High-throughput phenotyping of health biomarkers in *Crassostrea gigas* by magnetic resonance imaging

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Context: IMAGIGAS project aimed to explore a non-destructive and non-invasive approach by using magnetic resonance imaging (MRI) to monitor at high-throughput health biomarkers of *Crassostrea gigas*, before and during infectious challenges by Ostreid Herpesvirus type 1 (OsHV-1).

Health biomarker ?

Global biomarker or specific of a physiological function ? It depends on the physiopathological phenomenon that lead to a health trouble. Bibliographical study and comparison with others animals models show that fluctuations of body weight are often considered as gross signs in clinical studies.

Hypothesis :
body weight as marker of general health status …

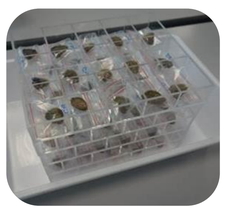
Acquisition method ?

Weighting the body of *Crassostrea gigas* is complicated by the water in the palleal cavity and the presence of a shell. Precision balance is often used to weight lyophilized flesh. To realize a non destructive measurement and to respect as possible the integrity of the mollusc, preliminar assays using MRI were completed in previous Irstea /Ifremer projects (analysis of grey levels of images). [b,c]

… estimated by MRI…

High-throughput ?

Increase of data acquisition (number of individuals and/or frequency of acquisitions) requires : a large study population, an identification system of individuals, an enclosure to maintain oysters in correct position, informatic tools to manage the data flow and extract the relevant information.



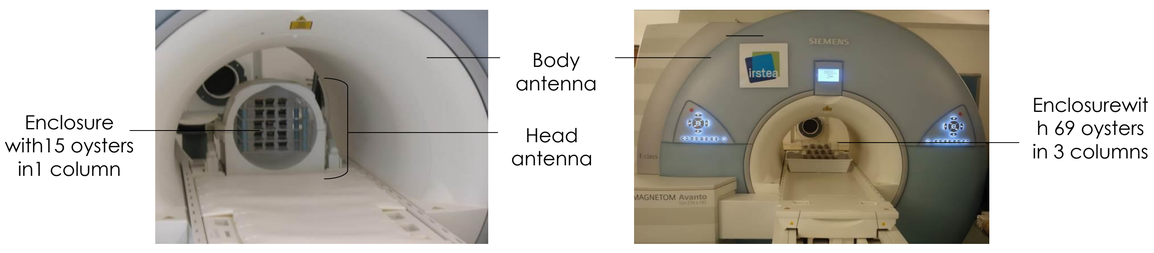
… at high-throughput.

