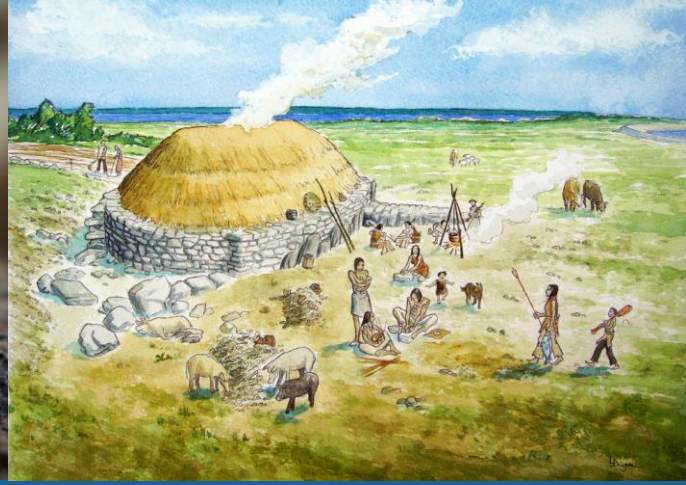




Meeting SEALEX – 17 Novembre 2021

WP1 : The construction of a cultural geodatabase

Les coquilles de *Patella sp*. issues d'amas coquilliers anthropiques, archives culturelles et environnementales des environnements côtiers :

Le cas des amas coquilliers de Béniguet et de Molène en mer d'Iroise

Jean-François Cudennec, Yvan Pailler, Pierre Stéphan, Yves-Marie Paulet

European Institute for Marine Studies, University of Western Brittany

Université de Bretagne Occidentale

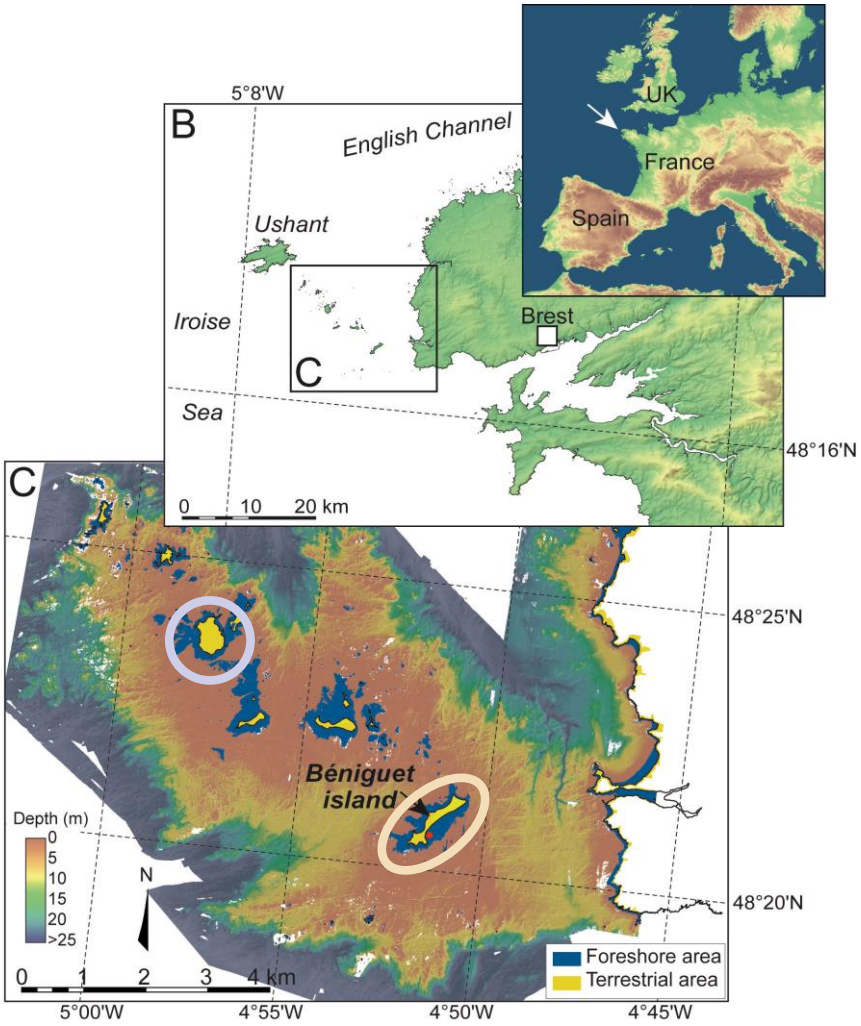
LEMAR laboratoire des sciences de l'environnement marin UMR CNRS/UBO/IRD/Ifremer

ISblue

ArMeRIE Archéologie Maritime et Recherche Interdisciplinaire Environnementale

iuem

The case of Molene archipelago : comparing different islands and different periods



Beg ar Loued site (Molène island)

A well known site with strong archaeological context.

Limpet shell from two pit structures are investigated :
- SC 7 : 2576 – 2467 Cal B.C. (Late Neolithic)
- SC 21: 1920-1761 Cal B.C. (Early Bronze Age)

Béniguet shell middens

Three shell layer interbedded in aeolian sand dune. No excavation yet and reduced archaeological context.

- Beni-200 : 2455 – 2200 Cal. BC (Chalcolithic, Bell Beaker culture)
- Beni-201: 2187 – 1960 Cal. BC (Early Bronze Age)
- Beni-202 : 640 – 675 AD (Early Middle Age)

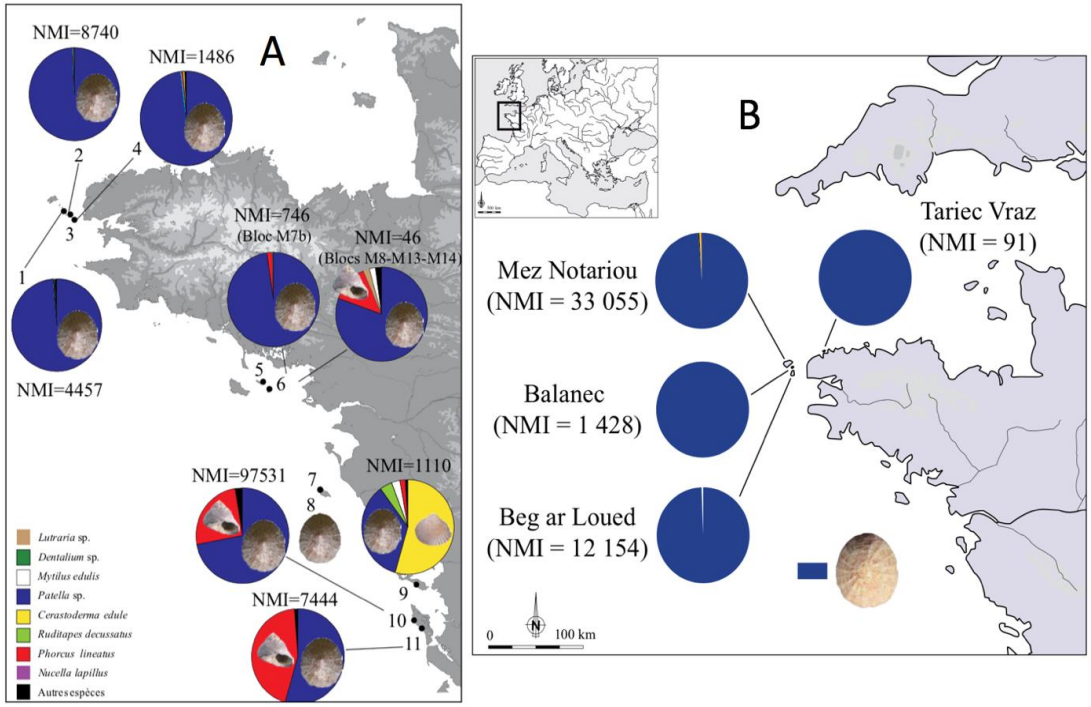
French Atlantic Shell middens

- Remnants of human activities

- Mostly composed of mollusc shells

- Also contain bones, sherds, lithics, botanical remains...

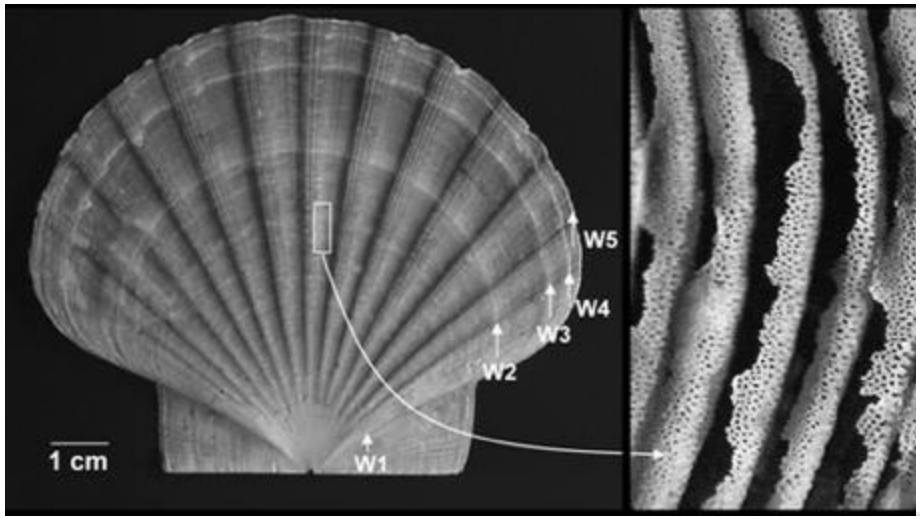
Archaeological limpet shells from Kerlinou excavations (late Iron Age)



