Klaipeda University
Marine Research Institute

aqua VIP

Interreg South Baltic

EUROPEAN UNION

European Regional Development Fund

RAS technology for whiteleg shrimp

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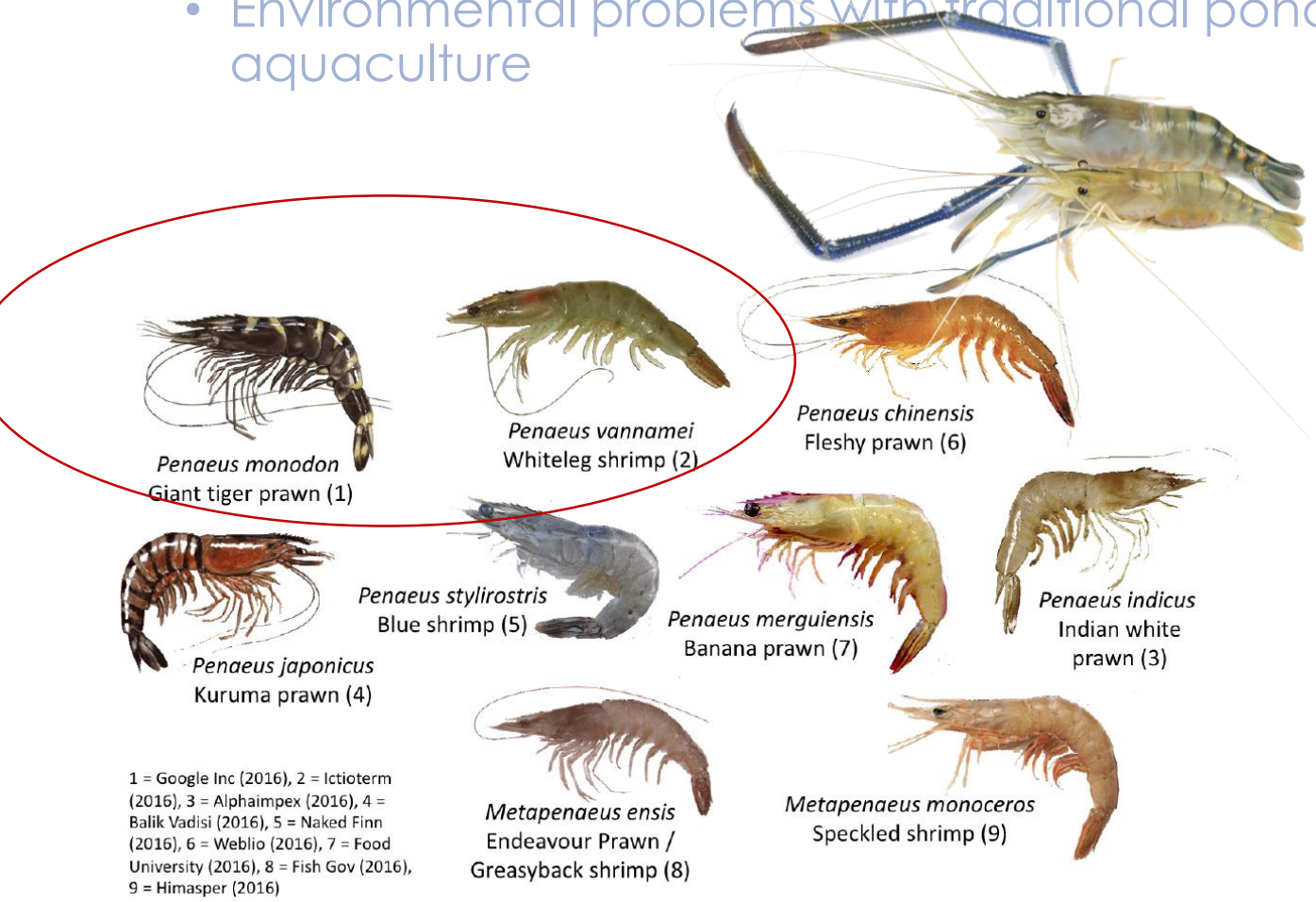
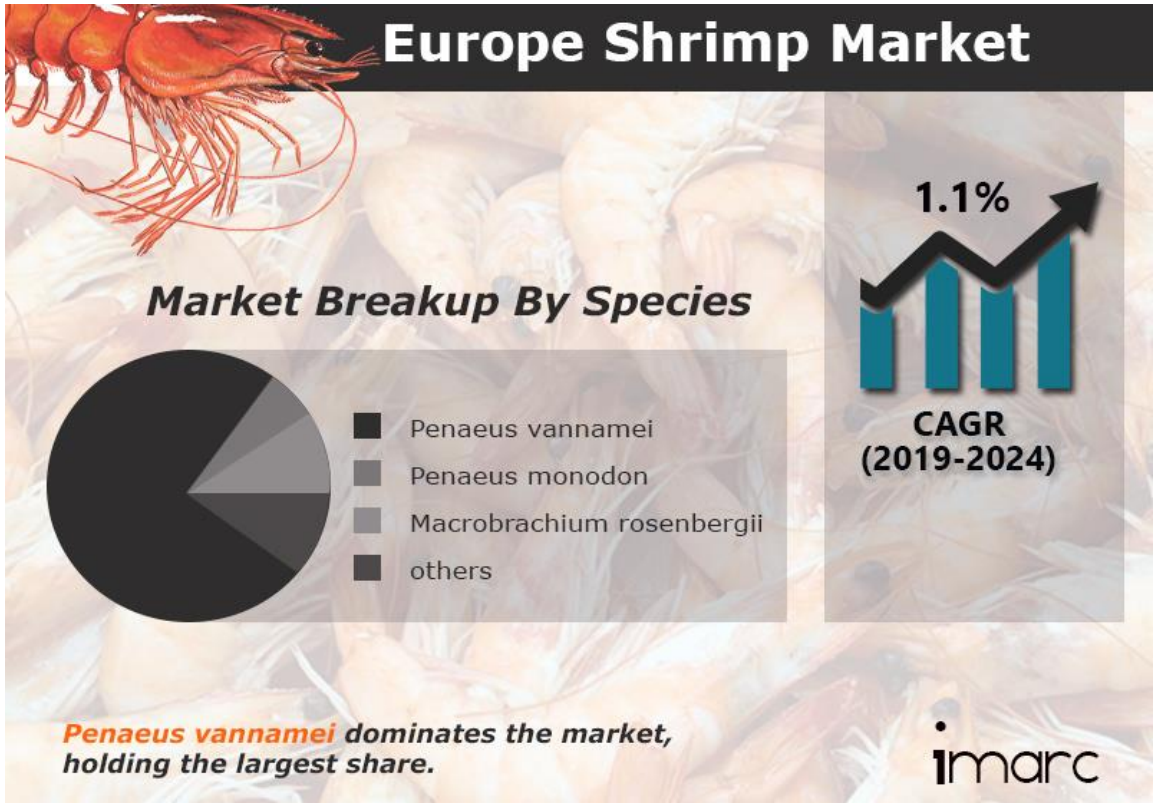
Shrimp aquaculture

