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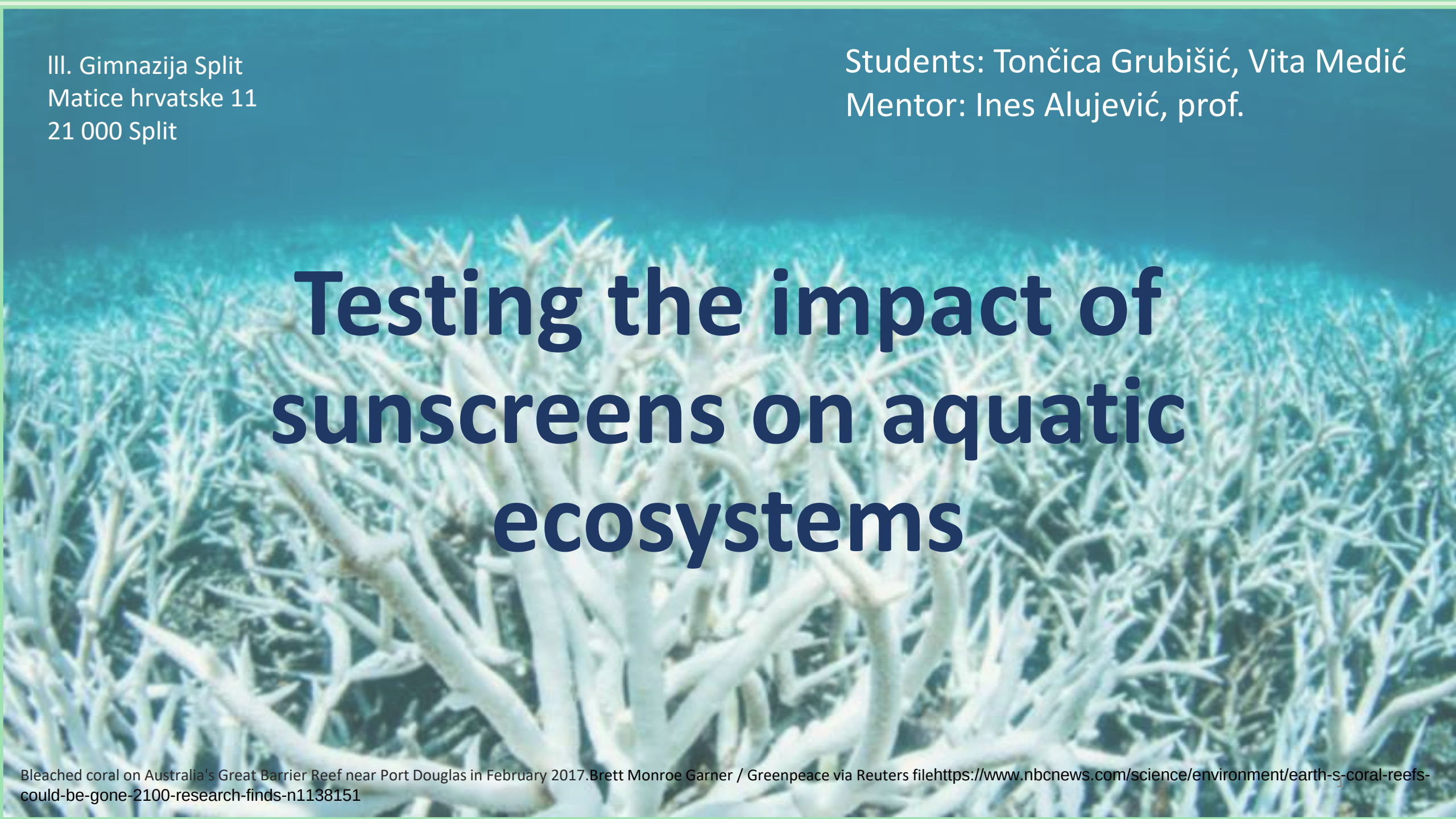
Testing the impact of sunscreens on aquatic ecosystems



Bleached coral on Australia's Great Barrier Reef near Port Douglas in February 2017.Brett Monroe Garner / Greenpeace via Reuters filehttps://www.nbcnews.com/science/environment/earth-s-coral-reefs-could-be-gone-2100-research-finds-n1138151

Topic selection

- A current ecological problem.
- The community is not aware of the harmful effect of sunscreens on aquatic ecosystems.
- Disturbing the ecological balance of underwater ecosystems.