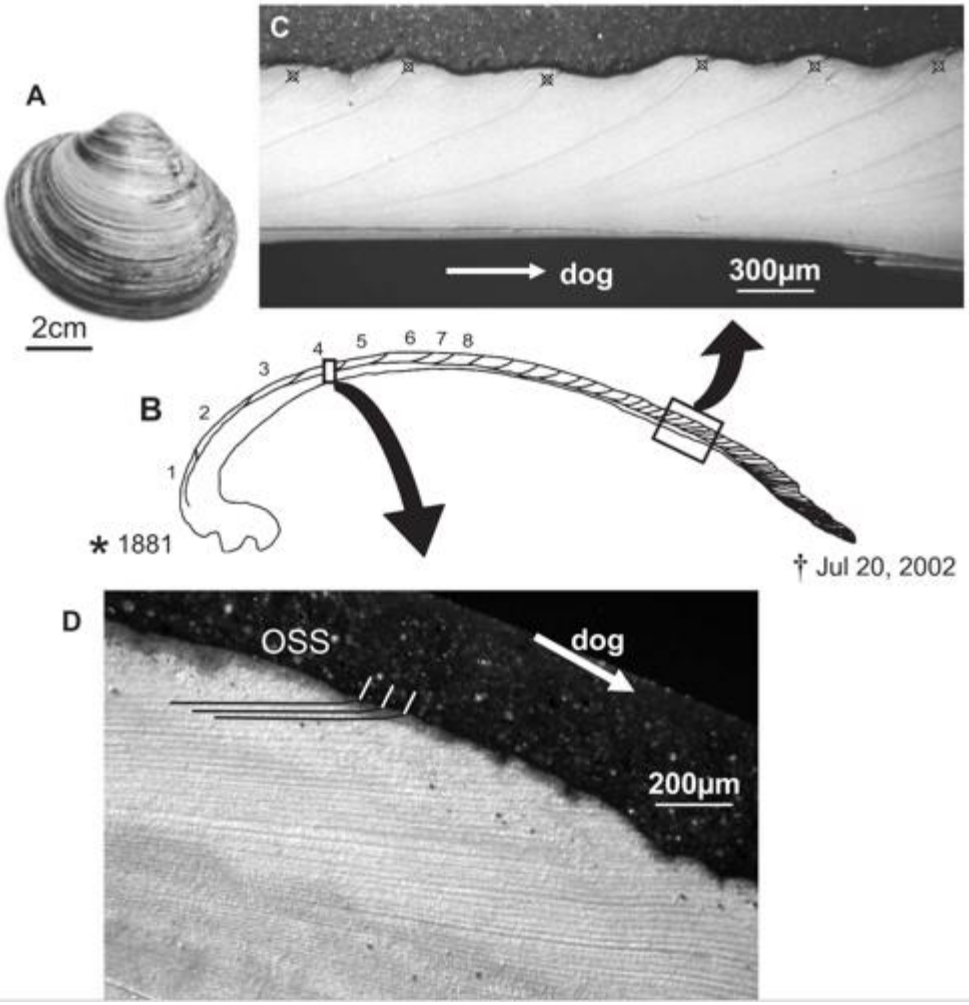
Composition of pre- and protohistoric Atlantic shell middens

Principe de base

- Déterminer le rythme de formation des stries pour lire dans les coquilles comme dans un calendrier



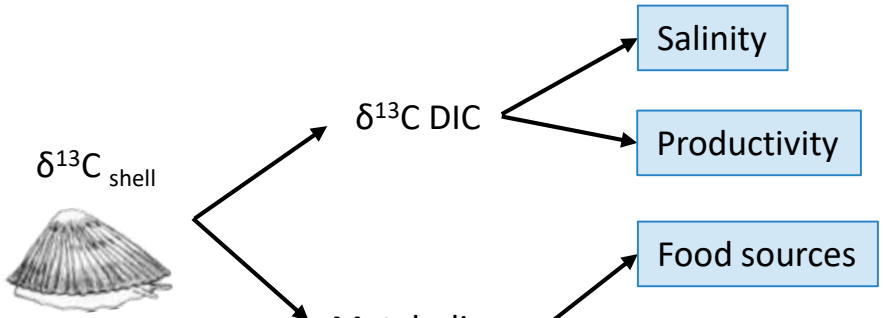
Pecten maximus : strie journalière

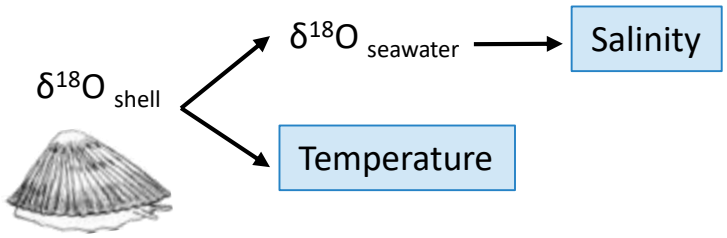


Arctica islandica : Stries journalière et annuelles ; espèce longévive
Butler et al., 2013

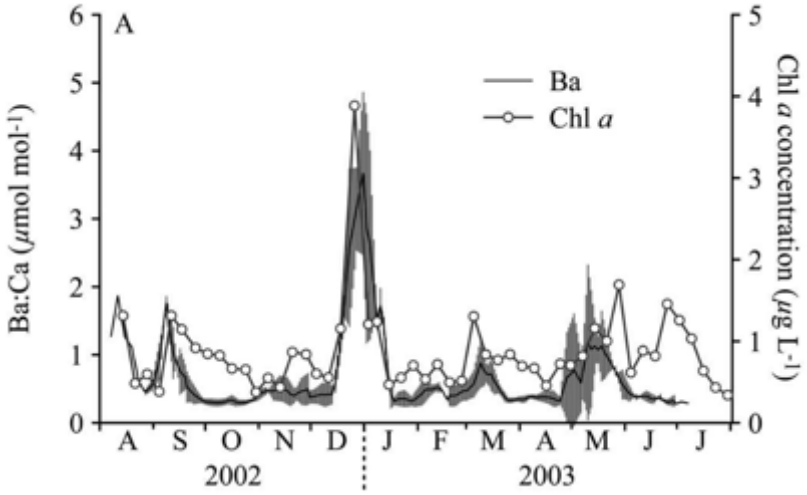
Un panel d'outils

- Les isotopes stables : $\delta^{18}O$ et $\delta^{13}C$
- Les éléments traces : Mg, Li, Ba…





Exemple d'élément trace :



Variation temporelle de la concentration en Barium dans les coquilles de *Comptopallium* radula et en cholophylle dans l'environnement (Thébault *et al.*, 2009)

Un panel d'outils

- Les isotopes stables : **$\delta^{18}O$** et $\delta^{13}C$
- Les éléments traces : Mg, Li, Ba…

$\delta^{13}C_{shell}$

$\delta^{13}C$ DIC → Salinity

$\delta^{13}C$ DIC → Productivity

Metabolic carbon → Food sources

Metabolic carbon → Ontogeny

$\delta^{18}O_{shell}$

$\delta^{18}O_{seawater}$ → Salinity

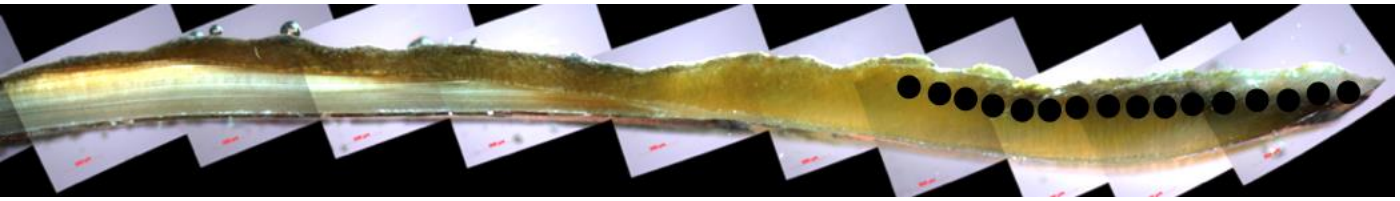
Temperature

Calcite – water $\delta^{18}O$ relationship

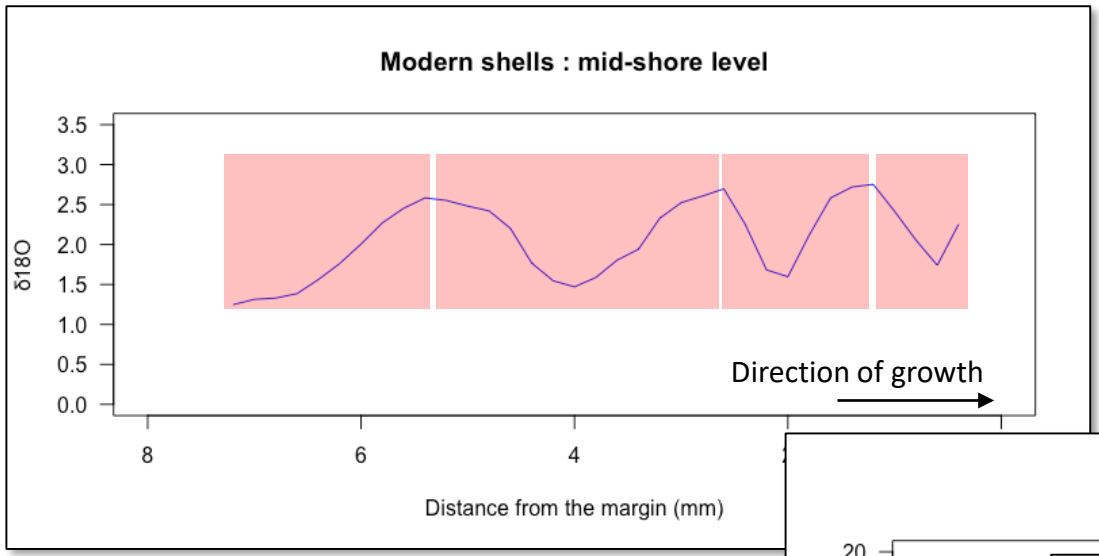
$$SST\ (°C) = 16.9 - 4.38\ (\delta_{calcite-}\ \delta_{water}) + 0.1\ (\delta_{calcite}-\ \delta_{water})$$

O'Neil *et al*, 1969

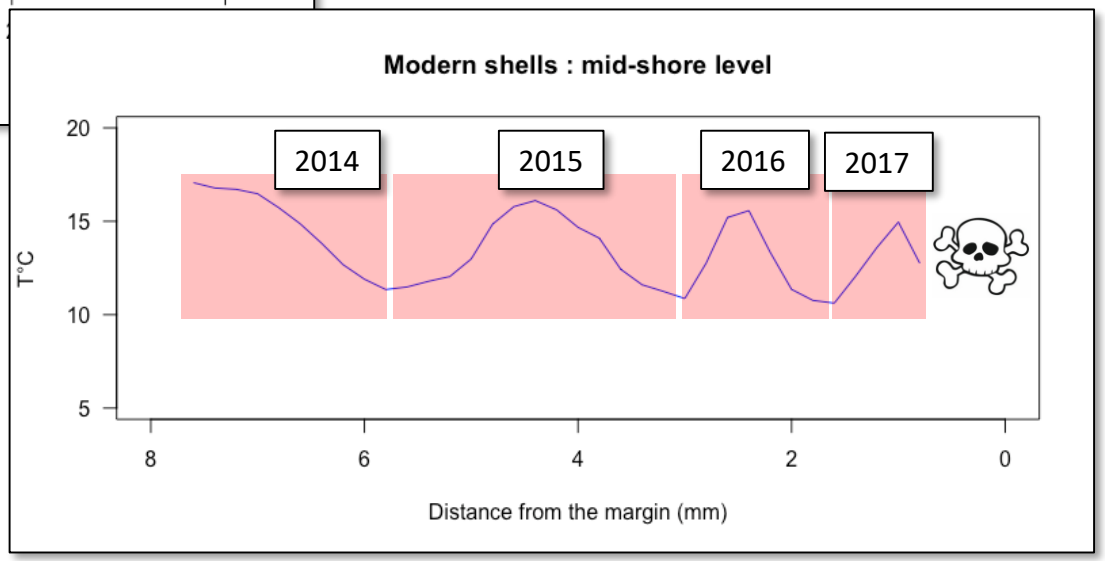
Shell oxygen isotopes can help determine the seasonality of harvest



