

Synthesizing Artificial Replicates of Rising Coral Gamete Bundles

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Background

Broadcast spawning in coral sexual reproduction is an annual shared behavior among most reef species. During spawn, clumped haploid cells are ejected from the coral body in spherical “gamete bundles,” rising in the water column at varying species-dependent rates before fertilizing into larvae at surface waters. However, whilst much is known about coral function after gametes have been fertilized, there is little understood about the fragile and unique bundles preceding broadcast. Hence, analytical observation of the phenomena is highly lacking, with lesser-known sources capable of recreating said phenomena.

Hypothesis

- Species specific coral gamete bundles can be individually replicated utilizing artificial particles.

Methods

1. Coral Rising Velocities



Figure 1: Tracking of individual lab-recorded coral spawnings. Species include:
- *Acropora cervicornis*
- *Diploria labyrinthiformis*
- *Orbicella faveolata*
Larvae were tracked using DLTdv software in MATLAB¹.

2. Artificial Particle Rising Velocities

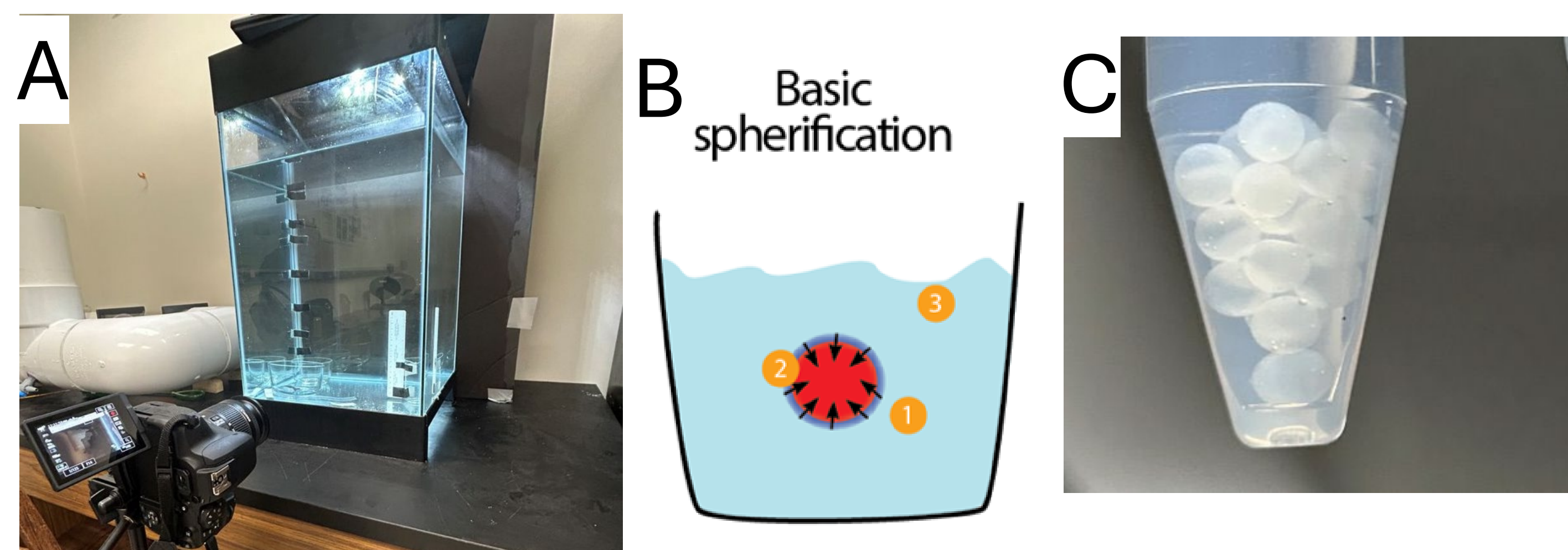


Figure 2: A) Seawater column tank for ejecting and recording (right). Videos taken on Canon EOS Rebel T8i camera (left). B) Simple two liquid stage process of alginate spherification. Methanol is seeded in one liquid, dropped into another forming an active surface membrane². C) Variations in seeded methanol percent composition produce spheres with various densities.

