



ParaFishControl





ParaFishControl

welcome!



28 PARTNERS

13 COUNTRIES

ParaFishControl Industry Forum “Mediterranean Fish Parasite Management Strategies”

Organised at the 19th International Conference on Diseases of Fish and Shellfish

Date and Time: Tuesday, 10 September 2019; 16:00-19:00

Location: Alfândega do Porto Congress Centre - Room D. Maria R. Nova da Alfândega, 4050-430 Porto, Portugal



19th International
Conference on Diseases
of Fish and Shellfish

Industry Forum “Mediterranean Fish Parasite Management Strategies”



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Advancements and upcoming results

Dr. Ariadna Sitjà-Bobadilla

Project Coordinator



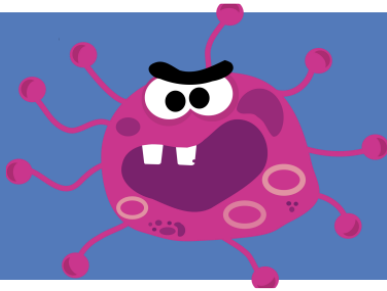


Advanced Tools and Research Strategies for Parasite Control in European farmed fish



5 years collaborative project:

- Total cost: 8 104 133.75 €
- EU contribution: 7 800 000 €



Parasites are constraining aquaculture industry

- Different parasites, culture conditions
- Different background knowledge

Global Objective



- To increase sustainability and competitiveness of European aquaculture
- Improving understanding of fish-parasite interactions
- Developing innovative solutions and tools for the prevention, control and mitigation of the major parasites




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WHY THIS PROJECT, WHY PARASITES?

Economic Impact of Parasites in Finfish Aquaculture

- Direct mortality
- Morbidity: Decreased FCR & growth, parasitic castration
- Increased susceptibility to other diseases (opportunistic)
- Reduced ability to cope with changes and handling
- Harvest downgrades, loss of market, reduced durability
- Costs of treatments, prevention strategies, mort disposal, etc.
- World (Shin et al., Global Aquaculture Advocate, 2015):
 - Estimated losses due to parasitism: hatchery (20 %), growout (1-10% harvest)
 - Parasites' annual cost : from \$1.05 billion to \$9.58 billion
- EU (+ Norway) (H. Rodgers, FishVetGroup):
 - The value of salmon aquaculture in 2016: €12.5 billion 
 - Parasite impact: €525 to 725 million pa (direct & indirect)



SOLUTIONS !!



WHO, HOW, WHAT?

Industry



Research



13 countries

28 partners



UNIVERSITÀ DEGLI STUDI DI UDINE

WP leaders



WP1		Geert Wiegertjes	Geert.Wiegertjes@wur.nl	WU
WP2		Ivona Mladineo	mladineo@izor.hr	IOR
WP3		James Bron	j.e.bron@stir.ac.uk	UoS
WP4		Oswaldo Palenzuela	oswaldo.palenzuela@csic.es	CSIC
WP5		Niels Lorenzen	nilo@vet.dtu.dk	DTU
WP6		Alastair Cook	alastair.cook@cefas.co.uk	Cefas
WP7		Miguel Angel Pardo	mpardo@azti.es	AZTI
WP8	 	Marieke Reuver Emma Bello (o.b.)	marieke.reuver@aquatt.ie	AquaTT
WP9		Ariadna Sitjà-Bobadilla	coordination.parafishcontrol@csic.es	CSIC

Parasite group	Parasite species	Fish
Crustaceans	<i>Lepeophtheirus salmonis</i>	AS
	<i>Ceratothoa oestroides</i>	ESB, GSB
Monogeneans	<i>Sparicotyle chrysophrii</i>	GSB
Myxozoans	<i>Tetracapsuloides bryosalmonae</i>	RBT
	<i>Enteromyxum leei</i>	GSB
	<i>Enteromyxum scophthalmi</i>	TB
	<i>Sphaerospora molnari</i>	CC
	<i>Thelohanellus kitauei*</i>	CC
Microsporidians	<i>Enterospora nucleophila*</i>	GSB
Ciliates	<i>Ichthyophthirius multifiliis</i>	RBT, CC
	<i>Philasterides dicentrarchi</i>	TB
Dinoflagellates	<i>Amyloodinium ocellatum</i>	ESB
Amoebae	<i>Paramoeba perurans</i>	AS
Oomycetes	<i>Saprolegnia parasitica</i>	AS, RBT
Zoonotic helminths	Anisakidae, Opisthorchidae, Diphylobothriidae	All

Abbreviations: AS = Atlantic salmon (*Salmo salar*); CC = common carp (*Cyprinus carpio*), ESB = European sea bass (*Dicentrarchus labrax*), GSB = gilthead sea bream (*Sparus aurata*). RBT= rainbow trout (*Onchorhynchus mykiss*), TB = turbot (*Psetta maxima*). * Emerging or exotic parasites.



