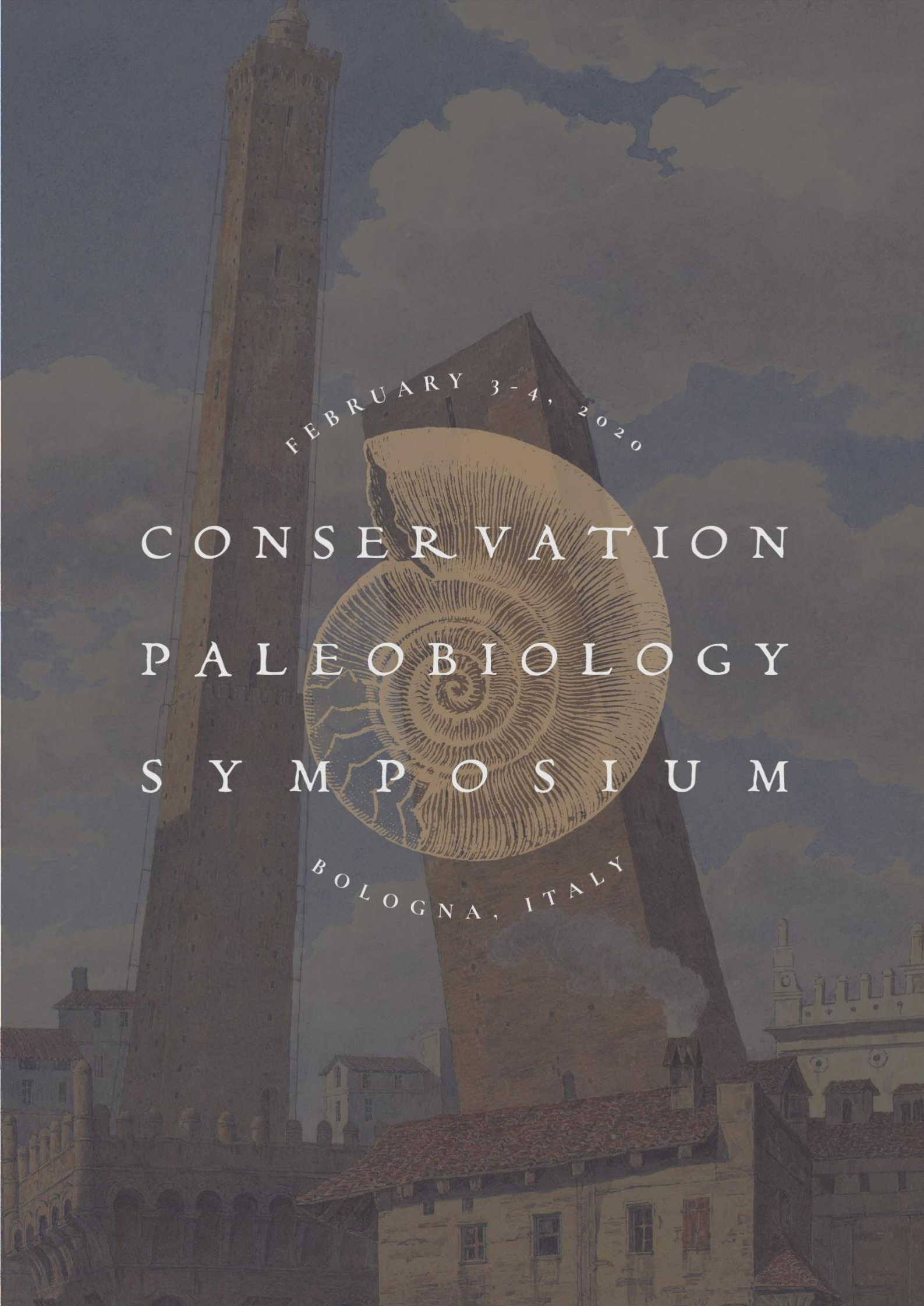
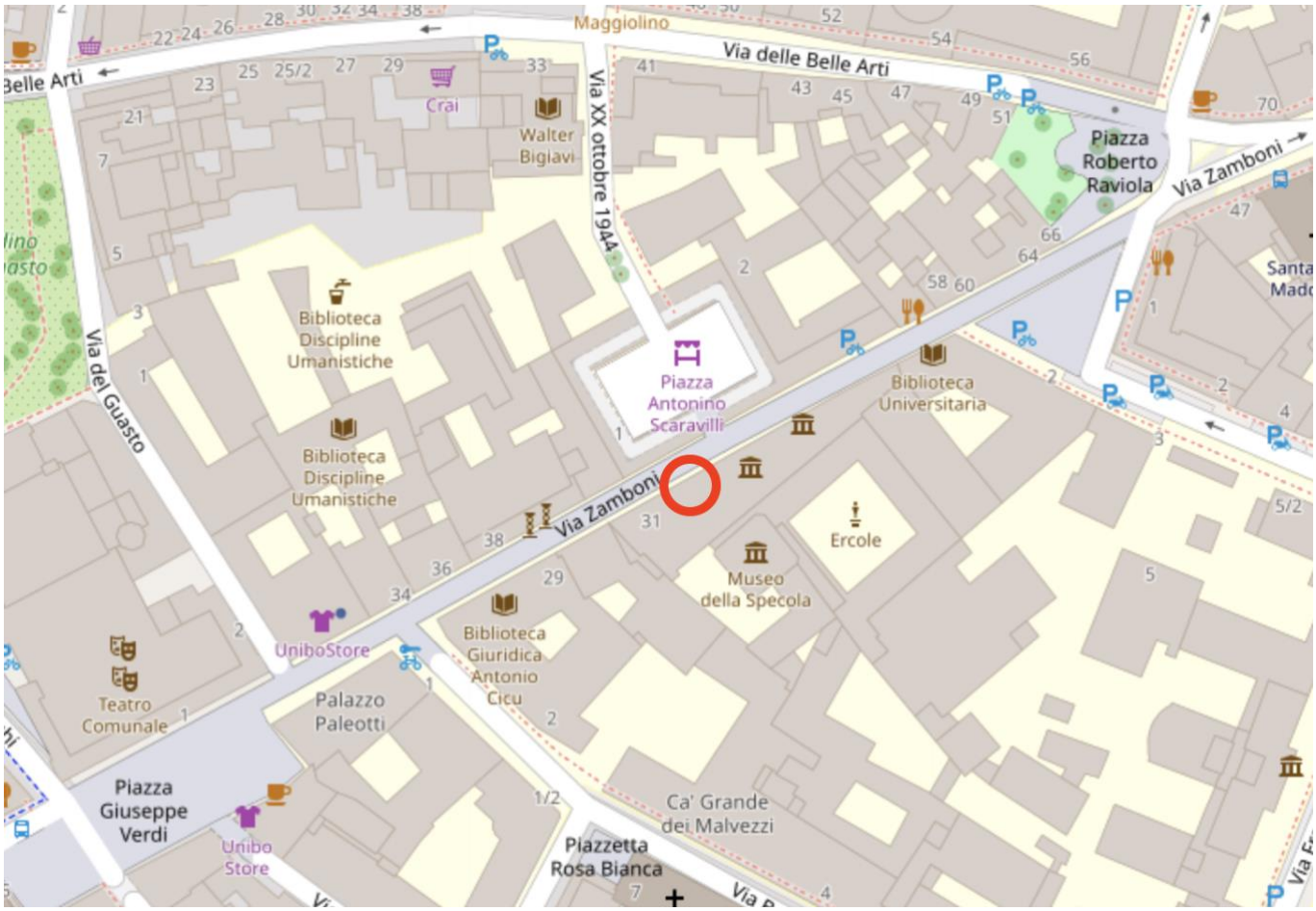

FEBRUARY 3-4, 2020
CONSERVATION
PALEOBIOLOGY
SYMPOSIUM
BOLOGNA, ITALY

Contents

General Information

Venue location

The venue of the symposium will be the **Academy of Sciences of Bologna.**



The address of the venue is: Via Zamboni, 31, 40126 Bologna, Italy (In the *Palazzo Poggi*). The Google map location is: https://goo.gl/maps/6QdUxpdYPawPh3sR6

There will be a person attending the door at all times during the symposium. If you find the door closed, ring the bell and someone will open it. We are grateful to the volunteer students from the University of Bologna who will staff the door.

Social media

Please tweet about the symposium and presentations using the hashtag **#PaleoBo**. If you prefer to keep your presentation out of social media, please ensure you mention this at the beginning of your talk.

Tourist information

You can find a lot of information at www.bolognawelcome.com. The tourist office is in Piazza Maggiore. They can provide maps and other information in English. They organize a daily guided tour in English from 10:30 to 12:30. 15 euro per person.

Some of Bologna's secrets

La Dotta, La Grassa, la Rossa.
Bologna is called *La Dotta, La Grassa, la Rossa*; The Learned one [owing to the oldest university in the world and rich scholarly history], The fat one [for its delicious food], The red one [owing to its left-leaning political soul]. This is no secret but on a table of the University of Bologna headquarters in the Palazzo Poggi (next to the symposium venue), there is the inscription: *Panum resis*: Knowledge is the basis of all decisions.

Little Venice Little Venice
There are many medieval canals under Bologna, now covered. In a small window on the street one can open a little door in a window and see one of these canals. It is near the *Gatto Nero* (Trattoria dal Biassanot), which is also one of my favourite restaurants.

The three arrows
There are three arrows stuck on the ceiling of the portico In Strada Maggiore, just at the Entrance of Corte Isolani. Legend tells of three robbers, intent on killing a "noble man", but were distracted by a beautiful girl at a window and misfired hitting the wooden ceiling of the portico.

The four whispering corners
The columns of the Palazzo del Podestà vault allows you to whisper secrets across the arch. Apparently devised in medieval times "to confess lepers", whatever that means.