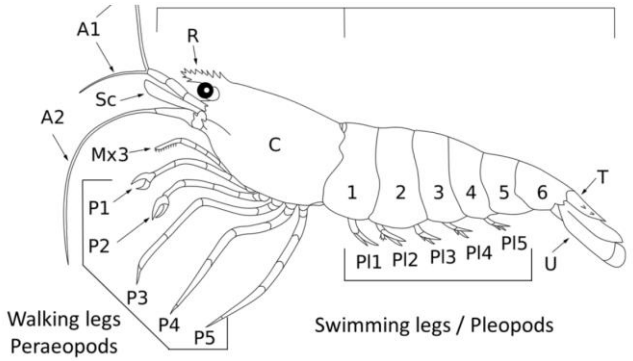
- Consumption and demand is increasing
- Environmental problems with traditional pond aquaculture

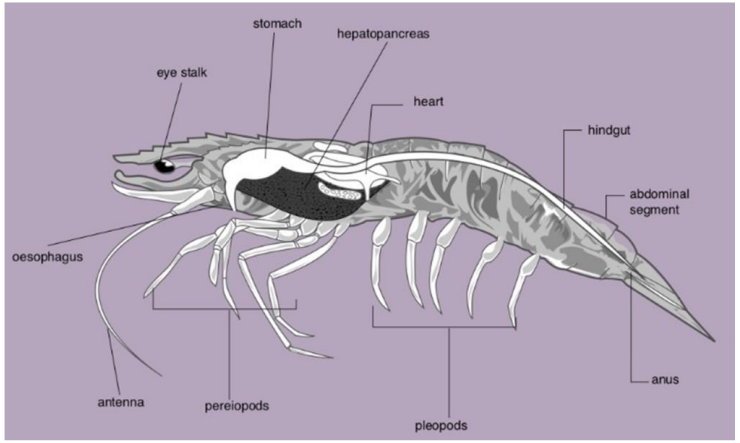




Whiteleg shrimp

- *Litopenaeus vannamei*
- Pacific Ocean species
- Grow up to 230 mm
- Before establishment of aquaculture, coastal and off-shore fishery supplied the production





Development of shrimp aquaculture

- Shrimp aquaculture started in 1973 in USA from stocks of Panama
- Guidelines for the provision of healthy shrimp stock material for the US industry in 1989 as part of the US Marine Shrimp Farming Program.
- Specific virus diseases, especially the White Spot Syndrome Virus (WSSV) outbreaks in 90's from Asia
- Specific pathogen resistant strains developed in Hawaii

Most important and devastating Diseases:

Viral Diseases

Spawner –isolated mortality virus (SMV)

Baculoviral midgut gland necrosis virus (BMNV)

Lymphoid organ Parvo-like virus (LOPV)

White Spot Syndrome Virus (WSSV)

Baculovirus penaei (BP)

Monodon Baculovirus (MBV)

Rhabdovirus of penaeid shrimp (RPS)

Taura Syndrome Virus (TSV)

Infectious Hypodermal and Hematopoietic Virus (IHHNV)

Lymphoid organ vacuolization virus (LOVV)

Hematopoietic Virus (IHHNV)

Hepatopancreatic Parvovirus (HPV)

Yellow Head Virus (YHV)

Gill-associated virus (GAV)

1995 ← USA

1998 ← Central/South America

1999 ← Mexico

2011 ← Saudi Arabia

PL supply

- SPF (Specific Pathogen Free) certified suppliers
  - USA suppliers leads the market
  - Growing opportunities in Europe

