Understanding mucosal health through innovative strategies and alternative systems that reduce the use of experimental fish

Carlo C. Lazado & Elisabeth Ytteborg

Nofima

Begge har en PhD i molekylærbilogi og jobber i avdeling for Fiskehelse på Nofima, Divisjon for Akvakultur

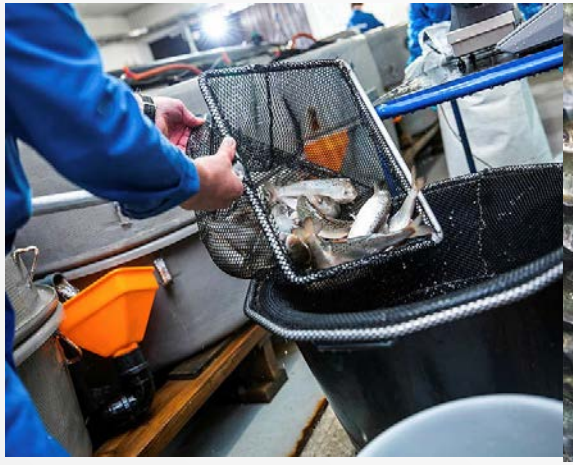
Nofima

Pris

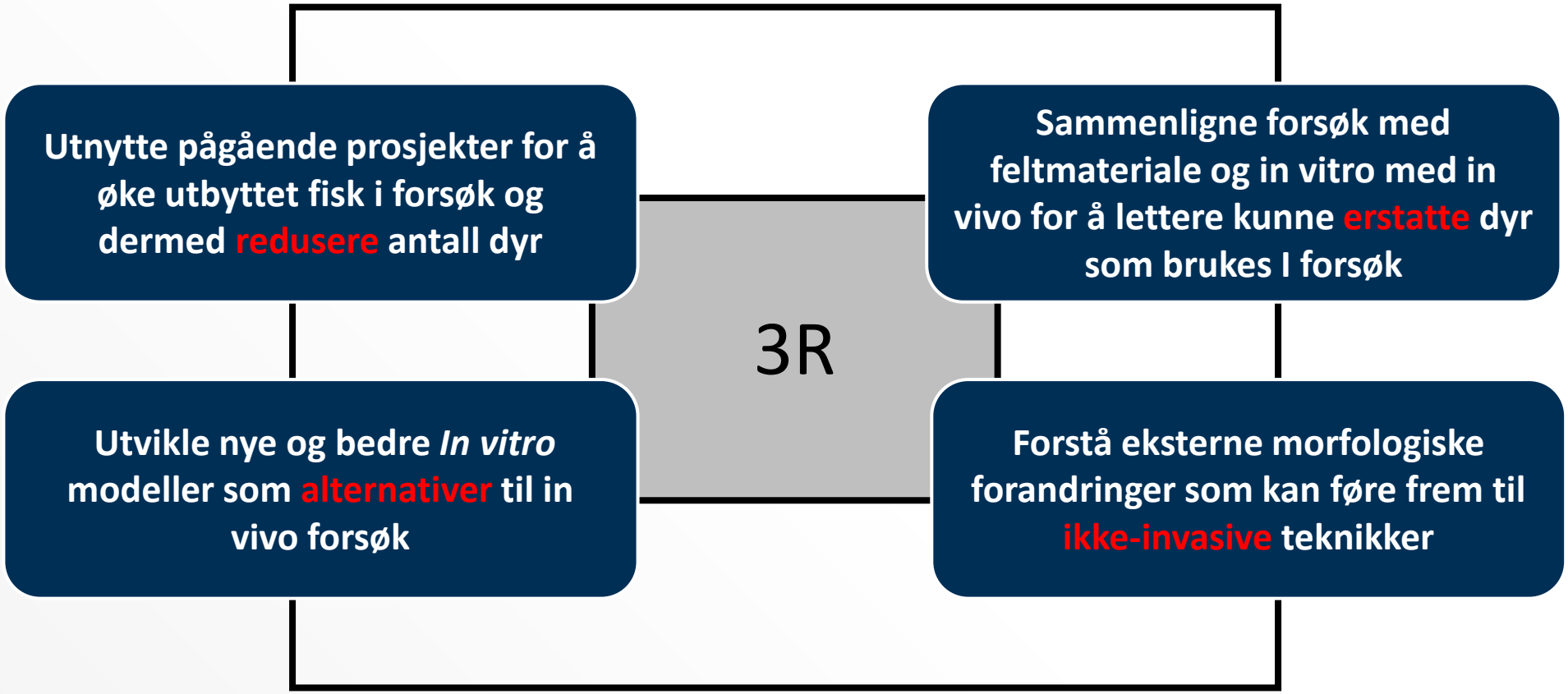
For fremragende arbeid med å utvikle strategier for å redusere antallet forsøksdyr i studier av fiskehelse

Utgangspunktet for vår interesse

- **Dyr i forsøk:**
  - Over 90% av alle forsøksdyr som brukes i Norge er fisk (ca. 2 millioner i 2020)
- **Dyr i produksjon:**
  - Ca. 20% av all oppdrettslaks dør før de når slakt
  - 50 millioner rensefisk som brukes til å bekjempe lakselus dør hvert år
- **Relevante utfordringer:**
  - Gode ikke-invasive metoder for å evaluere fiskehelse mangler
  - Modellsystemer for uttesting av behandlinger eller for evaluering av fiskehelse må utvikles




Hovedlinjene i arbeidet vårt



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Mulighet til å jobbe på tvers av prosjekter

Strategisk internprosjekt over 3 år:

- Ønsket ikke å kjøre egne forsøk, men heller hente ut fisk fra pågående forsøk
- Utvikle bedre modellsystemer
- Utvikle ikke-invasive analysemetoder

