Corso di Dottorato di Ricerca in Scienze della Vita e dell'Ambiente - Ciclo XXXVII

The role of microbiomes in marine systems

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It is known that marine multicellular organisms live in close relationship with their microbiome. Microbiomes provide the hosts with numerous abilities such as nutrient supply, defence and development, becoming an integral component of the host physiology. Moreover, microbiomes show a large variability in composition and structure across hosts, likely due to the capacity of the hosts to select microbes specifically from the environment. There is evidence that organisms own a stable core microbiome (set of microbial taxa characteristic of a specific host or environment) which can be useful to better understand the functional feature that are essential for each different species. However, core microbiomes must be contextualized in the frame of the significant adaptive and/or maladaptive changes in microbiome composition among individuals in distinct populations under different environmental conditions such as geographic location, presence of pollutants and stressors, including climate change.

To increase the understanding of these microbiomes dynamics and evolutionary significance it is necessary to identify core and variable microbial taxa, their adaptative features to environmental conditions and the mechanisms of microbiome establishment and selection. These include horizontally-transmitted microbes (selected from the environment by each host generation) and vertically-transmitted microbes (persisting across life stages and generations, thus coevolving with the host and favoring reciprocal adaptation).

Despite the scientific community increasing interest on the evolutionary processes and adaptation strategies of marine organisms, information on the specific role of microbiomes to such processes is still limited and further investigations are necessary.

Aims

1) To broaden the knowledge of the functional role of microbiomes in organisms living in different environmental conditions, including extreme environments and polluted areas.
2) To investigate the intraindividual, intraspecific diversity of microbiomes associated to invasive species and their role in the adaptation of such species in non native habitats.
3) To understand the specific abilities that microbiome could provide to the hosts in order to cope with different extreme conditions (such as Dead Sea basin and Antarctic ecosystem).

Methods

Prokaryotic and Viral abundances, both in sediments and water

Extracellular Enzimatic Activities, in sediments

Quantity and quality of organic matter through spectrophotometric analyses (Proteins, Carbohydrates, Lipids and Chlorophyll)

SEM analyses and microphotography

DNA extraction in sediments and water (eDNA) and in selected species for the presence of core microbiome

Sequencing and statistical analyses of microbial community

Task 1

Bioplastic is rapidly growing as the main alternative to traditional plastic, especially for single use products such as cutlery and cups. Although labelled as completely biodiegradable multiple experiments have shown that biodegradation in natural environment is slower than in landfill and it could take years to completely disappear thus creating environmental problems. In order to investigate the biodegradation processes, biofilm formation and evolution and the effects of bioplastic in the benthic compartment an experiment was set up: shore sediment and seawater were collected in Palombina (Ancona, Italy) and equally divided in glass beackers to create microcosms. PLA (poly-lactic acid), one of the most produced bioplastic was added to experimental units in pieces of 1,5 x 1,5 cm. Microcosms were kept at costant temperature of 20°C and with a day/night cycle of 12h in a climatic chamber and sampled every months for a total duration of 6 months.

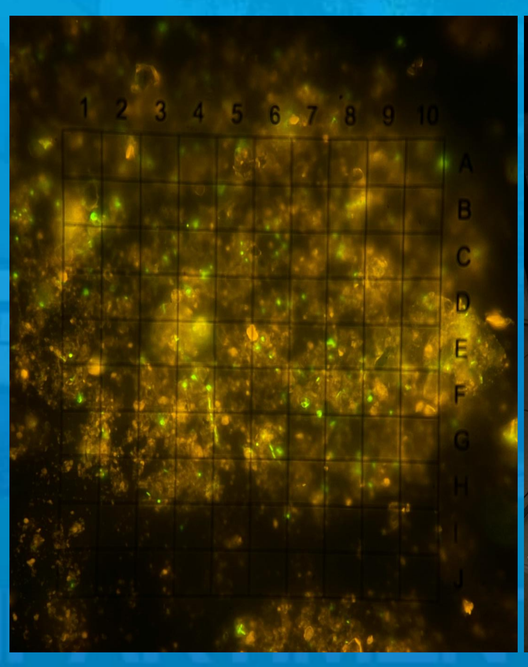

Fig. 1 Coloured slides (SYBR Green I) to estimate prokaryotic abundance

Fig. 2 Microcosms used for the experiment of exposure of bioplastic to marine sediment

Task 2

The Dead Sea is one of the most extreme environment in the world, characterized by extreme salinity (approximately, 34%), low pH and a unique ionic composition (with Magnesium as main cation) . These features makes life almost impossible except for Bacteria, Archea and Fungi. Moreover the Dead Sea is changing over time: salinity is expected to increase during the next years mainly due to high evaporation and low regional precipitation and the increase of tourism has already led to the accumulation of litter in some part of the basin. Sediments, water and salt crystals from the Dead Sea were taken from 3 different zones characterized by different levels of pollution in order to investigate the possible effect of the litter in the microbial community. In addition, part of the sediment will be analyzed for the presence of meiofauna and, if present, associated microbiomes will be analyzed to determine the putative advantages that could give to the hosts.

Task 3

Marine non indigenous species (NIS) are causing severe ecological and economic impacts worldwide and the Mediterranean Sea is becoming a major hub for the transfer of such invasive species. Moreover, the increase of temperatures due to climate change is accelerating this process with the rate of introductions for the Mediterranean in the 3-year period 2017-2019 of 8 species per year. Among the numerous NIS species (666) in the Mediterranean, ascidians are aggressive competitor for space and resources causing the decrease of native species and thus disrupting the natural ecosystem. Despite the well-known features that help the spread of Ascidians (such as high rates of reproduction and production of deterrent substances on the body surface) limited attention has been given to the role of their microbiome in the success of their establishment outside native habitats. A species of invasive ascidians present both in the Tyrrhenian Sea and the Adriatic Sea was selected to study its symbiotic microbial community with attention to intraindividual and intraspecific prokaryotic diversity. Additionally, the ascidian associated microbiomes will be investigated also to clarify the positive functional roles that some bacteria may give to the invasive host, contributing to its establishment success.