



The REBUS fungal collection for the space organic waste exploitation

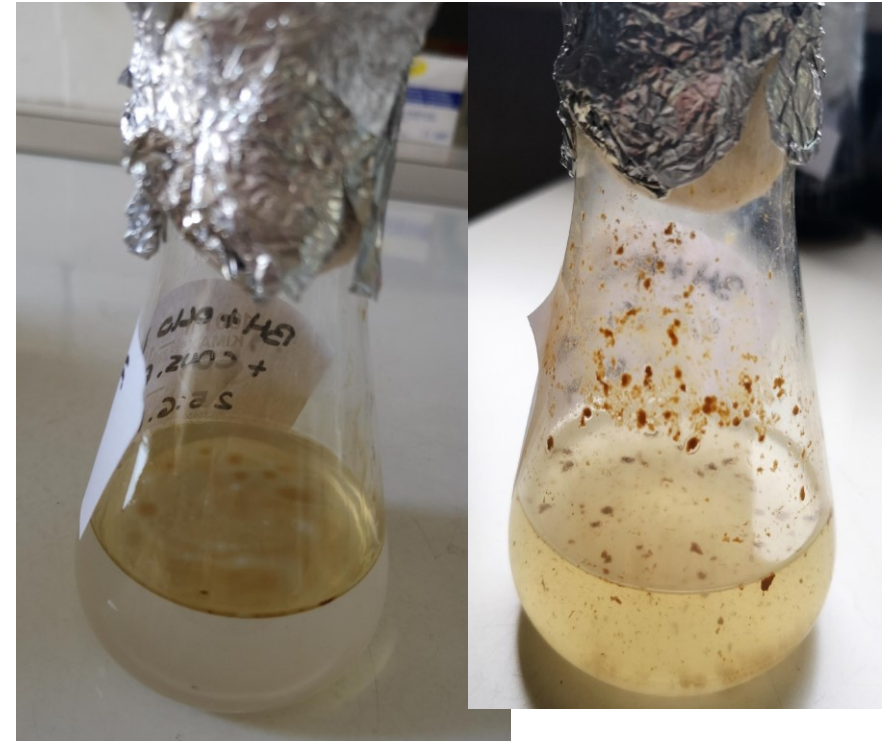
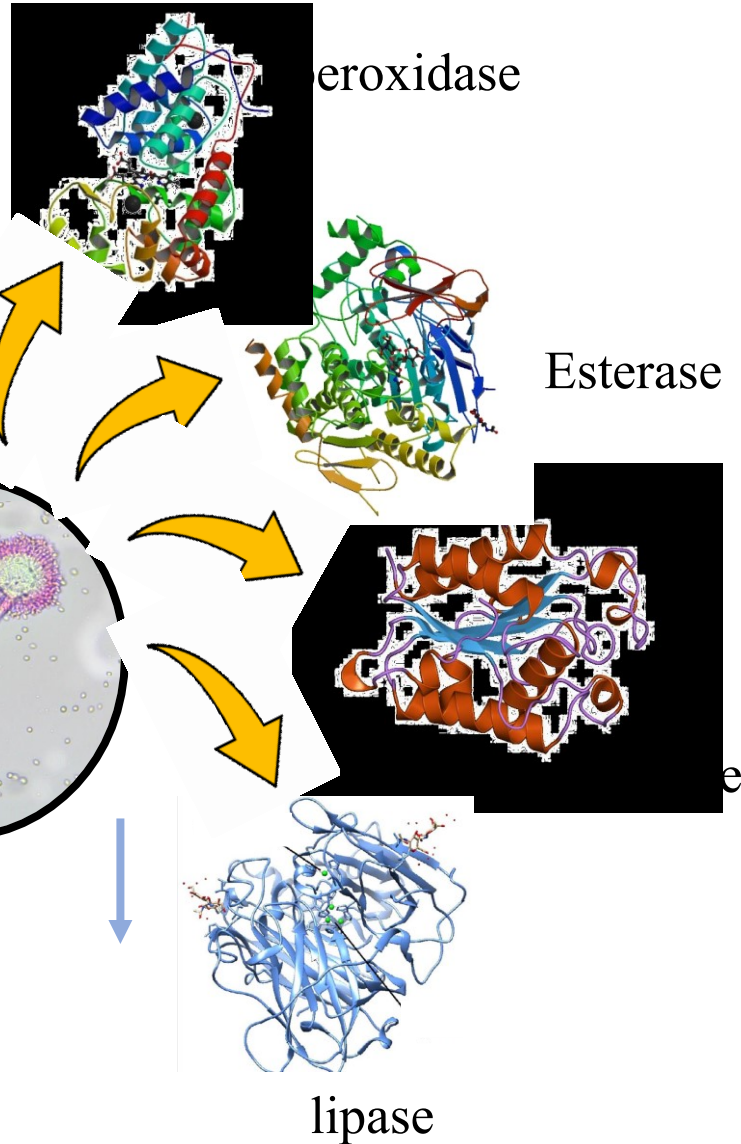
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Fungi can degrade materials and change them thanks to their strong enzymes

Some examples



Fungal activity on hydrocarbons mixture after one week





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Biodiversità ed Ecologia dei Funghi

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Visualizza Modifica Elimina Revisioni Traduci

