bARKoding: bioinformatics data to improve environmental quality and human health of an endangered insular system: the case of Magoodhoo Island - Maldives

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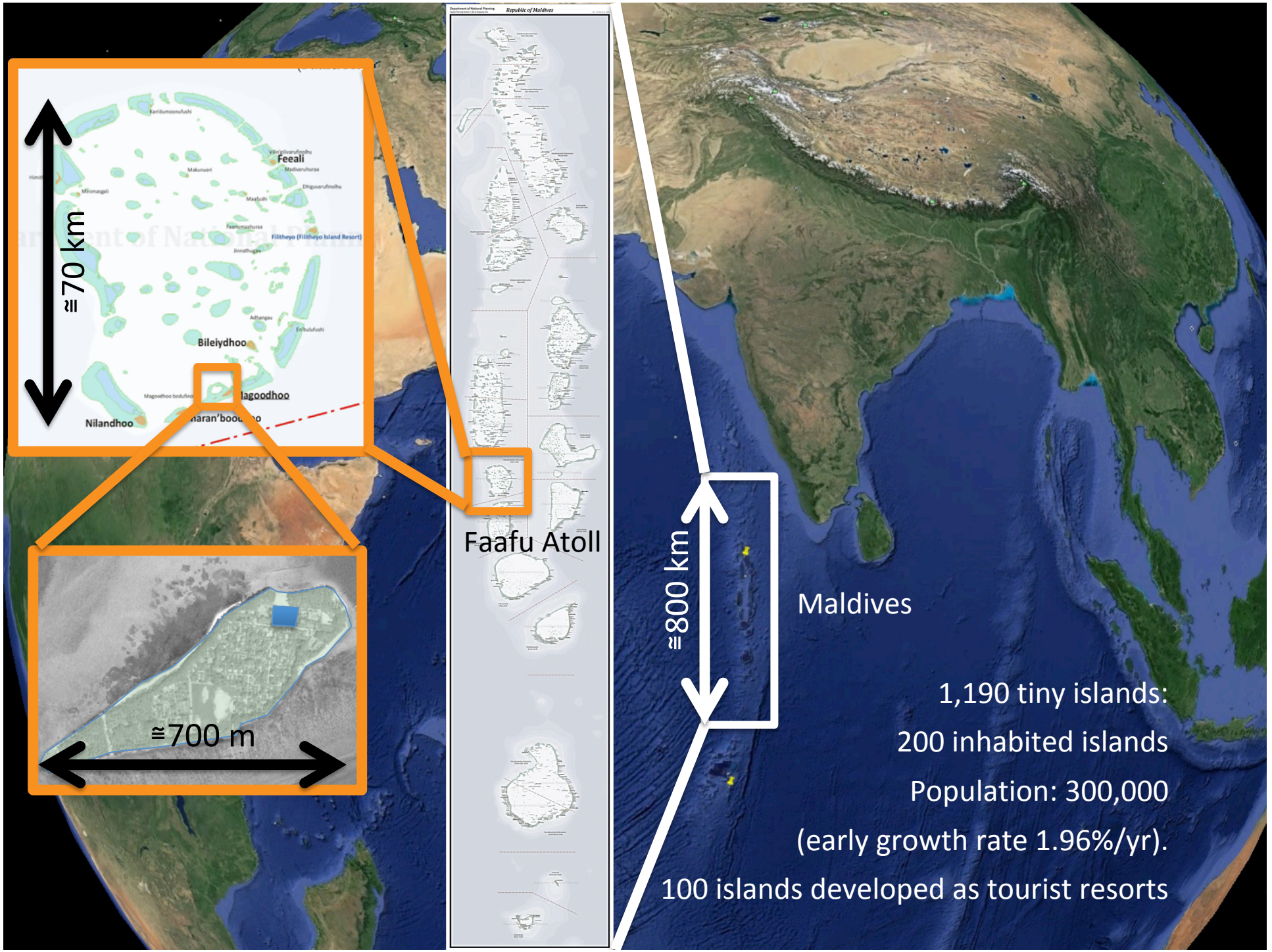

