The Pearl Oyster: from national icon to guardian of Qatar's marine environment

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Abstract

The NPRP9-394-1-090 project "Pearl Oyster: from national icon to guardian of Qatar's marine environment" had as main aim to develop and apply an integrated suite of chemical and biological methods as early warning tools to assess the "health" of Qatar's marine environment. The central theme consisted in an investigative monitoring program around the use of the pearl oyster, *Pictada imbricata radiata*, as a sentinel or guardian species. We have characterized the main environmental contaminants of concern at a selected number of sites around the Qatari coast (UmmBab, Al Khor, Al Wakra and Simaisma), during 2 years, in summer and winter. Potential ecological effects of contaminants (targeted and untargeted) were investigated at different biological organization levels (gene, chromosome, cell, individual, population), through a multidisciplinary approach, using classical and genotoxicological endpoints, integrative histopathology and transcriptomic responses to the different environmental stresses. To our knowledge, this is the first time an integrated approach connecting all these disciplines has been applied in the Qatari marine environment. We present here the main results, of this 3 years project, obtained in all different disciplinary approaches. The results of this project will leave a legacy of resources for future Qatari researchers, including an open access transcriptome data base and the first description of common pathologies observed in the pearl oyster *P. i. radiata*. Moreover, they will also represent a sound science-based baseline data essential for conservation and management planning, by integration of the data from all the different disciplines applied in the project to assess the potential ecological effects of contaminants at different biological levels.
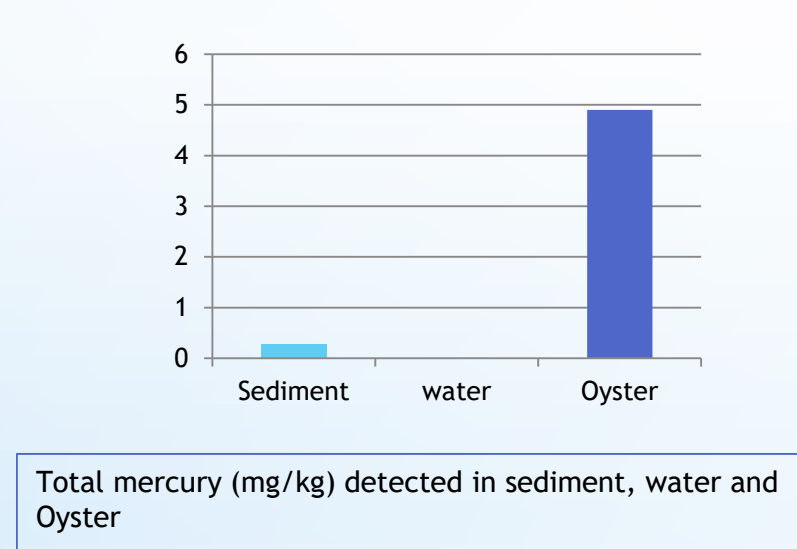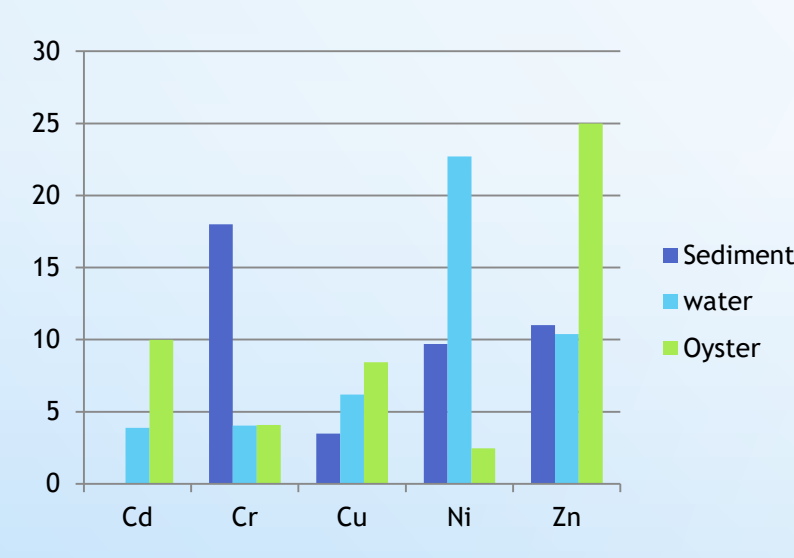
Key words: Marine Environmental Health; Marine Eco-genotoxicology; Integrative histopathology; Transcriptomics; Pearl oyster

Chemical characterization

Objectives: define the levels of trace metals and organic pollutants within the oyster *P. i. radiata*, water and sediment. Identify levels of emerging contaminants and sewage markers, with an emphasis on genotoxic compounds.

