DEAD SEA MICROBIOLOGY

Treball de Fi de Grau 2014 - Microbiologia

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Introduction

The Dead Sea is one of the most hypersaline environments on Earth (347g/l). Its water level is 417 m below the sea, and the lake is over 300 meters deep, but the water level decreases 1 m every year due to evaporation and the small water inflow.
The ionic composition is dominated by divalent cations, like Magnesium and Calcium, and its pH is about 6.
This characteristics make this lake a truly inhospitable environment and a very difficult place to develop life. [1]

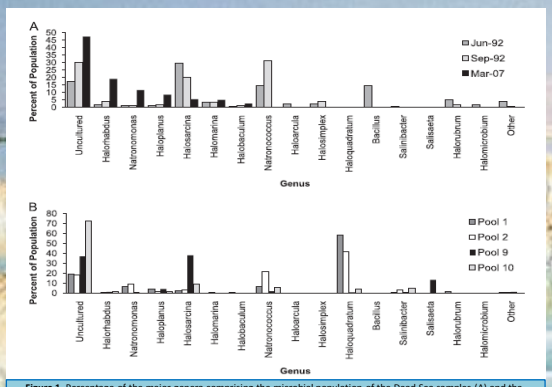


Figure 1. Percentage of the major genera comprising the microbial population of the Dead Sea samples (A) and the mesocosm pool samples (B).

Archaea

The prokaryotic community is dominated by extremely halophilic archaea, family Halobacteriaceae. (Figure 1) The bacteriorhodopsin pigments in their membranes, give a red color to these organisms.

The most studied archaea are the following:

Haloarcula marismortui was the first archaea isolated from the Dead Sea.
Halobaculum gomorrense
Halorubrum sodomense
Haloferax volcanii (Figure 2)

Numbers in archaeal blooms:
1963 → 5.6x10^6 cells/ml
1980 → 1.9x10^7 cells/ml
1992 → 3.5x10^7 cells/ml

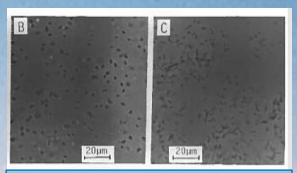


Figure 2. B: *Haloferax volcanii*. **C:** *Halorubrum sodomense*.

Bacteria

The first isolated bacteria were *Chromohalobacter marismortui* and *Halomonas halmophila*.
The most important bacteria are anaerobic (order Haloanaerobiales), these include fermentative bacteria and denitrifiers.
The most representative species of this order are:
Halobacteroides halobius
Orenia marismortui
Sporohalobacter lortetii

Bacteria are in very low numbers. [2]

Freshwater springs

Recently, researchers have discovered deep freshwater springs on the lake floor, with new types of microorganisms growing in biofilms. The top of the springs' rocks are covered with green biofilms. The bottom of the rock is covered with a white biofilm, formed by sulfate-reducing bacteria. (Figure 3)
In this community exist a great diversity of Archaea and Bacteria, so it can be a source of new investigations.

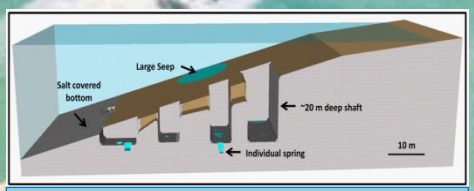
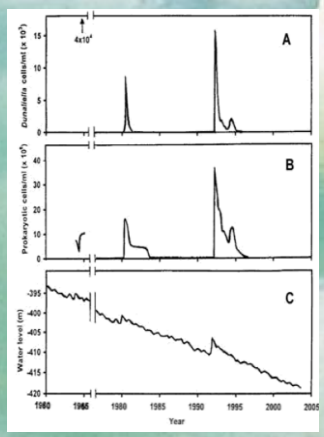


Figure 3. Structure of the freshwater springs



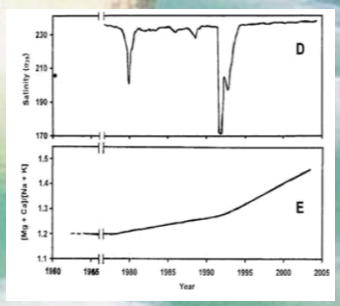


Figure 4. A: Population density of the unicellular green alga *Dunaliella*. **B**: community density of prokaryotes in the upper meters of the water column. **C:** the water level of the Dead Sea. **D:** the salinity of the upper water layer. **E:** molar ratio of divalent and monovalent cations of the Dead Sea.

Viruses

Between 0.9-7.3x10^7 virus-like particles/ml were enumerated, with a variety of morphologies.
Viruses may play a major role in the decline of halophilic archaeal communities in the Dead Sea. [4]

Fungi

At least 26 species have been found, most of them belonging to the ascomycetes. The most common genus are *Aspergillus* and *Penicillium*. [3]

Gymnascella marismortui is a true halophile, and may be endemic of Dead Sea. (Figure 5)

Numbers:
Water column → 0.1-0.2 cfu/ml
Sediment → 8.9-91.1 cfu/g

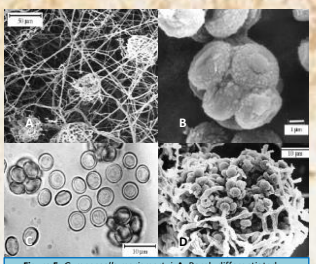


Figure 5. *Gymnascella marismortui*. **A**: Barely differentiated ascomata (SEM). **B**: Asci and ascospores (differential interference contrast microscopy). **C:** asci and ascospores (differential interference contrast microscopy). **D:** Asci surrounded by peridial hyphae (SEM).

Algae

The unicellular flagellate green alga *Dunaliella parva* is the most important eukaryotic organism in the Dead Sea, and the only primary producer. (Figure 6, 7)

Numbers:
1964 → 4x10^4 cells/ml
1980 → 8.8x10^3 cells/ml
1992 → 1.5x10^4 cells/ml

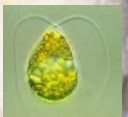


Figure 6. *Dunaliella*

Figure 7. *Dunaliella*

Ecology of blooms

When the upper water layers become diluted with fresh water from rain floods, and phosphate is available, a bloom of *Dunaliella* can be developed. (Figure 4, 8)

Dunaliella bloom is followed by growth of red halophilic archaea, that impart a reddish color to the water.

Glycerol produced by *Dunaliella* is the main source of organic nutrients for archaea.

When the salinity becomes too high for *Dunaliella*, they disappear from the water column and archaeal communities decline, hypothetically by the action of bacteriophages. [5]

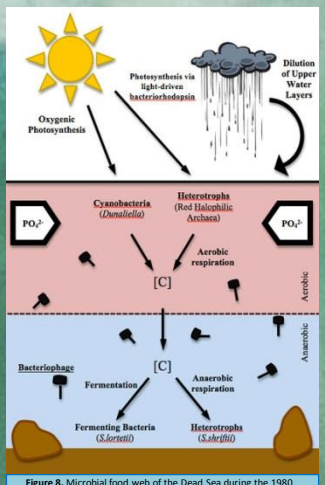


Figure 8. Microbial food web of the Dead Sea during the 1980 and 1992 bloom.

Conclusions

- In the Dead Sea exist a great diversity of microorganisms, subject to constant changes due to phenomena such as evaporation or water dilution.
- A big percentage of the microbial population is unculturable, so more studies can give us information of their role in the ecosystem.
- Some of the microorganisms have unique characteristics that can provide us information about the evolution and adaptation to extreme environments.

References

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