Hemp
Panis vita, Canabis protectio, Vinum laetitia (Bread is life, cannabis is protection, wine is joy) is inscribed under three arcades of the portico at the beginning of Via *Indipendenza* (on the right side with your back to Piazza Maggiore). A nod to the economic advantages that the city has historically obtained from the cultivation of hemp.

Neptune's finger
Look for the dark tile on the floor to get the view that the artist, Giambologna, wanted you to fully appreciate Neptune. Incidentally, The four dolphins on the statue represent the major rivers known in the world at the time (1565) - Ganges, Nile, Amazon River, Danube.

Pre-symposium informal gathering

On Sunday 2nd February, some of the organisers will be at the **Mercato di Mezzo** (Via Clavature, 12, 40124 Click here for map) at around 6pm for pre-symposium aperitifs. If you are in town, you are welcome to join us. Each person will handle their own bills.

Tours

We have arranged two tours for attendees. The first tour is to the Specola Museum of Astronomy on Monday 3rd. It will start from the venue around 5.15pm and will finish before 7.00pm. It will be led by Prof. Bruno Marano and is limited to a maximum of 15 people. The second tour is to the The Geological and Paleontological Museum "Giovanni Capellini". It will be led by Prof. Giambattista Vai. It will be one hour long, and begin at 10am on Wednesday 4th February starting at the museum in via Zamboni 63. Space is limited to 20 people. We thank both Profs. Bruno Marano and Giambattista Vai for very kindly offering these tours. Tickets to both tours will be allocated on a first-come first-served basis. To reserve your spot, sign up using this form: https://forms.gle/TFbZ7bcZv8NEvvrBA

Contact

If you need assistance contact me (Aaron) on my Italy phone (+39 3480531747) or whatsapp (+507 68727486), or contact Daniele (+39 339 233 6867). aaronodea@gmail.com, daniele.scarponi@unibo.it

Organisers

Aaron O'Dea, Daniele Scarponi, Paolo Albano, Laura Airoldi

Special thanks

Alessandro Cheli, Brigida de Gracia, Bruno Marano, Chiara Vallese, Costantino Zuccari, Erin Dillon, Federica Costantini, Gian Battista Vai, Giulia Tartaglia, Jessica Lueders-Dumont, Jonathan Cybulski, Jorge Morales, Kate Hibbs, Lisa Carrera, Luna Girolamini, Martin Zuschin, Marissa Batista, Matt Larsen, Massimo Zini, Max Titcomb, Michaela Berensmeier, Michal Kowalewski, Michele Azzarone, Miriam Greaves, Nadia Santodomingo, Niklas Hohmann, Pierpaolo Ciuffi, Piero Zannini, Rachel Burgess, Rafal Nawrot, Sara Meschiari, Sharon Pittau, Silvana Pacifico, Simone Toller, Thomas Gusmeo. All the children at the International School of Bologna.

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA
DIPARTIMENTO DI SCIENZE BIOLOGICHE
GEOLOGICHE E AMBIENTALI

Smithsonian Tropical Research Institute

Abstracts

Plenary: Modified urban waterfronts: learning from the past (mistakes) to build a “bluer” future

Laura Airoldi

Human populations, ocean uses and economic activity in coastal seas are rising rapidly and so is the human footprint on the global ocean. Estimates suggest that today 60% of the world’s major marine ecosystems have been degraded or are being used unsustainably, with loss of environmental quality, vital ecosystem services and livelihood. Urbanisation is spreading to offshore areas and non-urban coasts at an incredibly fast rate, and the current and future challenges faced by increasingly urban oceans, exacerbated by acute climate change impacts, are diverse and substantial. To answer these challenges we need to build a greater knowledge base, think across disciplines, break down traditional barriers across sectors, and communicating a wider awareness of the seas to the general public. Despite their human dominated nature, marine urban systems can still support a variety of communities and ecosystem services, provided developments are planned, designed and implemented in ecologically meaningful ways. There is also growing evidence that by supporting ecosystem resilience and services, marine protection can go hand in hand with social equity and economic viability. I will introduce a conceptual framework for designing marine developments that meet multifaceted socio-ecological goals, and will offer examples of “nature-based” approaches that could provide better outcomes in terms of spatial quality, biodiversity values, sustainability of natural resources, ecosystem functioning, socio-ecological resilience and eventually human wellbeing. I will also explore the scientific challenges to biodiversity optimization constrained by human use and engineering limitations, and highlight research gaps to increase the short-and long-term success of conservation and rehabilitation efforts in the urban ocean.

Ancient mtDNA suggests population dynamics of wild wolves in the Italian peninsula

Paolo Abondio, Marta Maria Ciucani, Kyriaki Koupadi, Davide Palumbo, Marco Galaverni, Patrizia Serventi, Elena Fabbri, Gloria Ravegnini, Sabrina Angelini, Elena Maini, Davide Persico, Romolo Caniglia and Elisabetta Cilli*

The gray wolf (*Canis lupus*) is a widespread large carnivore of the Northern hemisphere. Even though the species is now protected by law in many countries, its numbers are still relatively low and its survival has been endangered by human activities in the past. It's very high mobility allows for gene flow among contiguous populations even when they are significantly differentiated, due to habitat and prey specialization. In particular, the Italian gray wolf (*Canis lupus italicus*) represents a genetically unique case, as its population falls exclusively in the mitochondrial haplogroup 2. However, recent complex demographic changes lead to a drastic reduction in the number of animals, both locally and the world over. This makes its phylogeographic history difficult to understand from modern specimens only and the reason of the distinctiveness of the Italian wolf is still matter of debate. In order to disentangle the population dynamics of the Italian gray wolf, 19 samples from Northern Italy, ranging from the Last Glacial Maximum to the Middle Ages, were analyzed for a portion of the hypervariable region 1 of the mtDNA, which is informative for canid phylogenetics. After haplotype reconstruction, a phylogeny of the viable samples was built using worldwide ancient wolf and dog haplotypes, as well as the contemporary Italian wolf. The study found a match with ancient wolf mtDNA from northeastern Europe and to contemporary Italian wolf haplotypes. The Pleistocene samples matched with dog sequences representative of mtDNA clade A. A Holocene sample was instead related to haplogroup 1. This study clarifies the origin and past genetic variability of the Italian wolf population. It also allows to infer the patterns of gene flow across past and modern Eurasian wolf populations, as well as with modern Italian wolves. In particular, it highlights a strong decrease in genetic variability of the Italian wolf, since the Last Glacial Maximum until today.

Shells from the shoreline - a new perspective on changing Lake Tanganyika

Jonathan Todd, Ellinor Michel*

Lake Tanganyika is the second oldest and deepest lake on Earth, containing 18% of the world's unfrozen fresh water. Its hyperdiverse, largely endemic fauna (fish, molluscs, crustaceans etc.) is largely confined to the extremely narrow, bath-tub rim of this steep-sided, ancient rift lake. Here, diverse benthic faunas adapted to clear waters are under increasing threat from increased anthropogenic sedimentation from the land, and rising anoxic waters from the depths. In the pelagic zone, a critical artisanal fishery is declining. Short sediment cores from the lake reveal profound environmental and microfaunal changes to have occurred over the past century on local and regional scales. Around this highstand rift lake sedimentary outcrops are too limited to establish the response of the endemic macrofauna to environmental change. An unexpected source of data is available. Around the lake large numbers of long-dead, reworked mollusc shells can be collected by SCUBA from the lake bottom and beaches with calibrated C14 dates as old as 3000 years. Recent taxonomic work combined with extensive collecting has elucidated the taxonomy and distribution of abundant and species-rich snail clades, with many highly localized taxa as well as species-poor widespread taxa. A common mismatch in live-dead occurrences attests to geographic range contractions and extinctions in the past few centuries. A major scientific drilling project is being developed which will provide views on the dynamism of this system before human impacts. Cores of several 100,000-millions of years are expected. Our emerging view is of a taxonomically richer, more dynamic and volatile molluscan fauna than previously suspected and one in which both short-ranged and widespread species are under increasing extinction threat.

The Shell Beds of Lake Tanganyika: Palaeoecology, Environmental Change and Living Systems

Ellinor Michel, Jonathan Todd, Michael Soreghan*

Shell beds are full-circle, biologically generated habitats for living organisms and key windows on past environments in fossil outcrops and cores. Lake Tanganyika (LT), Africa, has huge carpets of shell beds; up to 30% of shallow soft substrate consists of densely packed shelly substrates dominated by dead shells of a single gastropod species (*Neothauma tanganyicense*). Like other biogenic habitats such as reefs, LT shell beds host a rich, endemic fauna of sponges, fish, molluscs, crabs and other organisms. Some of these appear not only to be specialised on this unique substrate, but to have speciated in situ. We are assessing this geologic-biologic system to determine how origin and persistence of the shell beds relates to population and evolutionary history of shell bed organisms and to ecosystem structure. Our multi-disciplinary project includes a range of approaches, from genetics of *Neothauma* to structural and sedimentological geology of the depositional systems. COI sequences reveal significant population structuring among living *Neothauma*, implying restricted gene flow even in this ubiquitous species. Understanding the mechanism of formation and age of these shell beds is critical for a range of issues from rates of divergence to interpretations of paleoclimates. These shell beds are impacted by increasing rates of sedimentation caused by anthropogenic land-use changes. Preliminary data indicate that modern sediment blankets on the shell beds are thick and extensive enough to 1) preclude sponge growth, 2) remove cryptic habitats and 3) fragment these ecosystems into isolated patches.