➢ Prosjektet resulterte i 14 publiserte artikler

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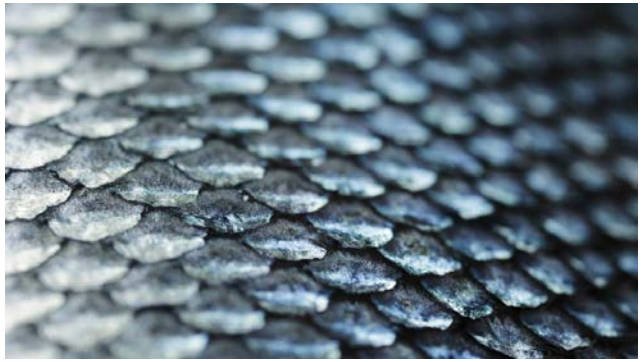
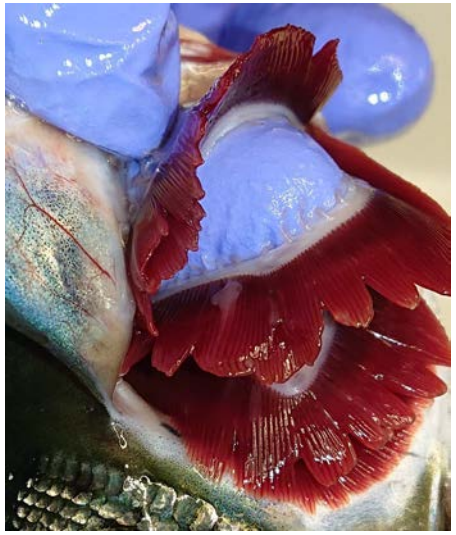
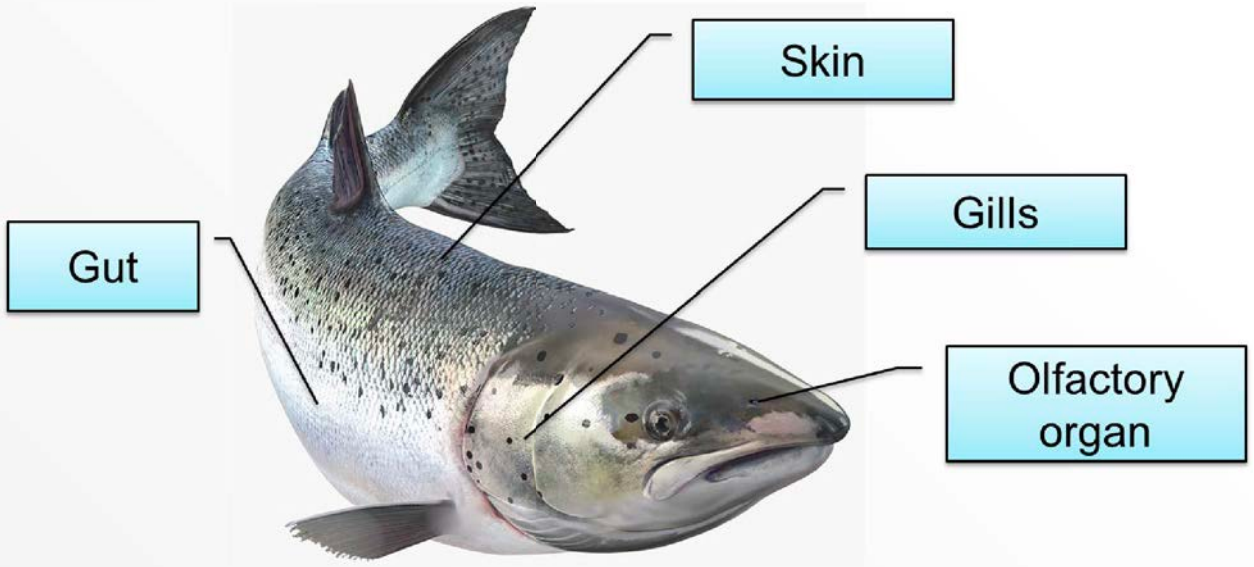
Mukosale vev - Reflekterer de miljøene og de faktorene fisken utsettes for

Skinn
Gjelle
Nese
Tarm







Gross morphology

Gene/Protein expression

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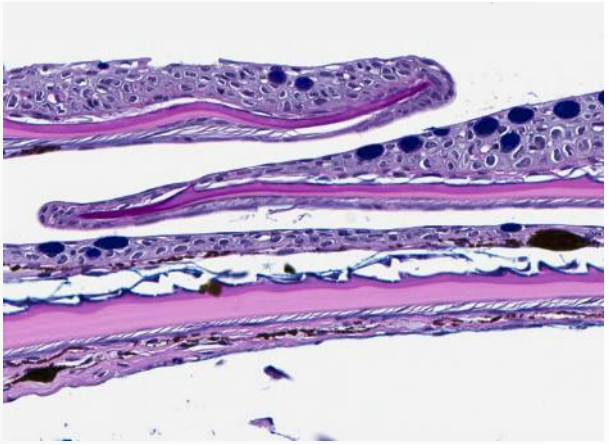
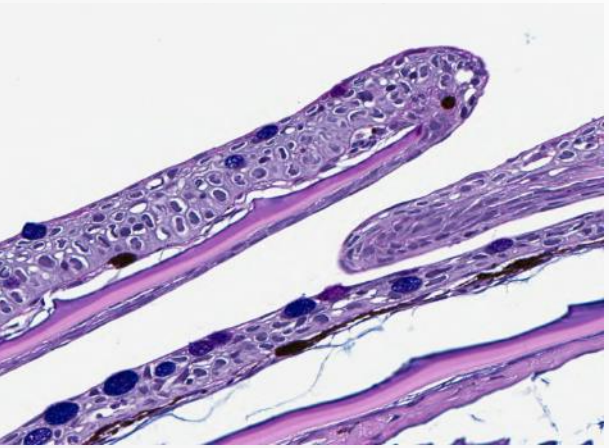
Må kjenne vevene og lære hvordan de responderer på ulikt stimuli

Frisk



Moritella inisert



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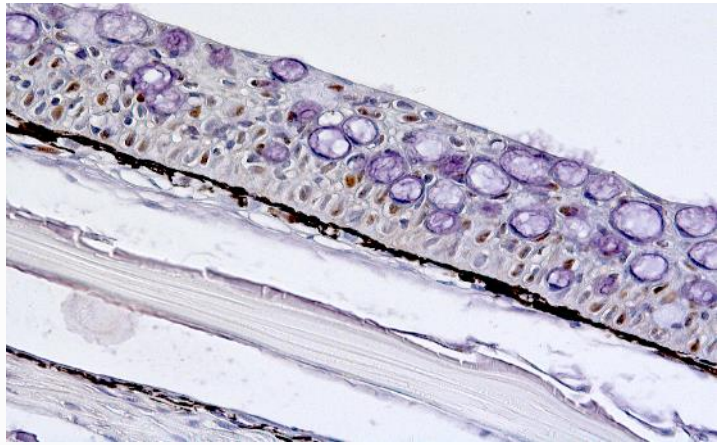
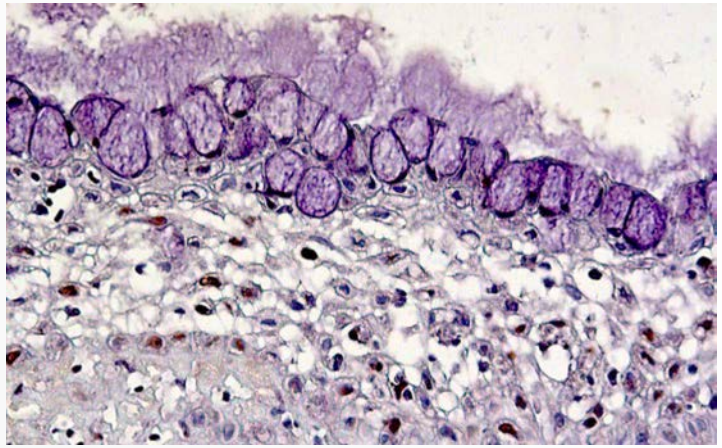


Stresset



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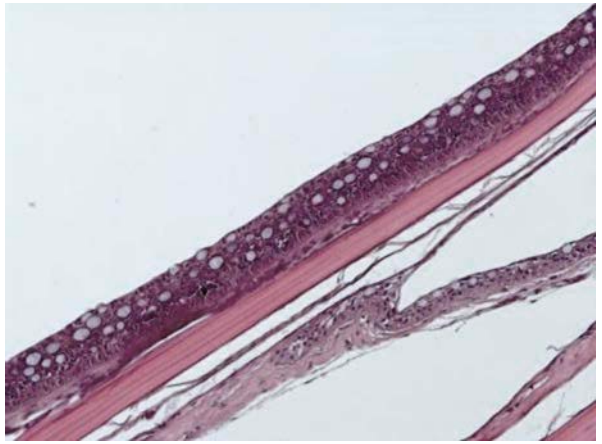
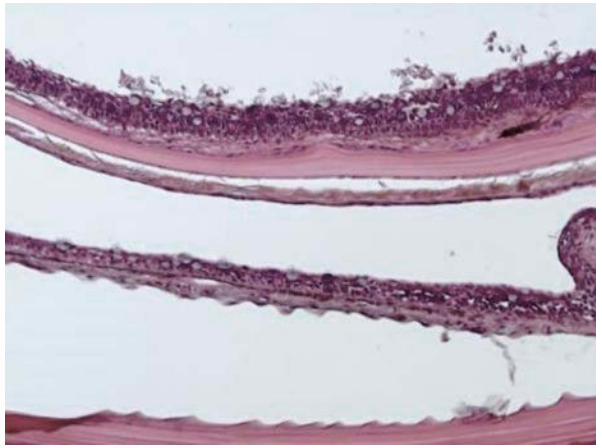


