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Experience-sharing sessions

Coralligenous habitats monitoring

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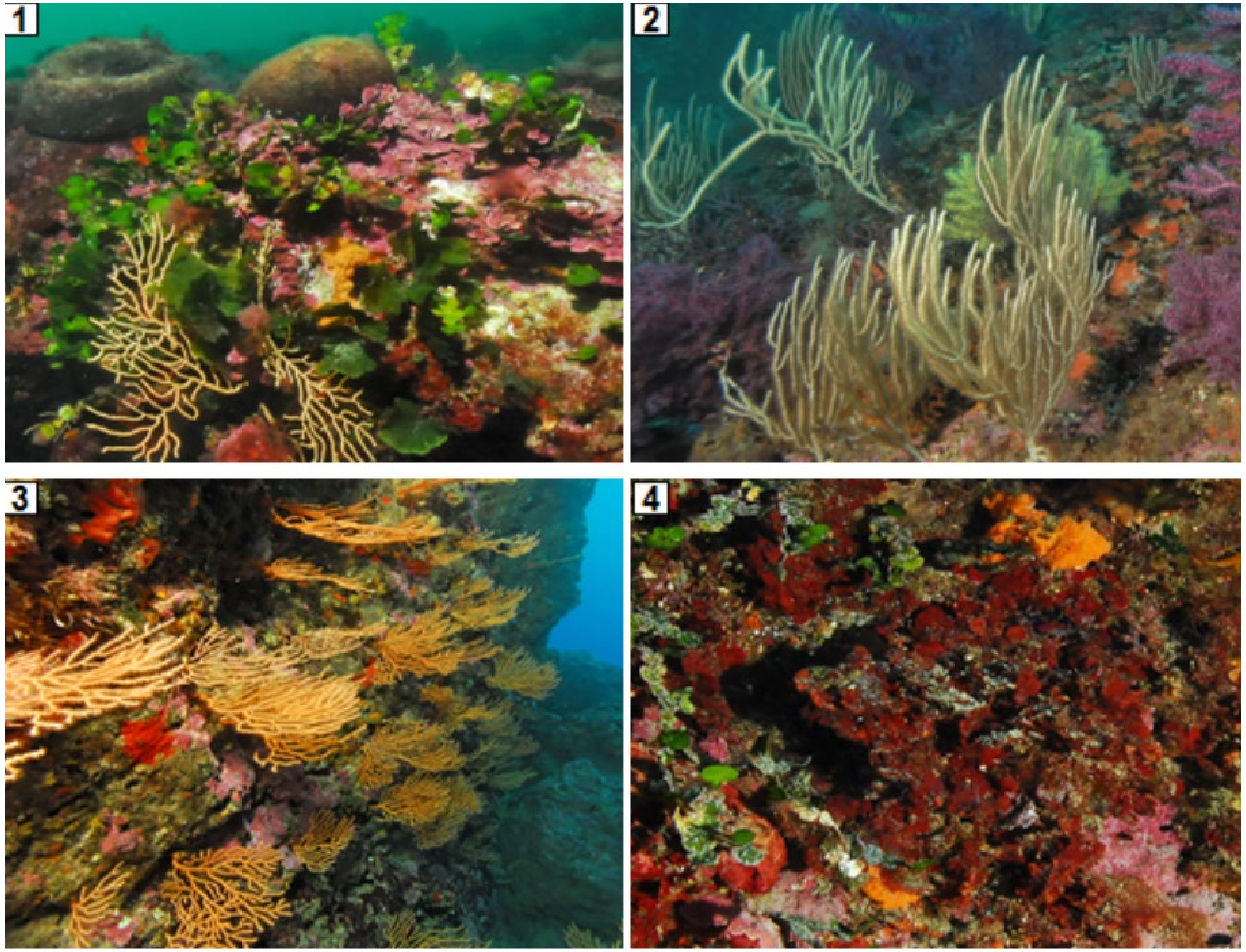
Characteristics , importance & complexity of Coralligenous habitat

