



WP 20: Grow out Husbandry Meagre

Task 20.3 Development of feeding methodology

“Sub-task 20.3.2. Test of different feeding methods on growth performance and feeding behavior of meagre”



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Task 20.3. Development of feeding methodology.

➤ **Sub-task 20.3.1. The effect of different stimuli on meagre feeding behavior.**

➤ **Sub-task 20.3.2. Test of different feeding methods on growth performance and feeding behavior of meagre.**

The study examines the effect of the most common feeding methods on the basic production indices and feeding behavior of meagre.

Feeding methods:

- **Feeding by hand.**
- **Scheduled automatic feeding with electric feeders.**
- **Self - feeder.**

The evaluation is based on:

- **Production indices.**
 1. **Specific growth rate (SGR)**
 2. **Feed conversion ratio (FCR)**
 3. **Daily feed consumption (DFC)**
 4. **Condition factor (CF).**
- **Fish feeding behavior indices.**
 1. **Feeding activity (Self-feeder activation)**

Additionally were estimated the:

 - **Gastric Evacuation Rates of fish.**
 - **Histology in meagre eye.**

First experiment (EXP1)

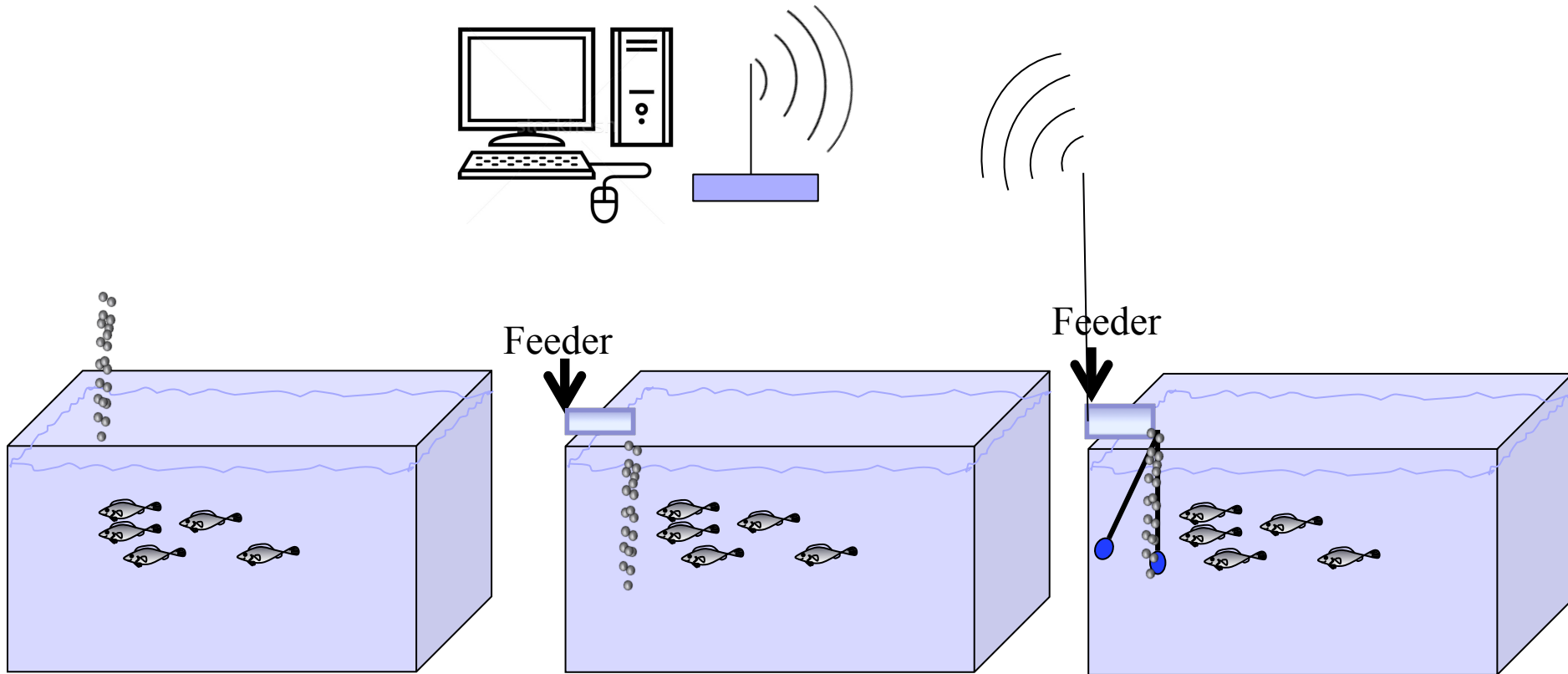
- Individual size of 60 g
- 500 l indoor tanks in triplicate
- The photic conditions were formed from:
 1. sun light (windows on the walls)
 2. fluorescent lamps from 08:00 to 18:00h (max 650 lx)