Main results:

✓ A comprehensive set of data on the levels of metals, TPH, PAHs and CECs in the coastal environment of Qatar

Trace metals concentrations (ppb) detected in sediment , water and Oyster

Total mercury (mg/kg) detected in sediment, water and Oyster

✓ Novel methods for the combined targeted/non-targeted analysis of CECs in marine samples

✓ The detection of new contaminants in marine samples

Highlighting the importance of complementing targeted analyses with a non-targeted approach

Integrative histopathology

Objectives: to investigate infectious and non-infectious disease conditions using histopathology. Share key findings using digital pathology technology.
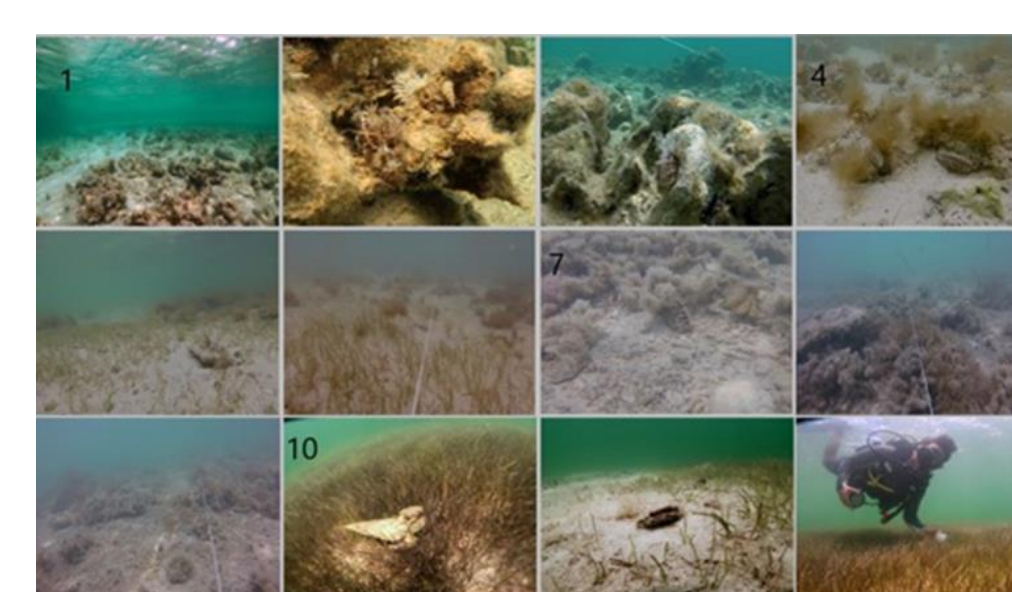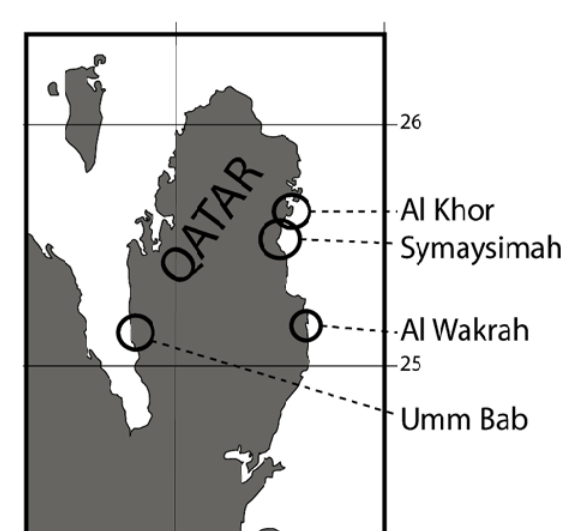
Main results:

✓ A few oysters displayed an infection with a bucephalid trematode infection with multiple trematodes within the connective tissues surrounding the digestive gland in these individuals (A, B,C, D).

✓ A second trematode infection was also observed but at a lower prevalence within the tissues, 1 or 2 pathogens present in each section (A,B, C, D).