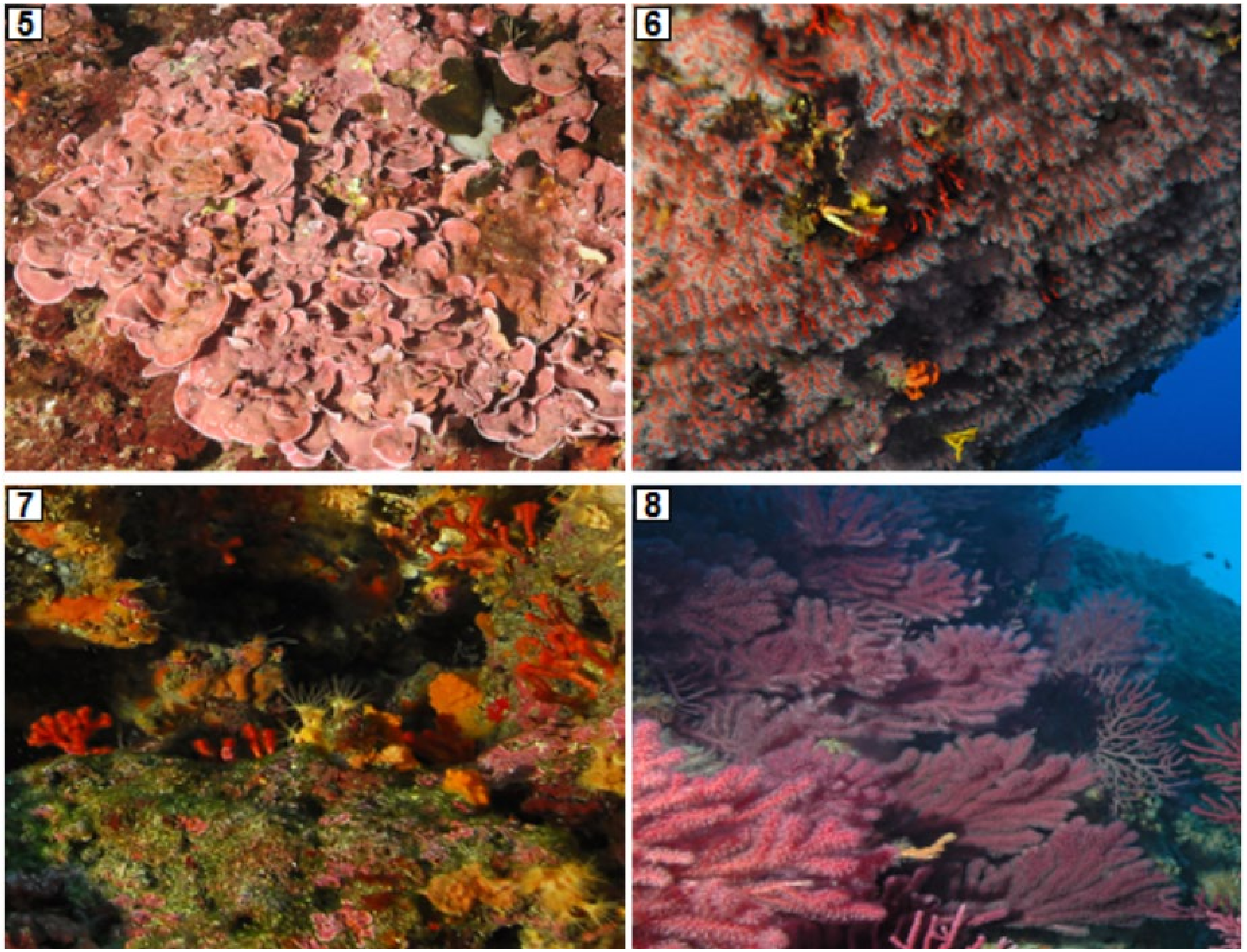
- Coralligenous habitat has presence from photic zone up to final limit mesophotic zone where the main bio-constructures are calcifier organisms especially coralline algae species, also corals, molluscs
- In term of biodiversity, the Coralligenous habitat is considered as the second benthic ecosystem in the Mediterranean. It is estimated that it includes around 1300 algae, 1200 invertebrate species (RAC –SPA) (First is *Posidonia oceanica* seagrass meadows)
- Dominant specie and main builders may vary across depth and region



(1) Udotea peteolata and Halimeda tuna, (2) Eunicella singularis, (3) Eunicella cavolini, (4) Peyssonnelia squamaria (Rhodophyta)