Massive extirpation of native species from the Israeli Mediterranean shelf

Paolo G. Albano, Jan Steger, Marija Bošnjak, Beata Dunne, Zara Guifarro, Elina Turapova, Bella S. Galil, Gil Rilov, Martin Zuschin

We quantify a large-scale extirpation of native species from the Israeli Mediterranean shelf, a region strongly affected by rapidly changing environmental conditions and the introduction of non-indigenous species, based on an extensive sampling programme of mollusks on intertidal to subtidal soft and hard substrata. We reconstruct historical species richness from shelly death assemblages, quantify the time range they cover with radiocarbon dating, and compare their richness with today's living assemblage diversity. The median native richness is 50% of the historical richness for the intertidal, but only 8% for the subtidal down to 40 m. Samples from the mesophotic zone show a much higher median of 42%, which is likely an underestimation due to sampling constraints. In contrast, non-indigenous species show assemblages matching the historical richness. Additionally, a comparison between today's and historical native species maximum size shows that shallow subtidal native populations are mostly non-reproductive. In contrast, non-indigenous populations reach reproductive size. These results suggest that a recent large-scale change in environmental conditions is strongly favoring non-indigenous species and is the main cause behind the shallow subtidal native species decline.

Southern sounds: tracking Conservation Paleobiology perspectives in the South American continent

Matias do Nascimento Ritter, Fernando Erthal, Sabrina Coelho Rodrigues and Marcello Guimarães Simões*

The recent advances in Conservation Paleobiology goes back to multiples origins, but all appear to be related to the development of Actualistic Taphonomy. The fact that the most dead-fossil remains are time-averaged indicates that the record of non-contemporaneous remains is useful to access information prior to the human footprint, the so-called pristine environments. The use of the fossil record as a biased library (parallel to History, where words used to be spread out by winners: preservable taxa) has improved our perspective of how we can approach modern environmental issues despite our own atavism. In this context, a few South American paleontologists have historically pioneered on those baselines studies, initially carried out mostly on São Paulo Bight, southeastern Brazil: firstly with brachiopod and bivalve time-averaging estimates, having the living brachiopod *Bouchardia rosea* as a flag-species in Conservation Paleobiology, given the low dead-live fidelities of these brachiopod-bearing accumulations, and the discoveries of noncommon biologic interactions, as parasites, algae symbiosis and predator-prey interactions. These all have built a robust base that fosters us to look now for the future: how should we collaborate from now on? That is the purpose of this short communication. A new generation of South American taphonomists has emerged in this scenario. The nowadays sounds that we wish to spread out from the south are likely to be so strong as those baselines' studies, but now concentrating our efforts on Conservation Paleobiology.

Plenary: The application of deep-time palaeontological data to conservation

Erin Saupe

Palaeontology has long aimed to contribute to the understanding and forecasting of climate change impacts, and to provide baselines from ecosystems undisturbed by anthropogenic influence. I will analyse which of priority questions in conservation may be answerable using palaeontological data. Specifically, I will focus on whether deep-time paleontological data (pre-Quaternary) are relevant to conservation, with reference to case studies from my own work—both past and ongoing.

Molecules meet fossils – revealing diversification dynamics in Bryozoa

Helen L Jenkins, Farideh Moharrek, Paul D Taylor, Dennis P Gordon, Mary Spencer Jones, Andrea C Hall, Emanuela Di Martino, Daniele Silvestro, Natalie Cooper, Piotr Kukliński, Leandro M Vieira, Ana C Almeida, Joanne S Porter, Björn Berning, Wayne Florence, Heather Grant, Abigail M Smith, Andrey N Ostrovsky, Javier Souto Derungs, Malgorzata Krzemińska, Jean-Georges Harmelin, Philip Bock, Aaron O'Dea, Eckart Håkansson, Olga N Kotenko, Russell S Orr, Andrea Waeschenbach

Recently developed methods allow for the simultaneous analysis of molecules and the fossil record to uncover the patterns and processes of diversification through time and space. As yet however, there have been few studies that apply these approaches to invertebrates in marine environments. Cheilostome bryozoans, with their rich fossil record, provide an opportunity to fill this gap and to study diversity dynamics in the marine realm over the last 160 million years. Central to our analyses is a time-calibrated phylogeny of extant and extinct cheilostome taxa, which is generated through the combined analysis of a novel genome-skimming dataset (mitogenomes and ribosomal operons) and a morphological character matrix of extant and fossil species. We use this phylogeny as a framework to reveal rates of speciation and extinction through time. The inferred fluctuations will be explored in light of palaeoenvironmental conditions, the origin(s) of morphological and functional traits and increased competition through the cumulative filling of ecological niches through time. By examining the interplay between abiotic and biotic factors, we aim to assess their relative contribution to driving past changes in marine biodiversity. We hope these insights may provide a context to the threats faced by marine biota in a future ocean.

Drivers of paleodiversity fluctuations in Bryozoa

Farideh Moharrek, Paul D Taylor, Helen L Jenkins, Dennis P Gordon, Daniele Silvestro and Andrea Waeschenbach*

The extensive evolutionary history of the phylum Bryozoa provides a wealth of fossil data for modelling biotic and environmental drivers of diversification. However, despite their well-studied and extensive fossil record, bryozoan fossil occurrence data are poorly represented in the main public fossil repository, Paleobiology Database (PBDB), which has led to the development of machine learning methods to text mine bibliographic collections for fossil occurrence data. Here, we apply a Bayesian framework to estimate origination, extinction, and preservation rates over the past 160 million years of the currently most diverse bryozoan clade, the order Cheilostomata. Our genus-level analyses explore data from a) published text-mined ranges1, b) manually curated ranges, and c) PBDB occurrence records. We also used a Bayesian model to simultaneously estimate correlations between diversification dynamics and multiple environmental trajectories and diversity dependency. Our analyses indicate that cheilostome diversification is characterized by several shifts in origination and extinction rates, often matching the most important geological boundaries. These findings show that mass extinctions affect the diversification of cheilostomes genera by altering both the extinction and origination regimes. Our findings also confirm that origination and extinction rates are governed by fundamentally different processes and highlight the effect of past climatic changes on the diversification of cheilostome bryozoans, thereby providing a window into future diversification dynamics in a rapidly changing ocean.

Extracting Ancient Environmental DNA (aeDNA) from Hong Kong Coral Sediment Cores

Alison Corley, David Baker, Jonathan Cybulski, Shelby McIlroy*

Historical reconstructions of past coral reefs inform our understanding of the impacts of environmental stressors over extended timescales. Chronologies based on taxonomic identification of subfossils in reef-matrix cores have a limited scope, as they can only analyse organisms capable of long-term preservation – rendering inaccessible questions surrounding soft-bodied animals, algae, plants, bacteria, and fungi that play critical ecological roles. Integration of metabarcoding of ancient environmental DNA (aeDNA) preserved in the sediment record has emerged as a tool that can detect changes in the presence of these elusive taxa, enhancing our interpretation of a range of past ecosystems. However, these approaches can be challenging, given that aeDNA is generally highly degraded and found in low concentrations – even more so in warm, turbid coral reef environments where forces acting against long-term DNA preservation are pronounced. Even so, Gomez Cabrera et al. (2019) successfully employed high-throughput sequencing of the 18S rDNA gene of DNA extracted from archival cores from the Great Barrier Reef to reconstruct 750 years of concurrent change in the eukaryotic aeDNA communities and coral clasts. Using cores and surface sediments collected within coral communities in Hong Kong, we aim to build on applications of modern molecular technologies for aeDNA by (1) testing the efficacy of using a range of universal primers (COI mtDNA, 18S rDNA, 16S rDNA) for amplifying different taxa to increase detection of community diversity and (2) specifically targeting and identifying changes in corals' algal symbionts with Symbiodiniaceae-specific primers (ITS2). Here, I present our preliminary protocol development and the outcome of initial aeDNA extractions from pilot cores. We expect that aeDNA sequence data from sediment cores throughout Hong Kong will provide insight and further context for local coral community turnover reported in the last century.

Investigating Heracles' myth of the Lernaean Hydra

Danae Thivaiou, Efterpi Koskeridou, Christos Psarras, Konstantina Michalopoulou, Niki Evelpidou, Giannis Saitis, George Lyras

Interventions of human interaction with the natural environment are recorded in ancient Greek mythology. One such instance is the myth of Hercules and the Lernaean Hydra, where the hero had to fight a nine-headed beast. This corresponds to the effort of people living in the area of present-day Lerni (eastern Peloponnese, Greece) who tried to tame the waters of a karstic system multiple times in order to avoid floods and the propagation of diseases. In the present work, a core from the area of the mythical lake is studied. This area, now dried and cultivated, is part of a karstic system and constituted a marshland. A sedimentological analysis was carried out and the assemblages of molluscs were investigated. Dating of the core was done by dating levels of peat using the radiocarbon method. Most of the sediments are clays varying between dark grey and greenish-grey colours, whereas there are only few layers of gravel, which suggests the absence of fluvial influence. An alternation of dryer and wetter periods is observed, with the presence of multiple layers of peat. The dry periods are believed to be the result of human interventions that were recorded in the myth of Hercules. Freshwater molluscs are present, the most abundant belonging to Planorbidae.