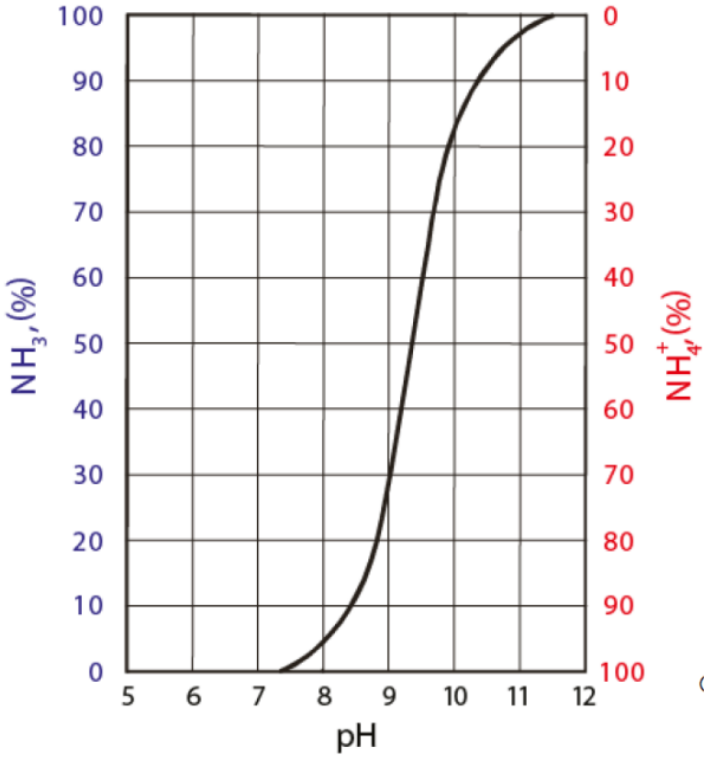
- Supply of **PL 10-15**
- Air freight – up to 36h with reasonable survival
- Acclimation importance
- Feeding
  - Live *Artemia* prey
  - Sufficient prey density
  - Starter artificial feed

Culture parameters

- **Target water quality values**

		Critical values
Temperature	28 - 30° C	**24 / 20**
Oxygen	5,0 – 9,0 ppm	**1 mg/L**
Oxygen saturation	80-100 %	
Carbon dioxid	<20 ppm	
pH	7,0 – 8,3	**<6.5 / >10**
Salinity	0,5 – 35 ppt	**>15**
Chloride	>300 ppm	
Natrium	>200 ppm	
Iron	<1 ppm	
Total hardness (CaCO3)	>150 ppm	
Ammoniua (als NH3)	<0,03 ppm	
Nitrite	<1 ppm	
Nitrate	<220 ppm	

(ppm = parts per million, ppt = parts per thousand)



Feeding, FCR, growth, survival

- Feeding should be constant
- FCR <2 (1.5-2)
- Moulting – an issue
- SGR ~1.6 g/week
- Stocking density 5-7.5 kg shrimps/m² tank
- Under favorable husbandry conditions, a survival rate of 60% from PL to harvest is achievable in a commercial recirculation plant.
- Beginner's effect

First shrimp RAS in Lithuania

- Pilot infrastructure created within **InnoAquaTech** project.
- RAS for *L. vannamei* shrimp cultivation integrated with renewable energy sources at KU Business Incubator
- The goal is to acquire shrimp cultivation knowledge and to optimize growth technology for local conditions.

KLAIPĖDOS MOKSLO IR TECHNOLOGIJŲ PARKAS

InnoAquaTech

Interreg South Baltic

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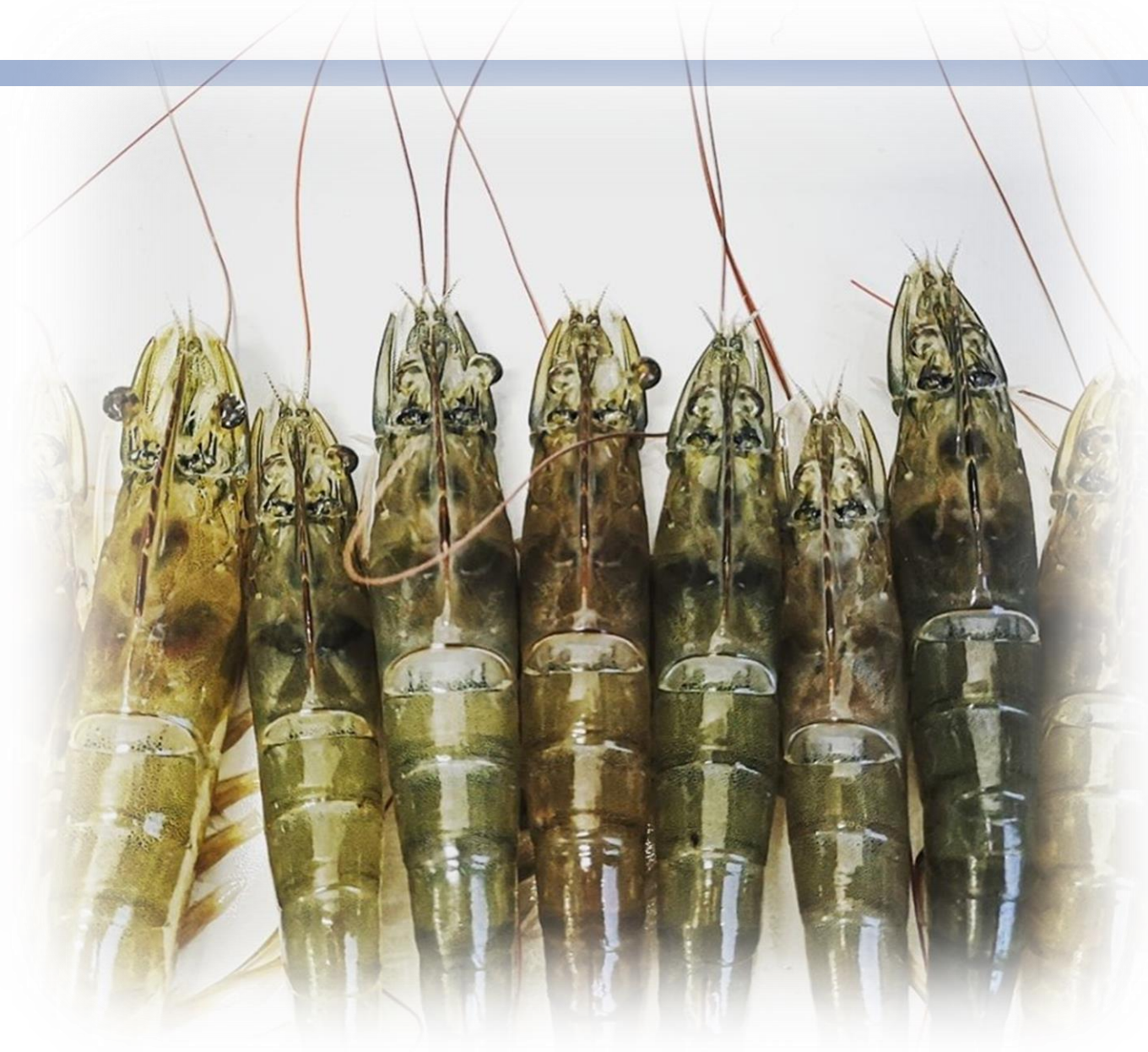
Aquaculture Competence Center

