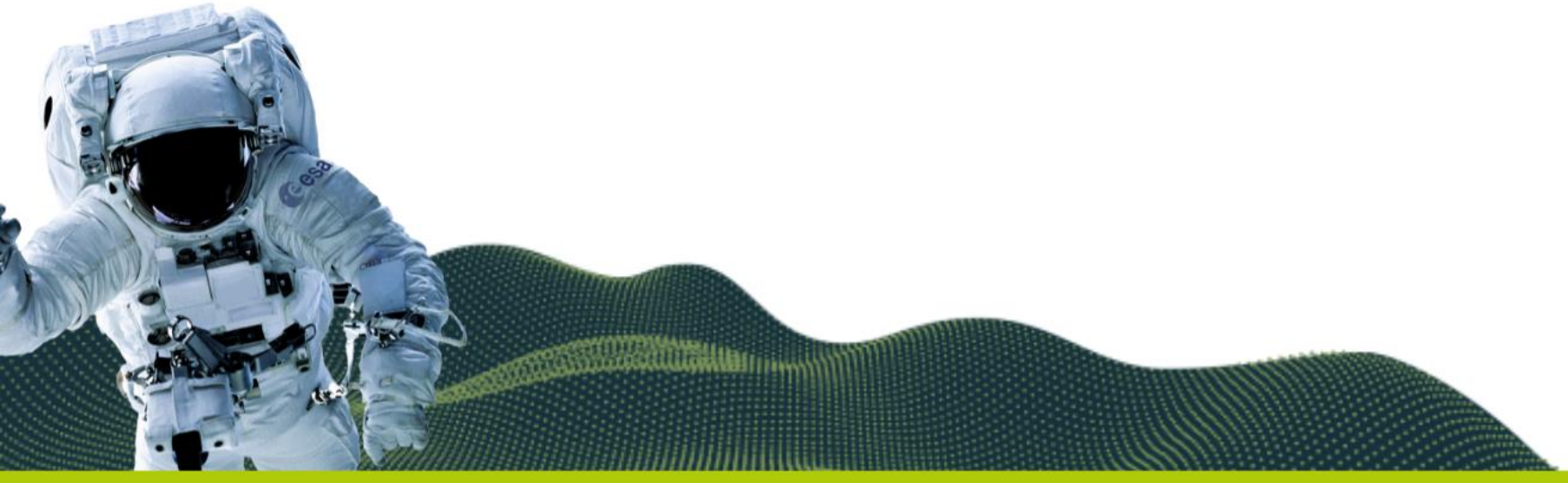
MELISSA
MICRO-ECOLOGICAL LIFE SUPPORT SYSTEM ALTERNATIVE

2022 MELISSA CONFERENCE
8-9-10 NOVEMBER 2022

CREATING A CIRCULAR FUTURE

Super food for space, from a “complex biological system” to a simplified plant model.

Leone Ermes Romano and Giovanna Aronne



Aims

The specific research aims of this proposal are to identify:

a) The cultivation protocols that could maximize growth and nutritional performances of Lemnaceae in space

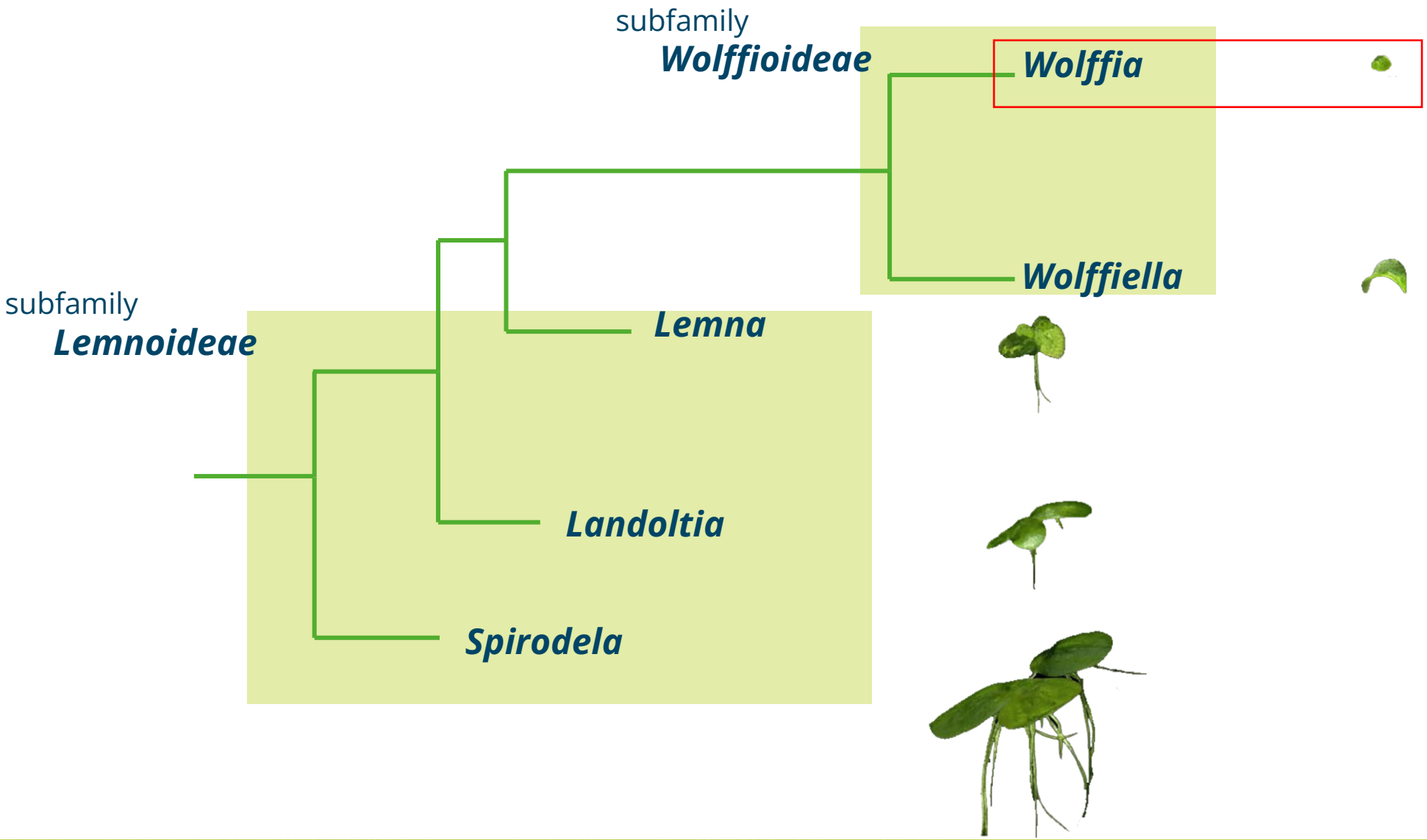
b) Identify the requirements and preliminary design of an automated space cultivation system.

