



Corso di Dottorato di Ricerca in Scienze della Vita e dell'Ambiente - Ciclo XXXVI

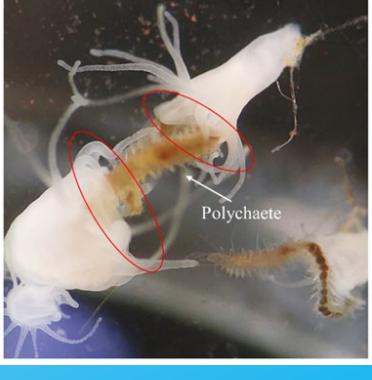
Compete or cooperate?

Protocooperation in catching large prey may be the driver of gregarism in cnidarian polyps

Chiara Gregorin

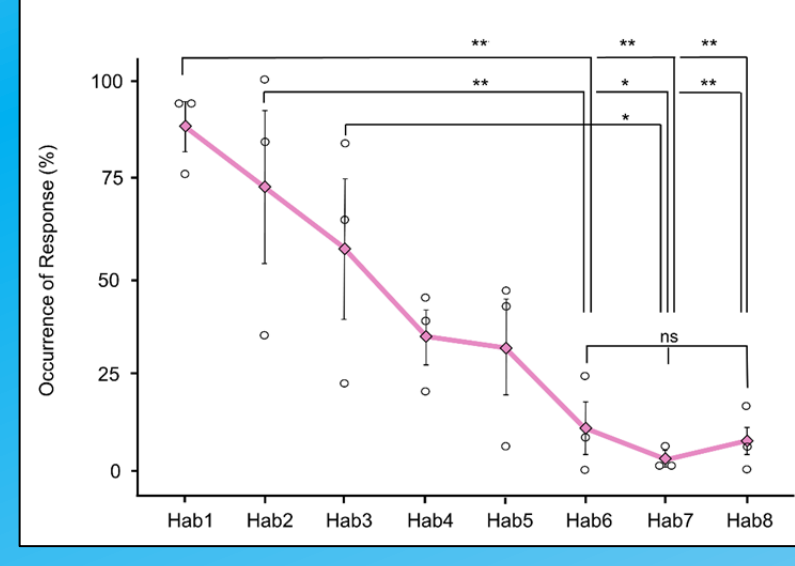
Supervisor: Prof. *Stefania Puce*, Prof. *Luigi Musco*, Dr. *Tomas Vega Fernández*
Laboratorio Zoologia, DiSVA

1 Collective predatory behavior & Non-associative Learning




Collective predation through **PROTOCOOPERATION** allow polyps to share both efforts and gains of large prey exploitation, being beneficial for all group members

After being trained in the large prey predation, polyps mimic that predatory behavior when stimulated by large prey cues.

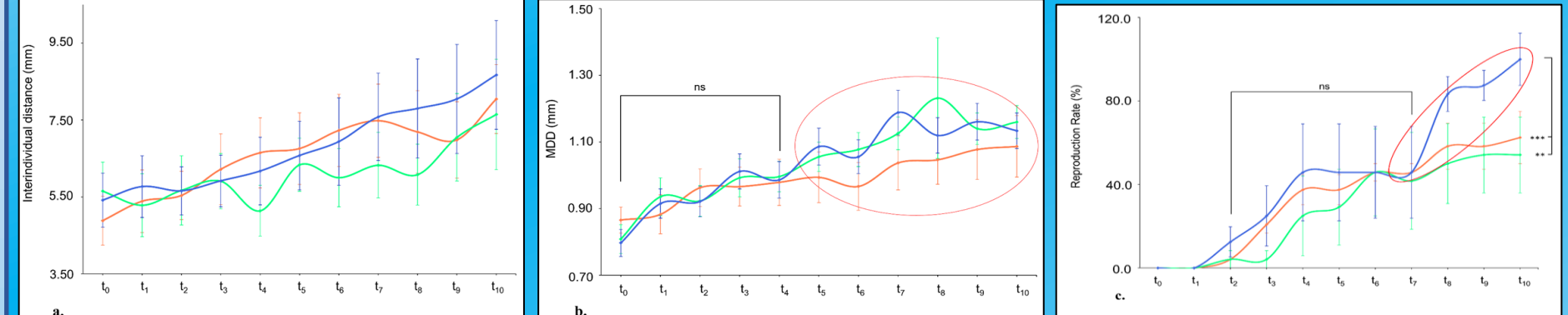


The response to the stimulus decreases during repetitive trials, indicating **HABITUATION**, a process referring to the **NON-ASSOCIATIVE LEARNING**