≅70 km
Feeali
Bileiydhoo
Nilandhoo
Faafu Atoll
≅700 m
≅800 km
Maldives
1,190 tiny islands:
200 inhabited islands
Population: 300,000
(early growth rate 1.96%/yr).
100 islands developed as tourist resorts

uninhabited islands (≈ 900)

islands used exclusively as resorts (≈100)

islands inhabited by local populations (≈ 200)

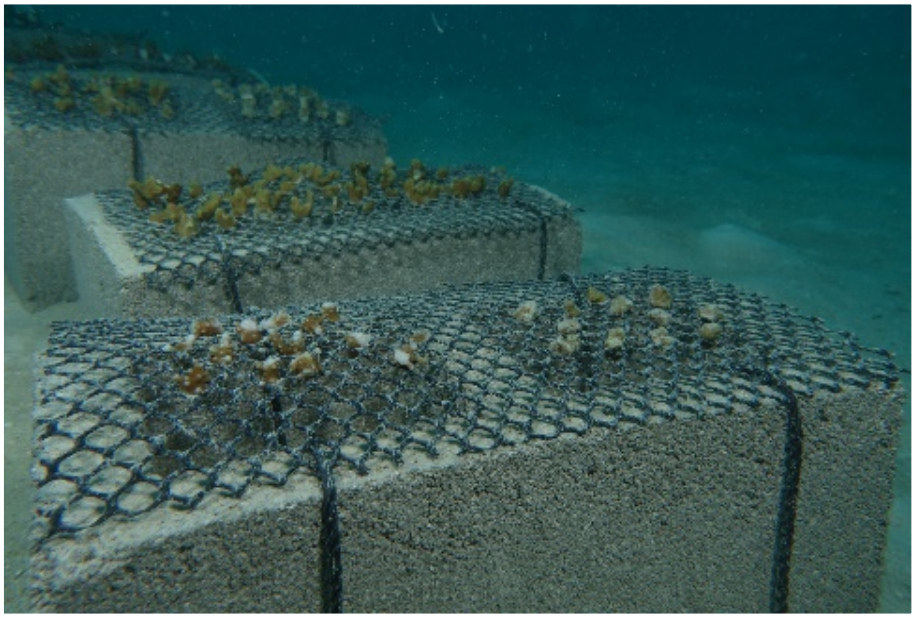
islands inhabited by locals and researchers (1)

Magoodhoo Island (Faafu Atoll)

700 x 300 m
800 inhabitants


CORAL DISEASES
Death of the colony
Fertility reduction
Growth rate reduction
Lower species richness
Shift of the community structure
Shutterland, 2004


OLYMPUS



uninhabited island (Adanga)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MALDIVES OUTPOST
MALDIVES

Acropora muricata mortality associated with extensive growth of *Caulerpa racemosa* in Magoodhoo Island, Republic of Maldives

