Alternatives to Copper Paint as Herbivore Deterrents

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Abstract

Intertidal ecologists often employ copper-based paints to restrict herbivore movement into or out of experimental plots. However, copper is toxic to many organisms, including fish, algae, and mollusks, and the use of such paints will soon be phased out by the State of California. To explore alternatives to copper paint, we examined the herbivore deterring efficiencies and metal-teaching qualities of copper paint, copper tape, copper coil, zinc paint, and the gum resin Tanglefoot. Copper tape was most effective in the field whereas copper coil was most effective in the lab at restricting herbivore movement. In both the field and the lab, copper paint emitted the greatest amount of metal of all the deterrents tested.

Results

• In the lab, there were significant differences among the effectiveness of deterrents, with copper coil being the most effective at preventing herbivore movement (ANOVA, p < 0.05) (Fig. 1).
• Copper tape and copper paint were significantly better at preventing herbivore invasion; copper tape was also significantly more efficient than Tanglefoot (p < 0.05) (Fig. 2).

Discussion and Future Research

• Copper paint is clearly not the sole option for deterring herbivores from experimental plots
• Copper tape and copper coil were both more effective at controlling grazer movement and had decreased quantities of metal discharge than did copper paint. A possible downfall, however, might be copper oxidation, in which case the treatments would need more manual upkeep. Copper paint needs to be applied only once every six months.
• Zinc paint, however not quite as effective as copper paint, leached a substantially smaller amount of metal.
• Tanglefoot has no metal-diffusing qualities. It does, however, need reaplication approximately every two weeks.
• It would be helpful to examine the longevity of the tested deterrents, and in a larger experimental site.
• The DGT analyzes in the lab and in the tidepools represent very extreme levels of metal concentration. These deterrents would generally be used in more open, tidal-washed areas, causing highly increased dilution of metal ions.
• After detecting copper coil’s considerable effectiveness in the lab, we designed a second field experiment very similar to the one mentioned here. Results are pending.
• The four organisms in this experiment are key grazers in many rocky intertidal zones. We would like to continue this research by observing the behavioral effects (such as foraging behavior and reaction to predators) of the measured metal concentrations on these species.

Experimental Questions

• What are possible alternatives to copper-based paints as an herbivore deterrent?
• What are the differences in efficacy between deterrents?
• What are the amounts of metal ions being leached from each deterrent?

Materials

• Copper paint (CP), an anti-fouling paint
• 3 cm wide copper tape (CT), commonly used around gardens to prevent snail entry
• 6 mm diameter copper coil (CC)
• Zinc paint (ZP), also an antifouling
• Tanglefoot (TF), a gum resin used to prevent pest damage to trees
• Z-Spar (ZS), a marine epoxy, used in this experiment as a control

Diffusion Gradient in Thin Films (DGT) Analysis

• We used DGTs (stationary devices that measure diffusive gradients of metals) to observe the quantities of metal being leached from our deterrents.
• In the field, we placed 10 x 10 cm² plots in the same manner as in the laboratory (N = 6).
• We created the treated and control plots in the same manner as in the laboratory (N = 3).
• We monitored the number of marked herbivores remaining in each plot for 5 d.
• The number of invaders was also recorded and removed upon notation.

Field

• We examined the herbivore inclusion and exclusion efficiencies of CP, CC, TF, as well as ZS controls.
• 10 x 10 cm² plots were constructed on a flat, wave-exposed rocky intertidal four feet above sea level.
• We created the treated and control plots in the same manner as in the laboratory (N = 6).
• We positioned plots in a flow-through seawater tank and separated by mesh dividers.
• We added 3 each of L. digitalis, L. scabra, Littorina spp., and Tegula funebralis to each plot and monitored their escape from plots over 5 d.

Discussion

• DGT analysis revealed copper paint to leach the highest amount of copper. Elevated zinc was detected in the lab with the zinc paint treatment.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Relevant Metal Concentration (ppb)</th>
<th>% Increase from control*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper paint</td>
<td>2.67</td>
<td>74%</td>
</tr>
<tr>
<td>Copper coil</td>
<td>1.96</td>
<td>513%</td>
</tr>
<tr>
<td>Copper tape</td>
<td>2.50</td>
<td>550%</td>
</tr>
<tr>
<td>Zinc paint</td>
<td>2.67</td>
<td>178%</td>
</tr>
</tbody>
</table>

Laboratory. *Control tested 0.32 ppb Cu, 0.60 ppb Zn.

Field. **Control tested 0.25 ppb Cu.

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