INTERNATIONAL FOSSIL CORAL AND REEF SOCIETY

Second Early Career Researcher Symposium

Abstract Booklet

24 November 2022

CONTENTS

INTERNATIONAL FOSSIL CORAL AND REEF SOCIETY

CODE OF CONDUCT

The International Fossil Coral and Reef Society (IFCRS) was created to connect individuals interested in fossil corals, sponges and reef ecosystems in the broadest sense. Researchers and students are the core of our Society, but general enthusiasts are also warmly encouraged to join our growing community. **We strive to foster a safe, inclusive, and respectful community that values the diverse perspectives and experiences of all members. Harassment or disrespectful behaviour of any kind is not tolerated.** By participating in IFCRS activities, you agree to adhere to the following code of conduct at all times. The IFCRS council will enforce this code as necessary to ensure that all participants feel welcome, and we reserve the right to remove those who are found to be negatively contributing to the society and its activities. The IFCRS is committed to diversity, inclusion, and accessibility for all, and expects members of the society to uphold these values, and treat all equally.

Members of the IFCRS and participants in its activities are expected to treat one another with respect and dignity regardless of gender, gender identity and expression, sexual orientation, marital or parental status, age, immigration status, disability, physical appearance, body size, race, ethnicity, nationality, religion (or lack thereof), socioeconomic background, educational background, career stage, career trajectory, or scientific opinions.

We believe all members of our society and participants in activities have:

- The right to be safe from harassment or discrimination in all its forms
- The right to fully engage in all the activities on offer
- The right to have any complaints or concerns investigated, regardless of career position

We ask everyone to help us maintain an inclusive and safe Society for all by agreeing to the common principles of our code of conduct:

- being courteous, respectful and professional towards others
- valuing the diversity of participants, their views and opinions

If you are being harassed, notice that someone else is being harassed, or have any other concerns, please contact the IFCRS council via fossilcoralreef@gmail.com

Ultimately, please remember why we are here: to network, diversify our knowledge, meet new people, and above all, to enjoy science!

DIGITAL IMAGES AND SOCIAL MEDIA POLICY

During the symposium, do not photograph or record a talk without the author's express permission. While the default assumption is to allow open discussion of presentations on social media, attendees are expected to respect any request by an author to not disseminate the contents of their talk.

We request that authors indicate at the start of their talk whether they are happy for the presentation to be shared on social media or not. We also recommend the use of an image similar to that adjacent to express that you do not give permission for your presentation to be shared on social media or recorded in any way.

Throughout the symposium, we will use the hashtag **#IFCRS2022** to share updates about the symposium and presentations. You may also tweet us using our Twitter handle: **@fossil_reef**.

JOINING THE SYMPOSIUM

The symposium will be conducted fully online. Within due course, you will receive an email with a link to join the symposium. Please note, this link will be sent to the email address you registered for the symposium with. For the symposium, we will make use of the platform Zoom. If you are unfamiliar with Zoom, you may familiarise yourself via the following link: https://zoom.us.

A LETTER FROM THE IFCRS PRESIDENT AND SECRETARY

Dear participants of the Second IFCRS Early Career Researcher Symposium, dear colleagues and friends,

It is our great pleasure to welcome you in the name of the International Fossil Coral and Reef Society. Being proud that the increasing contribution of early career scientists in our society has led to the success of the first IFCRS Early Career Researcher Symposium organized in October 2021, we strongly encouraged and welcome the organization of this second edition.

As in 2021, also the organization was deliberately entrusted to an early career scientist who is in charge of all the aspects of the one-day ECR symposium. We thus thank Danijela Dimitrijević (PhD student at Geozentrum Nordbayern, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany) for her enthusiastic work and all the time and effort she put into the organization.

These one-day ECR symposia close the gap between the society's symposia organized every 4 years in order to provide a new exciting and interesting forum for young scientists interested in all kinds of research topics related near or far to fossil corals and reefs. Next year, the 14th Symposium of the International Fossil Coral and Reef Society will be held in Poland (10-16 September 2023: https://fossilcoralreefs.com/). We hope that a high number of ECRs will participate at this flagship event of our society.

A main goal of the society is to keep alive and active the interest of young scientists in the study of reef ecosystems and to highlight the importance to study their fossil records from different perspectives, at different spatio-temporal scales. New ideas and new approaches are crucial for the future of our research as they stimulate discussions and shed the light on our community.

We wish you to enjoy the day and to have interesting and valuable exchanges with the different participants at this symposium. We also hope that many of the young scientists will have the opportunity to continue their research and to see them at the upcoming events of the society.

Francesca Bosellini (IFCRS President)
Markus Aretz (IFCRS Secretary)

A NOTE FROM THE ORGANISER

Dear delegates,

I wish you a warm welcome to the second IFCRS Early Career Researcher Symposium!

First of all, I would like to thank our speakers for accepting the invitation to share their amazing research with us! I am also grateful to lab representatives for taking the time to introduce their labs and share potential projects with young researchers. Last but not least, thank you, the participants, for signing up for this event, we are very excited to have you here!

