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Effect of Macroplastic Type, Color, and Floating Behavior on Settlement and Succession of Marine Biota

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PEPPERDINE

Summer Undergraduate Research in Biology

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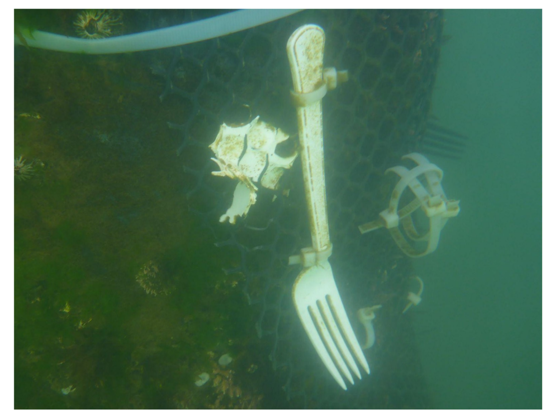
Abstract

Biofouling, the accumulation of organisms such as algae or barnacles on artificial substrates, can have harmful ecological effects when paired with plastic pollution. Organisms attach to floating plastic debris and can be carried to places where they may become invasive or cause the debris to sink to the seafloor, further disrupting aquatic life. This study examines how biofouling occurs on different types and colors of plastic, including loose and fixed surgical masks. Black and white plastic forks and coffee lids were submerged for three weeks on pier pylons at Paradise Cove, Malibu, photographed weekly, and analyzed for settled organisms. The number of barnacles increased each week, with no significant difference between plastic type or color; however, there were significantly more barnacles on the undersides than tops of lids, as well as more algae on white rather than black plastics. These results suggest that geometry has a higher impact than color for invertebrate biofouling on plastic, while algae settlement is higher on white plastics.

Methods

Site: Pier at Paradise Cove, Malibu, CA. Pylon A was furthest from shore (end of the pier), followed by pylons B and C.



1. 3 meshes with attached plastic items were secured to pylons underwater.

2. Meshes were retrieved from the ocean, photographed weekly, then returned. (Types: white and black forks, coffee lids, loose and fixed surgical masks, glass petri dishes.)

3. Individual items were photographed and analyzed for barnacle density and algae coverage. (From left to right: top of white lid, bottom of white lid, juvenile barnacles under microscope, surgical mask, all from week 3.)

Conclusions

- **Barnacle density**
  - Color did not significantly impact barnacle density.
  - More barnacles settled on the undersides of lids, suggesting a preference for concave or sheltered surfaces.
- **Algae cover**
  - Algae cover was significantly higher on white plastic, likely indicating a higher bioreceptivity for white surfaces.
- **Surgical masks**
  - Biofouling and algae growth likely caused the increase in weight of submerged masks.
  - Mask floating behavior did not affect settlement.