Håndtert



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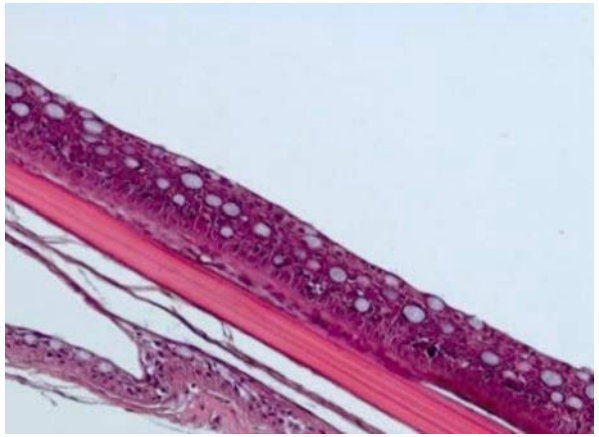
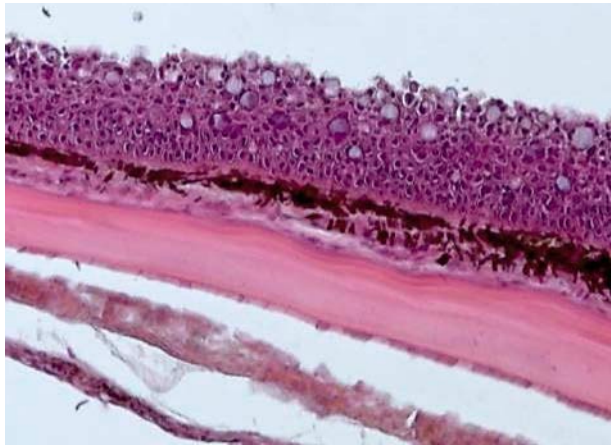


Behandlet



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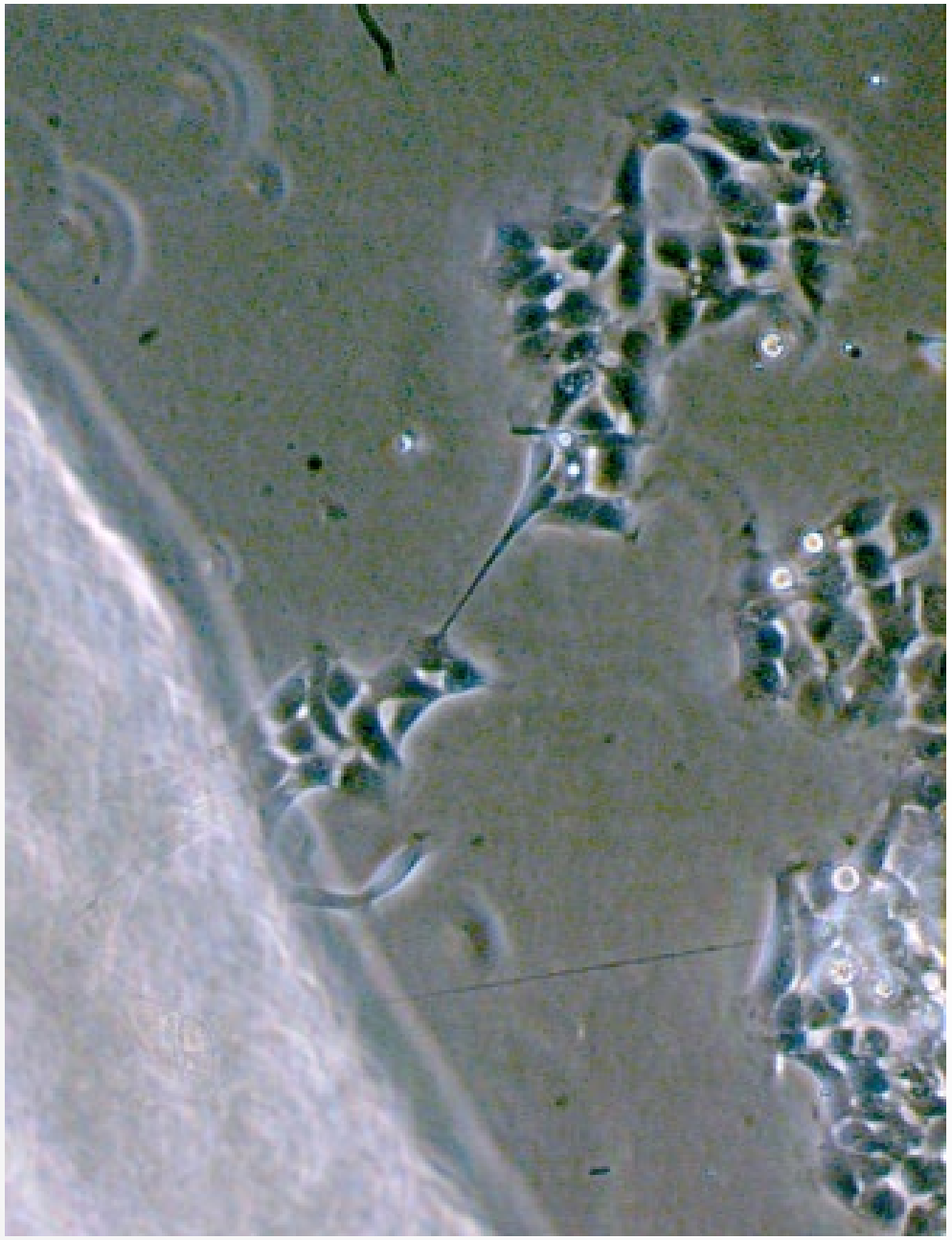