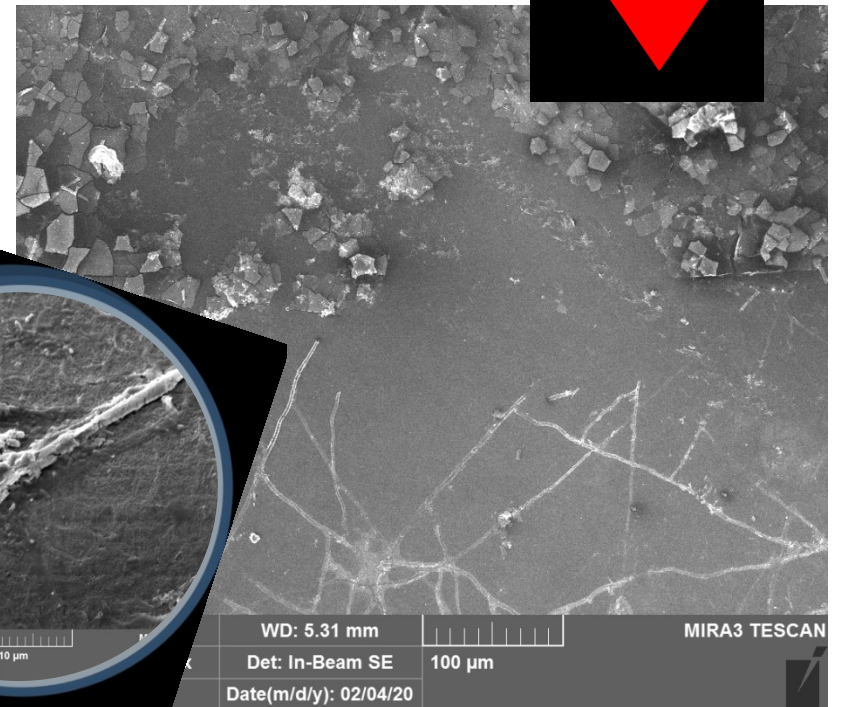
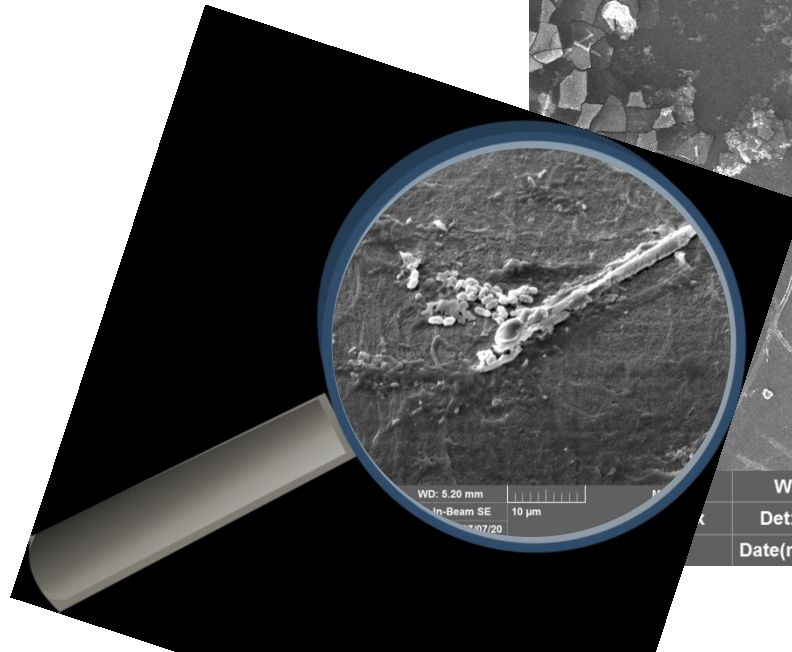
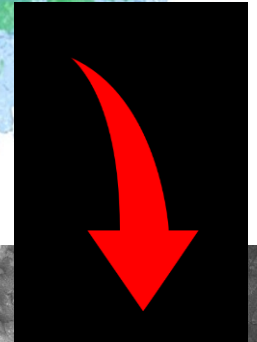
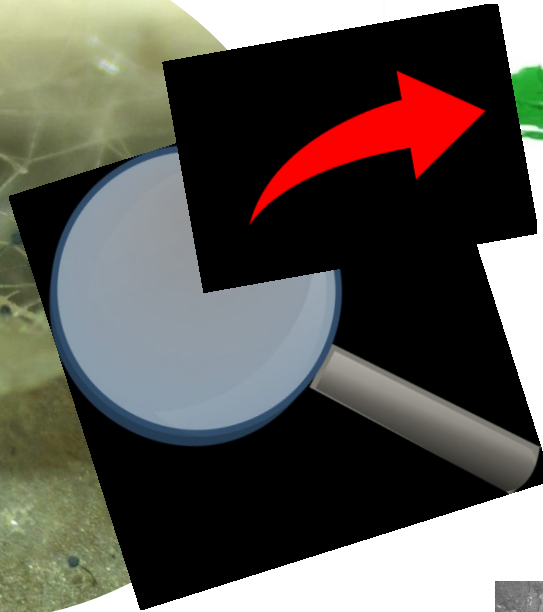
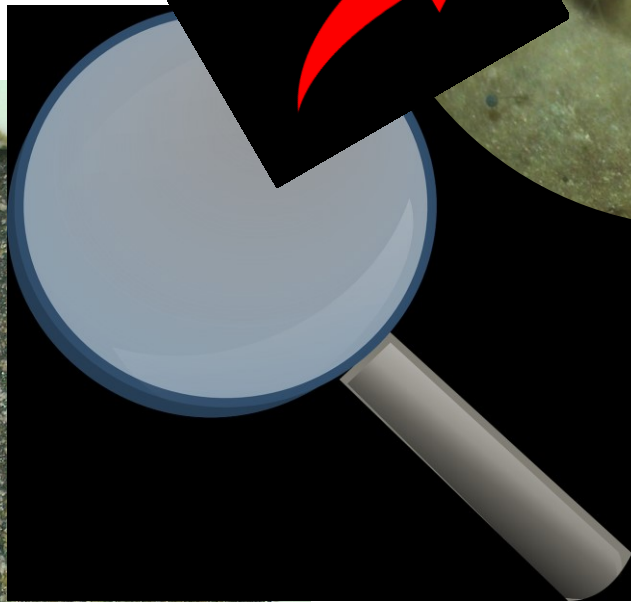
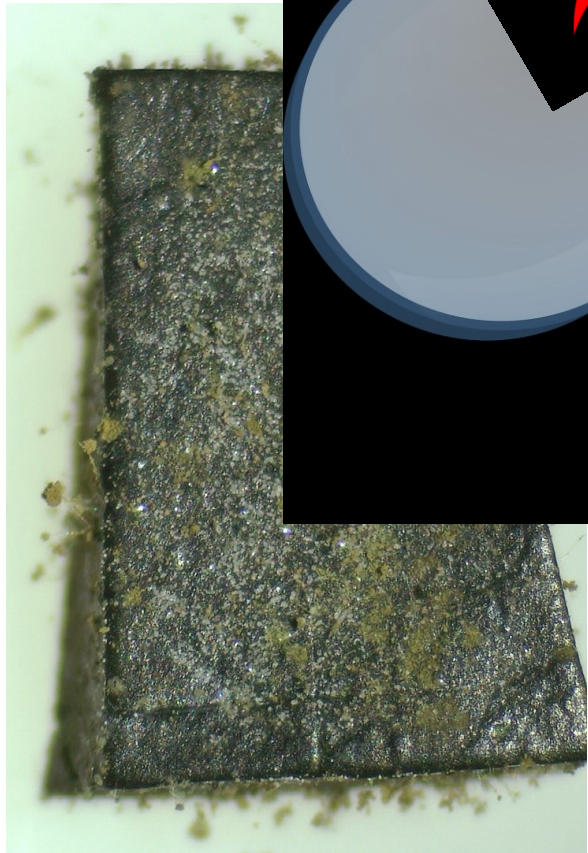
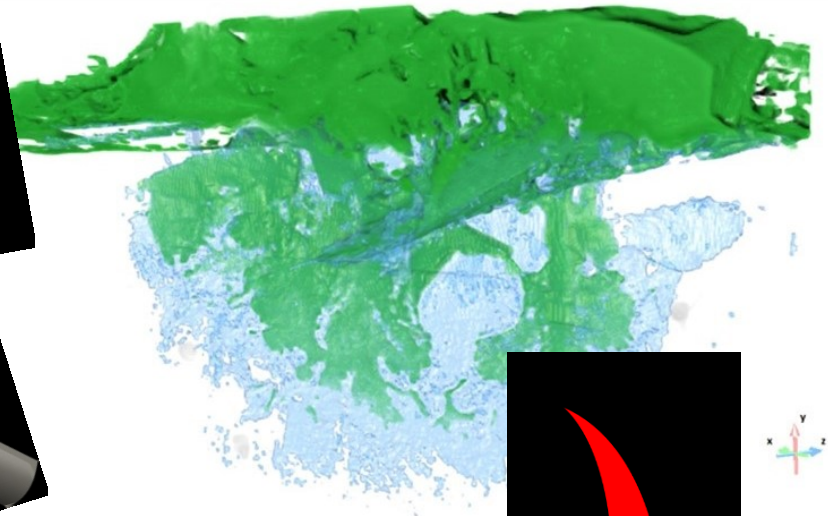
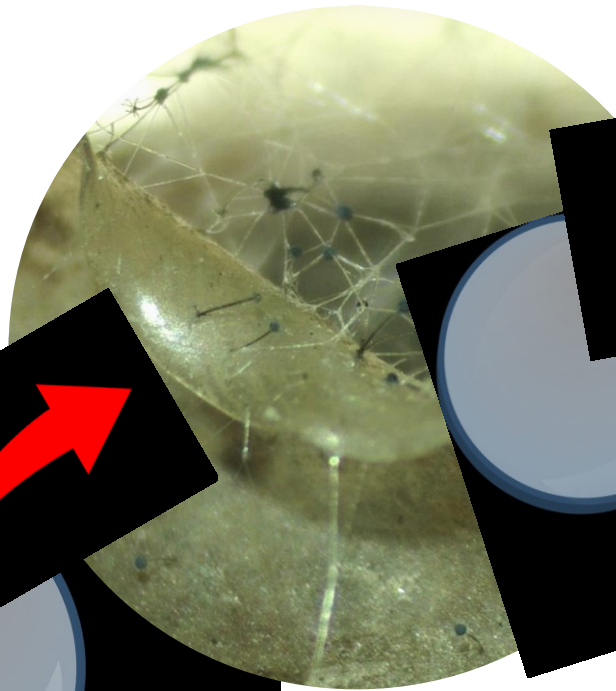
Macroarea di ricerca: Botanica - Micologia

Referenti: Solveig Tosi, Elena Savino, Carolina Girometta, Lidia Nicola

Settori ERC: LS8_2 Biodiversity; LS9_7 Environmental biotechnology and bioengineering; PER_11 Environmental engineering e.g. sustainable design, waste and water treatment, recycling, regeneration or