Results

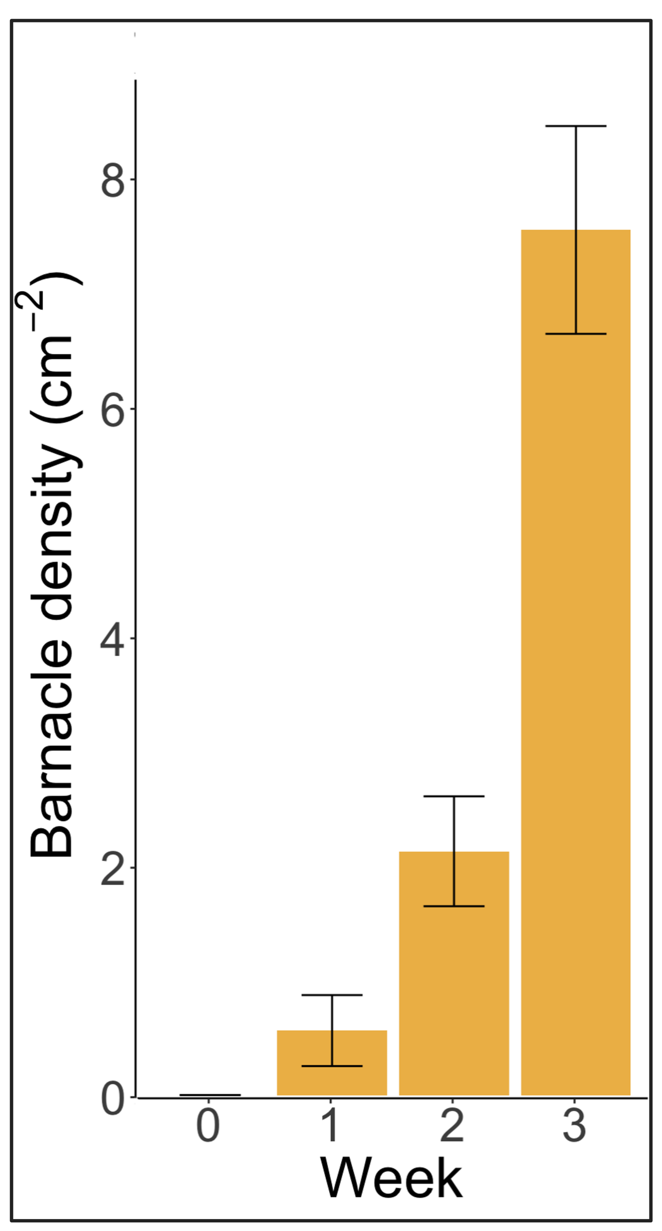


Fig. 1: Change in average barnacle density over time. Bars represent the average barnacle density for all items. Error bars represent the standard error. Week 0 indicates the time before the meshes were submerged.

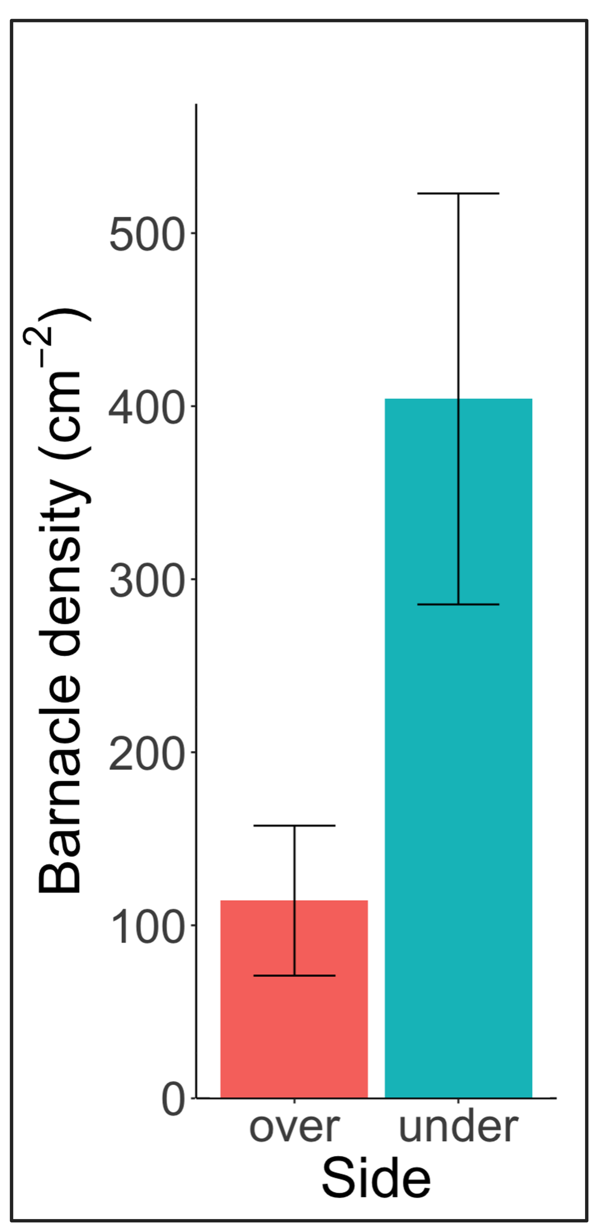


Fig. 2: Barnacle density on different sides of lids. Bars represent the average barnacle density on the over and underside of black and white lids. Error bars represent the standard error. The groups are significantly different, with p=0.01 when using a Kruskal-Wallis rank sum test.