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Enterospora nucleophila



Enteromyxum leei



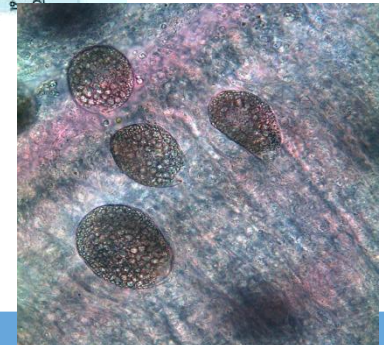
Photo by A. Siliá-Bobadilla



Sparicotyle chrysophrii



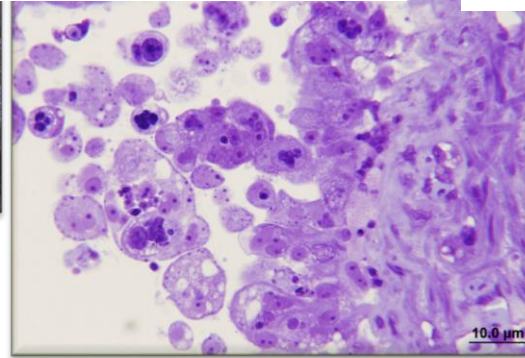
Ceratothoa oestroides



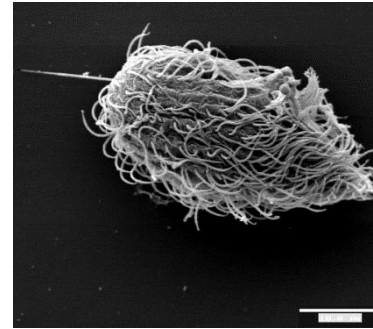
Amyloodinium ocellatum



Enteromyxum scophthalmi



Philasterides dicentrarchi



Lepeophtheirus salmonis



Paramoeba perurans



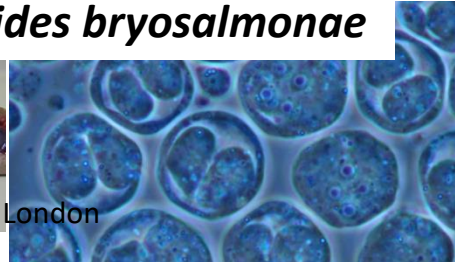
Saprolegnia parasitica



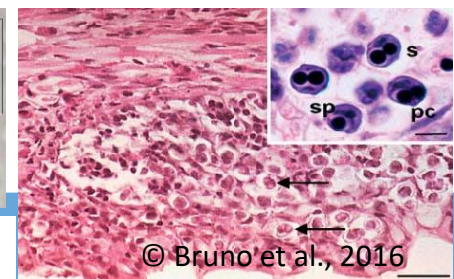
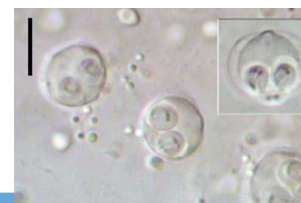
Tetracapsuloides bryosalmonae



© NHM, London



Ichthyophthirius multifiliis



© Bruno et al., 2016

Telohanellus kitauei

Sphaerospora molnari



We are a mature project: ends 31 March 2020



2020

2015

WHAT ARE WE DOING ?