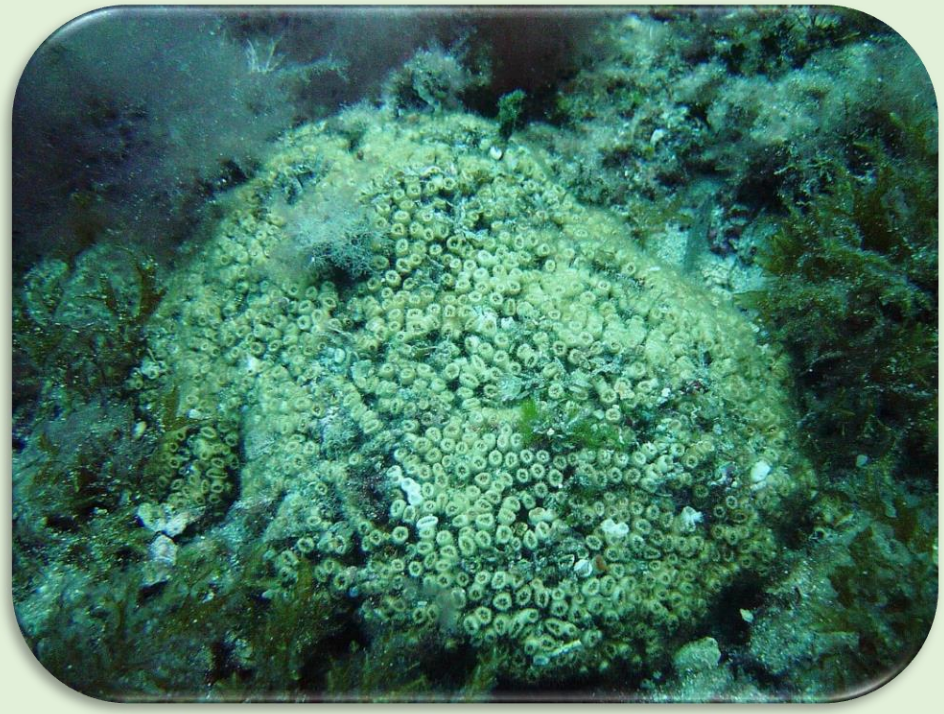


Figure 1. Bush coral *Cladocora caespitosa* (Linnaeus, 1757)

https://www.morski.hr/u-nacionalnom-parku-mljet-nalazi-se-najveci-greben-busenastog-kamenog-koralja-na-svijetu/

Figure 2. Periska *(Pina nobilis L.)* in the seagrass meadow of Posidonia *(Posidonia oceanica* (L.) Delile)

Autor: Arnaud Abadie - [1], CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=90786391

Table 1. Sunscreens - basic division

Sunscreens		Harmful ingredients
Mineral (ZnO, TiO_2)	nanoparticle-free	___
	with nanoparticles	nanoparticles can damage chloroplast components[1]
Chemical	toxic compounds-free	___
	contain toxic compounds	octocrylene oxybenzone homosalate etc. can inhibit photosynthesis[2] lead to coral bleaching in very low concentrations

- Reef-Safe - contains only mineral UV-blocking ingredients
- Reef-Friendly - does not contain oxybenzone or octinoxate (does contain other chemical-based ingredients)

[1] Šoltić, M., 2023. Analiza nanočestica titanijevog dioksida i cinkovog oksida u kremama za sunčanje, Prirodoslovno-matematički fakultet Sveučilišta u Zagrebu, Zagreb.
[2] Zhong, X. i sur. 2019. Significant inhibition of photosynthesis and respiration in leaves of Cucumis sativus L. by oxybenzone, an active ingredient in sunscreen, Chemosphere 219, 456-462.

- 25% of the sunscreen product applied on the skin is diluted in water within 20 minutes[3].
- Up to 14,000 tons of sunscreen end up in the world's oceans every year[4].

[3] Danovaro R, Bongiorni L, Corinaldesi C, Giovannelli D, Damiani E, Astolfi P, Greci L, Pusceddu A (2008) Sunscreens cause coral 1342 M. Chatzigianni et al. bleaching by promoting viral infections. Environ Health Perspect 116:441–447. https://doi.org/10.1289/ehp.10966
[4] American Chemical Society. "Sunscreen and cosmetics compound may harm coral by altering fatty acids." ScienceDaily. ScienceDaily, 9 January 2019. <www.sciencedaily.com/releases/2019/01/190109110048.htm>

Sunscreens used in the study

Figure 3. Mineral cream labeled reef-friendly (non-nanoTiO_2 and octocrylene)

Figure 4. Mineral cream (nano ZnO, TiO_2)

Figure 5. Chemical cream (octocrylene)

Figure 6. Chemical cream without octocrylene and nanoparticles (harmful dibutyl adipate)

Lemna minor root regrowth test

- Measuring the length of the newly grown root.
- Used in wastewater pollution testing.
- Fast and easy to do.
- Proven suitable by interlaboratory testing.

Figure 7. Duckweed with a newly grown root under a magnifying glass

Lemna minor L.

- The most widespread type of duckweed
- Fast growth and high nutrient removal efficiency
- Easy cultivation
- Suitable for conducting tests