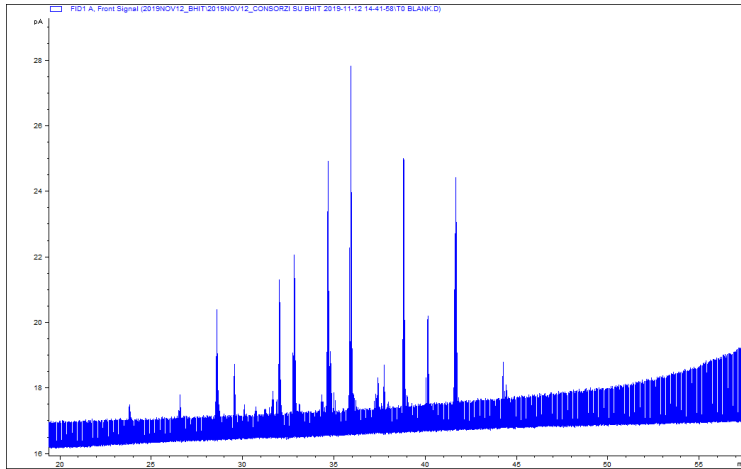
The Fungal collection of the University of Pavia maintains fungi degrading different kind of substrata, and recalcitrant material such as hydrocarbons, plastics, rubber, lignine, cellulose

Some fungi of our collection attack plastics and tire rubber

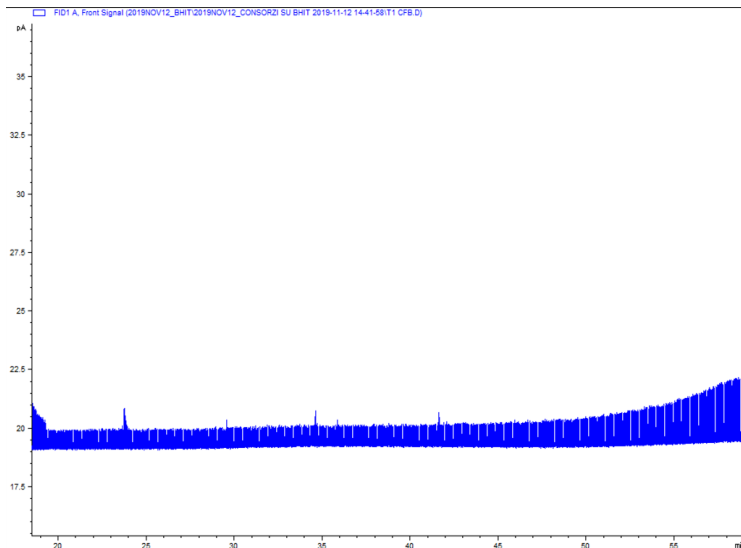


WD: 5.31 mm
Det: In-Beam SE
Date(m/d/y): 02/04/20
MIRA3 TESCAN

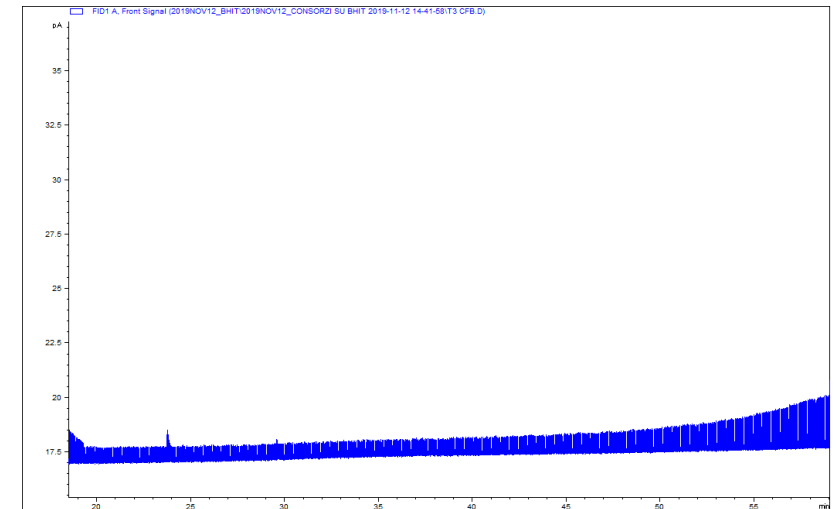
Some fungi of our collection attack hydrocarbons



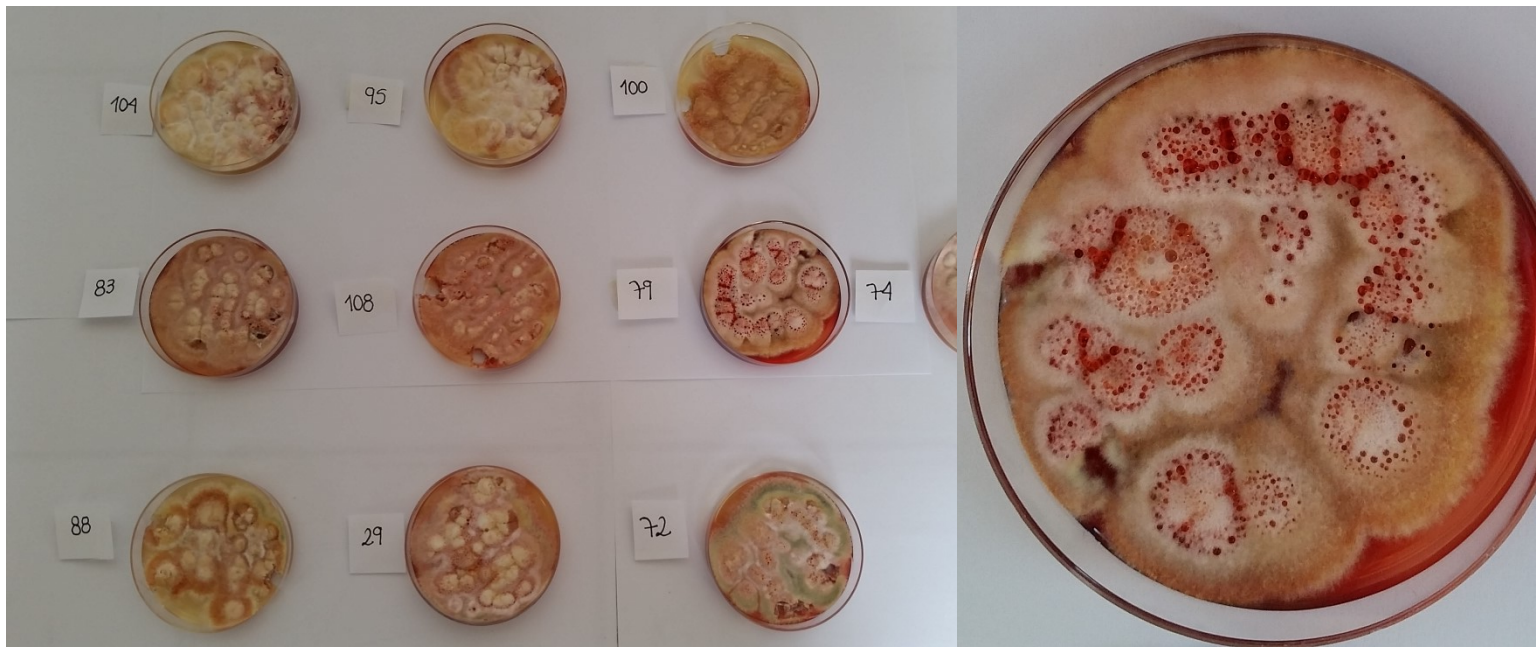
The original hydrocarbon mixture



hydrocarbon mixture after 4 days of treatment with fungi and bacteria



hydrocarbon mixture after 1 week of treatment with fungi and bacteria



Selecting the fungal activities for degrading and transforming waste in useful material or growing on in situ resources