ESA Contract No. 4000133778/21/NL/CBi

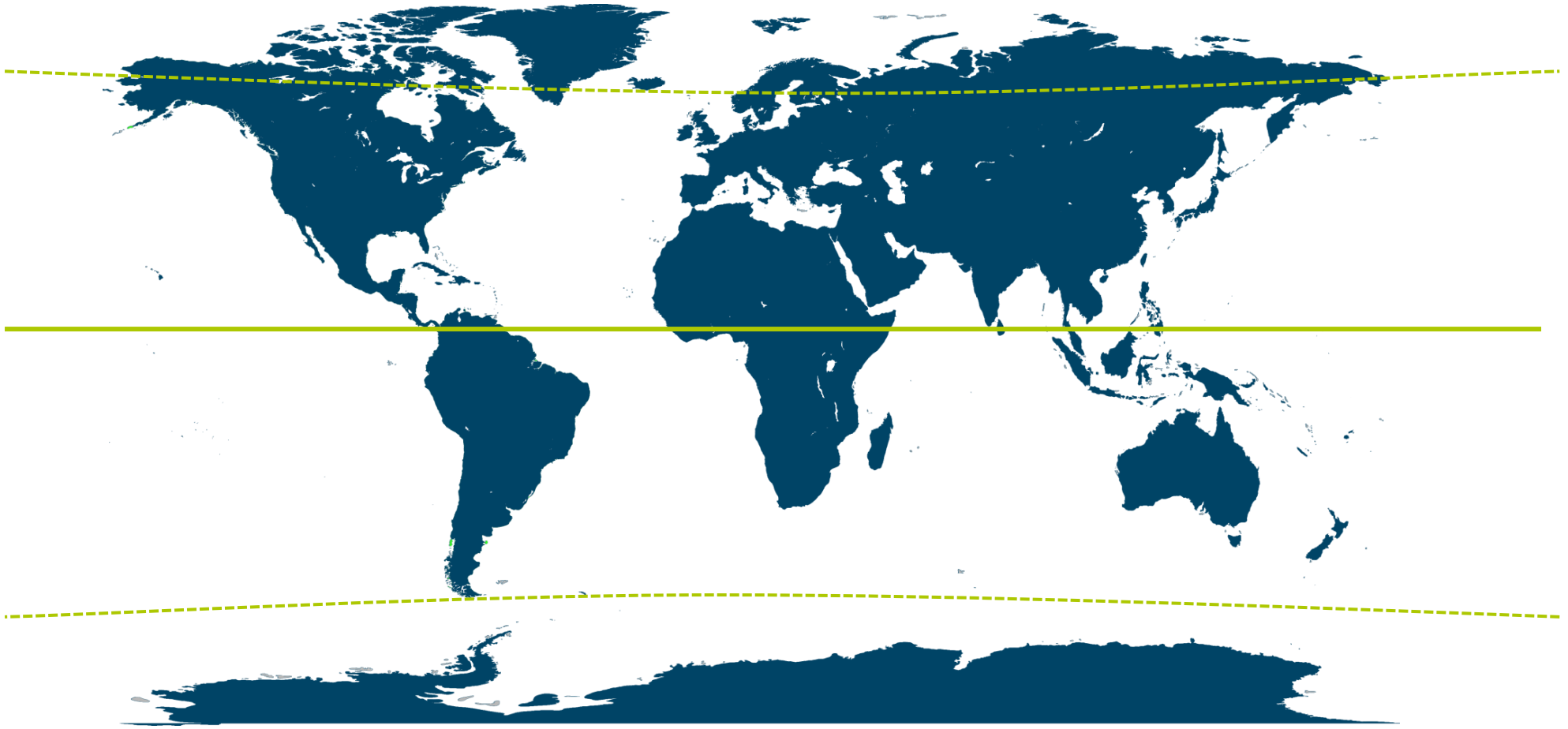
Informatica Service

Work Breakdown Structure

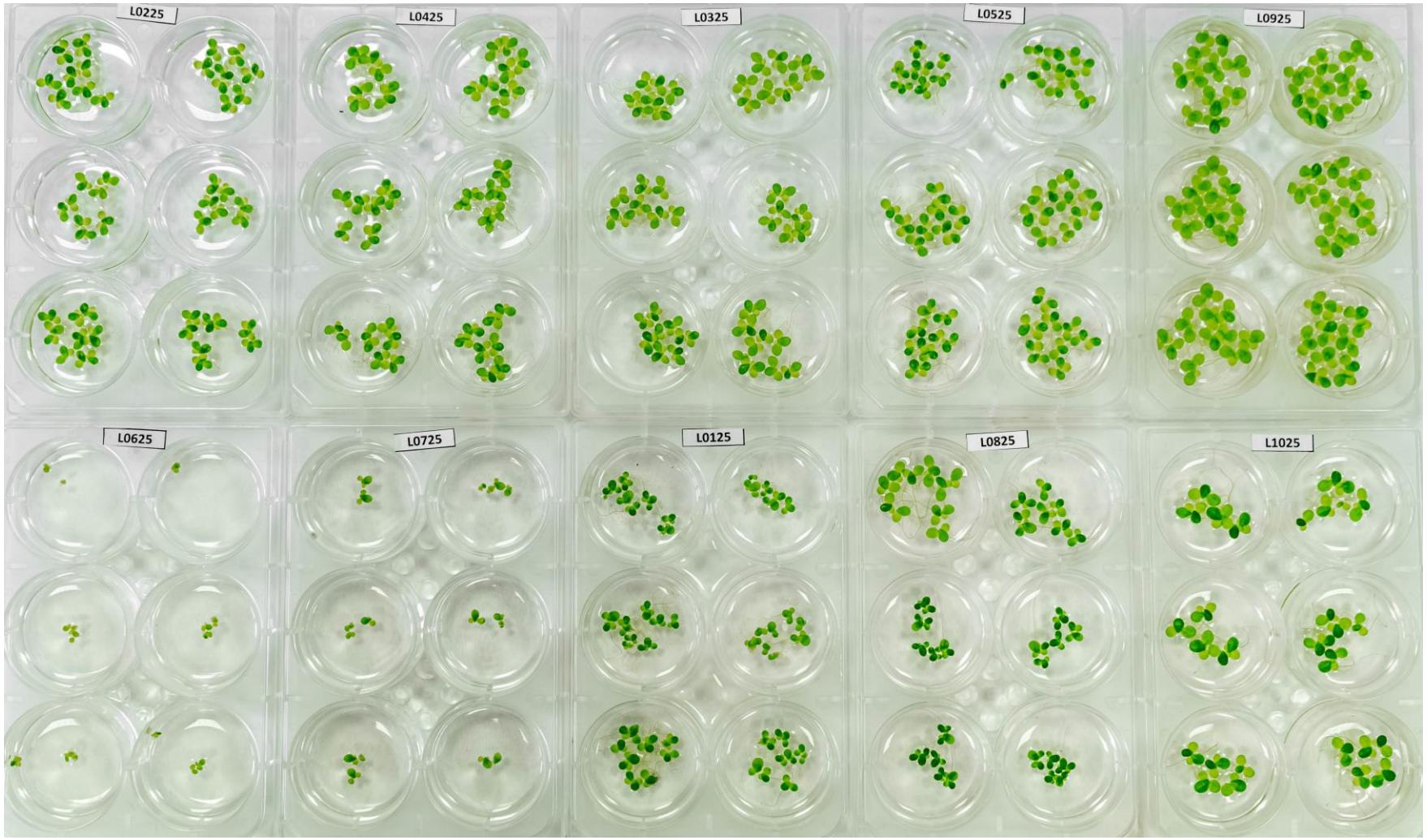
Fmily of Lemnaceae



Geographical distribution of Lemnaceae



Intraspecific trait variability



UNINA's Wolffia Collection

Why *Wolffia globosa*?