Second experiment (EXP2)

- Individual size of 700 g
- 5000 l outdoor tanks in duplicate
- Natural sun light (max 35000 lx)

Common experimental parameters

- The photoperiod (May to August)
- Open circuit system
- Natural sea water (38 psu) from littoral well
- Water renewal of 400% per hour.
- Temperature was 19°C
- Oxygen saturation was above 75%
- Fish were sampled every 4 weeks,
- Duration 12 weeks



❖ Hand feeding

Feeding ad libidum

(08:00, 12:30 and 15:30)

❖ Scheduled feeding with electric feeder.

Activated three times per day
(08:00, 12:30 and 15:30)

❖ Self-feeder

Activated by fish



	Self feeder	Hand feeding	Scheduled feeding
Weight (initial)	64.71 ± 1.96	62.23 ± 2.90	64.58 ± 0.79
Weight (final)	132.48 ± 11.60	133.59 ± 5.22	138.24 ± 1.63
SGR	0.80 ± 0.08	0.86 ± 0.02	0.86 ± 0.01
FCR	1.07 ± 0.11	1.25 ± 0.10	1.15 ± 0.03
DFC	0.73 ± 0.07^a	0.92 ± 0.07^b	0.85 ± 0.01^{ab}
CF (initial)	0.99 ± 0.04	1.02 ± 0.02	0.96 ± 0.01
CF (final)	0.92 ± 0.04	0.93 ± 0.02	0.94 ± 0.02

- All of the feeding methodologies used for meagre rearing during EXP1 provided satisfactory growth results.
- DFC was lower at the self feeding method in comparison with the other methods.
- However, these differences did not significantly reflect on the FCR values between the different feeding methodologies that were used.

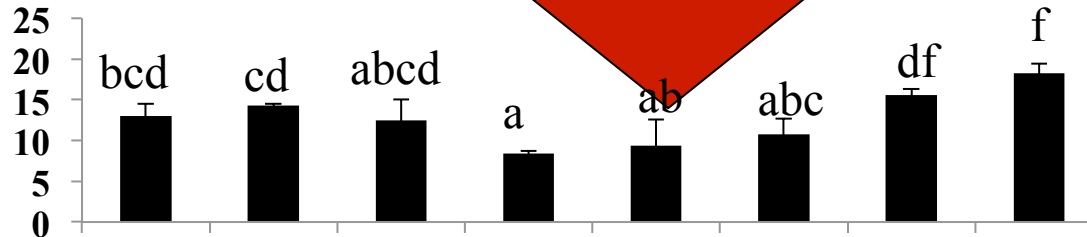
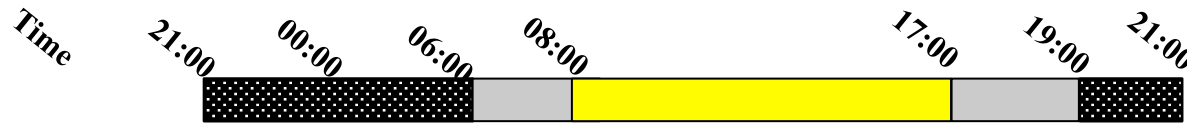
	Self feeder	Hand feeding	Scheduled feeding
Weight (initial)	739.88 ± 23.38	775.95 ± 57.39	673.04 ± 79.35
Weight (final)	927.72 ± 4.50	1090.00 ± 95.14	905.90 ± 112.49
SGR	0.32 ± 0.05^a	0.49 ± 0.02^b	0.42 ± 0.01^{ab}
FCR	1.27 ± 0.27^a	1.42 ± 0.23^{ab}	1.83 ± 0.19^b
DFC	0.40 ± 0.02^a	0.68 ± 0.09^b	0.77 ± 0.06^b
CF (initial)	0.95 ± 0.00	0.94 ± 0.00	0.93 ± 0.04
CF (final)	1.10 ± 0.02	1.06 ± 0.07	1.02 ± 0.00