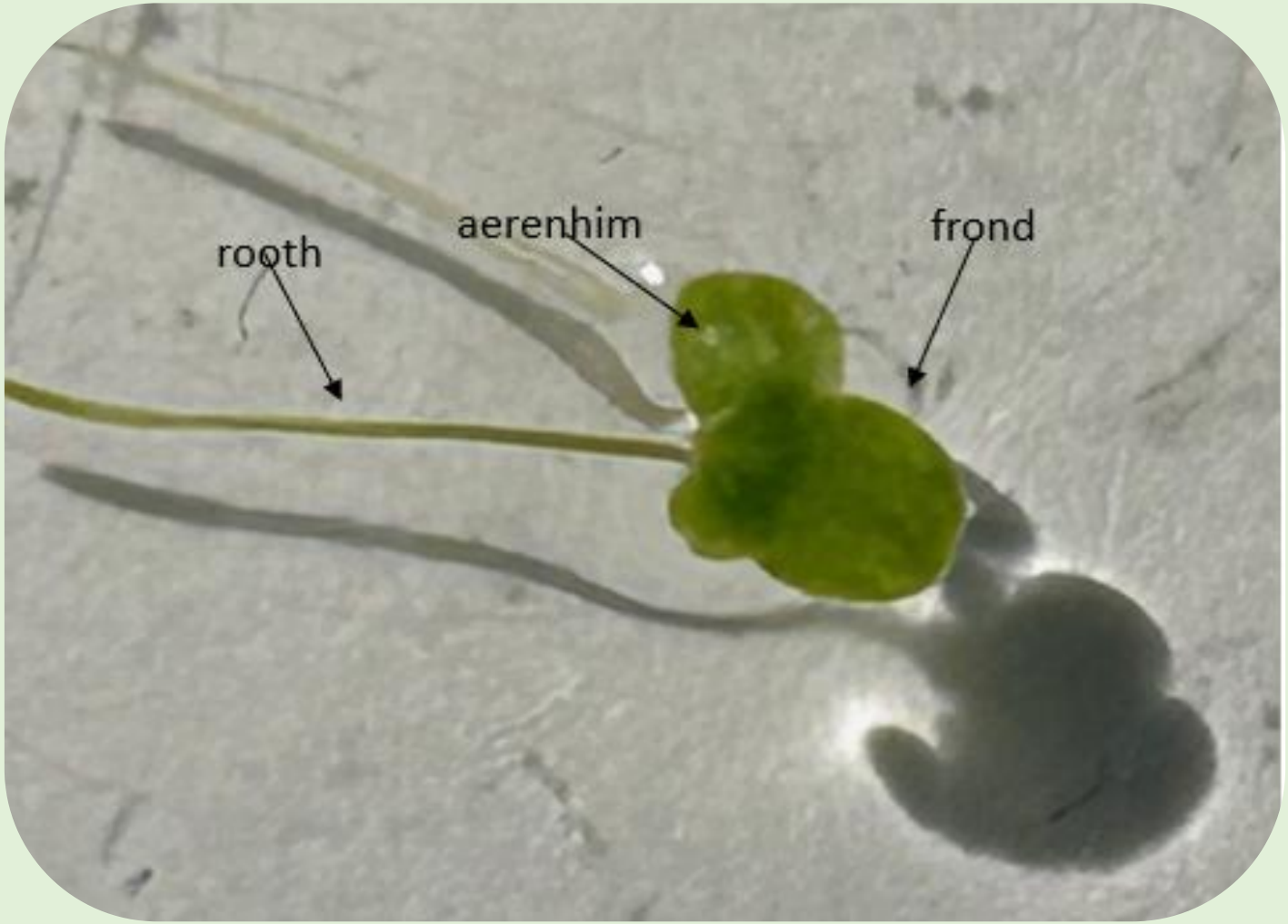


Figure 8. Duckweed structure

Data Analysis

- The length of the root was measured in a computer program *ImageJ*, https://imagej.net/ij/

- The statistical significance of the results was determined by the ANOVA test using an online statistical calculator Datatab (2023.), $p<0,05$

Research Aim

- To investigate the effect of commonly used sunscreens on the test organism *Lemna minor* L.
- To determine the effect of different types and concentrations of sunscreen on the length of newly grown roots in relation to the control group.
- To point out an ecological problem and encourage those responsible to protect particularly endangered habitats.

Hypotheses

- A reduction in root length will be noticed in test organisms treated with all sunscreen solutions.
- Roots treated with solutions of chemical creams with harmful compounds will be shorter than roots treated with a cream solution advertised as "reef-friendly".
- A mineral sunscreen that contains nanoparticles will cause a greater reduction in root growth than one without nanoparticles.
- A greater reduction in root growth will be caused by solutions of higher concentrations of sunscreen.