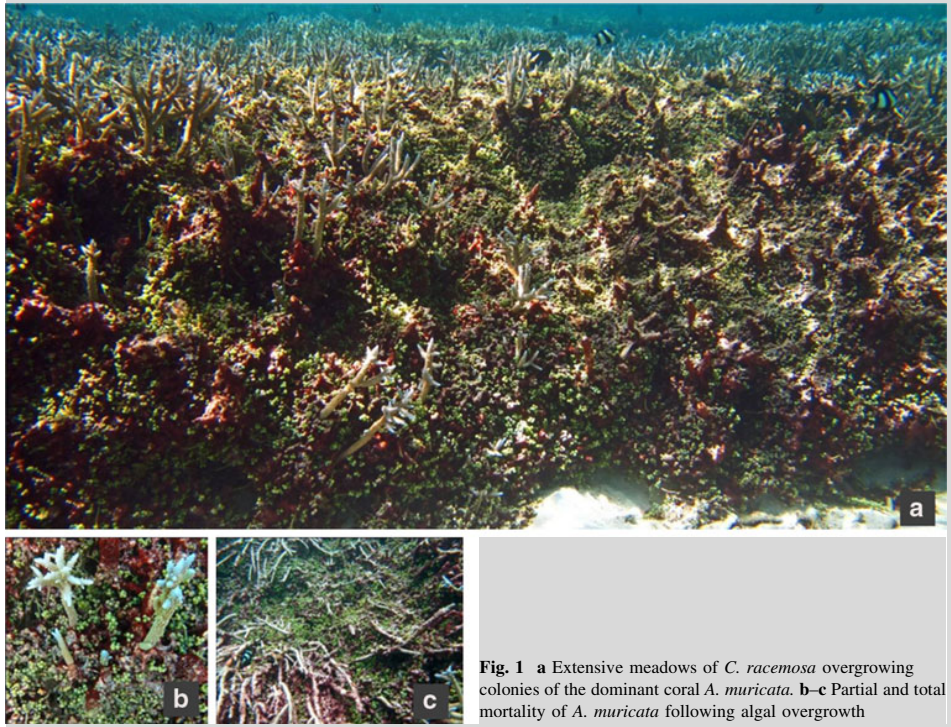


Fig. 1 **a** Extensive meadows of *C. racemosa* overgrowing colonies of the dominant coral *A. muricata.* **b–c** Partial and total mortality of *A. muricata* following algal overgrowth

Caulerpa racemosa, a common and opportunistic species widely distributed in tropical and warm-temperate regions, is known to form monospecific stands outside its native range (Verlaque et al. 2003). In October 2011, we observed an alteration in benthic community due to a widespread overgrowth of *C. racemosa* around the inhabited island of Magoodhoo (3°04′N; 72°57′E, Republic of Maldives). The algal mats formed a continuous dense meadow (Fig. 1a) that occupied an area of 95 × 120 m (~11,000 m^2) previously dominated by the branching coral *Acropora muricata.* Partial mortality and total mortality (Fig. 1b, c) were recorded on 45 and 30% of *A. muricata* colonies, respectively. The total area of influence of *C. racemosa* was, however, much larger (~25,000 m^2) including smaller coral patches near to the meadow where mortality in contact with the algae was also observed on colonies of *Isopora palifera, Lobophyllia corymbosa, Pavona varians*, *Pocillopora damicornis,* and *Porites solida*. Although species of the genus *Caulerpa* are not usually abundant on oligotrophic coral reefs, nutrient enrichment from natural and/or anthropogenic sources is known to promote green algal blooms (Lapointe and Bedford 2009). Considering the current state of regression of many reefs in the Maldives (Lasagna et al. 2010), we report an unusual phenomenon that could possibly become more common.