The Early Career Researcher Symposium is a wonderful idea introduced and organized for the first time last year by Angelina Ivkić and Lewis Jones. Their vision was to offer the opportunity to Early Career Researchers (ECR) to present their work in the years between the main society meetings, which happen every four years. With over 70 delegates, 14 labs, and 8 talks, last year's symposium was a huge success.

At the second ECR Symposium, we look forward to ten ECR talks ranging from extant cold-water coral reefs to fossil tropical reefs, corals, giant clams, sharks, and much more! The symposium will begin with the plenary talk delivered by Professor Markus Aretz from the University of Toulouse. In his talk, he will walk you through the tropical reefs of the Carboniferous period.

This year the ‘Meet the Labs’ session will be presented throughout the day between the main talks. I warmly encourage you to ask questions to lab leaders about their projects and collaboration opportunities either during or after the symposium.

Lastly, it is very important that all exchanges are conducted in a positive and respectful manner. Therefore, please be mindful of others, be kind and enjoy the event! Thank you again for attending our symposium.

With the warmest regards,

Danijela Dimitrijević

SCHEDULE

Thursday 24th November 2022 (Time zone: UTC + 01:00)

See time chart on next page for time zone guidance

10:00–10:30 Welcome address

Plenary talk

10:30–11:15 Markus Aretz

From corals and reefs to Carboniferous geodynamics, palaeogeography and climate

11:15–11:30 Tea and Coffee Break

Invited talks and labs Session 1

11:30–11:45 Angelina Ivkić

How are interpretations of data from fossil coral reefs influenced by sampling methods? A comparison.

11:45–11:55 Wolfgang Kiessling

Paleobiology Lab

11:55–12:10 Anna-Selma van der Kaaden

Self-organization in (extant) cold-water coral reefs

12:10–12:20 Jarosław Stolarski

Biostructures and Biomineralization Working Group

12:20–13:30 Lunch Break

Invited talks and labs Session 2

13:30–13:45 Matthieu Saillol

New insights on Lower Devonian reefs from Southwestern Europe

13:45–13:55 Katharina Methner

AG Brachert Lab

13:55–14:10 Yael Leshno Afriat

Transition from coral to stromatoporoid patch reefs in Callovian (Middle Jurassic) equatorial warm waters: Makhtesh Gadol, Israel

14:10–14:20 Nadia Santodomingo

NHM Corals - Reefugia

14:20–14:35 Amelia Penny

Reef-building in Ordovician seascapes

14:35–14:45 Francesca Bosellini

Paleobiology and Paleoenvironments of Cenozoic Marine Tropical Ecosystems Lab

14:45–15:15 Tea and Coffee Break

Invited talks and labs Session 3

15:15–15:30 Kimberley Marshall-Mills

A window into biomineralization in giant clams through time: opportunities and challenges

15:30–15:40 Markus Aretz

Paléo-environnements et paléo-océans (Paléo) Lab

15:40–15:55 Erin Dillon

Reconstructing natural variability in shark communities on coral reefs over millennia using fossil dermal denticle assemblages

15:55–16:10 Addis Hailu Endeshaw

Taxonomy of Pleistocene reef coral family Merulinidae (Cnidaria: Scleractinia) from the Danakil Depression, Ethiopia

16:10–16:25 Kathrine Maxwell

Past sea-level changes derived from fossil coral reef terraces: Records from the Philippines

16:25–16:40 Matias Gomez-Corrales

Speciation in Caribbean corals

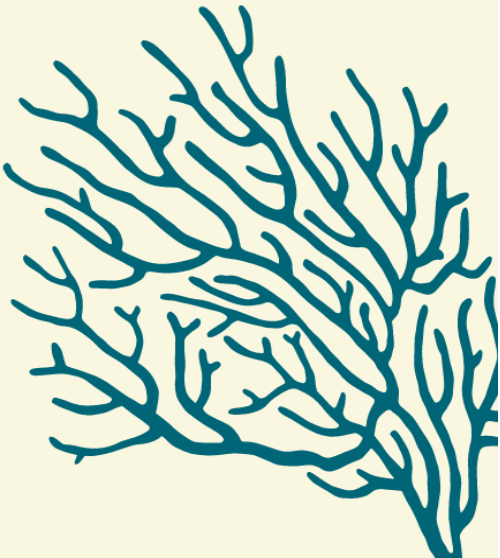
16:40–17:00 Closing address

TIME ZONE CONVERTER

Below we provide a time zone converter for your ease. Active time zone refers to the time zone that will be active during the time of the symposium (24th November 2022). Local start time refers to the start time of the symposium in the local time zone. If you have any queries about your specific time zone, please do let us know. The following is also a very useful resource: **Time Zone Converter – Time Difference Calculator**

