

Have you ever heard of crabs that hitchhike through the seas on the back of whales? Were you aware that there are red-blinking colonies of clones that silently drift through the ocean? Or that fish bathe in freshwater springs that gush out of the bottom of the sea? You will find these and many other enthralling stories in this book, which presents some of the most fascinating facets of current marine research. In exciting chapters you will get to know exotic, colourful and sometimes even frightening creatures. You will learn what insights marine scientists have gained in recent years about life in the sea; whether on their expeditions with high-resolution cameras, through autonomous diving robots or highly sensitive measuring instruments. Dive with us into this remote world... if you dare...



ALL ABOUT FISH AND FELLOWS

TIM SCHRÖDER

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UNTOLD SCIENCE STORIES
FROM THE VAST OCEAN

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All about fish and fellows
Untold science stories from the vast ocean

About the Author

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PREFACE

The Ocean is a long-lasting companion of mine. As a child my parents often took me to the beach during our holidays. However, I only started seeing the ocean as a vital habitat when I participated in an internship at a Nature conservation association at the North Sea when I was 14. You might say that the German Bight does not really fit the picture of the term “ocean”. This is probably because you don’t encounter waves crashing non-stop against the beach and rocks that so slightly separate the land from the mysterious underwater world. Here, at the north coast of Germany you can find the biggest extent of mudflats worldwide, stretching 500 kilometres also along the Danish and Dutch coastline – the “Wadden Sea”. Powered by the gravitational pull of the moon and Earth’s centrifugal force, the area between the Dutch village Den Helder and the Danish town Esbjerg is free of seawater every twelve hours during low tide. Tourists that come to visit this vast sea of silt and mud for the first time, often associate this ecosystem with a desert. But this barren looking mudflat is teeming with life. Countless worms, crabs, muscles and snails live buried in the ground. They serve as a rich buffet for fish and millions of migratory birds that use the Wadden Sea

for a pitstop to fill up on fuel before continuing to Scandinavia and Siberia.

I was overwhelmed when I first caught sight of this vast outstretch of mudland, reaching to the horizon and filled with the sound of thousands of chirping birds and the smell of algae and salt – a haven for your soul and body. Over the coming years I took nearly every school holiday as a chance to travel to the Wadden Sea and be an intern at the Nature conservation association; and during this time, my passion for the oceans and the determination to study Biology grew.

During my studies I got to travel to other oceans too. I saw the Mediterranean Sea with its unique clear waters off the coast of Croatia, and the powerful Atlantic coast where the enormous Namibian red dunes swirl down to kiss the coastline and the bordering sea. I learned that every region of the oceans is unique and provides for a variety of fascinating creatures that amaze in their diversity.

I distinctly recall the moment when I went diving for the first time in the Mediterranean Sea and caught a glimpse of a pair of observing eyes which belonged to a squid. It was looking at me as if to say “You’ve been rumbled!”, not at all like the fish with their empty gaze. It was fascinating but spooky at the same time. I was used to being looked at that

way by cats and dogs, but not by a slimy creature that you usually only come across when it's rolled up as a shrimp on your plate. Later I learned that the cephalopods, to which my observer belonged, are indeed highly intelligent. This and a lot of other experiences intensified my love for the ocean. And so, I chose a career as a scientific journalist, often writing about the Oceans, Marine Physics, Oceanography, and the dangers of Climate Change, but mostly about the ocean's inhabitants. In this book, I have collected most fascinating facts about marine animals, plants and phenomena which I have had the honour to encounter through my work over the past years. The result are stories of quite absurd creatures, record holders and animals so beautiful they could take your breath away. I hereby would like to invite you, dear reader, to understand and hopefully share the love that has connected me and the ocean for so many years now. ☪

THE ART OF LIVING



Sponge *Euplectella*

SPONGEBOB'S™ CLASSMATES

Sponges show us how to build lightly yet sturdily. They demonstrate how to conduct light. But above all, they can fight tumours and viruses, as sponges are the pharmacies of the oceans.