Characteristics , importance & complexity of Coralligenous habitat

- Living, spawning , hatching area for many species
- They build physical structures and reform the ambient permanently .
- Very slow grow rate

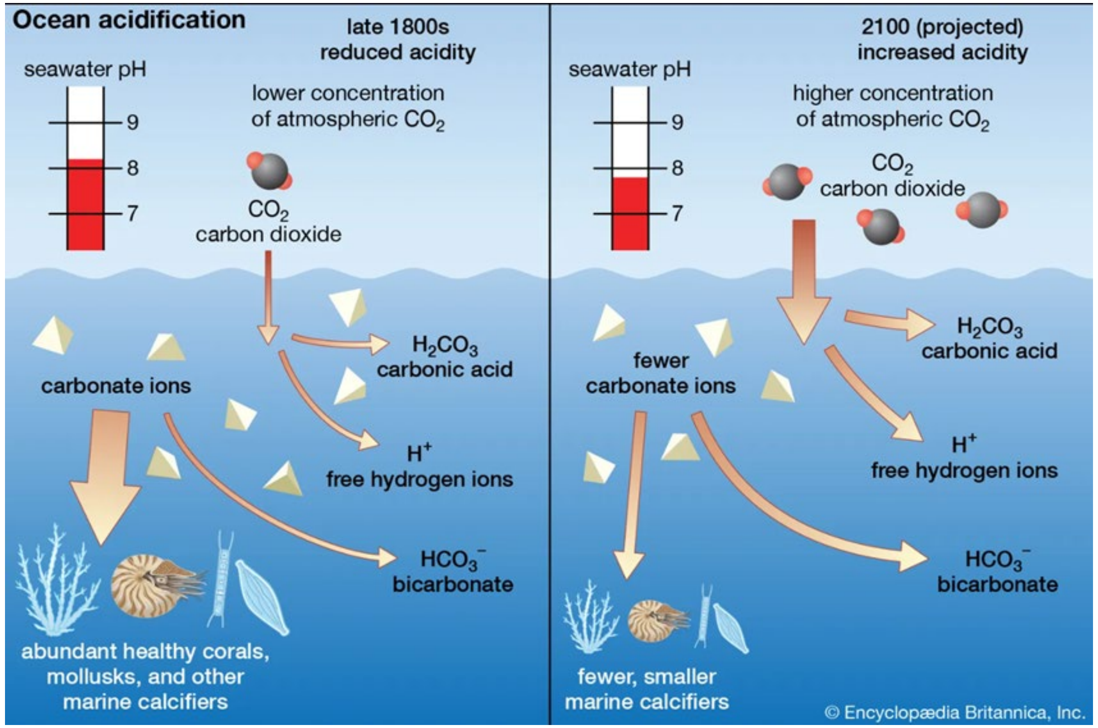


(5) Mesophyllum alternans Coralline algae, *(6) Corallium rubrum* Coral , *(7) Myriapora truncata (Pallas, 1766)* Bryozoa *and (8) Paramuricea clavata* (red coral) (© Zuberer F.)