Location	Active time zone	Local start time
Australia Central (Adelaide)	UTC + 10:30	19:30
Australia East (Brisbane)	UTC + 10:00	19:00
Australia West (Perth)	UTC + 08:00	17:00
Austria	UTC + 02:00	11:00
Belgium	UTC + 02:00	11:00
China	UTC + 08:00	17:00
Denmark	UTC + 02:00	11:00
Egypt	UTC + 02:00	11:00
France	UTC + 02:00	11:00
Germany	UTC + 02:00	11:00
Ireland	UTC + 01:00	10:00
Israel	UTC + 03:00	12:00
Italy	UTC + 02:00	11:00
Jamaica	UTC - 05:00	04:00
Malaysia	UTC + 08:00	17:00
Moldova	UTC + 03:00	12:00
Morocco	UTC + 01:00	10:00
Pakistan	UTC + 05:00	14:00
Poland	UTC + 02:00	11:00
Singapore	UTC + 08:00	17:00
South Korea	UTC + 09:00	18:00
Spain	UTC + 02:00	11:00
Turkey	UTC + 03:00	12:00
United Kingdom	UTC + 01:00	10:00
United States of America (Dallas)	UTC - 05:00	04:00
United States of America (Denver)	UTC - 06:00	03:00
United States of America (Las Vegas)	UTC - 07:00	02:00
United States of America (New York)	UTC - 04:00	05:00

Abstracts



Plenary Talk

FROM CORALS AND REEFS TO CARBONIFEROUS GEODYNAMICS, PALAEOGEOGRAPHY AND CLIMATE

Markus Aretz[1]

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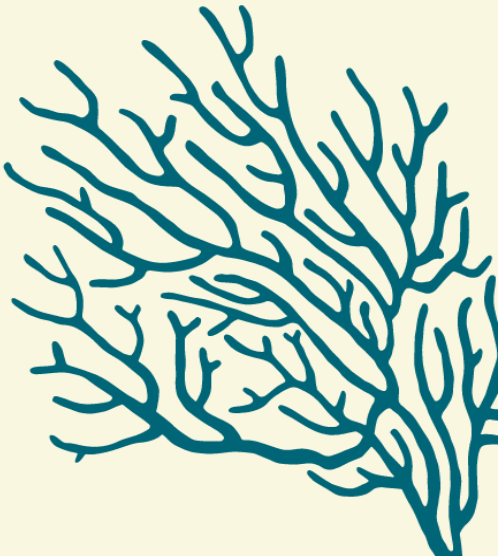
After the end-Devonian mass extinctions, the Carboniferous biota experienced recovery and major diversification, both in the ocean and on land. This happened when major geodynamic reconfigurations (Variscan Orogeny) and climate changes (Late Palaeozoic Ice Age) took place.
In this talk, we will use several short case studies to demonstrate the evolution of Carboniferous corals and reefs in time and space. We will travel to several palaeocontinents, which help us to cover various parts of the Carboniferous tropical realm. First, the focus will be on corals. After taxonomic studies of rugose corals combined with carbonate facies studies in Western Europe, we will then focus on biodiversity changes during the Mississippian (lower Carboniferous) on local and regional scales. Then we will explore palaeobiogeographic patterns between Gondwana and Laurussia and come back to the discussion on configurations of Pangea A and B.
The second part will focus on the evolution of Mississippian reefs and mounds. We start with an inventory of reef types, which will underline the importance of microbial communities for successful Carboniferous reef formation. Even on a global scale, true coral reefs are rare at that time, but we will see some of them. This inventory is also used to work out a recovery pattern after the collapse of the reef ecosystem in the end-Devonian.
The third part of the talk will focus on a global perspective and try to link coral and reef evolution with global changes. This includes the confrontation of our field-based coral and reef data with data obtained from numerical modelling of e.g. palaeoclimate and ocean circulation patterns. Hence, we will explore how the aforementioned changes influenced and controlled the evolution and distribution of Carboniferous corals and reefs. Without question, they have been driving forces, for example in the creation and destruction of ecospaces, but we will also explore how our coral and reef data can help to better understand and constrain those major changes

Invited talks



HOW ARE INTERPRETATIONS OF DATA FROM FOSSIL CORAL REEFS INFLUENCED BY SAMPLING METHODS? A COMPARISON.

Angelina Ivkić[1], Felix Puff[1], Andreas Kroh[2], Abbas Mansour[3], Mohamed Osman[3], Mohamed Hassan[3], Abo El Hagag Ahmed[4] and Martin Zuschin[1]

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[2] Natural History Museum Vienna, Geological-Paleontological Department, Vienna, Austria
[3] South Valley University, Department of Geology, Qena, Egypt
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Line Intercept Transect (LIT), Point Intercept Transect (PIT), and Photoquadrat (PQ) are the most common quantitative sampling techniques in modern and fossil coral reefs. Data from coral reefs obtained by the different methods are compared and used in conjunction with each other between various reef ages and localities. Since the rise of the field "conservation paleobiology", reefs that lived in periods with warmer temperatures in the past are particularly interesting for comparisons with modern reefs.

