong fish may have been illustrated; for example the food-web diagram on p. 52 appears to have an algal-turf scraping parrotfish and algal-turf browsing tang both feeding directly on a coral. But I include such reservations merely for balance,

and against this, despite being previously well-read on the subject, within a majority of the double-page sections, I found (or was reminded of) important facts of which I was unaware (or that I had more likely forgotten). For example, that the origin of the coral-zooxanthellae symbiosis stretches back 200 million years to the Jurassic, or that sweeper tentacles used mostly in interspecific aggression between colonies can stretch as far as 10 cm to attack neighbours. For me the book proved a most pleasant form of revision, and I recommend it pretty much without reservation.

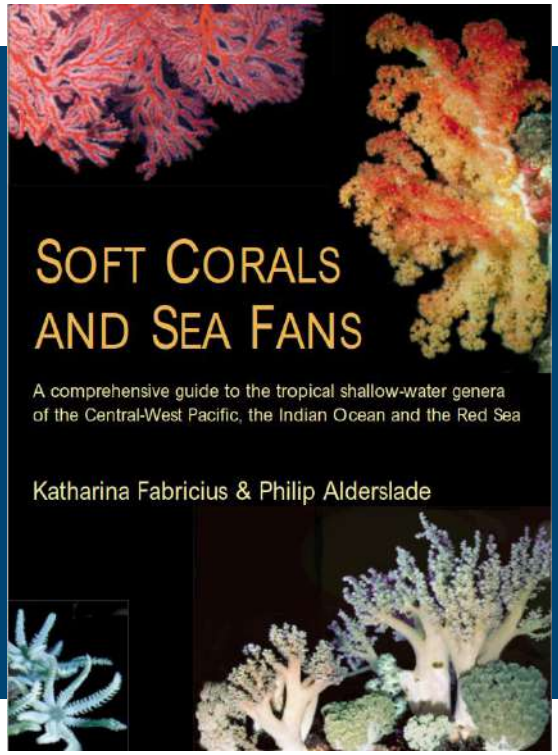
Rupert Ormond (Marine Conservation International & Heriot-Watt University, Edinburgh)

Soft Corals and Sea Fans:

A comprehensive guide to the tropical shallow-water genera of the Central-West Pacific, the Indian Ocean and the Red Sea

Katharina Fabricius and Philip Alderslade
Publisher Australian Institute of Marine Science
(264 pages)

Now available in pdf form without charge from:
https://www.researchgate.net/publication/258516656_Soft_Corals_and_Sea_Fans_A_comprehensive_guide_to_the_tropical_shallow_water_genera_of_the_central-west_Pacific_the_Indian_Ocean_and_the_Red_Sea



To mark the 20th anniversary of its publication, the authors of "Soft Corals and Sea Fans: A Comprehensive Guide to the Tropical Shallow-water Genera of the Central-West Pacific, the Indian Ocean and the Red Sea" have made a pdf version of this indispensable resource available as a free download. This is indeed a birthday gift to the entire coral reef research community! First published in 2001, Fabricius & Alderslade (F&A) has been out of print for a number of years, and the remaining stock that Phil Alderslade had kindly made available for the price of postage from Tasmania has dwindled over time. My first piece of advice to any student or researcher beginning to work on Indo-Pacific octocorals has always been to do whatever it takes to obtain a copy of this book. Fortunately, that will now be easier than ever.

As indicated by its complete title, F&A is a truly comprehensive guide to the shallow-water tropical octocorals of the Indo-Pacific, the only identification resource available outside of the widely scattered and poorly illustrated primary literature. It is a critical starting point for beginners and taxonomic experts alike to narrow identification to genus. Richly illustrated with in situ photographs, it also includes simple but extremely effective line drawings of the sclerites (microscopic skeletal elements) whose characteristic morphology and distribution throughout the colony distinguish octocoral genera. The accompanying text is succinct and well organized, guiding the reader to the most important aspects of colony form, polyps and sclerites necessary to distinguish similar taxa, and also briefly summarizing known habitat and zoogeographic distributions and patterns of abundance. The book's introductory section offers a very readable tutorial on the anatomy, ecology and reproductive biology of octocorals, as well as excellent protocols and advice on tissue preservation, microscopy of sclerites and field survey methods. Many times over the years I've wished a similar resource was available for other geographical regions as I've combed the primary literature (much of it in German or French) trying to identify an unfamiliar octocoral from the Atlantic, the deep sea or polar regions.