Influence of surface ocean density on plankton calcification

Stergios Zarkogiannis, Assimina Antonarakou, George Kontakiotis, Graham Mortyn, Aradhna Tripati, Mervyn Greaves*

My research focuses on planktonic foraminifera shell mass variations and their role in the global carbonate budget and the carbon cycle. Planktonic foraminifera are marine (passively floating) unicellular protozoa and their numerous skeletal remains comprise statistically important (paleo)climatic signal carriers. It has been observed that these organisms produce heavier shells during glacial periods and lighter masses during interglacials. The cause of this behavior is still unknown and different hypotheses have been proposed to explain it, but with limited success. My results suggest that it is mostly ocean density that is responsible for the observed changes in foraminifera shell weight, thus playing a great role pelagic calcification calcification. During cold climatic periods calcifying plankton, floating passively in seawater, would need to increase its shell mass in order to counteract the increased buoyancy force exerted on it by a denser glacial ocean, and remain at optimum living depth. This mechanism has the potential to explain on a global scale the consistent records of carbonate maxima and minima in pelagic sediment cores from the world oceans, which are indicators of glacial and interglacial climatic fluctuations accordingly. Furthermore, during interglacials, when waters are fresher and lower in density, there organisms would need to precipitate lighter shells than during glacials in order to maintain their optimal habitat depth. Such abiotically-driven reduction in planktonic calcification will decrease the [CO2] in seawater, as a by-product of intracellular calcite formation and increase its alkalinity, thereby providing a mechanism for the ocean to counterbalance anthropogenic atmospheric pCO2 increase. Additionally, planktonic foraminifera shell weight may serve as past seawater density proxy. Thus foraminifera weighing may provide a robust glimpse to oceanic paleocirculation and thus paleoclimatic reconstructions.

Network Paleobiology: Understanding the spatiotemporal dynamics of the Earth-Life System

Alexis Rojas

The biosedimentary record reveals the complex interactions between plate tectonics, climate, and the evolution of life. Understanding the spatiotemporal dynamics of such an Earth-Life System is being transformed by the integration of geohistorical data into a quantitative framework based on network theory. This so-called network analysis is an increasingly popular alternative to classic multivariate procedures used in paleobiology because it can handle spatial, temporal, environmental, biological and other information retrieved from geohistorical archives, providing an integrative approach for macroecological and macroevolutionary research. As might be expected of an emergent interdisciplinary field, methodological inconsistencies and conceptual issues in the large body of network paleobiology studies as well as rapid development of the network theory make it difficult to compare outcomes across studies and limit applications of networks into paleobiology. Here we describe the underlying concepts and address various practical aspects of the network analysis that paleobiologists are likely to face when designing network-based representations of natural phenomena, including network construction, clustering, robustness assessments, and visualization. We illustrate the Network Paleobiology framework through case studies of biostratigraphy, evolutionary biogeography, and biotic transitions. We focus on a network framework to analyze multilayer relationships in which layers represent a series of time intervals in Earth's history and capture spatiotemporal aspects of the biosedimentary record. This multilayer network approach allows integration of ecological, genealogical, biogeographic, and other macroevolutionary units into a hierarchical framework, fundamentally transforming our view of paleobiology.

Thirty-million years of turbid reefs in the Coral Triangle

Nadia Santodomingo, Zarinah Waheed, Ali bin Syed Hussein, Allia Rosedy, Chris Perry, Sindia Sosdian, Brian Rosen, and Kenneth Johnson*

The Coral Triangle (CT) region contains the most diverse marine ecosystems on Earth. This high biodiversity is at risk due to anthropogenic impacts, and thus identification of potential ecological refugia is a high priority. Recent work suggests that shallow turbid mesophotic habitats may play this critical function. Our palaeoecological studies in the CT (East Borneo) have shown that the first coral assemblages in this region (~30 Ma) were mainly low-relief patch reefs that developed under low light and high sediment inputs – conditions that mitigate thermal stress on corals. These shallow turbid habitats hosted a high coral diversity with 100 morphospecies (55 genera) in the Oligocene and 234 morphospecies (79 genera) in the Miocene. Faunal turnover at generic level has not been significant with 85% of extant genera already present in the early Miocene, suggesting that once taxa appear, they can persist over a long time. To test the hypothesis of turbid habitats as reef refugia that emerged from our fossil evidence and to better understand the role of light and sediments in the resilience of these habitats, we surveyed a mosaic of turbid reefs in Darvel Bay (Sabah). Detailed light profiles and sediment accumulation rates are being used to characterise the different sources of turbidity: urban, mangroves, coastal runoff, and river inputs. Coral cover and diversity have been estimated from video transects and over 200 coral samples. Preliminary comparisons of ancient and modern turbid reefs show similarities in richness and fauna composition. Live coral cover varies from 33% in the most turbid locality to 48% in the least turbid locality. Through the combination of fossil and modern data, we have strong evidence that turbid reefs have played an important role during the origins and maintenance of coral diversity in the CT. Moreover, the high live coral cover and diversity of modern turbid reefs suggest that these habitats may act as crucial ecological refugia.

Beware of zombivalves! Shell exhumation, diachronous production and stratigraphic disorder in the post-glacial fossil assemblages on the northern Adriatic shelf

Rafał Nawrot, Daniele Scarponi, Adam Tomašových and Michał Kowalewski*

Reconstructions of long-term history of anthropogenic impacts and baseline communities based on marine sedimentary archives requires proper understanding of their temporal resolution. We examined variation in median age and scale of time-averaging among four bivalves species collected from a 2.3-meter-long core recording the post-glacial transgression on the northern Adriatic shelf. Within 5-cm-thick core intervals, time-averaging within species varied between ~200 and 7,400 yrs, while the differences between their median ages ranged between ~2 and 6,400 yrs. Moreover, although the median ages of *Varicorbula*, *Timoclea* and *Parvicardium* increased with increasing burial depth, shells of *Lentidium* appeared age-homogeneous throughout the core. Age unmixing revealed a single massive peaks in the abundance of this shoreface species around 14 cal ka BP, coincident with the initial marine flooding of this shelf area. Reconstructed onsets and durations of shell production across the four species can be directly linked to their bathymetric preferences and the relative sea-level history at the site. The diachronous production histories and subsequent exhumation of old shells through bioturbation and sediment reworking resulted in the the top 40 cm of the seabed containing ecologically mixed fossil assemblages characterized by multi-modal age distribution and millennial-scale age offsets between co-occurring species. These results suggest caution when using estimates of time-averaging based on a single species as a proxy for the temporal resolution of the total fossil assemblage. Moreover, species identity and ecology should be considered when determining the geochronological framework of sedimentary successions based on radiocarbon dating of shells. On the other hand, our results demonstrate that fossil assemblages from transgressive deposits preserved on continental shelves offer an underutilized source of data on population responses to past episodes of rapid sea-level rise.

Assessing Data Quality in Conservation Paleobiology: Common Trends and Suggestions for the Future

Kimberly Cook, Robert Montoya*

The variety of sources from which conservation paleobiologists derive their data is both a blessing and a curse. Currently, the data are largely proprietary, strongly domain-specific, or curated by individual researchers. While some decentralized data sources exist, this does not mean that the publication, published data, and its sources are related to one another in a meaningful, discoverable way. There is a need to assess the current infrastructure available to support interactions between paleontological and neontological data in order to develop best practices in data quality assurance. This can be done through interviews with conservation paleobiology practitioners and contextualizing the results of those interviews within the domain's main research areas: abiotic interactions (e.g. climate and environment), biotic interactions (i.e. with other species and conspecifics), dispersal, trait evolution, speciation, and extinction (from Fritz et al. 2013). This presentation will outline current data quality within the conservation paleobiology community and provide suggestions from an information science perspective.

Resilience of nearshore communities to natural climate change in the northern Adriatic

Daniele Scarponi, Michele Azzarone, Rafał Nawrot, Aaron O'Dea, Michał Kowalewski*

Consequences of climate change on marine ecosystems are hard to predict, especially for ecological communities whose ability to migrate is limited (e.g., due to enclosure in restricted seaways). We analyzed late Quaternary assemblages of mollusks preserved in nearshore sedimentary successions of the Adriatic Basin to explore how coastal marine benthic communities responded to natural climate change in the past. We focus on three time periods (1) the last interglacial (<125ka BP), when regional temperatures were 0.5 to 1.3 °C higher than today (representing a possible future analogue), (2) the last late glacial 14.5-18.0 ka BP, and (3) the mid-Holocene 6.0-1.0 ka BP, when conditions were similar to today but with minimal human impact. We used data on abundance of mollusk fossil samples to assess structure and dynamics of benthic communities using multivariate and resampling approaches. We found that from the last interglacial to the glacial period, benthic communities underwent a dramatic compositional reshuffling, characterized by a reduction in abundance of exclusively Mediterranean species and an increase in cosmopolitan species and those with boreal affinities consistent with biogeographic shifts driven by cooling. When the northern Adriatic returned to warmer conditions in the mid-Holocene, nearshore communities were indistinguishable in structure to their previous interglacial states. This implies that in the face of extreme changes in temperature, nearshore communities are remarkably resilient (rather than persistent or stochastic). In conclusion, our historical results suggest that if local and regional threats could be controlled, coastal marine communities of the northern Adriatic should respond resiliently to future climate change.

Coral growth and bioerosion on ancient and modern turbid-water reefs in the Coral Triangle: How well do these potential reef refugia function?

Kenneth G. Johnson and Nadia Santodomingo*

The Coral Triangle region of Southeast Asia hosts the highest marine diversity on Earth, yet the drivers responsible for the origins and maintenance of this global biodiversity hotspot are not fully understood. Recent studies of exceptionally preserved Miocene and Pliocene fossil assemblages from Indonesia and Malaysia suggest that much of the diversity is found in turbid water settings and that these so-called “marginal” habitats might be acting as cradles and refugia for reef biota during times of past environmental change. Ongoing work is showing that turbid water reefs can host highly diverse biota, but are the corals able to maintain carbonate budgets to allow significant reef building? In this study, we analysed coral growth and bioerosion rates using micro computed tomography of fossil and modern colonies from turbid and clear-water settings. The resulting data were compared with published growth rate data accessed on coraltraits.org. Overall, there is no significant difference in growth rates between colonies living in different habitats. For bioerosion, the abundance and distribution of common ichnotaxa within the colonies was also not significantly different between turbid and clear-water settings. These results suggest that coral communities living in turbid-water settings can deliver positive carbonate budgets required to build and maintain reef structure and provide one of the key ecosystem functions of coral reefs. These new data add to the increasing evidence that turbid reefs have played a significant role as ecological refugia since the Miocene and these habitats are home to important communities that will allow coral reefs and their diverse biota to persist during ongoing rapid anthropogenic climate change.