They incredibly like

- Food waste
- Waste from cultivation
- Urine
- Paper, plastic and hydrocarbons

They can grow on regolite



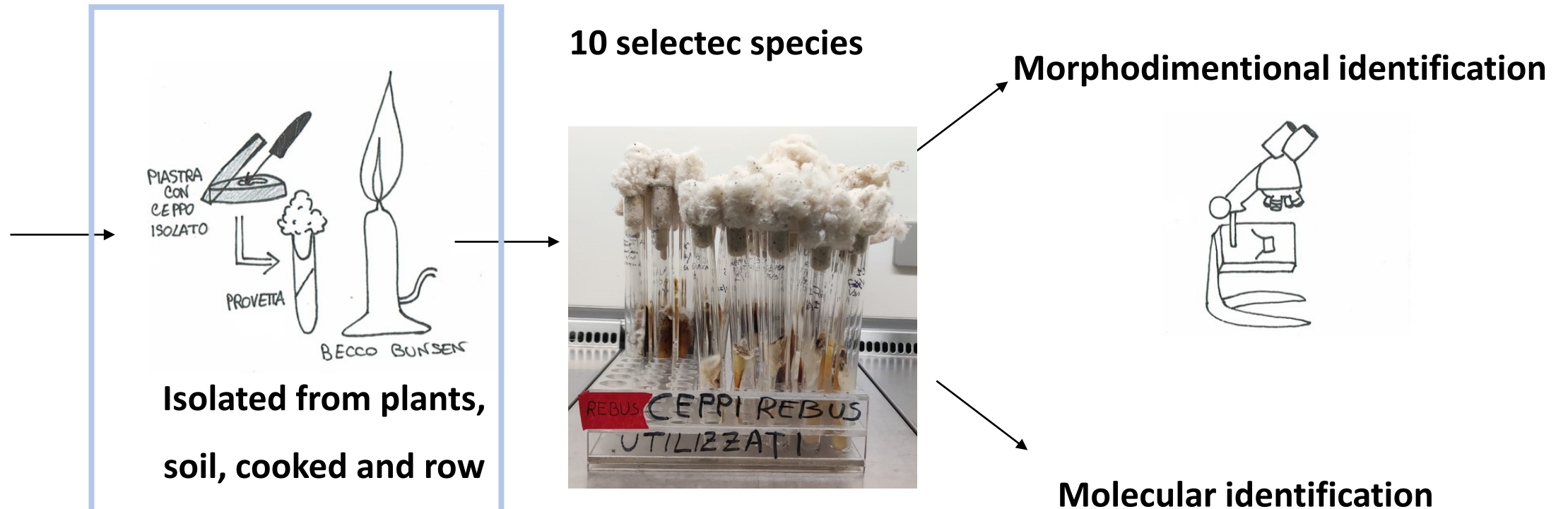
The collection of fungi for space of the Rebus project.
A very limited and special collection



Guidelines to select the right fungi

- no pathogens for plants and humans
- No production of airborne propagules and spores
- the colony must grow on the substratum in very stiky way
- they must be few and easy to be handled by the crew
- they must maintain thier biological characteristic to stay in space hambient and withstand radiation and microgravity

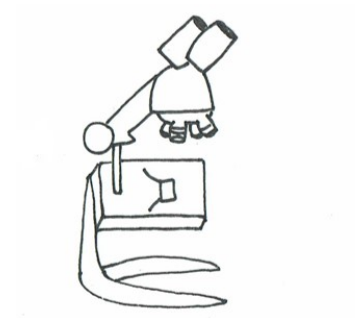
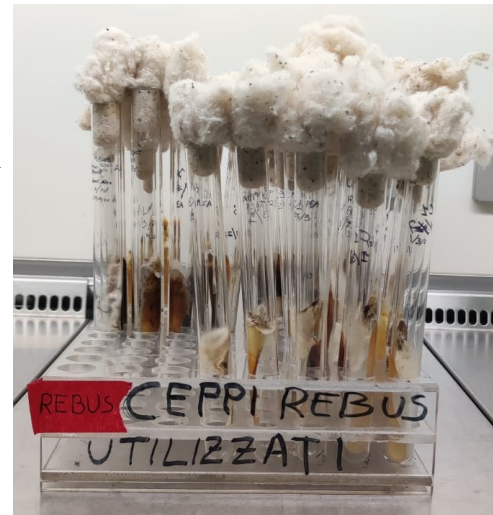
The selected fungi for REBUS project



10 selectec species

Morphodimensional identification

Isolated from plants,
soil, cooked and row
food



Molecular identification

They are long term maintained in:

- freezer -80 gradi
- lyophilized
- In water
- In soil

What we did with the selected fungi

Degradation of space waste

Reduction and transforming in soil
conditioner for plant production

Use the space waste for
cultivating edible mushrooms

biorigeneration

```
graph TD; A[What we did with the selected fungi] --> B[Degradation of space waste]; A --> C[Use the space waste for cultivating edible mushrooms]; B --> D[biorigeneration]; C --> D;
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For testing Degradation of space organic waste we used

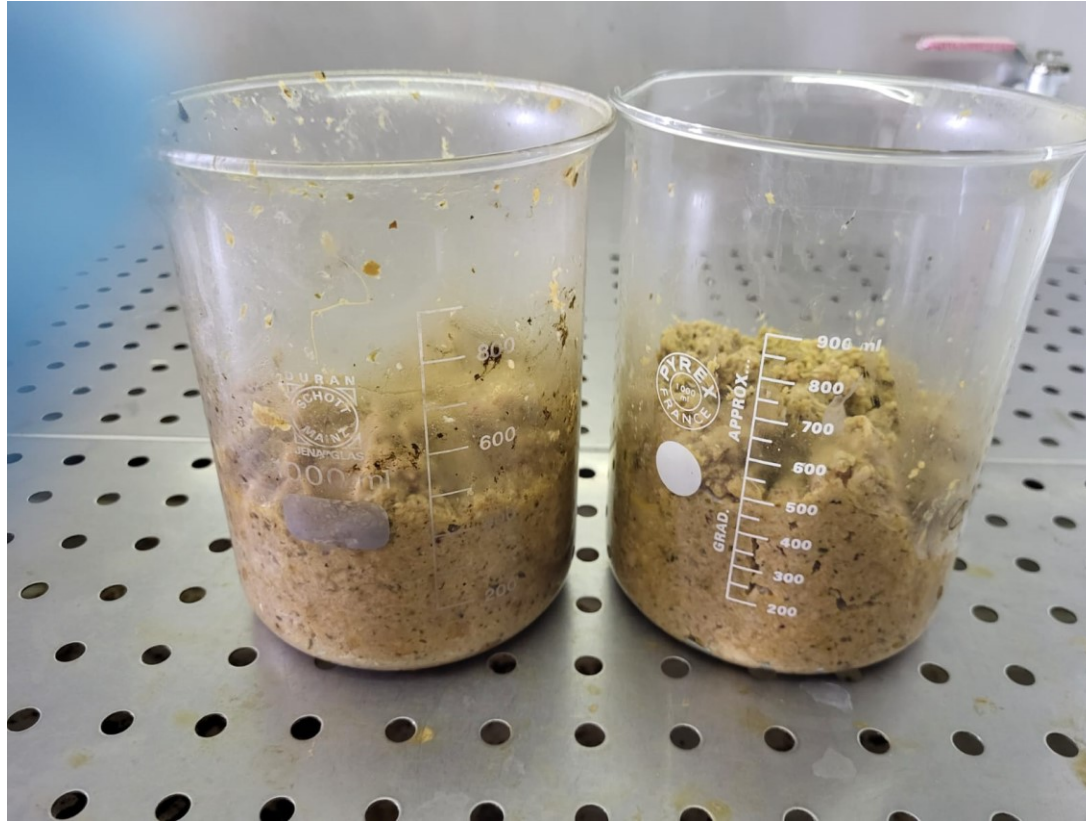
SOW (Space Organic Waste simulant of ISS, produced by research Unit of ENEA-REBUS)

Waste estimation

**(1 month, 3 crew members, total 8.4 kg.
Thales Alenia pers. comm)**

SOW: composed by waste of
food , plant cultivation remains,
Paper.

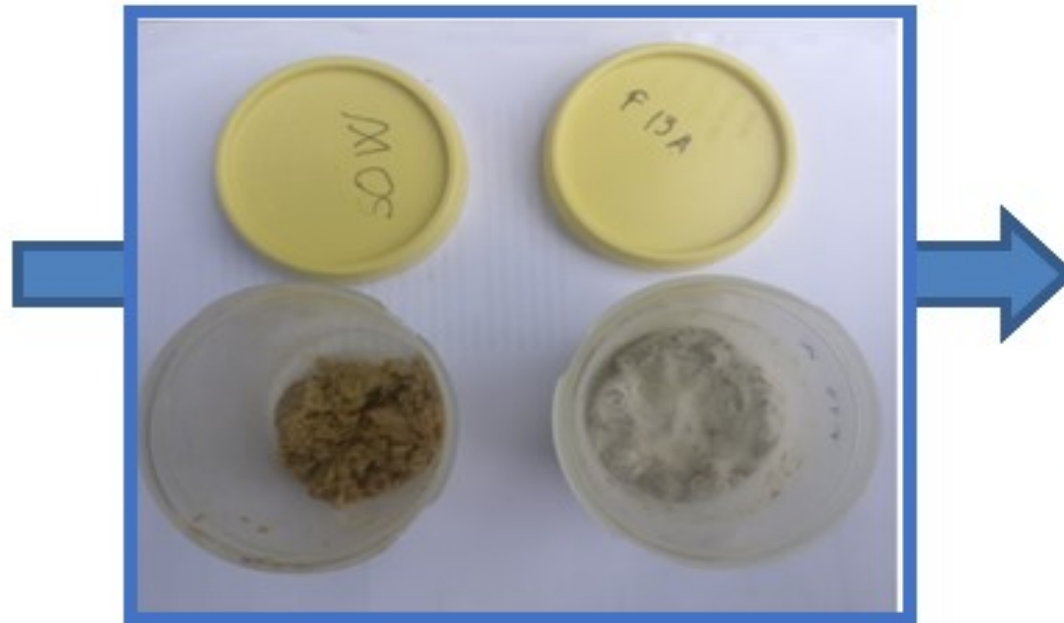
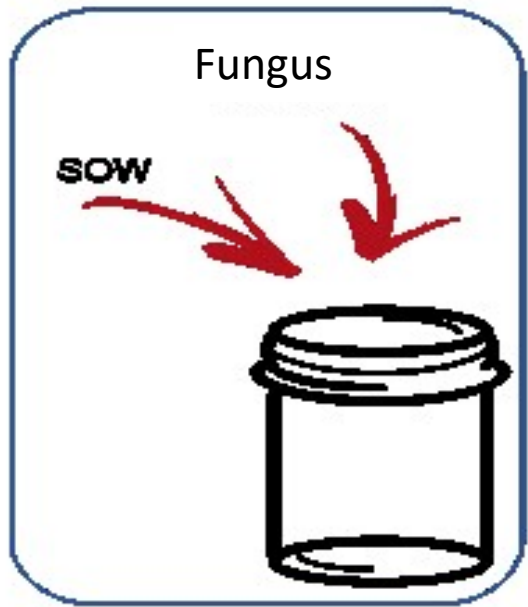
Based on the ISS crew diet



Stiky
Terribly smelly

Vey rich in fat