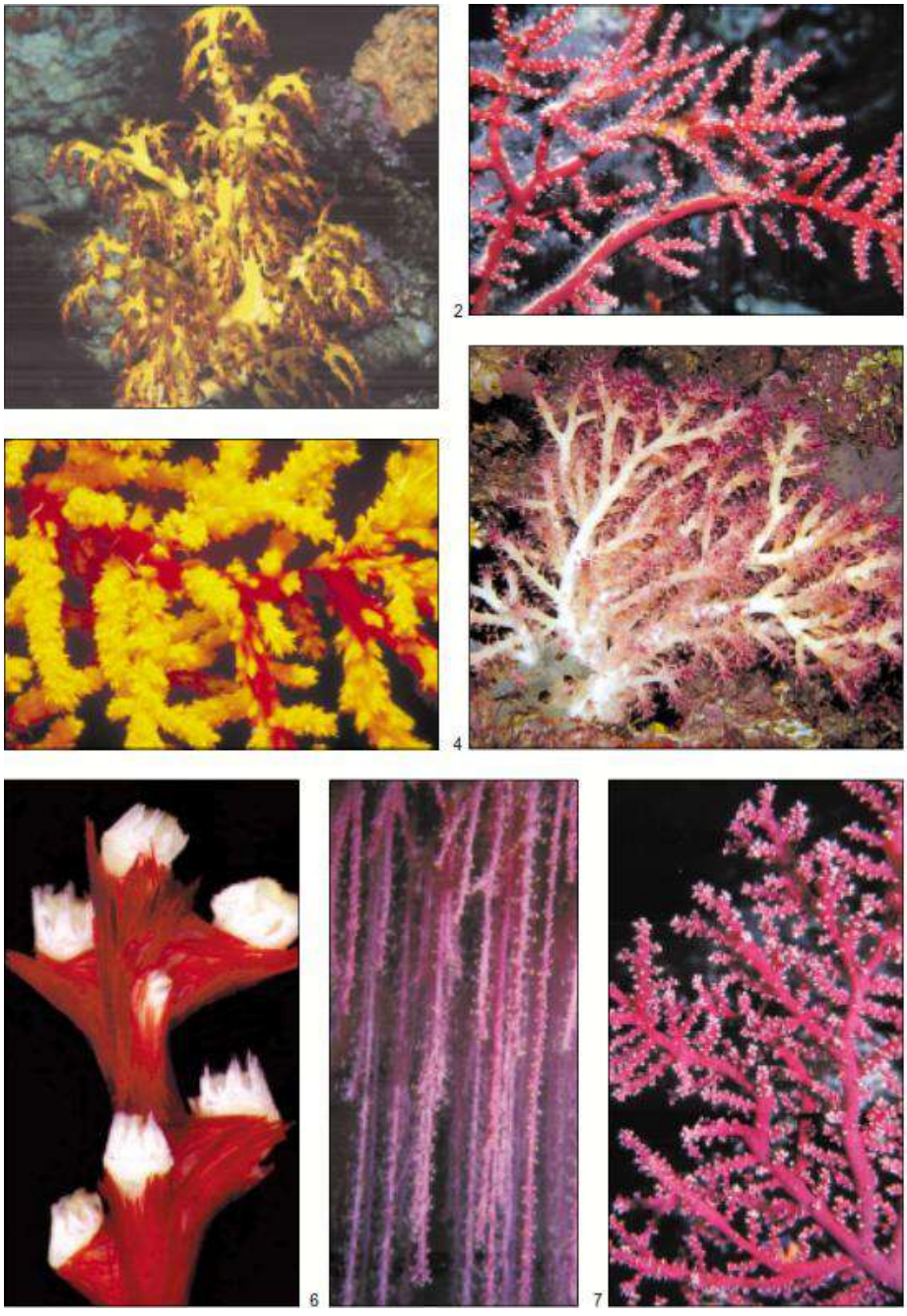
Despite having been published in 2001 upon the cusp of the molecular age (the same year the first molecular phylogeny of Octocorallia was published) most of the taxonomic information included in F&A is still very current. Although the subordinal groups and most of the families covered by the guide are now recognized to be poly- or paraphyletic, few formal taxonomic revisions have yet been made to those higher levels of classification. The subordinal ranks (Alcyoniina, Stolonifera, Scleraxonia, etc) still

offer a convenient way to organize taxa into groups that are morphologically similar albeit not phylogenetic clades. Similarly, little formal progress has been made at the species level, and in most of the genera covered by the guide it is still not possible to assign species names to most taxa with any degree of confidence. With just a few exceptions, there have been no or minimal changes to the genera presented, and F&A is still an accurate guide to their identification. Among the gorgonians, the five melithaeid genera have now been lumped into a single genus, *Melithaea*, a change that was foreseen at the time of publication and is discussed in the text. Among the soft corals, five new genera of Alcyoniidae and 10 genera of Xeniidae have been described since 2001, but the majority are monotypic taxa that are not geographically widespread and are rarely encountered. Perhaps the greatest taxonomic changes have occurred among the stoloniferous octocoral taxa as SCUBA divers and aquarists have become better at noticing these often tiny and inconspicuous colonies, resulting in the discovery and subsequent description of eight new genera, a new family (Arulidae) and the resurrection of a long-forgotten family, Acrossotidae.

In short, "Soft Corals and Sea Fans" has withstood the test of time and remains as valuable an identification resource today as it was when first published.

Given the slow pace of taxonomic research on octocorals and dearth of active taxonomists, it will likely remain "current" for the foreseeable future. Perhaps the renewed availability of this easy-to-use and beautifully illustrated guide will inspire more work on this neglected but charismatic and ecologically important group. Our heartfelt thanks to Katharina Fabricius and Phil Alderslade for their generosity in making this important work freely available to our community!