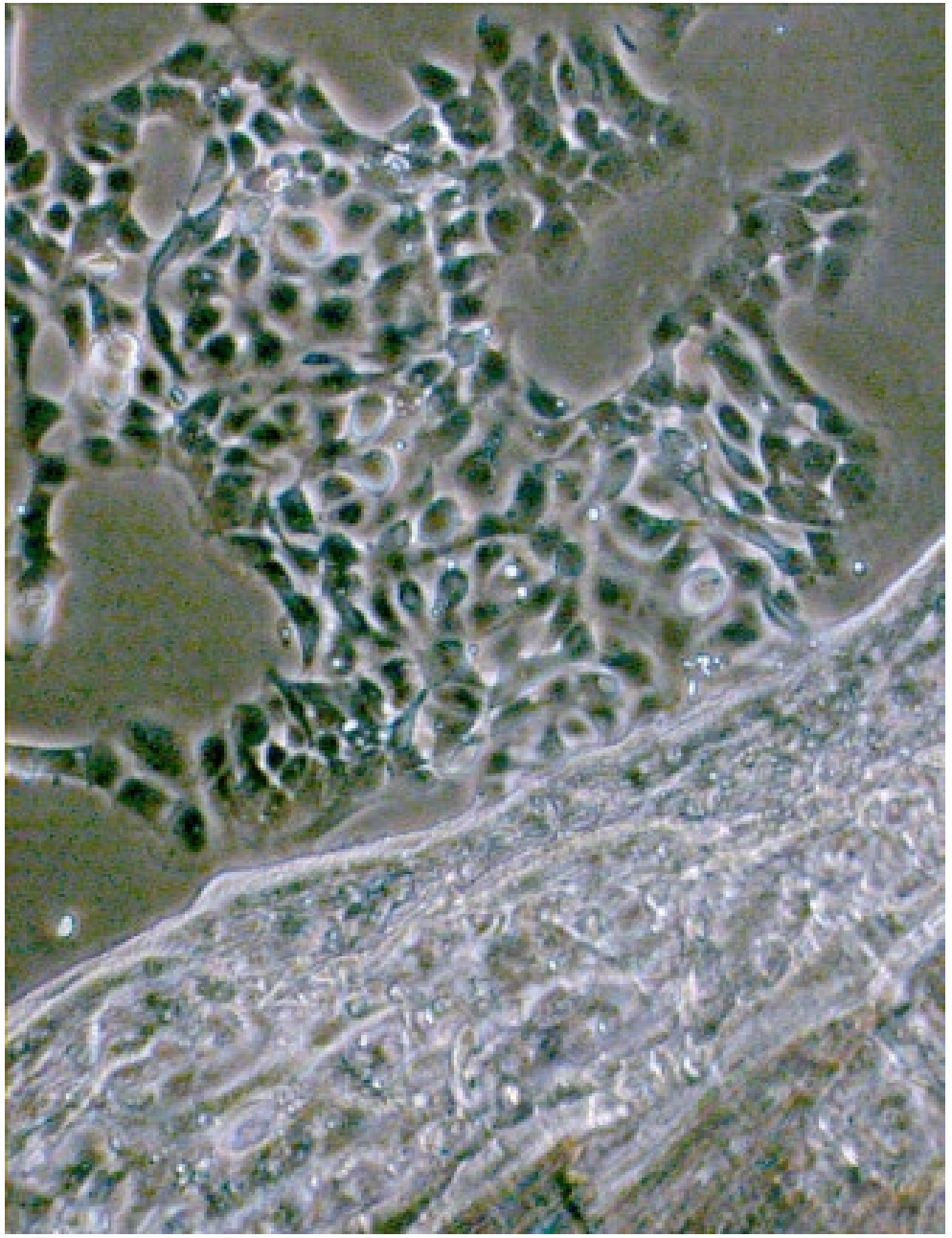

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Utvikling av modellsystemer

Laks:

- Gjeller
- Keratocytter - skinnmodell
- Leukocytter – immun/nese-modell

Rognkjeks:

- Keratocytter - skinnmodell

Torsk:

- Keratocytter - skinnmodell

Parametre testet

- Kjemikalier brukt i lusebehandling: PAA, H2O2
- Miljøparametre: Temperatur, pH, lys
- Patogener
- Vannkvalitet/behandling

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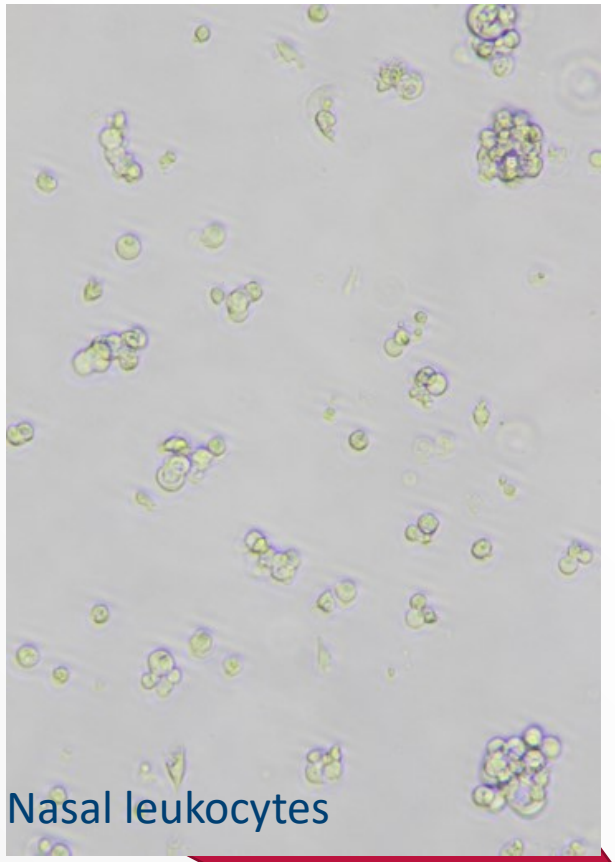
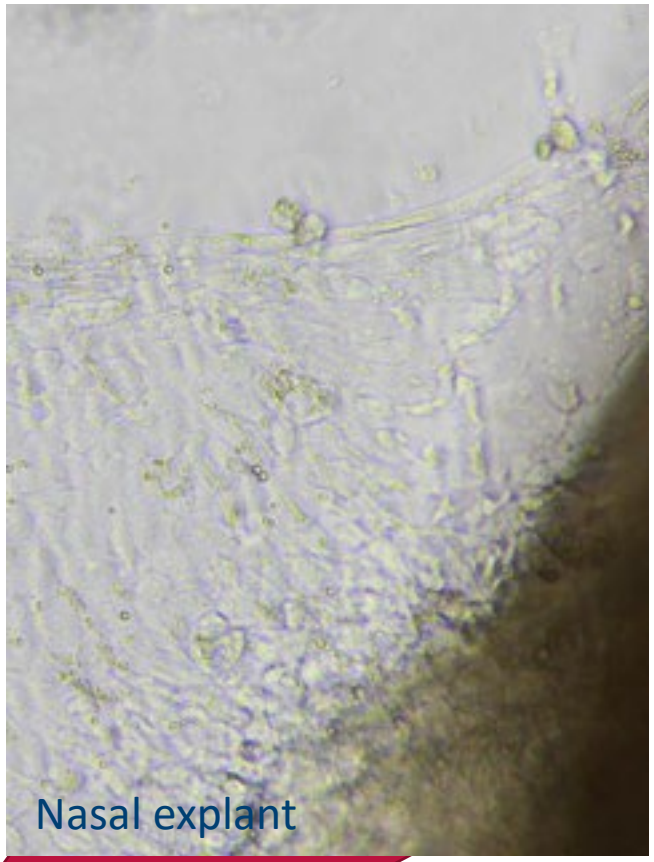


Nasal leukocytes



Nasal explant

Nofima

1st International Symposium
MUCOSAL HEALTH in AQUACULTURE
MHA 2019
September 11-13, 2019
Thon Hotel Storo
Oslo, Norway

See you in Madrid, Spain in 2022!