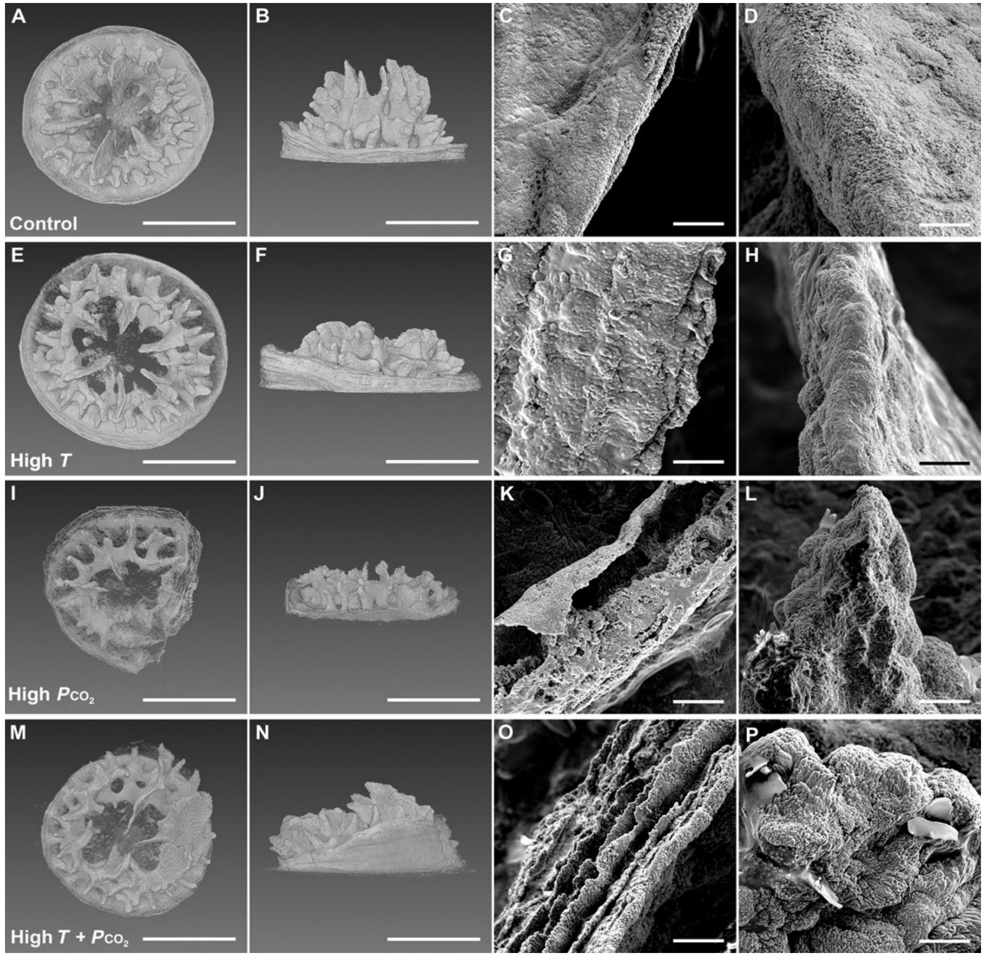
Ocean Acidification and Other traits

- Ocean acidification is the ongoing decrease in the pH of the Earth's oceans, caused by the uptake of carbon dioxide (CO2) from the atmosphere.
- CO2 reacts with seawater to form carbonic acid, which lowers the pH.
- This process is happening at an unprecedented rate, impacting marine ecosystems globally.
- A decrease of 0.1 pH units represents a 30% increase in acidity.