Catherine S. McFadden
(Harvey Mudd College, California)



Species from the family Nidaliidae (page 131)

REEF DEPARTURES

Tributes to recently departed members and reef scientists

Daphne Fautin (1946-2021)

Collated by Sue Wells with contributions from Bob Buddemeier, John Ogden, Betsy Gladfelter and Barbara Brown

Daphne Fautin, treasurer of ICRS for nearly 10 years (1992-2000) and one of its most active members, played a pivotal role in ensuring ICRS's survival in the 1990s. Despite high-level academic responsibilities and interests, and numerous students who doted on her, she threw herself into the administrative and financial issues of the Society. In 1992, membership was plummeting and the election for officers was challenged on several grounds, resulting in recognition that a revised, modern constitution was needed. Daphne, with her husband Bob Buddemeier (they met first at the second International Coral Reef Symposium in 1973), led the production of a new constitution and a highly proactive recruitment of new members, as well as fearlessly forcing existing members to renew their subscriptions.

Daphne was a force of nature throughout her life, inspiring and encouraging others, and at the same time becoming, as one obituary put it, "the biggest name in taxonomy of the Anthozoa in the world", leaving a legacy of monumental research contributions to cnidarian studies. She grew up mainly in Wyoming, with two years spent with her family in Kabul, Afghanistan, which gave her a taste for travel. As a child, she was precocious in her ability to memorize scientific names of plants and animals. Her love of science began early and framed her life.

Initially Daphne wanted to work on birds, but as part of her undergraduate study at Beloit College, she spent a summer at the Oregon Institute of Marine Biology, which led to realisation that her future lay in ocean science. In the late 1960s, she served in the Peace Corps in Malaysia, where she had her first encounters with coral reefs, helping a local fisherman who took tourists on snorkelling tours. She received her Ph.D. in zoology from UC Berkeley in 1972, writing her dissertation on sea anemones.

Following a period as the first female Curator and Director of Research at the California Academy of Sciences in San Francisco, she then took up a post as Professor of Ecology and Evolutionary Biology at the land-locked University of Kansas, where she worked for over 20 years, serving simultaneously as the curator at Kansas University Natural History Museum. She said that working as a marine biologist from dry land was not an impediment and that "You only need to be near an airport, not the ocean!" She travelled the world to numerous museums searching for type specimens, documenting their location and identifying specimens - her name is found on many specimen jars. She produced over 150 publications, working extensively on the sea anemone fauna of the Indo-

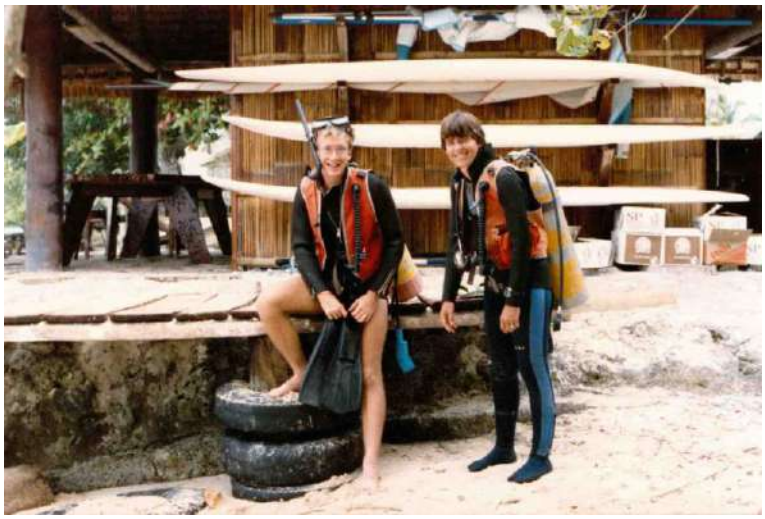
West Pacific and Antarctica, contributing to popular guides about anemone fish and their hosts and describing dozens of new species. One large sea anemone-like cnidarian species was named in her honor, *Relicanthus daphneae*. Her three NSF grants (2 of them 5-year grants from Partnerships for Enhancing Expertise in Taxonomy (PEET)) led to her 2016 capstone, an over 450 page publication – *A catalogue of families, genera, and species of the orders Actiniaria and Corallimorpharia*.

She was a member of the International Commission on Zoological Nomenclature (ICZN) (possibly the first woman), and served on the International Steering Committee of the Ocean Biogeographic Information System (OBIS), of which she was a founding member. She was also a member of the US National Committee for the International Union of Biological Sciences and numerous granting body committees. She chaired the US National Committee for the Census of Marine Life, was vice-chair of the Global Biodiversity Information Facility science committee, was Program Officer for the US National Science Foundation (NSF), and served as editor for multiple journals, including the *Annual Review of Ecology, Evolution and Systematics*. Daphne also served as the editor for Actiniaria and Corallimorpharia for the World Register of Marine Species (WoRMS). Her database 'Hexacorallians of the World', covering Actiniaria taxonomy, distribution and linked information, underpins the WoRMS treatment of these taxa, and became one of the first projects of the Census of Marine Life. She also contributed to development of the adaptive bleaching hypothesis, which led to a major diversification of reef coral research approaches in general.