- Established in 2018 by Klaipeda University and Klaipeda Science and Technology Park

- Aims to develop shrimp RAS technology and commercialize acquired know-how supporting local businesses.



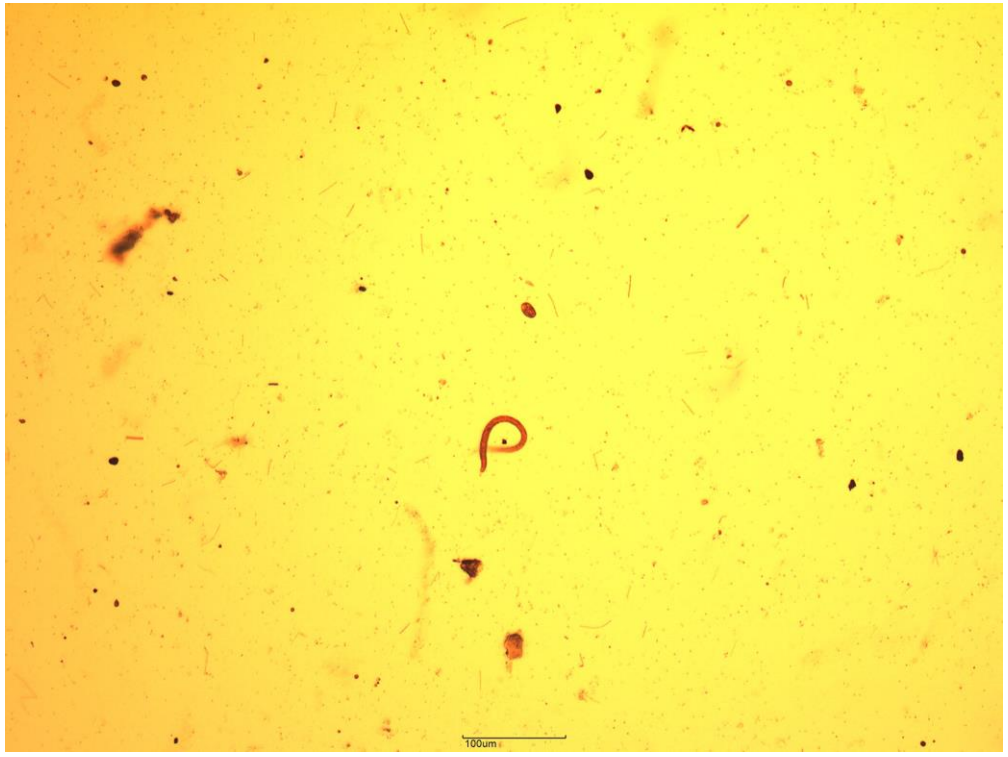
General parameters of the system:

- Artificial saltwater RAS
- Uses solar energy
- System setup in two rooms
- Water volume – ~40 m^3
- Daily water loss – ~2 % (so far)
- 8 rearing tanks, surface area – ~29 m^2
- Max yield/cycle ~145 kg (5kg/m^2)
- Electricity consumption – 5 kW/month

- Mechanical (drum) filter
- Biological filter
- Sump
- Protein skimmer
- Denitrification filter
- Oxygenation cone
- Heater
- UV
- Monitoring and control system
- Salt water preparation system

