Importance of the influence of population habitat on the ecotoxicology assessment of sunscreen products: an analysis using sea urchin (*P. lividus*) fertilization and larval development bioassays

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INTRODUCTION

Environmental variability influences stress tolerance, local adaptation and phenotypic variation among populations. In this sense, habitat conditions could play a crucial role in marine life's ability to cope with pollution, thus being a determining factor in the assessment of environmental risk associated with contaminants.

Sunscreen formulations have become a focal point of scientific scrutiny and media attention due to their entry into ocean ecosystems. Predicting how organisms will respond differentially to sunscreens due to the natural variability in their respective habitats is crucial for assessing sunscreen's impact on marine ecosystems accurately.

Questions

- **Are populations living in pristine habitats more susceptible to the effects of sunscreens? Thus, is population a key factor in toxicity assessment?**
- **Are sunscreens labelled as "ocean respect“ or/ and with "new generation" UV filters less toxic than sunscreens containing "conventional" UV filters?**

WHAT WE DID…

Individuals of the sea urchin *Paracentrotus lividus* were collected by diving at two different selected sites (**Figure 1**).

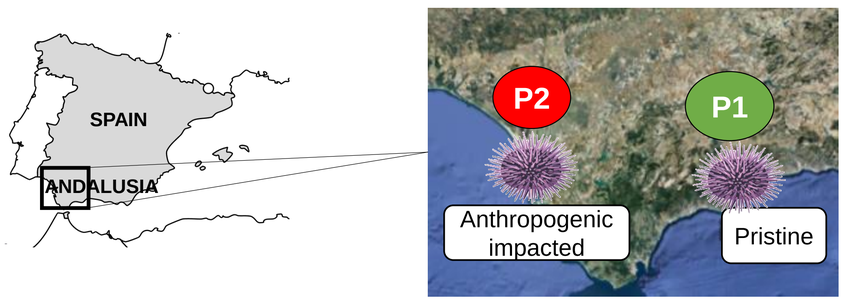

Figure 1. Geographical location of the two populations (P1, P2) of *P. lividus*.

Table 2. Tests used for ecotoxicological assessment of sunscreen in two populations of *P. lividus*.

Test	Duration	Endpoint
Fertilization	2 h	% fertililized eggs (with fertilization membrane)
Larval development	48 h	% normal developed pluteus (four well-developed arms)

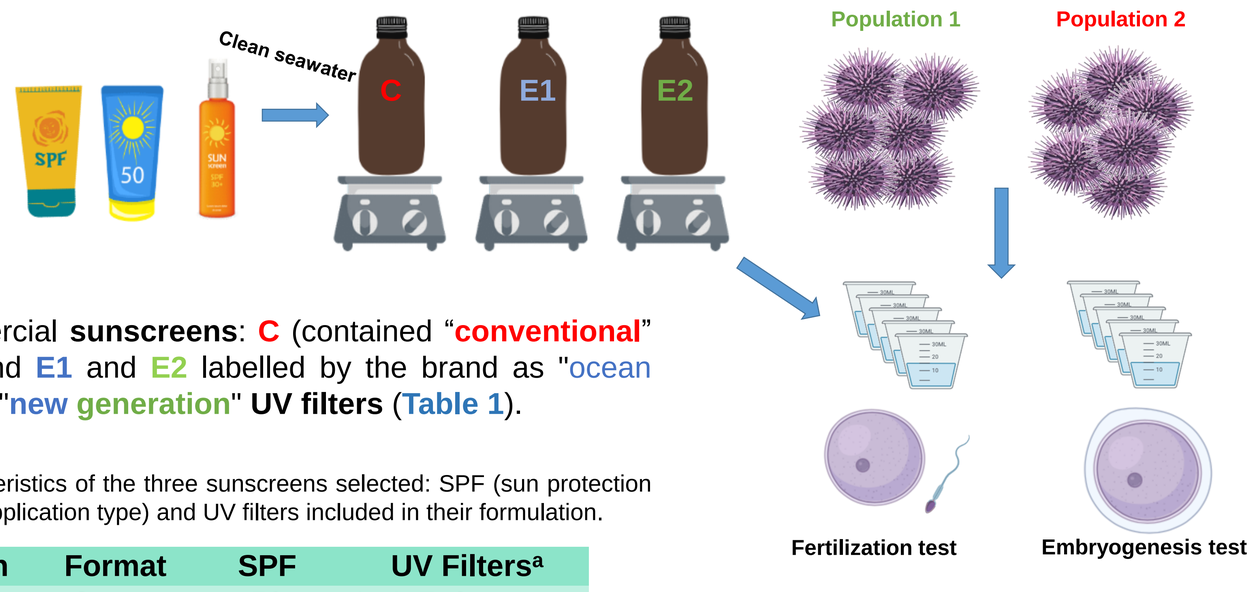

Figure 2. Experimental design.

Three commercial **sunscreens**: **C** (contained “**conventional**” **UV filters**) and **E1** and **E2** labelled by the brand as "ocean respect", with "**new generation**" **UV filters** (**Table 1**).

Table 1. Characteristics of the three sunscreens selected: SPF (sun protection factor), format (application type) and UV filters included in their formulation.