Daphne, in trademark earrings, identifying live specimens with students at the National Institute of Water and Atmospheric Research, New Zealand, 2007 (credit: Kareen Schnabel)

Personally, she will be remembered for her inquisitiveness, earrings, ready smile, love of flying (she was a licenced pilot and part owner of a Cessna 172), and knitting (her niece and nephew would receive gifts both of hand-knitted sweaters and of books and toys related to marine biology). She had an amazing ability to work from the time she got up to when she went to bed, and would spend hours responding to emails from around the world and helping others with their publications, none of which were safe from her editing skills. As she explained in the chapter about her in Betsy Gladfelter's 2002 book *Agassiz's Legacy*, "I teach scientific writing because I think that communication is another skill that is not being taught well. I regard that as an investment in the future, multiplying my science. I regard editorial duties similarly. And then you've had an effect on producing science that's going to be, if not important, at least clear and well received ….."

Daphne is a model for any aspiring woman reef scientist – and for all scientists for that matter. She demonstrated how academic rigour must be mixed with a genuine collaborative approach to science and recognised that social interactions with peers was key to unlocking progress – a belief that no doubt encouraged her support and determination to make ICRS successful.



Daphne (right) with Graham Stone, Madang, Papua New Guinea, late 1980s (credit: Jais Aben)

Walter Jaap (1940-2021)

Introduction compiled by Sue Wells from information provided by Pam Hallock

Walt (Walter) Jaap, very sadly and unexpectedly, died in May 2021. Much loved by numerous reef scientists and conservationists, he was born in 1940, and initially served in the U.S. Army as a diesel mechanic in Germany. Later he studied marine biology at the University of Miami, and then worked for Florida Fish and Wildlife Conservation Commission for 35 years.

Trained in coral taxonomy by John W. Wells, he spent over 50 years carefully monitoring and tracking Scleractinia throughout the Florida Keys and Gulf of Mexico, which resulted in his 2015 treatise on western Atlantic coral biogeography. In 1979, Walt was among the first to publish on coral bleaching, reporting a multispecies "zooxanthellae expulsion event" in the Florida Keys in 1973, which he astutely attributed to a localized, "solar-thermal elevation" event on the reef flat. He participated in the initial Tortugas Reef Atoll Continuing Transect Studies (TRACTS) expedition in 1976 and was a founding member of Florida's Coral Reef Monitoring Research Program. One of the monitoring locations in the Florida Keys is called Jaap Reef. In 1983, his testimony helped convince a federal judge to stop the U.S. Army Corps of Engineers from dumping dredge spoil off Egmont Key. Following retirement, he set up a consultancy evaluating coral reef damage.

His efforts to monitor and understand Florida's coral reefs were pioneering, and he mentored a generation of people now studying marine life. He also had a less well recognised global impact. He regularly participated in the International Coral Reef Symposia sharing his experiences, was always willing to help with information for the growing efforts to document the status of reefs worldwide, and regularly took part in activities to share management experiences and solutions globally.

Walt will be remembered for his passion for nature, his devotion to coral reefs and to coastal wetlands science and conservation, and by his family and friends for his orchid collection, home-brewed beer, and service to his church. For 41 years, he cared for a parrot named Siegfried, who survives him. Mike Risk's personal memories below give a wonderful sense of his generous nature and enthusiasm for life.

"Walt Jaap: a personal chronicle of loss" by Mike Risk

It seems there was never a time I didn't know Walt, that his helping hands and gorgeous grin were always part of my life. I know that can't be true, I know there must have been some time and place where we first connected. We probably ran into each other at one of those Florida reefy bunfights, went out for a beer or three, and hit it off. The world seems smaller now, and meaner...

Walt was, of course, a consummate reef biologist. His work, and his mentorship, had a value beyond estimation. He was one of the gang of Florida people back in the days when Florida had reefs, one of the gang for which only first names were needed: Gene, Phil, Alina, Brian, Jim, Bob, John, Billy, Jenni, Walt, …Coral reef biology could be described as a nest of snakes, except most snakes are harmless. Walt sailed untouched through the ins and outs, the ups and downs, never complaining, never badmouthing, always true to his word and honest as any kid from Duluth. I will let others speak to his role as a biologist. I want to speak to the loss we suffered when he died, a diminishing of the human quotient in the world. He is one of the giants on whose shoulders we all stand.

He was a man of many facets. He loved working with his hands, and one of his last projects was an enormous cross he made for his church in Florida. He understood the paradox of science, that the things we make with our hands will often outlive the things we create with our minds.

Jodie and I live in a timber-frame house we built in the woods almost 20 years ago. Timber-frame houses have an actuarial lifespan of around 1,000 years, so it's a great way to sequester a few tons of carbon by living in a nice house. Walt visited us several times. On one visit, he helped me cut a few rafters: these are 8x12's, 20' long, needing various notches and doodads. I was happy to carve his name on our Brag Beam with the others who helped-that part of Walt will be around for many years to come (picture above).