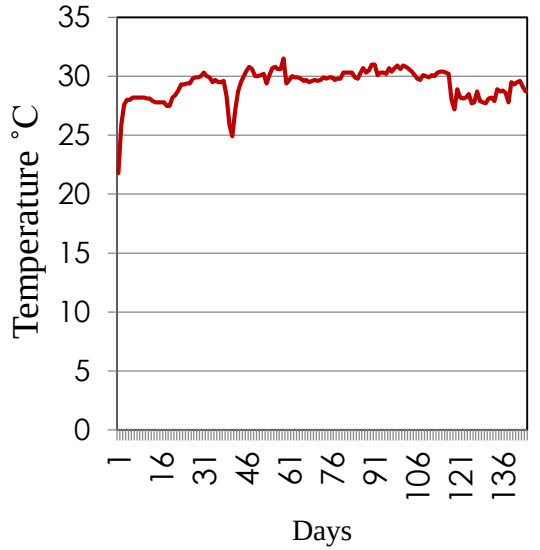
Standard RAS, with some specifics

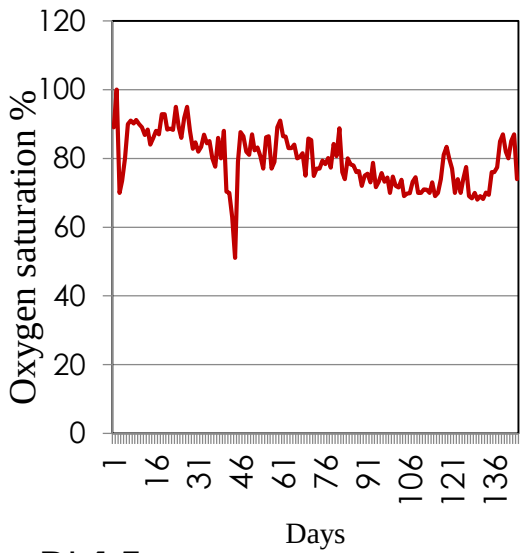
- Devices should be resistant to saltwater corrosion (glass fiber, plastic, stainless steel)
- Artificial water salting
- Protein skimmer
- Denitrification

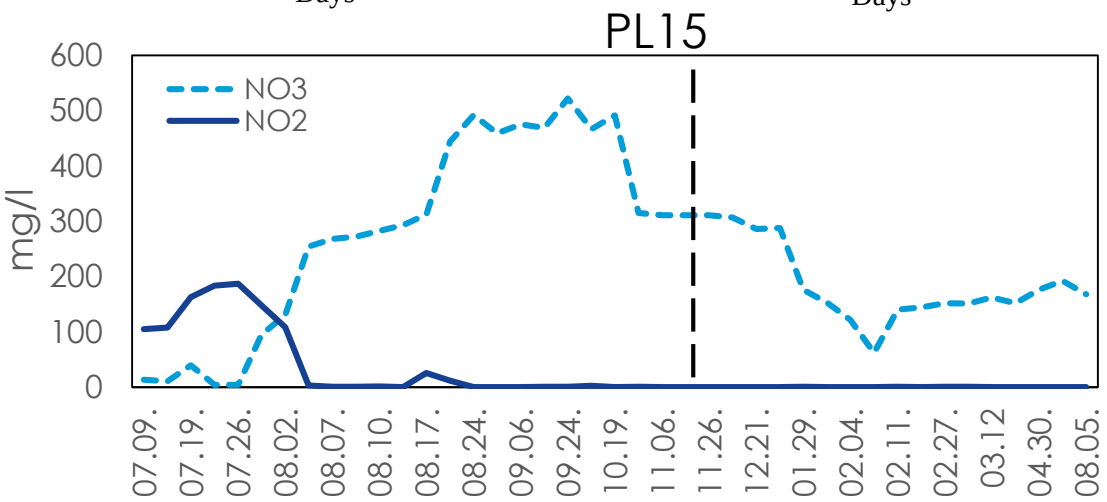


Water quality in RAS

- Temperature – 28.5 (28-30)°C
- Salinity – 15-16 ppt
- Oxygen – 70-90%, some drops to 40-50%
- pH – 7,6-8,1
- Mn – 351 µg/l; Fe – 70 µg/l;
- NH_4 – 0.04 mg/l (some short increases to 0.32-0.85 mg/l)
- Good nitrification, problems with denitrification
- Some increase in algae and nematode growth followed by ozonizer failure

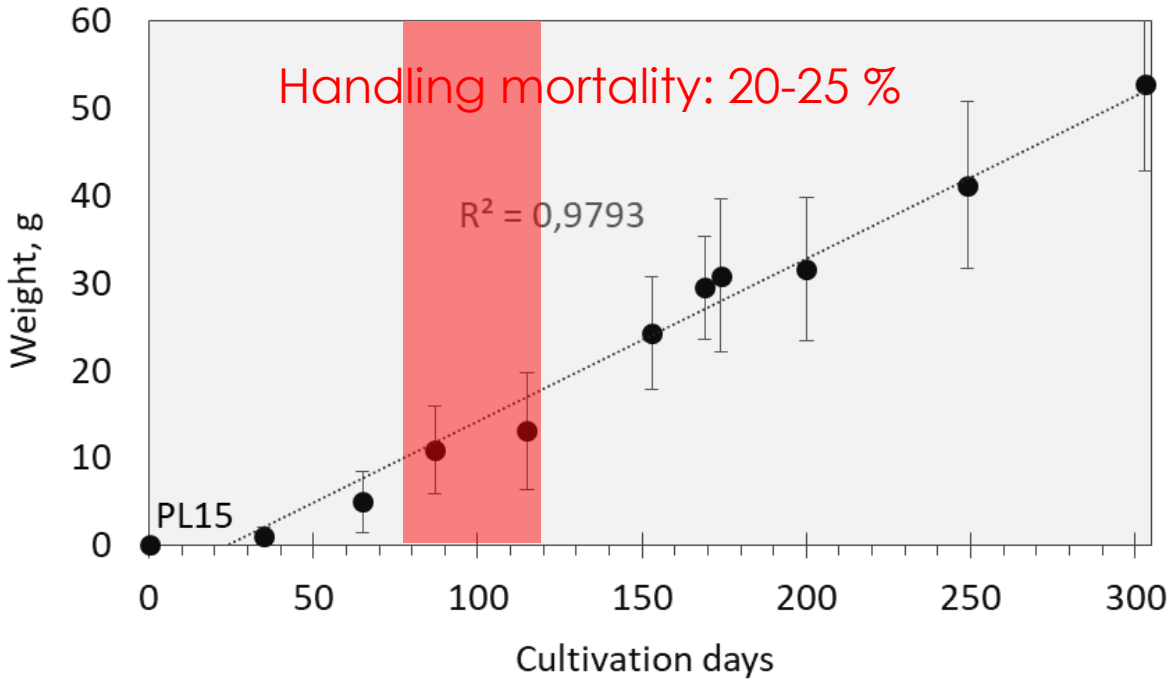






First results of growing *L. vannamei*

- Very poor transportation survival – ~50 % of 15 000 PL15
- Distributed into 5 tanks (1000 ind./tank)
- Growth to the market size took 5 months and average size was 24.3±6.4 g
- Stocking density 2,5-3 kg/m^2
- Total harvest 80 kg
- FCR – 1,9-2,0