Growth test on SOW and selection



The best strains growing on SOW

The collection for REBUS project purposes



F13 *Chaetomium globosum* Kunze

F16 *Dichotomopilus reflexus* Skolko & P. Carso

F35 *Byssochlamys nivea* Westling

F58 *Humicola fuscoatra* Traaen

C1 *Bjerkandera adusta* Will & P. Carso.

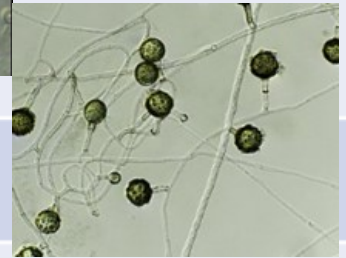
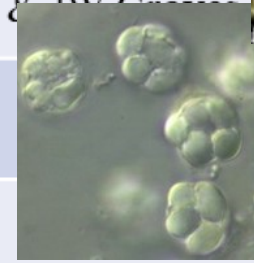
C4 *Ganoderma lucidum* Curtis P. Carso

C7 *Pleurotus ostreatus* P. Kumm

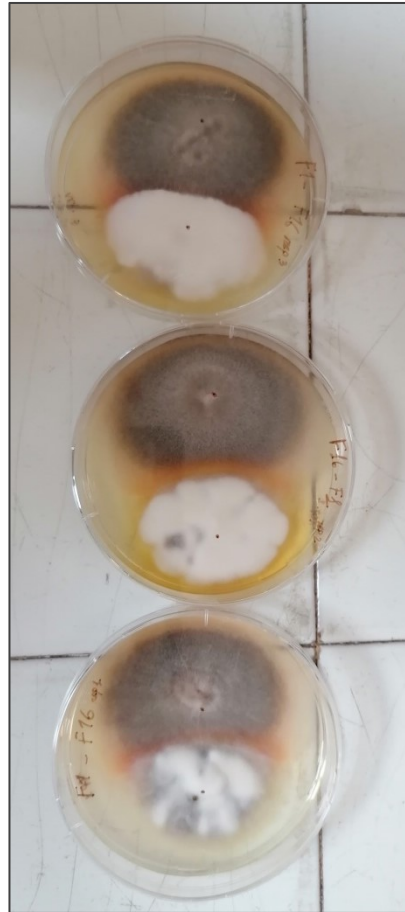
C9 *Schizophyllum commune* Fr

F1 *Monascus purpureus* Went

L1 *Torulasporea delbrueckii* Lindner



Looking for a good fungal consortium by dual cultures test



F1-F16



C9-F16

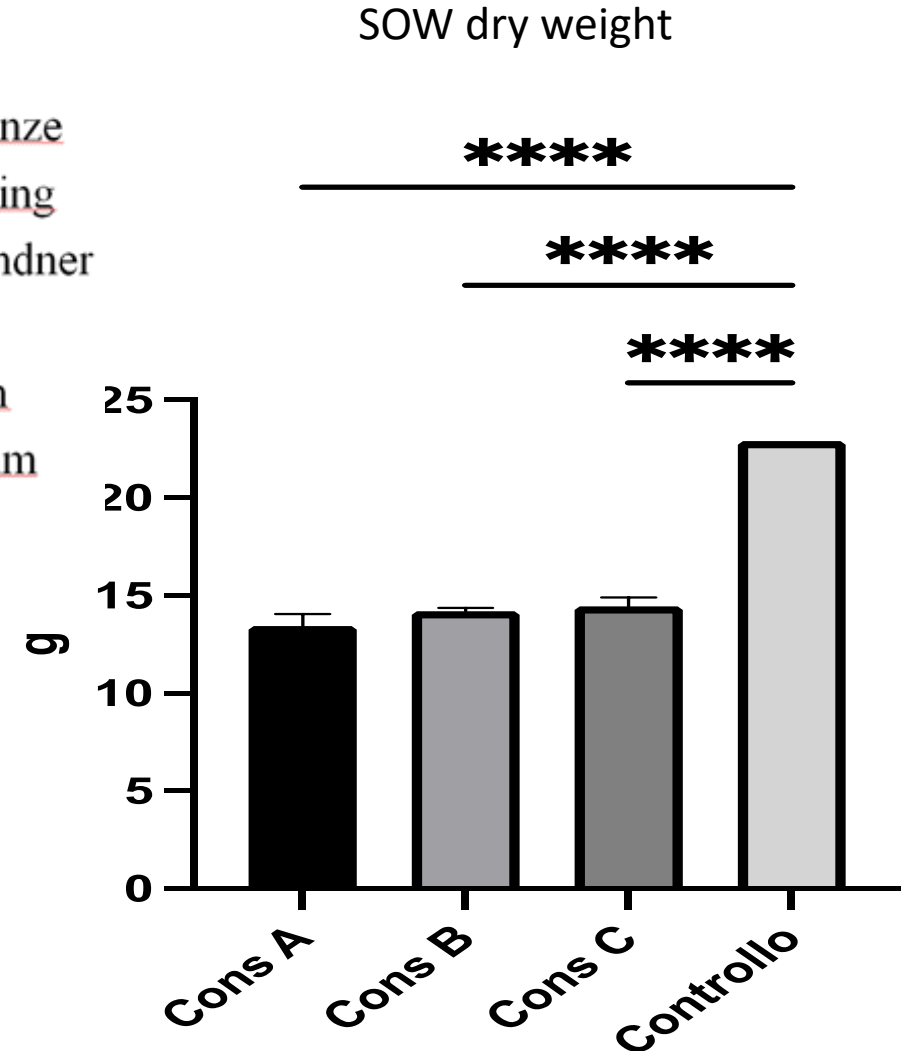


F1-C9

Comparing degradation action of different consortia on Space Organic Waste (SOW)

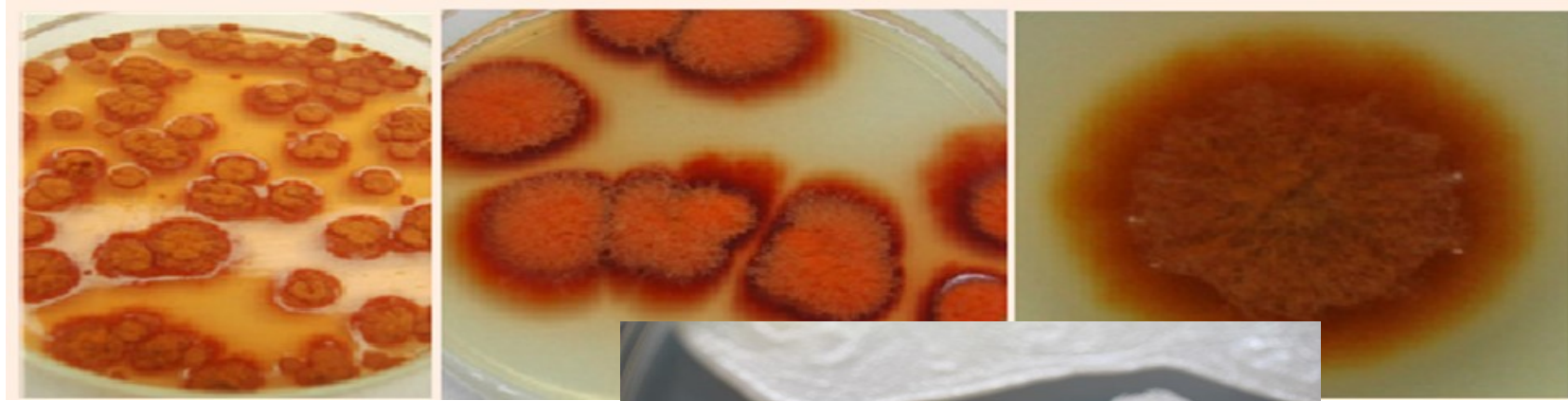
A	B	C
F13	F13	F13
F35	L1	L1
L1	F1	F1
F1	F58	
F58	C7	
C7		

- ❖ F13= *Chaetomium globosum* Kunze
- ❖ F35= *Byssochlamys nivea* Westling
- ❖ L1= *Torulasporea delbrueckii* Lindner