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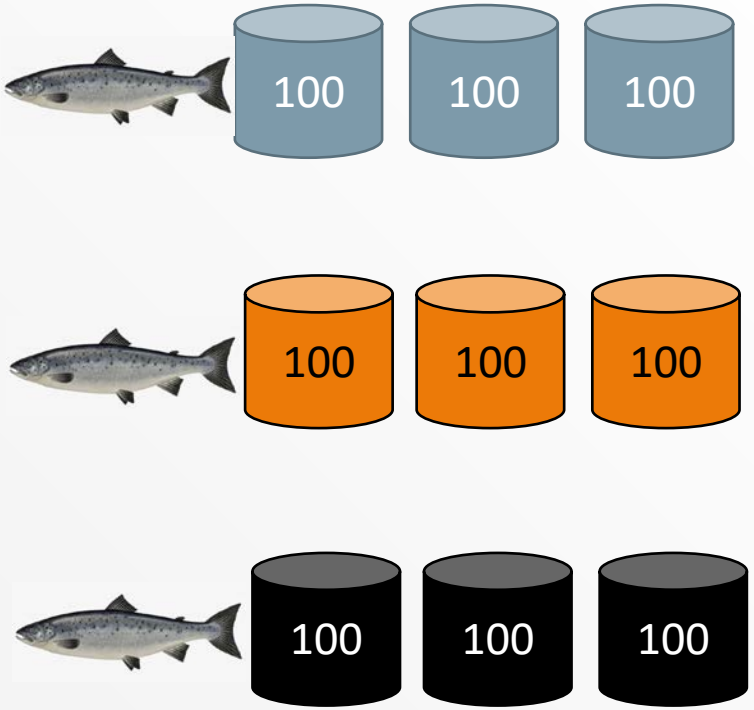
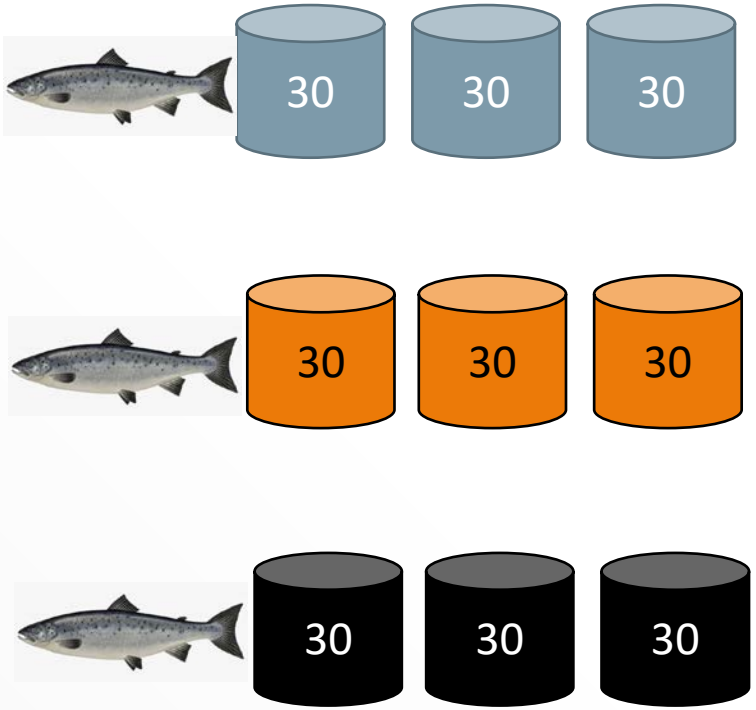
Utnyttelse av forsøksfisk

Hovedforsøk



Sideforsøk



Modellsystemer

Nofima

Oxidative chemical stressors alter the physiological state of the nasal olfactory mucosa of Atlantic salmon

Lazado, C.C., Voldvik, V., Breiland, M.W., Osório, J., Hansen, M. S., Krasnov, A. (2020) *Antioxidants. 9 (11), 1144*

Open Access Article

Oxidative Chemical Stressors Alter the Physiological State of the Nasal Olfactory Mucosa of Atlantic Salmon

by Carlo C. Lazado [1,*], Vibeke Voldvik [1], Mette W. Breiland [2], João Osório [1,3], Marianne H. S. Hansen [1] and Aleksei Krasnov [1]

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[2] Nofima, The Norwegian Institute of Food, Fisheries and Aquaculture Research, 9019 Tromsø, Norway
[3] CIISA, Faculty of Veterinary Medicine, University of Lisbon, 1300-477 Lisbon, Portugal
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Antioxidants **2020**, *9*(11), 1144; https://doi.org/10.3390/antiox9111144

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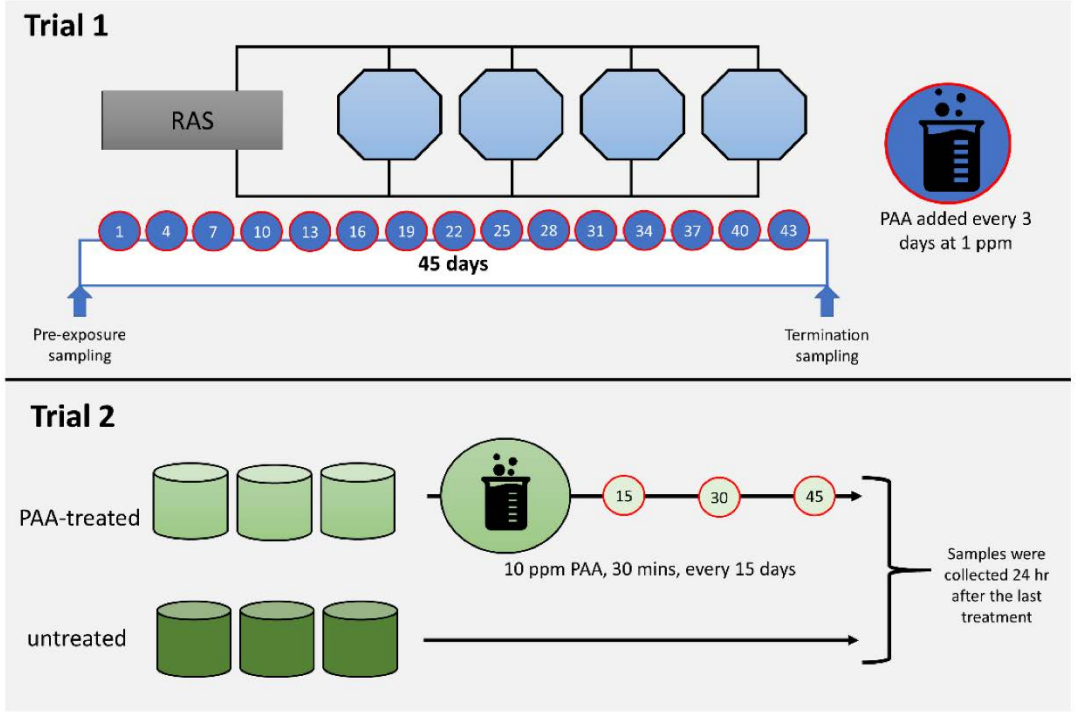
(This article belongs to the Special Issue Cellular Oxidative Stress)



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Temporal control of responses to chemically induced oxidative stress in the gill mucosa of Atlantic salmon (Salmo salar)

Lazado, C.C., Voldvik, V. (2020) ***Journal of Photochemistry and Photobiology B: Biology. 205, 111851.***

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Journal of Photochemistry and Photobiology B: Biology