The natural habitat of the duckweed used in the research

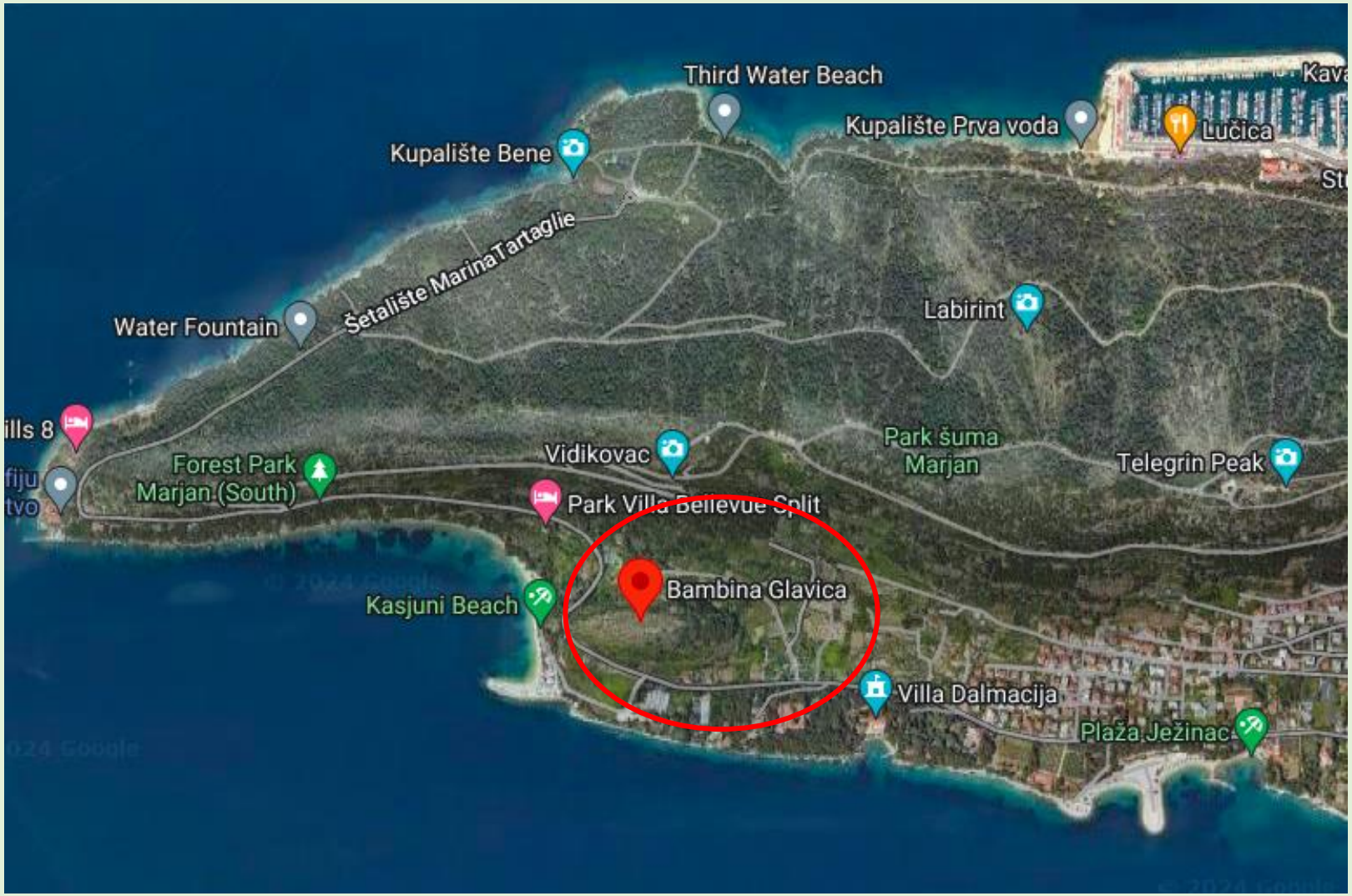


Figure 9. Natural habitat of the duckweed used in the study

https://www.google.com/maps/place/Bambina+Glavica/@43.5063358,16.3958611,1225m/data=!3m1!1e3!4m6!3m5!1s0x1335677c9d1d1b31:0xcbe8aeeebd9348f3!8m2!3d43.5063203!4d16.4031755!16s%2Fg%2F1218rwtm!5m1!1e4?entry=ttu

