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Rock Pool

Extraordinary Encounters
Between the Tides



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INTRODUCTION

Glimpsing the Underwater World



*Une fois qu'elle vous a ensorcelé, la mer vous tient
pour toujours dans son filet à merveilles.*

The sea, once it casts its spell,
holds you in its net of wonder for ever.

Jaques-Yves Cousteau

Borders are places of contrasting extremes, places where the rules suddenly change and the unfamiliar beckons. Beaches mark one of the most extreme frontiers on our planet, the line between land and sea, where our everyday experience gives way to an alien world in which we are not equipped to survive. On the other side of the tideline, life is tough. There are extreme temperatures, salinity, pressure and currents to contend with: challenges that are exacerbated by fierce competition for survival among the inhabitants of the shore.

The marine world is largely an unexplored one. It is easier to trek to the Poles or to scale the highest peaks than it is to wander the deepest seabeds. Even our shallowest waters are mostly known only to divers. Yet twice each day, for a few short hours, the sea's protective cover slips away. The border moves back and allows us to walk into this curious realm, where every creature has a remarkable story to tell, from the common limpet to the curled octopus. What we know is astounding, and there is much still to be discovered.

With every step I take down the beach, I am heading further into the seabed. I am trespassing in the marine world. More than once I have forgotten my place, becoming entranced by my exploration of distant rocks and kelp beds, finally looking up to realise that the water level has changed, that a current is flowing through gaps in the rock and that my way back to shore will soon be flooded. Heart pounding, feet flailing on seaweeds and slipping on rocks, I scramble to beat the flooding tide, hurrying to reach dry land before the sea cuts me off.

Afterwards, I tell myself that my panic was irrational, that there was no need to rush, but it is a fear I cannot overcome. Even on the calmest day the sea's power is immense, and I cannot shake the knowledge that this world is not mine. Neither can I shake the fascination it holds.

There is a beach that never fails to make me happy. It isn't in the Cornwall tourist brochures and you can't book in to a hotel there. There are no cafés, not even a road, but that is its charm. To visit Porth Mear, on the wild north coast near the stone stacks of Bedruthan Steps, is to take a flight from the highest, springy-turfed cliff tops to the hidden depths of the ocean.

I first knew it was a special beach when I was at primary school and a friend told me that his uncle had caught a giant

goby there. Or he might have said guppy; we didn't know much about fish then. Either way, it was a magical creature, with Mick Jagger lips and piggy eyes, and his uncle had scooped it from a pool so deep you could swim there if you dared.

Porth Mear was walkable from my home in Mawgan Porth with a bit of determination and a *Star Wars* flask of pink milkshake to keep me going, but it was easier if I could persuade my parents to take the car to the valley head and park alongside the Cornish hedge next to the wheat field. Every gap in the stacked and herring-boned slates sprouted with soft greenery, festooned with alexanders, cornflowers or valerian, depending on the season.

Beside the lonely whitewashed farmhouse that seemed to belong in a *Famous Five* mystery, a slate stile built into the wall crossed to the fields. The gate beside the stile was always unlocked, but I never went through it. Every time, I climbed that stile to secure the first unbroken view of the sea through the plunging sides of the valley, my lungs expanding to take in the Atlantic air. A splash of deep blue framed by towering cliffs rose to meet me as I descended, past the herd of warm-breathed brown cows to the tall marsh reeds below, then across the footbridge to the open beach.

Between me and the sea lay rocks, and between the rocks lay pools of clear water lined with seaweeds of every shape and colour: greens, pinks, browns and even blues. Within these pools anything was possible. During my first childhood visits, most of the wildlife was glimpsed for an instant and lost to view just as quickly. Fish zipped away and crabs tucked themselves under stones, fleeing my eager footsteps and splashing boots, but those moments, so brief they seemed imagined, never failed to thrill. As I grew, I learned to move more slowly and watch more closely, but the flash of a fish's flank reflecting the sun as it swims away still quickens my heart.