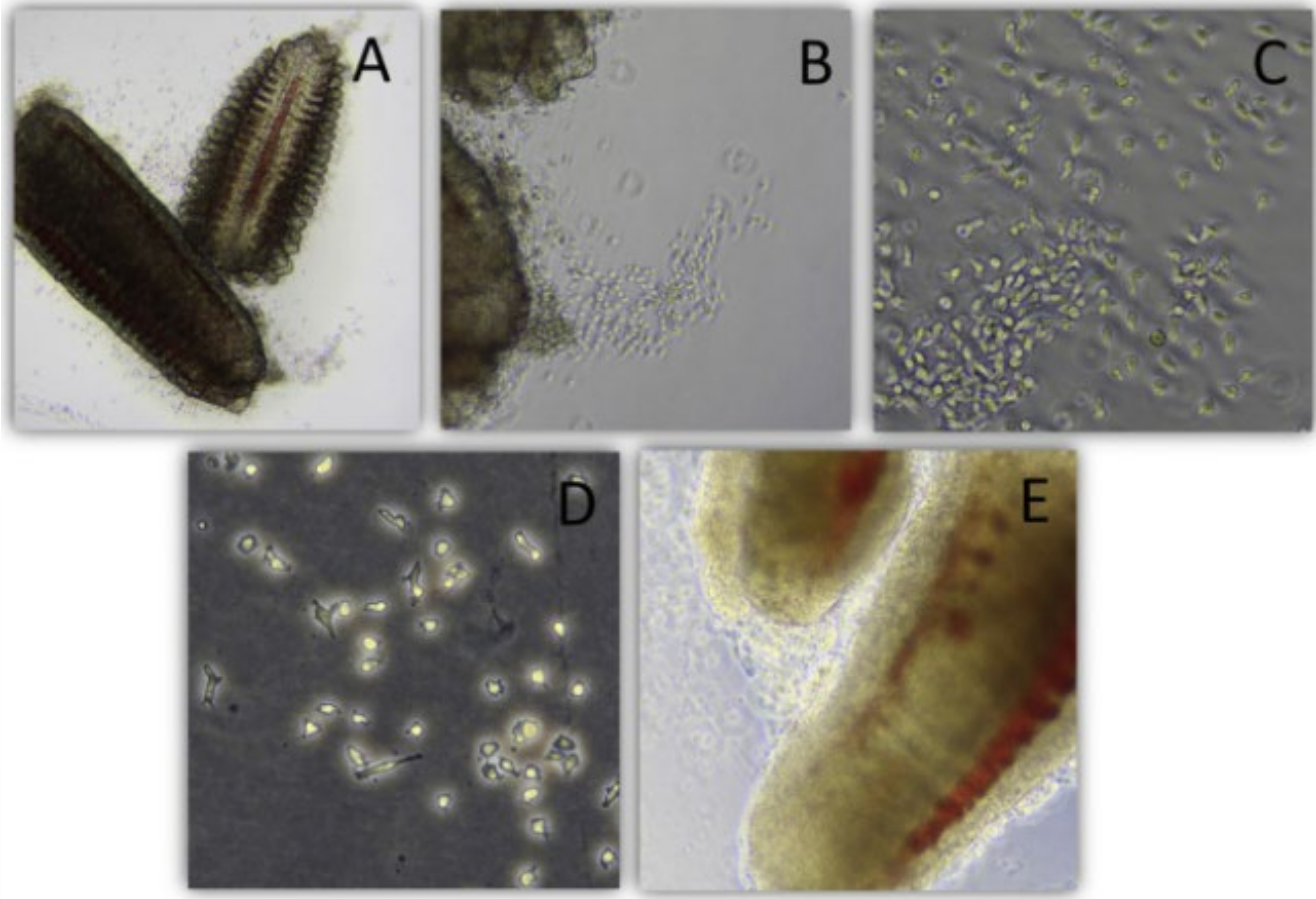
Volume 205, April 2020, 111851

Temporal control of responses to chemically induced oxidative stress in the gill mucosa of Atlantic salmon (*Salmo salar*)

Carlo C. Lazado, Vibeke Voldvik

Nofima, Norwegian Institute of Food Fisheries and Aquaculture Research, Ås, Norway

Received 14 August 2019, Revised 22 February 2020, Accepted 4 March 2020, Available online 6 March 2020.



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Deep neural network analysis - a paradigm shift for histological examination of health and welfare of farmed fish

Sveen L., Timmerhaus G., Johansen LH., Ytteborg E. (2020) *Aquaculture, 10:10, 736024*

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Aquaculture

Volume 532, 15 February 2021, 736024

Deep neural network analysis - a paradigm shift for histological examination of health and welfare of farmed fish

Lene Sveen, Gerrit Timmerhaus, Lill-Heidi Johansen, Elisabeth Ytteborg

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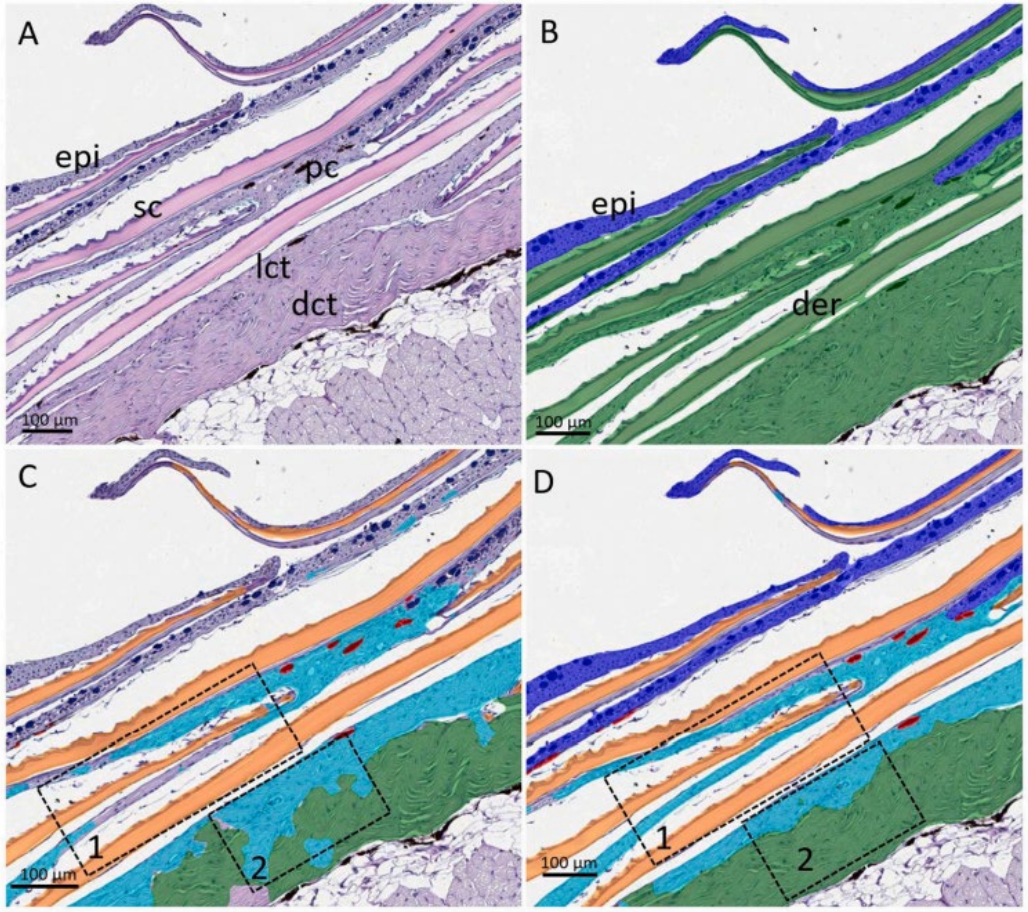