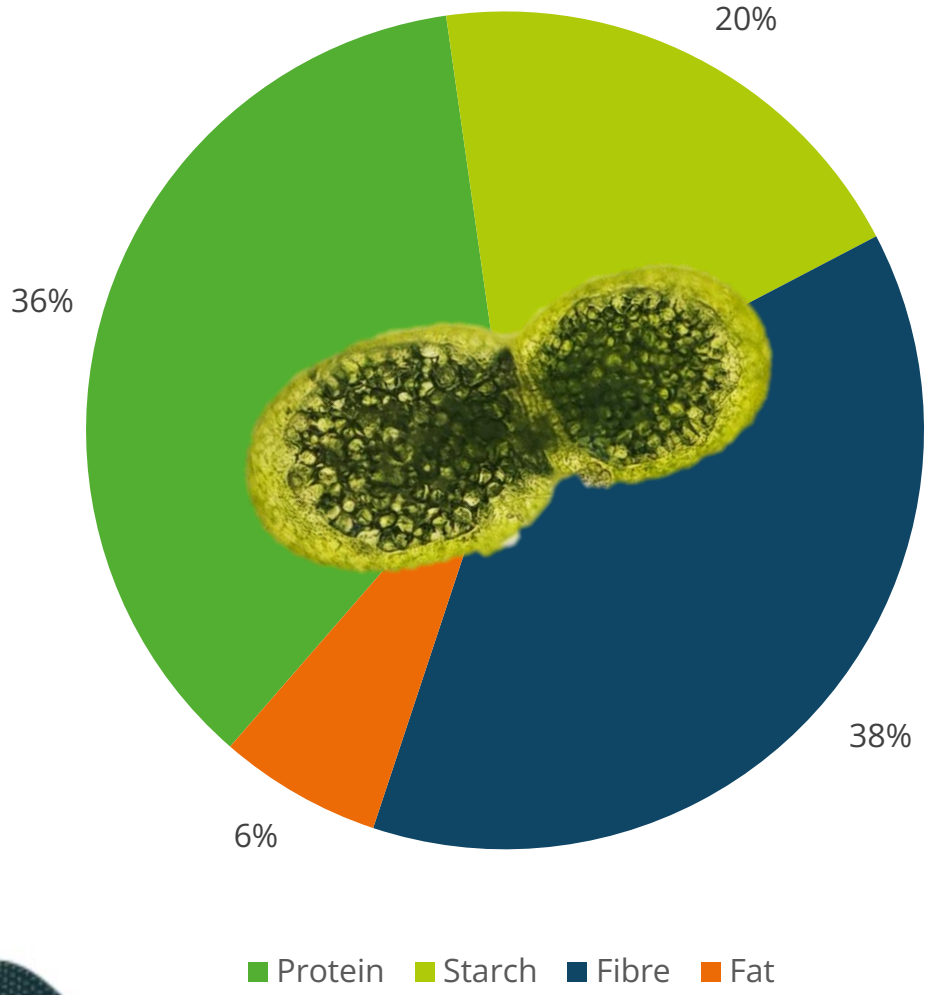
Fast biomass production

Species from the Lemnaceae family are the fastest-growing angiosperms

High nutritional values

Studies show that protein qualities from Lemnaceae are suited for children's nutrition

Nutritional values of *Wolffia globosa*



Why Wolffia globosa?

Fast biomass production

Species from the Lemnaceae family are the fastest-growing angiosperms

Large genome

Lower effect of induced mutations.

169,405 bp

High nutritional values

Studies show that protein qualities from Lemnaceae are suited for children's nutrition

Vegetative reproduction

Higher conservation of genetic traits.

High harvast index

Duckweeds can grow at the water surface or submerged, optimizing the cultivation area

Waste utilization

Wolffia globosa could take advantage of the waste stream

Literature Review

plants

MDPI

Review

The world smallest plants (*Wolffia* sp.) as potential species for bioregenerative life support systems in space

Leone Ermes Romano [1]* and Giovanna Aronne [1]

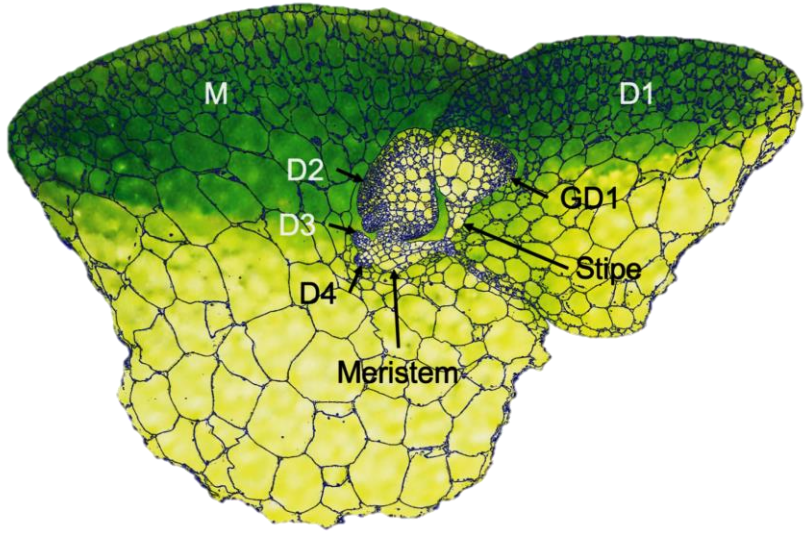
[1] University of Naples Federico II, Department of Agricultural Sciences; leoneermes.romano@unina.it; aronne@unina.it

* Correspondence: leoneermes.romano@unina.it;

Abstract: To colonise other planets, self-sufficiency of space missions is mandatory. To date, the most promising technology to support long-duration missions is the bioregenerative life support system (BLSS), in which plants as autotrophs play a crucial role in recycling wastes and producing food and oxygen. We reviewed the scientific literature on duckweed (Lemnaceae) and reported available information on plant biological traits, nutritional features, biomass production, and space