47 KOs collected in to P3



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- KO #1 - Risk Factors for parasite infections (Owner: Cefas, ANDROMEDA, AQUARK, CSIC, IOR, SKRET, USC, UNIBO, UNIUD)
- KO #2 - Infection model for *Saprolegnia* (both *diclina* and *parasitica*) (WU)
- KO #3 - White spot disease control with bacterial surfactant (Owner: KNAW, KU - Patent number EP17202669)
- KO #4 - Sparicotylosis alternative treatments (Owner: IOR)
- KO #5 - Anisakis detection portable kit (Owner: AZTI)
- KO #6 - Best Practices of farm management to avoid presence of Anisakis in farmed fish (Owner: AZTI et al.)
- KO #7 - Alternative treatment strategies for *Saprolegnia* (Owner: UNIBO)
- KO #8 - Ich recombinant protein and homogenate vaccines (Owner: KU, MTA)
- KO #9 - Expression of two proteins of *Ich* in *Pichia* (Owner: KU, W42)
- KO #10 - PKD Vaccine (Owner: UNAB)
- KO #11 - In vivo infection model for AGD in salmon (Owner: Cefas)
- KO #12 - In vitro infection model for AGD in salmon (Owner: UoS)
- KO #13 - Compound that works against *Paramoeba perurans* (AGD) (Owner: UoS)
- KO #14 - Salivary gland proteins from *Lepeophtheirus salmonis* (Owner: UiB and UoS)
- KO #15 - Vaccines against *Sphaerospora molnari* in carp (Owner: BCAS)
- KO #16 - Immunostimulants against *Sphaerospora molnari* in carp (Owner: BCAS, SKRET)
- KO #17 - qPCR for *Sphaerospora molnari* and *T. kitauei* (Owner: BCAS)
- KO #18 - Immunostimulants against *Amyloodinium ocellatum* (Owner: UNIUD)
- KO #19 - Alternative treatments for *Ceratomyxa oestroides* (Owner: IOR)
- KO #20 - Point of care for *E. leei* sea bream (Owner: CSIC, INGENASA)
- KO #21 - Infection models for *E. leei* (Owner: CSIC)
- KO #22 - Immunostimulants for *Ich* (Owner: KU)
- KO #23 - Alternative treatment strategies for Ich (Owner: MTA)
- KO #24 - Alternative treatment strategies for Ich (Owner: KU)
- KO #25 - Vaccines for *Saprolegnia* (Owner: UNAB)
- KO #26 - New monoclonal antibodies for PKD (Owner: VAL)
- KO #27 - Point of care tests for *Enteromyxum* spp. (Owner: CSIC, INGENASA)
- KO #28 - Alternative treatments for *Philasterides dicentrarchi* (Owner: USC)
- KO #29 - Vaccines for *Philasterides dicentrarchi* (Owner: USC, CSIC, INIA)
- KO #30 - Point of care test for *P. perurans* (Owner: Cefas)
- KO #31 - Repository of diagnostic methods (Owner: CSIC, DTU, UNIBO, IOR, UoS, UNAB, Cefas, BCAS, MTA, USC, KU)
- KO #32 - SHIELD new diet for sea bream (Owner: SKRET)
- KO #33 - Strategy to block the interaction of BAFF with its receptor as a treatment against proliferative kidney disease (PKD) (Owner: INIA-UNAB - Patent in progress)
- KO #34 - Challenge model for *Amyloodinium ocellatum* (Owner: UNIUD)
- KO #35 - Sequencing of *Amyloodinium ocellatum* (genome) (Owner: UNIUD)
- KO #36 - Vaccine for *Amyloodinium ocellatum* (Owner: UNIUD)
- KO #37 - Two different qPCR protocols for detection of *Neoparamoeba perurans* (AGD) (Owner: DTU)
- KO #38 - qPCR and ICH protocols for detection of *Tetracapsuloides bryosalmonae* (PKD) (Owner: DTU)
- KO #39 - qPCR for *Enterosporea nucleophila* (Owner: CSIC)
- KO #40 - Methods for detection, quantification and discrimination of genotypes/serotypes of *P. dicentrarchi* (Owner: USC).
- KO #41 - Tools for detection and identification of zoonotic metacercariae (Owner: UNIBO)
- KO #42 - Sequencing of *Enteromyxum leei* (genome) (Owner: CSIC)
- KO #43 - Sequencing of *Enteromyxum scopthalmi* (genome) (Owner: CSIC)
- KO #44 - Sequencing of *P. dicentrarchi* (genome/ transcriptome) (Owner: USC).
- KO #45 - Sequencing of *Sphaerospora molnari* (genome/transcriptome) (Owner: BCAS).
- KO #46 - Sequencing of *Paramoeba perurans* (genome/transcriptome) (Owner: Cefas, UoS).
- KO #47 - Sequencing of *Sparicotyle chrysophrii* (genome/transcriptome) (Owner: IOR, HCMR, CSIC).