- ❖ F1= *Monascus purpureus* Went
- ❖ F58= *Humicola fuscoatra* Traaen
- ❖ C7= *Pleurotus ostreatus* P. Kumm



Choosing the minimum consortium

- *Monascus purpureus* Went



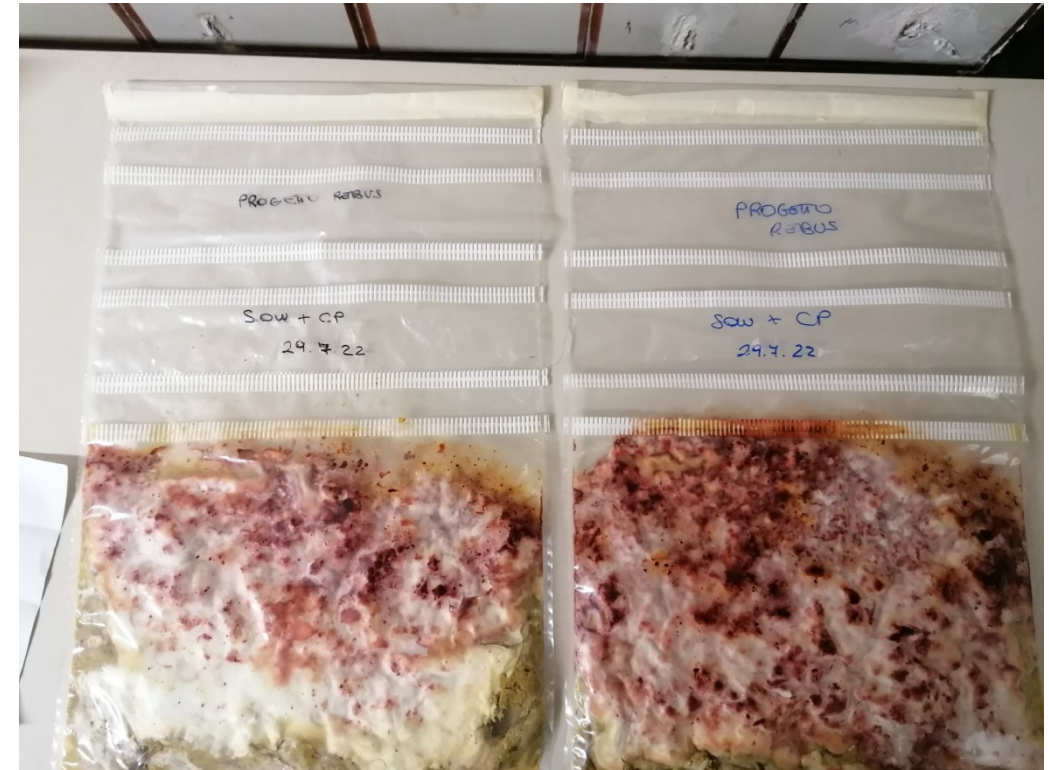
- *Torulasporea delbrueckii* Lindner



- *Chaetomium globosum* Kunze



The minimum consortium growing on SOW after 20 days at 20°C



The bad smell of the Space Organic Waste completely disappeared

Space Organic Waste after fungal degradation and lyophilization



Is this a possible fertilizer for plant cultivation?

Is this a new material?

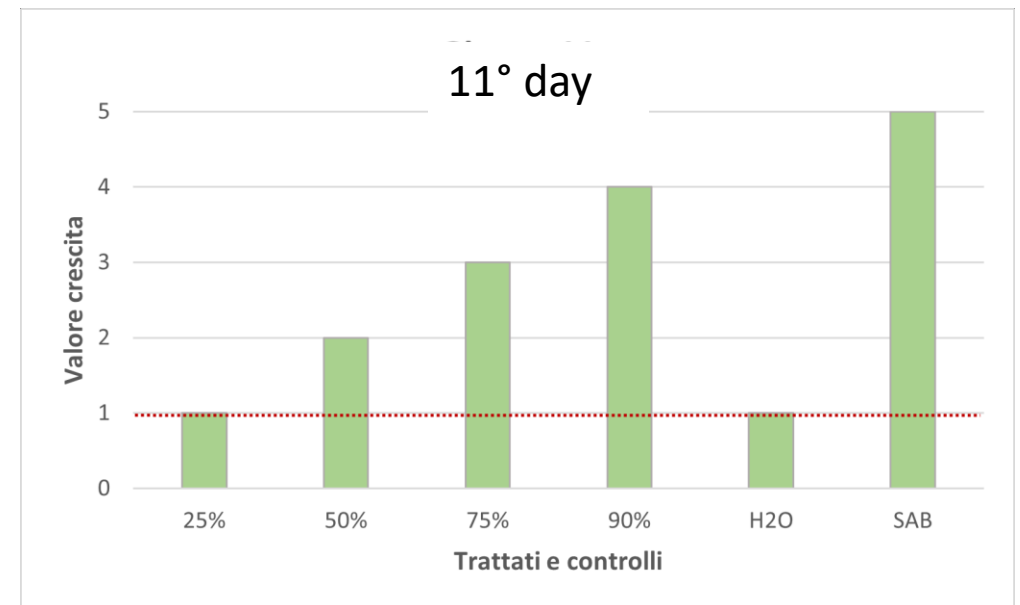
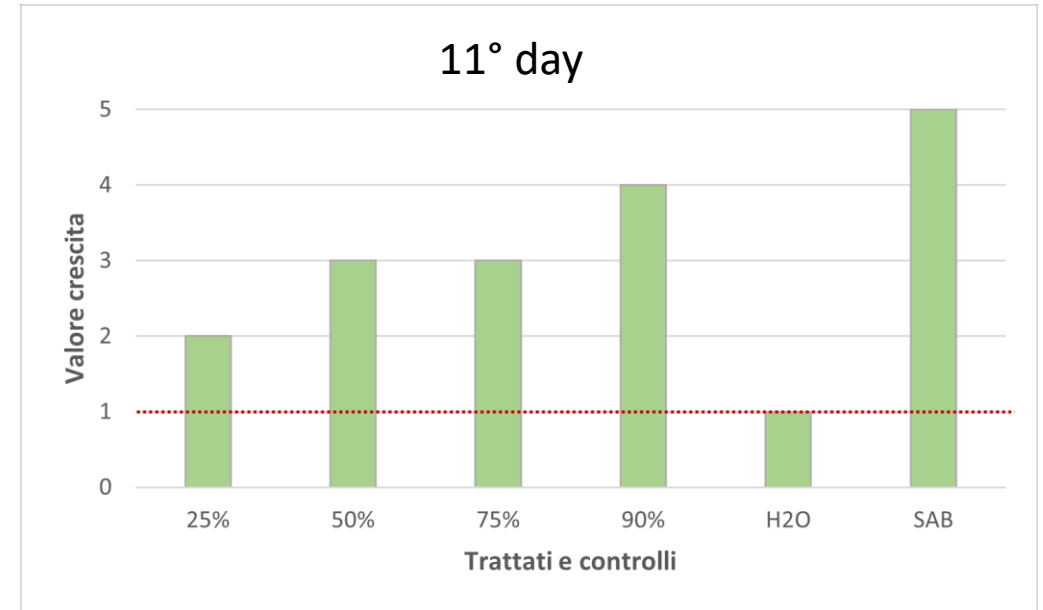
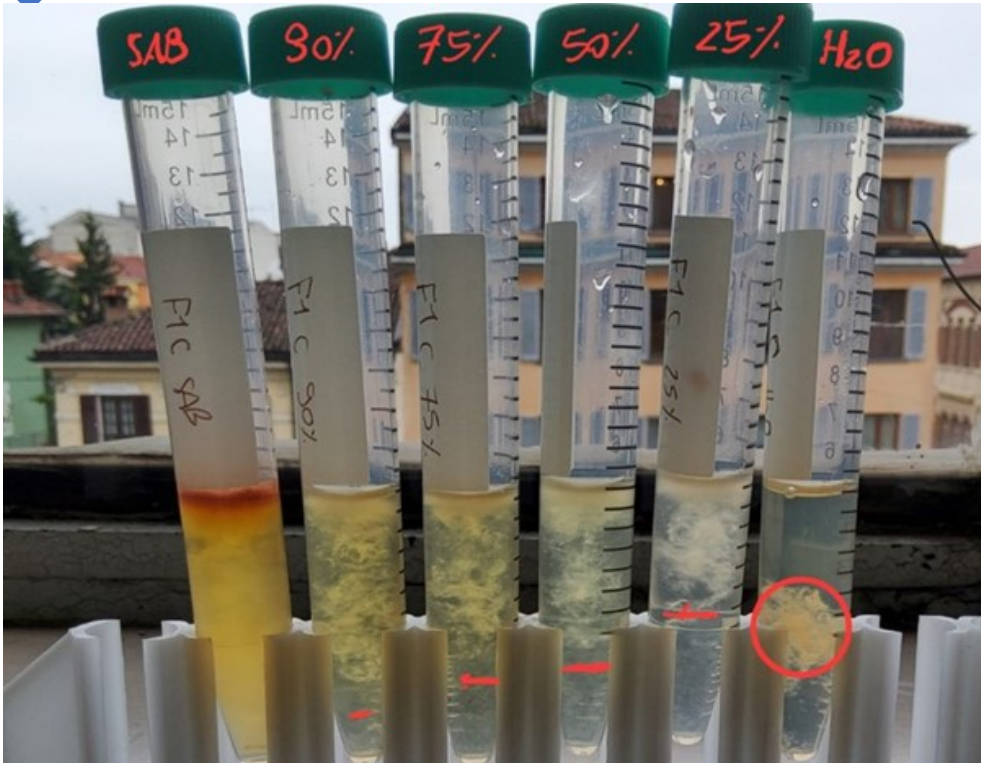
Isolating....

Screening radiations.....

Being eaten again.....

Is this a possible good food for breeding delicious insects?

Some strains like URINE
Such as *Monascus purpureus*
or *Schizophyllum commune*





Can we use space organic waste to cultivate edible mushrooms in space?