✓ Metacercarial cysts of a an unknown metazoan were observed within the byssal gland in oysters sampled from Al Khor and Al Wakra (F).
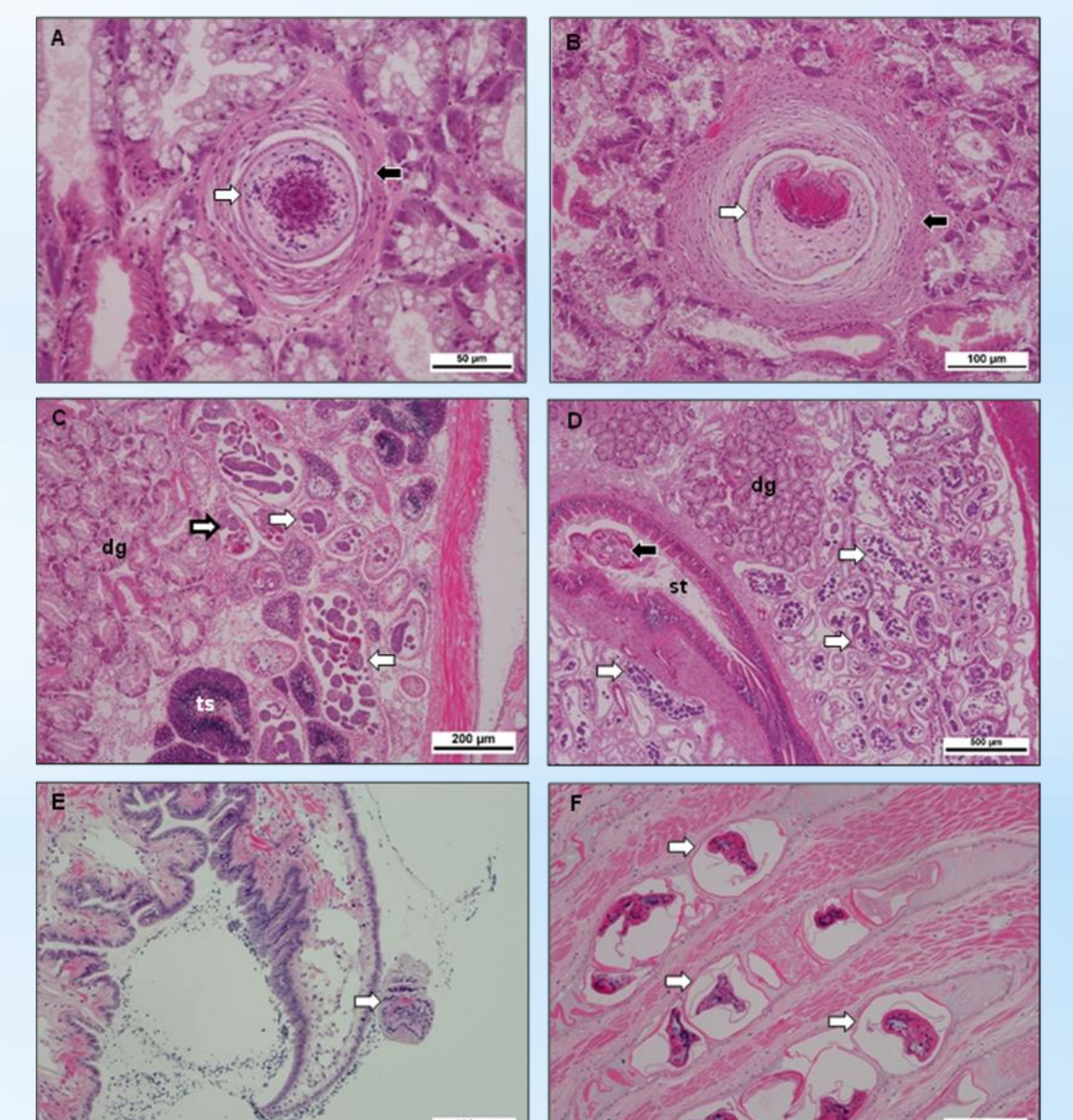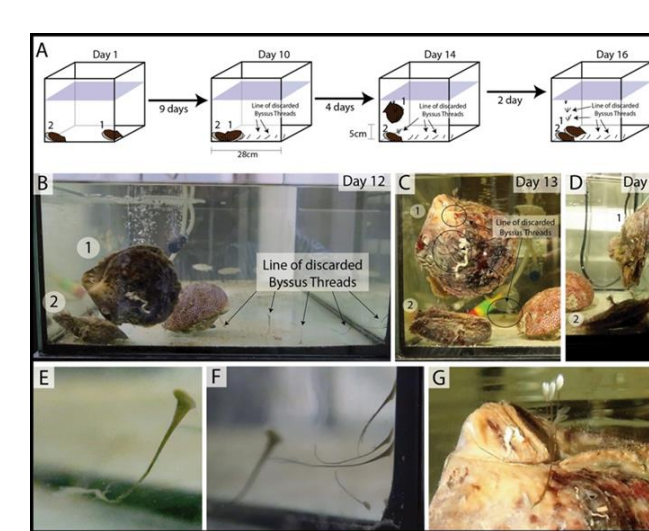