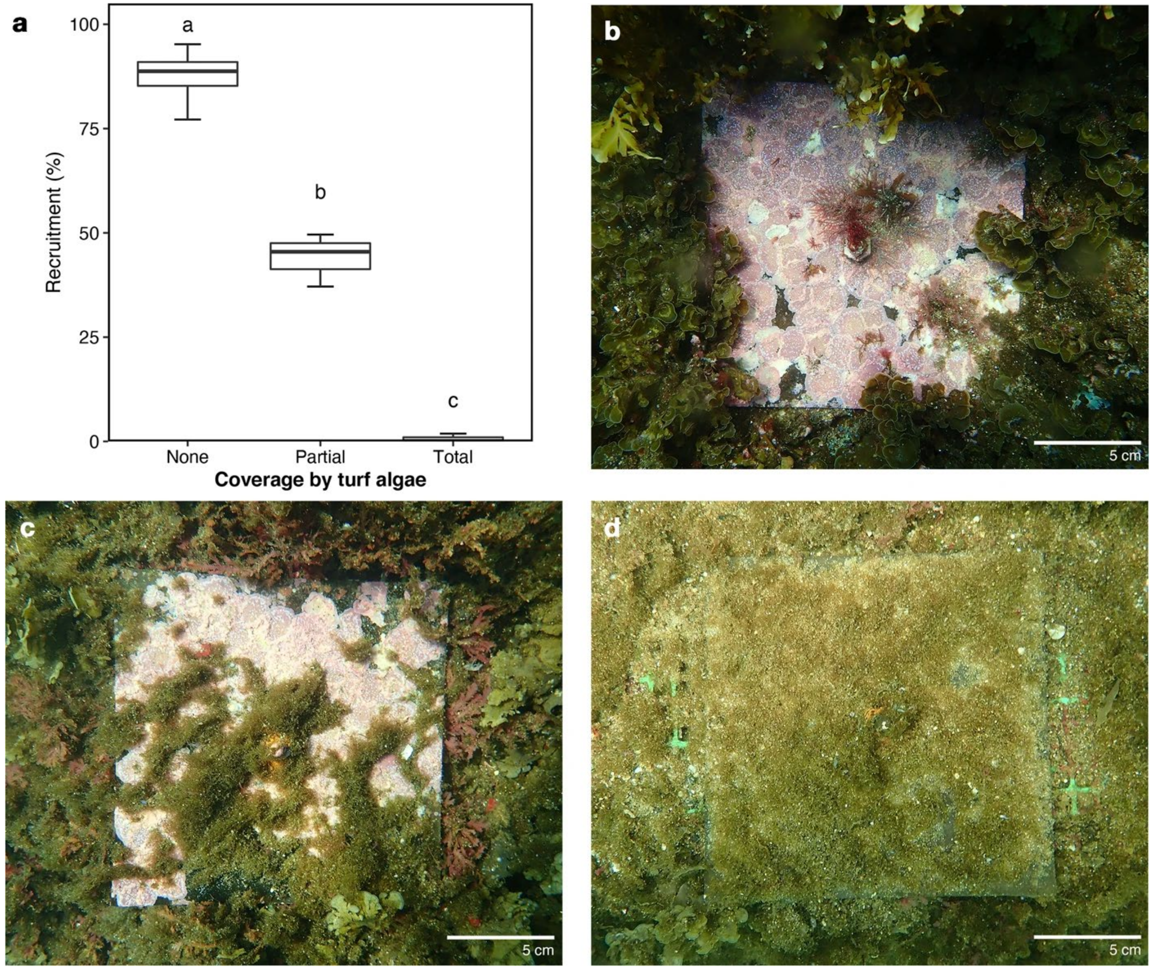
Ocean acidification



Ocean Acidification



Taryn Foster et al. ,Ocean acidification causes structural deformities in juvenile coral skeletons. Sci. Adv.2,e1501130(2016).DOI:10.1126/sciadv.1501130



Harvey, B.P., Allen, R., Agostini, S. *et al.* Feedback mechanisms stabilise degraded turf algal systems at a CO_2 seep site. *Commun Biol* **4**, 219 (2021). https://doi.org/10.1038/s42003-021-01712-2

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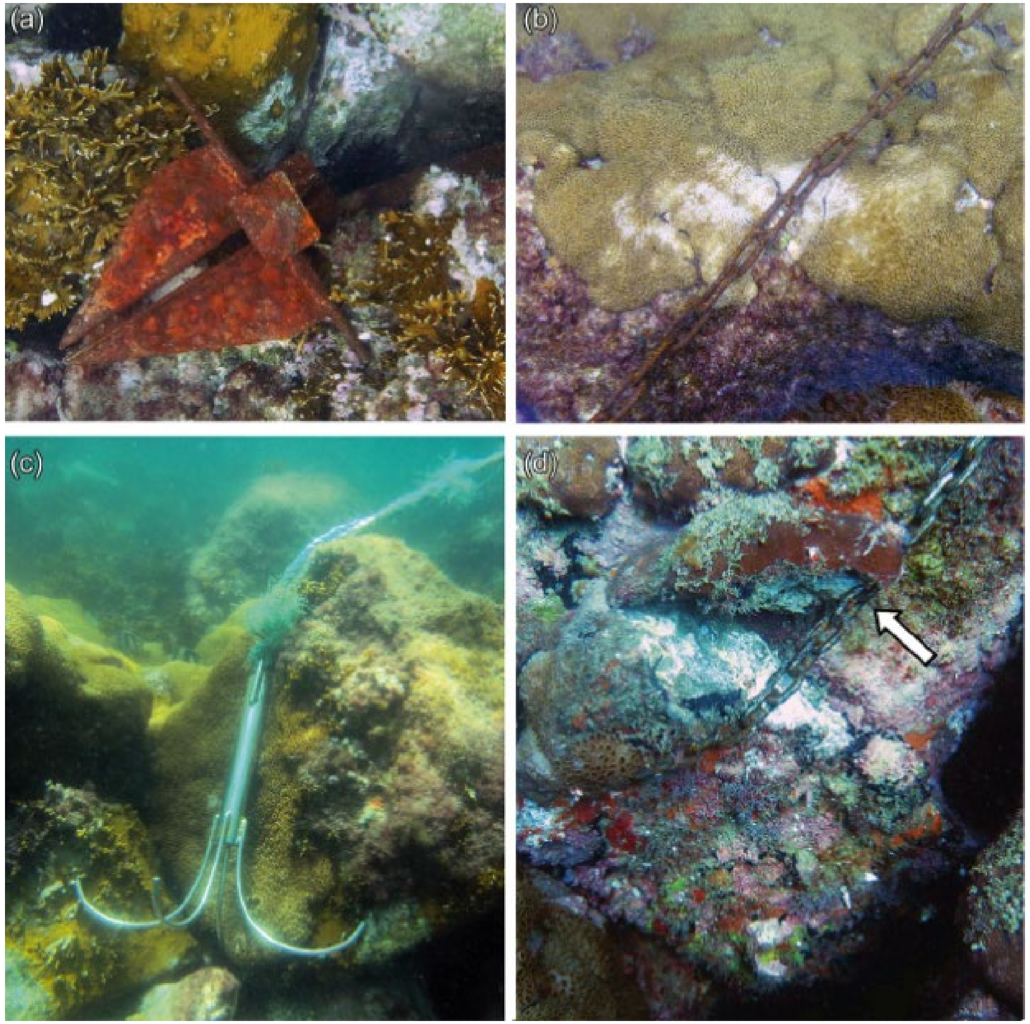
Habitat sensitivity

