



Magnesium-tolerant fungi from the bitterns

Silva Sonjak¹, Bükay Yenice Gürsu², Nina Gunde-Cimerman¹

¹Department of Biology, Biotechnical Faculty, University of Ljubljana, Ljubljana, Slovenia

² Biyoloji Bölümü, Fen Edebiyat Fakültesi, Eskişehir Osmangazi Üniversitesi, Eskişehir, Turkey

Saline waters dominate the Earth

- Oceans: 96.5%
- Saline groundwaters (inland seas or saltwater lakes): 1%

Salts in hypersaline environments:

- NaCl (most common)
- MgSO₄
- MgCl₂
- CaCl₂
- others

Solar System
(ubiquitous)

Biological systems
(cofactor, stabiliser – DNA, lipids, chlorophyll)

Earth's crust
(2% weight)

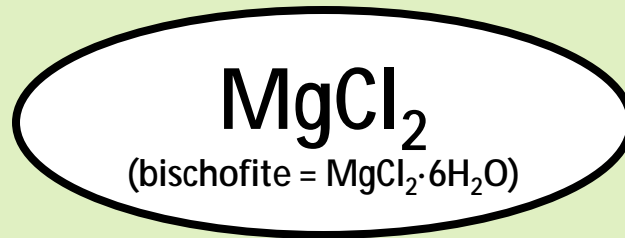
Magnesium
(Mg)

Sea water

(3th most abundant element)

Evaporate deposits and brines
Athalassohaline waters (Dead Sea)

MgSO₄, MgCl₂



Highly soluble in water (> 5 M = aw < 0.4)



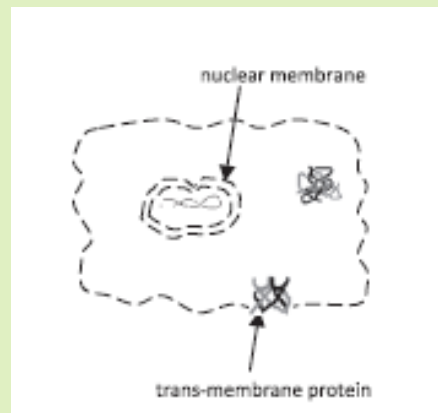
Water activity reduction (loss of cell turgor)

Chaotropic activity (destabilization of cellular macromolecules)

Is there life in MgCl_2 -rich (dominated) environments ???

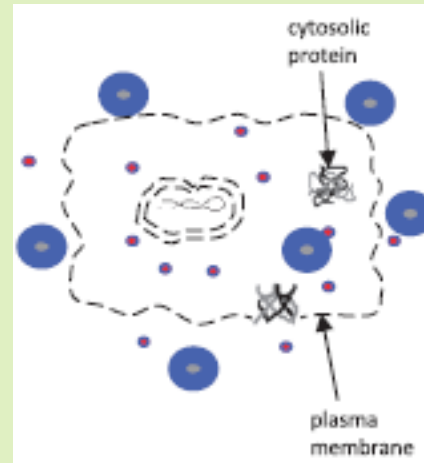
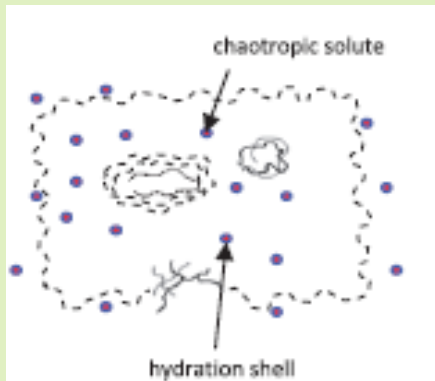
- **< 1 M MgCl_2**
Inhibition of *a test enzyme In vitro*
- **1.26 M MgCl_2**
Inhibition of microbial growth *In vitro*
(Samples from deep sea MgCl_2 -dominated brine lake with up to 5.05 M MgCl_2)
- **2.3 M MgCl_2**
The upper limit for life