Because he was always so helpful to others, it was a pleasure to be able to do something for him. Some years ago, he was building…something. I think maybe a planer table. Anyway, it needed a quantity of really strong hardwood, something in which Florida is limited. I filled my largest suitcase with big pieces of 8/4 KD beech. The people at US Customs were somewhere between curious and suspicious ("One pair socks, one pair underwear, a toothbrush and WOOD?") but Walt was delighted.

One of his favourite things was teaching others, especially kids. A friend up here organizes events for Youth Literacy, and her Career Day happened to come when Walt was up here on one of his visits. We got Walt to talk about being a Sub Driver. These are mostly rural kids, ages I guess 8-12…Walt was in his element talking about driving research subs around seamounts and deep reefs, kids' eyes bugging out so far they almost fell out. Those children will never forget meeting him - there may be no future sub drivers in that cohort - you never know - but he made an impact.

He liked visiting us, I think because it reminded him of the area around Duluth. He'd fly in, I'd meet him in Buffalo or Toronto, and we'd hit some Niagara wineries on the way north to the cabin we had before we built the house. We'd ski all day, then sit around the woodstove at night sampling adult beverages and gossiping. In summer, we would mountain-bike on the dirt roads and through the forest trails. Our friends up here remember him fondly.

He was here during the 2002 Winter Olympics in Salt Lake. He was a great hockey fan, and Canada played the US for the Gold Medal. Feelings ran high in front of the TV, in a good-natured way. Intake was also high of some of Ontario's best microbreweries. Unfortunately for Walt, some of those beers had a higher alcohol content than what he was used to - he missed the Third Period. But do not worry, we were all happy to tell him the final results when he surfaced.

Walt, with Sylvia Earle and a NOAA submersible.

His other passion, after Karilyn, corals and carpentry, was music. We met up at the First Deep-water Coral Conference in Halifax in Spring of 2000, and after that he and Karilyn toured Cape Breton. If you don't already know, Cape Breton is the mecca of roots/Celtic music in North America. He had an absolute ball. To people like me and Walt, "rap" is the sound Natalie McMaster's heels make as she dances and fiddles. He turned me on to the Transatlantic Sessions, which remain a delight.

We had a professional relationship which began by accident. For some strange reason, I was invited to Florida, to Key Largo in Dec. 2000, as part of a panel to examine the monitoring programs evaluating the status of the reefs. (Spoiler alert: we concluded that Walt's program, FMRI, with Jim Porter, Vlad Kosmynin, Phil Dustan and others, was the best one, that they had established decline was well under way, that monitoring had done its job and mitigation should now take over. The phrase "regional mass extinction" was removed from our report before it went to press.)

Walt introduced their program, and gave an excellent yet depressing talk - but I had noticed something. "Walt, what's that honkin big red patch on the side of that *Diploria* you used as your first slide?" Turns out it was a huge colony of the coral-destroying boring sponge *Cliona deletrix*, which is a fecal bioindicator. There are tons of it in the Keys-one colony we measured at 5m x 3m. The red patches can be seen from light aircraft in the passes leading to the open ocean. I funded Christine Ward-Paige and we produced work that I was sure would convince anyone, anywhere, of the threat from land-based pollution. We could not have done it without Walt. He came up here, he sat with Christine for days, walking her through the FMRI work, the stats they used and how the data were processed. He had the patience of a saint and the turn of phrase of Yoda.

During the Cold War, Walt was stationed in Germany. Only one man stood between European civilization and the hordes of Russian armour that would pour through the Fulda Gap. Ah, but they must have known Walt was there, because they never came. In 2003, we went to the Second Deep-water Coral Conference, in Erlangen. It was near to where Walt had been stationed, and he graciously offered to guide Jodie and me around parts of Germany and Austria.

During the conference, I got up one morning, staggered over to the park, and tried to stumble through some sort of workout. Through the trees, I could see some annoying person sprinting around, jumping up and down "…bloody German fitness freaks", I grumbled…then the annoying person who was Walt ran up, stopped, said "I think I have a problem". He lifted his sweaty T-shirt, and his whole trunk was covered with an angry red outbreak.

We whipped him to the local clinic, where diagnosis was instant (shingles, a horrible affliction with a cute name) and treatment prompt. And