Experimental populations that were fed by hand and scheduled feeding showed the highest SGR, FCR and DFC values in comparison with the self-feeder methodology (P<0.05).

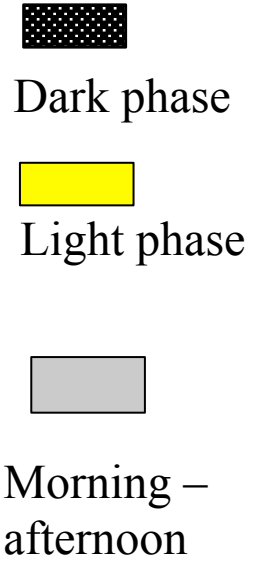
Results EXP self-feeder activity



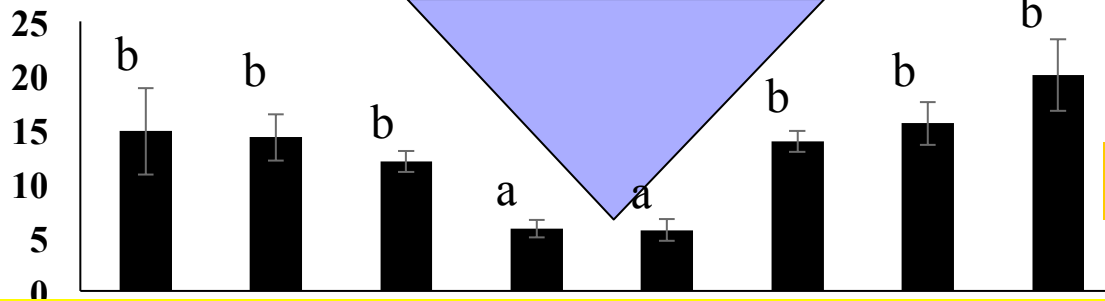
Distribution (%) of the self feeder activations in the period of 24h.



EXP1



➤ The feeding activity of the fish in both experiments was significantly lower during the period of the light phase (8-10 hours).



EXP2

➤ This phenomenon was more intense in outdoor tanks, which were exposed to direct sunlight and the intensity of light was much higher.

(Two Way ANOVA, Student – Newman – Keuls Method, P<0.05).

Periods of the day

Feeder

07:00

12:00

18:00

EXP 1



➤ **Outdoor tanks EXP 2: The distribution of the fish in the morning and the afternoon was homogenous.**

➤ **Under direct sunlight fish remained at the duskiest area of the tanks.**

For this reason the meagre:

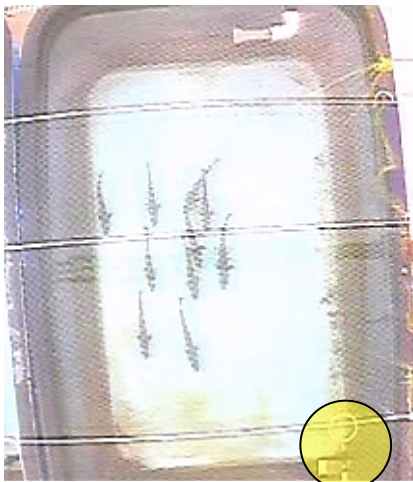
- **During noon exhibited low self-feeding activity (lower growth rates).**
- **The FCR was higher at the group with the scheduled feeding, because there were detected uneaten food pellets during the feeding at 12:00, (noon).**

07:00

12:00

18:00

EXP 2



Two main questions were extracted from all the above information.

