Deliverable 19.1
Analysis of access provided by ULPGC Marine Science and technology Park: types and users

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Executive Summary

Objectives

The infrastructures of ULPGC Marine Science and Technology offers facilities for the marine cultivation of fish, crustaceans and molluscs, which allow us to carry out nutrition and feeding experiments with animals at different stages of cultivation. Three different facilities are available: (i) for genetic experiments like crossbreeding, inbreeding, epigenetic crosses or selection programs for families of, at least, 48 half sibs or 96 full sibs, or more when mass spawning is used; (ii) RAS units completely equipped to challenge separately with up to three different pathogens at the same time, in all phases of fish life cycle including breeders, larvae and juveniles of marine fish species; (iii) an ingredient processing laboratory, a feed production hall, two series of digestibility tanks, and three wet labs to test diets and ingredients for either larvae (including automated start feeding), juveniles or breeders of marine fish species, both commercial or new species for aquaculture.

Main Results:

Five research accesses have been completed, four focused on fish and one on corals in collaboration with the Max Planck Institute. Of the four experiments involving fish, two were conducted with gilthead seabream and two with European sea bass, all of them evaluating the inclusion of ingredients or additives that could improve health and disease resistance, as well as ensure the quality of the final product. The other TNA has contributed to understanding the physiology of black corals and their mass-transfer capacities across morphologies and scales—species that create dense Marine Animal Forests (MAFs) in oceans worldwide, fostering high biodiversity.

Authors/Teams involved:

The team of researchers from the University of Las Palmas de Gran Canaria (ULPGC) who contributed to the scientific supervision of the projects as well as the monitoring of the experiments included Marisol Izquierdo, María Jesús Zamorano, Lidia Robaina, Juan Manuel Afonso, Daniel Montero, Félix Acosta, and Rafael Ginés.

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1. Overview of TNA users projects realized in TNA ULPGC

1.1.1. Installations

Warm Water Species Selection Unit (WWSSU) is an infrastructure where genetic selection programs can be done for families of, at least, 48 half sibs or 96 full sibs, containing culture tanks (1 m3 and 0.5 m3) and breeders tanks (10 m3, 40 m3 and 80 m3), where fish culture is possible from larvae until adults. Marine Biosecurity Station (MBS) comprises three main RAS units completely equipped to separately challenge with up to three different pathogens at the same time in all phases of fish life cycle including broodstock, larvae and juveniles of marine fish species. Each of them is provided with automatic and programmable control of flow, oxygen concentration, temperature, pH and feeders and is designed to content up to 18 circular tanks of 0.5 m3. Feed Ingredients-additives Testing Unit (FITU) includes an ingredient processing laboratory, a feed production hall, two series of 15 digestibility tanks (200 and 500 litres) and three wet labs with 170 tanks of 100, 200, 500 and 1 000 liters, as well as two lines for commercial scale testing, provided with computer controlled automatic, auto-demand or manual feeding and waste feed collectors (feed intake control), to test diets and ingredients for either larvae (including automated start feeding), juveniles or broodstock of marine fish species

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1.1.2. User projects

Min. quantity of access units to be provided according ther DoA: 1577
Total number of access units (sum of access units in the table): 621