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Morphology, Transcriptomics and In Vitro Model of Skin from Polar Cod (Boreogadus Saida) and Atlantic Cod (Gadus Morhua)

Ytteborg E., Hansen ØJ., Høst V., Afanasyev S., Vieweg I., Nahrgang J., Krasnov A. (2020). *Fishes, 5, 34*

Open Access Article

Morphology, Transcriptomics and In Vitro Model of Skin from Polar Cod (*Boreogadus Saida*) and Atlantic Cod (*Gadus Morhua*)

by Elisabeth Ytteborg [1,*], Øyvind Johannes Hansen [1], Vibeke Høst [1], Sergey Afanasyev [2], Ireen Vieweg [3], Jasmine Nahrgang [3] and Aleksei Krasnov [1]

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[2] Sechenov Institute of Evolutionary Physiology and Biochemistry Russian Academy of Sciences, Torez 44, 194223 Saint-Petersburg, Russia

[3] Department of Arctic and Marine Biology, UiT The Arctic University of Norway, Tromsø PO Box 6050, N-9037 Langnes, Norway

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Rognkjeks

- 50 + millioner rensefisk årlig

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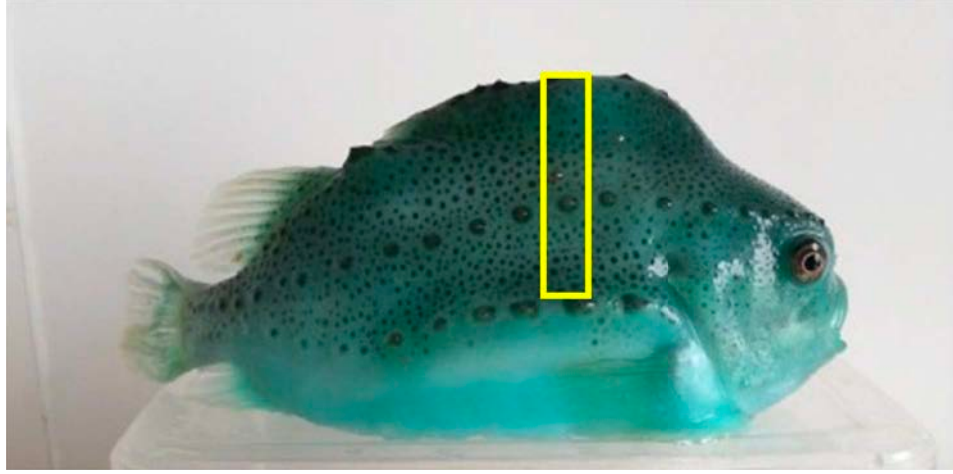
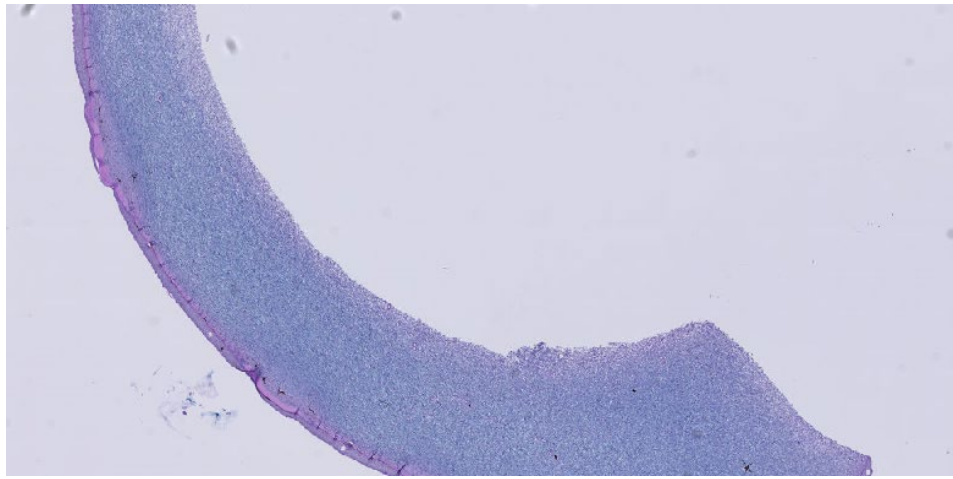
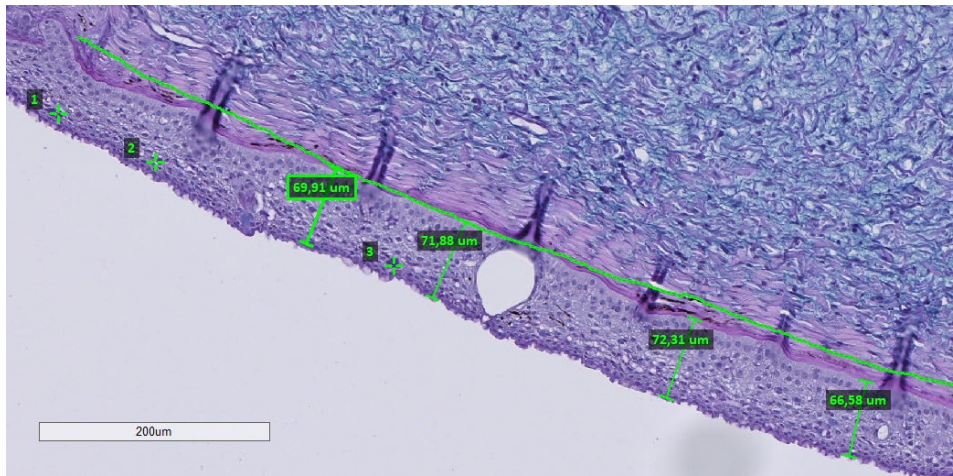
Rognkjeks

Utvikle verktøy som kan brukes til å forstå og evaluere helsen til rognkjeks og hvordan ulike produksjonsmetoder i laksenæringen påvirker den:

- Histologisk karakterisering av barrierer: gjeller, skinn og nese
- Utvikle qPCR – assays
- Utvikle in vitro - modellerskinncelle







Use of mucus as a biological matrix to assess immunity

International Journal of *Molecular Sciences*

MDPI

Article

Chemically and Green Synthesized ZnO Nanoparticles Alter Key Immunological Molecules in Common Carp (*Cyprinus carpio*) Skin Mucus

Ghasem Rashidian [1,*], Carlo C. Lazado [2], Heba H. Mahboub [3], Ramin Mohammadi-Aloucheh [4], Marko D. Prokić [5], Hend S. Nada [6] and Caterina Faggio [7,*]

fishes

MDPI

Communication

Secretory Proteins in the Skin Mucus of Nile Tilapia (*Oreochromis niloticus*) are Modulated Temporally by Photoperiod and Bacterial Endotoxin Cues

Carlo C. Lazado [1,2,*] and Peter Vilhelm Skov [1]

1 DTU Aqua, Section for Aquaculture, The North Sea Research Centre, Technical University of Denmark, 9850 Hirtshals, Denmark; pvsk@aqua.dtu.dk
2 Nofima, Norwegian Institute of Food, Fisheries and Aquaculture Research, 1430 Ås, Norway
* Correspondence: carlo.lazado@nofima.no; Tel.: +4764970114

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Linking external morphology to physiological data