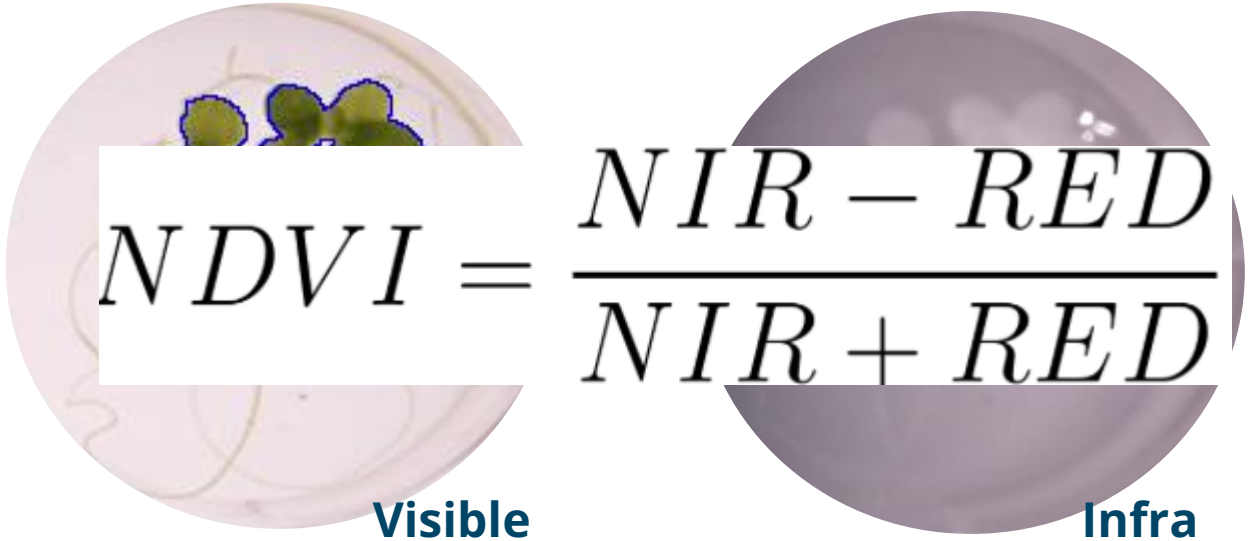
Current Work

- OMIS - Open multispectral imaging system
- Machine Learning
- Environmental control
- Clinorotation experiment
- What is next?



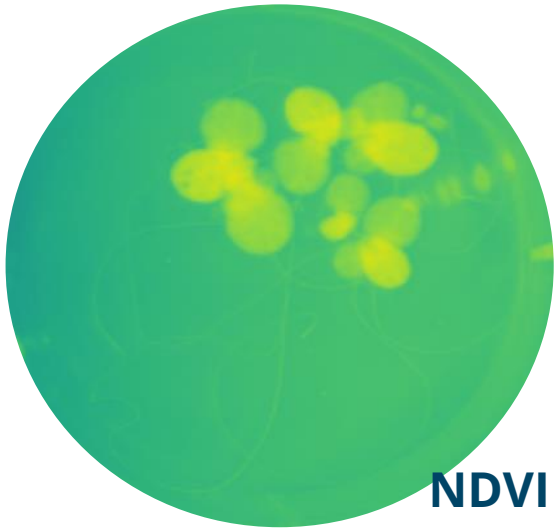
OMIS – Open multispectral imaging system