Patella vulgata

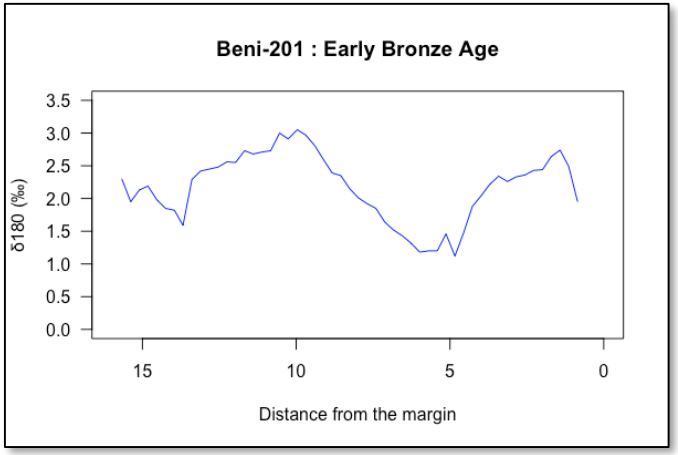


Calcite – water $\delta^{18}O$ relationship



Different sampling designs for different purposes

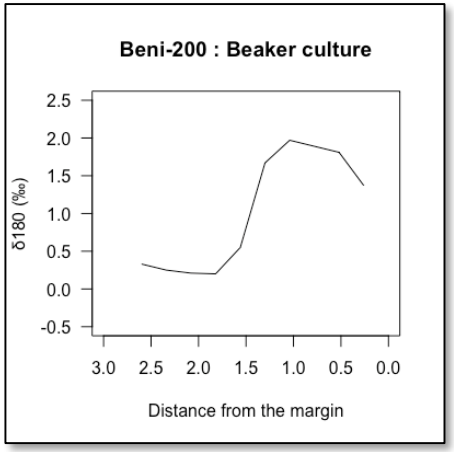
Long series of measurements : testing the seasonality of isotopic signals



- Check the quality of the signal
- Higher number of samples : more time and more money per shell
- 4 long series for each period (Béniguet), 1 for each period (Molène)

Long series are needed to test the accuracy of the signal, but they are more interesting for palaeo-environmental reconstructions

Short series of measurements : increasing the number of analysed shells



- Low number of samples : less time and money per shell
- No possibility to assess the quality of the signal
- 6 short series for each period (Béniguet), 21 for each period (Molène)

Total data set :
74 shells
1164 carbonate samples

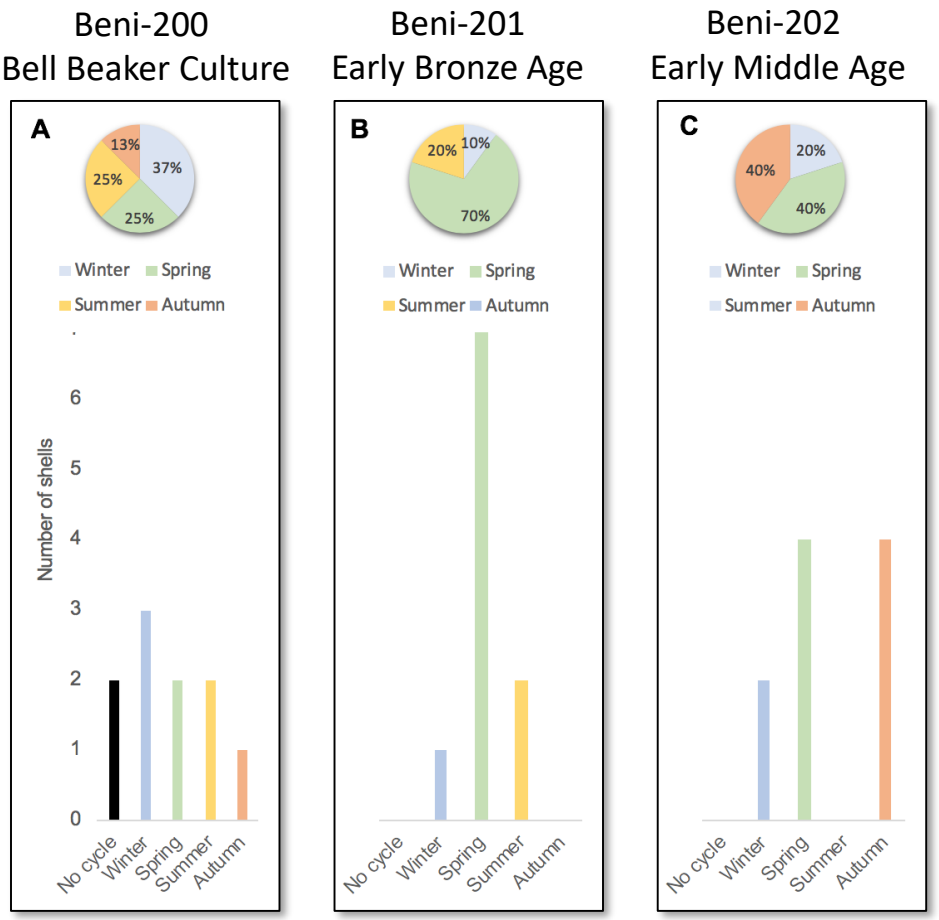
Short allow to analyse a higher number of shells and increase the reliability of the study

Detecting different practices at different periods : the example of Béniguet island

How to interpret these differences ?

Limpets are sedentary and *Patella vulgata* is a common species on the shore : probably not a question of resource availability.

"Absence of proof is not proof of absence" : mobility or seasonal consumption ? hungry gap ?



Annual distribution of *Patella vulgata* shells harvesting for each of the three stratigraphic units investigated in this study. Each period is represented by 10 analyzed shells.

Detecting different practices at different periods : the example of Molene island

How to interpret these differences ?

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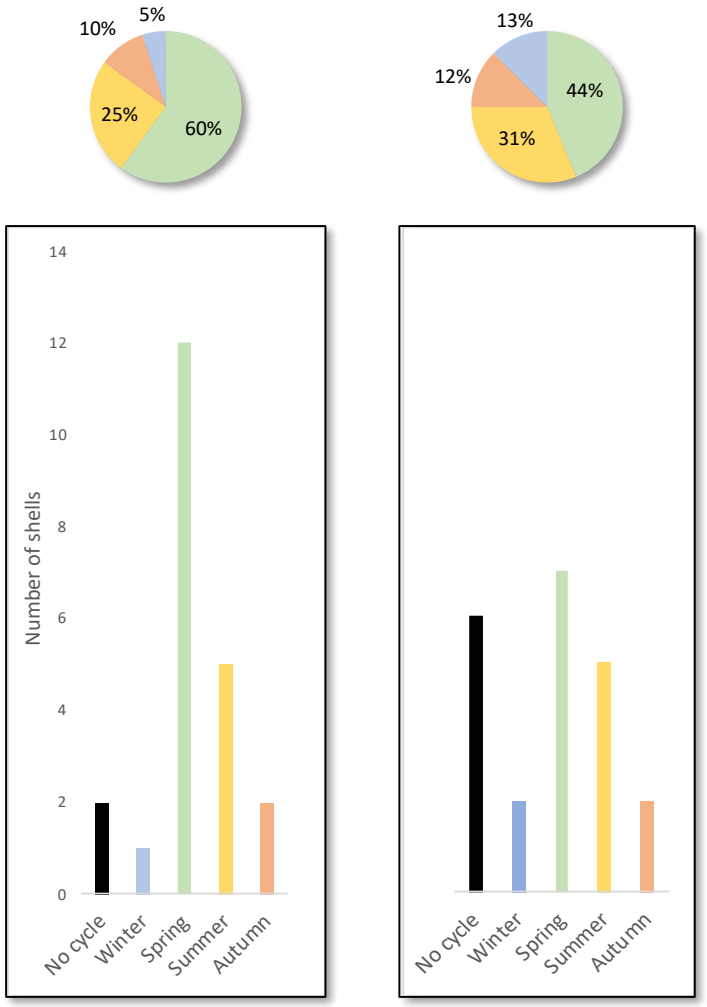
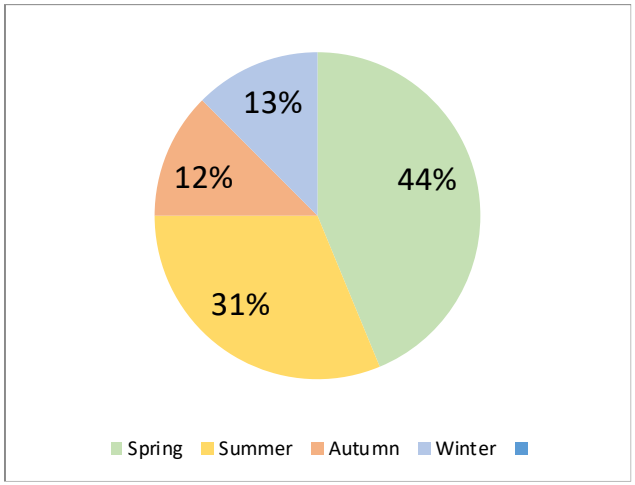


SC 07
Final Neolithic

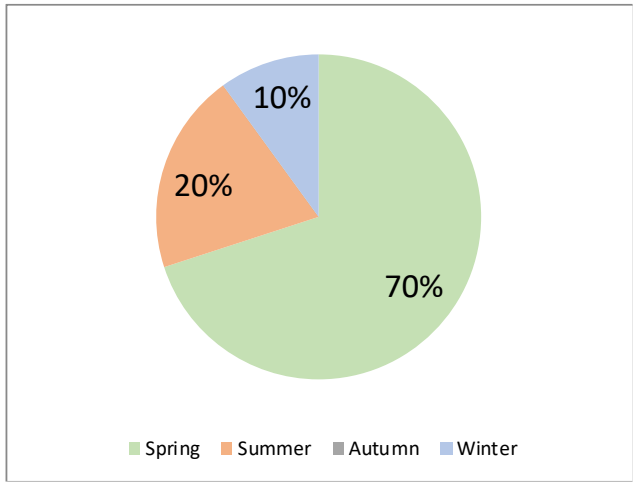
SC 21
Early Bronze Age

Annual distribution of *Patella vulgata* shells harvesting for the two pits SC07 and SC21

Detecting different practices at the same period : the example the Early Bronze Age



Molène (SC21) :
SC 21, Early Bronze Age 1920 - 1761 Cal B.C.