However, fossil reefs differ from modern reefs as they are diagenetically altered and time-averaged. In particular, the impact time averaging has on the results of a survey is highly dependent on the analytical method chosen to study the fossil reefs. While a number of studies compared different quantitative methods in modern reefs, so far very few studies dealt with the comparability in fossil reefs and between fossil and modern reefs. Therefore, we compare LIT, PIT with 10, 20 and 50 cm intervals, and PQ in two Pleistocene reef localities in Egypt. We find that alpha diversity, reef cover and community composition are dependent on the method chosen: Plotless (LIT, PIT) methods cannot be directly compared with plot (PQ) methods. However, results on coral cover are similar between LIT and PIT and community composition is indistinguishable, but alpha diversity is dependent on the interval used for PITs.

We discuss the implications of our findings for comparisons of coral reefs of various ages and localities and ultimately, we recommend to survey Pleistocene reefs with PITs with 20 cm intervals. This recommendation is given because alpha diversity is well captured, the amount of time averaging recoded by PITs is reduced in comparison to PQs, the PIT results can be directly compared to reefs analyzed by LITs, and the method is time efficient.

SELF-ORGANIZATION IN (EXTANT) COLD-WATER CORAL REEFS

Anna-Selma van der Kaaden[1]

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Cold-water corals build mounds in the deep-sea that are tens of kilometres wide and hundreds of meters high. A general theory of cold-water coral reef/mound formation is still lacking. Several examples exist of cold-water coral reef- or mound systems that resemble regular self-organized spatial patterns of e.g. arid vegetation and musselbeds. We therefore investigated whether self-organization, the process whereby system-scale patterns arise due to local interactions between the system's components, can provide such a general theory for cold-water coral reefs.
With hydrodynamic simulations we confirmed that cold-water coral reefs have the ecosystem engineering ability to modify the water flow, thereby enhancing on-reef coral growth and worsening conditions in between the reefs. Such so-called "scale-dependent feedbacks" create the potential for self-organization. With statistical tools we further confirmed that the patterns at which cold-water coral reefs occur are regular, which is another indication of self-organization.
Cold-water coral reefs and mounds consist largely of biogenic material with some captured sediment and so it seems likely that these patterns are self-organised rather than pre-existing. Placing cold-water coral reefs into self-organization theory helps us to understand their future (how will they respond to global change?), present (what are the drivers of cold-water coral growth?), and past (which I might hear during this symposium!).

NEW INSIGHTS ON LOWER DEVONIAN REEFS FROM SOUTHWESTERN EUROPE

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Silurian and Middle-Upper Devonian times show a peak in Phanerozoic reef development. They are the well-known stromatoporoid-coral reefs, which formed some of the largest reef belts (Copper and Scotese, 2003). However, during Lower Devonian times, such reefs are scarce and mostly represented by small-sized patches and biostromes, especially in what is today southwestern and central Europe (Copper, 2002). Here, most reefs have only been summarily studied or mentioned in larger-scaled regional geological studies. My PhD project aims to better understand the constraints impacting reef development and the structure of reefal communities to decipher reefs' evolution during the Lower Devonian. Herein, we present the first preliminary results and observations from several field campaigns across three main areas, the French Basque Country (Château-Pignon and Adarza reefs), the Carnic Alps (Hohewarte reefs) and the Armorican Massif (Porz Boulou reef).

In the French Basque Country, at Château-Pignon, a 30m thick biostrome is composed of the accumulation of tumbled reef-builders. However, in situ preserved reef builders are found in a 2 m thick horizon, where several small low-relief patches (50cm in thickness for 1-2m of diameter) are formed by mostly small branching tabulate corals. At Ardaza, a 100m thick succession of crinoidal limestones contains at least 3 levels of bioconstructed patches. Here, patches are larger and taller (2-3m in thickness for 6-8m in diameter) than at Château-Pignon. They consist of massive stromatoporoids associated with elongated tabulate corals and some massive bryozoans. In both Basque localities, the sediment trapped in the framework is a crinoidal wackestone to mudstone. The situation in the Carnic Alps is different. In the 120m of the Hohewarte Formation, 8 patchy buildups are successively identified. These patches are similar in geometry, about 10 m in diameter and 2-4m in thickness. They consist of a mixed framework built by stromatoporoids and tabulate corals. Compared to the Basque Country, the stromatoporoids are smaller with much more abundant lamellar growth forms. Tabulate corals are more often in a domal to bulbous massive colony shape. The sediment trapped in the framework is a crinoidal packstone with a very low siliciclastic content, sometimes sparitic crystallisation fills the voids between reef-builders. At La Pointe d'Armorique in the Armorican massif, the Porz Boulou reefs show two small patches (less than 2 m in thickness and diameter) composed of massive colonies of tabulate corals at the base. At the top, the massive forms are replaced by smaller branching tabulate coral colonies, with only a few stromatoporoids documented. The sediment trapped by the framework is a mix of carbonates and shales with high amounts of crinoid, thamnoporoid coral and bryozoan debris.