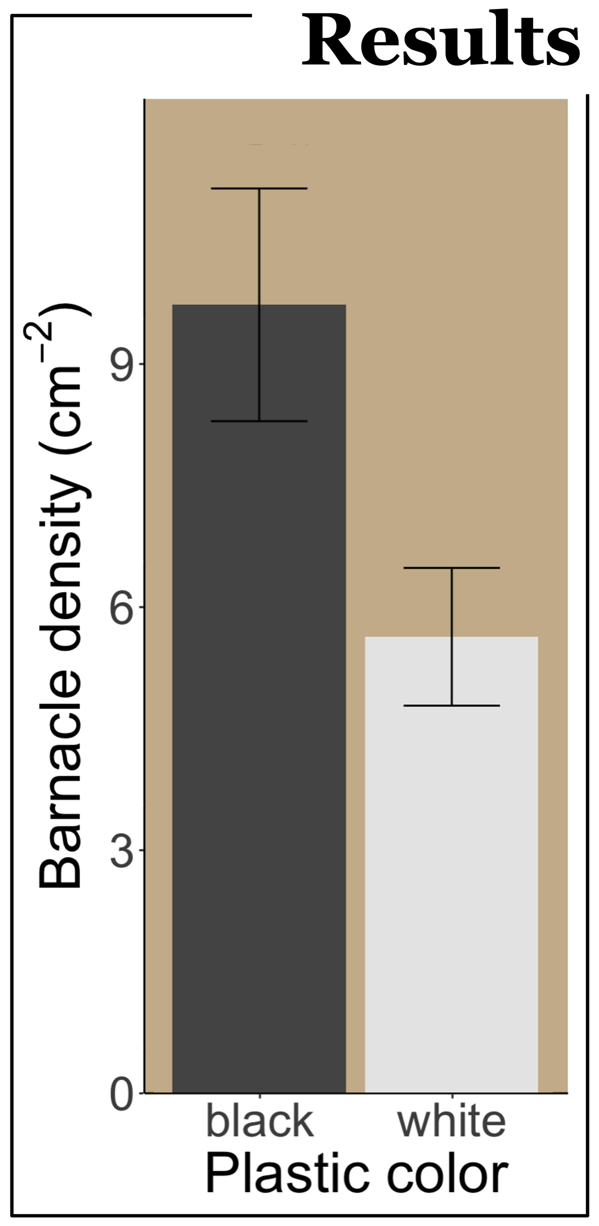


Fig. 3: Barnacle density on different plastic colors. Bars represent the average barnacle density on white and black plastics on week 3. Error bars represent the standard error. The groups are not significantly different, with p=0.058 when using a Kruskal-Wallis rank sum test.

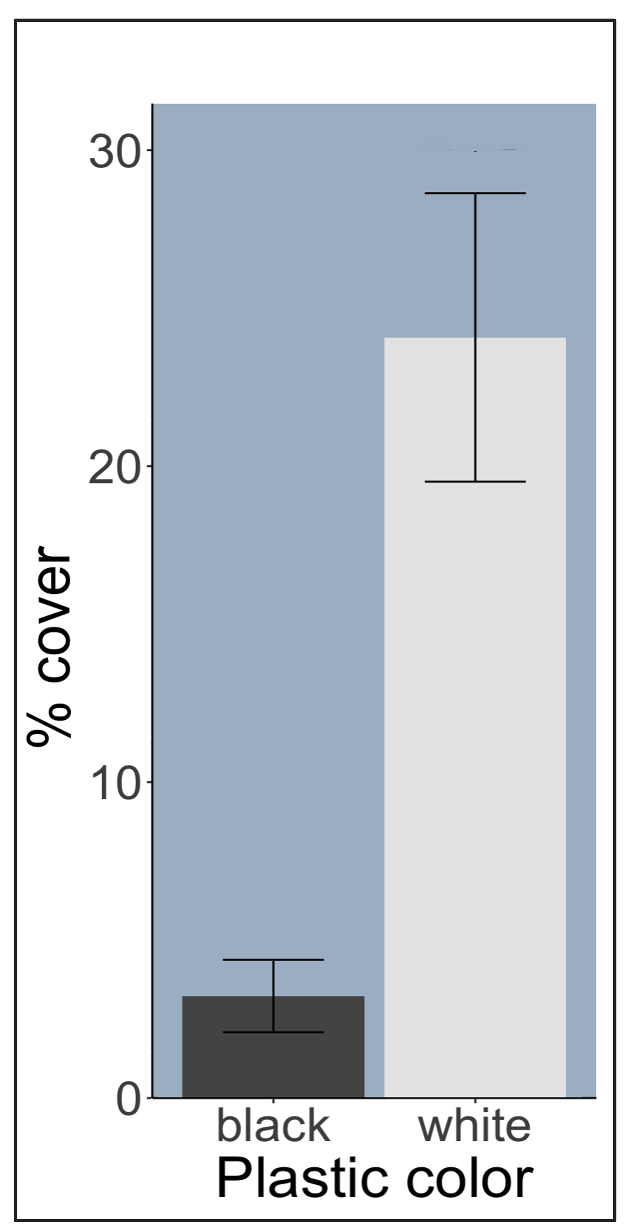


Fig. 4: % cover of algae on white and black plastics (forks and lids). Bars represent the average estimated % cover. Error bars represent the standard error. The groups are significantly different, with p=0.0001 when using a Kruskal-Wallis rank sum test.