Béniguet (Beni-201) :
Beni-201, Early Bronze Age 2187 - 1960 Cal. BC

How to interpret these differences ?

- Year-round harvest on Molène is coherent with the archaeological context (larger island, stone house) : permanent settlement
- Under the hypothesis of constant practices, the results of Beniguet island may reflect a seasonal occupation of the island, or just a punctual limpet meal. .

Conclusion

- Limpet shells isotopes provide information about the seasonality of harvest
- This information alone is not enough to determine the seasonality of sites occupation
- It a new and complementary tool, which needs to be coupled with other seasonality proxies : fish and bird bones, fruits, other molluscs isotopes…

Les coquilles de *Patella sp*. issues d'amas coquilliers anthropiques, archives culturelles et environnementales des environnements côtiers : approches sclérochronologique et moléculaire

Cynthia Oliveira, Jean-François Cudennec, Yvan Pailler, Pierre Stéphan, Morgane Ollivier, Christine Paillard, Yves-Marie Paulet

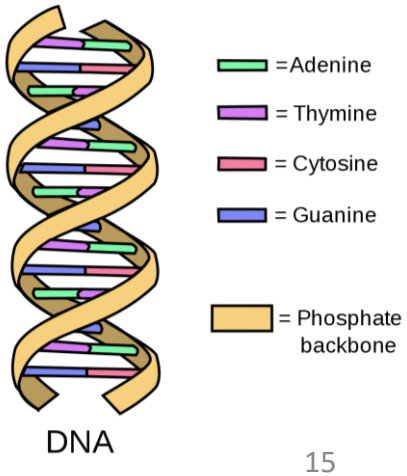
Post-doctorat, IS-BLUE, projet flagship SEALEX, WP1 (coord. Y. Pailler)
Encadrement : Y.-M. Paulet (sclérochronologie), C. Paillard (outils moléculaires)
Début : janvier 2022 – 10 mois

Mieux comprendre les amas coquilliers et de l'occupation de l'île de Béniguet *via* deux méthodes de complémentaires :

- Sclérochronologie
  - Saisonnalité des amas coquilliers ➔ mieux comprendre l'occupation de l'île au cours du temps

- Biologie moléculaire (ADN anciens)
  - Caractériser les espèces présentes dans les amas coquilliers (vertébrés, mollusques, arthropodes)
  - Caractériser le régime alimentaire des habitants de l'île au Néolithique et à l'âge du Bronze ancien
  - Caractériser le microbiote de la patelle et les communautés microbiennes de la colonne d'eau environnante (et évaluer l'effet des saisons)

- Quelles info ?
  - Qui est/était là ? **Identification taxonomique** (bactéries, animaux, plantes…)
  - Fonctions métaboliques
  - …
- Où ?
  - **Sédiments**
  - Restes calcifiés (os, otolithes, **coquilles de mollusques**…)
  - …
- Comment ?
  - Extraction
  - Préparation librairie
  - Séquençage
  - Traitement bioinformatique



- Quelles info ?
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  - Traitement bioinformatique

ADN ancien dans les coquillages

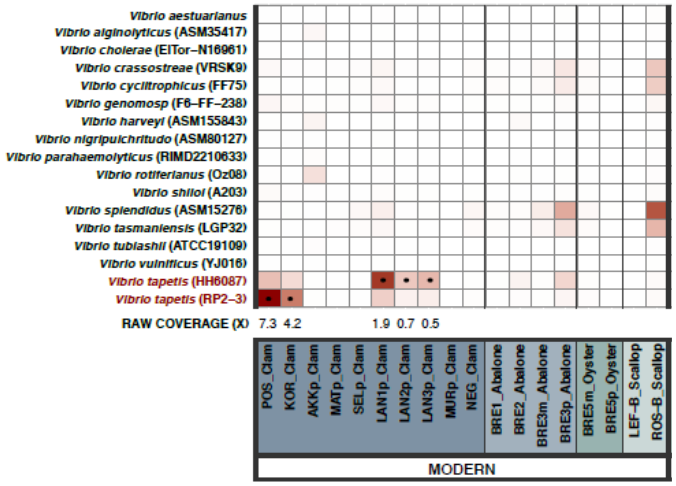
ADN environnemental

ADN bactérien

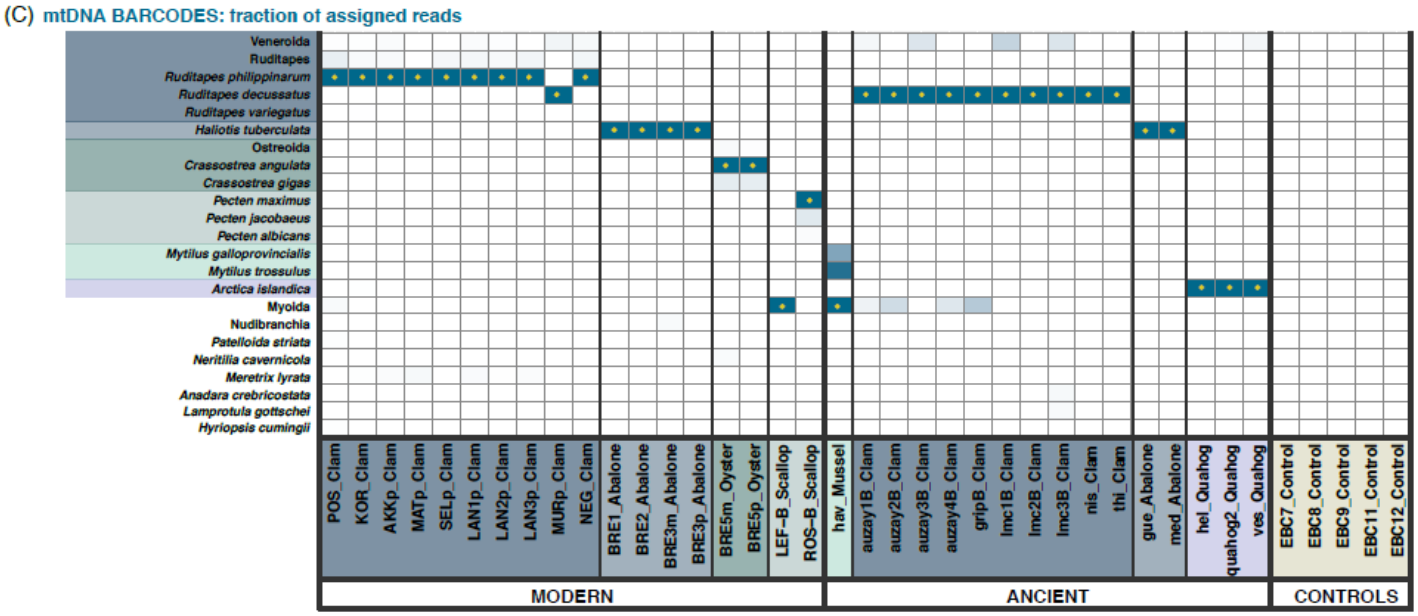
ADN microbiote

ADN de l'hôte

Identification of vibriome within the shells



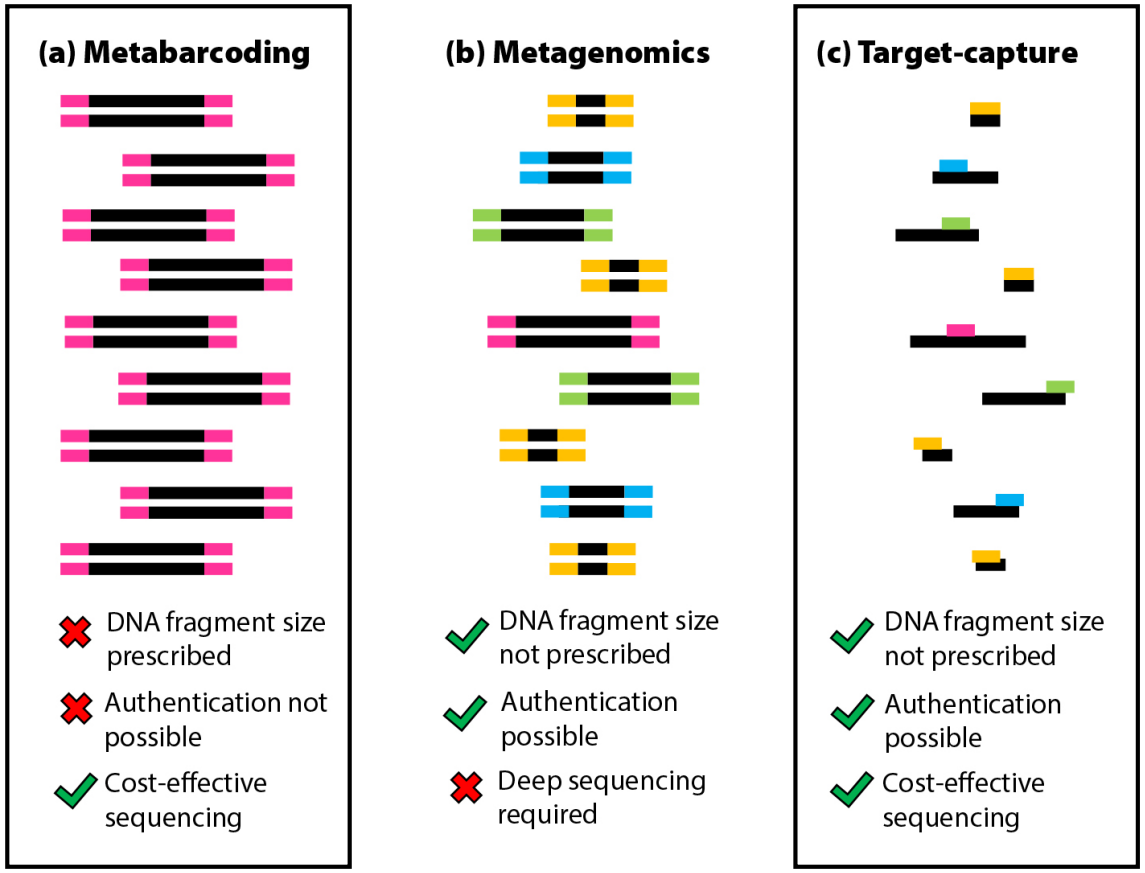
Mollusc taxon identification



Der Sarkissian *et al.*, 2017. *Mol. Ecol. Res. ; Labex Mer*

- Quelles info ?
  - Qui est/était là ? **Identification taxonomique** (bactéries, animaux, plantes…)
  - Fonctions métaboliques
  - …
- Où ?
  - **Sédiments**
  - Restes calcifiés (os, otolithes, **coquilles de mollusques**…)
  - …
- Comment ?
  - Extraction
  - Préparation librairie
  - Séquençage
  - Traitement bioinformatique