Thilafushi Island – The Maldives's bin

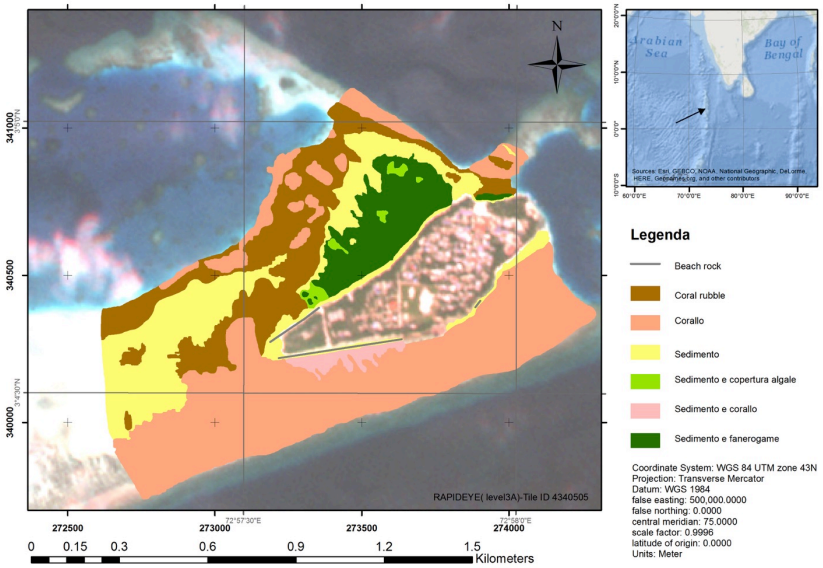
Typical discharge on a local island

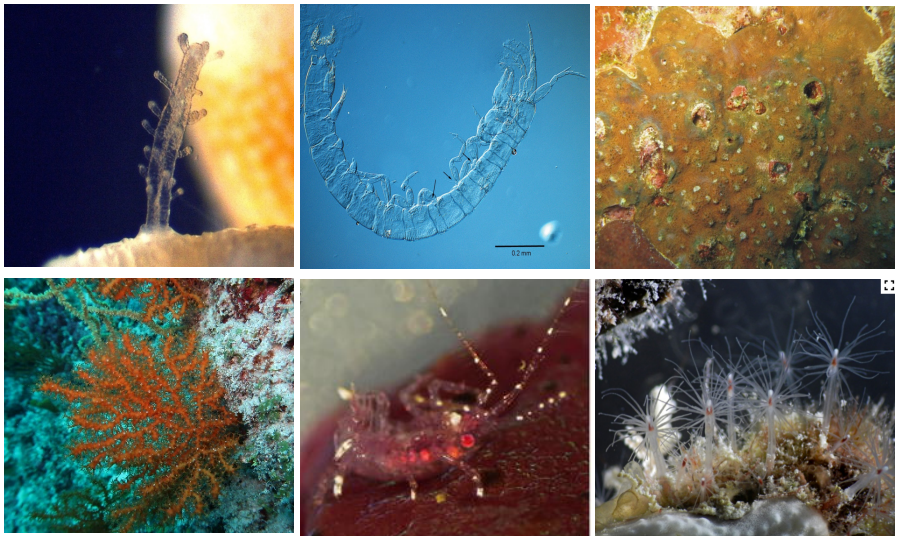
Incinerator on a resort island

Main research fields

- Ecology and physiology of coral diseases
- Integrative taxonomy, ecology, evolution of invertebrates
- Ecology and diversity of symbiotic relationships
- Ecology of corallivorous organisms
- Habitat mapping, land use, and monitoring using satellite images and drones
- Anthropological, sociological and geographical studies on climate change, waste management, religion, etc.
- Drug consumption
- Etc.

> 20 new records/new descibed species
> + dozens of new species to be described





bARKoding – The first barcoded island

The Republic of the Maldives is worldwide considered an icon of the environmental challenges threatening Small Island States.

It is a vulnerable archipelago facing a series of threads linked to the combined effects of **climate change**, **pollution**, and **anthropization**.

Ocean water and coral reefs are vital for the economy of the Maldives. The two major industries – **fisheries** and **tourism** – directly rely on the health of the marine ecosystem

Faafu-**Magoodhoo island** is representative of >60% of the inhabited islands (<1000 inhabitants; 20-30 hectares)
Documented stressors: eutrophication, waste management, coral mortality, reef alienation, etc.

Adanga island: typical uninhabited island, generally less stressed than other inhabited islands (e.g. Magoodhoo)

bARKoding – The first barcoded island

To plan the most efficient strategy to **protect and improve biodiversity** it is essential to define:

i) the most efficient **identification and monitoring tools** for biodiversity analysis combining the recent advances in molecular biology and in bioinformatics

ii) a new tool able to estimate the **effect of biotic and abiotic stress on biodiversity** by using informatics approach proved by machine learning and prediction model.

iii) a new **strategy of urban and territorial planning** able to preserve functional biodiversity and enhance human wellness (e.g. reduce biotic and abiotic pollutants).