Plenary: Is conservation paleobiology useful?

Jeremy B.C. Jackson

Paleobiological and historical data provide definitive evidence for the timing and extent of past natural and human environmental perturbations and their consequent impacts on ecosystems. Such insights have also provided a much needed correction to many ecologists' misguided notions of what is 'pristine' or 'natural' based only upon recent information. But beyond greater refinements to this ever expanding obituary for nature, it remains unclear how paleobiology might contribute to achieving concrete conservation targets. Humans now dominate all of Earth's ecosystems, including massive disruptions of biogeochemical cycles, climate change, transformations of land- and seascapes, and cascading losses of biodiversity. We live in a post-natural world in which, barring our own extinction, the rules of ecology and evolution will never be the same. Nevertheless, paleobiologists are increasingly good forensic ecologists. Critical analysis of past ecological crises can help us to identify characteristics of species and assemblages (life histories, diets, habitats, and biological interactions) that conferred greater resilience to historical perturbations or favored their subsequent establishment and persistence. Such insights could in turn contribute guidelines for the functional restoration of novel Anthropocene ecosystems.

Using the paleontological record to demonstrate the importance of conserving for change

Jenny McGuire

To establish the most effective conservation strategies, we must understand the ecological dynamics of the systems that we are trying to conserve. But we do not know the extent to which plants and animals shift their ranges in response to changing climates. Here we ask how rapidly do biomes transition in response to changing climates and to what extent do human impacts prevent species from tracking their preferred climate. We examined 16,043 fossil pollen assemblages from 310 sites to reconstruct vegetation community residence time and recovery time across North America during the past 20,000 years. We find that the median residence time of any given biome is between 230 and 460 years. Most interestingly, residence time is strongly correlated with rates of climate change. During periods of rapid climate change, plant biomes are unstable, dynamically moving on the landscape. These findings forebode that plants will need to exhibit dynamic responses to impending climate change. So, what is the extent that human impacts affect species movement abilities? We have previously found that human impacts limit organisms' ability to track their current temperatures by 24%. However, not all species are affected by human impacts to the same extent. Using the fossil record of North American mammals from the last 12,000 years, we demonstrate that human impacts have altered the ranges of climatic conditions they inhabit, and different species are being affected differently. Importantly, the climates where we find mammals today do not necessarily represent their natural habitats. These findings indicate that North American ecosystems will have to dynamically respond to today's changing climates, but that they will be impeded by human-impacted landscapes. Conserving for change and promoting landscape connectivity to facilitate movement in response to changing climates will help mitigate the effects of rapidly changing climates on North American biodiversity.

BioResilience: Biodiversity resilience and ecosystem services in post-conflict socio-ecological systems in Colombia

*Ted Feldpausch, Dunia H. Urrego, Naomi Millner, Toby Pennington, Lina Mercado, Monica Amador, Felipe Franco-Gaviria, Julieth Serrano, James Edward Richardson, Dolors Armenteras, Cesar Velásquez, Ismael García-Espinoza**

This project will examine the long-term resilience of Colombian forest ecosystems to environmental and climatic changes and improve understanding of the future implications of forest degradation for Colombian society. We focus on forests that are not pristine in that they are used by local communities and are affected by logging and fire. This fills a research gap in understanding how forests, which may be regarded as biologically 'degraded', have undergone changes in biodiversity, in ecosystem services, and in how they participate in local and global cycles of carbon and energy. The project will achieve this by building a network of permanent ecological monitoring plots across gradients of forest environment and degradation to allow evaluation of biodiversity and measurement of processes such as current and historical effects of fire, and carbon storage and changing climate. This data will be integrated with socio-cultural research, focusing on existing cultures of biodiversity conservation. This understanding is essential if the scientific evidence is to be integrated into long-term management plans and policy, as forest degradation in Colombia is strongly associated with changes to the fabric of social life, including the effects of sustained conflict. Participatory research and interviews will also allow the views and perceptions of key stakeholders, especially local communities, to influence our research priorities and outputs from the beginning.

Taphonomy of Panama's Pacific coral reefs and their historical resilience

Jonathan Cybulski, Jihane Benbahtane, Brigida De Gracia, Aaron O'Dea*

Environmental change in the Anthropocene puts coral reefs in danger of losing their past ecosystem functionality. Nonetheless, some modern stressors have historical antecedence, meaning historical records can provide insight into future reef conditions and aid in the human-management of these systems. The Pacific coast of Panama, rich in geologic, ecologic, and human history, provides one such opportunity. Reefs in this region exhibited a major growth hiatus in response to >2000 years of strong ENSO conditions in the mid-Holocene (Toth et al. 2012), but this response varied across the region (Toth et al. 2017). This system presents an opportunity to ask what underpins variation in individual reef resilience and resistance in response to the same stressors. To this end, we conducted a coring expedition and collected 14 reef-matrix push-cores from five reefs in the Gulfs of Panama and Chiriquí. Our cores record the dynamics of benthic communities over spatial scales ranging from meters to 100's km spanning ~5500 years. Coral subfossils were subjected to a rigorous taphonomic analysis to characterize post-mortem biological and physical features, resulting in over 15,000 assessments. We also gathered >20,000 other physical (e.g., coral length), environmental, and biological (e.g., % algae, and urchin composition) characteristics and explored how these variables correspond to published proxy data. Preliminary results reveal that reef community dynamics are variable across spatial scales, with some reefs in close proximity experiencing strikingly-different patterns of change that cannot be explained by large scale processes. Additionally, we failed to observe the clear taphonomic signal of reef shut-down seen by Toth et al., but did find reefs exhibiting compositional shifts between multiple coral taxa and rhodoliths. Location-specific responses makes interpreting these data challenging but important for conserving coral reefs under continued environmental change.

Basin-wide homogenization of benthic soft-bottom communities in the wake of anthropogenic habitat degradation in the northern Adriatic Sea

Alexandra Haselmair, Ivo Gallmetzer, Anna Wieser, Adam Tomasovych, Martin Zuschin*

Shallow epicontinental seas play an important role in the coastal economy of many countries by sustaining fisheries, tourism, aquaculture and other economic activities. Their exploitation can have large-scale ecological effects that are easily overseen because they often built up over decades or centuries, and historical ecological reference data are usually not available. In this study, we compare live (LA) and dead (DA) assemblages of soft-bottom molluscs in the northern Adriatic Sea and show how these communities shifted from regionally distinct species pools with diverse functional structure in the past towards a basin-wide more uniform recent community dominated by infaunal suspension- and detritus feeders. This shift was detected in a wide range of benthic soft bottom habitats and irrespective of the degree of time-averaging in the DAs, suggesting that Live-Dead discordance does not result from taphonomic processes, but is a true ecological signal of mollusc communities changing in response to anthropogenic habitat alteration. Main causes for the identified community shifts are eutrophication and bottom trawling leading to a removal of epifaunal cover, sediment siltation, and the establishment of organic-loving species adapted to higher sediment instability. The recent, functionally impoverished and homogenized community marks a new ecological baseline that has no analogue in the Holocene history of the northern Adriatic Sea.

Chamelea gallina response to anthropogenic and clime driven environmental change: the case study of the Holocene fossil records from Po-Adriatic system (Italy).

Alessandro Cheli, Arianna Mancuso, Marco Stagioni, Giuseppe Falini, Stefano Goffredo, Daniele Scarponi*

This pilot investigation explores the variations in skeletal features and growth of the edible bivalve *Chamelea gallina* from the Holocene shoreface deposits of the Po-Adriatic system (Italy) and present-day settings. The aim is to assess phenotypic variation occurred in different environmental conditions and determine how the impact of anthropogenic warming could affect this economically important bivalve species in the future. Shell features are investigated at macro (biometry), micro (texture) and nanoscale (composition) levels on five horizons rich in *C. gallina*: two from the Early Holocene, one from the Middle Holocene and two from the present-day shoreface settings, south of the Po delta. We investigated valve skeletal features (height, width, bulk density, micro-density and porosity) in relation to valve length, used as a rough proxy of the animal age. No variation was observed in shell CaCO3 polymorphism (i.e., 100% aragonite) or in compositional parameters among the analyzed horizons. Across all targeted *C. gallina* levels, juveniles are more porous than adults, suggesting that *C. gallina* promoted an accelerated shell accretion, at the expense of possessing a mechanically weaker shell, in order to quickly attain the size of sexual maturity. Spearman's rank correlation analyses between sea-surface-temperatures (SSTs) and valve skeletal parameters were also performed, showing a positive correlation between SSTs and both micro-density and bulk density: today's populations show less dense shells, possibly as a result of lower temperature that increase the energetic costs of shell formation, with decreasing aragonite saturation state. This study aid understanding the biotic response of *C. gallina* to environmental shifts and offers an important baseline for assessing the short- to mid-term impact of anthropogenic activities and climate-driven changes on this species of great socio-economic relevance.

