Where There Are Waves There Are Stories

Richard Hamblyn

'What people always forget about the sea,' my father used to say, 'is just how damned *heavy* it is. Any wave higher than your knee will knock you over. Any wave higher than your chest will flatten you. And anything higher than your head – well, you don't want to be around to find out.'

He knew what he was talking about, his work as a fisheries biologist having taken him across many of the world's coastal waters. His stories of near-misses – of a powerful rip-tide pulling him out into an otherwise calm sea off Australia; of a vast rogue wave appearing out of nowhere in the middle of the North Atlantic – were both terrible and enchanting, conveying in the clearest of cautionary terms the respect one should always show the sea. One of my abiding childhood memories is of standing on the shoreline with my older brother, throwing pebbles at a bobbing target as we waited for our father to hoist us into his fibreglass rowing boat, the salty smell of which I can still recall, nearly fifty years later. We would splash our way out into the English Channel, until we met the slow swells that signified that we were far enough from shore to be authentically 'at sea'. Even from this distance of time I can remember the dizzying sensation of knowing that an elemental threshold had been crossed. Years later, when I first encountered Cicero's comment that there are three categories of people: the living, the dead, and those at sea, I understood immediately what he meant.

To stand on the shore, watching the waves' endless advance, as they rise, change colour, fold over themselves and collapse into foam and spray, is to witness one of the earth's most remarkable natural processes, in which something apparently integral, with defined shape and volume, is transfigured into something formless and chaotic. No wonder that Italo Calvino's self-taught hero, *Palomar* (1983), begins his sincere yet doomed attempt to understand the universe while watching waves on a beach. Or, more precisely, watching *a* wave on a beach, in an effort to follow its trajectory. But, as he soon discovers, it is very difficult to isolate a wave, separating it visually from the one that immediately follows, or from the one that immediately preceded it, and it's even harder, he finds, to keep one's attention on a single advancing wave front when it keeps colliding and separating into other, smaller waves, with different speeds and sounds and directions of travel. In short, he concludes, 'you cannot observe a wave without bearing in mind the complex features that concur in shaping it and the other, equally complex ones that the wave itself originates'. And Palomar was right: a wave might seem like a simple phenomenon, a moving pattern that marches across the sea towards the shore, but there is a lot more to ocean waves than might at first appear. Like snowflakes, every wave is unique while also being part of a collective entity, with each contributing its own small share to the perpetual transference of energy across the waters of the globe.

THE LIFE AND DEATH OF A WAVE

When an incoming wave breaks on the shore it looks as though the sea has come to the end of a long journey, but in fact the water itself has hardly moved. Wind-driven sea waves transmit energy, not water, and the turbulence in the swash zone is the result of that energy encountering an obstruction – usually the shelving sea floor – against which it noisily dissipates. It is at that point that the wave transforms, from an energy-transporting wave of oscillation to a water-moving wave of translation, more commonly known as 'swash' or 'surf'.

Waves are usually generated by the friction between wind and the surface of the water. As wind blows across the sea, the disturbance and perturbation cause a small wave crest to form, and the resulting up-and-down motion begins to transmit kinetic energy through the water in the form of a series of waves. Water particles participate in the wave motion by bumping into one another and transferring energy through the water, while the average position of the particles doesn't change. As the waves grow, the energy (but not the water) passes from crest to crest, as is apparent when a piece of flotsam, say a tin can, can be seen bobbing up and down on the spot as waves pass beneath it.

Waves are classified according to their wave period or wavelength (the distance between two crests), from the smallest capillary waves to the greatest waves of all, the tides. *Capillary waves* are the small rippled disturbances that first appear on the surface of wind-blown water, that have been known to mariners for centuries as 'cats' paws'. The characteristically rippled appearance of capillary waves is due to light breezes (blowing at speeds of about 3-4 metres per second) that generate wavelengths typically less than 1.5 centimetres. Such gentle wind is not enough to cause travelling waves to form. The threshold wavelength at which surface waves begin to travel is above 1.7 centimetres: anything shorter than that will be suppressed by the water's surface tension. But if the wind continues or strengthens, blowing consistently over a substantial stretch of water, the initial ripples will begin to form longer waves, and the second class of sea-wave – *gravity waves* – will then begin to form.

Gravity waves occur when wavelength grows to around 1.5 metres, and gravity joins forces with wind as the main dispersing agent, overcoming the influence of surface tension. A slight convexity in the wave shape is needed to give the wind something to work on, and as soon as a wavelet develops a leeward face and a windward back, the wave (as it now is) will begin to climb: the water's line of least resistance is to go upward as the energy in the wind is transferred to the sea. The surrounding wave field will now be a complex interaction of wind-driven components, with different wavelengths and periods, and with waves often propagating in different directions, a pattern known as a *wind sea*.