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

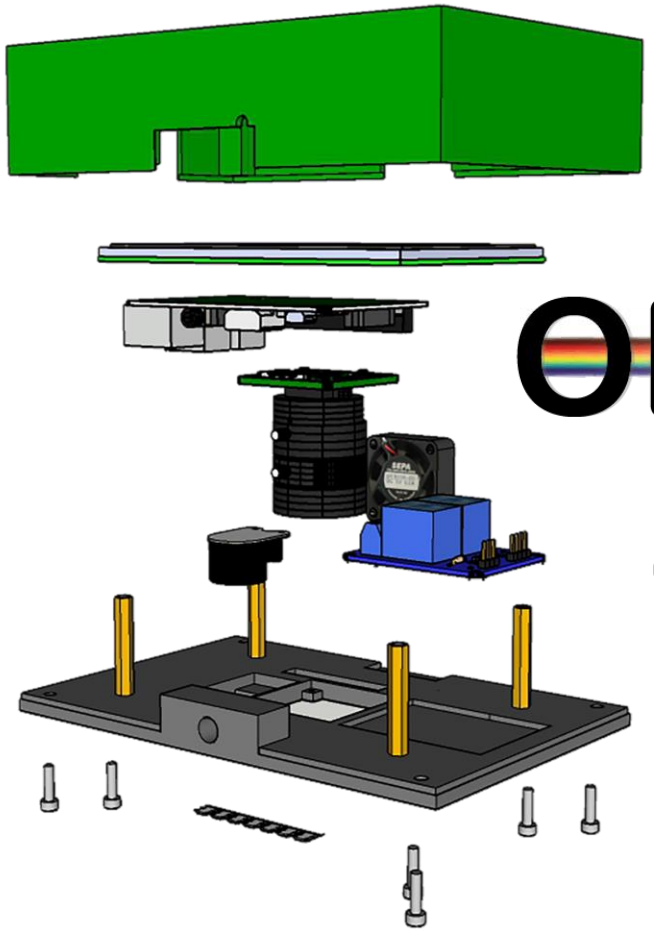


Visible

Infra Red



NDVI



Supervised machine learning

Input data

Training

Output

Supervisor

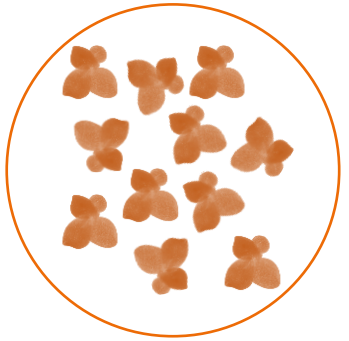
Training data

Desired output

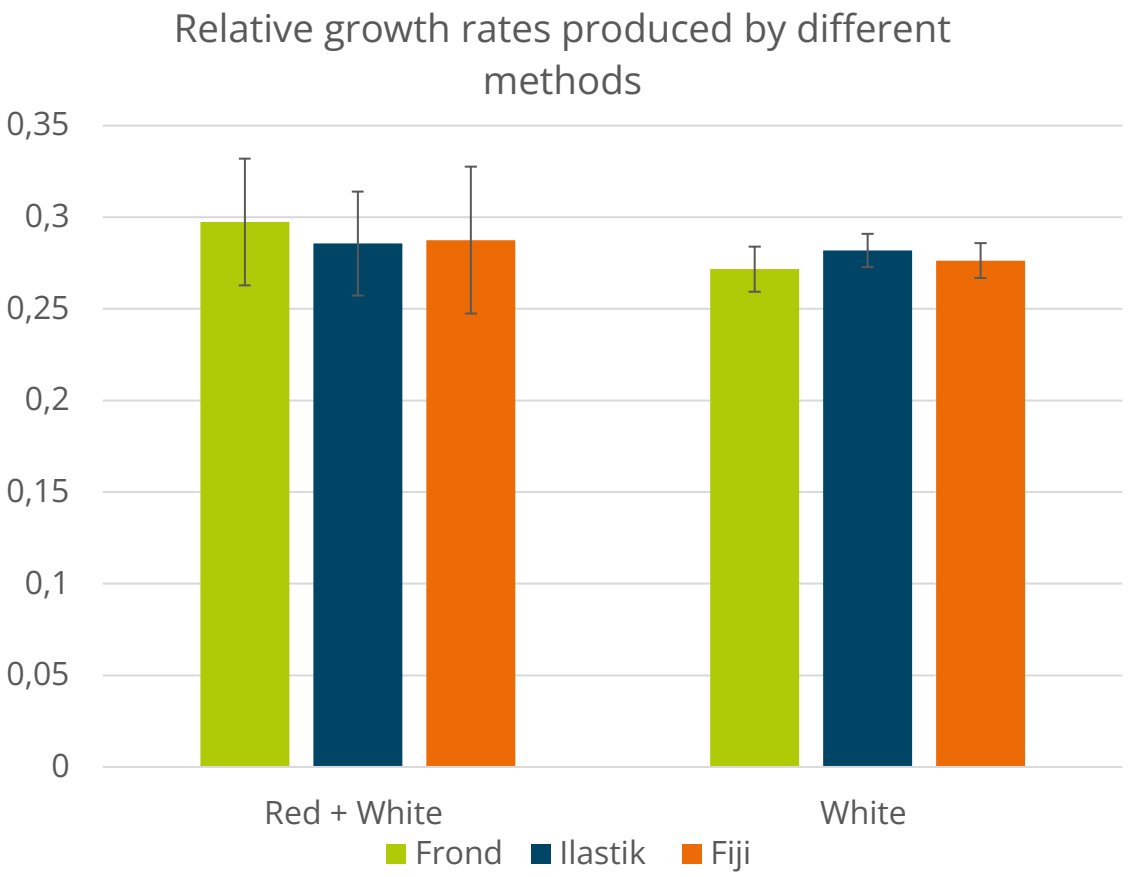
Prediction Algorithm

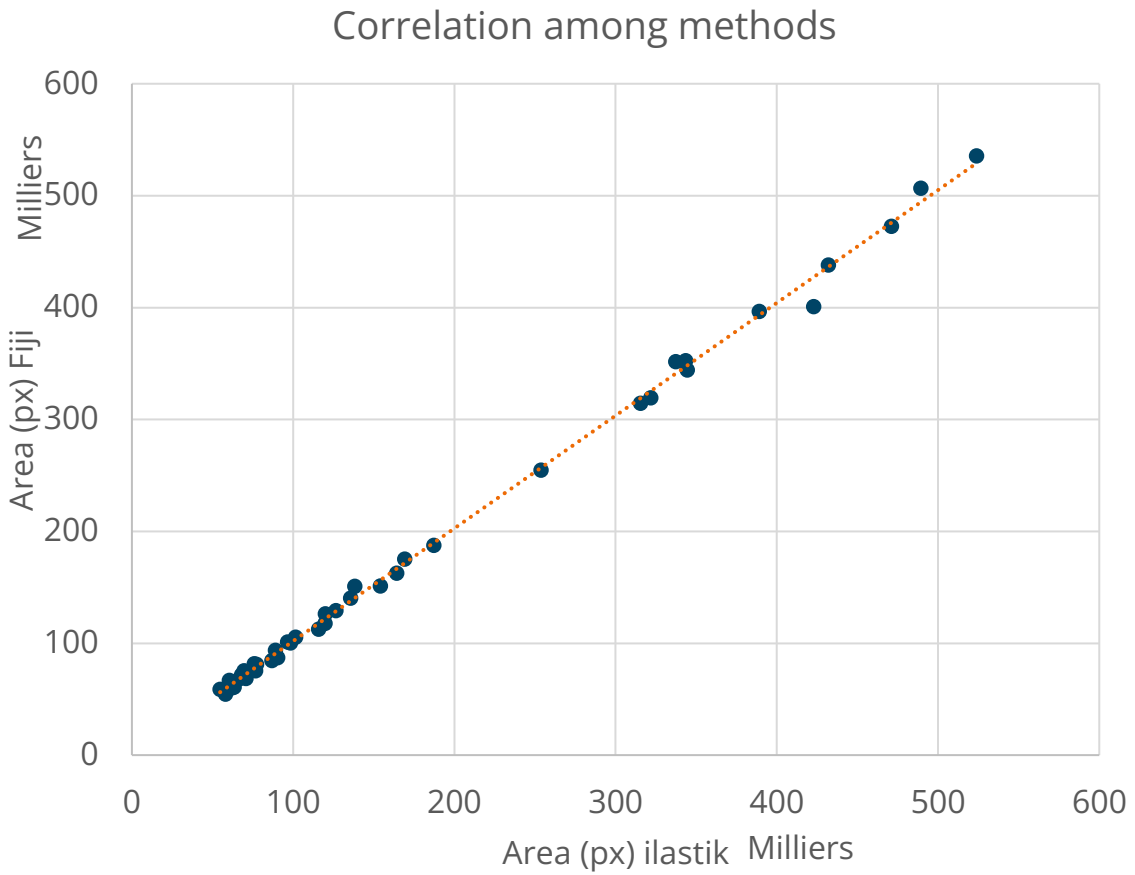
Classified

Background

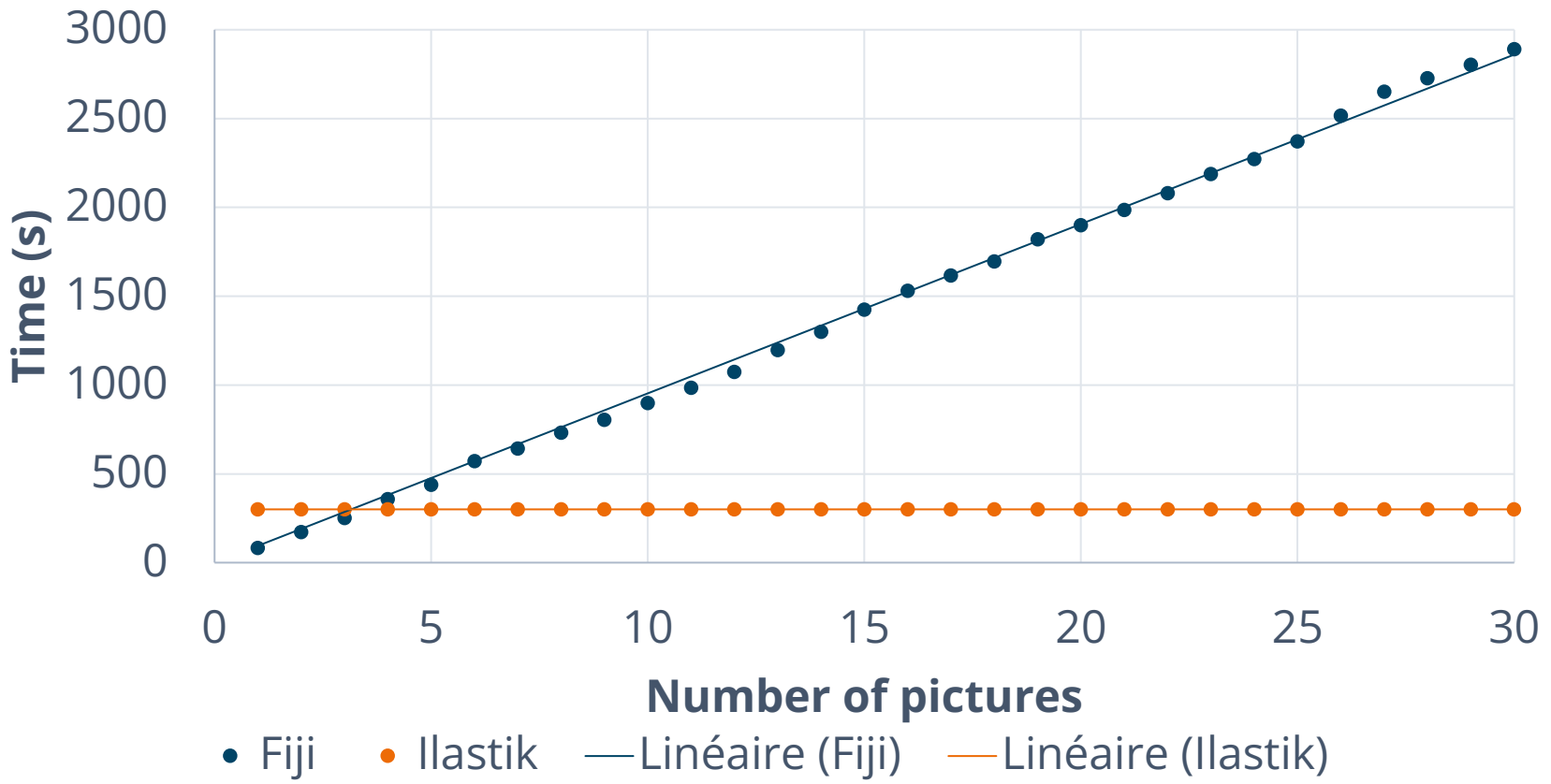


Results

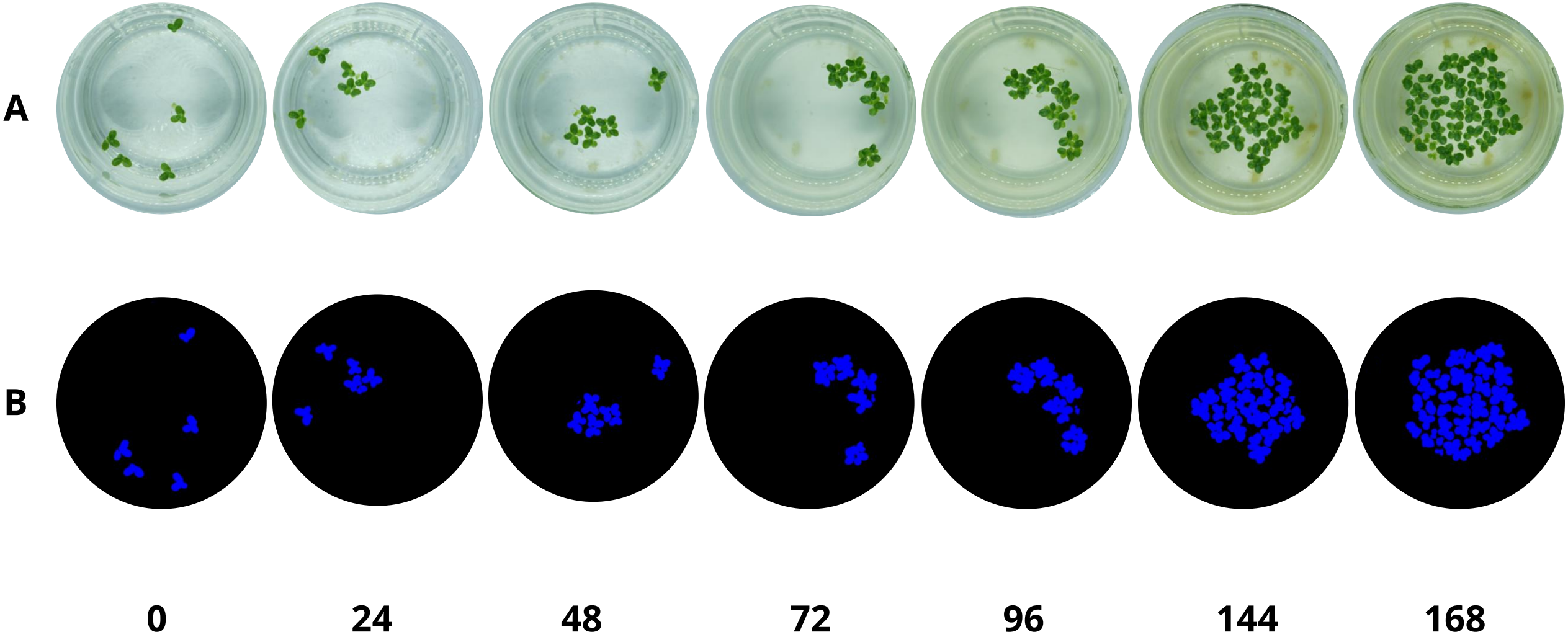

Relative growth rates produced by different methods
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
Red + White
White
Frond
Ilastik
Fiji


Correlation among methods
600
500
400
300
200
100
0
Milliers
Area (px) Fiji
0
100
200
300
400
500
600
Area (px) ilastik
Milliers

Time required by the operator to perform the analysis



Output



Assessing growth with machine learning

plants

MDPI

Article

A Machine-Learning Method to Assess Growth Patterns in Plants of the Family Lemnaceae

Leone Ermes Romano *, Maurizio Iovane, Luigi Gennaro Izzo and Giovanna Aronne

Department of Agricultural Sciences, University of Naples Federico II, 80055 Portici, Italy; maurizio.iovane@unina.it (M.I.); luigigennaro.izzo@unina.it (L.G.I.); aronne@unina.it (G.A.)
* Correspondence: leoneermes.romano@unina.it

Abstract: Numerous new technologies have been implemented in image analysis methods that help researchers draw scientific conclusions from biological phenomena. Plants of the family Lemnaceae (duckweeds) are the smallest flowering plants in the world, and biometric measurements of single plants and their growth rate are highly challenging. Although the use of software for digital image analysis has changed the way scientists extract phenomenological data (also for studies on duckweeds), the procedure is often not wholly automated and sometimes relies on the intervention of a human operator. Such a constraint can limit the objectivity of the measurements and generally