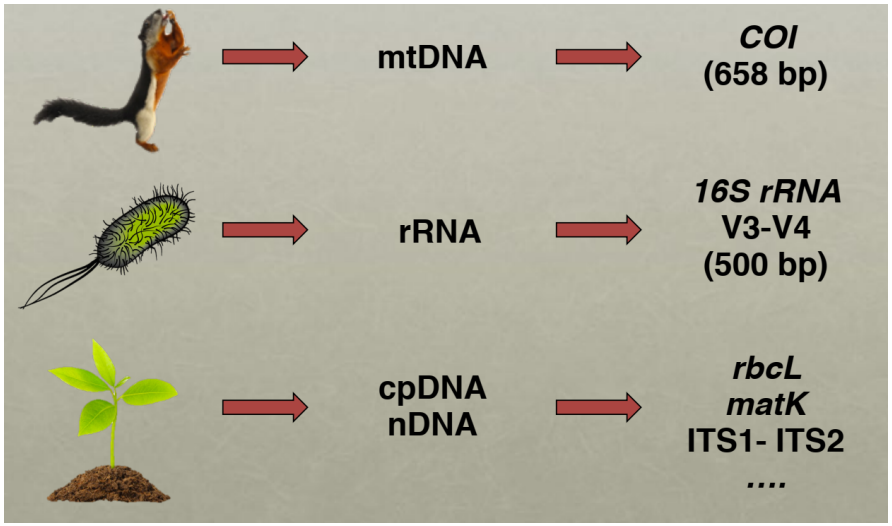
bARKoding – The first barcoded island

To estimate whole biodiversity at the isolated and endangered areas

Data collection: Magoodhoo and Adanga islands (~ 0.5 km^2), 2 years period from the upper limit of the tropical forest to ~20 m deep

