Shedding light on how illumination shapes fish collective dynamics

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In this experimental study, we investigate how illumination affects the collective motion of a large school of approximately 50 fish (rummy-nose tetras, *Hemigrammus rhodostomus*). We use two order parameters to quantify the structure of the group as we systematically alter the fish's visual range by gradually varying ambient light intensity. Our results indicate that at low light levels, the fish are unable to form a cohesive group, but as light intensity increases, the degree of alignment of the school increases. As we further increase the illuminance, the school structure transitions from a polarized state to a highly regular and stable rotational configuration (milling). Our findings highlight the importance of vision for cohesive collective motion in free-swimming fish schools, as opposed to the short-range hydrodynamic sensing via the lateral line, which is insufficient in this context. Overall, this experiment provides new insights into the interaction mechanisms that govern the emergence and intensity of collective motion in biological systems.

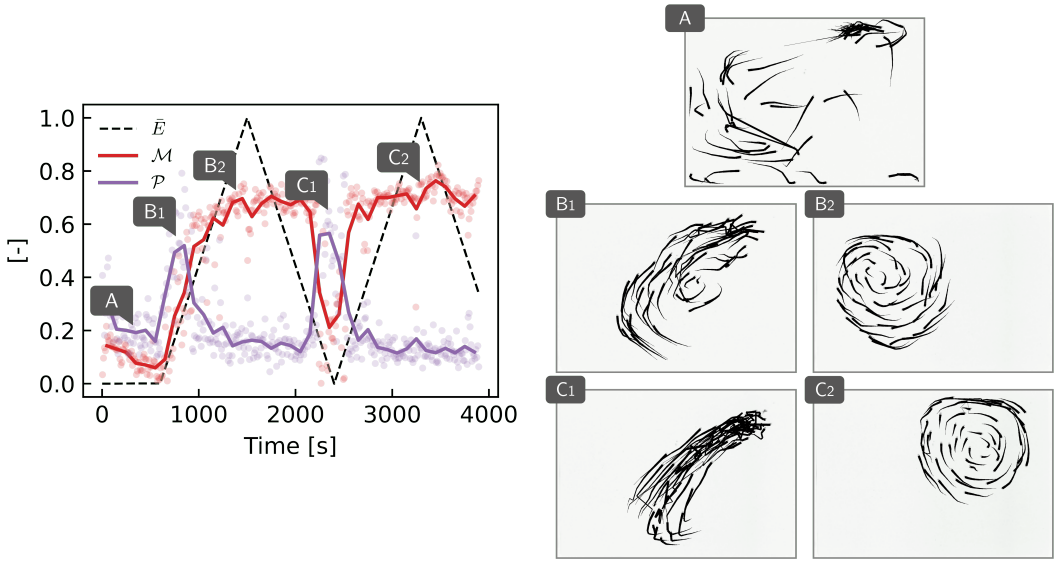

Figure 1. (left) Experimental time signal of the milling $\mathcal{M}$ and polarization $\mathcal{P}$ parameters for a group of 53 fish experiencing variations of the illuminance ($\bar{E}$, normalized) over a 1h time period. **(right)** Trajectories snapshots showing the different phases of the school, exhibiting the strong correlation between organization level and available visual cues.

Références

1. Lafoux, B., Moscatelli, J., Godoy-Diana, R., Thiria, B., Illuminance-tuned collective motion in fish, **arXiv :2301.09577** (2023).