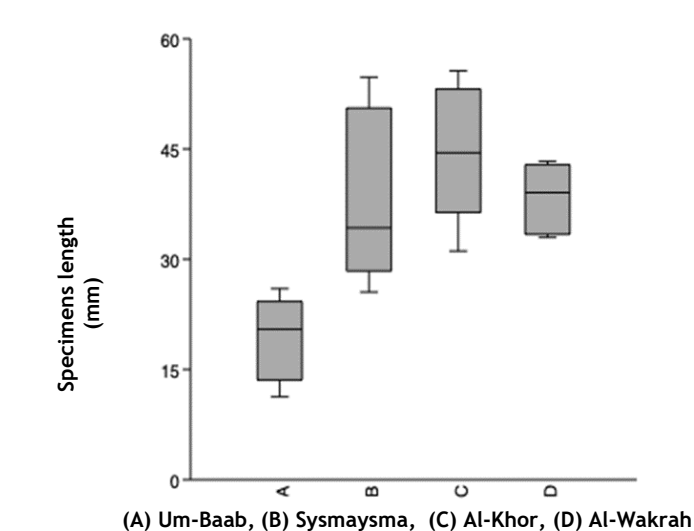## Ecological characterization

✓ Sampling sites

Umm Bab - *Higher salinity (1-3)*; Al-Wakra – *within urban Centre(4-6)*; Al-Khor – *within urban Centre (7-9)*; Sismaisma (10-12).

Main results:

✓ *P. i. radiata* behavioral displacement ability

✓ Negative effect of salinity

(A) Um-Baab, (B) Sysmaysma, (C) Al-Khor, (D) Al-Wakrah

✓ The effect of the harsh summer (temperature) over the species recruitment

✓ First comprehensive information on seasonal recruitment and growth

✓ Importance of shallow coastal ecosystems as population's nursery

Genotoxicological characterization

Objectives: to establish the genotoxicological profile of the populations of *P. i. radiata*

Main results:

✓ The highest aneuploidy levels were observed in Simaisma, followed by Umm Bab

Aneuploidy levels for the summer and winter samplings, in all sites

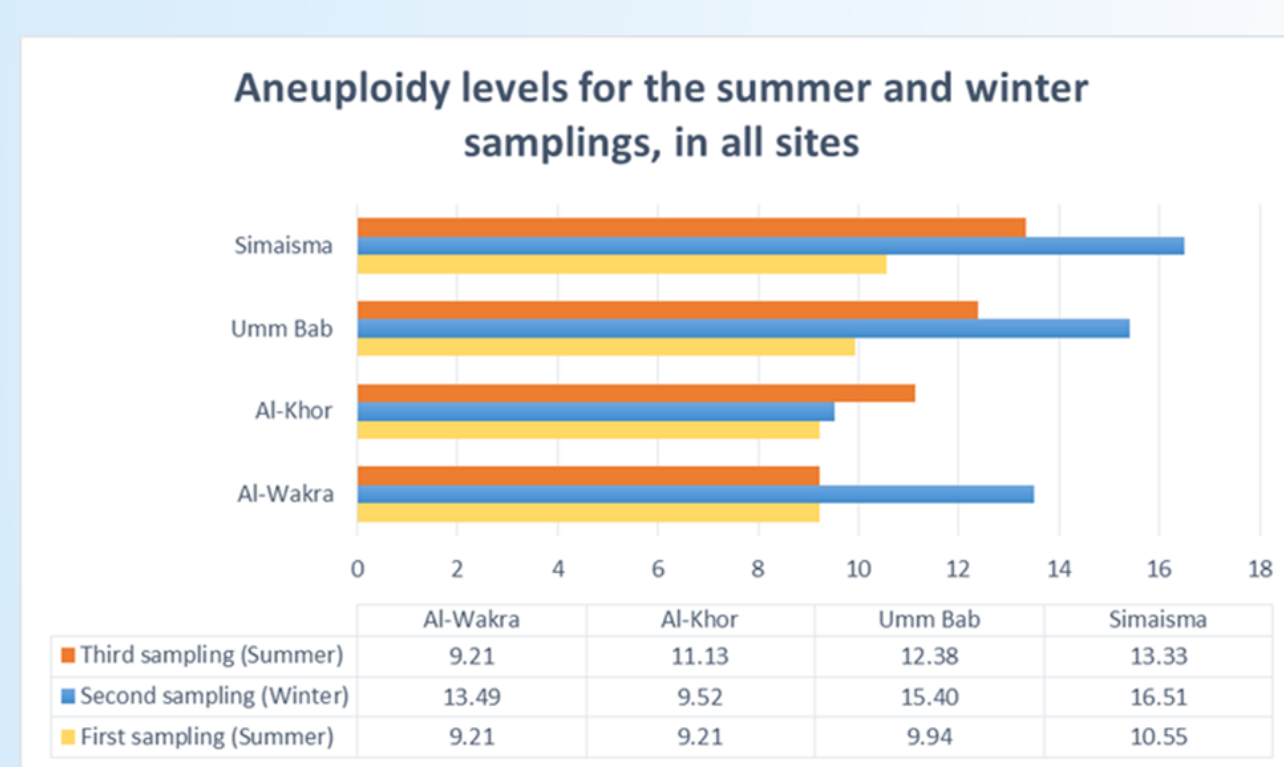|	Al-Wakra	Al-Khor	Umm Bab	Simaisma
Third sampling (Summer)	9.21	11.13	12.38	13.33
Second sampling (Winter)	13.49	9.52	15.40	16.51
First sampling (Summer)	9.21	9.21	9.94	10.55

✓ Interestingly, Al-Khor is the only site that showed a continuous increase in the aneuploidy levels

✓ Metaphases with four missing chromosomes (2n-4) were observed in Umm Bab, Al-Khor and Al-Wakra.
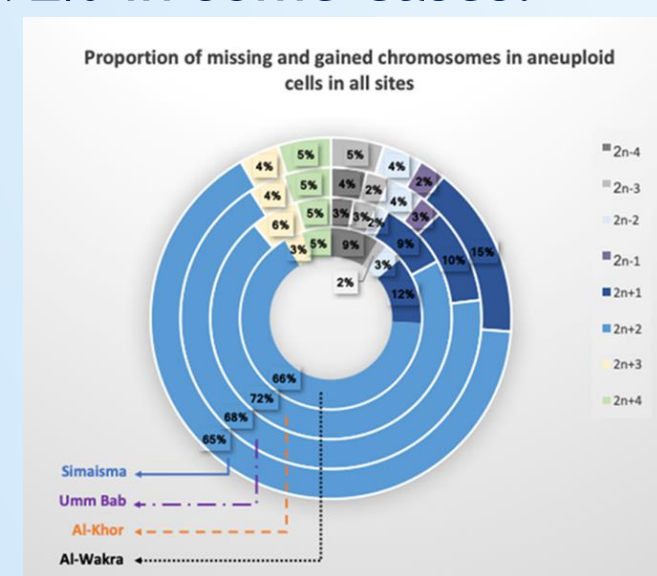
✓ Consistency of uncommon chromosomal gain –hyperdiploidy- pattern in all sampling rounds, up to 92% in some cases.

Proportion of missing and gained chromosomes in aneuploid cells in all sites

✓ The identification of the extra and missing chromosomes (by performing the karyotypes of selected aneuploid cells after restriction enzyme banding) has showed a preferential lost in mainly 2 chromosomal pairs

Transcriptomic responses

Objectives:

–to understand the molecular basis on how *P. i. radiata* deals with stress.