- ❖ Why do meagre exhibit high feeding activity under low light intensity?**
- ❖ Why was feeding activity reduced for 8-10 hours?**

Further analyses were performed and additional deliverables were produced.

- Histological analysis on the retina of the meagre eye.**
- Gastric Evacuation Rates of the meagre.**

❖ The arrangement of double cones (DC) in rows, is connected with:

- Schooling behavior.
- The perception in two dimensions.

☐ The previous explains:

- Why meagre tends to swim close to the bottom (sea cages, tanks or natural habitats).
- Why meagre tends to wait for the feed to drop to their level of swimming, rather than actively swim to the surface as soon as feeding begins.

The relative cell densities in different layers of the retina are considered as a comparative indicator for the classification of a species as nocturnal or diurnal.

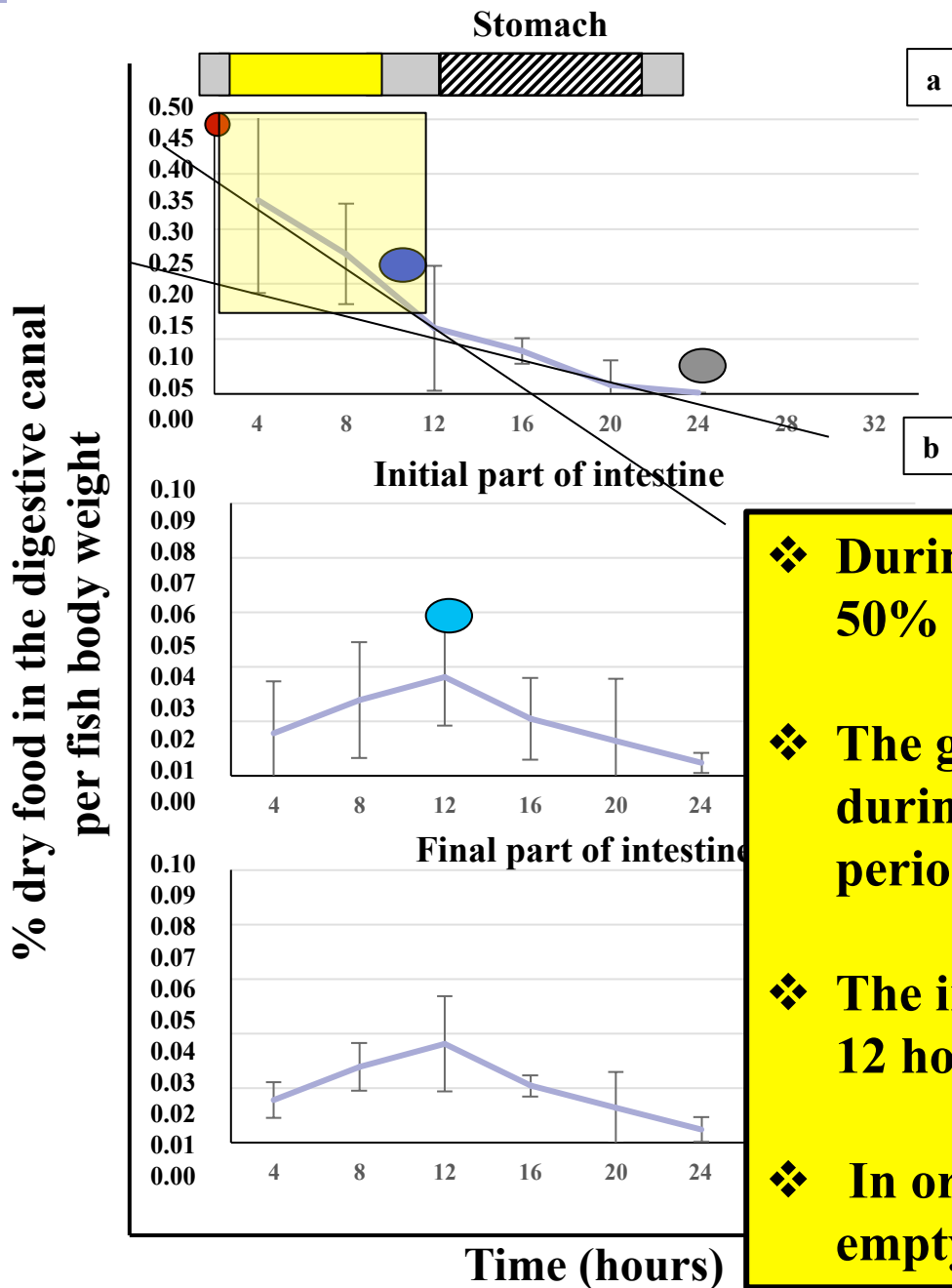
The high number of rods (RN) is connected with the high nocturnal activity of meagre.