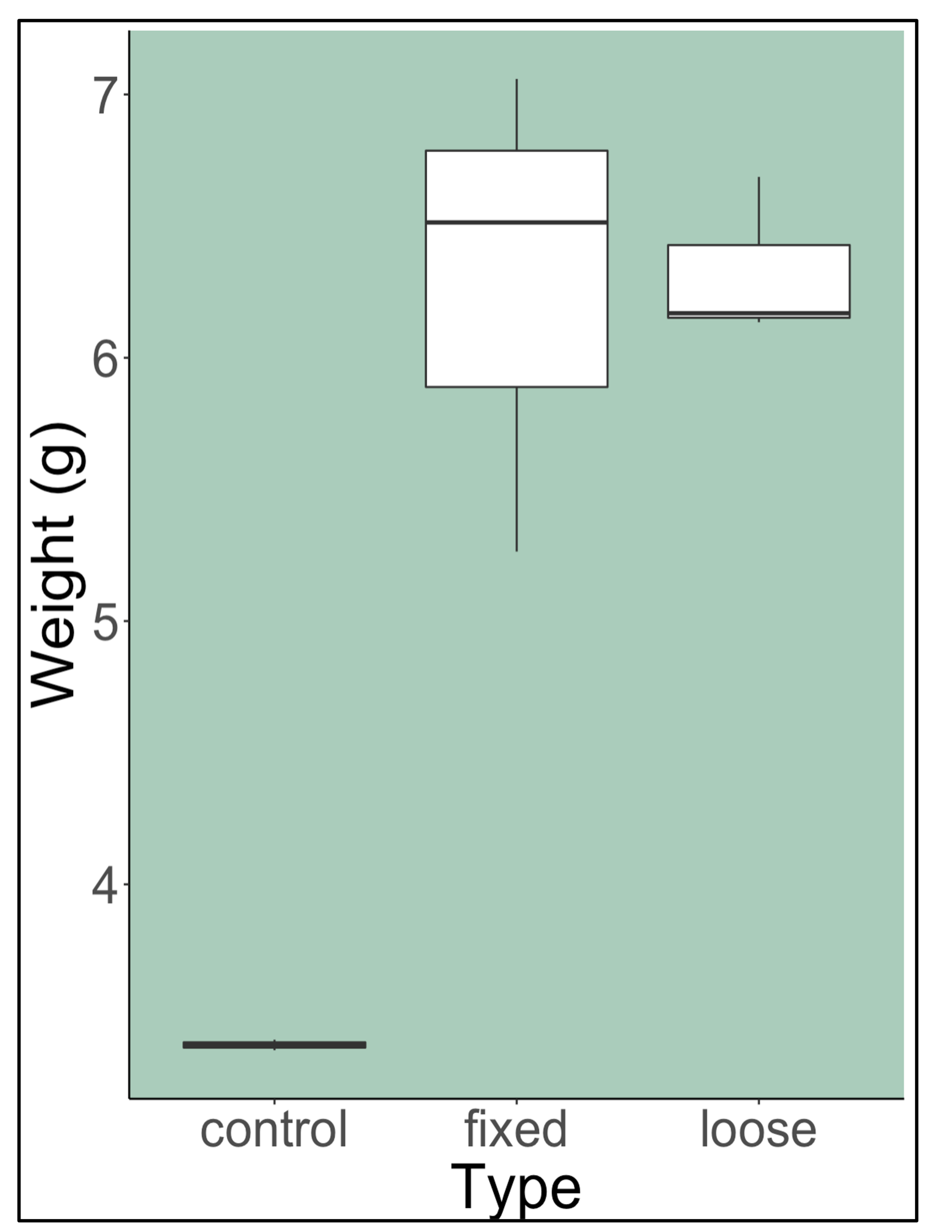


Fig. 5: Dry weight of surgical masks before and after experiment. Boxplots display the median, quartiles, and range of data. Fixed and loose masks were weighed after Week 4 of the experiment. There is no significant difference between fixed and loose masks when using a Kruskal-Wallis rank sum test (p=0.8). Control masks' dry weight were different from Week 4 masks' dry weight, with p=0.046.

Future Directions

- Knowledge of settlement time periods would allow for future experiments with fewer but more intensive data collections, including species identification or DNA analysis of biofilms and turf algae.
- A future extension to this experiment could focus on different colors or materials of surgical masks.

Acknowledgements

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