Identification at species level: Classical systematics + molecular techniques

DNA barcoding and **eDNA metabarcoding**



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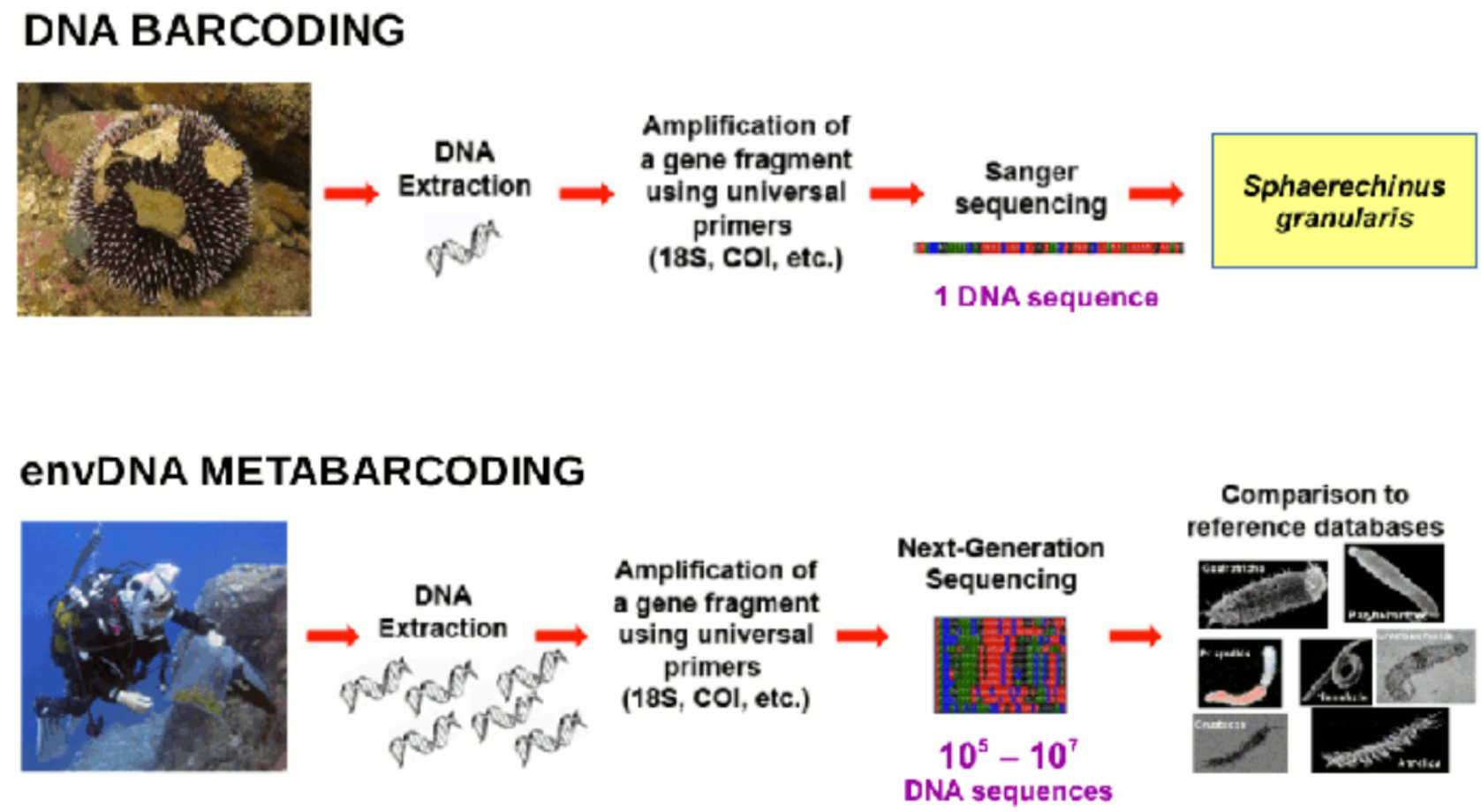
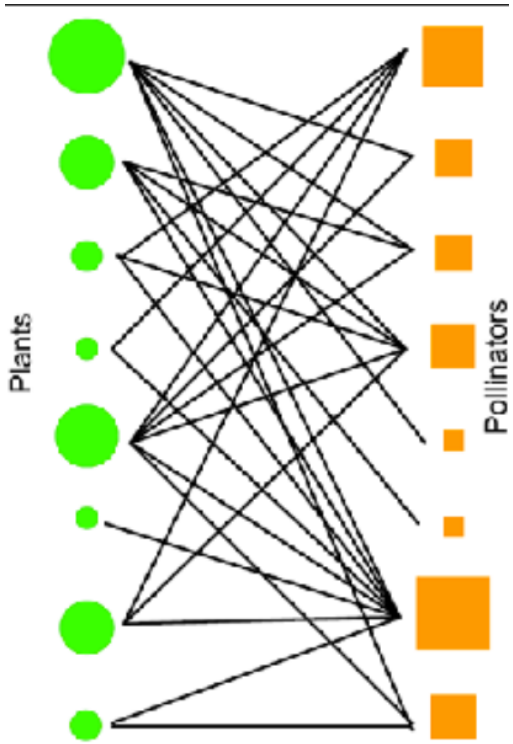
DNA barcoding and eDNA metabarcoding



bARKoding – The first barcoded island

Bioinformatics: design new tools shared with the *LifeWatch* platform to integrate molecular data with other sources of information such as ecological interactions, climatic conditions, chemical features, economical interest, etc



Define a machine learning system to predict the effect of abiotic and biotic stress on biodiversity and to define suitable resilient strategies.

bARKoding – The first barcoded island

The main research products are:

1. Achievement of the **first completely DNA barcoded islands**

2. Realization of a **dataset of species characterized from the functional point of view** and from the point of view of the relations of the **functions correlated with the human activities**

3. Generation of **metadata** that can be used also by the **local population**

4. **Comparison** between **differently exploited islands**:
   local island vs unhinabited island

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