The previous explains:

meagre tend to reduce the feeding activity at high light intensities.

Values are per 100 μm length of retina

	Mean	Standar deviation
Rods	164.03	19.75
Cones	6.25	0.99
INL	35.53	4.97
Ganglia	4.72	1.10
Cones/Rods	0.04	0.00
Ganglia/INL	0.14	0.04
Rods/Ganglia	37.27	14.00
Rods/ INL	4.68	0.73
Cones/Ganglia	1.44	0.67



Gastric evacuation rates of:
 a) stomach,
 b) initial part of intestine,
 c) final part of intestine.

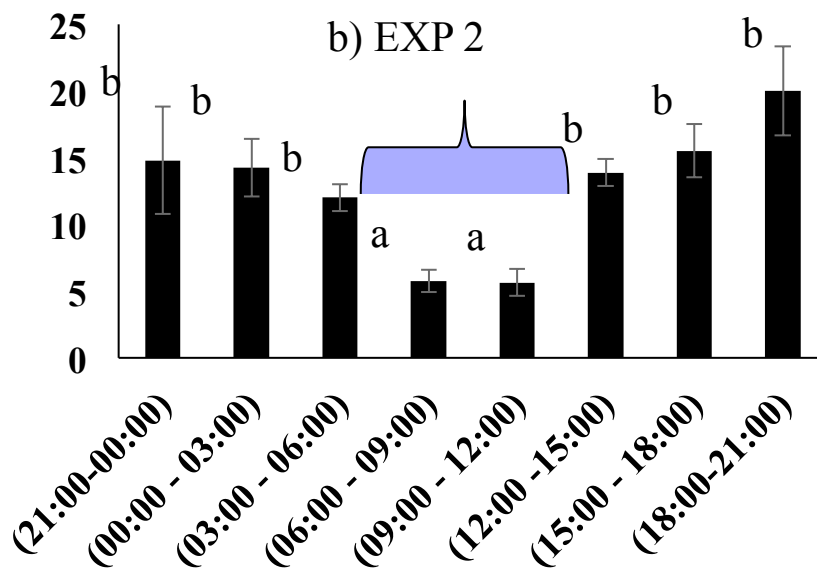
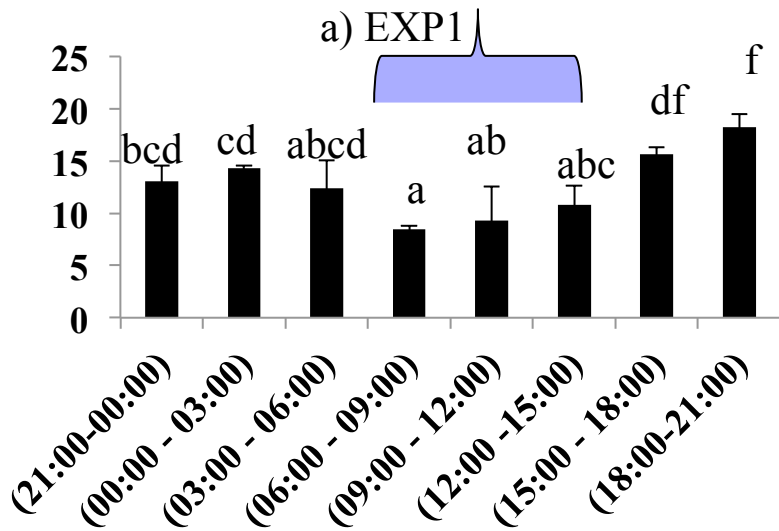
● Force Feeding with pellets (0.5 % of the fish body weight)