2 Aggregation & Fitness

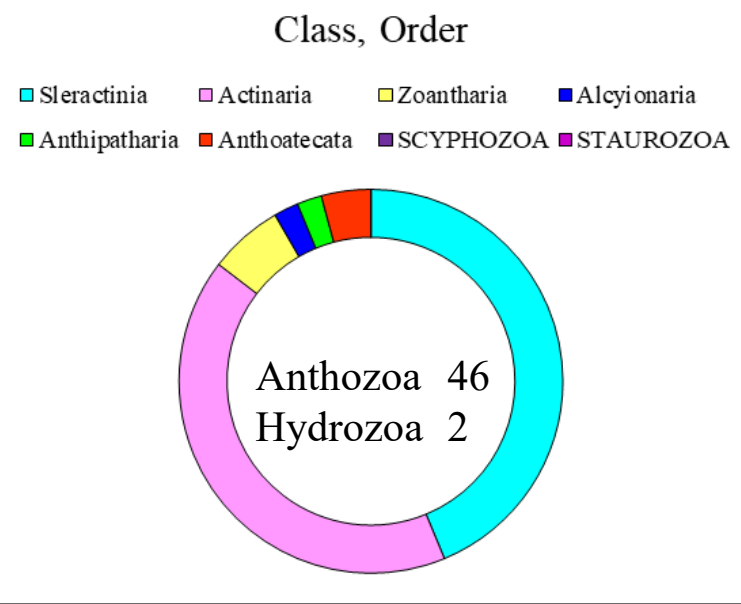


The **LARGE PREY** in addition to small-size zooplankton improve the **FITNESS** (reproduction rate and growth) of *Aurelia coerulea* polyps (Cnidaria, Scyphozoa), and encourage them to get close to each other, forming **AGGREGATIONS**



HOW COMMON is LARGE PREY PREDATION among CNIDARIAN POLYPS?

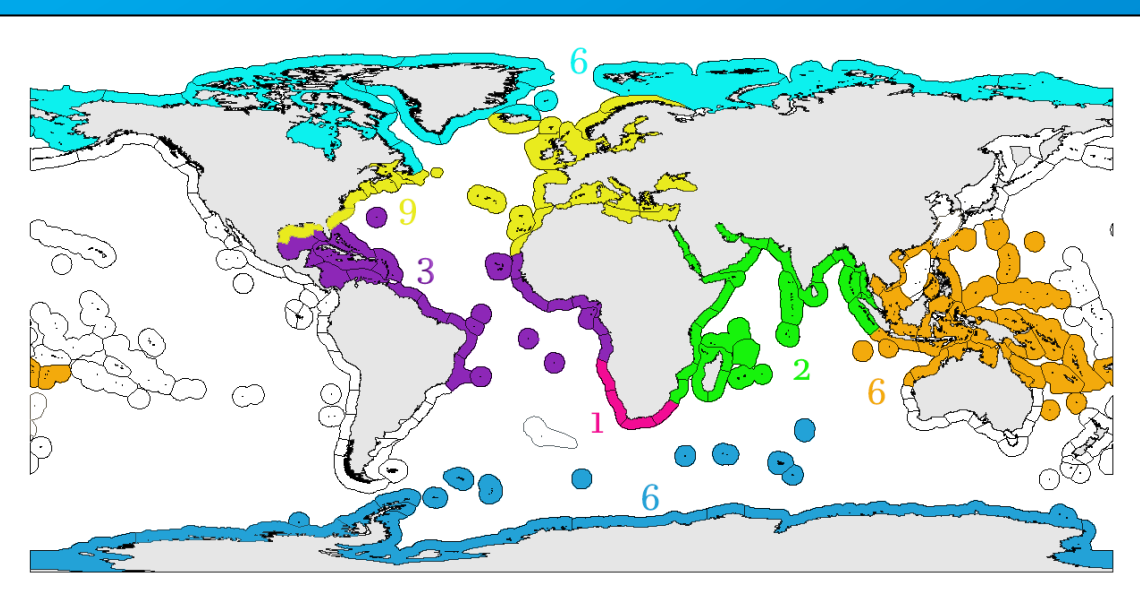
MACROPHAGY = "Feeding on items that are very much larger than the organism consuming them".



