GAIN
Green Aquaculture Intensification

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 773330

Innovative circular processes for bivalve shells valorisation

Martiña Ferreira, Diego Méndez & Leticia Regueiro
ANFACO-CECOPESCA

June 2021

First of all, hello to everyone and welcome to this unit coordinated by Anfaco, and produced by Martiña Ferreira, Diego Méndez and Leticia Regueiro.

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Part 2: Historic examples of shellfish by-product valorisation

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In this second part we look at some historic examples of shellfish by-product valorisation.

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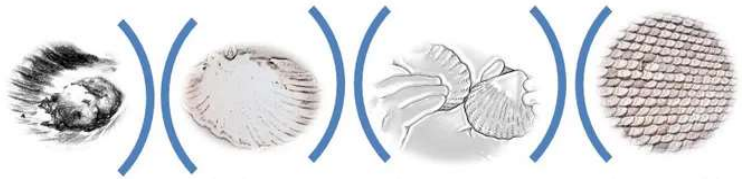
PAST USES: Scallop a circular economy example from 1000 years ago

Circular economy concept in scallops come from XII century.

Scallops have been used as: ashtrays, musical instrument, for cooking, amendment to the soil, drinking utensil and as construction material.



Looking more generally at Galician uses for shells, we should consider the example of scallop.
The circular economy is a current concept based on the evolution of the well-established concept of the 3Rs (reduce, reuse and recycle) to a multi-R system (rethink, redesign, redistribute, recover, repair ...) seeking a cycle of continuous use of resources. The long history of the scallop as a food has allowed us to explore a myriad of applications in search of an integral multifunctionality of the mollusc, already named in the Códice Calixtino in the twelfth century.

Some of the possibilities of this material across the years are non-industrial applications but with varied options:

- It was used as musical instrument. The scallop is an important element in Galician percussion, a symbol of our traditional music.
- Also it was used as an ashtray. With the introduction of New World crops in Europe during the 16th century, a new use appears: their use as ashtrays to collect tobacco ashes. It can still be seen today in many cafes in Galician region.
- Another application is as container for cooking. In fact. the scallop is one of the few foods that has its own built-in kitchen container, as its concave shell is *par-excellence* where it is cooked and served.

- A traditional use in Galicia is as a soil conditioner. As the main component of the shell is calcium carbonate, after its crushing, it was used as an excellent neutralizer of the acidity of the soils that is characteristic of Galician soils, and as a pH corrector. This allows a notable increase in crop production, by increasing the mineralization rate of organic matter present in the soil.
- Also scallops were used as a drinking utensil. The concave shell is a simple and practical instrument for drinking from fountains and streams. Important for a pilgrim, hikers or circular explorer.
- Finally it is important to highlight their importance as a construction material. Vernacular architecture in Galicia used the "flat" shell of the scallop as a waterproof layer in coastal areas. On the island of La Toja, located in O Grove, Pontevedra, you can admire the chapel with this construction technique as you can see in the images at the right side

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PAST USES: Construction

Shells from molluscs have been used in the construction in many coastal settlements around the globe.
For instance, shells have been used in construction in the Saloum Delta, Senegal as far back as 5000 years ago

Specifically "Tabby" is a form of concrete made by heat-treating shells to form lime, and then creating a mixture of lime, sand, water, ash and broken shells. Oyster shells have been traditionally used in this process. Tabby structures are still standing in Florida, Georgia and the Carolina's, as well as parts of Spain and Southern England.

One of the main uses of the shells in the past is related to the construction field.

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Shells from molluscs have been used in construction in many coastal settlements around the globe. Specifically Tabby is a form of concrete made by heat-treating shells to form lime, then creating a mixture of lime, sand, water, ash and broken shells. Specifically, the oyster shells have been traditionally used in this process. The origin of Tabby is disputed between North Africa, India, and Spain. However the word, Tabby comes from the Spanish word "tapia" meaning "earth compacted between boards".
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PAST USES: Construction

Tabby consists of: lime+shells+sand+water+ash

Tabby Composition consists of:
Lime as the binder, the glue. The shells as the aggregate. The Sand is used to prevent shrinkage and cracking of the tabby mixture.
River sand is used; since beach and dune sand contained too much salt.
Other ingredients are water and ash.
The "recipe" for tabby is equal parts lime, sand, water, and shells, plus small amounts of wood ash.
Ash by-product from burning the shells could be used to increase hydraulicity, which is the ability of a binder to harden in contact with water, contributing to tabby's durability.
This use for construction is low cost, considering the materials, but very laborious and it does not resist fire well.

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PAST USES: medicinal uses.