Environmental Control

Temperature

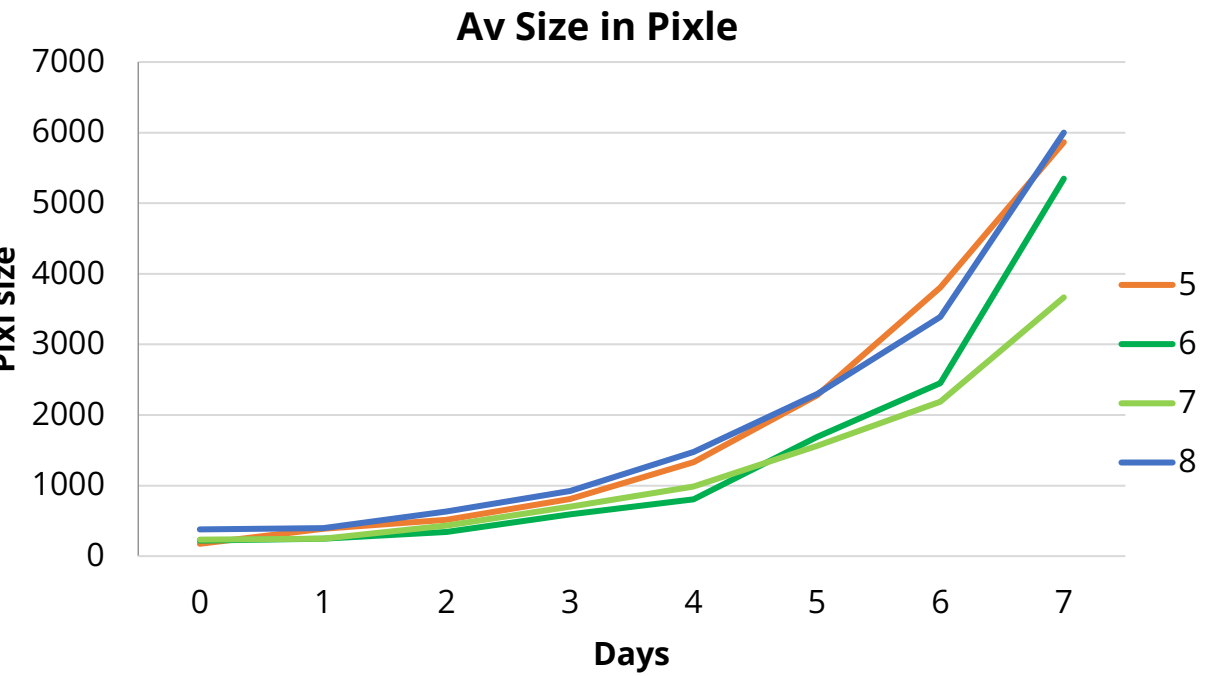
- *Interaction between plant and temperature*
- *Intraspecific interaction*
- *Accession temperature effect*
- *Find the most suitable temperature*

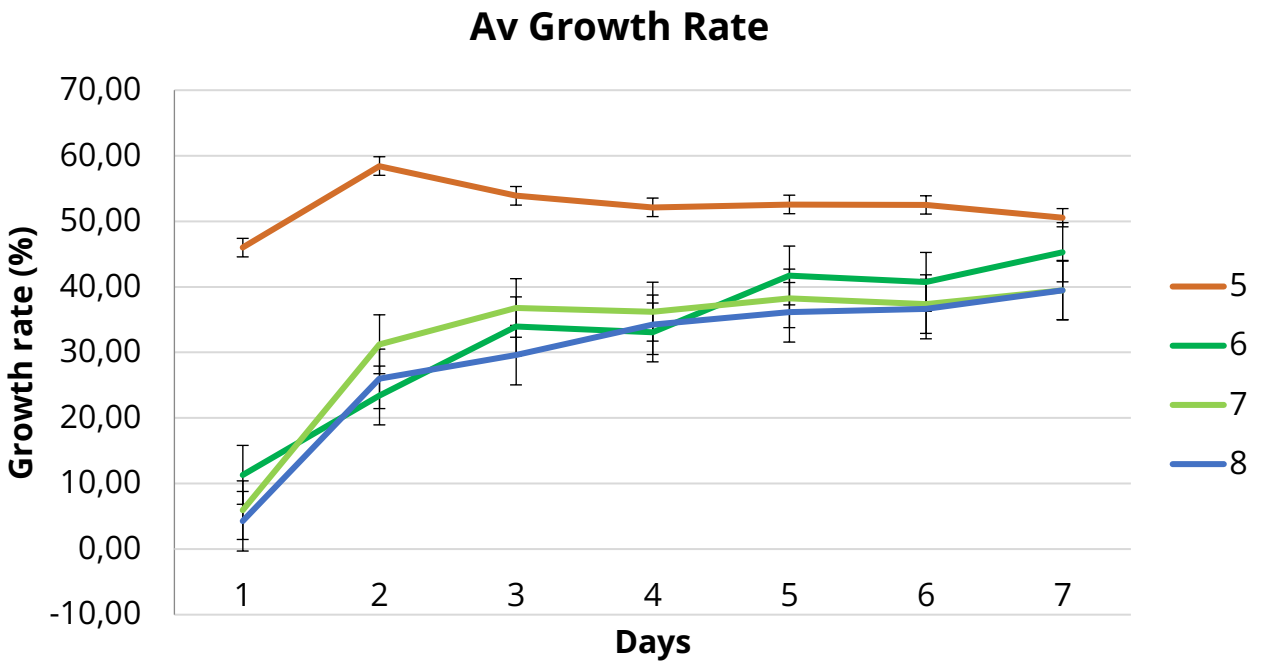
Light

- Plant's interaction with light
- The effect of light on the growth of *Wolffia* plants
- The effect of light quality/quantity
- Effect of light quality/quantity on the nutritional values