1-Generating a more positive public perception



Environmental impact



Animal welfare



Food security

KO#6

**0% zoonotic helminths
in farmed fish**



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Zoonotic risks in:

- marine and freshwater farmed fish: 0 %
- fish products: 0%
- Feedback to EATiP and FEAP done
- Feedback to ESFA to be done



- Allergenicity of zoonotic helminths: expanded to *Contracaecum*
- Recommendation to determine the presence and transfer of allergens from aquafeeds to fish



- Smart solution to ensure safety of fish products
- Good practice handbook for Minimum Parasite Infection



We have recently presented a Spanish Standardization Proposal to the committee CTN 173/SC2 based on WP7 results

Interaction wild-farmed fish



1. ***S. chrysophrii*** and ***C. oestroides*** between wild and farmed GSB and ESB
2. Characterisation of possible transfer of ***S. parasitica*** from farmed to wild salmonids and viceversa.
3. Epidemiological model to determine the transfer of ***I. multifiliis*** between farmed and wild salmonids.

The transfer depends on parasite species and microlocation (we still do not precisely which parameters, e.g. currents, bottom type, salinity...). Thus, there is a strong evidence that it does exist, but at different "success rate". It is most prominent in *Ceratothoa* (aggressive natatory infective stages), at a lower degree for *Sparicotyle*, while *Saprolegnia* and *Ich* were evaluated using different approach, but even so.



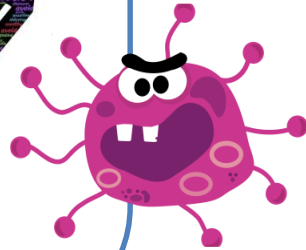
2 - Develop appropriate governance models