Results

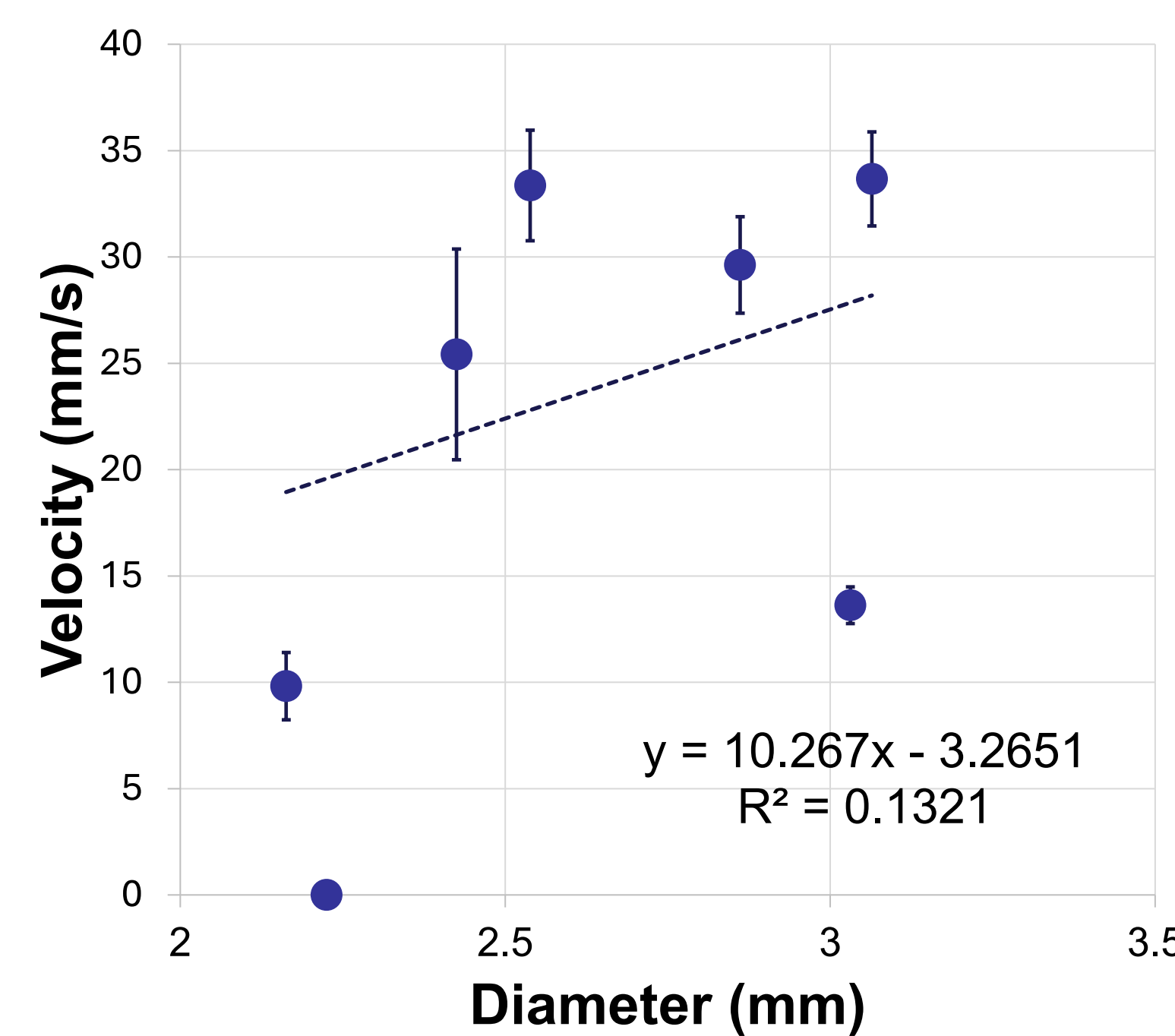


Figure 3: Average rising velocity versus diameter of artificial particles with one standard deviation.

- Low correlation between rising rates and diameter of artificial particles indicates low significance between any variance in diameter and rising rates.