Feeding manually x4/day
Growth rate 1.26 g/week
Mortality ~60-65 %
High cannibalism observed
Jumping issue

First harvest

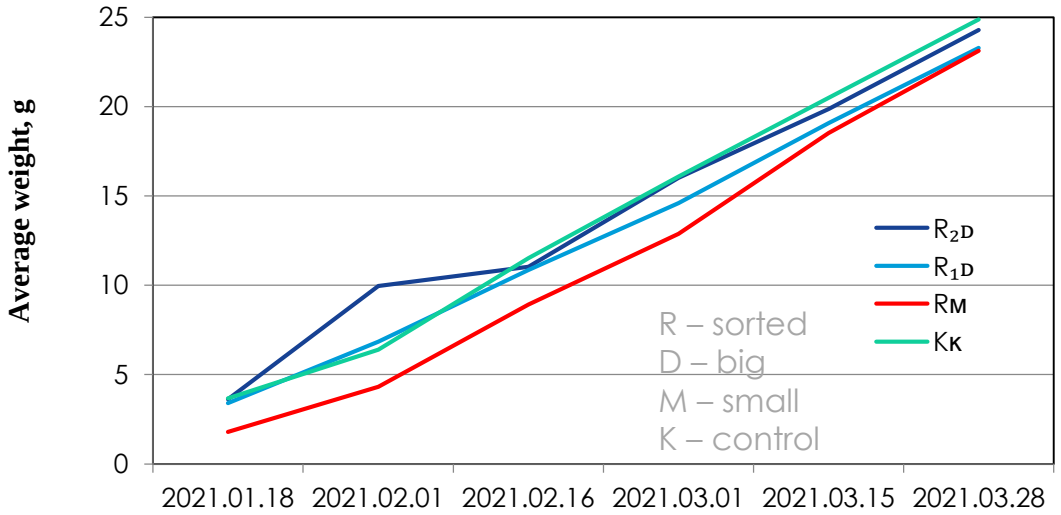
Technology optimization tasks

- Denitrification filter performance
- Water quality optimization **pH control**
- Feeding management **Automatic belt feeders**
- Stress reduction **Light regime**
- Reduce mortality – improve production
- Diseases? **Possibly low intensity vibriosis**
- Unequal growth rate during first months
- Shrimp tank design – extra surface area
- Water preparation – salt source