Advancing impact of diseases

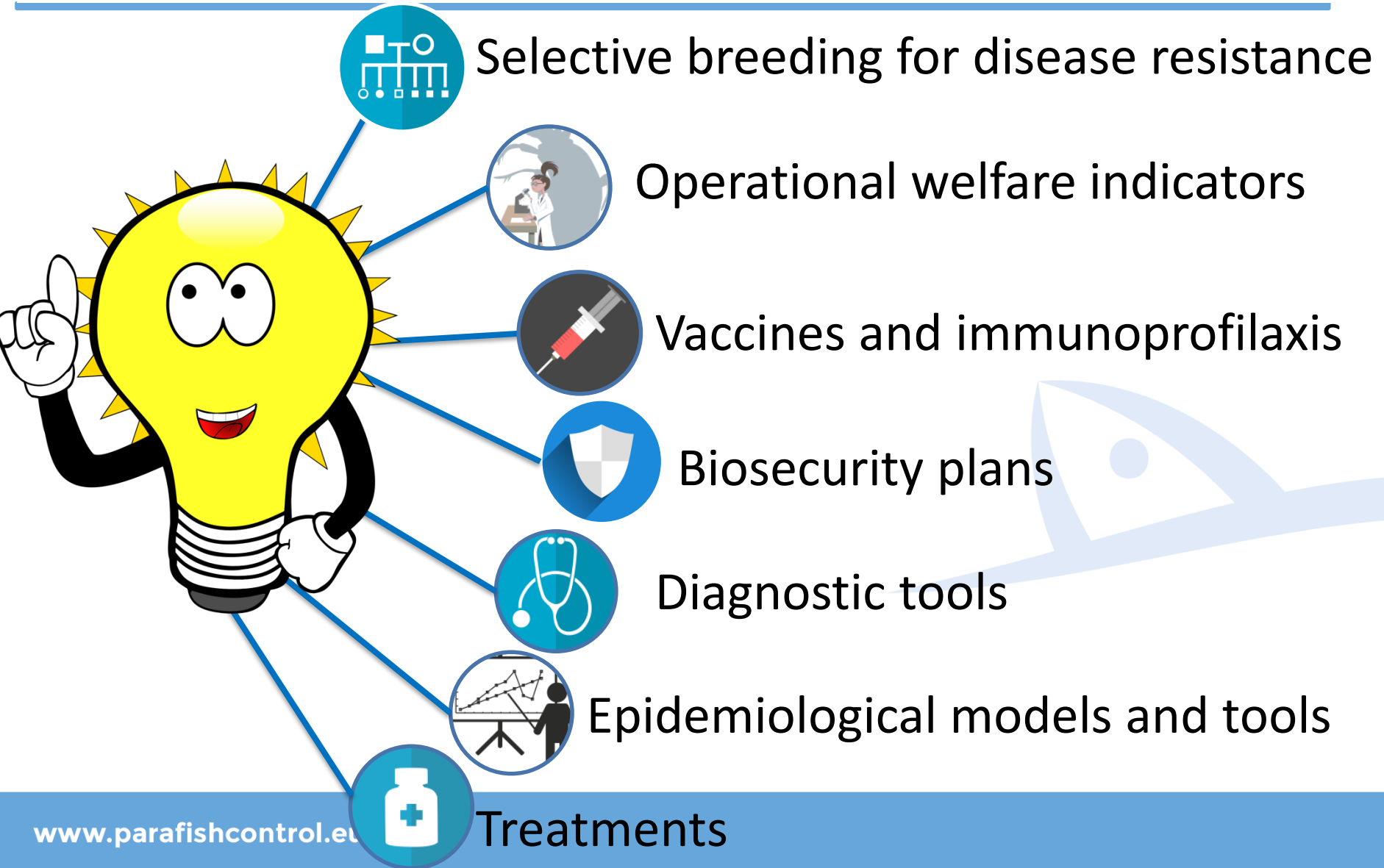


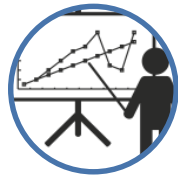
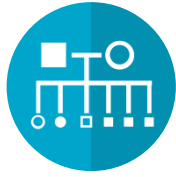
Minimizing impact of treatments



Avoiding spreading of pathogens

3 - Promote preventive measures to diseases and adverse health conditions





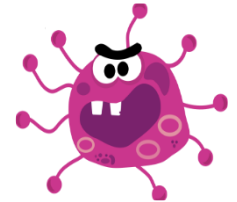

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Information essential for diagnostics, treatments, vaccines, biosecurity, breeding, welfare indicators, etc.

Knowing the parasite:

In vitro culture, life cycle, experimental transmission, genome, transcriptome, proteome



Knowing the host:

Immune response, histopathology, transcriptomics (RNA seq, qPCR-array)



- KO #35** - Sequencing of *Amyloodinium ocellatum* (genome)
- KO #42** - Sequencing of *Enteromyxum leei* (genome)
- KO #43** - Sequencing of *Enteromyxum scophthalmi* (genome)
- KO #44** - Sequencing of *P. dicentrarchi* (genome/ transcriptome)
- KO #45** - Sequencing of *Sphaerospora molnari* (genome/transcriptome)
- KO #46** - Sequencing of *Paramoeba perurans* (genome/transcriptome)
- KO #47** - Sequencing of *Sparicotyle chrysophrii* (genome/transcriptome)

KO#12 *Neoparamoeba perurans*

RTgill-W1 In vitro challenge model

Book for standard Operating protocols for parasite transmission and isolation

KO#49 *Philasterides dicentrarchi*
nkl gene good candidate for genetic breeding



KOs Vaccines and immunoprophylaxis



KO #36 - *Amyloodinium ocellatum*
Vaccine trials in lab

KO#10 Proliferative Kidney Disease (PKD)
DNA Vaccine field trials

Field-based
vaccination trials

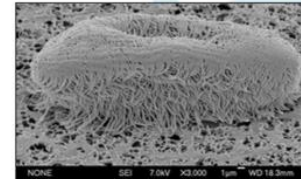


Enteromyxum leei
functional feeds

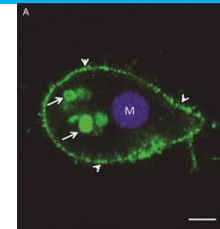
And others "in the oven"...



KO#9 *Ichthyophthirius multifiliis*
Recombinant vaccine in *Pichia pastoris*

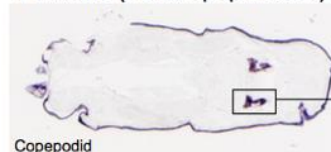


KO#29 *Philasterides dicentrarchi*
Variable Surface Protein (VSP)
expressed in *Pichia pastoris* as vaccine targets

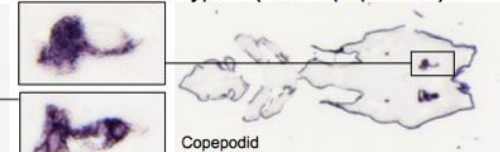


KO#14 Salmon louse
Salivary gland proteins - vaccine targets

Astacins (metallopeptidases)