All reefs studied in the Lower Devonian present a patchy geometry, often with a more biostromal than biohermal outline. However, important differences in the association and the morphology of the reef-builders may be linked to the variety of environmental settings in each region. Although some area seems to have better conditions for reefal development (i.e. the Carnic Alps), patch reefs are found in less favourable settings (i.e. Basque Country, Armorican massif). A comparison with other Lower and Middle Devonian reefs and their own environments shows that the environmental conditions may not uniquely explain the least abundance of the Lower Devonian reefs.

TRANSITION FROM CORAL TO STROMATOPOROID PATCH REEFS IN CALLOVIAN (MIDDLE JURASSIC) EQUATORIAL WARM WATERS: MAKHTESH GADOL, ISRAEL

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Jurassic reefs are known from a wide range of paleolatitudes, yet southern Tethyan reefs have been relatively understudied. Callovian (Middle Jurassic) coral reefs are particularly scarce in the southern Tethys, in contrast to the widespread occurrence of stromatoporoids towards the equator. The high abundance of stromatoporoids in southern Tethyan reefs was suggested to indicate their tolerance to oligotrophic and overheated waters. Recent studies affirmed the longtime hypothesis of a warm equable climate in low paleolatitudes during the Jurassic, which could account for the documented low diversities of low-latitudinal coral reefs during this time interval.

We present a case study showing possible evidence for the suggested connection between heat stress, low coral diversity and the success of stromatoporoids in the southern Tethys. The study focuses on the unique erosional depression of Makhtesh Gadol, southern Israel, which preserves a continuous section of the Callovian (Middle Jurassic). It is rich in fossils of benthic macrofauna, especially patch reefs of corals and stromatoporoids. Our quantitative analysis shows for the first time: (a) variation between a low- and high-diversity of coral patch reefs, and (b) a major shift from coral-dominated patch reefs in the lower part of the section to dominating stromatoporoids in the upper part. The faunal assemblage is used to reconstruct temporal and lateral variations in the depositional environment, indicating a shallowing upwards and increasing warmer waters. Beds of patch reefs with low coral diversity are correlated with isotopic reconstructions from the same section, providing evidence for elevated water temperatures. Our detailed analysis, together with isotopic reconstructions, points to the possible negative effect of heat stress on coral success. The faunal transition from corals to stromatoporoids is correlated with a similar shift in Saudi Arabia, improving the regional correlation to the Arabian Carbonate Platform.

REEF-BUILDING IN ORDOVICIAN SEASCAPES

Amelia Penny[1]

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The Ordovician was a time of tremendous evolutionary and environmental upheaval, including rapid diversification of marine organisms, and substantial changes in shallow marine environments. Reef communities reflect these changes; the Ordovician brought a proliferation of metazoan-dominated reefs, with a diverse assemblage of reef-builders including sponges, tabulate corals, stromatoporoids and bryozoans. The exceptionally well-exposed reef-bearing carbonate rocks of the Laurentia palaeocontinent present an excellent opportunity to investigate reef composition and growth in the Early and Middle Ordovician. This talk will examine what these exposures tell us about the composition and architecture of metazoan reefs during this interval, and how changes in reef-building communities influenced the seascapes of the early Palaeozoic. Given the ecological and evolutionary importance of reefs, such studies may help to provide constraints on the mechanisms by which marine diversity was generated and sustained.

A WINDOW INTO BIOMINERALIZATION IN GIANT CLAMS THROUGH TIME: OPPORTUNITIES AND CHALLENGES

Kimberley Mills[1]

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Giant clams (Tridacnidae) are iconic reef dwellers that fulfil critical roles in tropical coral reef communities due to their contributions to the structure, complexity and ecology of reefs. Their aragonitic shells also serve as valuable bioarchives to reconstruct past oceanographic conditions in tropical regions, maintaining geochemical and physical integrity in some specimens from the Paleozoic Era. Yet, a broad understanding of the preservation and physical alterations associated with the diagenesis of shells through geological time is lacking and understudied relative to other calcifiers (e.g. hard corals). Here, we present an overview of the architecture of giant clam shells collected from Borneo in the north corner of the Coral Triangle region. This archive includes modern *Tridacna squamosa* and *Hippopus hippopus* collected from a turbidity gradient and fossil *Tridacna sp.* collected from stratigraphic formations in the Late Miocene (9.4—9.8 Ma) and Pliocene (3.4—4.5 Ma). We use a suite of mineralogical and imaging techniques (Raman spectroscopy, petrography, scanning electron microscopy (SEM), electron backscatter diffraction (EBSD)) to gain insight into the growth, microstructure and crystallography of pristine and potentially altered aragonitic and calcitic zones. Results show fine-scale differences in daily growth increments, crystallite arrangements and crystallographic orientation between shells, hinting at progressive fusion and/or recrystallization of aragonite platelets and loss of orderliness of crystals with age. However, we observe highly localized intra-shell variability (e.g. heterogeneous microstructural arrangements at a daily scale) throughout samples which impedes straightforward interpretation of preservation. Our work suggests that Tridacna shells are valuable paleoproxies that provide detailed insight into local environmental changes when nanoscale third-order aragonite platelets and crystallographic co-orientation strength are preserved. Ultimately, this study provides a thorough guide for future workers on the identification of pristine versus diagenetically altered giant clam shells and moving forward, localized assessment is needed to determine which areas of the shell may produce reliable proxy data.