Main results:

✓ Differential expression of RNA transcripts was analysed in each tissue;

✓ Each tissue had clearly defined patterns of expression;

✓ The most obvious differences in expression patterns occurred between digestive gland and other organs, with high levels of expression of many transcripts in the digestive gland alone.
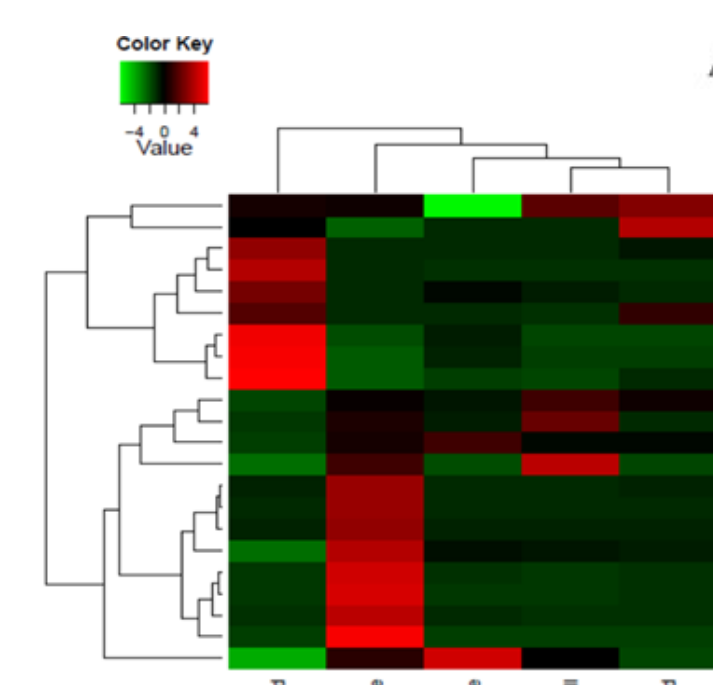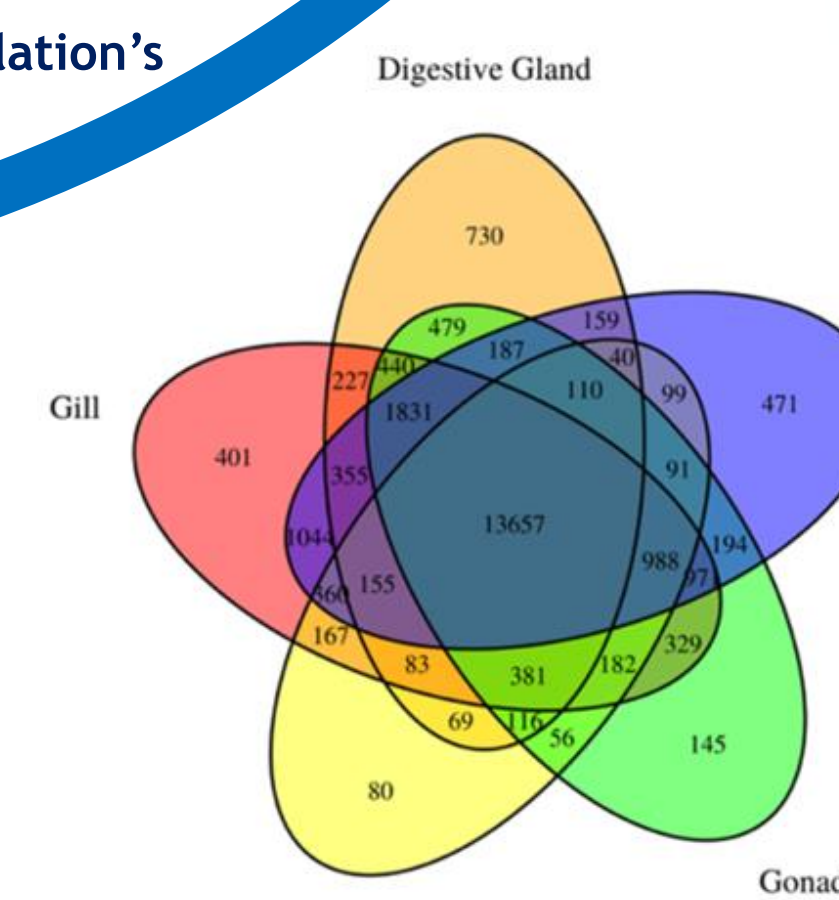
✓ Proteins associated with shell (and therefore pearl) formation that have previously been detected in *Crassostrea gigas* through shell isolation and protein sequencing;

✓ Clear presence of transcripts involved in shell (and therefore pearl) formation.