



A SEA CHANGE

HAS THE SCOURGE OF OCEAN WASTE PLASTIC BECOME A DISTRACTION FROM THE RAW POTENTIAL OF THE SEA'S RESOURCES? MEET A NEW GENERATION OF FUTURE-PROOF BIOMATERIALS MADE FROM SEAWEED, SEDIMENT AND OYSTER SHELLS.

by **Cat Olley**

In Greek mythology, Prometheus is the mighty fire-bringer who taught humankind how to wield the wild essence of nature. So it is a fitting moniker for Prometheus Materials, a Colorado startup that may be close to tackling one of our most pressing climate challenges: the grey plague of concrete.

If it were a country, concrete would rank third in emissions behind China and the United States, thanks to a potent mix of intensive production and utter ubiquity. Prometheus Materials has found an answer in microalgae, which will grow a bio-cement that reproduces itself like coral when seawater, sunlight and CO₂ are added. Unlike traditional Portland cement, formed under fierce heat of around 1,450°C, it can be produced at ambient temperatures with near zero carbon emissions. Prometheus gave us fire – his namesake has worked out how to do without.

The two-year-old company, now backed by the Microsoft Climate Innovation Fund, has joined a growing contingent of studios and startups making radical use of marine resources. Leading the imitation game is French firm Scale, whose fully recyclable Scalite material looks and acts much like marble, but is made exclusively from fish scales discarded by the fishing industry. Gallic shores also supply Gwilén, which funnels sediment from Breton fishing ports into its Zellige-esque tiles.

'In many coastal regions, people knew how to work with the sea for materials, like using seaweed as fertiliser, food or in pharmaceutical applications. But much of that knowledge got overlooked and forgotten,' says Dutch material researcher and designer Nienke Hoogvliet. 'Now, because of our increasing scientific knowledge about the ocean, we're slowly starting to see it as a source for change again.'

She suspects it was a childhood spent wandering the beaches of The Hague that first planted the seed, but says a particular walk while at art school sparked a 'fascination' with seaweed. The resulting Sea Me furniture collection, which takes a zero-waste approach to seaweed-based yarn and dyes, now resides in the Centraal Museum in Utrecht. Two years ago, she co-launched Zeefier – 'sea proud' in Dutch – a startup dedicated to 'upscaling' natural seaweed dyes for textiles and next year will present, alongside her partners, the market's first seaweed-dyed products.

In praise of algae

If any marine material is threatening to go mainstream, it's seaweed. In March, all three winners of the inaugural Tom Ford Plastic Innovation Prize produced seaweed-based biodegradable packaging, with one recipient, London studio Notpla, calling it 'one of our greatest weapons against climate change'.

Abundant and fast-growing, seaweed can be sustainably farmed without the need for land, fresh water or fertiliser. It plays a vital role

in absorbing carbon and sheltering marine life in the sea, but can turn toxic when vast fields proliferate at the shoreline and begin to decompose. Alarmed by the speed at which seaweed was encroaching on the beaches of Brittany, Paris-based designer Samuel To-matis has dedicated his practice to its study, producing everything from algae-based paper and bricks to a leather alternative, which he describes as 'a dialogue between science, design and artisan-ship'. Seaweed textiles are taking off – among the most high-profile ambassadors is SeaCell, a Florida-based firm spinning breathable fabrics from tree cellulose fibres and brown algae found in the Icelandic fjords. Chilean designer Margarita Talep, meanwhile, has just started taking commissions for her ethereal algae-based vessels, which evoke their origins through ruffled forms.

Wary of upsetting delicate marine ecology by harvesting wild seaweed, Dutch designers Eric Klarenbeek and Maartje Dros have established the SeaweedCycle, a closed production loop that connects labs who grow seaweed 'embryos' to land farmers who use it to nitrify plants. They have used algae – an umbrella term for usually aquatic plants that encompasses all seaweeds – to create everything from a 3D-printed biopolymer dress for Iris van Herpen to a replica of Peter Ghyczy's Garden Egg chair. Says Dros: 'The seaweed economy in the Netherlands is just kicking off. These organisms have the potential to restore our planet's balance and ecology, if done responsibly and right.'

The hard shell

Hyein Choi, the co-founder of Korean-based design studio Newtab-22, agrees that the lessons coming out of labs are fuelling the design industry's interest in the ocean ecosystem. 'It has become more accessible – and there is always high demand for sustainable ways of building for the future,' she says. Newtab-22's headline act is Sea Stone, a terrazzo-like material made from ground oyster shells and natural binders that it has used to produce home accessories such as mirrors and trays, as well as tiles recently used to clad a COS store in Busan. It relies on simple chemistry: oyster shells contain more than 90 per cent calcium carbonate, which is equivalent to limestone. French startup Ostrea's 'marine terrazzo' uses 65 per cent recycled seashells, while Swedish designer Carolina Härdh studied the waste streams of Gothenburg restaurant Vrå to produce its brutalist furniture from oyster shells and fish-bone glue.