RECONSTRUCTING NATURAL VARIABILITY IN SHARK COMMUNITIES ON CORAL REEFS OVER MILLENNIA USING FOSSIL DERMAL DENTICLE ASSEMBLAGES

Erin Dillon[1]

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Shark populations have declined steeply over the last half century, yet evidence of shark abundance and diversity before human impact is limited. This is particularly true for sharks in coastal habitats such as coral reefs, where many threatened species occur in close proximity to human stressors. Without historical baselines to document what has been lost, it is challenging to implement meaningful management targets informed by natural variability and understand how the loss of these important predators has transformed reef ecosystems. In this talk, I will discuss how fossil shark scales (dermal denticles) can be used to reconstruct shark communities on coral reefs over the last several millennia. I will first introduce the methods we refined to isolate, identify, and interpret denticles preserved in the recent fossil record. I will then use denticle assemblages to quantify variability in reef shark abundance before human impact on both coasts of the Isthmus of Panama and assess their resilience in the face of ongoing overfishing. These retrospective data, in turn, can help contextualize recent declines and reveal sharks' recovery potential across different regions.

TAXONOMY OF PLEISTOCENE REEF CORAL FAMILY MERULINIDAE (CNIDARIA: SCLERACTINIA) FROM THE DANAKIL DEPRESSION, ETHIOPIA

Addis Endeshaw, Nadia Santodomingo[2] and Anneleen Foubert[1]

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Coral reefs are the most diverse marine ecosystems in the world. They are mainly built by Scleractinia corals and their hard skeletons turn them into excellent fossil archives. The taxonomic composition of reef-building organisms in the fossil record is used as a proxy to better understand environmental changes in the past. The Danakil Depression in the northern Afar (Ethiopia) is characterized by the occurrence of fringing coralgal reefs at its western, central and eastern margins These coralgal reef terraces developed respectively at MIS 7 and MIS 5e when the Red Sea flooded the Danakil Depression.

This study focuses on the taxonomic descriptions and identifications of the Scleractinian coral family Merulinidae from samples collected during the SNF-funded SERENA (SEdimentary REcord of the Northern Afar) project. Surveys were done in 2013, 2015, 2017, 2019 and 2020 with the aim to understand the taxonomy and paleoecology of the coralgal reef terraces. In total, 578 coral samples were collected from 32 coral outcrops and 350 specimens were examined in this study. Samples were cleaned for detailed morphological analysis. Preservation conditions of the fossil specimens were considered to avoid taxonomic biases. Quantitative and qualitative morphological characters were studied on the specimens or thin sections using standard microscopy techniques and X-ray micro-tomographic scanning (Bruker 2211).

The Merulinidae fauna of the Danakil Depression comprises 16 genera: *Astrea*, *Caulastraea*, *Coelastrea*, *Cyphastrea*, *Dipsastraea*, *Echinopora*, *Favites*, *Goniastrea*, *Leptoria*, *Merulina*, *Mycedium*, *Oulophyllia*, *Paragoniastraea*, *Paramontastraea* and *Platygyra* with 68 species. All these species are the first records for Pleistocene coralgal reef terraces of the Danakil Depression. Results evidence new records of *Caulastraea tumida*, *Caulastraea furcata*, *Cyphastrea hexasepta*, *Cyphastrea chalcidicum*, *Dipsastraea helianthoides*, *Dipsastraea veroni*, *Merulina scabricula*, *Mycedium umbra*, *Oulophyllia crispa*, *Oulophyllia levis*, *Paragoniastraea australensis*, P*aramontastraea salebrosa*, and *Platygyra contorta* for the occurrence of Pleistocene Red Sea Scleractinian species. Overall, those results contribute to the understanding of the current Scleractinia phylogenetics framework and the global biogeographical distribution of Scleractinian corals.