In an ever-changing world, the beach is a constant. It is a paradox, changing with every tide, every season, every storm, yet

always the same. It is like an old friend, every part of it reassuring and familiar, but still able to surprise me. Over the years and decades I have often returned to this beach, and every time I uncover something new.

The ocean does not give up its secrets easily. This is part of its charm. The best pools are those most rarely uncovered by the tide, those that appear only when the moon is new or full and aligned with the sun to exert maximum gravitational pull on the seas.

I have never found a giant goby (or indeed a guppy) at Porth Mear. You rarely find what you set out to look for in the rock pools, but I have caught my breath as the shells around me come alive, with strange hermit crabs poking out their black and white chequered eyes on stalks; I have crawled under dark rocks to see scarlet and gold cup corals glowing like fires; and I have wavered many times at the edge of a pool so deep it draws me in, wondering what might lurk hidden there.

There are pools that you can only reach when the seas are calm and sleeping. It can take many visits to obtain the right conditions. The sea rarely falls quiet. The waves that pound this shore build up as they travel vast distances and hurl themselves against the rocks. If you set a course west from this bay, you would find nothing but open ocean until you hit Newfoundland.

Porth Mear is lovely on any day, holding you between its rocky ledges and playing out its ever-changing concert of sounds, from the roars and hollow explosions of waves against its caverns and gullies in winter to the gurgling of the stream over rocks and the trill of skylarks in summer. Even on the feeblest neap tide, the shore buzzes and clicks with life. Limpets scour the rocks clean of algae, crabs froth in every dark recess of the rocks, keeping their gills moist, and sea spiders paddle through the seaweed on their delicate limbs.

Nothing, however, is more incredible than when the conditions unite to roll back the edge of the sea and reveal the bed of encrusted rocks and swaying kelp forests beneath. At these times, and for a short while only, you can walk on the seabed as though you are diving without air tanks.

When you enter this world of lobsters lurking in their caves, of bright anemones spreading their tentacles and of a thousand alien creatures living their alien lives right in front of you, it truly feels like you are breathing underwater.

Wherever I go, I seek out beaches. They are woven through my life; the fabric that holds me together, inseparable and steady. Beaches are a changing constant in a constantly changing world, lingering in my thoughts even when I find myself far from the sea. Every walk through the rock pools, from the tideline to the low water mark, takes me on a journey into the marine world and challenges my understanding of my own world and of myself.

At the inhospitable upper edges of the shore, I witness the extraordinary tenacity of animals struggling to survive; struggles that dwarf whatever petty annoyances I may face in my everyday world. Here, all that counts is the present moment. The change of perspective can be dizzying, as though my reflection has changed into something I recognise better: the curious child I have never quite left behind. When I look closer, everything about seemingly unmoving animals like limpets, barnacles and anemones is mind-bendingly strange. The sole focus of the creatures that live in this extreme habitat is survival: not to be battered by waves, desiccated by the sun or to have their legs bitten off by a fish. Life, in the end, is all that matters.

As I move out to the midshore, I feel increasingly aware that every creature here is perfectly adapted and I am the alien. Even the tiniest blob of jelly is able to cope with being endlessly

submerged and exposed, fending off attacks with weapons and bioengineering that make human inventions seem feeble by comparison. Camouflage, armoury, chemistry and cunning abound in every pool.

By the time I reach the lower tidemark, the astounding diversity becomes overwhelming. Nothing here resembles my terrestrial world and I move with cautious fascination among the thick turfs of colourful unmoving sponges, sea mats and sea squirts. It is a place of boundless discovery that calls me back time and again. This is the gateway between the shore and the deep, a place that fills me with a mixture of curiosity and fear. Anything is possible.

PART ONE

LIFE AT THE EXTREME

The Upper Intertidal Zone

Until I slept on a beach, as Cornish teenagers do during a weekend of parties, I hadn't realised how much life there was at the interchange between the terrestrial and the marine worlds. Even as I bedded down in a sleeping bag on the dry sand above the tideline, still wearing my swimmers under a baggy jumper, I could hear the flicking of sandhopper tails against the material of the bag as they launched themselves away. I picked up a mermaid's purse – the horned egg case of an undulate ray – from among some dried seaweed lying beside my elbow and the long, black body of a rove beetle broke through the sand beneath it. In the glow of my torch, a sea slater, the goliath marine equivalent of the woodlouse, ambled towards the debris of the tideline and a group of bats tumbled above my head, picking off flying insects.