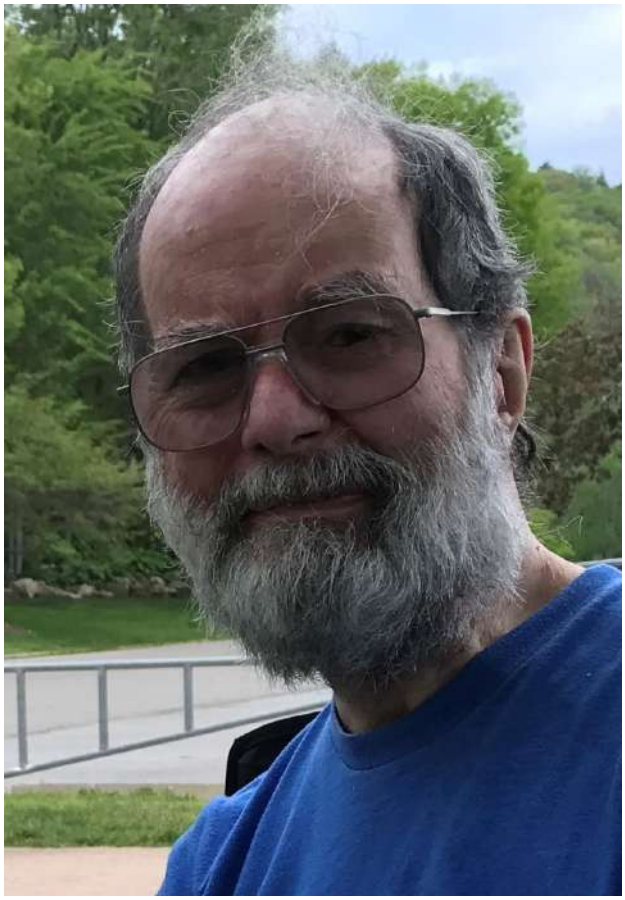
cheap, for any Americans reading this. The doctor took me aside, and she said "any other man would not have been able to get out of bed." But that was Walt. He got up, he worked, he helped people.

We never got to travel together again. There was some talk...Karilyn and Jodie wanted to go to COMICON (if you have to ask what that is, you can't go) in August in Las Vegas. We kicked that around for a while, but there was no way Walt or I were going to attend the conference, and hiking around Las Vegas in summer did not attract. We kept in touch, traded music and jokes and hockey stories - and then I heard.

This is not a good time to be an American. That country, our neighbour, is going through some very serious issues. It is good for the rest of us to understand that the US can produce people like Walt. Perhaps only the US could have produced Walt, that combination of open-hearted generosity, whip-smarts, and cheerful naivety. John Donne was right - we are all diminished.

Jeremy Woodley (1937-2021)

By Sue Wells and Catherine Woodley



Jeremy Woodley, who died in May 2021 after a long illness, was dedicated to building up reef research capacity in Jamaica and the Caribbean; he was an initiator of long-term monitoring programmes, a supporter of global conservation activities and a much-loved supervisor and teacher of marine sciences. Born in London, he initially served in the British Royal Navy (attracted by the opportunity to travel and study bird migration), before studying Zoology at the University of Oxford in the late 1950s. Influenced by the (guest) lectures of Dr. David Nicholls[4], he decided to study the functional anatomy of brittle-stars for his DPhil.

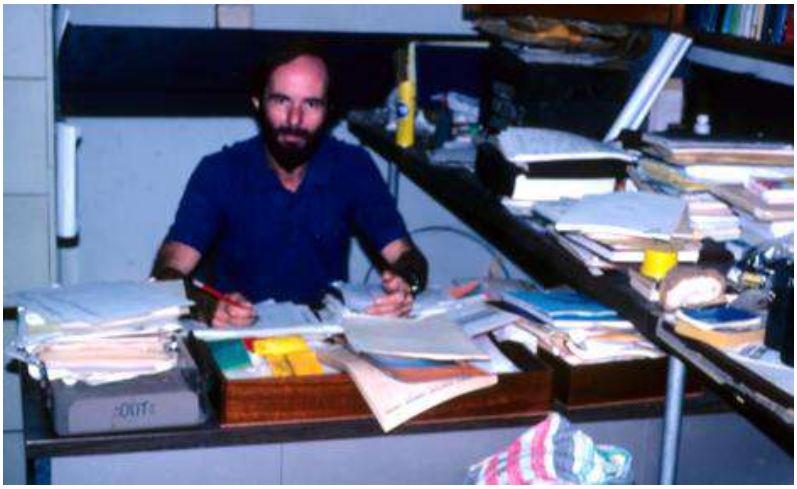
In 1966, he moved to Jamaica, and taught at the Zoology Department of the University of the West Indies (UWI) in Kingston. Over time, he saw numerous Caribbean and other biologists through their PhDs, and in 1969 took part in an expedition to Guam and Truk, looking at the Crown-of-thorns starfish, *Acanthaster*. By the mid-1970s, the marine laboratory, founded by Dr Thomas F. Goreau in the 1960s at Peach Beach and operated jointly by UWI and the State University of New York (SUNY), needed a new head. Tom Goreau died in 1970s, just before the brand new laboratory, built at Discovery Bay with funding from CIDA among others, opened. In 1975, Jeremy took over responsibility for its operation and visitor use, working there for 25 years, until 2000 (he was its longest serving director). He turned the quiet field station into one of the best known tropical marine scientific institutions, the globally renowned Discovery Bay Marine Laboratory (DBML), important not only for training biologists but also for generating foreign exchange for UWI and for Jamaica.

The initially underfunded and understaffed institution proved a major challenge. Jeremy was instrumental in raising numerous research and development grants, including one which led to the construction of staff flats allowing researchers from

[4] Then at Oxford University, later a head of the Biology Department at the University of Exeter, UK

Jamaica and around the world to be based on site. His commitment to training meant he designed and offered numerous specialized summer courses on tropical shallow-water ecosystems, with a major focus on reefs, which attracted foreign and local experts as teachers. In 1973, for example, he hosted groups from 32 overseas institutions, all of whom paid fees. The DBML was also at the forefront of technology, acquiring 3 small submersibles in the 1970s/80s, capable of reaching 1000ft – and attracting a visit of the *Calypso,* with Jacques Cousteau aboard.