PAST SEA-LEVEL CHANGES DERIVED FROM FOSSIL CORAL REEF TERRACES: RECORDS FROM THE PHILIPPINES

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Under the World Atlas of Last Interglacial Shorelines (WALIS), we produced a standardized database of Last Interglacial (LIG) sea-level indicators in Southeast Asia. Following this work, we revisited a site in west Luzon, Philippines where inferred LIG coral reef terraces were previously reported. Previous studies mapped LIG to Holocene marine terraces along the western coast of Pangasinan, west Luzon Island. The highest terrace, with elevations ranging from 100-155 meters above mean sea level (m amsl), was inferred to correspond to the Marine Isotope Stage 5e (MIS 5e, LIG) about 125 ka. Rising to about 14 m amsl along the coast of western Pangasinan are previously dated Holocene marine terraces. In this work, we present new geomorphic and stratigraphic data on the fossil coral reef terraces in Pangasinan, west Luzon which adds to the limited LIG sea-level indicators in the region. We conducted Real-Time Kinematic Global Navigation Satellite System (RTK-GNSS) surveys along select areas in western Pangasinan to provide precise elevations and geographic locations of these fossil sea-level indicators. We also analyzed available Interferometric Synthetic Aperture Radar (IfSAR)-derived digital elevation models to map and delineate the elevation patterns of these raised coral reef terraces. Based on initial analysis, we identified distinct levels of coral reef terraces which may correspond to several episodes of RSL change from the late Quaternary to the present. Analysis of sea-level indicators is important in constraining both regional and global drivers of sea-level change. However, our work proves to be more challenging due to the difficulties of finding pristine dateable materials for radiometric dating and doing field surveys during a global pandemic. Nonetheless, we hope that data from this research will help us further understand the different drivers of past sea-level changes in SE Asia providing necessary geologic baseline data for projections of sea-level change in the future.

SPECIATION IN CARIBBEAN CORALS

Matías Gómez-Corrales[1]

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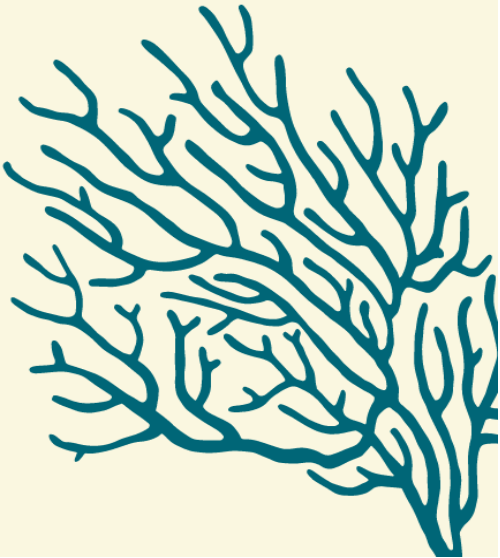
Coral reefs are the most biodiverse marine ecosystems, yet our understanding of how this diversity is generated is still superficial, especially for corals, the engineers of those ecosystems. To better understand the origin of species in Caribbean corals, we explored genomic and morphological variation in *Orbicella faveolata*, a major reef builder, across a depth cline (5-20 m) in Puerto Rico. Based on polyp density from 103 individuals and over 20,000 single nucleotide polymorphisms, we discover two genetically and morphologically divergent lineages that inhabit opposite depths of the depth cline, with a mixed zone of both forms around 11-14 meters. Using genomic data, we develop a model of the historical demography of these genetic lineages that suggest a recent divergence (~200 Ka), after which both shallow and deep lineages experienced population expansions. The changes in population size coincide with the increase in sea level between 0.75 and 0.45 Ma and the availability of shallow reef habitats across the basin. The period also overlaps with the extinction of the closely related species *O. nancyi* (the Orbicella organ-pipe) and the expansion of the shallow-water specialist *O. annularis*, indicating colonization of empty niches by these shallow-water specialists, including the *O. faveolata* shallow lineage uncovered in this study. Our work highlights the integration of increasingly available genomic data with paleontological information to better understand past changes in corals' population sizes and the origin of new lineages, which may allow us to have better predictive models of future reef ecosystems.

Meet the labs



PALEOBIOLOGY

GeoZentrum Nordbayern, FAU Erlangen-Nürnberg, Germany

Presented by: Wolfgang Kiessling
Contact: wolfgang.kiessling@fau.de
Theme: Reefs through time and space, Diversity Dynamics in Deep Time, Mass extinctions
Website: https://www.paleo-reefs.pal.uni-erlangen.de/

About

We look at ancient reefs with a data science lens. We host the Erlangen PaleoReefs Database and are one of the most active contributors to the Paleobiology Database. We also created the Ancient Reef Trait Database, where all sorts of traits of fossil reef corals and sponges are stored. Combining these databases with cutting-edge analytical methods (including machine learning) we are able to trace the evolution of reefs and reef builders in unprecedented detail.

Projects

- Projects in the planning phase - around the disparity between reef crises and biodiversity crises.

BIOSTRUCTURES AND BIOMINERALIZATION WORKING GROUP

Institute of Paleobiology, Polish Academy of Sciences, Poland

Presented by: Jarosław Stolarski
Contact: stolacy@twarda.pan.pl
Theme: Mechanisms of biomineralization, origin and evolution of Anthozoa
Website: Internal organization of the Institute is currently changing (thus no dedicated lab website which will be available next year). Website of the leader: http://biominerals.paleo.pan.pl/pracownicy/stolarski/jaroslaw_stolarski.html

About

The laboratory is focused on investigating biomineralization processes. In particular, we are interested in: (i) structural and biogeochemical features of biominerals, (ii) physiological and environmental factors affecting their formation, and (iii) their functional and phylogenetic significance. We conduct work on various groups of fossil and Recent organisms (e.g., corals, echinoderms) using modern analytical techniques (including experimental studies).