One might think that sponges are the most boring animals of all. They stick firmly to the seabed and do nothing but swirl. Millions of the finest cilia, the Latin word for eyelash, beat in unison inside their porous bodies and generate a current by sucking in water, suspended matter and food particles. Swirl, swirl, swirl. Sponges are the stoics of the oceans. They sit in the same spot their entire lives which can last a long time. Some sponges live for several thousand years. They are the record holders for the longest lifespan in the animal kingdom. Even in time-lapse photography, sponges remain still: If you are lucky, their bodies wrinkle a little in twelve hours. Apart from an infinitely slow twitch, so to speak, more life movement is usually not visible. Niklas Kornder from the University of Amsterdam recently discovered that sponges even sneeze in slow motion. Humans fling dust out of their noses with their snot in fractions of a second. The Dutch expert's time-lapse recordings reveal that sponges sneeze for half

an hour. During this time, they repeatedly contract and relax their skin surface to remove crumbs and dirt from their pores. Compared to a sponge, a sloth is a downright excited creature.

CAMEMBERT AND SCRAWNY FORESTS

No wonder that sponges were a secondary matter for science for a long time. It is only in the last few decades that marine biologists around the world have started to study these creatures more closely. It is estimated that there are almost 10,000 sponge species worldwide, far more than SpongeBob™ with his bathing sponge body. Some swank on the reef like bulbous, bulging wine barrels. Some stick under rocks like melted Camembert. Others stand close together in scrawny forests of long-fingered creatures. Sponges live in the pitch-black deep sea and in the sun-drenched waters of the coasts, thrive in the fresh waters of Lake Baikal and even in the murk of dirty docks. Among the most beautiful is undoubtedly *Euplectella*, a glass sponge that looks as fragile as a solidified stocking made of the finest lace.

Sponges are filled with a whole cocktail of biochemical substances. They are the pharmacies of the sea,

because those who are stuck to the ground can only defend themselves with a chemical weapon. Each sponge species has its own survival cocktail – glycoproteins as anti-freeze protection or toxins as poison to deter predators. Even marine slugs armed with their deadly radulas – tongues rough as sandpaper – reject the rested bottom-dwellers when they extend their chemical claws. Moreover, sponges produce antibiotic substances that prevent bacteria from overgrowing their skin.

A TONNE OF WATER A DAY

A kilogramme of sponge pumps and filters a tonne of water a day. And even a single millilitre can contain thousands of bacteria, including a huge amount of potentially harmful germs. An organism can only survive such a load of pathogens if it has an entire medicine cabinet at its disposal. Homer's ancient Greek warrior contemporaries already had an inkling of this: the ancient fighters pressed bandages made of sponges onto bleeding gashes and suppurating wounds. Today we know that many of these complex biomolecules not only inhibit inflammation, but also slow down tumour growth and even kill viruses.

Probably the best-known molecule from sponges is Ara-A, which an international team of researchers isolated from a sponge in 1975: it is one of the ingredients present in drugs that treat herpes. At the time, the researchers found that Ara-A paralyses the genetic reproduction of the viruses. The most important requirement for the industrial production of the herpes virus killer was also fulfilled: replicating the molecule of the natural substance in the laboratory. Since sponges only contain defence substances in homeopathic doses, it would be necessary to harvest square kilometres of sponges in order to obtain a dose that is effective for humans. In recent years, many magical substances from sponges have failed to overcome this hurdle. Avarol, a promising HIV drug, for example, made it to the clinical trial stage. But the replication in the laboratory failed; the synthesis of the large molecule was too complex. But the search continues. To discover new active ingredients, sponges are processed into a kind of puree. One drop of it can contain hundreds of compounds. The challenge is to pick out the right ones from this vast range of substances.