Installation number	Installation code	Project title	Project acronym	Description about the experiment	Coordinator	Already used installation (Yes/No)	Nature of the access unit*	Number of used access units during the project + access dates	(Potential) paper	How many people was trained by this procedure ?
1	ULPGC-FITU	Effect of KM inclusion towards enhancing the fillet nutritional quality	KM for fillet quality	To evaluate the role of KM towards enhancing growth and nutritional value of Gilthead seabream in grower phase, and towards enhancing the fillet quality including color, texture, and nutritional profile (fatty acid and amino acid profile). Further to test if the KM inclusion provides better protection to oxidative stress through reduced oxidation by testing expression levels of oxidative markers.	Kiranpreet Kaur, AKERBIOMARINE AS, Norway	Yes	tank-week	96 03/22/2024-03/28/2024	Yes	1
2	ULPGC-MBS	Development of sustainable weaning feeds for gilthead sea bream (Sparus aurata): the potential of fungi meal from Paecilomyces variotii as protein source to replace fish meal	FUNMEAL-AQUA-WEA	To study the potential of a single-cell protein product composed of a fungi meal of Paecilomyces variotii as fish meal replacer in weaning diets for gilthead sea bream (Sparus aurata). Effects on key larval performance indicators, stress resistance, disease resistance to Vibrio anguillarum and the general body composition of larvae as well as on health-related genomic parameters	Tanguy Rabillé, Univ Algarve, Portugal	Yes	tank-week	81 04/01/2024-04/30/2024	Yes	1
3	ULPGC-MBS	Use of PRObiotics in European sea bass (Dicentrarchus labrax) against the FISH bacterial pathogens Vibrio harveyi and Photobacterium	PROFISH	To test in vivo the efficacy of probiotics of the genus Bacillus administered with the diet to European sea bass experimentally infected with V. harveyi and P. damselae subsp. piscicida also analysing the effect on the biofilm of tank surfaces, assessing its composition both quantitatively and qualitatively. Fish will be analysed to see their health conditions and resistance to the pathogen, also by means of immune system analyses.	Giorgia Bignami, Univ Bologna, Italy	Yes	tank-week	180 05/19/2024-07/12/2024	Yes	1

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		damselae subsp. piscicida								
4	ULPGC-FITU ULPGC-MBS	Comparison of emerging alternative protein sources for juvenile sea bass (Dicentrarchus labrax) diets: effects on growth, digestive enzymes and health	NOVELFEEDBASS	To assess the performance of European sea bass juveniles (Dicentrarchus labrax) by partially or completely replacing the traditional marine proteins (fish meal) with emerging protein sources in the diet, with a focus on the growth performance, health, and disease resistance of fish fed these alternative diets compared to a practical control diet based on commercial current levels of fish meal and fish oil	Ana Teresa Goncalves, SPAROS LDA, Portugal	Yes	tank-week	225 (180 FITU / 45 MBS) user did not physically access the RI	Yes	1
5	ULPGC-FITU	Investigating Thermal Tolerance and Mass-Transfer Efficiency in Antipatharian Corals: Implications for Local Restoration and Aquarium Maintenance	TheMaTAC	To investigate the mass-transfer efficiency of antipatharian corals, focusing on the branched species Antipathella wollastoni. Antipatharians, known as black corals, are crucial habitat-forming species that create dense Marine Animal Forests (MAFs) in oceans worldwide, fostering high biodiversity.	Mathilde Godefroid, Max planck Institute (Germany)	Yes	tank-week	39 03/30/2025-04/24/2025	Yes	1