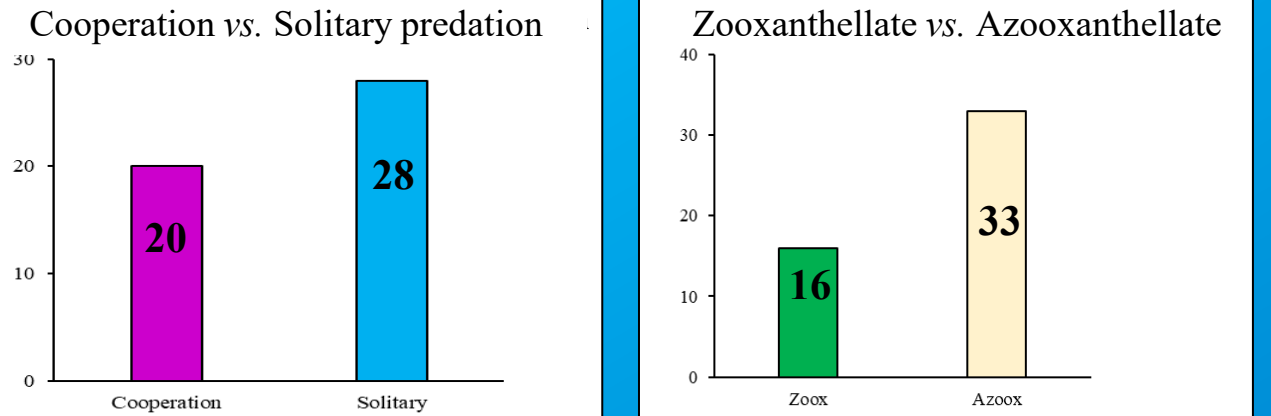
Scopus: "Cnidaria" AND ("large prey" OR "predation") → 162 papers → 7 accepted

Web of Science: "Cnidaria" AND ("large prey" OR "predation") → 207 papers → 10 accepted