It is no coincidence that the ingredients of these marine animals cure human diseases so effectively. Today, it is assumed that sponges are living fossils

and the direct descendants of the first primitive animal from which all higher organisms evolved. The sponge remained in its primal form and preserved archaic metabolic functions that humans have long since lost, but which today they could clearly make good use of from time to time, for example, when they get sick.

DINOS ARE JUST TEENAGERS

For a long time, researchers did not even know how to classify these creatures.

The oldest prehistoric animals that can be found in excavations today are sponges. Some are 600 million years old. Compared to that, the fossils of the dinosaurs, with their 200 million years, are just teenagers. But what we are actually dealing with was unclear for a long time. Sponges were relegated to a place in the grey area of life, demoted to Parazoa, “secondary animals”, separate from the real “animals”, the Metazoa.

Today we know that they are indeed “real animals” – and that they have more in common with us humans than suspected. Many proteins that we humans have built-in to us are also found in the sponges. These can be proteins of the immune

system, proteins for cancer defence or other bodily functions. It is extremely unlikely that evolution would invent such sophisticated proteins with such complex functions on several separate occasions. Therefore, scientists assume that sponges are our first and oldest relatives. And they are by no means primitive. On the contrary: more metabolic processes take place in sponges than in all other living creatures. It looks as if the sponge is a kind of multi-functional metabolic archetype and as if every higher developed animal with its specific specialisation has discarded this diversity as unnecessary ballast.

LIVING GLASSWORKS

But it is not only the sponges' substances that are impressive. Their structure is also fascinating – especially their needle like skeletons. These microscopic spicules have been known for centuries. They make bath sponges so beautifully scratchy. It is only in recent years, however, that researchers have really understood what spicules are all about: They are made of pure silicate, of glass. This makes sponges living glass factories. Humans need hundreds of degrees of heat to make glass. Sponges, on the other hand, are able to manufacture silicate under extremely

moderate conditions in the sea, and to do so in such a precise and well-ordered manner that no chemistry laboratory in the world can match. A few years ago, scientists unravelled this biological glass production: Two proteins, silicatein and silicase, transform the silicic acid dissolved in water into the biosilicate molecules, from which the needles grow out layer by layer. The sponge is thus one of the very few creatures in the world that can synthesise non-living, inorganic raw materials. The sponge *Monorhaphis*, for example, has only one enormous spicule: it is three metres long and centimetres thick. *Monorhaphis* sticks out of the muddy seabed like a spear. The actual body hangs suspended like a spiked marsh-mellow far from the mud in the fresh seawater.

In the glass sponge *Euplectella*, in turn, tiny spicules grow together to form the finely woven “stocking” – an elongated cavity that is closed at the upper end. *Euplectella* grows in the waters around Japan. There it is popular as an exotic wedding gift. Not only because it is so beautiful, but also because of its symbolic value: In Japanese waters lives the shrimp *Spongiicola venusta*, which specialises in an existence inside the “stocking”. *Spongiicola* feeds on what the sponge’s cilia fan in. Eventually, it is so large that it can no longer fit through the spicule web – and

is trapped inside. Males and females often inhabit their prison together – the perfect symbol for a marriage that ideally should last a lifetime. For centuries, brides and grooms have therefore given each other sponges as wedding gifts – occasionally with a shriveled pair of shrimp inside.

But the silicate not only acts as a beautiful supporting structure. It can do even more. For a long time, biologists wondered why some sponges contract when they are poked, not only at the point of pressure, but occasionally also on the rear end. No one could explain how the pressure stimulus travels so quickly to the other side of the sponge; after all, these primitive animals do not have a nervous system. A few years ago, however, researchers at the University of Genoa made a sensational discovery: the biosilicate skeleton conducts light. By now, there are many indications that sponges use it to push information through their bodies. Cities are currently boasting about their modern fibre-optic communication networks – but sponges have clearly been using them for 600 million years. ☞