** Access units describe how accesses are calculated, typically 1 day x 1 pot, 1 season x 1 microplot, etc …*

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2. TNA projects

2.1.1. TNA projects description

1. Effect of KM inclusion towards enhancing the fillet nutritional quality - **KM for fillet quality**. Krill meal (KM) emerges as a promising sustainable marine ingredient in aquafeeds, providing a rich source of protein, amino acids, phospholipids, omega-3 fatty acids, and bioactive compounds. This study aimed to investigate the effects of including KM (3, 5 and 7 % of the diet) on growth performance, nutrient utilization, and antioxidant defenses in juvenile gilthead sea bream *(Sparus aurata*) exposed to a crowding stress challenge. The dietary inclusion of 7 % KM could effectively replace up to 47 % FM in the diet (8 % FM in 7 % KM in comparison to 15 % FM in control diet), without compromising growth or feed conversion. Although not statistically different, dietary supplementation with 5 and 7 % KM showed a tendency to further optimize feed conversion ratio and nutrient efficiency ratios compared to the control FM diet. Under stressful conditions, a significant interaction between diet and time was observed in fish blood omega-3 index (O3I). At 24 h after the stress challenge, all dietary treatments except KM3 presented a significant increase in n-3 PUFA, EPA, DHA as well as OI3, whereas a decrease in MUFA. At 7d (168 h) post-stress, fish fed the control diet presented a significant reduction in O3I down to the basal levels. On the contrary, those fish fed KM5 and KM7 diets kept increased O3I levels as well as n-3 PUFA content to the end of the stress challenge. Indeed, 24 h after stress, fish fed KM5 and KM7 showed a lower increase of cat and sod gene expression in head kidney, which was further inversely correlated with fish blood OI3. Therefore, these results show that KM modulates red blood cells fatty acid profile by increasing fish OI3 after stress as well as potentially functioning as an antioxidant modulator in fish feeds for mitigating stressful conditions. Hence, KM is a valuable functional ingredient in aquafeeds, aiming to expand the basket of raw materials with functional properties to be used in aquafeed formulation to enhance fish robustness. A manuscript has been published with the results obtained from this TNA. Carvalho et al., 2025. Aquaculture 598 741957. DOI: 10.1016/j.aquaculture.2024.741957

2. Development of sustainable weaning feeds for gilthead sea bream (Sparus aurata): the potential of fungi meal from Paecilomyces variotii as protein source to replace fish meal - **FUNMEAL-AQUA-WEA**. This study explores the potential of sustainable weaning feeds for gilthead sea bream (*Sparus aurata*) larvae by evaluating the fungal meal, *Paecilomyces variotii* (PEKILO®) as a protein source. The research involved formulating diets with increasing levels of *P. variotii* (5, 10, and 15% inclusion) and evaluating their impact on larval growth performance, survival, stress resistance, and disease resistance against *Vibrio anguillarum*. The experiment was conducted with larvae (28 dph) fed over 18 days. Results indicated a dose/dependent effect of *P. variotii,* and could effectively use up to 10% of Pekilo in diet without negatively affecting growth performance and survival. Larvae fed with higher levels of *P. variotii* (15%) exhibited a significant ($p<0.05$) amelioration pathogen resistance. Increasing levels of *P. variotii* did not significantly affect whole-larvae proximate composition but did affect their fatty acid content. Fish fed the 15% *P. variotti* diets exhibited a significant decrease in DHA whereas n-6 fatty acids were significantly higher in larvae fed that diet. Moreover, the inclusion of 15% of *P. variotii* in larval diets led to significant changes in the expression of immune-related genes after infection with *V. anguillarum*. This study demonstrates the potential of *Paecilomyces variotii* fungal meal as a sustainable ingredient with a level of 10% in the larval diets for gilthead sea bream, improving larval growth and response to infection, offering a promising solution for improving the sustainability of aquaculture. This TNA led to a master thesis by Mr. Tanguy Rabillé at Universidade do Algarve (Portugal). A paper is being prepared with the TNA results and other analyses done with the samples obtained. An abstract has been submitted to the Aquaculture Europe 2025 symposium, to be held at Valencia (Spain) in September 2025.

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3. Use of PRObiotics in European sea bass (*Dicentrarchus labrax*) against the FISH bacterial pathogens *Vibrio harveyi* and *Photobacterium damselae* subsp. Piscicida – **PROFISH**. In order to find alternative solutions to the use of antimicrobials in aquaculture, we performed an experimental trial based on the administration of probiotics in the feed to marine fish to evaluate their effects on the intestinal microbiome and, after challenge with a bacterial pathogen, on the survival and defense mechanisms of the fish under trial. More specifically, in this study we used the probiotic *Bacillus velezensis* D-18 supplemented to the commercial diet given to European sea bass (*Dicentrarchus labrax*), maintained in a closed recirculating system, subsequently infected with *Vibrio harveyi*, a common pathogen in Mediterranean marine farming. Since both the probiotic and the pathogen used are strong biofilm producers, we also examined the biofilm from tanks to assess the possible antagonism in the biofilm formation between the two bacterial organisms. At the end of the trial, the relative survival percentage of the group fed with *Bacillus velezensis* D-18 was 50 %, compared to the control group, which presented 27 % survival, and statistics analysis demonstrated strain D18 significantly increased fish survival. The results of the analyses carried out on serum, intestine and environmental biofilm are being elaborated for statistical interpretation of the results and a scientific paper to be submitted to an international peer reviewed journal is in progress. A person was trained.