- Extraction : fort risque de contamination ➔ laboratoire dédié
- Préparation librairie / Séquençage : 3 méthodes
- Traitement bioinformatique

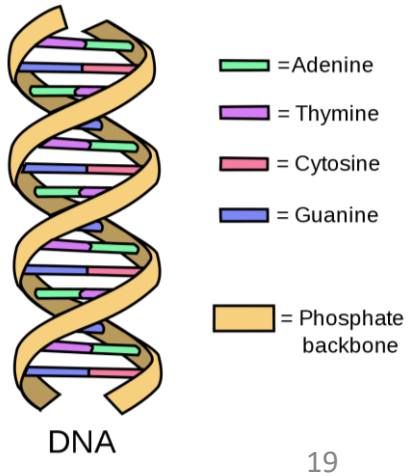


Armbrecht, 2020

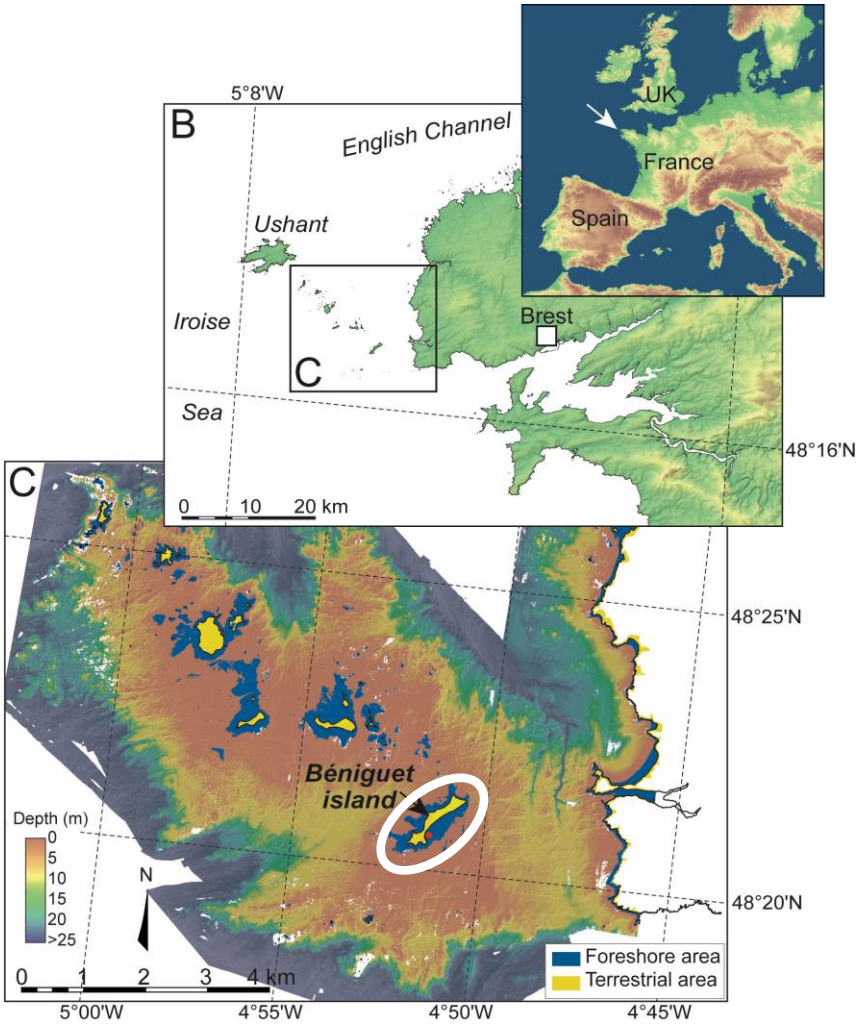
Propriétés de l'ADN ancien :

- Faibles quantités
- Fragmenté
- Modifié chimiquement

Collaboration avec ECOBIO (Rennes) :
Morgane Ollivier
Nathan Martin



Béniguet, Porz ar Puns (TR1 – TR2)



Béniguet, chantier école, Août 2021

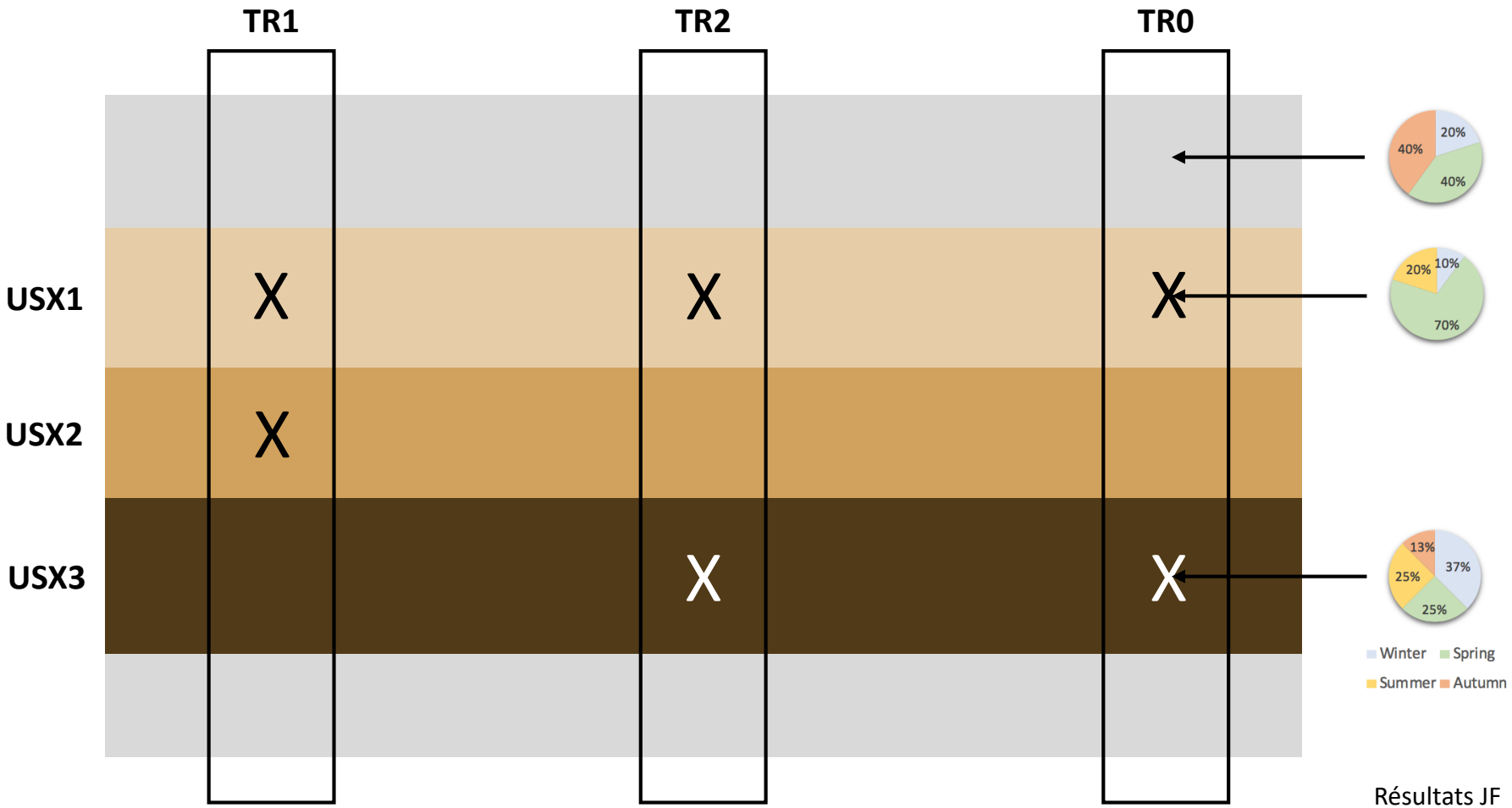
Béniguet, Porz ar Puns (TR1 – TR2)

Coquilles de Patelles

Sédiments piégés sous les Patelles

Sédiments

Béniguet, Porz ar Puns (TR1 – TR2)



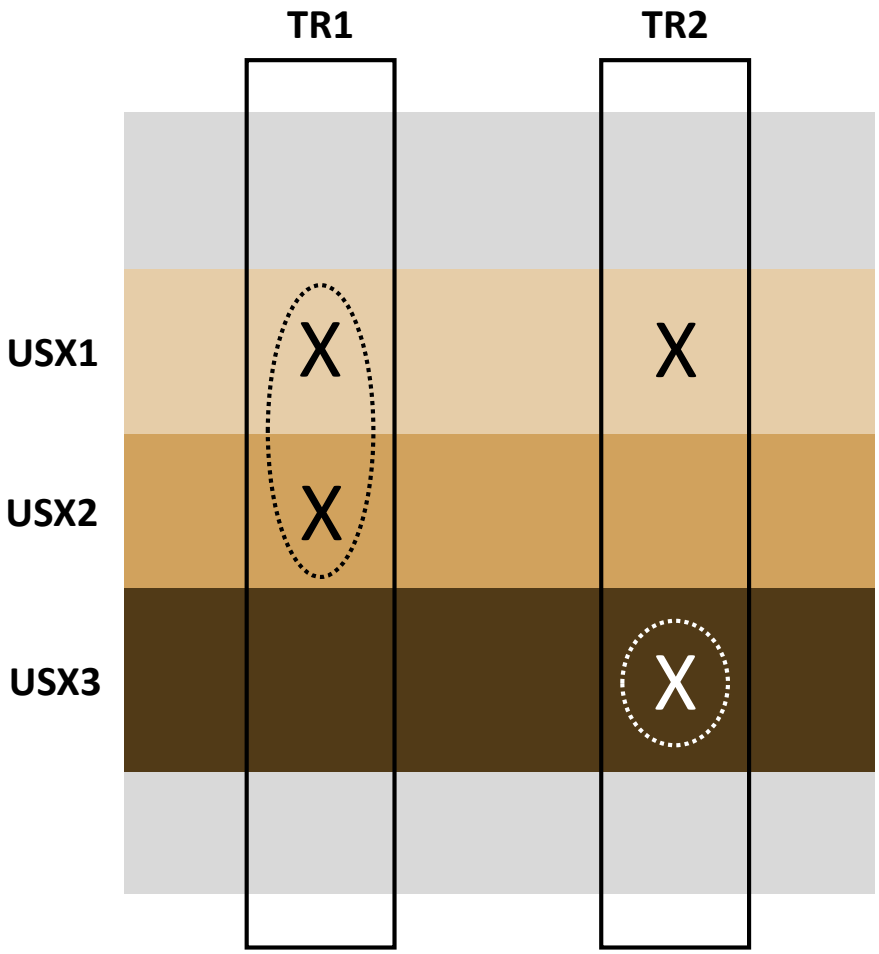
Résultats JF Cudennec

USX1: 2000-1800 BC (bronze ancien)