Unraveling environmental and ecological changes in late Holocene marine sediments - new data from a gravity core from the west Northern Adriatic Sea

Michaela Berensmeier, Martin Zuschin, Adam Tomašových

A 3-m-long gravity core taken from 31 m water depth provides new insights about marine Holocene sediments of the W Northern Adriatic Sea. Large environmental and ecological shifts, particularly in the uppermost decimeters are indicated by changes in geochemistry (XRF core scanning data, geochemical bulk analyses) and molluscan composition. The whole record consists of mainly silt-sized quartz and mica and can be divided in 4 facies types: (1) laminated silty sediments with some sands, terrestrial plant remains and scarce mollusc shells (at 175-300 cm sediment depth), (2) bioturbated silty, fine-sandy sediments with terrestrial plant remains, scarce mollusc shells and calcirhizomes (70-175 cm), (3) strongly bioturbated, clayey silt with increasing abundance in mollusc shells (20-70 cm), and (4) clayey silt with a peak in molluscan shell abundances and diversity with abundant bivalves (*Corbula gibba*) and gastropods (*Turritellinella tricarinata*, 0-20 cm). C14-calibrated amino acid racemization analyses of valves of the bivalve *Corbula gibba* indicates the presence of an uppermost, surface-mixed layer with very young shells (median = 50 years) and an age-homogeneous composition down to 30 cm depth (median = 3000 years). This downcore shift in age distributions probably indicates that the 20th century shells of *Corbula gibba* are not mixed beyond 10 cm. This pattern implies decreasing bioturbation and increasing sedimentation in the study area in the 20th century.

Extinction risk controlled by interaction of long-term and short-term climate change

Gregor Mathes, Jeroen van Dijk, Wolfgang Kiessling, Manuel Steinbauer*

Current climate change threatens biodiversity at global scales. Assessing the extinction risk from climate drivers is a major goal of conservation science. Few studies, however, include a long-term perspective into assessments. Here we evaluate how observed extinctions in the geological past can be predicted from the interaction of short-term climate change with long-term temperature trends. We show that positive palaeoclimate interactions substantially increase the extinction risk of terrestrial and marine genera for most fossil clades. Warming on top of long-term warming trends increases extinction risk, whereas a warming pulse has less severe effects when following long-term cooling. The memory of palaeoclimate interactions varies among fossil clades but can be up to 60 myr long. The effect size of palaeoclimate interaction is similar to other key factors such as geographic range, abundance, or clade membership. Insights arising from this previously unknown driver of extinction risk might attenuate recent predictions of climate-change induced biodiversity loss.

Dermal denticle assemblages can reflect changes in shark abundance on coral reefs over time

Erin Dillon, Douglas McCauley, and Aaron O'Dea*

Many coastal shark populations have declined steeply over the last several decades, but longer records of change are unavailable. This hinders our ability to determine baseline shark abundance, understand natural variation in shark communities over time and space, and interpret sharks' functional roles on coral reefs in natural and human-impacted systems. Here, we explore the use of dermal denticles, the small tooth-like scales that cover the bodies of sharks and rays, as a new tool for reconstructing historical shark communities on coral reefs. We first conducted a fidelity study at Palmyra Atoll, central Pacific Ocean and found that denticles accumulating in the surficial sediments of low-energy reef habitats correlated well with estimated shark abundances across sites. We then compared denticle assemblages extracted from mid-Holocene (~7ka) fossil reefs in Bocas del Toro, Panama with modern reefs in the same area to investigate how shark communities have changed over time. Denticle accumulation rates (number of denticles per amount sediment per unit of time) were, on average, five-fold higher on the fossil reefs than on the modern reefs, implying that these reefs supported many more, or larger sharks, 7000 years ago. Furthermore, we observed a significant shift in the relative abundance of denticle morphotypes over time. "Abrasion strength" denticles belonging to demersal sharks (e.g. nurse sharks) increased in relative abundance on the modern reefs, whereas "drag reduction" denticles, which are associated with fast-swimming species (e.g. requiem and hammerhead sharks), decreased in relative abundance, suggesting an ecological shift in shark communities on these reefs. These new data can provide insight into pre-human shark communities on coral reefs and can help guide management targets.

Linking internal carbonate chemistry regulation and calcification in corals growing at a Mediterranean CO_2 vent

Fiorella Prada, Marlene Wall, Jan Fietzke, Erik Caroselli, Zvy Dubinsky, Leonardo Brizi, Paola Fantazzini, Silvia Franzellitti, Tali Mass, Paolo Montagna, Giuseppe Falini, Stefano Goffredo*

Corals exert a strong biological control over their calcification processes, but there is a lack of knowledge on their capability of long-term acclimatization to ocean acidification (OA). We used a dual geochemical proxy approach to estimate the calcifying fluid pH (pHcf) and carbonate chemistry of a Mediterranean coral (*Balanophyllia europaea*) naturally growing along a pH gradient (range: pHTS 8.07–7.74). The pHcf derived from skeletal boron isotopic composition (δ11B) was 0.3–0.6 units above seawater values and homogeneous along the gradient. The homogeneous gross calcification rate, internal pH and carbonate chemistry confirm that the features of the "building blocks" – the fundamental structural components – produced by the biomineralization process were substantially unaffected by increased acidification. Furthermore, the pH up-regulation observed in this study could potentially explain the previous hypothesis that less "building blocks" are produced with increasing acidification ultimately leading to increased skeletal porosity and to reduced net calcification rate computed by including the total volume of the pore space. In fact, assuming that the available energy at the three sites is the same, this energy at the low pH sites could be partitioned among fewer calicoblastic cells that consume more energy given the larger difference between external and internal pH compared to the control, leading to the production of less building blocks (i.e., formation of pores inside the skeleton structure, determining increased porosity). However, we cannot exclude that also dissolution may play a role in increasing porosity. Thus, the ability of scleractinian corals to maintain elevated pHcf relative to ambient seawater might not always be sufficient to counteract declines in net calcification under OA scenarios.

Conservation clues beneath the pavement: using fossils to guide sustainability planning in urban Southern California

Emily Lindsey, Elizabeth Ellwood, Alexis Mychajliw*

In a rapidly changing world, scientists and practitioners have begun looking to information from the past to better plan for the future. This conservation paleobiology approach of using fossils and other geohistorical records to inform restoration and management of modern ecosystems is increasingly being used to guide the trajectory of species and ecosystems in the novel climates and biotic communities of the Anthropocene, but these tools are rarely if ever applied in significantly human-modified landscapes. While forces of global and anthropogenic climate change are already impacting across a variety of landscapes, cities will be among the most severely affected environments. The process of urbanization creates additional challenges including habitat fragmentation, rising temperatures, and increased opportunity for human-wildlife conflict, and the ability of city planners and conservation biologists to respond to these challenges can be enhanced by incorporating local and regional fossil and historical records, which can give insight into organisms' ecological flexibility, baselines for ecosystem structure and function, and correlates of extinction risk. We use as our case study the megacity of Los Angeles, California, USA. As a heavily urbanized biodiversity hotspot with well-resolved fossil and historic records, Los Angeles is uniquely situated to inform sustainability planning using deeper-time ecological data. We have developed a working group of academics, conservation practitioners, and representatives of governmental and non-profit organizations based in Central and Southern California to begin incorporating these data into plans for restoration of urban green spaces, carnivore management, and fire mitigation. This framework also provides individuals living in urban areas with a new toolkit to make a difference in their local area, and it is the advocacy from these stakeholders that will ultimately effect change on both the city-wide and global level.

Estimating Downcore Changes in Skeletal Disintegration Risk in Holocene and Anthropocene Environments

Niklas Hohmann, Adam Tomašových*

Preservation of skeletal remains is thought to be positively linked to rate of burial, i.e., high burial exposes them to destructive processes for a shorter time. However, downcore changes in time-averaging documented in Holocene skeletal assemblages implies that per-individual burial rates of skeletal remains of the same age cohort can be variable, e.g., owing to bioturbation. Estimation of time (and sediment depth) over which skeletal remains are exposed to destruction is thus not straightforward. This variability in the depth of burial exposes them to different intensities of destructive processes that is typically highest in sediments on or close to the seafloor, and accordingly changes their probability of disintegration. This complicates both the reconstruction of taphonomic conditions downcore and the reconstruction of biological archives from age cohorts of skeletal remains. We present the AALPS (Aging ALong burial PathS) model to estimate downcore disintegration risk and taphonomic age, based on sediment-depth distribution of postmortem age of individual skeletal remains. It accounts for sediment mixing and time-averaging, incorporates knowledge of changing sediment input, and can be applied to individual cores and taxa. As an application, we discriminate between distinct hypotheses of changes in skeletal disintegration risk in cores from the Northern Adriatic Sea. The method provides new insights into the taphonomy of skeletal remains in Holocene and Anthropocene environments and age unmixing of paleoecological time series, which can be used in conservation paleobiology to reconstruct ecological baselines to guide future conservation efforts.

Researches of the past: shell mounds as geo-archives for changes in clam body size

Anna Assumpção, Felipe Caron, Fernando Erthal, Eduardo Barboza, Raphael Pinotti, Leonir Colling, Matias Ritter*

Shell mounds are structures built by human groups of fisher-gatherers around 10,000 to 1,000 years ago that were widely distributed in the southern Brazilian coast. These structures are constituted mostly of mollusk´s shell recording a biased, yet useful, past biodiversity of marine and estuarine environments. For example one of the most common marine species found in the Southernmost Brazil shell mounds is the infaunal yellow clam, *Amarilladesma mactroides*, a species still commonly used for cooking and for fishing bait. The size of the specimens recovered from shell mounds can reveals how abiotic and biotic factors influenced them. When comparing with the size of the modern shells, it is possible to verify the clues of how body size would have changed over time. Therefore it would increases information to Conservation Paleobiology, whose premise is to use geohistorical records, observing long-term perspectives on species to ecosystems dynamics. The objective of this research is to compare the valves´ body size from two shell mounds (around 3,000 B.P), located in the northern coast of Rio Grande do Sul, Brazil, with modern shells gathered from two beach sectors. The body size of the mollusks was pair-compared using the t test ($\alpha = 0.05$). In all analyses, only those larger than 43 mm and left valves were used, and resampling without replacing was carried out to locations with the largest n sample. The asymmetry and kurtosis tests were made to better understand the shell size frequency distributions. The average body size was significantly higher in shell mounds ($p < 0.05$). The asymmetry and kurtosis test displayed that there is a left bias of the data and a tendency of homogenization to the recent one. The use of geohistorical perspectives allows an assessment of population changes from a much larger scale than that used in most long-term ecological studies. Thus, the value of shell mounds to Conservation Paleobiology is here demonstrated and discussed.