- ❖ During the first 8 hours, the stomach lost 50% of the initial amount of food. ●
- ❖ The gastric evacuation rates were higher during the light phase than the other periods of the day.
- ❖ The intestine reaches its maximum filling 12 hours after the forced feeding. ●
- ❖ In order the digestive canal to become empty required 24 hours. ●

Self feeder activation - Gastric Evacuation Rates

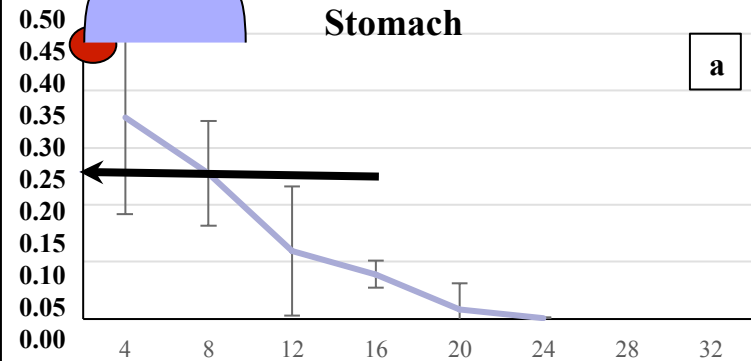


Distribution (%) of the self feeder activations in 24h.



Periods of the day

% dry food in the digestive canal per body fish weight



At 19 °C, refeeding activity was observed 8 hours after the previous feeding activity.

This is connected with the evacuation rate of the digestive canal. The fish act for refeeding when the stomach content is lower than 50% from the previous feeding.

*****A basic information to consider for the development of feeding methodology.**

- ❖ **The methodology of the self-feeder offers useful information related to feeding activity.**
- ❖ **The feeding activity of the meagre was higher at low light intensity.**
- ❖ **The rearing of meagre (50 -100g) in indoor tanks offered satisfactory growth in all three applied methodologies (low light intensity).**
- ❖ **At 19 °C, 50% of the stomach content is transferred to the rest of the digestive channel after 8 hours. This fact is connected with the feeding activity of meagre.**
- ❖ **Scheduled automatic feeding and feeding by hand can provide satisfactory results for meagre growth in larger individuals (700-900g), in outdoor tanks.**



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“Sub-task 20.3.1. The effect of different stimuli on meagre feeding behavior”