Environmental Control

Temperature



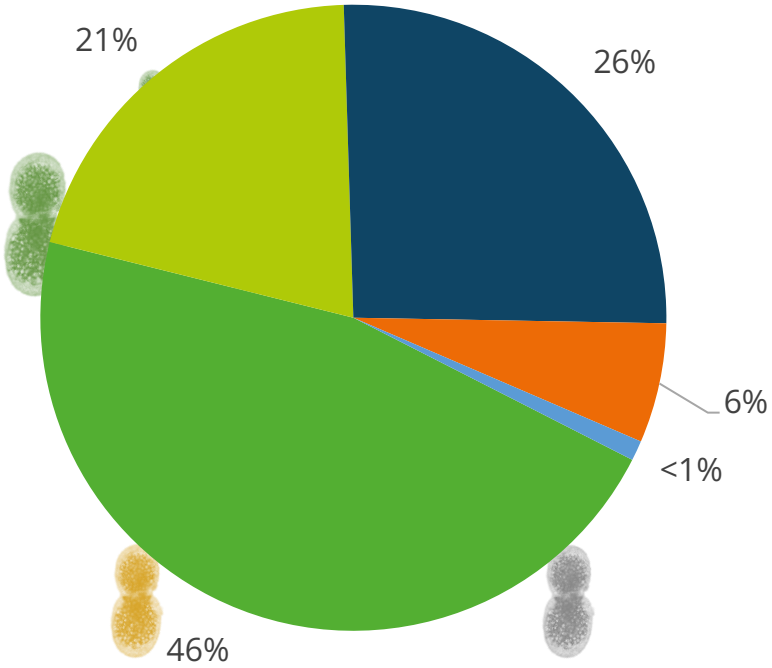


Environmental Control

Light

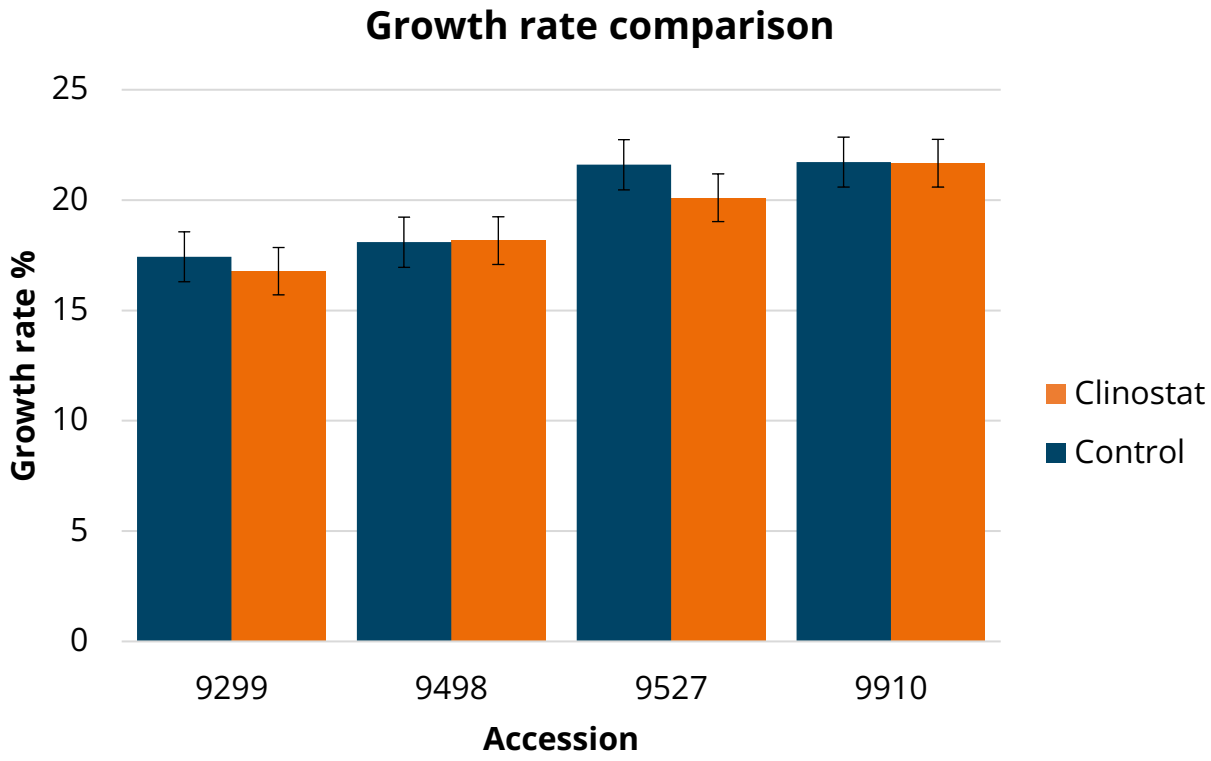
Quality

Quantity



Clinorotation

No significant difference between treatments

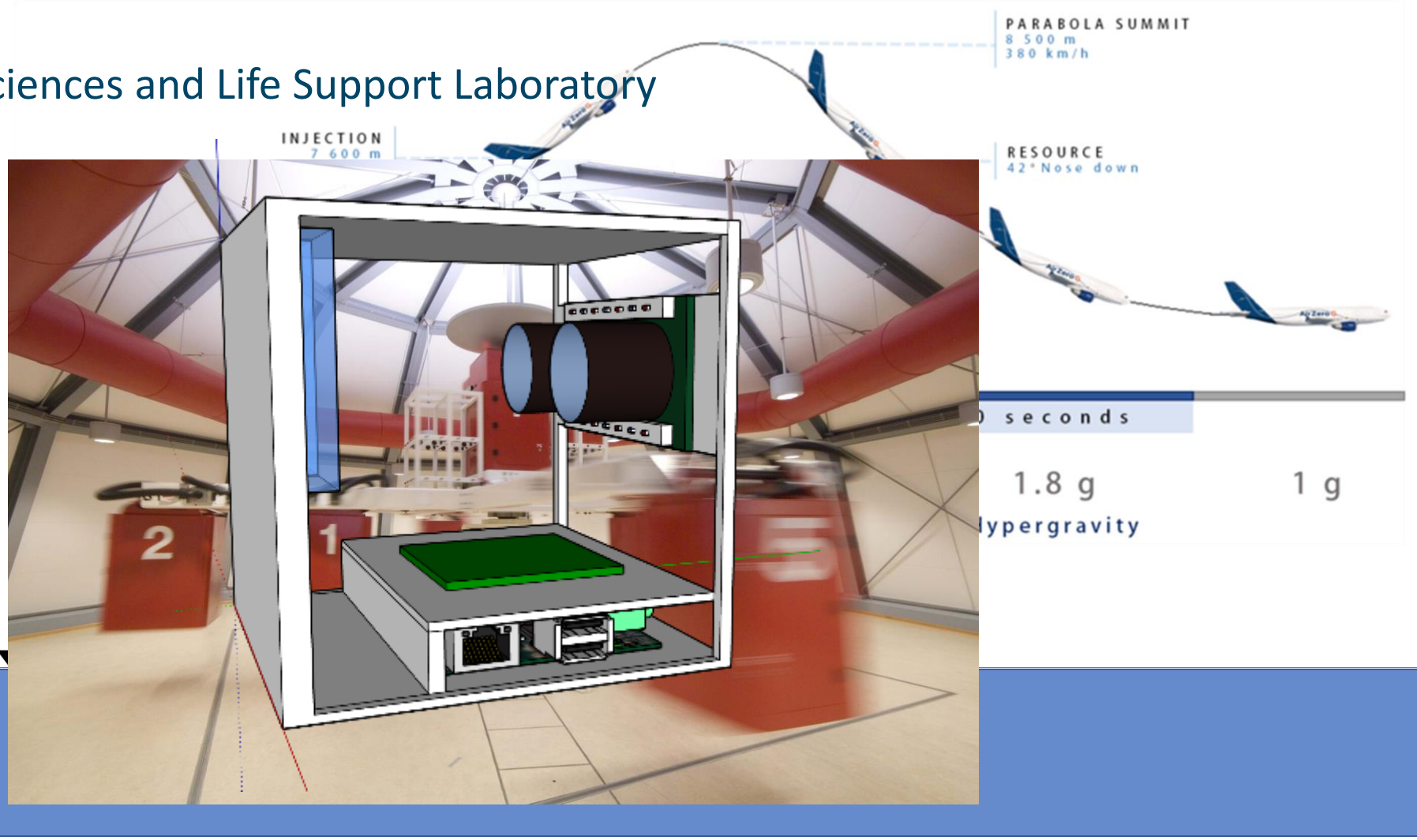


Future activities

ESA Life, Physical Sciences and Life Support Laboratory

Parabolic flight

International Space



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THANK YOU.

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Follow us

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