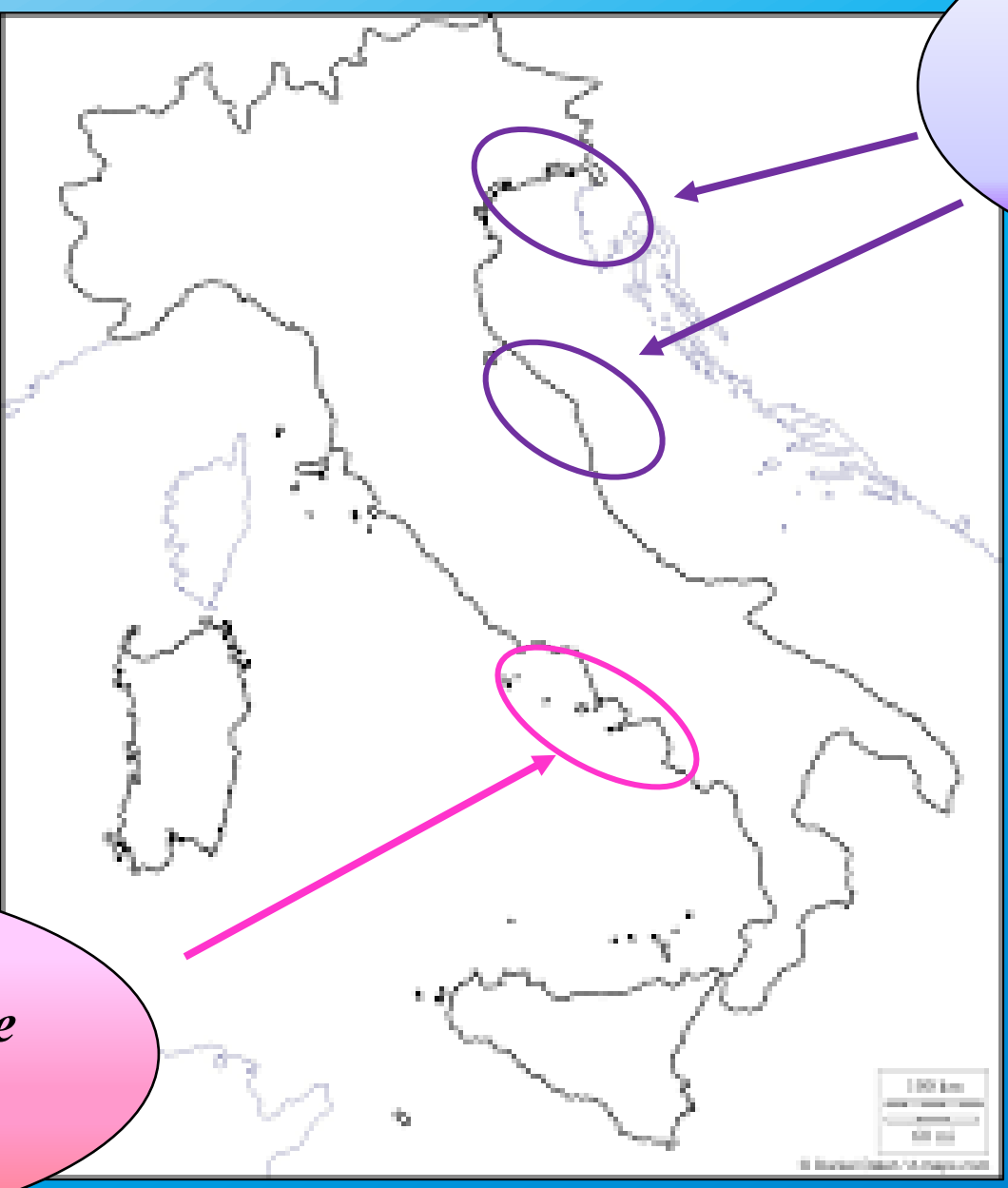
Manual Research → **TOTAL: 36 scientific articles**



(Spalding, 2007)



WHAT I OBSERVED in the Sea


Anemonia sp.
Rhizostoma pulmo
Aurelia sp.

Astroides calycularis
Parazoanthus axinellae
Cladocora caespitosa
Pelagia noctiluca

Protocooperation is related to jellyfish blooms, when jellyfish are pushed in high number toward the coast, increasing the chance for prey and predator to encounter

WHAT I OBSERVED with Laboratory experiments

Model Organism: *Exaiptasia diaphana* (Rapp, 1829) → Key species for the study of the symbiosis anthozoans – zooxanthellae



Healthy: $7.25 \times 10^5 \pm 2.77 \times 10^4$ cell ml⁻¹

Bleached: $1.75 \times 10^5 \pm 7.42 \times 10^4$ cell ml⁻¹

AIM: test the efficiency of protocooperation in bleached anemones as a strategy to overcome the negative trophic effects of bleaching