When longer gravity waves propagate over deep water, they move rapidly away from the generating wind, at which point they are known as *swells*, with a typical wavelength greater than 260 metres, up to a maximum of 900 metres. Swells, which are characteristically smooth and crestless, lose so little energy as they cross open water that it's possible for one generated in the Antarctic Ocean to travel all the way to Alaska at full strength, taking several days to cover the 18,000-kilometre journey. Swells tend to flatten out as they mature and move away from their source, and ripples and capillary waves can form on top of underlying swells, chasing and overtaking one another, causing complex surface patterns to form. But even the longest-lasting swell will eventually approach a shoreline, at which point contact with the shoaling seafloor – or with some other obstruction, such as a harbour wall – will cause it to break and dissipate its energy remarkably quickly. At this point the wave undergoes a fundamental category change, from regularity to chaos, from life to death, a fast-moving parcel of headlong energy suddenly dispersing before our eyes.

THE STUDY OF WAVES

As Palomar discovered, it is hard enough to see a wave precisely, let alone try to understand one. Like the winds that form them, they have a habit of evading observation. Calvino's fictional autodidact had, in fact, a real-life ancestor in the form of an eccentric British geographer named Vaughan Cornish, who in the 1890s moved to a house on the southern English coast, where he became obsessed with the study of sea waves. In a memoir published towards the end of his life, he recalled how every day, 'the beautiful, mysterious and insistent waves' drew him to a path overlooking the shore, where he would watch them curl and break, while listening to the sounds of their ceaseless activity. Cornish ended up selling his house and becoming an itinerant geographer-explorer, devoting his life to the science of waves, to which he gave the name 'kumatology', from the Greek *kumas* ('wave').

In his many publications on the subject, Cornish argued that understanding waves was the key to all geographies, and he expressed particular admiration for the early Micronesian and Polynesian navigators, who were the first to fully comprehend the many physical and behavioural differences between ripples, waves, and ocean swells. As experienced long-range voyagers, they had learned to identify particular waves and swells by their tell-tale shapes, periods, and rhythms. Swells tend to bend around islands and spread out in the channels between them, and the overlap of multiple swells from different directions produces distinctive interference patterns that are complex, yet ultimately readable: when a swell meets a reef or an island, part of it bounces directly off, forming reflected waves of shorter length, while part of it is refracted, dragging where it touches the shore, and creating turbulent cross currents and distortions. If a far-off island deflects a prevailing swell, its presence can be 'felt' by an experienced navigator, even from a considerable distance.

It was these kinds of interference patterns that the celebrated Micronesian 'stick charts' were invented to record. These flimsy-looking artefacts are the world's most impressive examples of early oceanographic knowledge, with groups of islands represented by cowry shells, and the swells and movements of the sea around them indicated by the patterns of the latticed framework. The curved reeds show where swells are deflected by an island, while the short, straight strips indicate the currents flowing near land. At least two categories of stick-chart have been identified: the so-called *rebbilib* charts, showing familiar routes and currents by swell, and the *mattang* charts, illustrating more general principles of wave interference (such as the way a swell steepens as sea depth decreases, heralding an approach to land), which offered a key to reading new or unfamiliar waters. These frail objects seem to have been used as mnemonic aids on shore rather than charts for use at sea, but they illustrate an expert understanding of the complex interactions of land and water. By these means the early Pacific navigators voyaged to every island within the vastness of Oceania – the remotest specks of land on Earth –, their only technologies being the double-hulled canoe with its claw-shaped sail, and a profound knowledge and understanding of the swells and currents of the sea.

An insight into how such knowledge was passed down the generations can be found in the work of the anthropologist David Lewis, whose landmark book, *We, The Navigators* (1972), describes how trainee navigators in the Marshall Islands were taken out to sea in order to learn the secrets of the swells directly through their bodies:

> The elder skippers would take the younger man out to the ocean. They would be in a boat, but they would lay the young man in the water, on his back, and tell him to float and relax so that he would get to know the feel of the waves as they came along.

Such was their deep somatic connection to the sea that older Marshallese navigators often preferred to lie prone in their canoes, pressing an ear to the boards for minutes on end before calling out directions to the helmsmen, while others stood, carefully balanced, 'plumbing' the long ocean swells, feeling their effects through their bodies in subtle shifts from the vertical. It was this intimate, bodily communion with the ocean and its movements that made the argonauts of the western Pacific the greatest navigators the world has ever seen.