Methodology

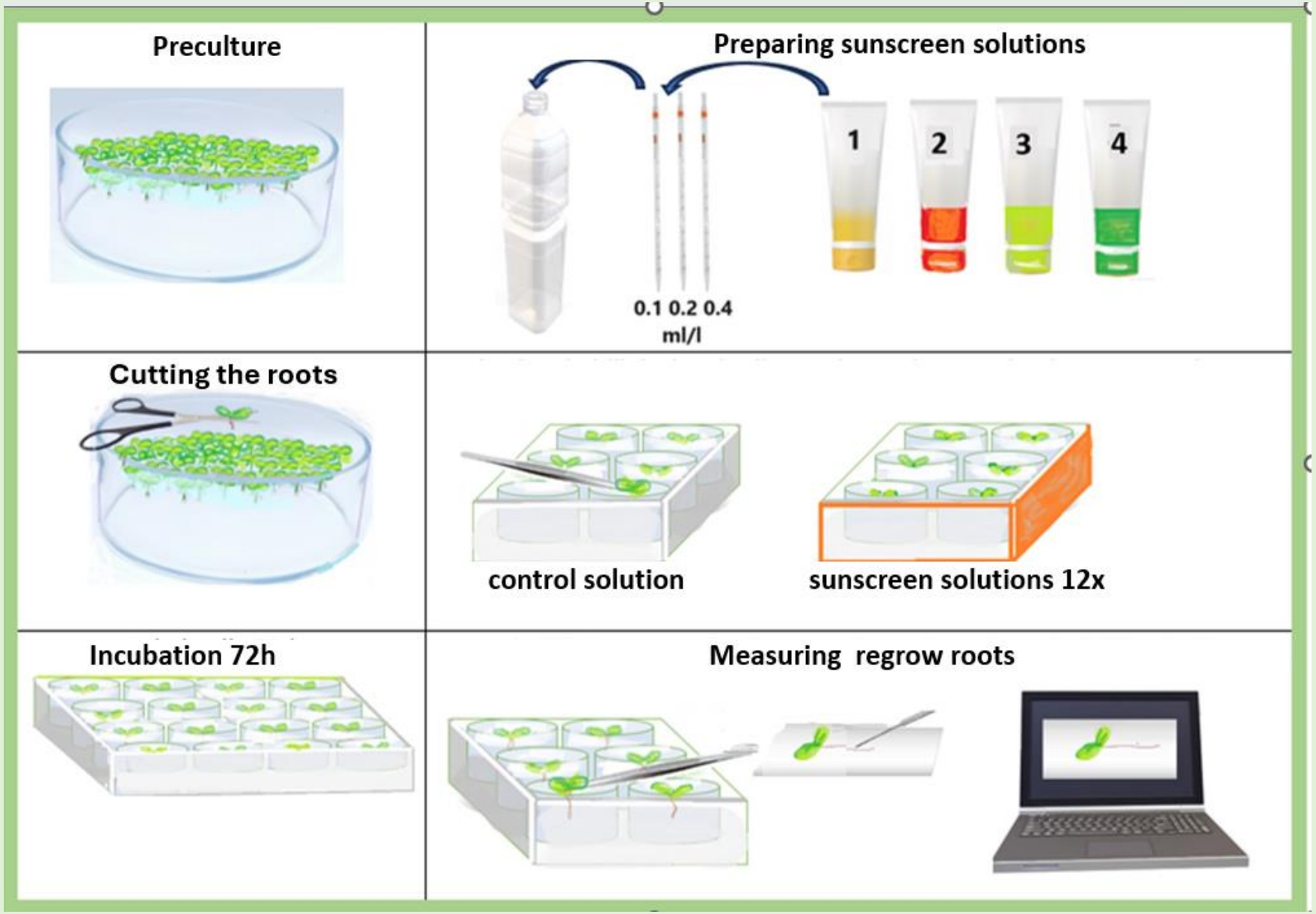


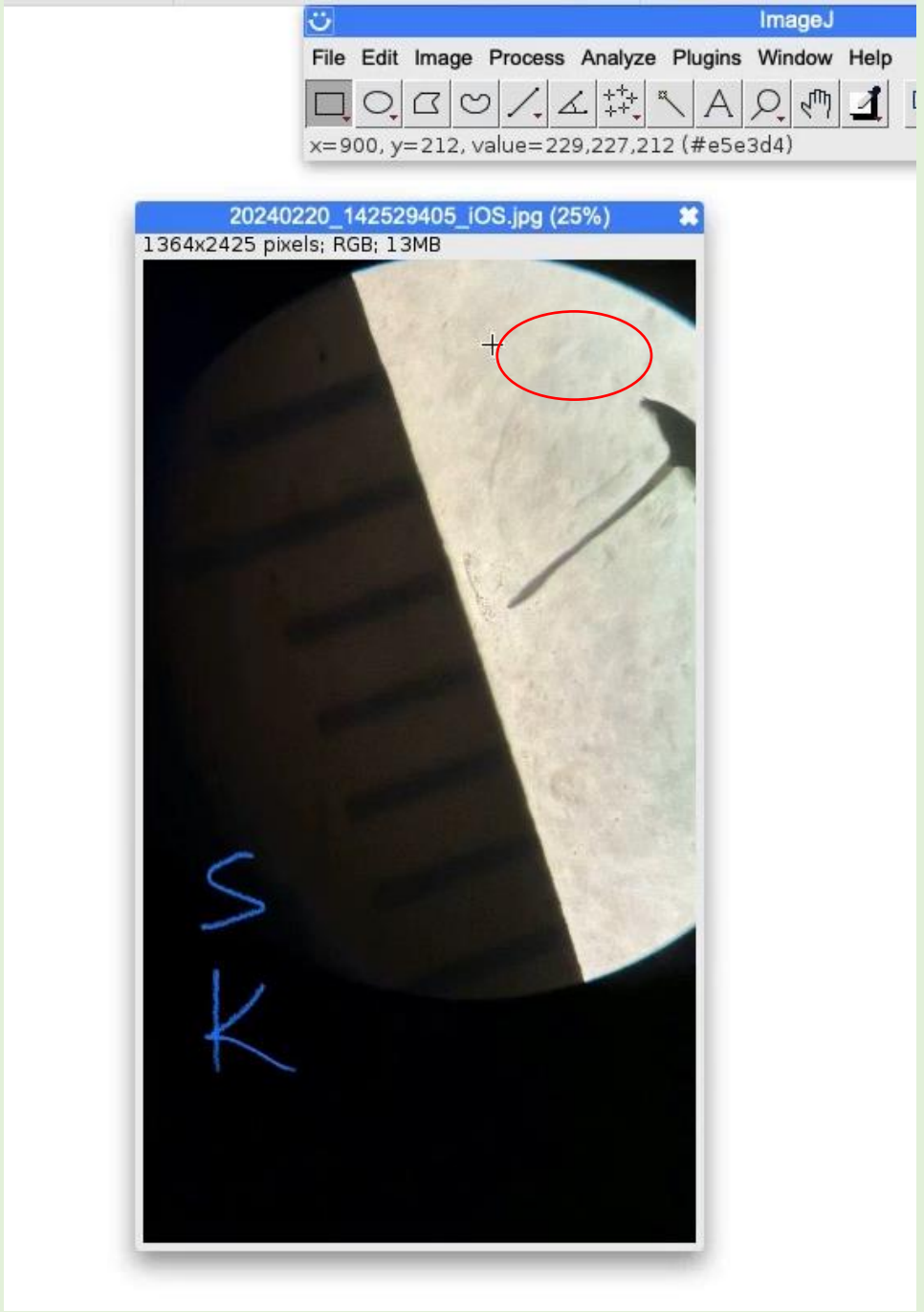
Figure 10. Metodology

Figure 11. Duckweed in a germination solution

Figure 12. SC solutions of different concentrations

Figure 13. Placing the roots on the glass for observation under a magnifying glass

Figure 14. Individual duckweeds


ImageJ
File Edit Image Process Analyze Plugins Window Help
x=900, y=212, value=229,227,212 (#e5e3d4)
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1364x2425 pixels; RGB; 13MB