Distressed about the declining health of reefs since his arrival in Jamaica, Jeremy supported innumerable research activities into the causes, including hurricanes, *Diadema* mortality, coral bleaching and disease. In an attempt to mitigate overfishing, Jeremy set up the *Fisheries Improvement Project (FIP)* in 1988, which involved working with the local fishers, a novel approach at the time. Although, in his typically modest way, he felt that social science expertise was needed, he began talking with fishers about the problem, and they started to monitor catches. The next step was developing one of the first gear-exchange programmes: in the Two-for-one Mesh Exchange, fishers were invited to surrender small-mesh traps in exchange for large mesh to build two traps for every one turned in. In 1991, 250 small-mesh traps were taken in, broken up, and the old wire was given to local women to make chicken coops. The value of sanctuaries with no fishing was also raised with the fishers (both male and female – Jeremy always recognised the need to involve all).



Jeremy, at his famously untidy desk at Discovery Bay.

His collaborative and gentle manner must have been a large factor in their acceptance of the idea, which led to the creation of the Discovery Bay Fishery Reserve (now Special Fishery Conservation Area) and of the associated Alloa fishermen's cooperative that now manages the reserve; this is marked by conspicuous buoys and patrolled by rangers drawn from the fishers. In 1988, Jeremy and others had also prepared a proposal for the development of a Marine Park at Montego Bay, which led ultimately to a marine parks system in Jamaica.

Jeremy played important roles regionally and globally. He helped to develop CARICOMP, the Network of Caribbean Marine Laboratories that still monitors reefs and other tropical marine ecosystems, and contributed his time generously to global initiatives to compile information on reef health, including the Global Coral Reef Monitoring Network reports and publications compiled by the UNEP World Conservation Monitoring Centre. When the International Coral Reef Initiative (ICRI) was founded, Jeremy helped to ensure the involvement of the Caribbean countries. In developing, at the first ICRI meeting in the Philippines (1995), the ICRI Plan of Action, he pushed for the necessary focus on training and capacity building. In 1998 he attended the first International Tropical Marine Ecosystems Management Symposium (ITMEMS) in Townsville, Australia (1998), helping to develop the ITMEMS initiative as a mechanism for sharing knowledge about reef management.

In 1993, he moved back from Discovery Bay to Kingston to become Director of the new Centre for Marine Sciences and was instrumental in finding space for it within the Faculty of Science and Technology. When he retired in 2000, Jeremy moved to Ontario, Canada where his wife lived. Jeremy was deeply loved by many in the reef world - teachers, students, colleagues, collaborators. He was always generous and considerate, and greatly appreciated for his kindness and equanimity; as Les Kaufman put it in a tribute “he was a modest soul in a sea of divas and a stabilizing influence in a tumultuous world”.

Paul Yoshioka (1945-2021)

By David Ballantine, Richard Appledoorn & Nilda Aponte[5]

It is with great sadness we report that on June 1, 2021, the Caribbean marine sciences community lost an intellectual stalwart, Dr. Paul M. Yoshioka. Born in Wa-hiawa, Hawaii, in 1945, Paul obtained his Ph.D. from Scripps Institution of Oceanography, where he based his doctoral dissertation on bryozoan ecology. Following graduation, Paul worked for six years at the Center for Energy and Environmental Research in Mayagüez, Puerto Rico. Paul joined the Department of Marine Sciences (DMS), University of Puerto Rico-Mayagüez in 1985, where he worked until his retirement in 2012.

Paul possessed a sharp sense of humor and was well liked and well respected as both a person and scientist. All who knew him considered Paul to have a "laid back" persona; however, coupled with a keen intellect. Paul was generous with his time and expertise, both with his colleagues and the students he mentored; he was regarded as a superior classroom teacher. In service to the region, Paul hosted the 1989 biennial meeting of the Association of Marine Laboratories of the Caribbean in La Parguera, Puerto Rico, and then served as Executive Director from 1990–1997.

Paul's principal area of research within the Department of Marine Sciences was quantitative marine ecology, particularly focused on gorgonian ecology and population dynamics. As a marine science faculty member, Paul published 25 peer-reviewed papers, 16 as first author. Perhaps more important than the number of his publications was the high number of citations his publications have received. In addition to research, Paul was regarded by graduate students as a superior professor, teaching courses in biological oceanography, population and community ecology, and statistical research methods. His lectures typically were framed around current research questions, and he expected excellence from his students. During his tenure, Paul trained 11 MS and five PhD students. Five of his students went on to enjoy academic careers, while others took up positions in federal and state agencies.

Paul Yoshioka in retirement in Florida with a large snook.

Paul possessed broad interests. He was an avid and skilled fisherman, and despite his marine zoological background, Paul was a serious plant enthusiast. Paul was an avid orchid grower as well as a palm tree and Heliconia expert. Paul's home in El Rosario, Puerto Rico was surrounded by lush tropical gardens, replete with personally constructed ponds. A sushi dinner at the Yoshioka "finca" was a memorable experience that many of us will fondly recall for years.