The sea came and went, the waning moon struggling to draw in the foaming edges of the waves and, soon giving up, dropping the new tideline well away from my sleeping bag before retreating. Through the night periodic screaming squabbles broke out among the gulls and small, unidentified feet pattered on the sand, moving closer and away, hidden in the deep darkness. Uneasy giggles rippled through the group when creatures came too close, and none of us truly slept. Short bouts of sleep were broken by stargazing and whispered conversations, but by the time the dew settled on our sleeping bags and the dark merged into the grey monochrome shapes of dawn, most of my friends were asleep. Herring gulls strolling the shore slowly took shape, then the dark crows, a magpie and finally something else, grey and low, sniffing at the ground. More of these shadowy forms followed, some standing tall with their ears raised, some skittering down the dunes and defying the stares of the gulls. Rabbits.

Undisturbed by our sleeping forms the rabbits hopped closer. Doing what I couldn't tell, as surely there was no grass for them here. Perhaps they were curious about us.

Soon, daylight transformed the beach, the lifeguards arrived to open their hut for the day, casting us suspicious looks, and the first group of visitors scuffed through the sand, carrying windbreaks and surfboards. In front of them was nothing but a wide, empty beach, with gulls soaring overhead on the morning's thermals. It was as though all the life on the shore had been no more than a magic midsummer's dream, fallen still with the dawn.

The zones of a beach are fluid and hard to define, but we can consider the upper shore to be the area from the highest tideline to parts of the beach that are only just reached by the smallest neap tides. At this upper limit of the beach there are many terrestrial visitors. Toads sometimes spawn in pools and rivers that straddle the border, adders may bask in the morning sun on the rocks. It's not unknown at night for hedgehogs to snuffle past. Otters travel through, moving seamlessly between fresh and saltwater.

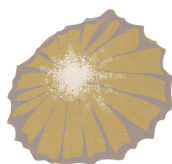
There are terrestrial plants, lichens and animals that specialise in surviving on cliffs, in dunes and at the margins of the sea, able to tolerate the storms, salt and spray, but, except for a few invertebrates that have found ways to hide in air pockets in the midshore rocks, these terrestrial life forms don't survive below the tideline.

Most marine life, of course, needs to be underwater to breathe and survive, but the upper shore is only covered by the sea for a short time each day. Creatures that live here are exposed to storms and frosts, and to the harsh rays of the sun together with drying winds, which evaporate the water and send the salt content of pools sky high. There is an inflow of fresh water from streams and rain which does the opposite, lowering the salinity. Despite the extreme conditions, not everything perishes here. Some species have made this zone their home. In return for their incredible survival skills, they enjoy limited competition and

keep themselves largely out of reach of marine predators. They have found ways to cope with the varying temperatures and salinity and, above all, to avoid the greatest enemy of any marine creature: drying out.

CHAPTER 1

Limpet



Limpets are so abundant that I unthinkingly overlook them. Their shells litter the tideline, rolling and clattering underfoot on my way to the rock pools. I barely take a few steps down the shore before their upturned cones appear, living on the rocks. There's certainly no skill in finding them, sitting motionless, only slightly camouflaged by their pale yellow, orange and brown streaks. Their sloping roofs are as familiar and safe as houses, as solid as if they were part of the rock itself. They're hiding in plain sight because few creatures take an interest in them. They seem unremarkable. This is the shore, though, and nothing is unremarkable.

Though it can be peaceful, a beach is never quiet. As well as the ever-present rumble and roar of sea and wind, there are trickling streams, the trills and screams of seabirds and odd booms and gasps of air as the waves force water into hidden holes in the rocks. I'm crouching to examine barnacles when I hear something new, a sound which is so like footsteps on pebbles that I look around. No one is near.