RESULTS

Average length of newly grown roots

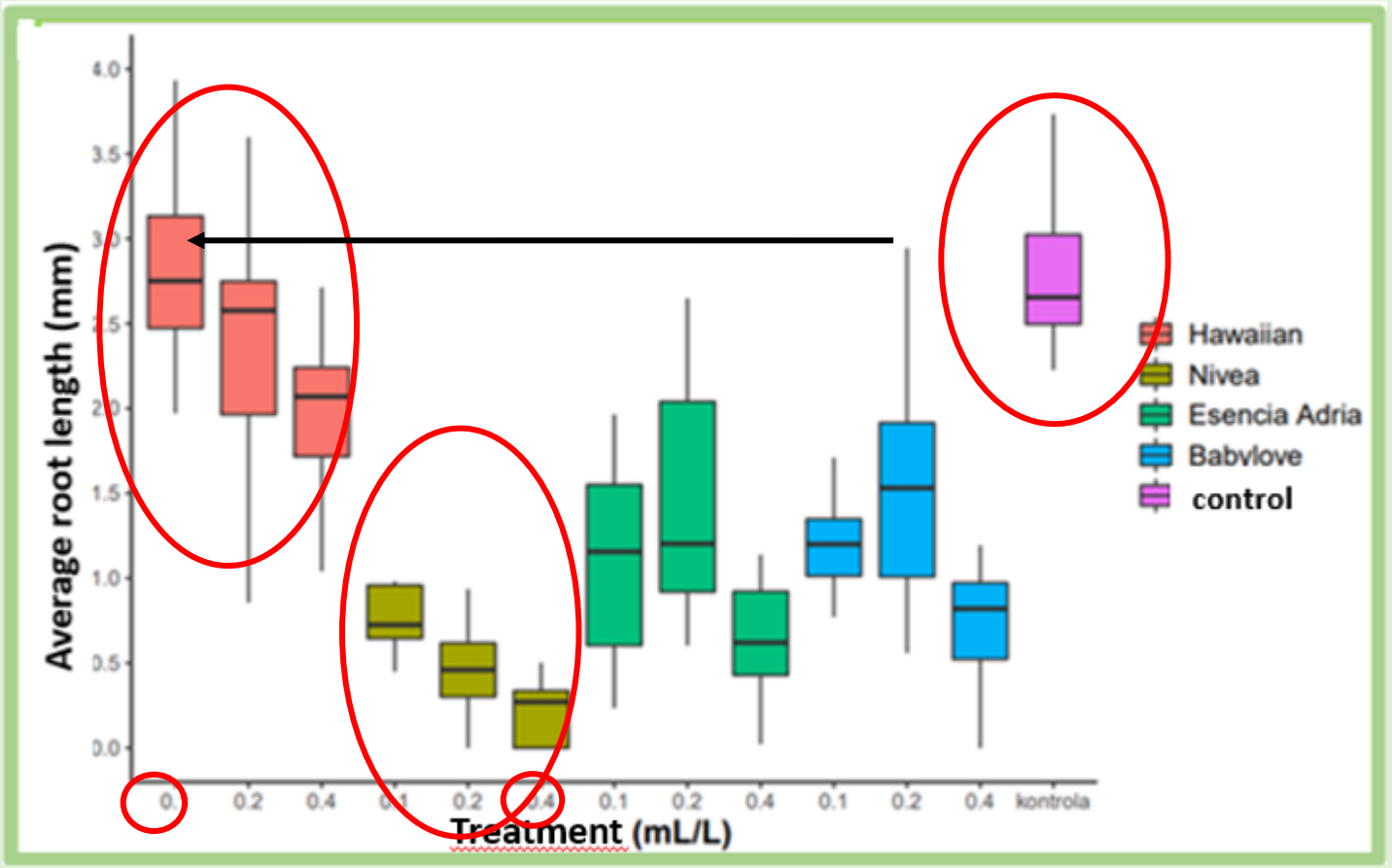

Figure 15. Average root length (mm) in solutions of all sunscreens after 72 hours of treatment

- Only in individuals treated with Hawaiian cream (concentrations 0.1 mL/L and 0.2 mL/L) there was no statistically significant deviation in length compared to the control (germination solution)
- A significant difference in root length was noted between individuals treated with all concentrations of Hawaiian cream (without nano particles) and Nivea cream (with nano particles)

