- Biochemistry / Medical awareness

POTIONS from the OCEANS

Hidden beneath the waves, myriad marine species hold the key to treating some of our most aggressive illnesses.

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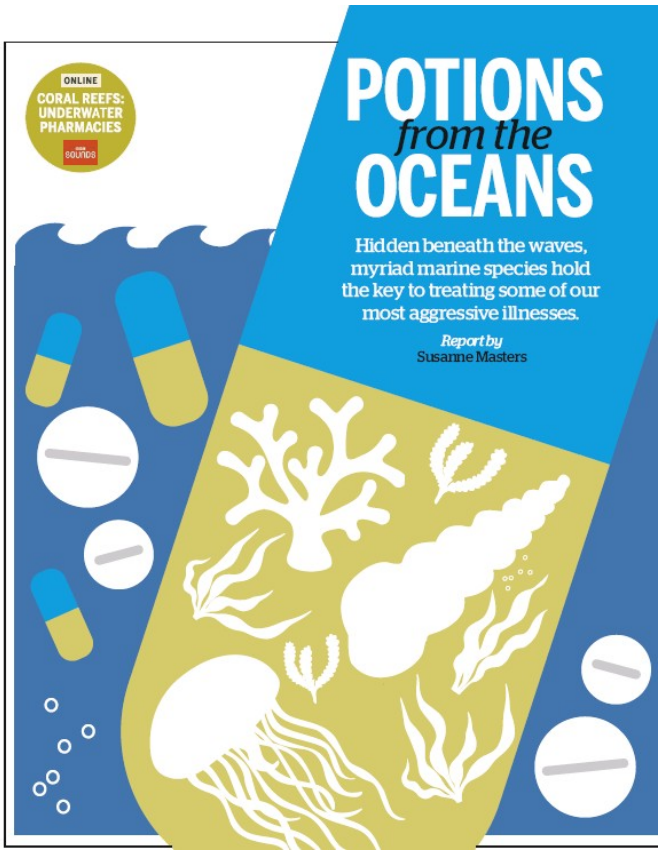

Think about harnessing the medicinal potential of the natural world, and images may come to mind of the archetypal explorer cutting a path through a tangle of exotic jungle. But in our constant search for new cures and treatments from the wild, attention is increasingly moving from land to sea.

"Tropical rainforests are treasure troves of biodiversity and possibility, but there are many other underexplored biomes worth investigating for natural pharmaceuticals," says Cassandra Quave from Emory University, Georgia, USA, who spent her early career looking at uses of plants in the Peruvian jungle. "With marine environments still relatively underexplored, medicine from the ocean is at the frontier of drug development."

Marine bioprospecting, as it's known, may be a relatively new area of science, but the ocean has long been giving up its riches for use in traditional medicine. In the Aegadian Islands, off the coast of Sicily, locals collect the fresh leaves of Neptune grass from the shallow seabed and use them as compresses to treat haemorrhoids. Meanwhile, seahorses, which are already threatened by trawling and non-selective fishing methods, are highly sought after for their supposed healing properties. "Seahorses are used in traditional medicine around the world, particularly in China," says Sarah Foster, research associate with Project Seahorse. "Large-scale consumption has been also documented in Indonesia and Vietnam."

Sponge saviours

Marine pharmaceuticals first emerged in the 1950s, with a shallow-water sponge that grows in the Caribbean Sea. With no scales or hide to protect itself, nor teeth, claws or spines to defend itself, this sedentary species relies instead on an unseen chemical arsenal. Two substances, spongothymidine and spongouridine, were isolated from the plant by scientists and used in the development of antiviral and anti-cancer drugs. The research eventually led to revolutionary treatment for leukaemia, and AZT, the drug that has transformed a diagnosis of HIV from a death sentence to a treatable condition.

Seventy years on, this field of research has expanded rapidly. Today, diverse forms of undersea life – from coral to cone snails – provide the basis for pharmaceuticals and materials that can treat a host of human health conditions (see p37).

Tapping the ocean for its medicinal bounty has been a slow process, not least because of the nature of the environment itself: the capability to reach, observe and explore the underwater world has only been fulfilled in recent decades with the advent of scuba equipment and remotely operated vehicles. But the tides are a-changing – various factors are now providing a real impetus for marine bioprospecting.

Mission medicine

First, there's a pressing need for new pharmaceuticals. Accelerating antibiotic resistance is considered by the World Health Organisation to be a severe threat to global well-being. Boasting a repertoire of unusual compounds, marine species offer myriad possibilities in the search for chemicals that could lead to the development of new drugs.

Then there's the Nagoya Protocol, which came into being in 2014. This international agreement aims to ensure that the benefits arising from research into genetic plant and animal material

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are fairly shared. It also strengthens the sovereignty of countries over their own biodiversity, making biopiracy (taking resources without permission) more difficult. So, countries with underexplored marine riches off their shores can be more proactive in research. Finally, the threat of deep-sea mining looms over oceans worldwide. As terrestrial deposits of minerals such as manganese, lithium and cobalt – used in the manufacture of smartphones and green technologies – are depleted, eyes are turning to the sea as a potential new source. But deep-sea species are little known, fragile and can have limited distributions. If we start scraping away the sea floor before we've had a chance to safeguard the creatures that live there, we could destroy a wealth of biological resources before we even recognise their worth.

Some marine species don't necessarily offer medicinal potential but are still essential to biomedical science. Possibly the most famous example is the horseshoe crab, whose brightblue blood is highly sensitive to bacterial toxins, and has for decades been harvested to check that medical equipment and drugs are free from contamination. Other, lesserknown species include Gelidium seaweeds, whose gelatinous agar is used to culture bacteria for drug trials, and a jellyfish known as crystal jelly, whose green fluorescent protein, inserted into bacteria, enables researchers to observe a host of cellular processes.

At a fundamental level, marine bioprospecting begins with observing wildlife. Dr Angela Ziltener, founder and president of Dolphin Watch Alliance, has observed IndoPacific bottlenose dolphins appearing to self-medicate with gorgonian corals. By rubbing against the corals, which are known to have an antimicrobial mucus layer, the dolphins may be treating themselves against infection. Ziltener is thus analysing gorgonian mucus to discover the contents of its chemical larder.

Safeguard the source

It's clear that the ocean could yield all manner of helpful therapies in the future. The big question, though, is how we balance our need for medicine with protection for the very species that provide it. It takes, for example, one ton of mangrove tunicate to yield just one gram of the chemotherapy drug Trabectedin.

According to Dr Julia Kubanek, an expert on marine microbiology, the answer lies in replication and assimilation: "The marine organisms that hold the secrets for future medicines do so by encoding their production in their genomes," she says. "The future is to unravel the genetic basis for these natural products and then recapitulate the genetic pathways in other organisms that can be grown in a lab – for example, in bacteria and yeast, which can be mass produced.

That way, we don't need to harvest wild plants or animals, and we can mix-andmatch parts of the molecules to make even better medicines. Life-saving drugs wouldn't have to cost the lives of marine species."

Rather than a pirate's chest of gold, the richness of the sea is offered in the form of chemicals from snails, slime and seaweed. As much as charismatic marine species such as dolphins, sharks and seals may capture our attention, the humble and often little-known marine species that can offer us life-saving treatments are equally deserving of conservation and appreciation.

Indeed, perhaps our need for medicine could play a part in safeguarding our oceans. "Now that we know how important marine ecosystems are to health – not only of the planet itself, but also that of its human inhabitants," says Kubanek, "people are paying a lot more attention to what happens underwater."