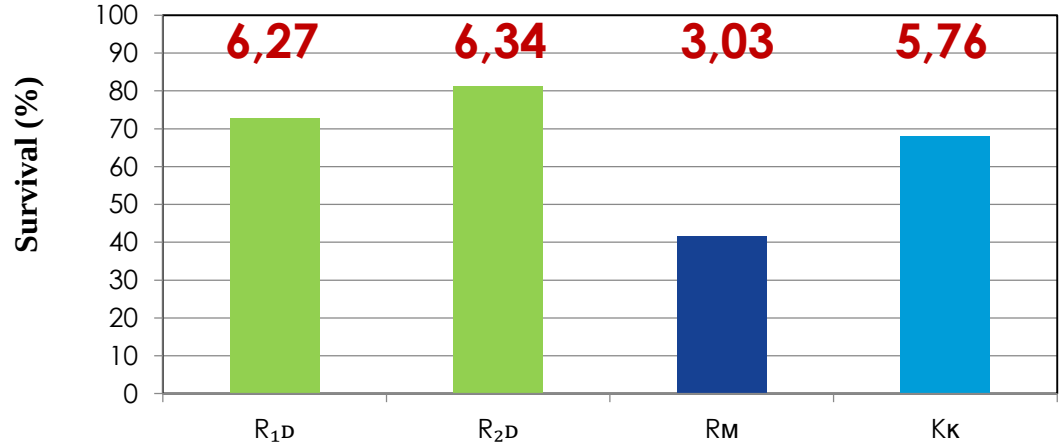
Technology optimization – extra surface

- **Shrimp tank design – extra surface area**

Technology optimization – improved growth



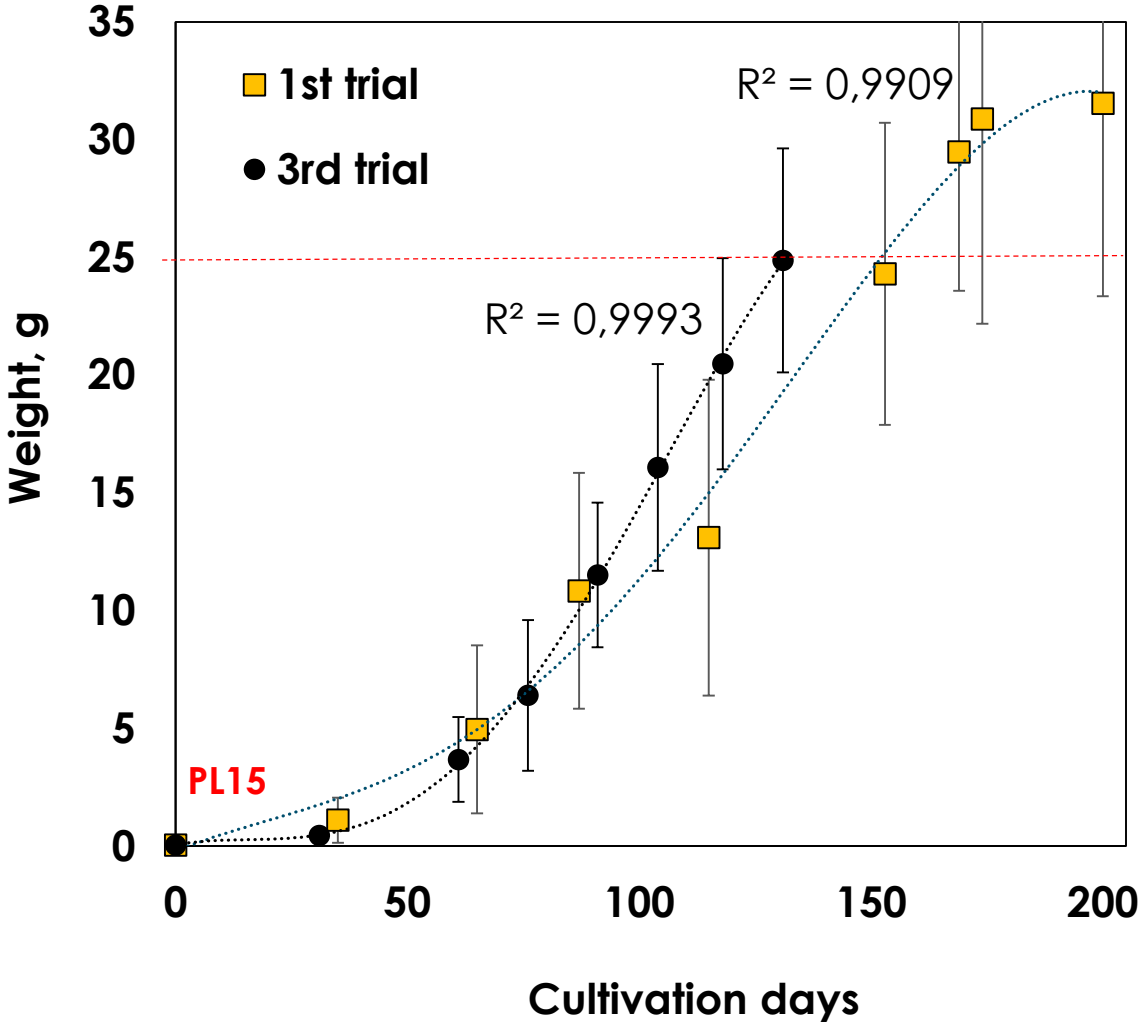
Harvested biomass (kg/m²)



According to Jonas Lelys work

- **Sorting experiment (+feeding management)**
- High growth rate sustained – market size in 4 months
- High mortality and compensatory growth in a group of small ones
- But only the harvested biomass matter!

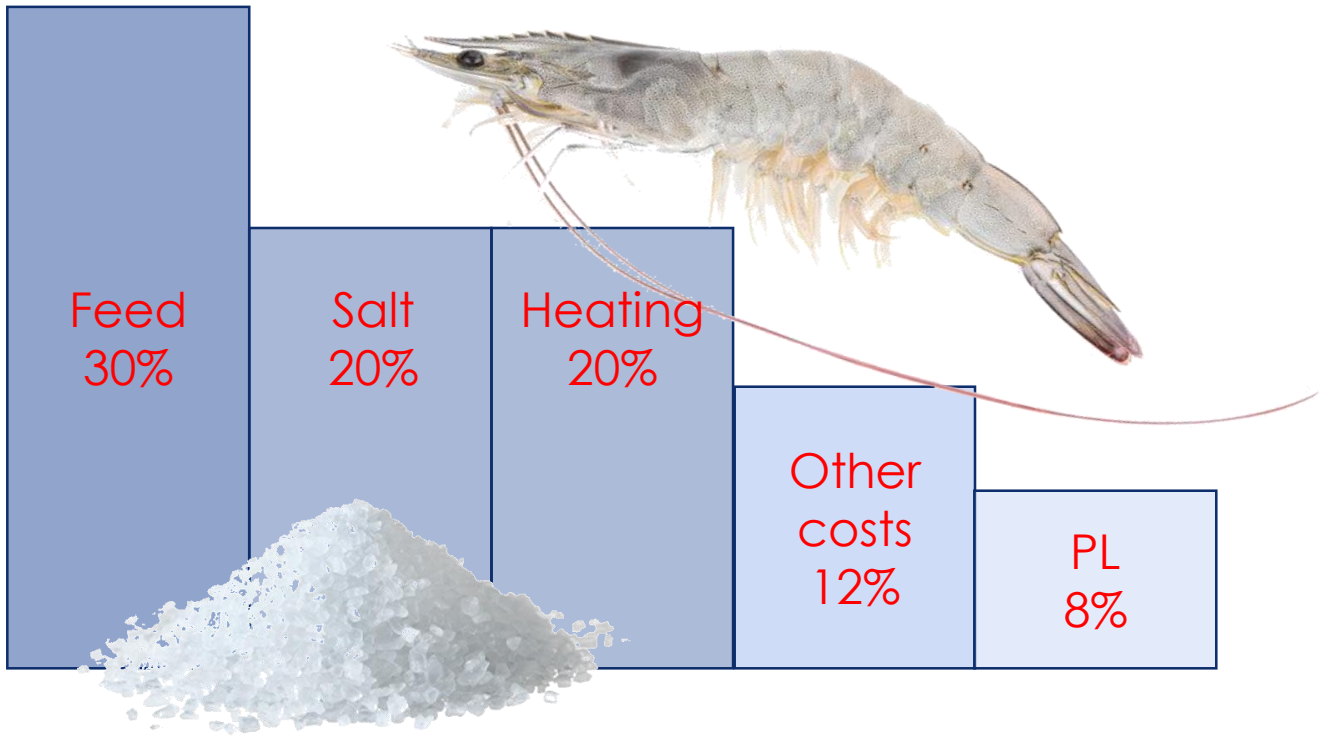
Technology optimization – improved growth