Average length of newly grown roots

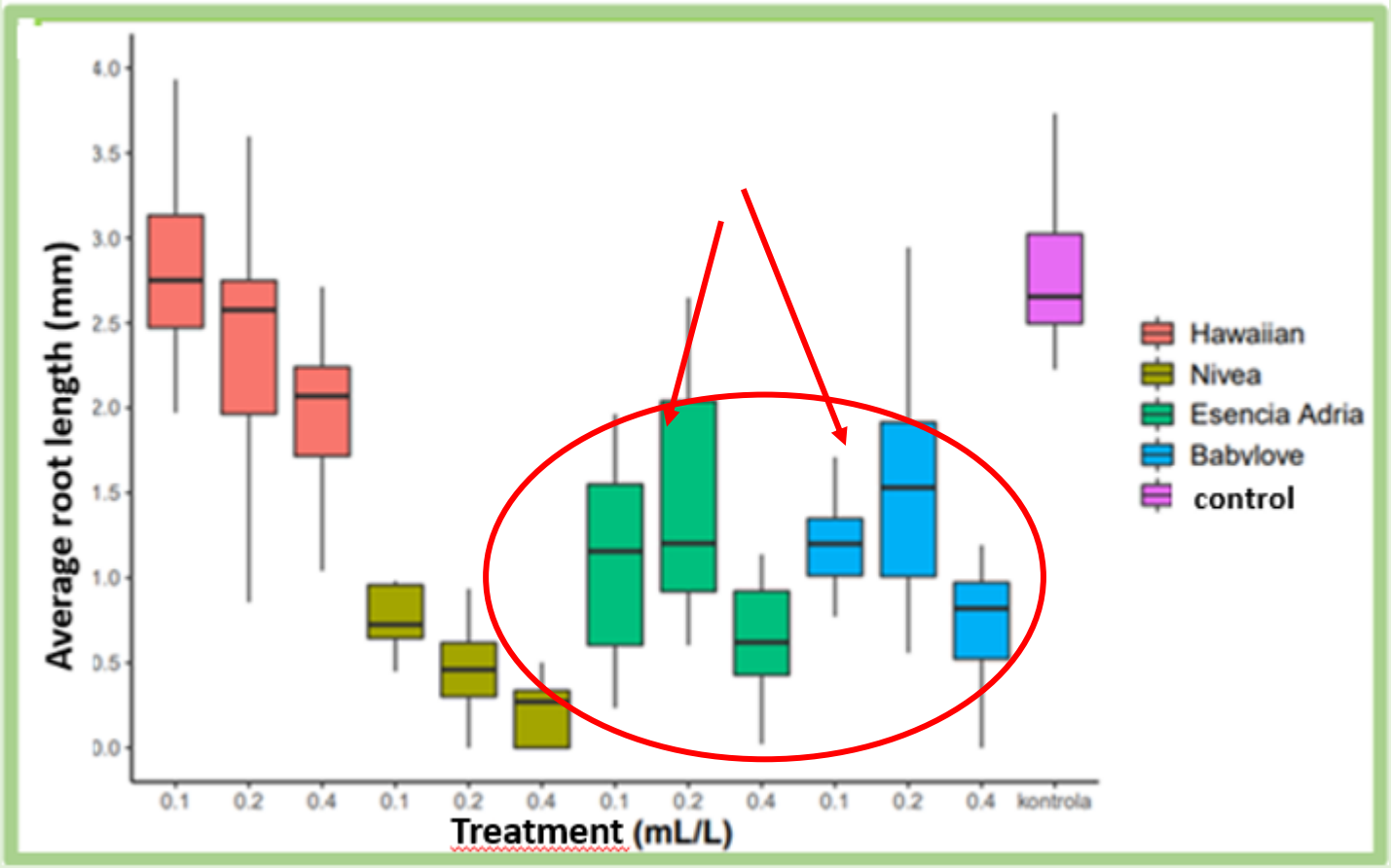

Figure 16. Average root length (mm) in solutions of all sunscreens after 72 hours of treatment

- After treatment with Esencia Adria and Babylove chemical creams, longer roots were measured from the treatment with the 0.2 mL/L solution compared to those from the 0.1 mL/L solution
- Esencia Adria and Babylove solutions showed similar effects on average root growth