4. Comparison of emerging alternative protein sources for juvenile sea bass (*Dicentrarchus labrax*) diets: effects on growth, digestive enzymes and health – **NOVELFEEDBASS**. To ensure the sustainability and profitability of aquaculture production, alternative nutritional strategies to conventional ingredients are needed. Among the most promising emerging protein sources are processed animal proteins (PAPs), insect meals (IM) or single cell proteins (SCPs), which have been widely studied lately. However, a holistic approach to the combined use of these ingredients is required. In this context, the present study aims to evaluate the potential of the combined use of these emerging ingredients (PAPs, SCP - *Corynebacterium glutamicum* and insect meal - *Hermetia illucens*) and their effects after partial or total replacement of fishmeal in the diet of sea bass juveniles (*Dicentrarchus labrax*.) Five experimental diets with two levels of fishmeal replacement (50 or 100%) were tested for 12 weeks to evaluate growth performance, proximate composition, and digestive enzyme activity in European sea bass juveniles. Besides, the resistance to Vibrio anguillarum infection was assayed after feeding period. Overall, the results show that the diets did not compromise growth performance, except the diet with total replacement of FM by IM and SCP (ALT100), which resulted in reduced growth and worse feed and nutrient utilisation, and also is the diet that compromises survival after Vibrio infection. Protein retention was not affected among the experimental diets, while lipid retention decreased with higher inclusion of MI and SCP. Proximal composition of whole-body as well as EPA and DHA levels were comparable among fish fed the different diets. Enzyme activity results showed efficient digestibility in the diets including PAP, while the inclusion of IM and SCP led to an increased effort by the fish to digest the proteins, especially when FM was completely replaced by these sources (ALT100 diet). The results showed that partial and total substitution of FM by PAPs and partial substitution by IM and SCP in the diet of juvenile European seabass is feasible. However, growth and lipid utilisation were negatively affected when FM was completely replaced by IM and SCP. A paper is being prepared with the TNA results and other analyses done by SPAROS with the simples obtained with the experiment.

5. Investigating Thermal Tolerance and Mass-Transfer Efficiency in Antipatharian Corals: Implications for Local Restoration and Aquarium Maintenance – **TheMaTAC**. This scientific proposal aimed to investigate the mass-transfer efficiency of antipatharian corals, focusing on the branched species *Antipathella wollastoni*. Antipatharians, known as black corals, are

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crucial habitat-forming species that create dense Marine Animal Forests (MAFs) in oceans worldwide, fostering high biodiversity. These species, particularly significant in subtropical regions like the Canary Island Archipelago, are often overlooked despite their ecological importance. Upon analysis of all results, it expects that this work will contribute significantly to understand the physiology of black corals and their mass-transfer capacities across morphologies and scales, but also across compartments (internal (across polyps) and external (coral-seawater interaction) mass transfer capacity. This will result in one peer-reviewed publication. A person was trained.