- Main bio constructure organisms use calcium carbonate for their body development are sensitive to ocean acidification.
- The fluctuations on the pH level affect worse than low pH level in general since the energy need become higher to regulate their defence mechanism
- Sensitive to sediment deposition on the surface
- Coralline algae species sensitive to overgrowing turf and they have very slow grow rate up to 5 mm per month.

Other threats

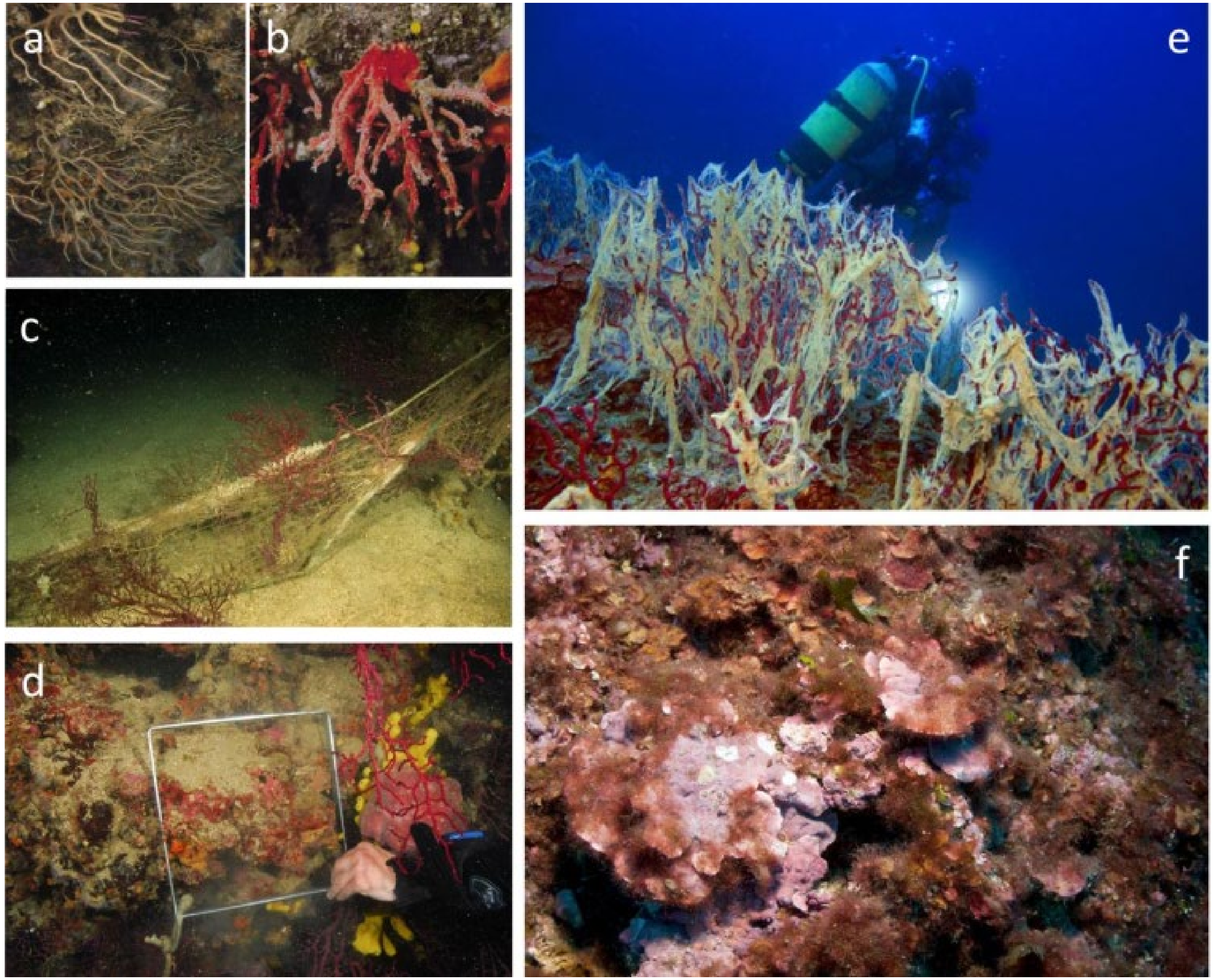
- Climate change
- Invasive species
- Anchoring
- Marine litter / Abandoned or tangled fishing gears
- Organic pollution (aquaculture etc.)
- Coastal erosion
- Illegal species collection