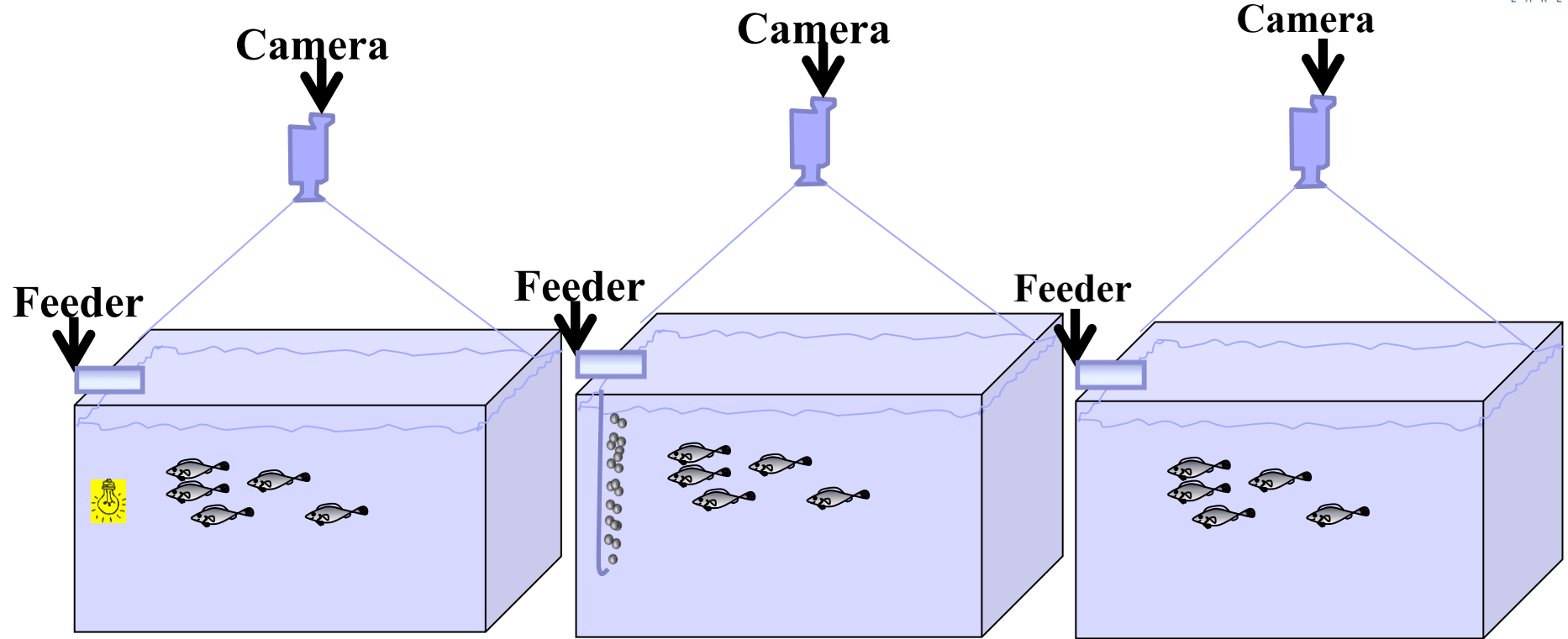
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Light
❖ light in the water column.

Bubbles
❖ air bubbles in the water column.

Control
Feeding without stimuli.

- **Light conditions affect the behavior of meagre.**
- **Meagre without direct sunlight (morning and afternoon) present higher motility than during direct exposure (noon).**
- **During noon (direct sun light exposure) fish prefer to inhabit dusky areas of the tank.**
- **Meagre is able to learn and remember specific stimuli that are associated with feeding.**
- **Meagre responded to air bubbles very quickly (from the second day of application).**
- **Meagre responded to the light stimulus only in low environmental light intensity.**
- **Both air bubbles and light or combinations of them can be used in an industrial setting, as they can be manufactured, implemented and managed easily with existing technologies in sea cages.**

From the experiments related with stimuli and the methodologies of feeding is clearly indicated that:

- ❖ In order to develop a feeding methodology or to optimize the feeding protocols in rearing conditions, we have to take in consideration the special characteristics of the main systems that are associated with feeding behavior that are, the digestive and visual system.**
- ❖ The feeding method for meagre can be based on the use of various stimuli (light or air bubbles) in order to attract the rearing population to the specific feeding area.**
- ❖ The development of a combinational, scheduled automatically feeding system with using various types of stimuli, can be used for the development of the most appropriate feeding methodology.**
- ❖ The shadowing of the sea cages is proposed as an additional process that will increase the effectiveness of an automated feeding system for meagre.**

Thank you

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