MgCl₂
Urea
Fructose

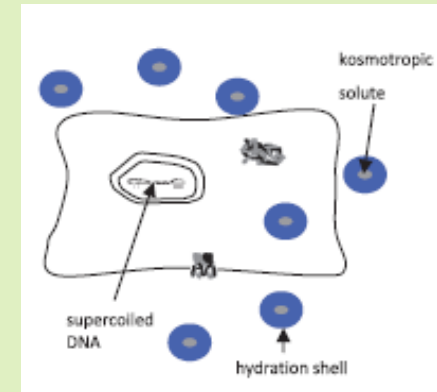


MgSO₄
NaCl
Sucrose
Compatible solutes

Chaotropicity



Kosmotropicity



weakened electrostatic interactions
and destabilized macromolecules

strengthened electrostatic interactions
and stabilized macromolecules

Growth on medium with MgCl_2

Archaea

Halorubrum sodomense
2.5 M MgCl_2 + 0.5 M NaCl
(Oren, 1983)

Bacteria

1.26 M MgCl_2
(Hallsworth et al., 2007)

Fungi?

(Williams and Hallsworth, 2009)

Hypersaline waters sampled



Water samples analysed

ION COMPOSITION (g l ⁻¹)							
WATER SAMPLES	Salinity	Mg ²⁺	Ca ²⁺	Na ⁺	K ⁻	Cl ⁻	Br ⁻
Athalassohaline waters							
Dead sea	340	40.7	17	39.2	7	212	5
Thalassohaline waters							
Sečovlje salterns BRINE - BITTERN	320	10.6	0.7	100.5	3.2	187	0.4

Fungi isolated from Dead Sea

Cladosporium spp. (> 50%) related to:

- *C. tenellum*
- *C. ramotenellum*
- *C. sphaerospermum*
- *C. cladosporioides*
- others



Different filamentous fungi

No Black yeasts

Fungi isolated from Sečovlje salterns

Water from reservoir (50 ml)

Brine stored for 3 years (50 ml)