Morphology of roots and leaves of treated duckweed

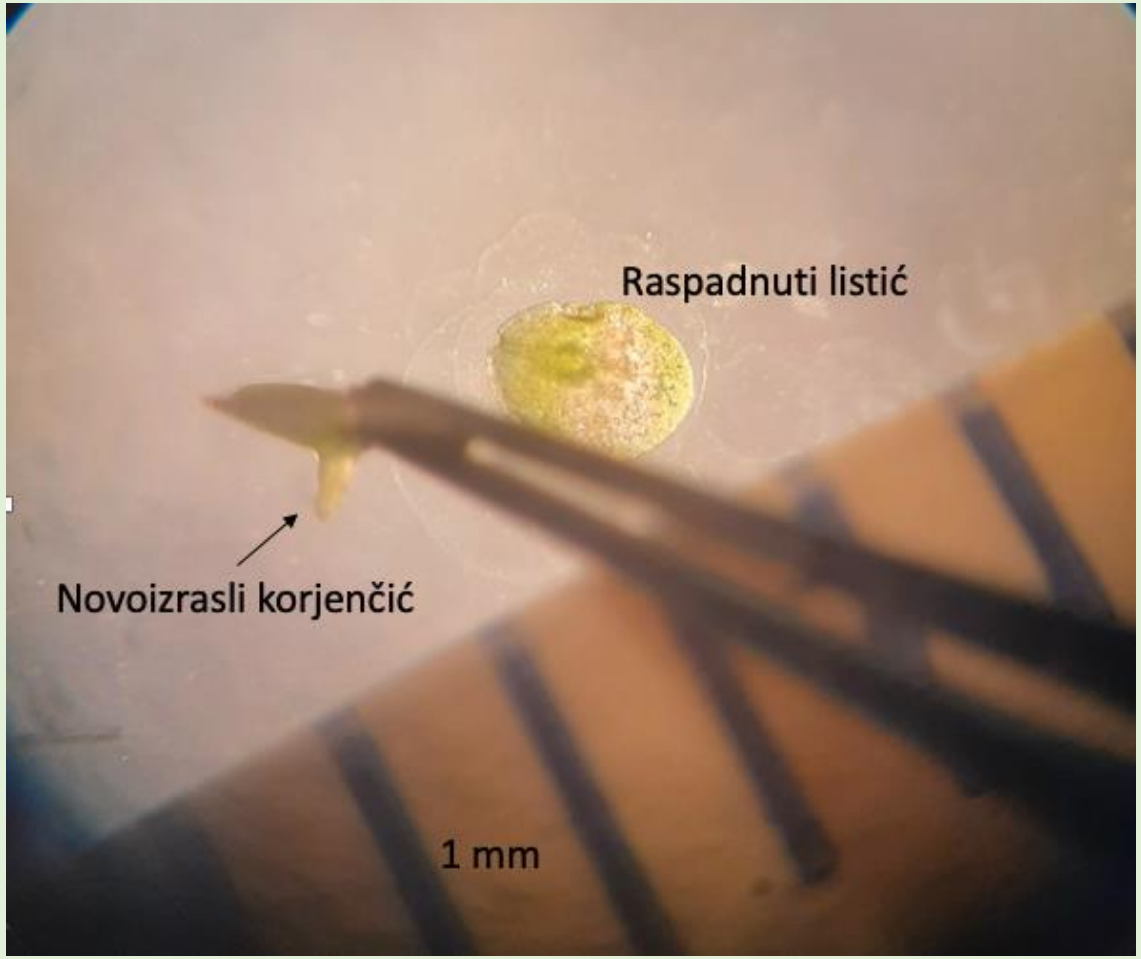

Figure 17. Root and leaves after 0.4 mL/L Esencia Adria treatement

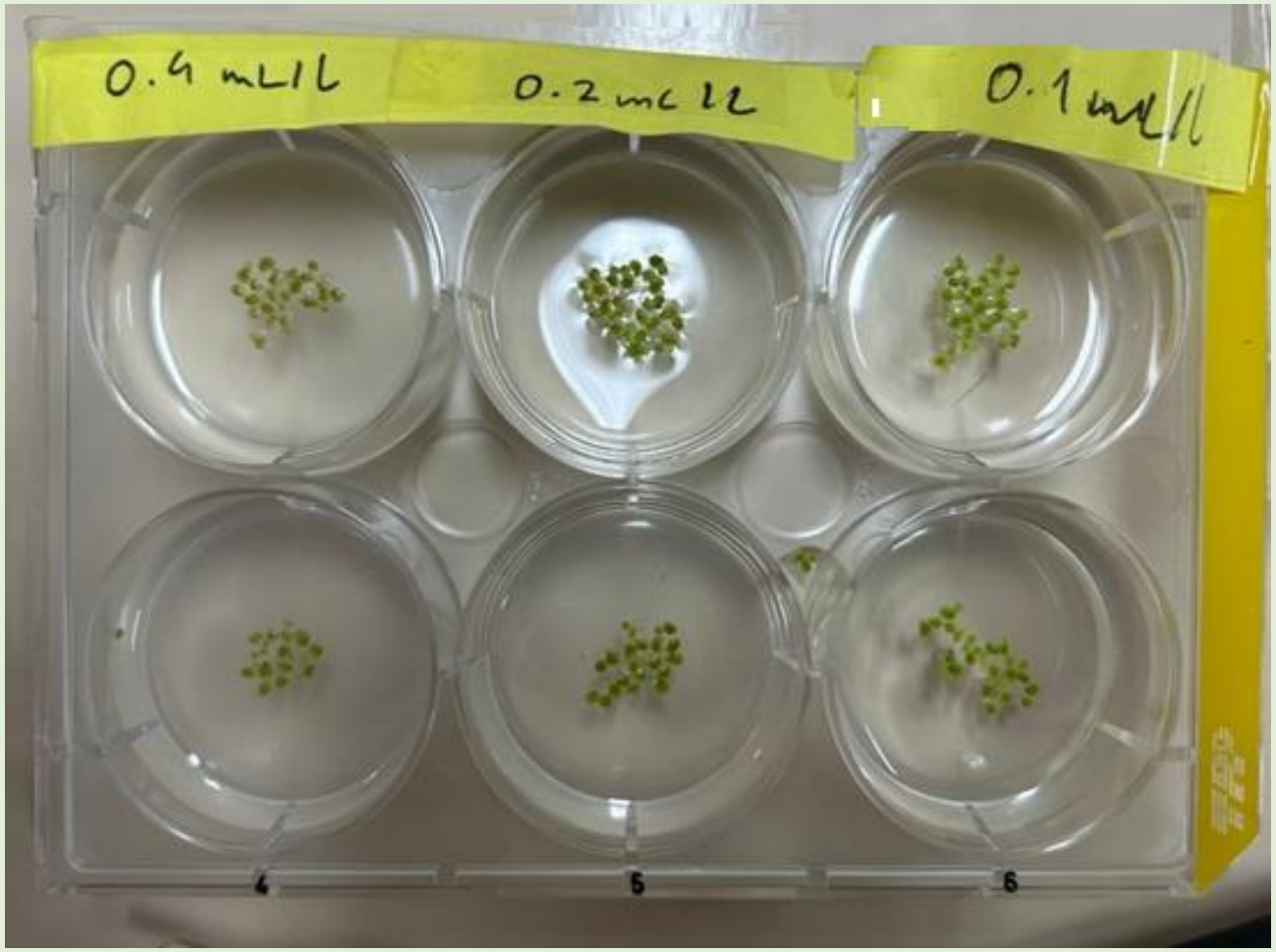

Figure 18. Duckweed treated with different concentrations of Esencia Adria cream solution

CONCLUSIONS

- Sunscreens that are not advertised as "reef friendly" inhibit the growth of duckweed roots. H1
- Sunscreen advertised as "reef friendly" significantly inhibited root growth only at a concentration of 0.4 mL/L. H2
- The greatest inhibition of growth in solutions of all concentrations was caused by the Nivea Sun cream with nanoparticles. H3
- Morphological changes are present in all individuals treated with sunscreen solutions, and they are most pronounced in individuals treated with a solution of 0.4 mL/L of Esencia Adria cream containing octocrylene.
- Roots treated with a solution of chemical creams at a concentration of 0.2 mL/L are longer than those in a solution with a concentration of 0.1 mL/L. H4


Thank you for your attention!