It's one of those days when the drizzle blows in with the mist and soaks you in minutes, the sort of day that keeps the shore creatures active even after the tide has slipped away. Long fronds of bladderwrack hang as heavy, brown fringes over the sides of the rocks, still bubbling with sea water that drips into the flow retreating down the shore. The crackling sound comes and goes, seemingly from all around me, making it hard to home in on the source.

I lift back the seaweed and two large limpets twist back and forth in front of my nose, lifting up the hems of their shells and swinging them round like twirling skirts, back and forth, dancing their way home. I hear the sound again, sharp and grating, like rock being chipped away. That's exactly what it is. These limpets are moulding the rocks to their shells. Only by achieving a perfect fit can they clamp onto the rock and avoid gaps which would let air in and dry them out. Using their powerful foot, limpets swing their shells against the stone beneath them, grinding a groove to sink into. Ordinarily they would do this as soon as the sea retreated, but today the saturated air and rocks have given them extra grazing time and they are only just rolling home.

Limpets are a type of marine snail from a large class of molluscs known as the gastropods: the word literally means stomach-foot. It may sound like a playground insult, but it is a reasonable description of how these animals move about. Although the underside of a limpet's shell is filled with a round muscular foot, its body remains largely hidden most of the time, even when it is feeding.

Gastropods feed using a tongue-like organ called a radula. In the limpet, the radula is fringed with teeth made of the strongest biological material known to science, goethite. When limpets feed, they rasp away at the rock with their radula, cleaning it of microalgae, chipping away at the substrata in the



Limpet feeding tracks on a rock. *Charlotte Cumming*

process. At night, when the drying sun has set, if you put your ear in close to the rocks you can hear the crackles of limpets feeding. At every opportunity they are to be heard noisily carving out their place in the world.

There's something heroic about the ways in which limpets mould their environment to their needs. Between the shells of living limpets, the oval grooves of previous residents are visible as permanent scars in the rocks. Zigzag markings left by grazing limpets can be extensive, almost artistic, especially on slate.

The rocks at the frontier of the upper shore are the marine equivalent of the savannah. Above them lie the desert sands around the tideline, below them the seaweed grows into thick tangled forests. Huge numbers of limpets can live on these plains, herds of them moving out to graze every time the tide rolls in. It's a perilous existence where timing is everything. Despite their dizzying feeding patterns, limpets cannot afford to dither on their way home. They must make it back to their home scar when the

tide retreats or find some other suitable place to settle, else they risk desiccation.

Like many other animals on the shore, limpets have deployed a chemical solution. In this case, mucus. By leaving chemical signals in their mucus, limpets can follow the trail back to their home spot. Not only that, but their mucus also has special sticky properties, which make it easier for certain types of algae on which they feed to grip the rock and settle.

In the absence of grazing limpets, the rocks would be covered in algae and even more slippery than they already are. When the *Sea Empress* oil tanker ran aground in 1996, spilling tens of thousands of tonnes of crude oil into the sea near Milford Haven in Pembrokeshire, over half the limpets were wiped out on many local beaches. This resulted in a dramatic bloom of gutweed, a green seaweed, around six weeks later. Laver, a brown seaweed that forms thin tar-like sheets on the rocks and is best known for its use in making laver bread, was next to establish itself. Then, as the beach recovered, it became entirely coated in bladderwrack. It took a couple of years for the limpet population to re-establish on the shore and several more before an equilibrium was reached between the limpet and seaweed populations, during which numbers of both fluctuated. Unassuming as they seem, limpets are an essential part of the rocky shore ecosystem.

There's a limpet I often admire. It lives halfway up the harbour wall in the mouth of the Looe estuary in Cornwall. Boats lift and drop alongside it, egrets stalk the muddy river bed below it on spreading yellow feet, jabbing at sand eels as they go, and tourists lean on the railings to admire the fishing boats. I stand alongside them looking down the wall as the sea flows in, covering my limpet.