Conservation Paleobiology Research Coordination Network

*Michal Kowalewski**

Conservation Paleobiology Research Coordination Network (RCN) is a new initiative recently funded by the National Science Foundation (USA). This RCN project intends to bring together scientists and stakeholders (communities, agencies, and industry) to ensure that historical archives effectively assist conservation efforts. The project will center on community-building activities and student education programs. Our primary goal here is to transform conservation paleobiology from a cluster of novel academic projects into an applied science that transfers geohistorical data to stakeholder groups and is adept at responding to stakeholder needs. The project aims both internal integration (i.e., bringing together disparate efforts, establishing best practices, connecting efforts across regions, and coordinating training in best practices) and external integration (i.e., networking of scientists and stakeholders to make conservation paleobiology a translational science wherein new knowledge evolves via interactions between scientists and scientific data users). We intend to use grass-roots strategies to build a Community of Practice which will engage in developing Working Groups that tackle key questions of conservation paleobiology, System-Focused Field Courses that engage students, junior faculty, and stakeholders, and Webinars dedicated to training future conservation scientists/practitioners. The RCN is managed by PI and the Steering Committee comprised of scientists, conservation practitioners, and stakeholders.

Data infrastructures for conservation paleobiology

Francesca Pilotto, Philip I. Buckland*

Data infrastructures linking fossil and modern biodiversity databases are essential for facilitating reproducible, cross-disciplinary data-driven research for long-term studies of climatic and human-driven changes on biodiversity. The Swedish Biodiversity Data Infrastructure (SBDI, https://biodiversitydata.se) is an ongoing initiative integrating multiple biodiversity and environmental databases, including Quaternary fossil data. The fossil data are part of the Strategic Environmental Archaeology Database (SEAD; www.sead.se) and BugsCEP database (www.bugscep.com), and consist of European fossil records for over 5000 plant and arthropod taxa from both archaeological and Quaternary geological sites. These data are being linked to modern biodiversity platforms through the Swedish LifeWatch (www.swedishlifewatch.se) project. The resulting infrastructure will be based on international standards and open-source software that are widely used in the biodiversity informatics community for data, metadata and exchange protocols, and will be part of the international Living Atlases community. We present the first results of research enabled by directly linking databases for Quaternary fossil data and modern biodiversity, and discuss some of the opportunities and challenges that this exercise presents. One such challenges is the taxonomic mismatch between modern and paleoecological databases, with paleodata often having a coarser taxonomic resolution than species level. On the other hand, assessments of the current distribution and conservation status of species are often incomplete, in terms of geographical and taxonomic representation. Despite these challenges, the combination of modern and paleobiodiversity data can, even with the currently available data, result in better informed species and habitat conservation plans. Species and habitat conservation will benefit from increased interdisciplinary synergies between conservation biology and environmental archaeology.

Trophic reconstruction using fossil otolith-bound nitrogen isotopes: first data from Holocene reefs

J.A. Lueders-Dumont, Daniel M. Sigman, Xingchen T. Wang, Katie Griswold, Chien-Hsiang Lin, Brigida de Gracia, Aaron O'Dea*

Stomach content analysis and stable isotope analysis in fish tissues have served as the primary tools in trophic ecology for decades but provide only a limited temporal window into the dietary history of fish. In contrast, otoliths accrue over the entire life history of the fish and can be measured in contexts where tissue is not available, for example, in otolith archives and sedimentary deposits. Analytical constraints have limited isotopic analysis of otolith- bound organic matter due to the low organic content of these aragonitic structures. Using methods that have their basis in persulfate-oxidation of otolith-bound organic matter followed by bacterial conversion to N2O, we find that the nitrogen isotopic composition (δ15N) of otolith organic matter is a robust indicator of fish diet. Using paired otolith and tissue samples from both hatchery -reared and wild fish, we provide validation of the otolith method. Otolith--bound δ15N records the dietary origin of otolith δ15N albeit with a species- specific trophic fractionation factor, and generally correlates with known trophic level information from a variety of species. Here, we present first data from trophic level obtained from fossil and subfossil fish otoliths retained in the coral reef matrix of Holocene Caribbean reefs. Representative taxa from Atherinidae and Gobidae families, two groups of low trophic level reef-associated fish, show decreases in trophic level regardless of their size. This indicates alterations to food web structure and energy flow on modern compared to Holocene food webs. Future work will measure δ15N in otoliths of high trophic level fishes. The application of this new otolith -bound proxy for trophic level holds promise for reconstructing changes to ecosystem structure on contemporary and prehistoric timescales.

From Applied Marine Paleoecology to Conservation Paleobiology

Daniela Basso, Valentina Alice Bracchi

Several actuopaleontological investigations on the taphonomy and absolute dating of marine biogenic accumulations occurring on present-day seafloors have provided evidence that they represent multisecular archives of marine associations that followed each other. Beside a variable degree of bias introduced by erosion or lateral transport and time-averaging of multiple generations, these death assemblages represent a long-term record of environmental history of coastal and shelf regions. The reliability of such record has been estimated via quantitative comparison of live and dead assemblages in modern environments. Benthic paleoecologists may use both biological and geochemical proxies for the circumscription of discrete ecological associations and the reconstruction of their relationships in space and time. Further insights on short-term variations of selected ecological variables (temperature, salinity, productivity) can be obtained from specific geochemical investigations (element ratios, stable isotopes, trace element) possibly associated to microsampling (e.g. laser-ablation techniques). This well-tested paleoecological approach can be usefully applied for providing ecologists with longer temporal perspectives on historical environmental changes. Some examples from the activity of the Milano-Bicocca researchers are presented.

Do source-sink dynamics explain molluscan distributions in the lowermost channel of the Colorado River? A preliminary test

Gregory P. Dietl and Jansen A. Smith*

Upstream water diversions and damming have rendered freshwater flows to the Colorado River estuary in the upper Gulf of California insufficient to support the original estuary. However, rather than abandon the crucial ecosystem services of the estuary, the Sonoran Institute and their partners are engineering a smaller, naturally functioning estuary within the original estuary by improving river-sea connectivity and acquiring freshwater inflows. Here we illustrate the utility of data derived from molluscan death assemblages in the river bottom to guide decisions on the timing, volume, and duration of freshwater deliveries to the engineered estuary. Preliminary abundance and body size data suggest that before the Colorado River stopped flowing disturbances from river discharge likely created a source-sink system between productive habitats (sources) at the mouth of the river and upstream, low-quality "sink" habitats, in which populations of marine molluscs living in the river channel were maintained only by larval dispersal from downstream source areas. Habitat quality (i.e., salinity conditions) was likely a key mechanism driving source-sink dynamics, but dispersal and predation may also have played influential roles. Identification of source-sink dynamics in the past has clear relevance for ongoing and future restoration efforts, in that successful habitat restoration in the upper reaches of the estuary for species that produce planktonic larval stages may not require environmental conditions that promote self-sustaining populations.

Collapsing Hotspots, Extinction, and Recovery: The Evolutionary History of Herbivorous Reef Fishes

Francesco Santini, Alex Dornburg, Bruno Frederich, Katarina Zapfe*

The coral reef ecosystems of today are rich in marine diversity with widespread economic value and a wealth of evolutionary historical narratives. As climatic and anthropogenically generated pressures continue to increase, the future of their nature and persistence remains uncertain. However, this is not the first instance the stability of these hotspot ecosystems has experienced decline in the face of rapid environmental change. The mid Eocene marks a fossil-rich time period for hotspots of marine diversity, and the fossil record is indicative of a transition from algae-dominated reefs to those with increasing hard coral cover and flats of highly productive, cropped algal matrices. This shift is catalyzed by a change from invertebrate grazers to more efficient herbivorous fishes, whose fossils mark the early stages of the predominate reef herbivores today, rabbitfishes (Siganidae) and surgeonfishes (Acanthuridae). Understanding the persistence mechanisms of these ecosystem-shaping herbivores provides critical insight necessary to forecast the future of modern reefs in the face of rising pressures. We combined morphometric analysis of fossil and extant taxa for these two prominent clades with a time-calibrated phylogeny to investigate the underlying patterns of herbivorous reef fish ecomorphology and speciation. Results provide a temporal perspective and show a marked increase in ecomorphological diversification coupled with the rise of modern reefs among these two clades, supporting patterns consistent with an extinction recovery model. The tempo and mode of these patterns, however, varies between the two groups, and indicates the viability of multiple evolutionary pathways leading to lineage persistence in the wake of ecosystem collapse.