Trypsin (serine peptidase)

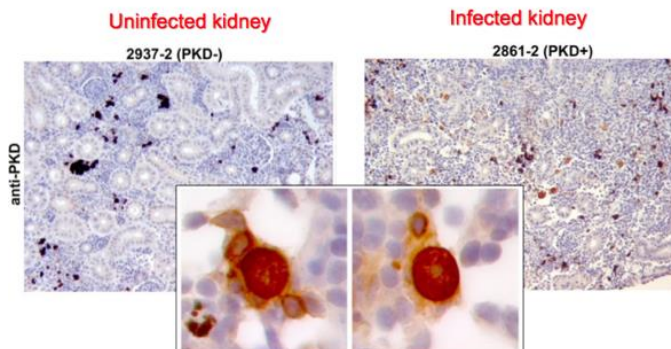


Copepodid

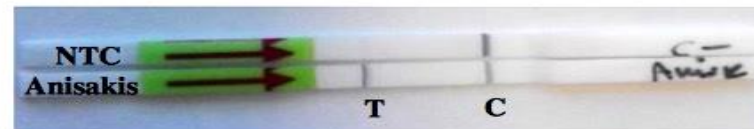
Copepodid



KO#26 Proliferative Kidney Disease (PKD) P14G8 Mab



KO#5 *Anisakis* Portable detection kit



LF RPA Assay for the detection of *Anisakis* simplex: Test line (T); Internal Control line (C). Negative Template control (NTC)

KO #40 *P. dicentrarchi* Methods for detection, quantification and discrimination of genotypes/serotypes

KO#41 Zoonotic metacercaria Tools for detection and identification

KO#39 *Enterospora nucleophila* qPCR & ISH protocols

POC: *Enteromyxum* spp.

Reference diagnostic methods for: *P. perurans*, *E. nucleophila* *T. bryosalmonae*

Repository of parasite diagnostic methods





KO#7 *Saprolegnia*
Treatments validation

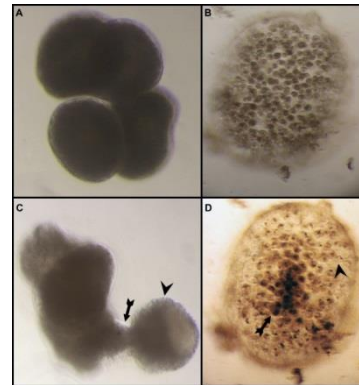
KO#28 *Philasterides dicentrarchi*
Nk-lysin (Nkl) AMP

KO #33 PKD Strategy to block the interaction of BAFF with its receptor as a treatment (patent in progress)

Optimal strategy for the use of salmon lice cleaner fish

KO#4 Sparicotylosis
Alternative Treatments

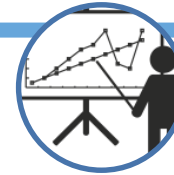
KO#3 *Ichthyophthirius multifiliis*
Bacterial Bio-surfactant (*Pseudomonas*)



PATENT
EDP ref: P1600045PC00 –
International PCT Application No.
PCT/EP2018/081923

START-UP: SUNDEW

And others “in the oven”...



Risk
Factor
Analysis

KO#7 Identification of risk factors for parasite introduction into and amplification within fish farms: *Sparicotyle chrysophrii*, *Enteromyxum leei*, *Enterospora nucleophila*, *Ceratomyxa oestroides*

Alpha version of the economic model

- Farm level tool developed in R Shiny
- Provides a user-friendly web-based interface through which partners and fish farmers can investigate some of the key findings
- Provides information on the relative likelihood of infection and intensity based on factors chosen by an end user.