There aren't many limpets here. The merging freshwater of the

river and salt water from the sea make the salinity highly variable. It's on the edge of what even a limpet can tolerate. Yet this limpet is huge. It would dwarf the limpets on exposed beaches and is wider than anything I've seen on even the most sheltered shores. I've never attempted to climb down and measure it, but it looks bigger than the maximum of six centimetres in length that all my books suggest it should be. I'm guessing it hasn't read the books.

Most striking of all is its profile. Limpets on exposed rocks and on the lower shore tend not to be tall, presumably to help them to survive storms and currents and because competition for food is greater, but other factors such as tidal range and temperature are thought to affect their growth. This limpet seems to have found the perfect sheltered conditions. It's the only limpet on this section of the wall and its sides and spire appear to extend further out every time I see it, as though challenging the moored boats to try knocking it off. Despite the danger of desiccation this high above the low tide mark, there's an abundance of algae about and the shelter of the seaweed enables the limpet to Hoover up the microalgae from the tall harbour wall. At this point in the estuary there aren't many barnacles, which can cover the rocks with their sharp tests, reducing the area available for grazing and creating uncomfortable obstacles for limpets to negotiate.

Unlike its smaller counterparts on the exposed rocks of wave-swept beaches, this towering limpet has a low life expectancy. It's already at least a couple of years old, so it may only have three to four years left to live. Slower growing limpets may live to 15 or 16 years old. Every time I pass the harbour wall I stop to check if my limpet is still there. It seems to be thriving now, but who knows if it can survive the next winter.

The alien existence of rock pool wildlife goes far beyond the ability to breathe underwater and cling on through the storms.

Everything about their way of life is surprising and reproduction is no exception.

It's not easy to tell by looking at a limpet what sex it is, but I suspect my enormous limpet is a female. Limpets prefer not to get involved with one another directly, releasing eggs and sperm out into the sea at a coordinated moment, probably during storms. The baby limpet spat settles on the rock after a few weeks developing in the plankton and remains sexually immature for around the first nine months of its life. These young limpets are relatively flat and are often marked with strong ridges and colours. As they grow, all young limpets become male. However, after two to three years as a male, they change sex, becoming female.

Although growth rates vary between shores, and between areas of greater or lesser exposure to waves, only the larger limpets on a given shore are likely to be female. This kind of gender fluidity is not uncommon in the marine world and seems to be a successful reproductive strategy as limpets are one of the most common and widespread animals on the shore.

The larger limpets have an advantage when it comes to fending off certain predators. Starfish love to feed on molluscs and use the many tube feet under their arms to seek out their prey. When a limpet feels a starfish encroaching onto its shell, investigating it as a potential meal, it will extend its body upwards, raising its shell before using the hard edge like an axe to strike the starfish's arm, chopping down then twisting and rasping away to inflict maximum damage. This surprisingly speedy manoeuvre was captured in the BBC's documentary *The Secret Life of Rock Pools* in which the presenter, Richard Fortey, likened the limpet to an 'animated mushroom'.

Almost wherever you go, from the top of the shore to the edge of the sea, there will be limpets of some kind. On most rocky

shores the classic cone-shaped common limpet, *Patella vulgata*, dominates, especially on this top stretch of shore. On fronds of kelp washed in by the tide, rows of blue-rayed limpets sparkle, their flecked turquoise bands catching the light in a way no camera can properly capture. Dig in among the tangled holdfasts of the kelp and you find older blue-rayed limpets wedged among sponges and barnacles. Several species of limpet live lower down on the shore than the common limpet.

When they die, the shells of all these limpets are tumbled through the waves and often end up on the strandline, among clumps of dislodged seaweed and other tideline treasures like cuttlefish bones and stranded jellyfish. Some are whole, while others are missing their tops where they have been pecked through by hungry oystercatchers, then worn into smooth rings by the waves.