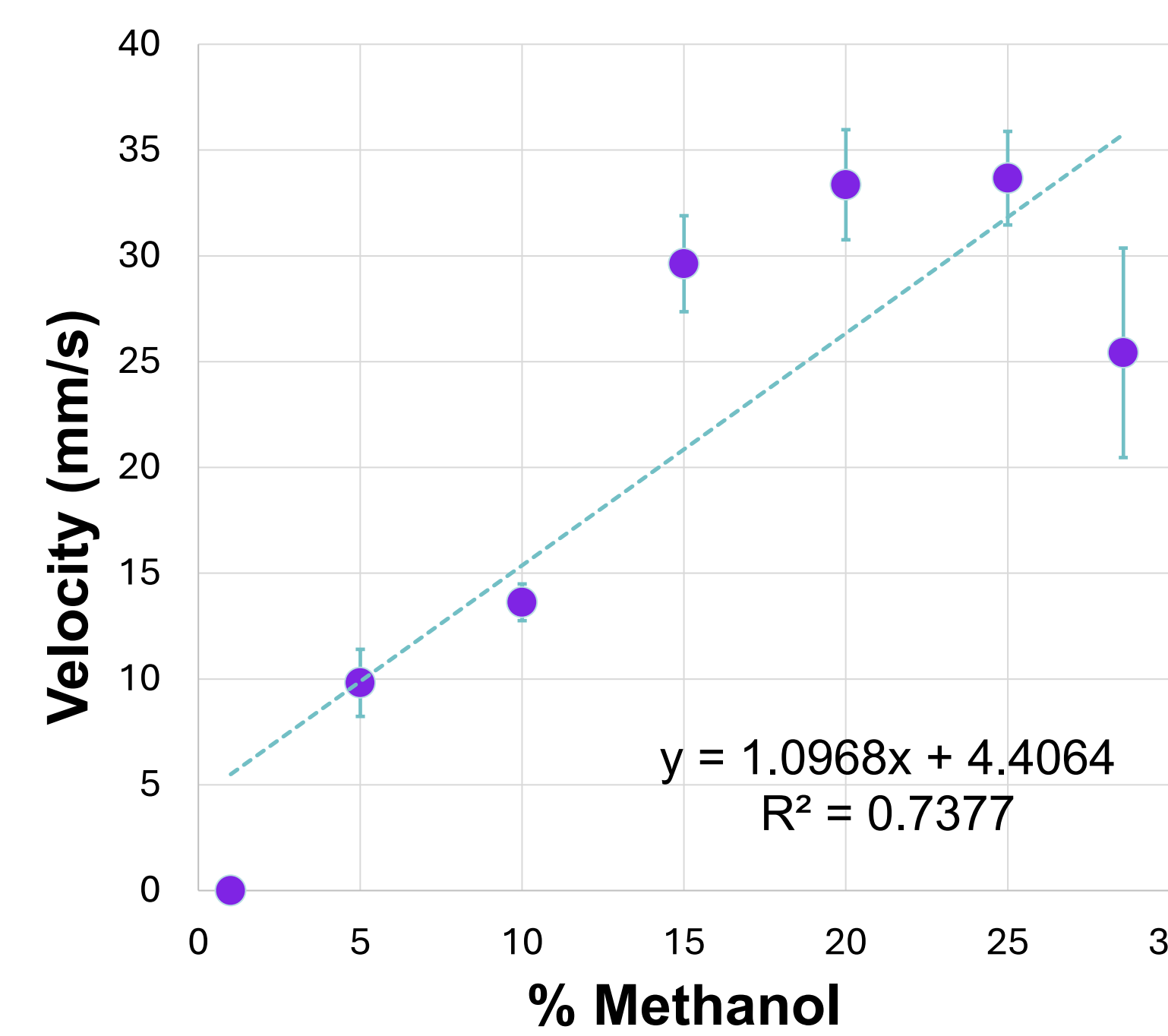


Figure 4: Average rising velocity versus methanol percentage of artificial particles with one standard deviation.

- High correlation indicates potential significance between percent composition of methanol and rising rates of artificial particles.