Projects

- Phase transformations of biogenic calcium carbonate in natural and experimental diagenetic systems: Implications for (paleo)environmental reconstructions and paleobiology.

AG BRACHERT

Leipzig University, Germany

Presented by: Katharina Methner
Contact: katharina.methner@uni-leipzig.de
Theme: (Eocene) reef corals, reef coral calcification, pedogenic carbonates, oxygen and carbon isotopes, XRD, X-radiography
Website: https://www.physgeo.uni-leipzig.de/institut-fuer-geophysik-und-geologie/forschung/geologie

About

The lab was established in 2008. MAT 253 + Kiel, XRD, X-radiography

Projects

- Reef coral calcification and climate dynamics during the Eocene greenhouse (EOCENE)
- Dual clumped isotopes (on pedogenic carbonates)
- Miocene climate change

NHM CORALS - REEFUGIA

University of Oxford / Natural History Museum, London

Presented by: Nadia Santodomingo
Contact: n.santodomingo@nhm.ac.uk
Theme: Coral Triangle, Cenozoic, systematics, biodiversity, turbid reefs, resilience
Website: https://tinyurl.com/3k6zvxv8 and https://tinyurl.com/palaeoxford

About

The NHM Corals team studies fossil corals to understand the effect of past environmental changes on the reef biota and help predict their response to ongoing and future changes. Our research stands on the enormous and valuable recent and fossil coral collections of the Natural History Museum, London (UK), which include type specimens from early expeditions to the Great Barrier Reef, Red Sea, and The Challenger, and fossil coral collections by Milne Edwards & Haime (UK), Duncan (Tertiary of West Indies and UK post-Palaeozoic), Gregory (Jurassic of India) and Stanley Smith (UK Palaeozoic). New collections gathered since 2010 comprise more than 70,000 specimens from the Cenozoic of the Coral Triangle. The NHM also counts on cutting-edge genomics labs and imaging facilities (SEM, CT-Scanning).
Our team was pioneered by Brian Rosen (Emeritus Researcher, still active), who joined the NHM in 1972, and Jill Darrell, Coral Curator (Palaeontology). The @NHM_Corals team is currently led by Ken Johnson (Senior Researcher) and Nadia Santodomingo (Scientific Associate), who recently joined the University of Oxford as a Lecturer in Palaeontology.
Although the NHM is not an academic institution per se, we closely collaborate with universities in the UK and other universities around the world to support the careers of undergraduate, master, doctoral and postdoctoral researchers. We are always keen to get in touch with motivated and talented students. Feel free to contact us:
Ken Johnson k.johnson@nhm.ac.uk
Nadia Santodomingo n.santodomingo@nhm.ac.uk

Projects

- Short master projects on coral taxonomy (morphology and genetics), sclerochronology, and reef (palaeo)ecology

PALEOBIOLOGY AND PALEOENVIRONMENTS OF CENOZOIC MARINE TROPICAL ECOSYSTEMS

Dipartimento di Scienze Chimiche e Geologiche, Università di Modena e Reggio Emilia, Italy

Presented by: Francesca Bosellini
Contact: francesca.bosellini@unimore.it
Theme: Paleobiology, Paleoecology, Corals, Foraminifera, coral reefs, Cenozoic, Mediterranean
Website: https://www.dscg.unimore.it/site/en/home/research/research-in-geology/paleontology-and-paleoecology.html

About

Our research targets evolution of tropical shallow-water marine calcifiers during the Cenozoic. We focus on biodiversity patterns and the response of marine organisms to past major Earth System changes and use ancient analogues aiming to contribute to the understanding of the future effects of global change on tropical marine ecosystems.

Projects

- None at the moment

PALÉO-ENVIRONNEMENTS ET PALÉO-OCÉANS (PALÉO)

Université Toulouse 3 Paul Sabatier, France

Presented by: Markus Aretz
Contact: markus.aretz@get.omp.eu
Theme: paleoenvironments, paléoecology, palaeodiversity, palaeogeography, stratigraphy, corals, echinoderms, cephalopods, carbonates, reefs, Palaeozoic, Mesozoic, Cenozoic, biomineralisation
Website: https://www.get.omp.eu/loa/accueil/themes-de-recherche/paleos/

About

Our research targets evolution of tropical shallow-water marine calcifiers during the Cenozoic. We focus on biodiversity patterns and the response of marine organisms to past major Earth System changes and use ancient analogues aiming to contribute to the understanding of the future effects of global change on tropical marine ecosystems.

Projects

- None at the moment, but just contact the group members and see what possibilities exist or can be developed.