Manuals describing IPMS for parasite management and handbooks describing good practices

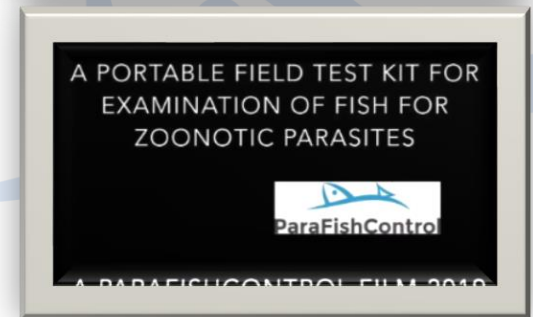
- **Manual 1 - Salmonids**
- **Manual 2 - European sea bass & gilthead sea bream**
- **Manual 3 - Turbot**
- **Manual 4 - Common Carp**



**Integrated
Parasite
Management
Strategies
(IPMS)**

Dissemination and KT Activities

- Project web page: www.parafishcontrol.eu
- Newsletters (3 issues - [Link](#))
- LinkedIn: 132 members 
- Twitter: 711 followers 
- Videos (3 - Watch the videos by clicking on the pictures!)
- Scientific publications: > 50 ([Link](#)) 
- Press releases and popularised publications: 12
- Participation in scientific conferences: 121
- Participation in other workshops & events: 51
- Ph D thesis: 3
- Organisation of workshops and training courses: 13
- Trade fairs and exhibitions: 10 
- Patents: 1 (521-049/16-7000)
- Others: 1 factsheet, 2 posters, 1 banners, etc.



16 peer-viewed articles in the last year

- 1) Cano I, et al. (2019). *In vitro* gill cell monolayer successfully reproduces in vivo Atlantic salmon host responses to *Neoparamoeba perurans* infection. *Fish & Shellfish Immunology* 86: 287-300. doi: <https://doi.org/10.1016/j.fsi.2018.11.029>.
- 2) Fernández C, et al. (2019). Methacarn preserves mucus integrity and improves visualization of amoebae in gills of Atlantic salmon (*Salmo salar* L.). *Journal of Fish Diseases* 42:6. doi: <https://doi.org/10.1111/jfd.12988>.
- 3) Hossameldin A N., et al. (2019). Detection of the intranuclear microsporidian *Enterospora nucleophila* in gilthead sea bream by *in situ* hybridization. *Journal of Fish Diseases* 42:6. doi: <https://doi.org/10.1111/jfd.12993>.
- 4) Byadgi O, et al. (2019). Expression of infection-related immune response in European sea bass (*Dicentrarchus labrax*) during a natural outbreak from a unique dinoflagellate *Amyloodinium ocellatum*. *Fish & Shellfish Immunology* 84:62-72. doi: <https://doi.org/10.1016/j.fsi.2018.09.069>.
- 5) Syahputra, K., et al. (2019). Transcriptomic analysis of immunity in rainbow trout (*Oncorhynchus mykiss*) gills infected by *Ichthyophthirius multifiliis*. *Fish & Shellfish Immunology* 86: 486-496. doi: <https://doi.org/10.1016/j.fsi.2018.11.075>.
- 6) Korytar T, et al. (2019). The kinetics of cellular and humoral immune responses of common carp to presporogonic development of the myxozoan *Sphaerospora molnari*. *Parasites & Vectors* 12:208. doi: <https://doi.org/10.1186/s13071-019-3462-3>.
- 7) Muñoz-Atienza E, et al. (2019). CK11, a Teleost Chemokine with a Potent Antimicrobial Activity. *Journal of Immunology* 202 (3) 857-870. doi: <https://doi.org/10.4049/jimmunol.1800568>.
- 8) Piazzon MC, et al. (2019). Acting locally - affecting globally: RNA sequencing of gilthead sea bream with a mild *Sparicotyle chrysophrii* infection reveals effects on apoptosis, immune and hypoxia related genes. *BMC Genomics*; 20:200. doi: <https://doi.org/10.1186/s12864-019-5581-9>.
- 9) Tedesco P, et al. (2019). *In vitro* activity of chemicals and commercial products against *Saprolegnia parasitica* and *Saprolegnia delica* strains. *Journal of Fish Diseases*; 42:237-248. doi: <https://onlinelibrary.wiley.com/doi/epdf/10.1111/jfd.12923>.
- 10) Øvergård AC, et al. (2018). Salmon louse rhabdoviruses: Impact on louse development and transcription of selected Atlantic salmon immune genes. *Developmental & Comparative Immunology* 86:86-95. doi: [10.1016/j.dci.2018.04.023](https://doi.org/10.1016/j.dci.2018.04.023).
- 11) Blanco-Abad V, et al. (2018). The coagulation system helps control infection caused by the ciliate parasite *Philasterides dicentrarchi* in the turbot *Scophthalmus maximus* (L.). *Developmental and Comparative Immunology* 87:147-156. doi: [10.1016/j.dci.2018.06.001](https://doi.org/10.1016/j.dci.2018.06.001). Click [here](#) to access the full text.
- 12) Guðmundsdóttir S, et al. (2018). Outbreak of viral haemorrhagic septicaemia (VHS) in lumpfish (*Cyclopterus lumpus*) in Iceland caused by VHS virus Genotype IV. *Journal of Fish Diseases* 42:1. doi: <https://doi.org/10.1111/jfd.12910>.
- 13) Patra S, et al. (2018). Biodiversity and host-parasite cophylogeny of *Sphaerospora* (*sensu stricto*) (Cnidaria: Myxozoa). *Parasites & Vectors* 11:347. doi: <https://doi.org/10.1186/s13071-018-2863-z>.
- 14) Lama R, et al. (2018). Turbot (*Scophthalmus maximus*) Nk-lysin induces protection against the pathogenic parasite *Philasterides dicentrarchi* via membrane disruption. *Fish and Shellfish Immunology* 82:190-199. doi: [10.1016/j.fsi.2018.08.004](https://doi.org/10.1016/j.fsi.2018.08.004). Click [here](#) to access the full text.
- 15) Piazzon MC, et al. (2018). Hints on T cell responses in a fish-parasite model: *Enteromyxum leei* induces differential expression of T cell signature molecules depending on the organ and the infection status. *Parasites & Vectors*, 11:443. doi: <https://doi.org/10.1186/s13071-018-3007-1>.
- 16) Abos B, et al. (2018). Dysregulation of B Cell Activity During Proliferative Kidney Disease in Rainbow Trout. *Frontiers in Immunology* May 2018; 9; Article 1203. doi: <https://doi.org/10.3389/fimmu.2018.01203>.