For every hero hauling plastic waste out of our oceans, there is another trying to prevent it from arriving there in the first place. California-based startup Cruz Foam, which counts Leonardo DiCaprio among its investors, has created a chitin-based compostable alternative to styrofoam, derived from the 12 million tons of shrimp shell waste produced annually. It has been designed to slot seamlessly into existing systems. 'There are a number of sustainable ►

packaging products emerging, but most lack scalability within the current supply chain, fail to achieve price parity, or can't match the technical requirements of conventional alternatives,' says CEO and co-founder John Felts. 'Cruz Foam was specifically developed to align with the same machinery used in the production of plastic foams'.

A rising tide

A naturally occurring polymer found in the exoskeleton of crustaceans and insects, chitin has been hailed as a wonder material. Emerging from Harvard's Wyss Institute, shrilk is a hybrid made from chitin-derived chitosan and silk protein that could one day suture wounds or support tissue regeneration. Meanwhile, New York-based designer Uyen Tran combines the same chitin with coffee grounds to create an embossable leather alternative called TômTex. Big names are catching on. Finnish design house Marimekko recently collaborated with materials innovators Origin by Ocean on a capsule collection of textiles printed using an algae-based thickener, while Italian surface brand Oltrematara has launched A Mare, a resin-based option consisting of 60 per cent waste seashells. However, for Hoogvliet, it's crucial that we do not repeat the mistakes we have made on terra firma, where unsustainable agriculture has left behind a legacy of exhausted soil and depleted biodiversity. 'I think it's very important that we see these "discoveries" not as something new to capitalise on,' she says, 'but as an opportunity to change the way we produce with care and lots of thought.' ■



Besitt-bench by
Carolina Härth



Vessel by Margarita Talep

Austeja Platukyte

CREATIVE RESEARCHER AND MATERIAL DESIGNER

What's the big idea? Seaweed Foam is a fully home-compostable bio-foam that can be used as an alternative to plastic packaging. It was created by accident, during experiments with different biomaterials. It showed good cushioning properties, so I researched potential applications and realised it would be ideal for packaging.

How does it solve a problem?

Today, we face a huge issue of synthetic waste because products that are designed to be disposable or for short-term use are made from durable materials like plastic.

Currently, the leading materials for degradable foam packaging are derived from corn starch. Producing disposable packaging from food materials is un-

economic and even unethical, because more than enough food is produced worldwide to feed the whole population, but around 811 million people are still starving.

Seaweed Foam is designed to function as a secondary packaging material, cushioning or packaging peanuts, but it could also be used for backpack and helmet paddings or to replace other synthetic styrofoam products.

What's next? I want to find local partners to supply raw seaweed waste as, at the moment, the project uses seaweed collected in Iceland. The aim is to collect local bladderwrack seaweed (*Fucus vesiculosus*) from the coastlines of countries bordering the Baltic Sea. Then it's a case of scaling up production.



PHOTOGRAPHY: EGLE CIMALANSKAITE

Davide Balda

MULTIDISCIPLINARY DESIGNER

What's the big idea? I'm creating a concrete alternative from by-products generated by small businesses in the Italian port town of Fano.

Inspired by the historic local production of Roman cement, it contains two main elements: clam shell waste, for its source of calcium carbonate, and volcanic ashes, such as *pozzolana*, which are rich in minerals like silicon dioxide and aluminium oxide. They make an excellent binder when mixed with lime and water.

We also add river sand or waste glass, plus *cocciopesto* – a type of terracotta waste collected from local potters.

How does it solve a problem? It's a geopolymer with the technical characteristics of natural rock – durability, hardness and resistance to chemicals, heat and sudden changes in temperature – so it can be used to produce everything from bricks and tiles to street furniture and sculpture. And it's carbon negative, as it absorbs carbon dioxide from the air.

The project is also about knowledge sharing and collaboration – we're joining forces to transform waste into something useful.

What's next? Technical refinement. The project has been awarded funding through several open calls, but I'm now looking to connect with companies interested in helping it evolve further. I want to generate 'concrete' change in the construction sector.



Pink vase by Newlab-22



Prometheus' materials



Zeefier by Nienke
Hoogvliet



PHOTOGRAPHY: FEMKE DEJERMAN

Lotte Wigman

DESIGN ACADEMY EINDHOVEN GRADUATE

What's the big idea? I've designed a tidal pool that interacts with humans and non-human life by capturing and channeling water. It's made of Seacrete, which I make by mixing shells and seaweed harvested from the Dutch coast with mussels and oysters from the food industry. These are combined with a seaweed-based binder. By only using these local resources, they stay in the biological material cycle and the

same ecosystem they came from.

How does it solve a problem?

Designing for the Symbiocene – an era of co-dependence between humans and the natural world – is an exciting new direction in eco-friendly building materials. This project proposes a new 'material culture' based on the sea and its inhabitants as an alternative to cement and concrete, which is the leading polluter in the building industry.

Oysters and mussels are abundant sources of lime. Seacrete gradually wears away, like cliffs eroded by the wind and sea, adding value to the landscape.

What's next? In my own practice, it will be designing and experimenting with bio-materials and researching new possibilities for future materials for architectural purposes. And I'll continue developing Seacrete to make the material even better for architectural applications.