USX2: 2200-2000 BC

USX3: 2500-2200 BC (néolithique final/ campaniforme)

X: unité stratigraphique échantillonnée



Sclérochronologie :

Patelles :

8 coquilles par US et par TR (24) :

- 6 coquilles en séries courtes (dates de pêche)
- 2 coquilles en séries longues (informations paléo-environnementales)

Autres mollusques : (collaborations)

Vernis (Split, SEA-EU)

Coquilles Saint-Jacques (J. Thebault, V. Siebert, LEMAR)

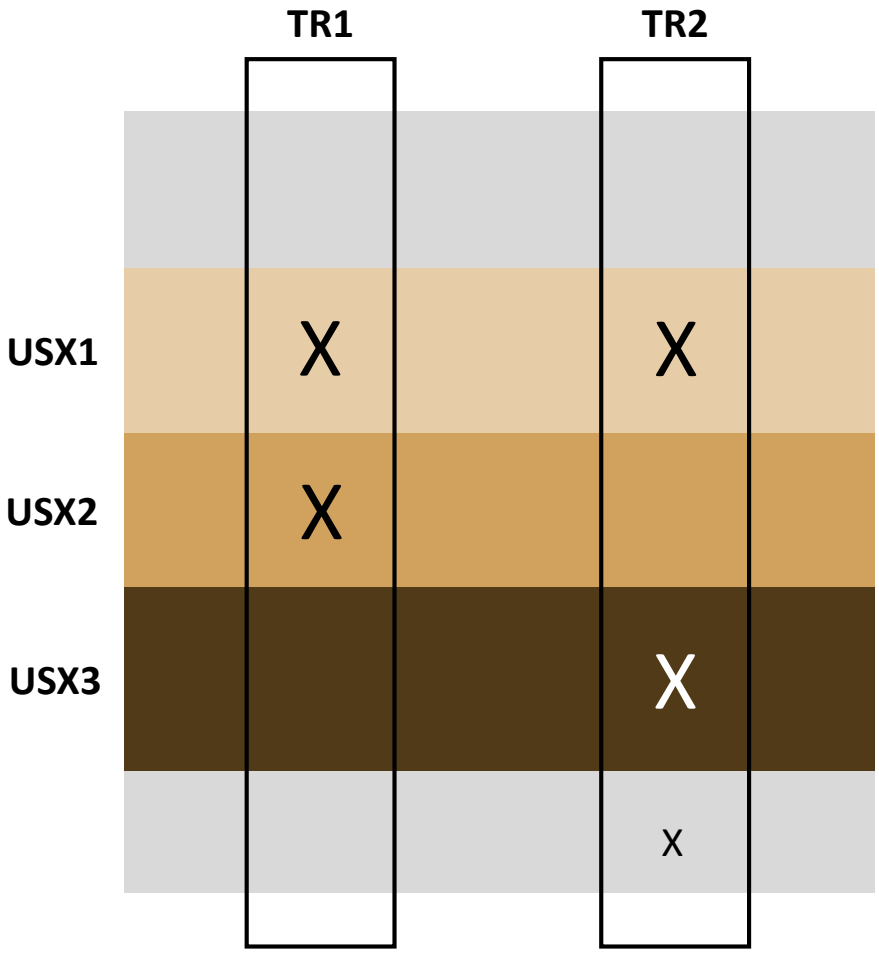
USX1: 2000-1800 BC (bronze ancien)

USX2: 2200-2000 BC

USX3: 2500-2200 BC (néolithique final/ campaniforme)

X: unité stratigraphique échantillonnée

Outils moléculaires - ADN ancien



USX1: 2000-1800 BC (bronze ancien)

USX2: 2200-2000 BC

USX3: 2500-2200 BC (néolithique final/ campaniforme)

X: unité stratigraphique échantillonnée

ADN ancien :

Échantillons :

Coquilles : 8 ou 12

Sédiments de patelles : 8 ou 12

Sédiments : TR2 (USX1, 3, 4 ; x 2 réplicats + control) ; TR1 (USX1 et 2 + control) : 12

Taxa ciblés :

Mollusques (LEMAR)

Arthropodes ?

Mammifères, Oiseaux, Poissons (ECOBIO Rennes : M. Ollivier, N. Martin)

Algue/Plantes (ECOBIO Rennes : M. Ollivier, N. Martin)

Procaryotes (LEMAR?)

Identification taxonomique mollusques :

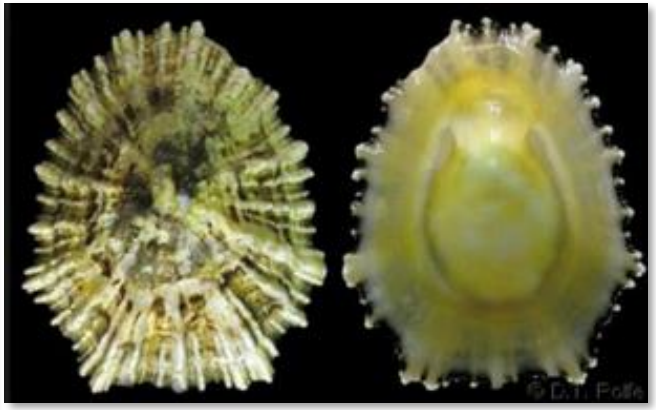
Moules (L. Orlando, C. Der Sarkissian)

…

Merci de votre attention

Three species of *Patella* live on Molène archipelago rocky shores

Patella vulgata



Patella ulyssiponensis

Patella depressa

Growth, shape and chemical composition of the shell depend on local environmental conditions

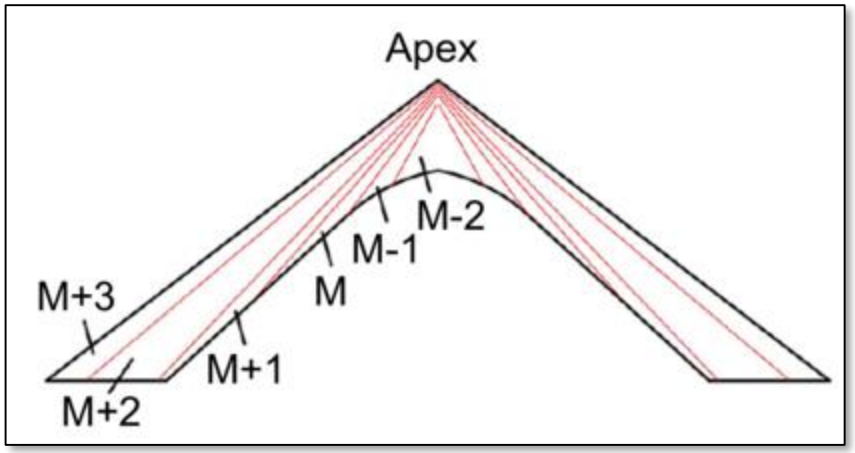
Archaeological limpet shells from Kerlinou excavations (late Iron Age)

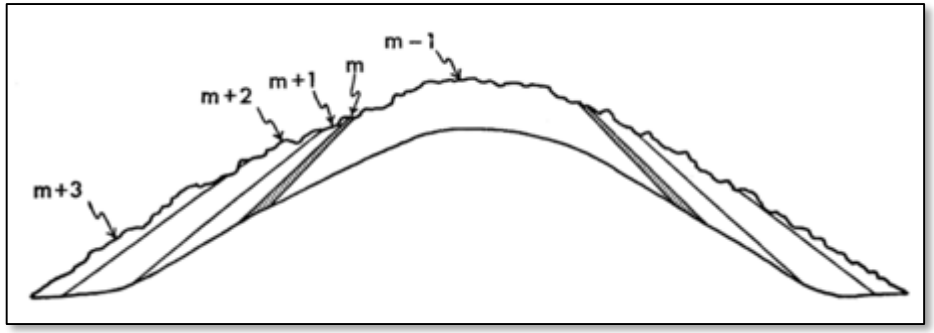
Wild *Patella vulgata* in its natural habitat
Béniguet island's shore, 09/12/2016

Limpets from low shore are flatter than high-shore limpets

Abundant in shell middens and still widely distributed in European coastlines, this species remain underexploited from a "palaeo-" perspective

Patella vulgata shell structure





Shell structures are named according to their relative position to the mysostracum (m)