ParaFishControl

Workshop on North European fish parasite management strategies

at Aquaculture Europe 2019 conference
is organized by European Aquaculture Society
Berlin, Germany
8th October 2019



PARAFISHCONTROL Final Conference Brussels, March 2020



Next training course



ParaFishControl



Universidad
Zaragoza

Advanced Course

DIAGNOSTICS AND PREVENTION FOR FISH PARASITE CONTROL IN AQUACULTURE

Zaragoza (Spain), 21-25 October 2019

SOLD OUT!



Contact us



Communication & Press

- Emma Bello
- emma@aquatt.ie



Management

- Dr. Enric Belles-Boix
- enric.belles-boix@inra.fr



Coordination

- Dr. Ariadna Sitjà-Bobadilla
- parafishcontrol.coordination@csic.es



- <http://www.parafishcontrol.eu>



AGENDA

16:00 - 16:30	<i>ParaFishControl Project and Expected Results</i> Dr Ariadna Sitjà-Bobadilla, ParaFishControl Project Coordinator, IATS -CSIC
16:30 - 16:45	<i>Economic Impact of Parasitic Diseases in Mediterranean Mariculture</i> Dr Alain Le Breton, Vet'au, France
Session 1 - Diagnostics	
16:45-17:00	<i>Towards an improved image of Mediterranean aquaculture products regarding food safety</i> Dr Andrea Gustinelli, University of Bologna, Italy
17:00-17:15	<i>New tools for diagnosis of Enterospora nucleophila</i> Dr Oswaldo Palenzuela, CSIC, Spain
Session 2 - Prevention	
17:15 - 17:30	<i>Vaccine for Amyloodinium ocellatum</i> Dr Paola Beraldo, University of Udine, Italy
17:30-17:45	<i>Vaccines for Philasterides dicentrarchi</i> Dr Ariadna Sitjà-Bobadilla, IATS-CSIC, Spain
17:45 - 18:00	<i>Economic model for risk factors in Mediterranean farms</i> Dr Ariadna Sitjà-Bobadilla, IATS-CSIC, Spain
Session 3 - Alternative Treatments	
18:00 - 18:15	<i>New treatments against sparicotylosis</i> Dr Ivona Mladineo, Institut za oceanografiju i ribarstvo, Croatia
18:15 - 18:30	<i>Alternative treatments for Ceratohoa oestroides</i> Dr Ivona Mladineo, Institut za oceanografiju i ribarstvo, Croatia
18:30 - 18:45	<i>Alternative treatments for Amyloodinium ocellatum</i> Dr Michela Massimo, University of Udine, Italy
18:45 - 19:00	<i>Open Discussion and Feedback from the Audience</i>

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