Giglio, Vinicius & Ternes, Maria & Mendes, Thiago & Cordeiro, Cesar & Ferreira, C.. (2017). Anchoring damages to benthic organisms in a subtropical scuba dive hotspot. Journal of Coastal Conservation. 21. 311-316. 10.1007/s11852-017-0507-7.

Other threats

a) naked branches (devoid of tissue) of the red gorgonian *Paramuricea clavata*
b) necrotic tissue (greyish in color) of the precious red coral Corallium rubrum
c) destructive impact of fishing nets; d) sedimentation over Coralligenous outcrops; e) mucilaginous algal aggregates over gorgonian branches;
f) invasive red turf algae *Womersleyella setacea* overgrowing coralligenous main builders, calcareous red algae.



Garrabou, Joaquim & Kipson, Silvija & Kaleb, Sara & Kružić, Petar & Jaklin, Andrej & Ante, Zuljevic & Rajkovic, Zeljka & Rodic, Petra & K, Jelic & D, Zupan. (2014). Monitoring protocol for coralligenous community. Developed within the framework of the MedMPAnet Project: Monitoring Protocol for Reefs -Coralligenous Community, MedMPAnet Project. 10.13140/2.1.1266.8482.

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Are we monitoring Coralligenous Habitats ?

All EU member states with marine waters are required to implement the Marine Strategy Framework Directive (MSFD)

- **Baltic Sea:** Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, and Sweden
- **North-East Atlantic Ocean:** Belgium, France, Ireland, Netherlands, Portugal, Spain, and the United Kingdom
- **Mediterranean Sea:** Croatia, Cyprus, France, Greece, Italy, Malta, Slovenia, and Spain
- **Black Sea:** Bulgaria, Romania, and Turkey

Each member state develops its own marine strategy, which includes monitoring programs to assess the environmental status of their marine waters and track progress towards achieving good environmental status.

- In some Mediterranean countries there are monitoring programs that covers also Coralligenous habitats under Marine Strategy Framework

Indexes to evaluate Coralligenous Habitats Status

Ecological Quality and Status:

CAI (Coralligenous Assemblage Index): Assesses overall ecological quality based on species composition.

CavEBQI (Cave Ecosystem-Based Quality Index): Specifically for underwater caves.