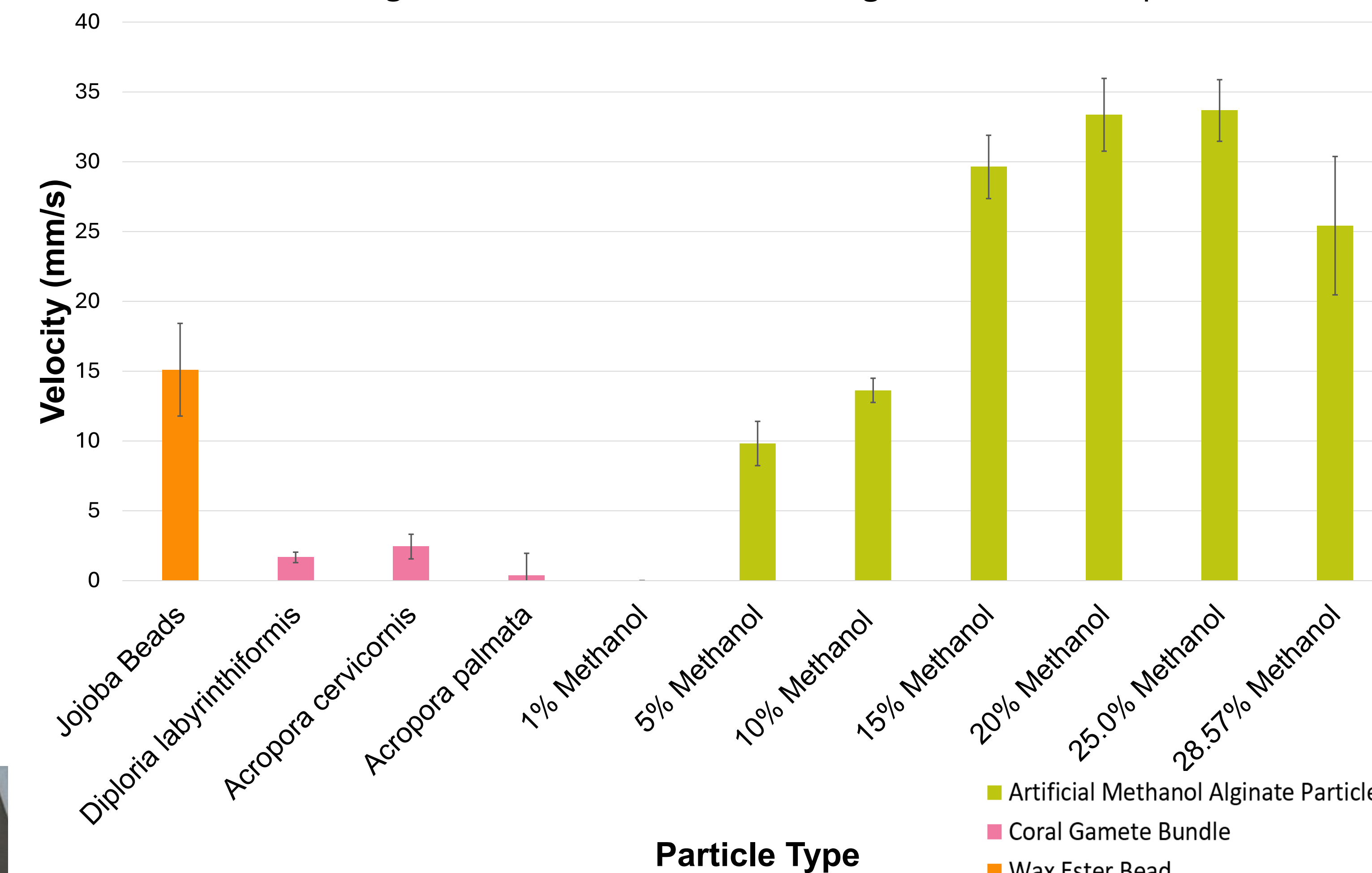


Figure 5: Average rising velocities observed in all particles tested with one standard deviation.

- Range of rising velocities observed in artificial particles displayed in green.
 - Observed rising rates appear to increase with increased methanol concentration.
 - This trend is parallel to what is observed in Figure 4, which also displays high correlation to the observed trend.
- Tracked rising velocities of coral spawns displayed in pink.
 - While velocities were slower than alginate spheres, variation suggests species individuality for rising rates.
- “Off the shelf” cosmetic bead particle alternative displayed in orange.
 - Does not compare to observed gamete rising rates. Non-adaptive to change / fit velocities desired.

Conclusions

- Artificial particles synthesized by alginate spherification seeded with methanol exhibit similar rising behavior and velocities.
- Differing gamete bundle rising rates are observed in various species → Alteration of methanol in synthesis.
→ Optimize particle density to match rising velocities.