Following retirement, he moved from Puerto Rico with his wife Beverly ("Cricket") Buchanan to Port St. Lucie, Florida. During his retirement, he volunteered at the Smithsonian Marine Station in Fort Pierce, Florida as a data analyst. He will be missed by all. The world of academia has lost a creative mind, his family a dear husband, father, and loving grandparent, the University of Puerto Rico-Mayagüez a valuable, dedicated professor, and all of us have lost a dear friend.

[5] Thanks to Beverly Yoshioka for providing some of this information, including the image. Reprinted with permission from the Caribbean Journal of Science, 51, 223-224.

ICRS Membership

ICRS membership is open to anyone interested in any aspect of the science of coral reefs. While the society's membership consists principally of researchers, managers and students with involved with coral reefs and associated ecosystems, other people with genuine interests in or concern for reefs, of any type, are welcome. The benefits of membership include:

- Receipt of the Society's scientific journal *Coral Reefs* (on-line)
- Free (on-line) access to all past issues of Coral Reefs
- Receipt of the Society's newsletter/magazine *Reef Encounter* (by email or on-line)
- Eligibility for the graduate fellowships, students travel grants and communications fellowships offered by the Society
- Eligibility for the multiple honors and awards given by the Society, including mid- and early-career and conservation awards
- Access to the Society's on-line membership services, including the on-line Membership Directory
- Reduced registration fees for the International Coral Reef Symposium and other meetings sponsored by the Society.

Full / Individual Member
Membership includes all the benefits listed above, but rates vary depending on the mean income level of the member's country.

Student Membership
The benefits are the same as for a Full / Individual Member, and include on-line access to Coral Reefs at a much reduced rate.

Family Membership
Family memberships are available for partners who live at the same address. Each receives the same benefits as Full Individual Members, but only one copy of any material is supplied.

Sustaining Membership
Sustaining Membership is for those Members who would like to contribute extra to support the work of the Society. They receive additional minor benefits and their support is acknowledged in Society publications.

Honorary Membership
Honorary Membership has been conferred on a small number of members who have rendered special service to the society or otherwise distinguished themselves in the field of reef science.

Membership services are now operated by Schneider Group which provides such services to academic societies. They may be contacted at:

ICRS Member Services
5400 Bosque Blvd, Suite 680
Waco, Texas 76710-4446 USA
Phone: 254-399-9636
Fax: 254-776-3767
email: icrs@sgmeet.com

The membership subscription varies considerably depending on the type of membership selected and the primary country of residence of the member. Very generous membership rates are available for students and residents of developing countries.

For low to low-middle income countries, full membership costs only $40 (US) per year, and student membership only $20 (US) per year.

For details of current rates and to complete the on-line membership form or download a hard copy please go to the society's membership portal at: https://icrs.memberclicks.net/

CALL FOR NEW EDITORIAL PANEL MEMBERS

We are eager to have extra members join Reef Encounter's editorial panel. We especially wish to recruit early-career researchers and graduate students (since the current editors are mostly retired - supposedly!) The time commitment is not large – the work mainly involving checking a few articles per issue for content and scientific writing, and canvassing for further items among colleagues. If you at all interested in developing your communication skills or in learning more about scientific publication, this could be an excellent (first?) step. Please contact the senior editor (rupert.ormond.mci@gmail.com) or any other member of the editorial panel (see email addresses page 2).

NOTES FOR REEF ENCOUNTER CONTRIBUTORS

Reef Encounter welcomes items for publications, especially:

General overview articles (3-5 pages long) on a particular reef science topic in which the author(s) has a special interest (for the **REEF CURRENTS** section)

Short communications / scientific letters (1-2 pages) reporting recent observations (for the **REEF EDGE** section)

General interest articles (3-6 pages) describing personal views and experiences (for the **REEF PERSPECTIVES** section)

Reef Encounter also welcomes

Announcements about future meetings, workshops and activities

Conference Reports about recent meetings, workshops

Book and Product Reviews for the **REEF SHELF** section

Descriptions and news of projects for the **REEF ACTIONS** section

Information to be included in the **REEF DEPARTURES** section (Obituaries)

Authors are encouraged to include colour pictures or other illustrations (normally 2-4 per article).
There are no specifications regarding the formatting of articles for submission to the editors – please submit them as WORD files (preferably with single spacing between lines).
However, we do require that references should be cited and listed using the style of the ICRS academic journal *CORAL REEFS*, see: http://www.springer.com/life+sciences/ecology/journal/338.
Articles from non-ICRS members are welcome, but the latter are generally given priority.
Items should be submitted by email to the senior editor (rupert.ormond.mci@gmail.com) or a relevant member of the editorial panel (see page 2).

CREDIT: Kevin KAL Kallaugher, The Economist, Kaltoons.com (with thanks to KAL for waving the usual fee)

An Indonesian fishermen with yellowfin tuna, to be marketed as part of a fairtrade program (see article "Integrated marine conservation and fisheries management approaches are prerequisites for reef protection in Eastern Indonesia" by Alan White and Tiene Gunawan (page 34)

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