ESCA (Ecological Status of Coralligenous Assemblages): Evaluates ecological status using deep macroalgae.

ESCA-TA (ESCA Total Assemblage): Extends ESCA to include sessile invertebrates.

CBQI (Coralligenous Bioconstructions Quality Index)**:** Evaluates the quality of coralligenous structures.

MAES (Mesophotic Assemblages Ecological Status): Assesses the ecological status of deeper assemblages.

MACS (Mesophotic Assemblages Conservation Status): Monitors the environmental status of mesophotic reefs.

Indexes to evaluate Coralligenous Habitats

Structural Complexity:

COARSE index (COralligenous Assessment by ReefScape Estimate): Characterizes and evaluates the structural integrity.

OCI (Overall Complexity Index): Measures overall ecosystem complexity.

3D-Structural Complexity Index: Focuses specifically on 3D structure.

Species-Based Assessments:

INDEX-COR: Uses a ratio of sensitive and tolerant species.

MedSens: Uses citizen science data to assess species sensitivity.

Regional and Specific Approaches:

NAMBER (North Adriatic Mesophotic BiogEnic Reefs): Adapted for the North Adriatic Sea.

Standardization and Methodology:

STAR (STAndardized coralligenous evaluation procedure): Aims to standardize metrics and protocols.

CIGESMED: A pan-Mediterranean program to study Coralligenous habitats and develop indicators for assessing Good Environmental Status

Common sampling practices

Sampling Practice	Usage across various index	Advantage	Disadvantage
Scuba diving	70 %	Economic easy to access	Depth limit Meteorological condition
Photo Surveys	60 %	Rapid sampling , easy to elaborate , data deposition	Taxon precision Deep water access
Video surveys	30%	Rapid sampling easy to elaborate	Taxon Identification problems , data deposit
ROV	20 -30 %	Useful for pre-survey habitat mapping	Cost of machine and technician

What are most monitoring components across various indexes

- Diversity / species richness as percentege cover. This is a very common method for assessing the abundance of different species or groups within the Coralligenous habitat.
- Necrosis, epibiosis This measures the extent of negative impacts on organisms (overgrowth, disease, damage from debris)
- 3d complexity of the structure Qualitative Assessments, Multibeam Sonar , Lidar (laser sensors)
- Litter / fishing gear
- Sedimentation

Challenges in Coralligenous Habitat Assessment

Knowledge Gab

Community Composition Knowledge: This varies across countries, making comparisons difficult. To monitor a habitat first we need to define existing biodiversity of Coralligenous habitat . It is not possible to understand Coralligenous 3d structure without using destructive technique at first step

Defining Environmental Status: It's difficult to define intermediate environmental status without historical data on biodiversity and pressures.

Sensitivity Levels Attributing sensitivity levels to species or groups is challenging, especially with varying levels of knowledge across regions.

Impact of Climate Change Heatwaves and changes in sea water circulation are significantly reshaping Coralligenous communities in the Mediterranean. Without having base data hard to estimate them

Coralligenous Health Understanding successional stages is key to evaluating Coralligenous health.

Recovery Knowledge Gap There's limited information on the recovery of habitat-forming species after mortality events.

Challenges in Coralligenous Habitat Assessment

Methodology Gabs

Inaccurate Assessments Indexes may produce inaccurate results due to low diversity related to natural site conditions rather than human impact.

Biodiversity Loss Causes It's important to consider natural factors like physical and chemical changes alongside human-induced impacts.

Establishing Monitoring Campaigns Periodic and continuous monitoring is needed to track changes in benthic communities.

Establishing fixed stations is crucial for observing dynamics.

Choice of Fixed Stations: Careful selection is needed to represent different habitats and environmental conditions.

Cost and Continuity : Since scientific community has no consensus what are essential variables to monitor and how to monitor calculation of cost of the monitoring not easy .

What we need to monitor

- Diversity ? Abundance ? Impact?

How to monitor

- Do we have convertible methods?
- How can we provide interoperable data?
- Could we categorise protocol steps respect to general structure ? Such as coral dominant , algae dominant

Advices

- Local impacts can be categorized? (tourism/invasive species/ land use etc)
- Could we use novel technology ? If yes which ones ?

Thanks

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