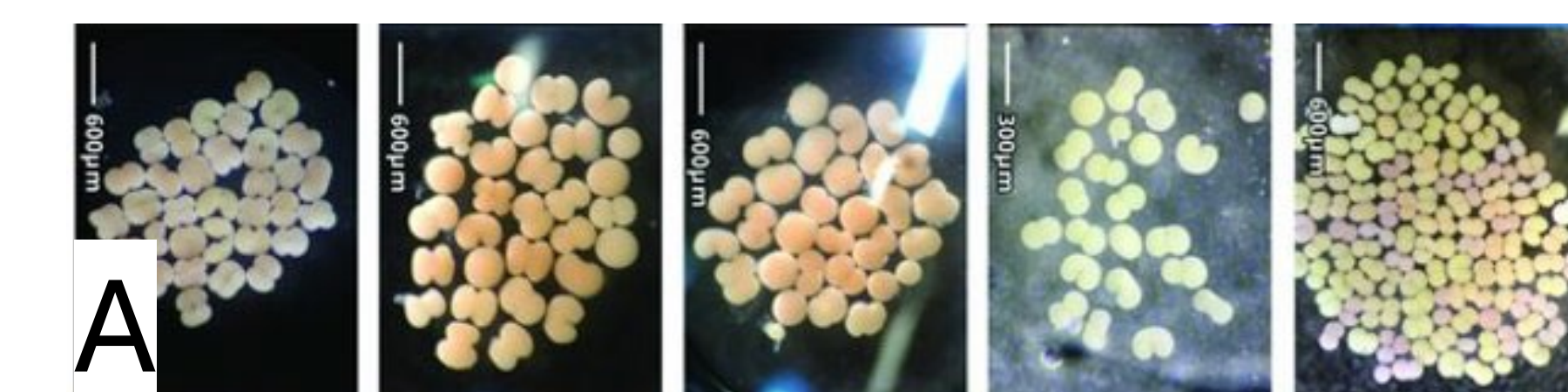
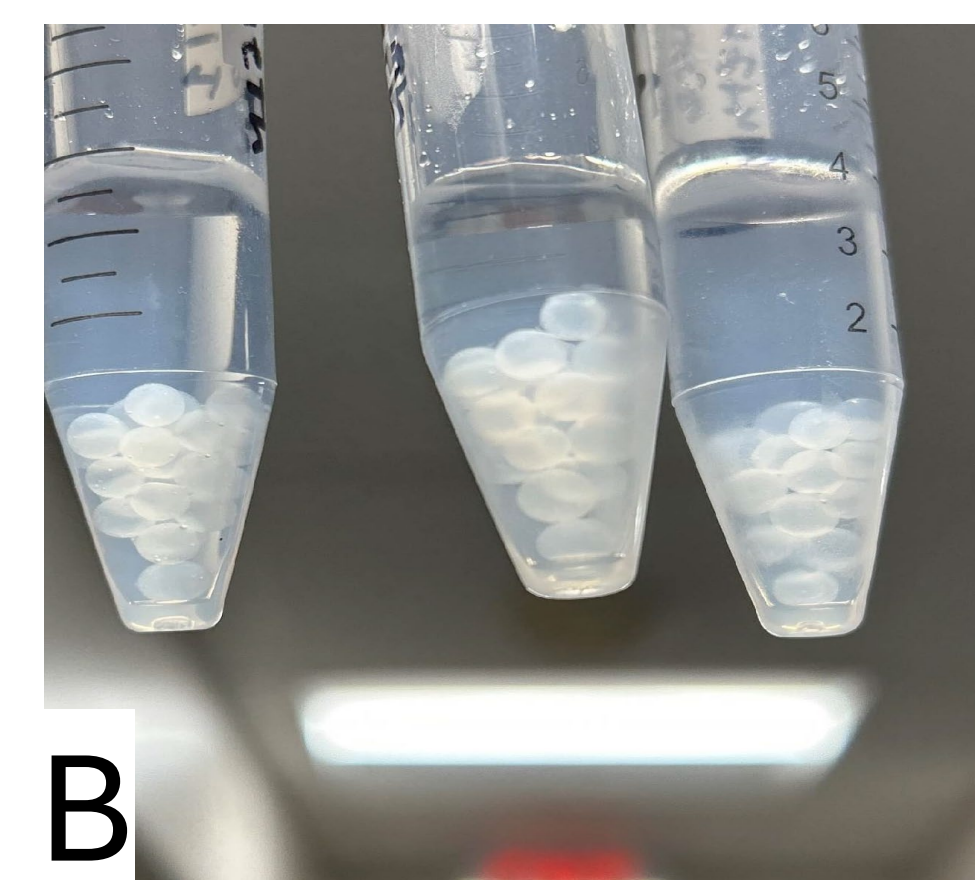


Figure 6: A) Variations in coral gamete bundle size, shape, and composition suggest unique rising behavior³. B) Artificial particles (alginate spheres) synthesized to exhibit various densities.



Future Directions

- Test lower concentrations of methanol in solution to determine if fluid densities makes a significant difference.
- Isolate a non-toxic, polar fluid to replace seeded methanol in particles → Safe field use.
- Match artificial particle rising velocities to their associated rising gamete bundles, other physical characteristics are implied → Densities of particles + gamete bundles.
 - Investigate other unknown physical characteristics besides density to compare among the natural and abiotic particles → buoyancy, drag, motility?

Acknowledgments

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