Es. *Pleurotus* nutrition values (per 100 g of product)

Calories: 25 Kcal

Proteins: 3,5 g

Carbohydrates: 4.5 g

Fats: 0,3 g

Choosing a good waste for growing *Pleurotus ostreatus*

Potato waste?



Or

Carrot waste?

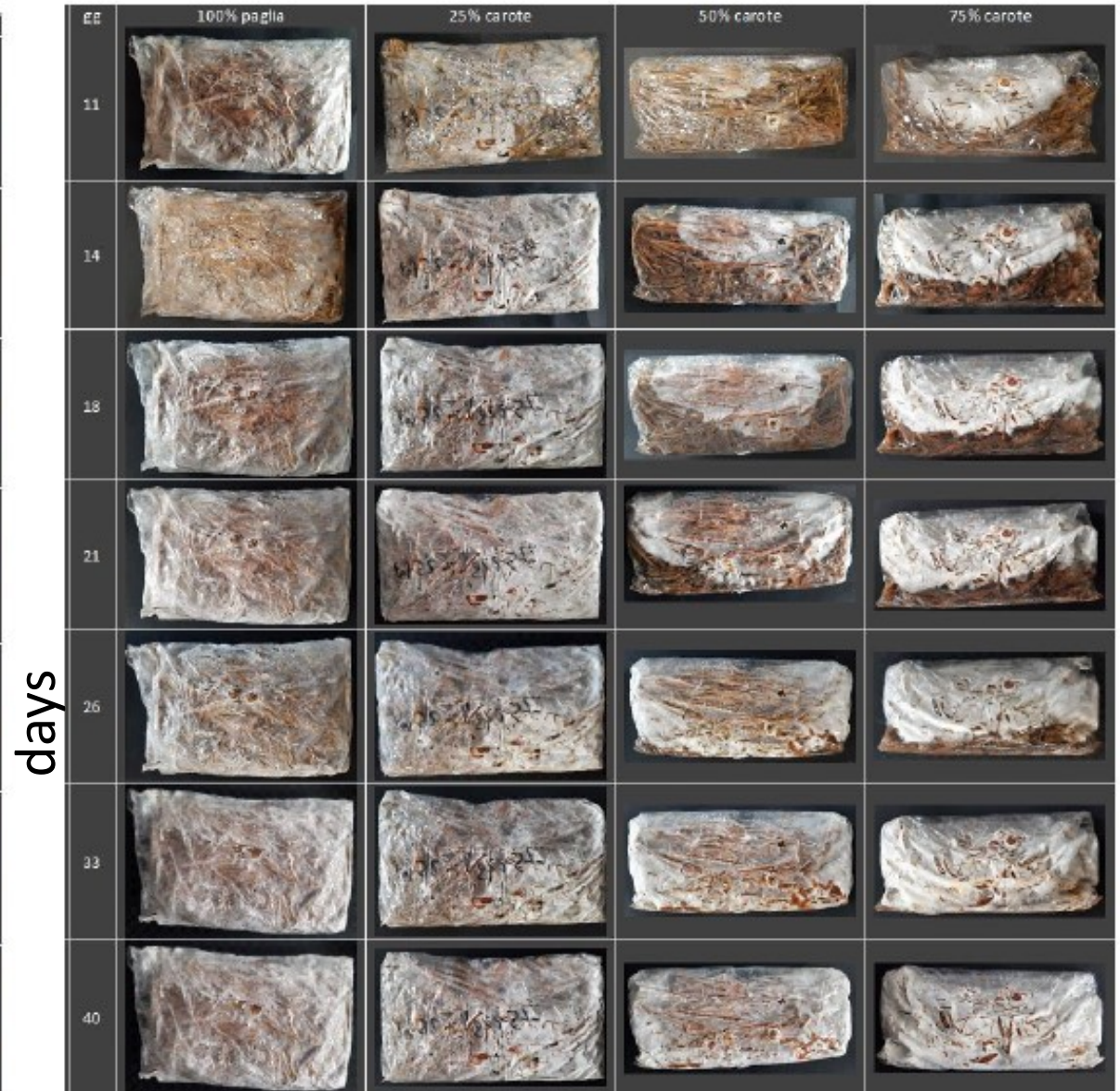


Pleurotus ostreatus mycelium growing on potato or carrot waste

100% straw 25% of potato 50% of potato 75% of potato



100% straw 25% of carrot 50% carrot 75% carrot



days

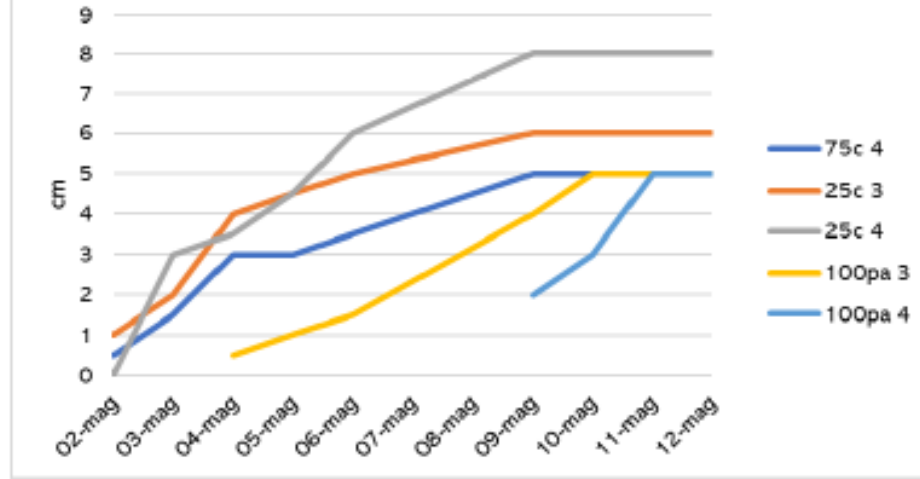
!! No mushrooms with potatoes

!! Good production with carrots

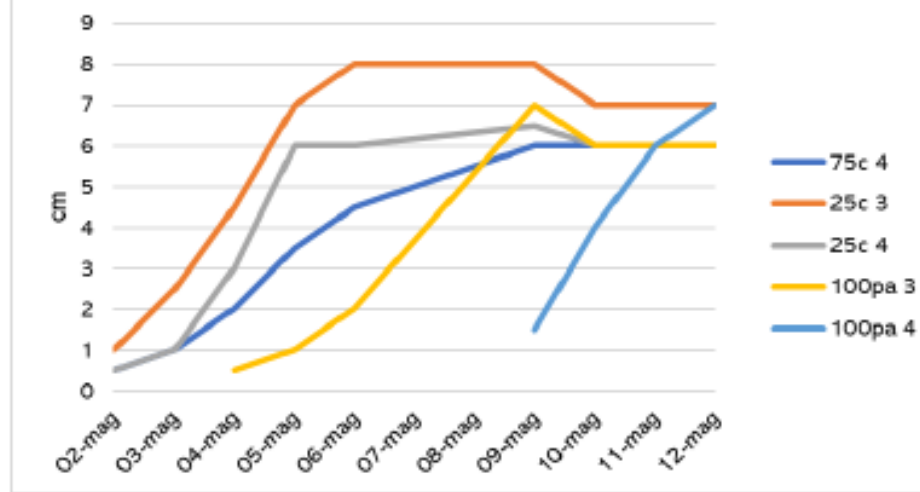
Best production with 25%
of carrot waste

	25% carote	25% carote	75% carote	100% paglia
1				
2				
3				
4				
5				
8				
9				

Mean Height of the mushrooms

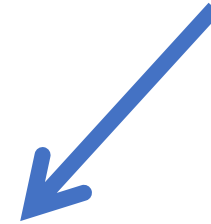
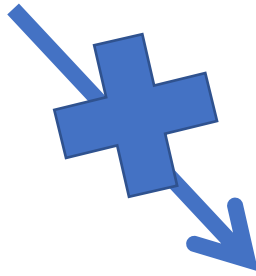


Mean Diameter of the cap



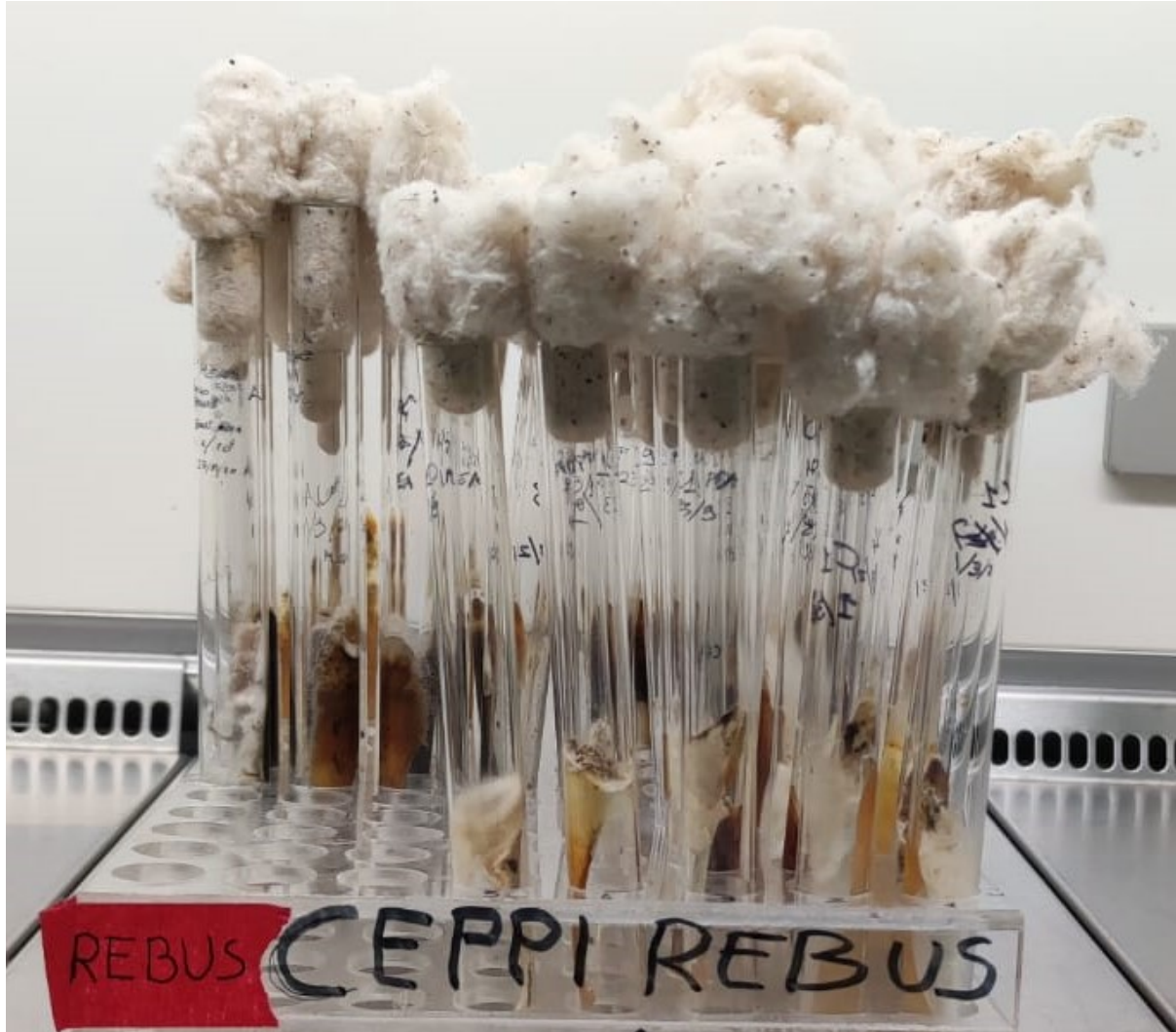


For a good
biorigenerative
process



REBUS Collection

The first collection of fungi for space



Thank you for the attention