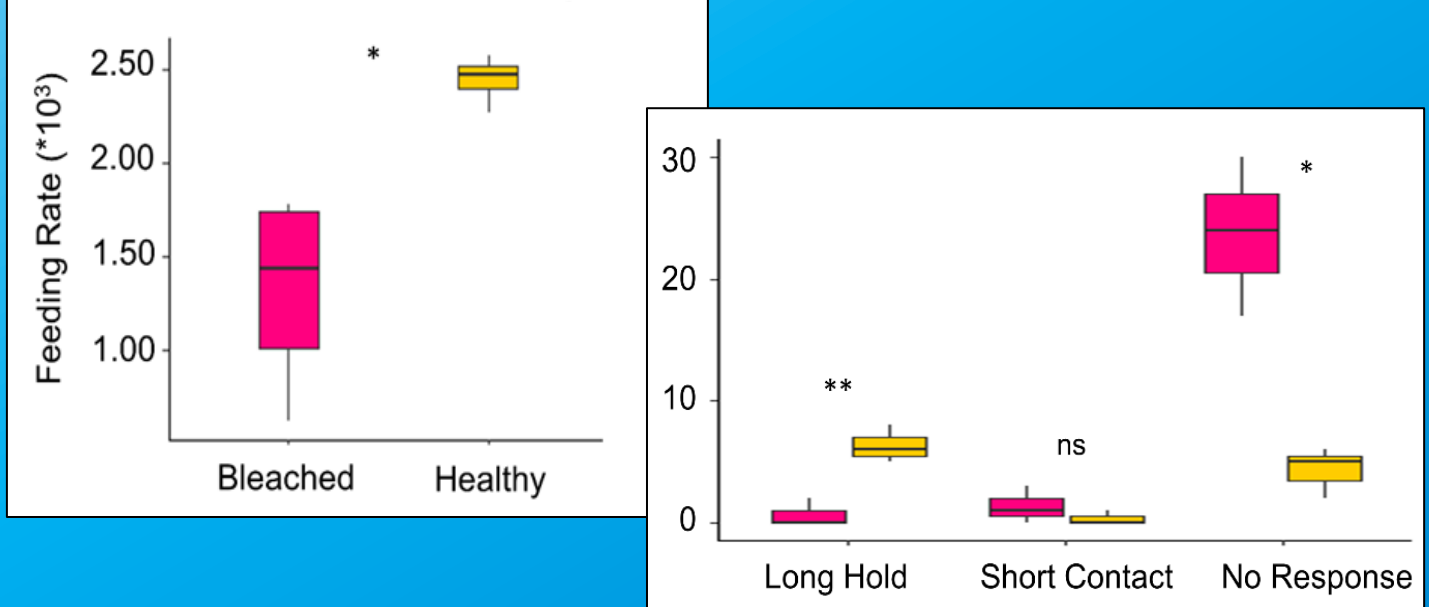
Suspension-feeding → *Artemia salina* 2000 ind/l

$$FR = \frac{d_i - d_f}{N^0 \text{ polyp} \cdot \text{time}}$$

FR = Feeding Rate; d_i = initial prey density; d_f = final prey density

Protocooperation for large prey capture → **one jellyfish for 1 hour**

- No Response
- Short Contact (≤ 60 sec.)
- Long Hold (> 60 sec.)
- Ingestion (> 1 hour)



NEXT ACTIVITIES:

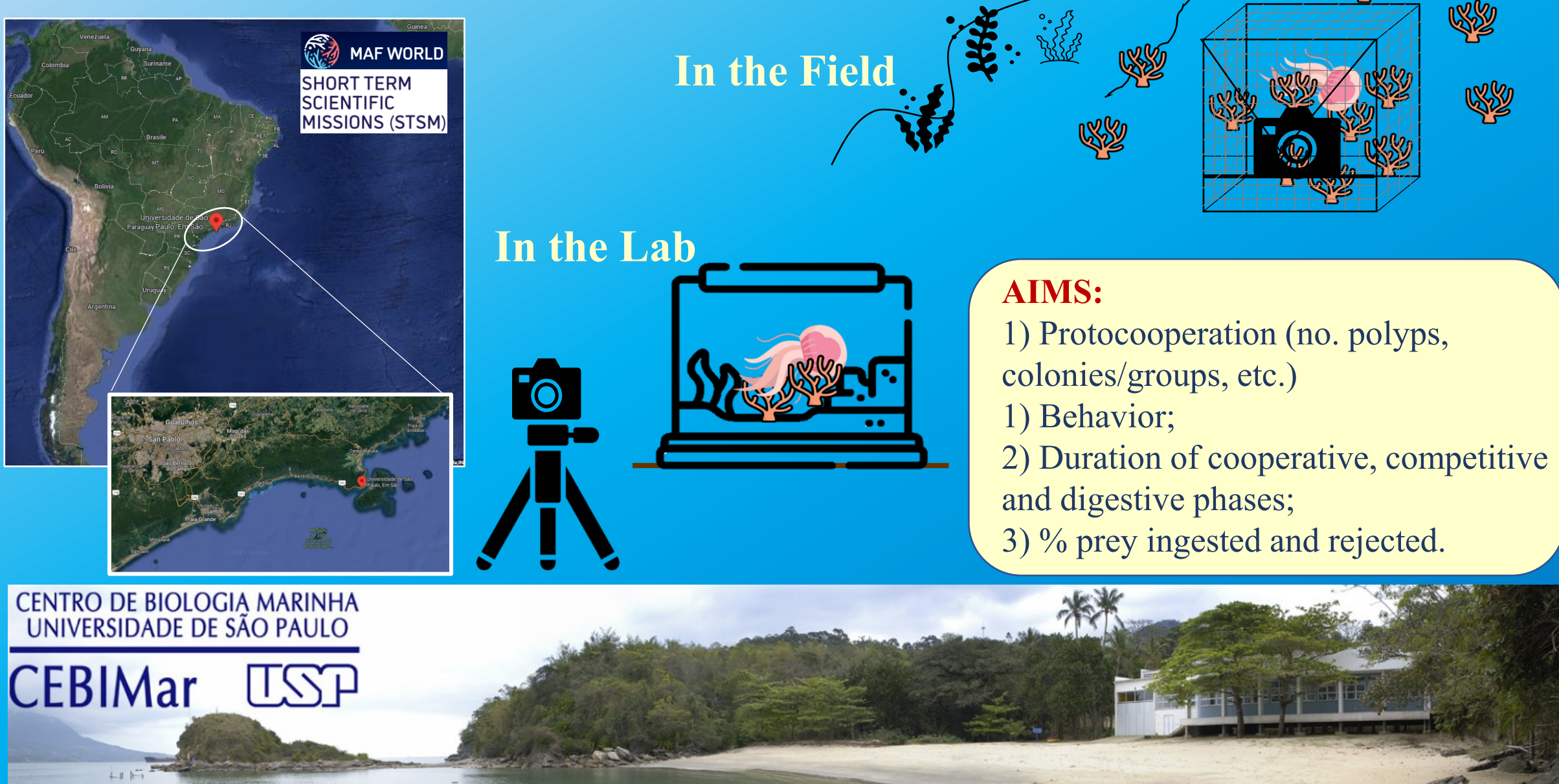
24 hours Time lapse – photo shooting

In the Field

In the Lab

AIMS:

- 1) Protocooperation (no. polyps, colonies/groups, etc.)
- 1) Behavior;
- 2) Duration of cooperative, competitive and digestive phases;
- 3) % prey ingested and rejected.



CENTRO DE BIOLOGIA MARINHA
UNIVERSIDADE DE SÃO PAULO
CEBIMar USP

Scheduled activities

Time /Activity	3 rd Year								
	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 24	Feb. 24
Writing/Submitting manuscripts	[Yellow]		[Yellow]	[Yellow]					
Conferences attendance		[ABS 2023 PORTLAND]				[EVOL MAR]			
Stay at USP / CEBIMAR - São Paulo - Brazil				[Blue]	[Blue]				
Field work - Data analysis					[Blue]	[Blue]			
Writing - PhD final report			[Green]	[Green]	[Green]	[Green]	[Green]		
PhD thesis DELIVERY								[Pink]	[Pink]

PhD curriculum publications:

- Gregorin C., Musco L., & Puce S. (2022). Protocooperation in *Tubastraea cf. micranthus* to catch large planktonic prey. *Marine Biodiversity*, 52(3), 34.
- Review: Macrophagy in Cnidarians – *in preparation*
- **Original Manuscript:** Group-foraging in Cnidarians: the collective exploitation of a large prey shapes the aggregation and fitness of *Aurelia coerulea* polyps (Cnidaria, Scyphozoa) – *ready for submission*
- **Original Manuscript:** First behavioral description of collective predation by cnidarian polyps and non-associative learning as possible explanation of their coordination – *in preparation*
- **Original Manuscript:** Heterotrophy in bleached sea anemones: do they improve the predation rate to balance the loss of symbionts? – *in preparation*

Extra PhD curriculum publications:

- Gregorin et al., 2020 <https://doi.org/10.3390/jmse8121021>
- Gregorin et al., 2021 <https://doi.org/10.3390/w13050711>
- Roveta et al., 2021 <https://doi.org/10.3390/app11020580>
- Roveta et al., 2022 <https://doi.org/10.1007/s10452-021-09940-8>
- Pulido Mantas et al., 2023 <https://doi.org/10.3390/jmse11040759>
- Di Camillo et al., 2023 <https://doi.org/10.1111/raq.12823>