My own journey into the rockpools began here on the tideline, as most children's journeys do, picking up shells, collecting and hoarding them in a cupboard in my bedroom until the door would no longer shut. No matter how often my parents told me I had enough shells already, I couldn't help myself. There was always a reason that I couldn't let a new find go. This latest shell was always the largest, the shiniest, the one with the most striking pattern or the quirkiest shape. I had to have it and the fact that my pockets and bedroom were full of sand never struck me as a problem.

A trip to Sussex to visit family friends at the height of my collecting phase introduced me to the slipper limpet. The shells of slipper limpets are so similar to limpet shells that they were originally placed in the Patellidae (limpet) family in 1758 by Carl Linnaeus, the great naturalist who first formalised the naming system. Although these shells were later found to belong to a different group of gastropod molluscs, the name 'limpet' stuck. I

was intrigued as I'd never seen one anywhere else and they were unlike any shell I knew, except perhaps for some similarities with the tiny smooth-sided Chinaman's hat shell, which is closely related.

Along some sheltered, muddy coasts in southern England and South Wales, the slipper limpet has taken over the tideline. Great piles of them accumulate on the shingle of the Sussex coast, until they are almost the only species to be found. There were so many on the beach in Worthing that, exciting as they were at first, even I soon tired of collecting them.

From the top, slipper limpets look almost like a mussel shell, oval without a spire like other limpets have. It's when you turn them over that you see how they acquired their common name. A flat white sill runs halfway across the underside of the shell, emerging from the point. If you look at them upside down they resemble a slipper, although the only thing that might wear one is a hermit crab that has failed to find anything better.

Slipper limpets shouldn't be in our waters at all. They were introduced between 1887 and 1890 from the North American Atlantic coast as an accident when people began importing American oysters, and first established in Essex. An earlier population in Liverpool Bay appeared briefly but died out. As a child, I was amazed that so many could congregate in one place. It was only when I was a bit more grown up that I discovered why the slipper limpet is so successful (I'd hoped the clue was in its wonderful scientific name: *Crepidula fornicata*).

Like true limpets, slipper limpets are sequential hermaphrodites, able to be either sex in the course of their lives but not both at the same time. Out at sea, or sometimes on the shore in the right conditions, a young slipper limpet spat will settle on the back of a mature female, attracted by her chemical signals. It grows on her shell and lives there, just as common limpets live in their home scar on the rock. Unlike a limpet, it

doesn't have to move to feed, simply filtering algae from the water with its oversized gills. Once attached to another slipper limpet, it will stay put for the rest of the older shell's life.

As the top slipper limpet develops it becomes male and fertilises the female it is sitting on. Over time other slipper limpet spats arrive, settling one on top of the other until they have created a stack, sometimes containing a dozen or more animals. A slipper limpet towards the top of this precarious tower is always male, while the more mature animals below become female. The members of the stack live out their whole lives this way, gradually moving down the pile, as when the female at the base dies the animal above takes her place. Of course, the males near the top of the pile of slipper limpets need to reach a long way to fertilise the females at the bottom. The stack curves as it grows to help minimise the distance between the males and females, but in this species, size is everything.

The Latin word *fornicata* means arched or vaulted, and rather

A slipper limpet stack starting to form.



disappointingly has nothing to do with the animal's sex life. The scientific name refers to the shape of the slipper limpet's shell, but I am not alone in finding *Crepidula fornicata* to be one of the more memorable scientific names.

Once again, my cupboards are bursting with limpet shells of every size and height. This time it's my ten-year-old son who brings them home from every beach trip, his pockets full to bursting, as he has done for the last eight years. We look at the shells together and wonder where each one made its home, what age it was and whether it survived long enough to take a turn at being female. Having the time and freedom to wonder at the world around us is one of the great benefits of home education and has allowed Junior to discover his own passions. The interconnectedness of nature means that one thing always leads to another, and neither of us is ever short of things to learn about.

The more I learn about limpets, the more I notice them, clinging on to life in places where almost no other marine life can thrive. They are the first thing I see as I set out towards the rock pools. They are ever-present, quietly, or sometimes noisily, shaping the rocks to their needs, controlling the seaweeds, reminding me that every animal I encounter here has an unexpected story to tell.