Sunscreen	Format	SPF	UV Filters[a]
C	Cream	50	1, 4, 7, 8
E1	Sun milk	50+	2, 3, 5, 6
E2	Oil	50+	2, 3, 6

[a] UV filters: (1) octocrylene, hexyl benzoate (7) titanium dioxide (nano), (8) zinc o (2) bemotrizinol, (3) ethylhexyl triazone, (4) octinoxate, (5) Iscotrizinol , (6) diethylamino hydroxybenzoyl xide (nano).

Exposure to 10 different concentrations of sunscreen: (ranged from 0- 500 mg/L).

The **fertilization and embryogenesis assays** were performed according to the procedure described by Volpi Ghirardini *et al*., (2005) and Fernandez and Beiras (2001), respectively (**Figure 2; Table 2**).

RESULTS

Fertilization

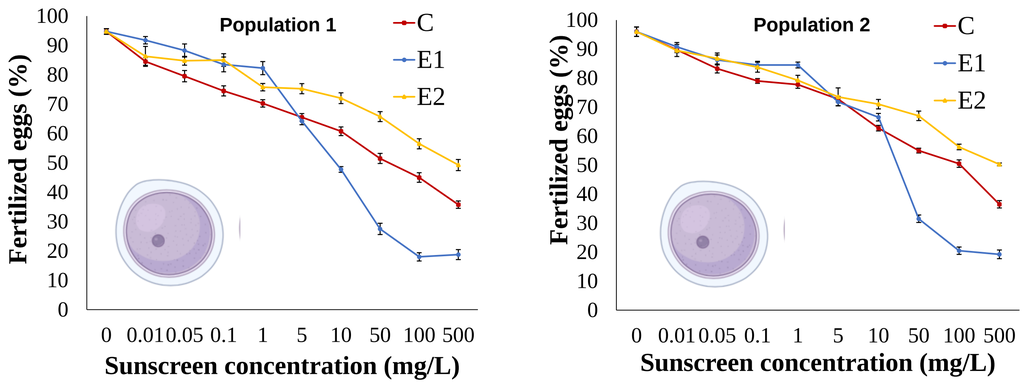

Figure 3. Percentage of fertilized *P. lividus* eggs after exposure to different concentrations of sunscreen for the two different populations.

Larval development

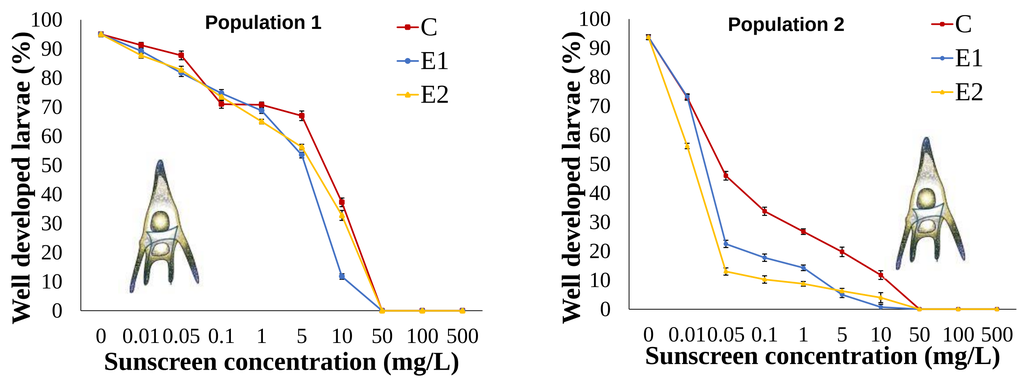

Figure 4. Percentage of well-developed *P. lividus* larvae after exposure to different concentrations of sunscreens for the two different populations.

Table 3. EC_{50} values for the fertilization of *P. lividus* Values in brackets indicate the upper and lower limits of the 95% confidence interval.

Population	Sunscreen	EC_{50} (mg/L)
P1	C	87.6 [55.2 – 145]
	E1	14.2 [11.4 – 17.6]
	E2	958 [520 – 2,060]
P2	C	138 [92.4 – 217]
	E1	28.5 [23.3 – 34.5]
	E2	806 [449 – 161]

Higher and significant malformations on larval development ($p<0.05$) were recorded in the population located at the anthropogenic impacted coast.
The sunscreen E1 labelled as “ocean respect” in sun milk format showed the highest toxicity.

Table 4. EC_{50} values for *P. lividus* larval development. Values in brackets indicate the upper and lower limits of the 95% confidence interval.

Population	Sunscreen	EC_{50} (mg/L)
P1	C	8.91 [8.27 – 9.6]
	E1	5.95 [5.54 – 6.34]
	E2	7.56 [6.76 – 8.32]
P2	C	7.51×10^{-2} [5.79×10^{-2} – 9.79×10^{-2}]
	E1	2.39×10^{-2} [1.94×10^{-2} – 2.91×10^{-2}]
	E2	7.64×10-3 [5.38×10-3 – 1.04×10^{-2}]

MAIN FINDINGS

- “New generation" sunscreens showed higher toxicity, indicating that more research should be performed in assessing the risk of these products before to be labelled as ecofriendly.
- Other parameters, such as the application format (e.g. cream, oil or sun milk) of these products may affect their toxicity.
- A selected battery of bioassays should be provided to stakeholders and cosmetic companies to support the establishment of criteria for labelling ecofriendly sunscreen products.
- The susceptibility among populations of the same species reflects the importance of considering habitat as a major factor in ecotoxicity testing.

BIBLIOGRAPHY

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