

Take home messages

Session 1 - Lessons from the Past to Inform the Future

- Different archives were presented: fossil coral, ancient reefs, coral cores, at different timescales (the session covered more than 400 million years of reef evolution). Spatial scales ranged from reef to colony, and processes inside coral polyps.
- We use these archives to track the past evolution of corals and reefs, reconstruct processes (coral calcification, reef development) and response to stress events.
- There is a clear need for more interdisciplinarity between paleobiology, geochemistry and biology to understand how corals and reefs change over time and respond to environmental disturbances.

Miriam Pfeiffer and Stéphanie Rey

Session 2 - Coral Reef Structure and Functioning

- Reef function acts on a large range of different scales, via different factors and through an immense diversity of organisms – which was well reflected in session 2.
- We are rapidly losing very important functions that control and maintain coral reefs as they should be, and it is difficult to keep track of the developments in such a complex system, as well as to know what needs to be done to improve the situation (... we know better what to avoid)
- But we are diverse, too. As a community working on coral reef science, we have a unique opportunity and responsibility to work *together*, to network, share and coordinate and standardize our efforts to maximize the outcome and to inform and instruct regulators, politicians and the public. Let's do it!

Session 3 - Biology and Ecology of Holobionts in Coral Reefs

- Corals- including octocorals, sponges, and fish are holobionts, complex entities which include the host and microorganisms. All partners, also the host, have to be taken into account in future studies, which was well reflected in session 3. Also, not all microbes are good symbionts, even if systematically associated to the host.
- The stability of the host-microorganism associations is driven by external stressors but also by nutrient availability and exchanges between the partners. Nutrient imbalance causes dysbiosis and a decrease in network connectivity, which in turn leads to coral disease and even mortality.
- There is a clear need for more comprehensive research into the role of each microbial partner, considering that there is not a unique holobiont model, but a wide diversity of potential models.

Christine Ferrer, Francesca Benzoni, and Laura Núñez Pons

Session 4 - Global Climate Change and Environmental Stressors

- It is still essential to continue studying the mechanisms governing coral reef responses to stressors, from molecular processes to population and community dynamics.
- There is overwhelming evidence that coral reefs are suffering worldwide due to both climate change and local stressors. At the same time, many studies show evidence of rapid acclimation and adaptation, from individual genotypes to the community level.
- The potential for rapid adaptation is already present in nature, as demonstrated by studies in natural laboratories, hot seas, and long-term lab experiments. This highlights the need for the protection and conservation of both the high genetic diversity and the variety of habitats and populations that reefs encompass, to safeguard their adaptation potential.

Session 5 - Coral Reef Anthropogenic Pressures, Conservation and Restoration

- Besides from global issues such as climate change, there is a clear need for longer and more comprehensive research into the full range of anthropogenic stressors and issues that affect coral reefs, from terrestrial runoff and pollution to disease, as well generating basic response and functional data for the whole diversity of scleractinian corals, fishes, and other organisms, in order to better predict the future of coral reef communities.
- Conservation efforts, such as the "30 by 30" agenda within COP28, are increasing, yet available data and subsequent conservation efforts remain unbalanced with regards to both the range of actions undertaken as well as geographic location.
- While conservation remains a top priority, there are numerous and rapidly increasing numbers of local- to large-scale restoration research projects and efforts, including the development of a wide variety of novel tools for coral reef managers to implement.

Timothy Ravasi and James Davis

Session 6 - Community-Based Monitoring and Ecosystem-Based Management

- Well-informed Ecosystem-Based Management (EBM) are urgently necessary to implement proper marine habitat and biodiversity conservation strategies worldwide
- Environmental policies cannot do without robust data and effective involvement of local populations and citizens in general, as primary stakeholders
- Well designed, standardised and indefinitely planned Citizen Science projects can potentially provide both scientifically sound Community-Based Monitoring data and option to fill the gap from managing authorities and citizen

Take home messages

Session 7 - Shallow Temperate Reefs

- Shallow temperate reefs are impaired by global change , including Marine Heatwaves and Ocean Acidification
- There is an increase of interest in the early-life stages and their responses to climate change
- Long-term observations, connectivity among populations, trait-based ecology, and using new technologies are important to better understand the dynamics of shallow temperate reefs

Nuria Teixido, Jeremy Carlot, and Steeve

Session 8 - Mesophotic and Cold-Water Coral Ecosystems

- Continued exploration has demonstrated that Mesophotic & Cold Water Reefs are broadly distributed
- Data indicates that these reefs vary with location (ie, not all deep reefs are the same, site specific processes)
- Conservation & Management will require additional research on structure & function, species assemblages, and oceanographic patterns, & ecological interactions (including facilitation, predation & competition)

Take home messages

Session 9 - Technological and Methodological Innovation in Underwater Surveys and Data Analysis

- An increasing attention to surveying, measurements and monitoring with different techniques and methodologies has been observed; the interdisciplinary approach is quiet consolidated.
- Use of machine learning algorithms and Artificial Intelligence application are diffused.
- Transfer of knowledge and skills to other disciplines and society (citizen science, citizen awareness) and tools for decision makers are given... We strongly suggest to maintain a technological and surveying session at next ECRS.

Alessandro Capra and Kimon Papadi

Session 10 - Coral Reefs Under a Socio-Economic Perspective

- MPAs are tools to protect the ocean ecosystems and the coastal communities, which rely on nature for their livelihood and well-being
- Coral reefs conservation and restoration benefits to the biodiversity and to the people who depend on the services that nature renders to the humanity
- Unsustainable practices (i.e., overfishing) lead to environmental damage (i.e., coral reef destruction), loss of ecosystem services (i.e., habitat for species and fish stocks decline), endangerment of natural assets, and threaten the associated industry (i.e., fisheries), jeopardizing the entire economy

Session 11 - Beyond Corals and Fishes - Evolution and Biodiversity of Neglected Reef Taxa

- Noncoral invertebrates are highly diverse but severally understudied, resulting in an incomplete understanding of a) their functional ecology and b) the services they provide to the coral reef ecosystem and society.
- Because of the large variety of important ecological functions and services they provide, conservation should also more thoroughly consider the vast diversity of non-coral invertebrates.
- Museum collections and especially the type material they house are important resources to anchor species surveys conducted by molecular methods, e.g. species identification, distinction, and phylogeny.

Take home messages

Session 12 - The Ocean Decade: The Science We Need for the Coral Reefs We Want

- **...is cross-scale**
- **...breaks down disciplinary silos**
- **...is inclusive**
 - invites diversity of thought and approach
 - not “owned” by any one group or person

Sally Keith, Thomas Felis, and Rucha K

Take home messages

Session 13 - Insights into Further Fields of Coral Reef Research Around the World

- Studies on corals and their habitats know no disciplinary frontiers
- Observational and interdisciplinary approaches are necessary to have a holistic view of ecological processes and their change over time
- New technologies offer tools to rapidly expand our knowledge at all levels of biological organization; however; only an effective networking among researchers can bring to solutions to face global crises