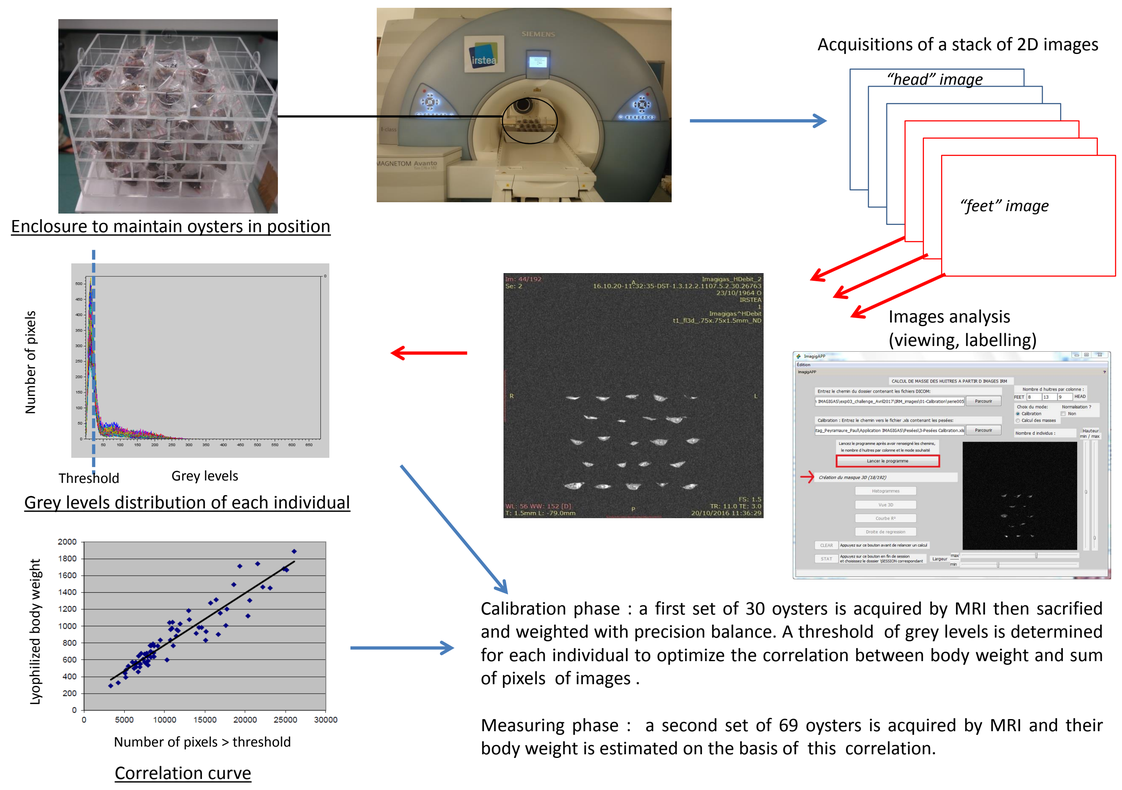
Methodological development

Pacific oysters sensitive to OsHV-1 and viral suspension / contaminated seawater were produced at Ifremer facilities. Experiments were conducted at PRISM platform of Irstea which provided a Siemens Avanto 1,5 T MRI. Processing of acquired data was realized using Scilab software.

→ MRI parameters : T1-weighted Flash 3D sequence with TR=11ms TE=2.98 ms, FOV=480mm, Matrix=640, Acc=2, Thickness=1.5mm, Nb of sections=192, BP=240Hz/px and Flip=20°.

→ Choice of the tunnel (body) antenna for the reception of the signal, withdrawal of the head antenna :





Calibration phase : a first set of 30 oysters is acquired by MRI then sacrified and weighted with precision balance. A threshold of grey levels is determined for each individual to optimize the correlation between body weight and sum of pixels of images .

Measuring phase : a second set of 69 oysters is acquired by MRI and their body weight is estimated on the basis of this correlation.

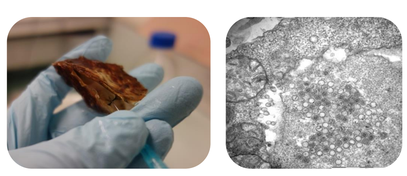
✚ extension of the volume of the measuring area

▬ MRI Images are affected by geometric distorsion, in particular for oysters far from the center of the magnet (not all the volume of the tunnel is usable),
There are also variations of signal intensity (grey levels) linked to the position of the oysters in the tunnel, which can be to a certain extent corrected by a so-called normalization approach.[a]

The estimation of body weight is based on a relation established between the sum of pixels whose grey level is greater than a particular value (threshold) in images taken by MRI and the weight of flesh of oysters measured by precision balance.

First results and applications perspectives

→ Throughput of MRI images acquisition : **69 oysters / 45 minutes.**
→ Code elaborated on Scilab can easily generate body weight estimation whatever number of oysters are used
→ Putting in to practice (in progress) : OsHV-1 challenge and evolution of body weight during an infection



Références :

[a] Davenel A., Quellec S., Pouvreau S.(2006). Noninvasive characterization of gonad maturation and determination of the sex of Pacific oysters by MRI. Magnetic Resonance Imaging, 24(8), 1103-1110.
[b] Flahauw, E., Quellec S., Davenel A., Degremont L., Lapegue S, Hatt P.-J. (2012). Gonad volume assessment in the oyster *Crassostrea gigas*: Comparison between a histological method and a magnetic resonance imaging (MRI) method. Aquaculture. 370–371(0), 84-89.
[c] Hatt, P.-J., Davenel A., Eliat P.-A., Quellec S. (2009). Magnetic resonance imaging as a means to assess the body growth and the gonad development of the oyster *Crassostrea gigas*. Aquatic Living Resources, 22(03), 331-339.

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