M-2 : radial cross foliated layer

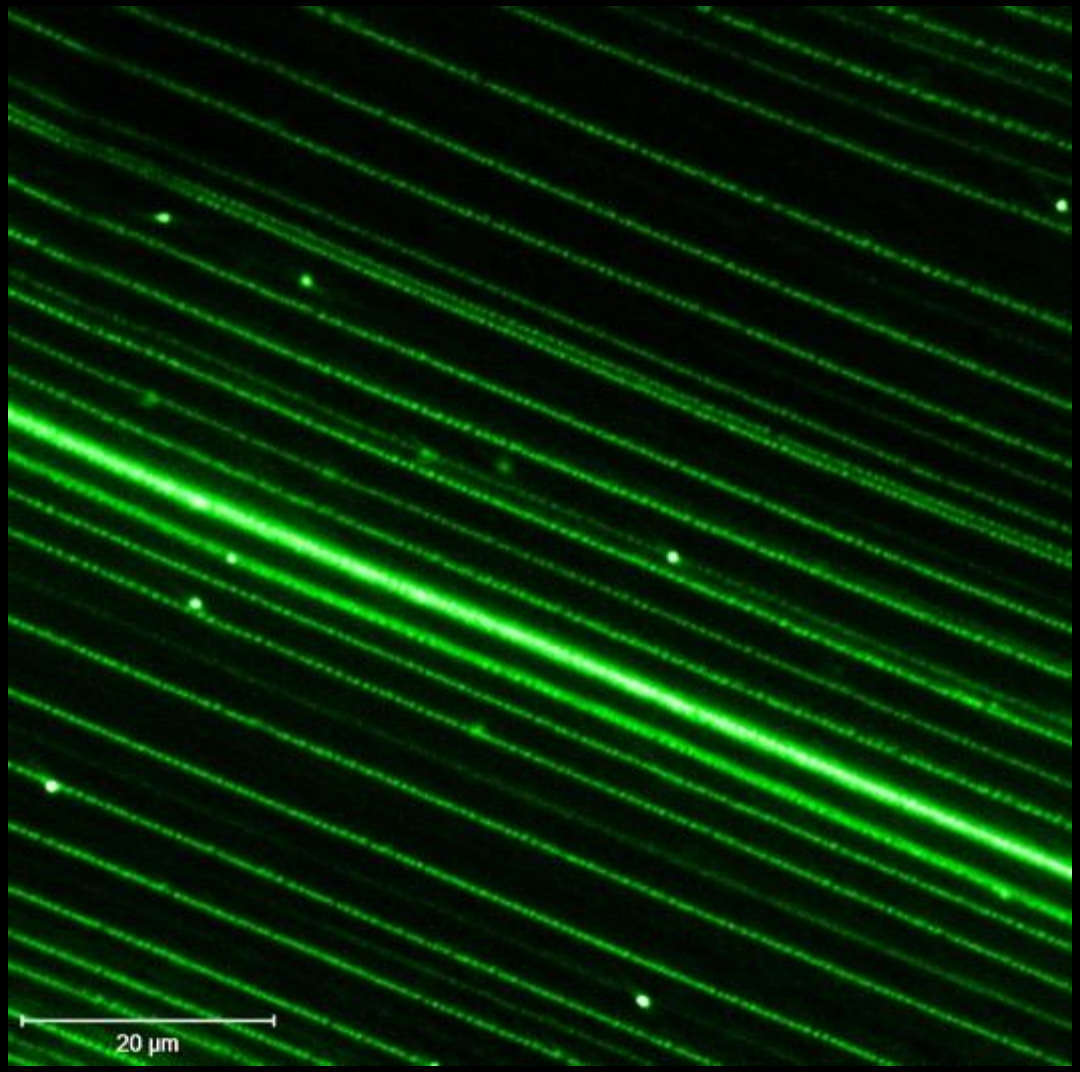
M-1 : radial crossed lamellar layer

M+1 : concentric crossed lamellar layer

M+2 : concentric crossed foliated layer

M+3 : radial cross-foliated layer

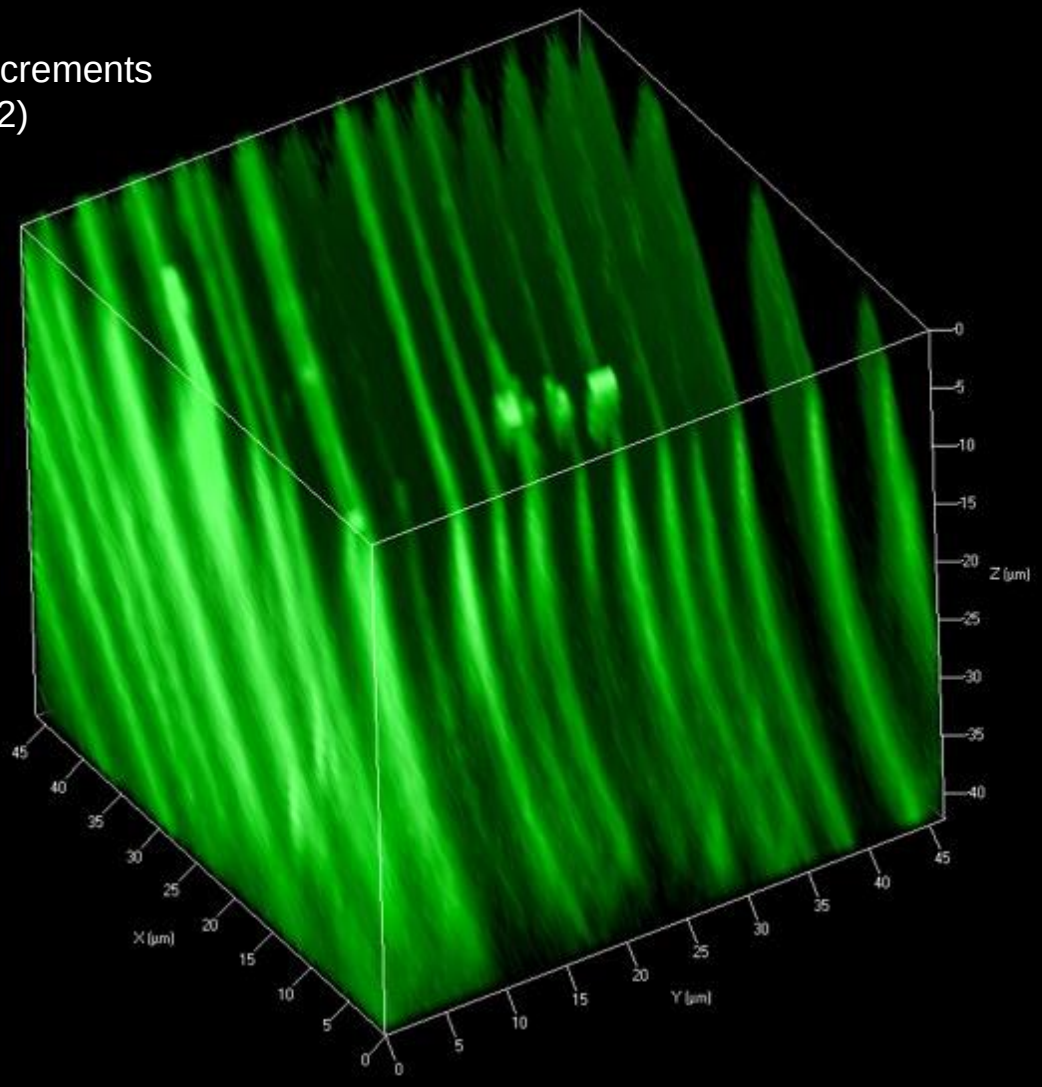
Introduction : *Patella vulgata* shell structure



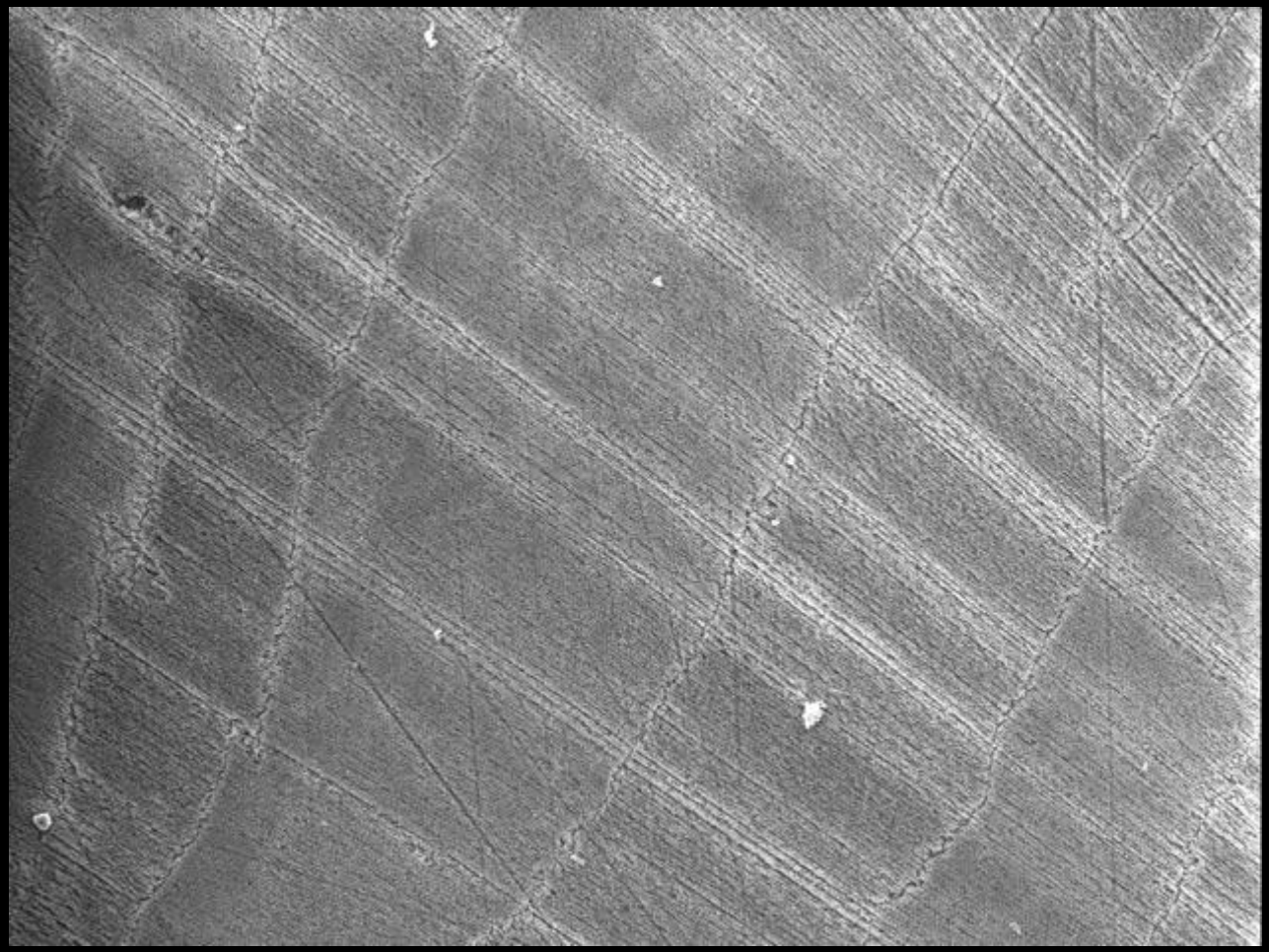
Confocal micro-increments observations (m+2)