2.1.2. Selection of One exemplary project

PROJECT: Investigating Thermal Tolerance and Mass-Transfer Efficiency in Antipatharian Corals: Implications for Local Restoration and Aquarium Maintenance – **TheMaTAC**. Fragments of *Antipathella wollastoni* and *Stichopathes* sp. were collected at 35 and 72 m depths, respectively. Fragments were maintained in open-circuit tanks in conditions similar to the site of collection (salinity, light, temperature, flow). They were fed twice per day with a mix composed of enriched *Artemia* and rotifers, supplied by the local Institute. All fragments looked healthy during the entire period of experimentation. Experiments aiming at quantifying the mass transfer capacity of the two species across scales were performed successfully. For all experimentations and visualizations, fragments were placed in a setup brought by the applicant, composed of a small flow chamber connected to a pump with adjustable flow, and of a Particle Image Velocimetry (PIV) system (camera with multiple magnifying lenses, laser). Flow fields were investigated in the two species using PIV, at two scales and under different flow conditions (No flow, Low flow). At low magnification, the flow around the entire fragment was resolved (Fig. 1A). At high magnification, the flow around the polyps was resolved, unraveling the presence of ciliary-induced flow in the two species (Fig. 1B). These observations suggest that the presence of cilia is a conserved trait across cnidarians.

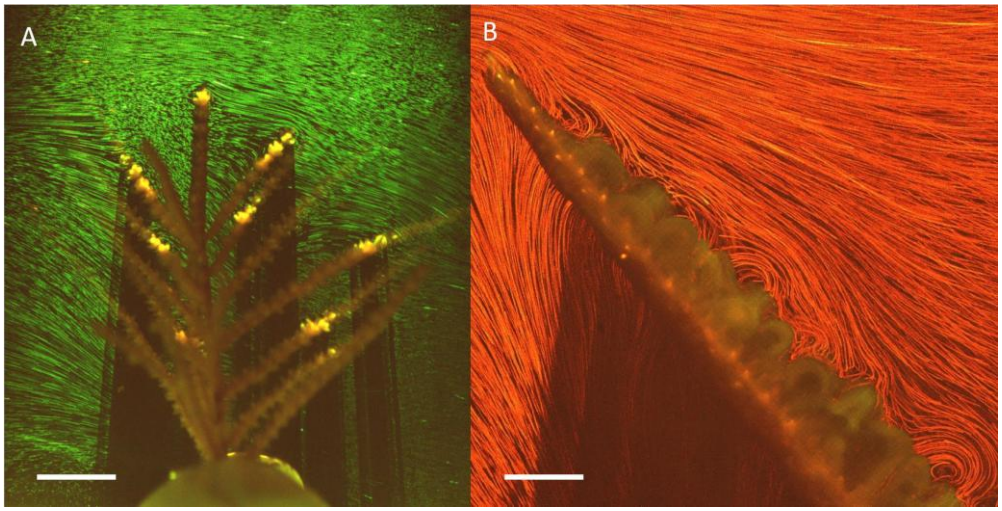

Figure 1. Particle Image Velocimetry (PIV) across scales, in Antipathella wollastoni. A. Low magnification PIV resolves flow field around entire coral fragment. Scale bar: 1 cm. B. High magnification PIV resolves flow field around a single branch, revealing ciliary vortices. Scale bar: 1 mm.

Mass-transfer capacities around the fragments of both species were quantified using sensPIV, which allows to resolve oxygen concentration in two-dimensions. Fragments were held in the dark and the oxygen concentration around the fragment was quantified under flow and in the absence of flow, at multiple time points. This approach was complemented with oxygen microsensor profiles at the tissue surface and in the mouth openings, which allow for a better

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resolution of fine scale oxygen gradients at a single location. Microsensor measurements were performed with beating cilia and under arrested cilia (upon addition of Sodium Orthovanadate). This allowed to quantify the effect of beating cilia on increasing mass transfer capacity (for oxygen), for both species. Finally, bulk oxygen was also measured, with and without Sodium Orthovanadate, using a PyroScience setup. Results revealed that Sodium Orthovanadate did not impact the metabolism of the coral host.

3. Reflection on results of the TNA programme

4. References

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Work Package Leader	Rafael Gines			
Work Participants				

Lead Beneficiary	ULPGC, Partner
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