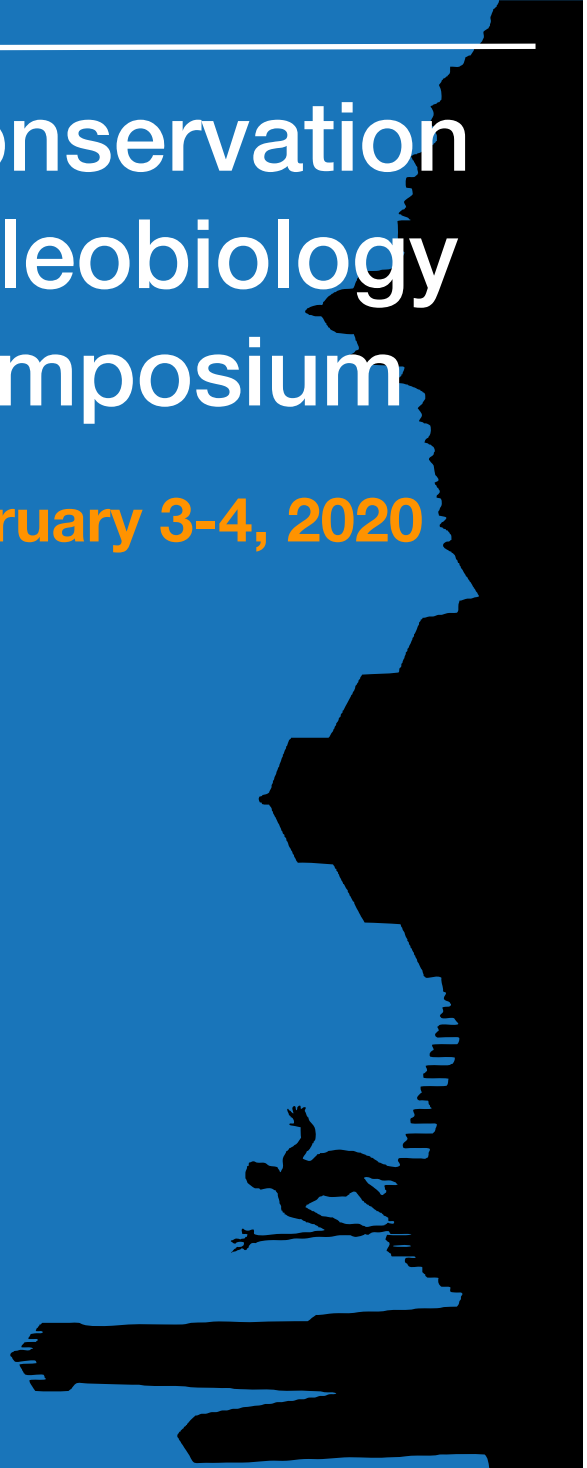
Functional consequences of extinctions: from the Pliocene to the Anthropocene

Catalina Pimiento

We used to think that the threats that marine vertebrates are experiencing today had no precedent. Based on an analysis of the fossil record, we overturned this assumption by showing that one third of the marine megafauna became extinct in the Pliocene. To gauge the potential consequences of this extinction for ecosystem functioning, we evaluated its impacts on functional diversity and found that 17% of their functional space was lost. This level of erosion contrasts with previous studies that have reported negligible functional changes after the (mass) extinction of marine invertebrates. A new study of a well-known extinction in the Caribbean reveal the mechanisms driving functional vulnerability and resilience: small, specious invertebrates can be persistently redundant (large number of taxa performing similar functions) through time, which in turn buffers them against extinction. Large vertebrates, on the other hand, tend to be functionally unique, thus highly vulnerable. After the extinction event that the marine megafauna experienced in the recent geological past, they would likely still be recovering today. Nevertheless, 30% of their species are currently deemed at risk of extinction by the IUCN. We forecasted how the eventual extinction of threatened species would affect marine megafauna functional diversity. Our simulations suggest that between 50% and 70% of their functional space would be lost. Therefore, the fate of marine megafauna in the Anthropocene has no precedent in the geological history.

Conservation Paleobiology Symposium

February 3-4, 2020



Bologna

Monday

08:30 Registration

09:00 Welcome

09:15 Plenary: Modified urban waterfronts: learning from the past (mistakes) to build a "bluer" future.
Laura Airoldi

10:15 Coffee

10:45 Ancient mtDNA suggests population dynamics of wild wolves in the Italian peninsula.
Paolo Abondio, et al.*

11:00 Shells from the shoreline - a new perspective on changing Lake Tanganyika.
Jonathan Todd, Ellinor Michel*

11:15 The Shell Beds of Lake Tanganyika: Palaeoecology, Environmental Change and Living Systems.
Ellinor Michel, Jonathan Todd, Michael Soreghan*

11:30 Massive extirpation of native species from the Israeli Mediterranean shelf.
Paolo G. Albano, et al.*

11:45 Southern sounds: tracking Conservation Paleobiology perspectives in the South American continent.
Matias do Nascimento Ritter, et al.*

12:00 Lunch

13:00 Plenary: The application of deep-time palaeontological data to conservation.
Erin Saupe

14:00 *Lightning:* Molecules meet fossils – revealing diversification dynamics in Bryozoa.
Helen Jenkins, et al.*

14:07 *Lightning:* Drivers of paleodiversity fluctuations in Bryozoa.
Farideh Moharrek, et al.*

14:14 *Lightning:* Extracting Ancient Environmental DNA (aeDNA) from Hong Kong Coral Sediment Cores.
Alison Corley,et al.*

14:21 *Lightning:* Investigating Heracles' myth of the Lernaean Hydra.
Danae Thivaiou, et al.*

14:28 *Lightning:* Influence of surface ocean density on plankton calcification.
Stergios Zarkogiannis, et al.*

14:35 *Lightning:* Network Paleobiology: Understanding the spatiotemporal dynamics of the Earth-Life System.
Alexis Rojas

14:42 Coffee

15:30 Thirty-million years of turbid reefs in the Coral Triangle.
Nadia Santodomingo, et al.*

15:45 Beware of zombivalves! Shell exhumation, diachronous production and stratigraphic disorder in the post-glacial fossil assemblages on the northern Adriatic shelf.
Rafał Nawrot, et al.*

16:00 Assessing Data Quality in Conservation Paleobiology: Common Trends and Suggestions for the Future.
Kimberly Cook & Robert Montoya*

16:15 Resilience of nearshore communities to natural climate change in the northern Adriatic.
Daniele Scarponi, et al.*

16:30 Coral growth and bioerosion on ancient and modern turbid-water reefs in the Coral Triangle: How well do these potential reef refugia function?
Kenneth G. Johnson and Nadia Santodomingo*

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA
DIPARTIMENTO DI SCIENZE BIOLOGICHE GEOLOGICHE E AMBIENTALI

Smithsonian Tropical Research Institute

Organisers
Aaron O'Dea, Daniele Scarponi,
Paolo Albano, Laura Airoldi

Special thanks
Alessandro Cheli, Brigida de Gracia, Bruno Marano, Chiara Vallese, Costantino Zuccari, Erin Dillon, Federica Costantini, Gian Battista Vai, Giulia Tartaglia, Jessica Lueders-Dumont, Jonathan Cybulski, Jorge Morales, Kate Hibbs, Lisa Carrera, Luna Girolamini, Martin Zuschin, Marissa Batista, Matt Larsen, Massimo Zini, Max Titcomb, Michaela Berensmeier, Michal Kowalewski, Michele Azzarone, Miriam Greaves, Nadia Santodomingo, Niklas Hohmann, Pierpaolo Ciuffi, Piero Zannini, Rachel Burgess, Rafal Nawrot, Sara Meschiari, Sharon Pittau, Silvana Pacifico, Simone Toller, Thomas Gusmeo.

All the children at the
International School of Bologna

Tuesday

08:50 Housekeeping

09:00 Plenary: Is conservation paleobiology useful?
Jeremy B.C. Jackson

10:00 Using the paleontological record to demonstrate the importance of conserving for change
Jenny McGuire

10:15 BioResilience: Biodiversity resilience and ecosystem services in post-conflict socio-ecological systems in Colombia.
Ted Feldpausch, et al.

10:30 Coffee [and group photograph]

11:00 The taphonomy of Panama's Pacific coral reefs and their historical resilience.
Jonathan Cybulski, et. al.*

11:15 Basin-wide homogenisation of benthic soft-bottom communities in the wake of anthropogenic habitat degradation in the northern Adriatic Sea
Alexandra Haselmair, et al.*

11:30 *Chamelea gallina* response to anthropogenic and clime driven environmental change: Case study of the Holocene fossil records from Po-Adriatic system.
Alessandro Cheli, et al.*

11:45 Unraveling environmental and ecological changes in late Holocene marine sediments - new data from a gravity core from the west Northern Adriatic.
Michaela Berensmeier, et al.

12:00 Extinction risk controlled by interaction of long-term and short-term climate change.
Gregor Mathes, et al.*

12:15 Lunch

13:15 Dermal denticle assemblages can reflect changes in shark abundance on coral reefs over time.
Erin Dillon, Douglas McCauley, and Aaron O'Dea*

13:30 Linking internal carbonate chemistry regulation and calcification in corals growing at a Mediterranean CO_2 vent. *Fiorella Prada*, et al.*

13:45 Conservation clues beneath the pavement: using fossils to guide sustainability planning in urban Southern California
Emily Lindsey, Elizabeth Ellwood, Alexis Mychajliw*

14:00 Estimating downcore changes in skeletal disintegration risk in Holocene and Anthropocene environments
Niklas Hohmann, Adam Tomašových*

14:15 Researches of the past: shell mounds as geo-archives for changes in clam body size.
Anna Assumpção, et al.*

14:30 Conservation Paleobiology Research Coordination Network. *Michal Kowalewski*

14:45 Coffee [and cons. paleo. RCN meeting]

15:30 Data infrastructures for conservation paleobiology.
Francesca Pilotto, Philip I. Buckland*

15:45 Trophic reconstruction using fossil otolith-bound nitrogen isotopes: first data from Holocene reefs
J.A. Lueders-Dumont, et al.*

16:00 From Applied Marine Paleoecology to Conservation Paleobiology.
Daniela Basso, Valentina Alice Bracchi*

16:15 Do source-sink dynamics explain molluscan distributions in the lowermost channel of the Colorado River? A preliminary test
Gregory P. Dietl and Jansen A. Smith*

16:30 Collapsing Hotspots, Extinction, and Recovery: The Evolutionary History of Herbivorous Reef Fishes.
Francesco Santini, et. al.*

16:45 Functional consequences of extinctions: from the Pliocene to the Anthropocene. *Catalina Pimiento*

17:00 Student prize announcement