Introduction : *Patella vulgata* shell structure

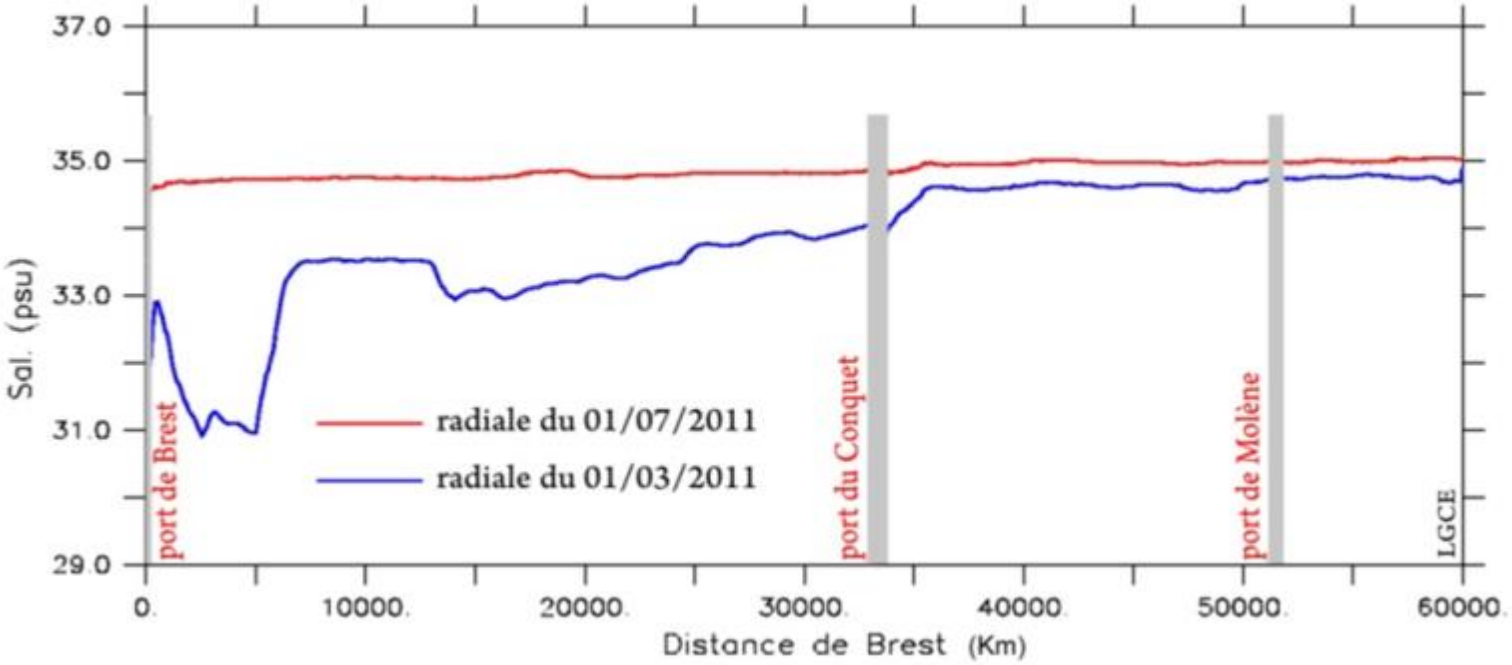
Confocal micro-increments observations (m+2)



Introduction : *Patella vulgata* shell structure

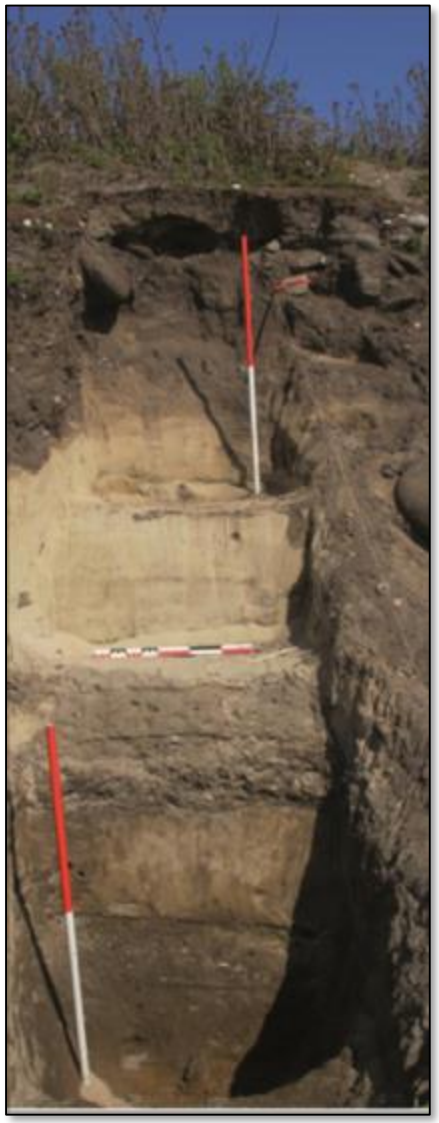


Scanning electron microscope micro-increments observations (m+2)



Surface salinity measured on the ship Enez Eussa III

Results : Temperature reconstructions



Modern shells amplitude

11.01°C / 16.55°C

- Beniguet-202 : 8.52 ± 1.2 °C / 17.57 ± 1.2 °C

Are these differences significant ?

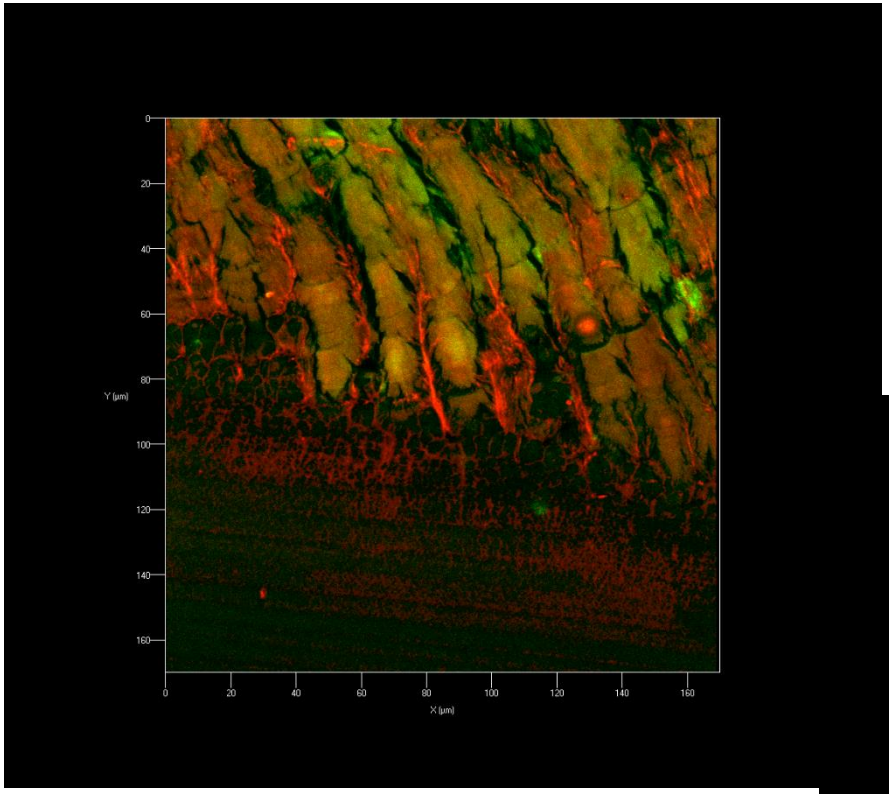
Do they mean something in terms of palaeo-environment ?

- Beniguet-201 : 9.75 ± 0.6 °C / 18.32 ± 0.6 °C

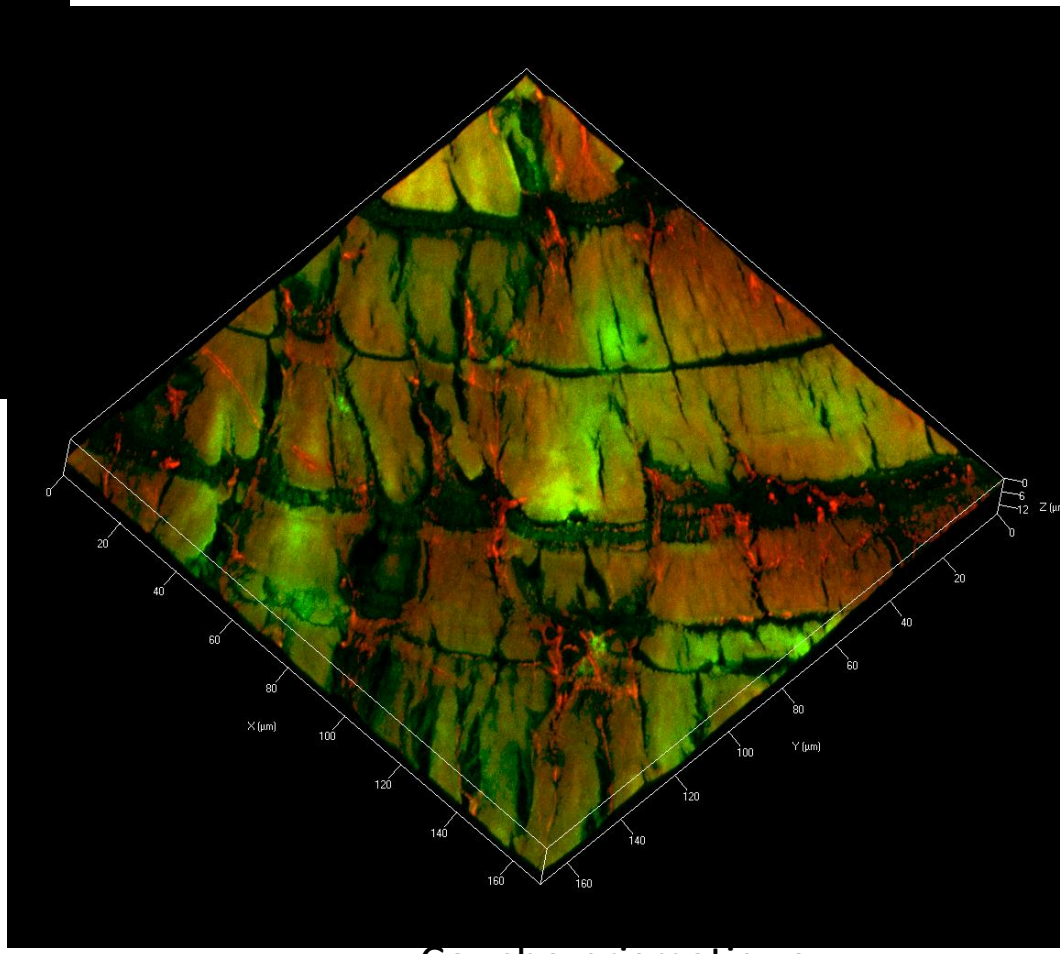
- Beniguet-200 : 10.4°C ± 0.4 °C / 18.35 ± 0.5 °C

FISH, sonde EUK (18S) + FITC

+ contre-coloration IP



Couche prismatique
et couche interne



Coquille 25-1

Couche prismatique