In Southern Africa, in the 19th Century, wearing a shell amulet was thought to help maintain health, fertility and luck. Oyster shell amulets coated in gold, silver, or electrum found in Egypt were known to have been worn during the Middle Kingdom as a form of functional jewellery that promoted good health.

British Museum

Another past use of the shells is related to their medicinal uses in form of amulets.
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Oyster shell amulets coated in gold, silver, or electrum found in Egypt were known to have been worn during the Middle Kingdom as a form of functional jewellery that promoted good health.

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PAST USES: Jewellery

Mollusc shells and jewellery have been intricately linked through history.
In fact, the oldest identified piece of jewellery in the world was discovered in Israel and is made from the shells of the sea snail *Nassarius gibbosulus*. This sea snail shell jewellery dates back to between 100,000 and 135,000 years ago

By 50,000 years ago, during the Upper Palaeolithic, shell adornments were common across Europe and Asia (Fernandez and Joris, 2007). Further, records of shell jewellery in Middle Palaeolithic archaeological sites have been used as evidence for the paradigm shift that early modern humans in the Levant and Africa were more behaviourally, socially, and culturally advanced than had been previously assumed.

However the shells as part of jewellery continues today.

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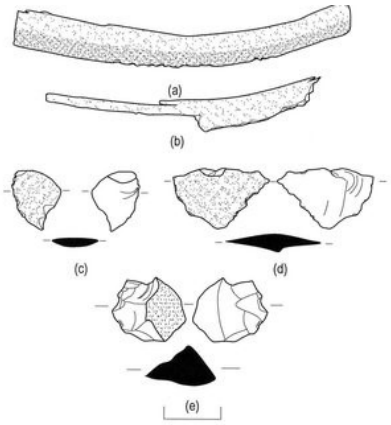
PAST USES: Tools

There are countless records of the use of mollusc shells as tools. Many of these applications are centred on their weight bearing potential and toughness: this is testament to mollusc shell strength and hardness which must have been clearly understood throughout modern human history.

A study of a single archaeological site in Texas recovered over 3000 shell artefacts, many of which would have been used as tools for a variety of purposes including hammering, bevelling, chipping, chopping, and cutting. Other examples of mollusc shells as tools include the sea snail *Melo melo* whose common name is the "Bailer shell", due to its use as a water bailing device in the canoes of native Australians. The shell is thought to have been used for many other tools, including as cooking pots by Australian Aboriginals.



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On this image you can see baler shell knives and flaked clam from midden sites, in Cape Range Peninsula.

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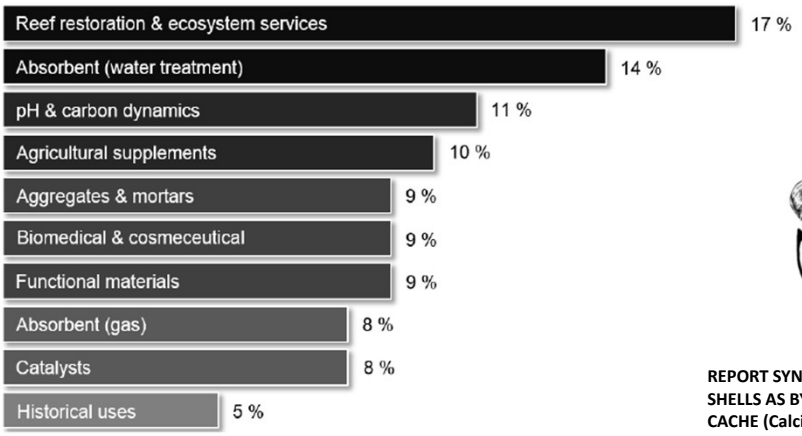
PAST USES: Tools



REPORT SYNTHESISING THE EXISTING AND POTENTIAL USES OF SHELLS AS BY-PRODUCTS OF THE AQUACULTURE INDUSTRY. CACHE (Calcium in a Changing Environment) PROJECT

https://zenodo.org/record/2662011/files/Shell_Waste_Report.pdf?download=1

On this slide you can see the main uses today according to the report provided by the Project Cache, "Calcium in a Changing environment".
The two uses leading uses accounting for 17% and 14% respectively, are in reef restoration and as an absorbent for water treatment.
Another similar use, for pH control ranks third. In these cases the use of shells to control the carbon dynamics can be useful in several water treatment applications.
The other uses, all of them important since they account for around 8-10% of uses, are as agricultural supplements, for use in aggregates and mortars, for biomedical and cosmeceutical fields, as well as functional materials, such as catalysts or gas absorbent.
Finally, the historical uses account for around 5% of the current applications.

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End of Part 2
Thank you for you attention

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We hope you have found this second part of the presentation interesting. When you are ready, you can proceed to Part 3.