Aquaculture 531 (2021) 735830

Contents lists available at ScienceDirect

Aquaculture

journal homepage: www.elsevier.com/locate/aquaculture

Crowding reshapes the mucosal but not the systemic response repertoires of Atlantic salmon to peracetic acid

Carlo C. Lazado[a,*], Lene R. Sveen[a], Malene Soleng[b], Lars-Flemming Pedersen[c], Gerrit Timmerhaus[a]

[a] Nofima, Norwegian Institute of Food Fisheries and Aquaculture Research, 1433 Ås, Norway
[b] Nofima, Norwegian Institute of Food Fisheries and Aquaculture Research, 9013 Tromsø, Norway
[c] Technical University of Denmark, DTU-Aqua, National Institute of Aquatic Resources, Section for Aquaculture, North Sea Research Center, P.O. Box 101, DK-9850 Hirtshals, Denmark

Aquaculture 532 (2021) 736076

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Aquaculture

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The optimum velocity for Atlantic salmon post-smolts in RAS is a compromise between muscle growth and fish welfare

Gerrit Timmerhaus[a,*], Carlo C. Lazado[a], Nikko Alvin R. Cabillon[b,1], Britt Kristin Megård Reiten[c], Lill-Heidi Johansen[d]

[a] Nofima, The Norwegian Institute of Food Fisheries and Aquaculture Research, 1433 Ås, Norway
[b] University of Highlands and Islands, Scottish Association for Marine Science (UHI-SAMS), Oban PA37 1QA, United Kingdom
[c] Nofima, The Norwegi
[d] Nofima, The Norwegi

Aquatic Toxicology 227 (2020) 105625

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Aquatic Toxicology

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Oxidant-induced modifications in the mucosal transcriptome and circulating metabolome of Atlantic salmon

Carlo C. Lazado[a,*], Lars-Flemming Pedersen[b], Katrine H. Kirste[a], Malene Soleng[c], Mette W. Breiland[c], Gerrit Timmerhaus[a]

[a] Nofima, Norwegian Institute of Food Fisheries and Aquaculture Research, 1433, Ås, Norway
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Aquaculture Reports 17 (2020) 100368

Contents lists available at ScienceDirect

Aquaculture Reports

journal homepage: www.elsevier.com/locate/aqrep

Morphomolecular alterations in the skin mucosa of Atlantic salmon (*Salmo salar*) after exposure to peracetic acid-based disinfectant

Carlo C. Lazado[a,*], Sindre Haddeland[b], Gerrit Timmerhaus[a], Ragnhild Stenberg Berg[c], Grigory Merkin[d], Karin Pittman[b,d], Lars-Flemming Pedersen[e]

[a] Nofima, Norwegian Institute of Food, Fisheries and Aquaculture Research, 1433, Ås, Norway
[b] Department of Biological Sciences, University of Bergen, 5006, Bergen, Norway
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[d] Quantidoc AS, 5006, Bergen, Norway
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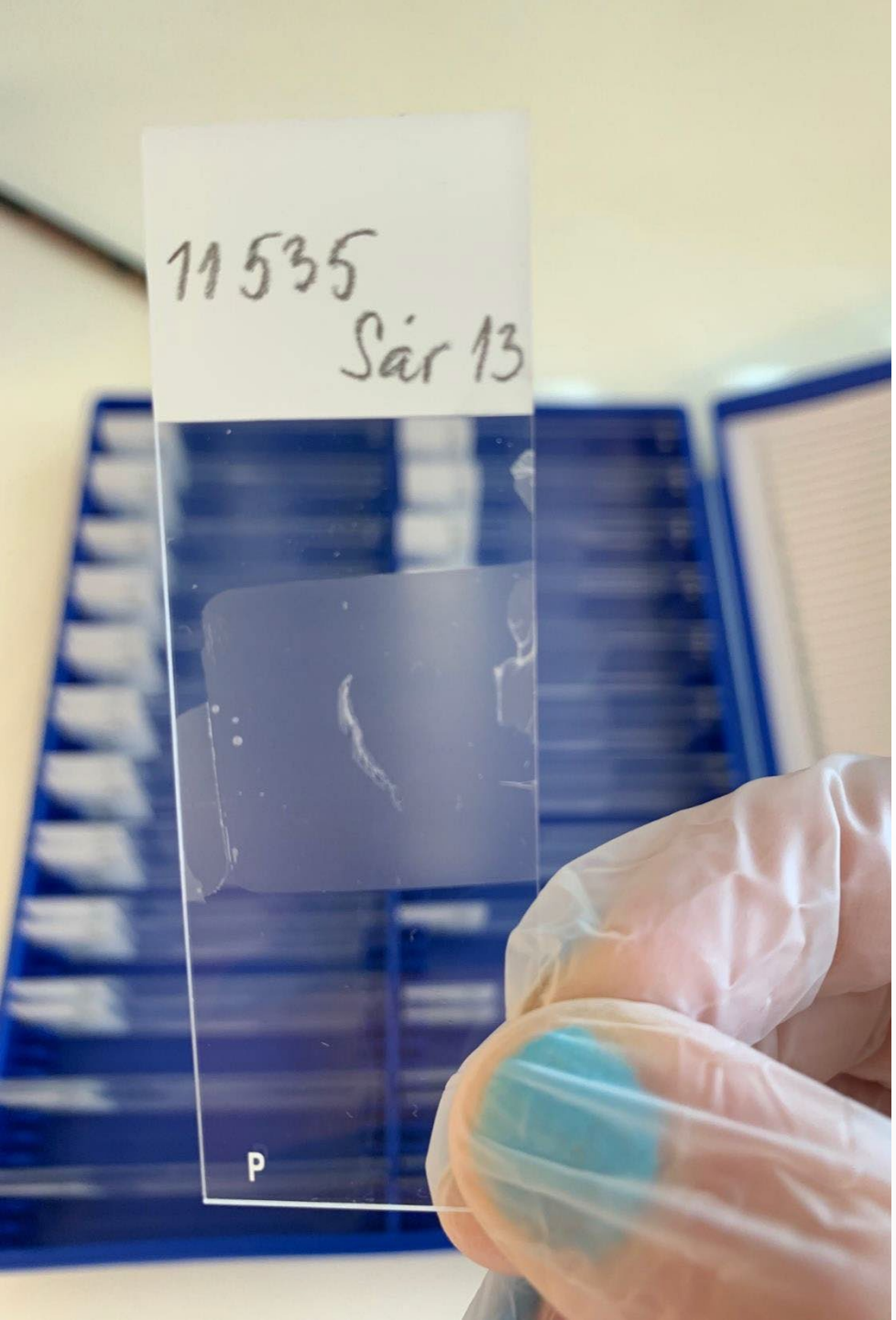

Fordeler ved å jobbe på tvers av prosjekter og utvikle modellsystemer

– foruten å få mer informasjon fra hvert dyr som brukes i forskning og å redusere antall forsøksdyr

- Muligheter til å få ut mer informasjon fra store forsøk som allerede er i gang
- Muligheter for å kombinere forsøk og sammenligne e.g. behandlinger på tvers
- Øker verdien i pågående forsøk
- Øker samarbeid og kommunikasjon over prosjektene
- Felles publikasjoner med en tyngre/bredere konklusjon

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Prisen

Special Session on:

3Rs in Aquaculture Research

Rimini, Italy.
Date: September 27-30, 2022
Theme: "Innovative solutions in a changing world"

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TAKK!

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