1 M MgCl_2

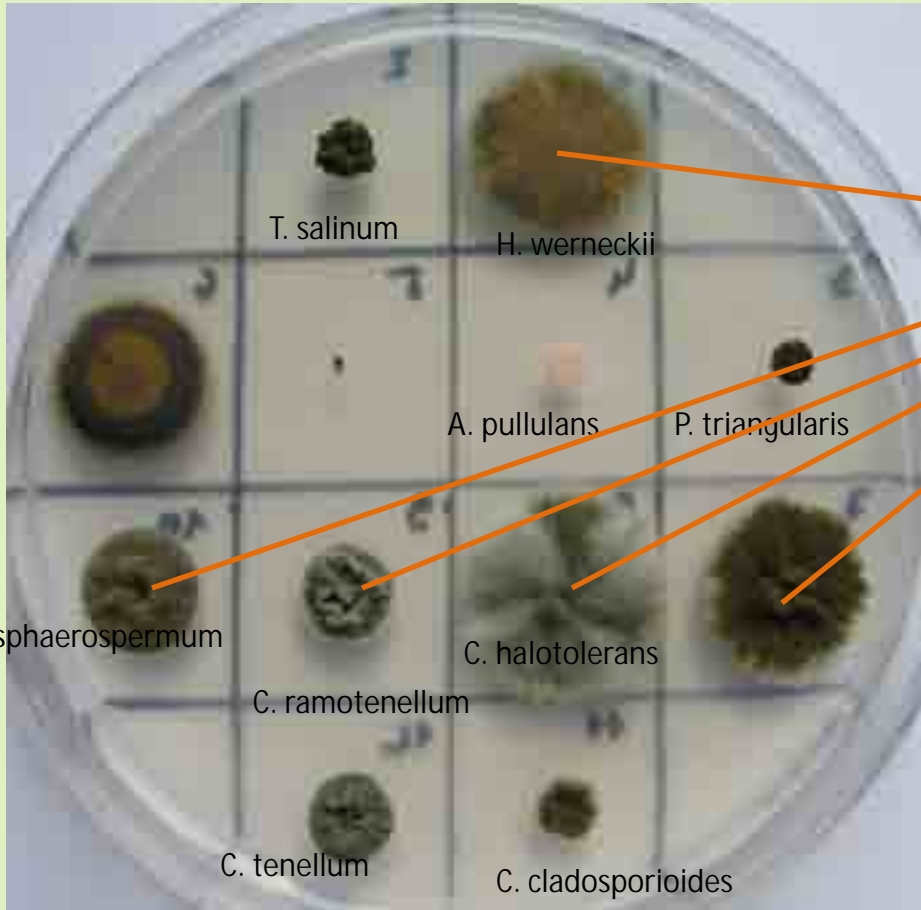


1.5 M MgCl_2

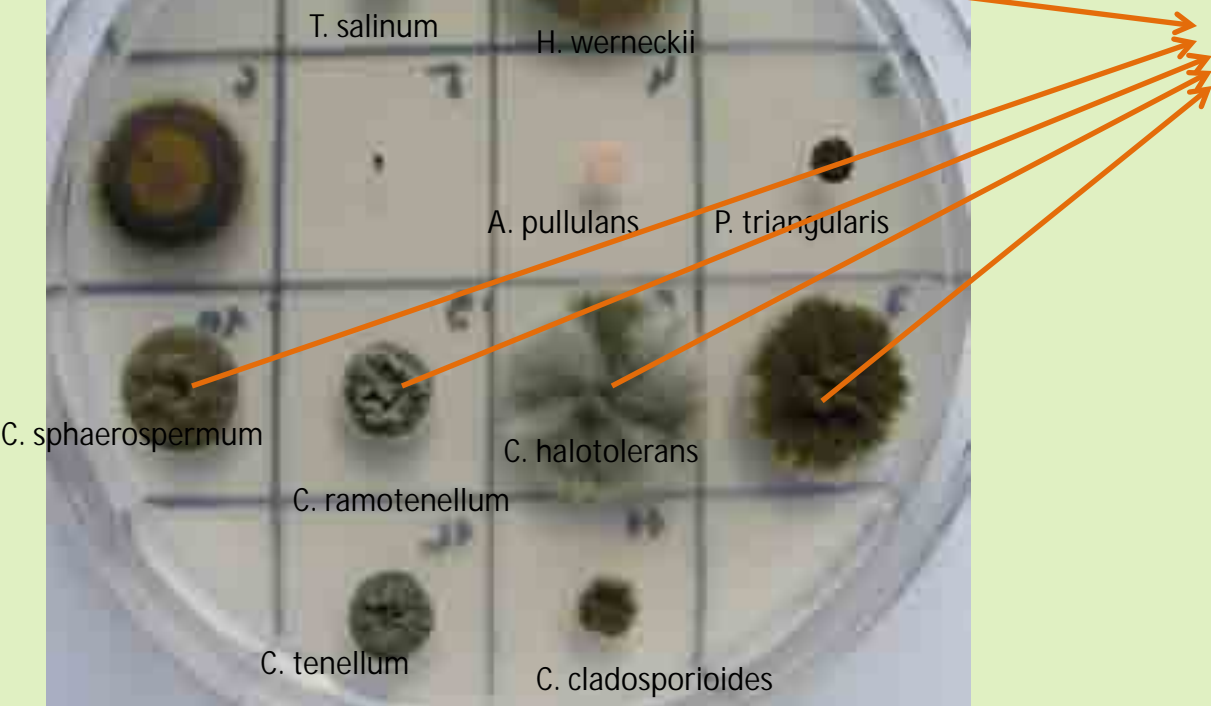


Growth of selected black yeasts on MgCl_2

MEA + 1.26 M MgCl_2



MEA + 1.7 M MgCl_2



Conclusions

- Halophilic / halotolerant *Cladosporium* spp. can be isolated in high numbers from Mg²⁺ rich waters.
- Halophilic / halotolerant black yeasts and related *Cladosporium* spp. can grow on medium containing at least 1.26 M MgCl₂.

Fungi as chaophiles

New class of extremophiles proposed by Hallsworth et al. (2007)