Economic performance of shrimp RAS?

- Fresh shrimp is a luxury product
- The production is costly
- What are the OPerating EXpenses?

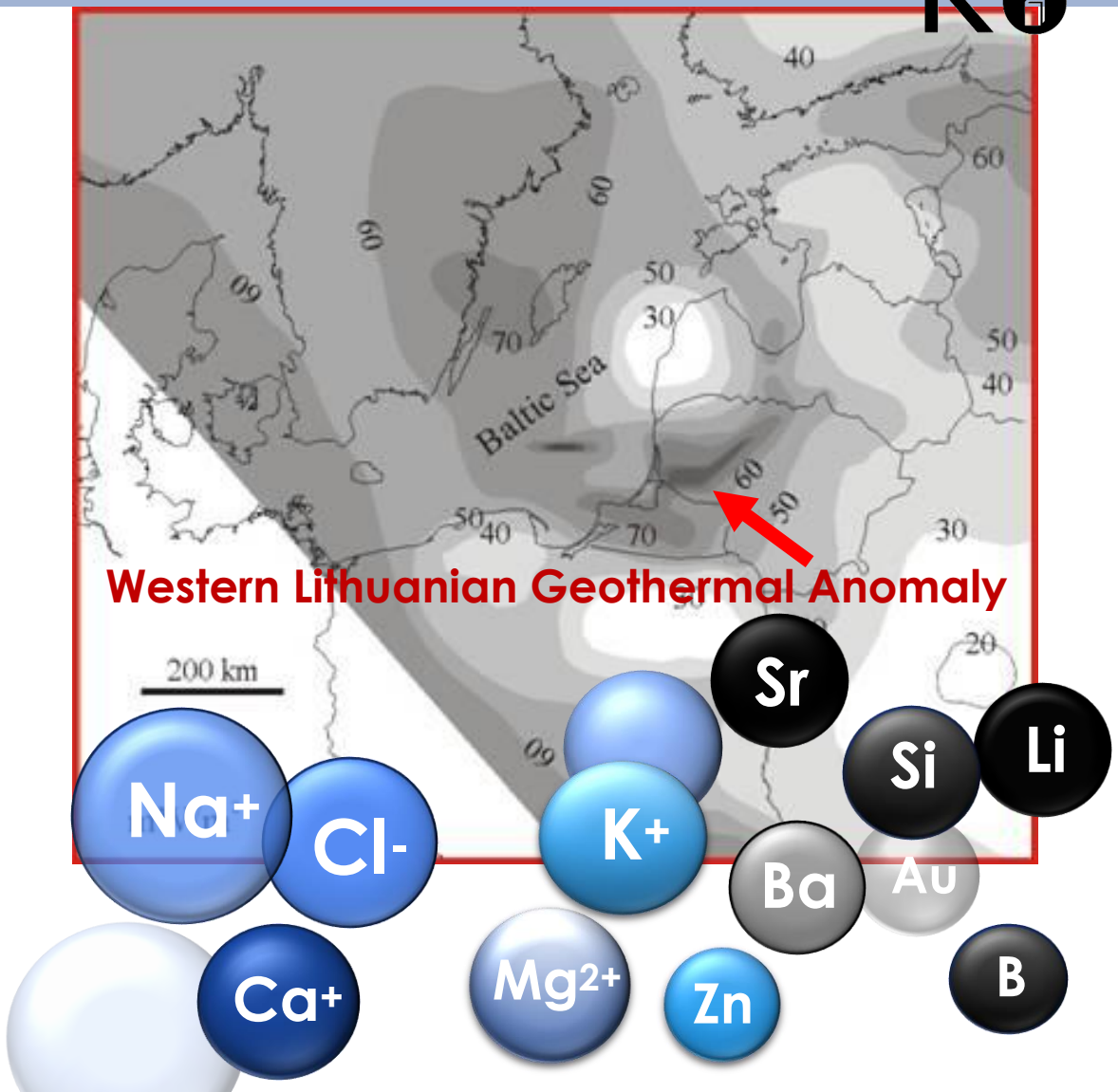
- Heating was not as crucial as it was thought initially
- High operational costs for salt



- **Solutions (that we are dealing with)**:
- Low cost salt mixture LCSM: (Na, Mg, Ca, K chlorides, Mg sulphate) (Galkanda-Arachchige et al., 2020)
- Geothermal brine

Geothermal solution for water salting?

- Geothermal brine seems promising solution
- Western Lithuanian resources (110 g/L) from 1300 m deep Cambrian aquifer, which is highly rich in sodium, calcium, magnesium and other, including trace, elements.
- Geothermal water closely resembles marine water composition
- Some trace elements of concern are present at higher concentrations



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Thank You!

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