Measuring the height of waves at sea has also been a long-standing challenge, given the visual complexity of moving crests and troughs. Judging wave-height by eye produces wide discrepancies in estimates, especially at sea, where the moving surface will be composed of waves of varying heights and periods, often travelling in differing directions. The theoretically simple matter of gauging amplitude from a moving crest to a still-water line is impossible when the water itself is never still. One method, in use for much of the 19th and 20th centuries, involved one mariner gauging a series of wave lengths from the deck, while a shipmate, stationed below, took a series of corresponding heights through a porthole. Such imprecise methods, which often failed to factor in the rolling of the ship, were one reason why it took so long for reports of so-called 'rogue waves' to be taken seriously. A rogue wave is a single, mountainous ocean wave that can appear as if from nowhere; the cause is not fully understood, but such waves are thought to arise from the anomalous focusing effect of strong winds and powerful currents that serve to unite a series of regular, overlapping waves and swells into one giant wave that can rear up from the surrounding sea to heights of 30 metres or more. The troughs of rogue waves drop so steeply that mariners refer to them as 'holes in the sea'; when a vessel drops into one of these yawning pits, the crew suddenly find themselves looking *up* at the sea, rather than down, the wall of water rearing before them like a cliff-face. Though rare, rogue waves are a threat to shipping, having capsized the occasional passenger ship and broken oil tankers in two, but oceanographers had long tended to dismiss such 'impossible' waves as the figments of seafarers' imaginations. It was only in the wake of documented encounters, such as the infamous 'New Year Wave', a single 26-metre behemoth recorded by laser sensors on a North Sea gas platform on 1 January 1995, that science began to take them seriously as a genuine ocean phenomenon. But in spite of more than a quarter-century's research since then, rogue waves remain little understood and impossible to predict.

THE IMPACT OF WAVES

As every mariner knows, the sea makes an excellent master, but a very poor servant: it will never do what you ask of it. Waves exert an impact on every aspect of coastal and marine life and infrastructure, both above and below the surface. Man-made structures such as ships, ports, oil platforms, pipelines, mooring systems, fishing and energy installations suffer considerable physical stress from wave action, while coastlines themselves are continuously shaped by wave-driven erosion and deposition. Any effort to protect coastal communities from the sea, such as stone jetties, breakwaters or sea walls, will have corresponding impacts on the sea itself, while the successful protection of one section of coastline can create unforeseen impacts further along the shore. If erosion and deposition are prevented or reduced in one area, neighbouring stretches of shoreline will consequently be affected by increases in erosion and deposition; and the more a coastline is ringed with sea defences, ranged in hope against the eternal waves, the less conducive to marine life it becomes.

There is also a psychological factor associated with man-made forms of sea defence. Much of the densely-inhabited coastline of Japan, for example, is ringed with sea walls, constructed as protection against the regular tsunamis that are a feature of the earthquake-prone northwest Pacific. Tragically, many of the nearly 20,000 people killed by the Tōhoku tsunami of March 2011 would have had time to evacuate the coast: warning sirens went off within minutes of the originating earthquake, and in places the tsunami took an hour to arrive. But many coastal communities felt safe behind the large sea walls that had protected them from tsunamis in the past. The strength of the magnitude 9.0 earthquake, however, caused much of Japan's northeast coast to subside by nearly a metre, lowering the sea walls and allowing the powerful, debris-laden tsunami to travel inland for several kilometres, with horrifying consequences.

Tsunami waves are far more destructive than wind-driven waves, as they are usually precipitated by undersea earthquakes, which cause the displacement of an entire water column. Unlike storm waves, which involve only the upper layer of a wind-driven sea, tsunami waves approach the shore with the entire weight of an ocean behind them. As became clear in 2011, sea walls, in the end, offer little defence against such elemental power, and Japan's self-image as a disaster-ready society was profoundly shaken by the tragedy. Even on Hawaii, the home of the Pacific Tsunami Warning System, the familiar sound of a tsunami warning siren will send dozens of excited youngsters down to the beach with surfboards under their arms. It seems extraordinary that, even after the terrible tsunamis of 2004 and 2011, with their widely-shared video footage of debris-strewn water bulldozing its way inland, that the daredevil mythology of surfing an 'off-the-Richter' wave remains as prevalent as ever. It should not need saying that tsunamis are completely unsurfable, but the allure of riding the Ultimate Wave remains stronger than any kind of warning issued by the civil defence authorities. And for Hawaiians, whose way of life reflects a centuries-long attentiveness to every aspect of the sea in motion, surfing is rooted far deeper in their culture than the more recent innovation of the tsunami warning system.

THE LANGUAGE OF WAVES

It is no surprise that surfing was invented on Hawaii, given the closeness of the islanders' relationship to the sea. The art of *he'e nalu* (literally, 'wave sliding') can be traced back to the islands' early Polynesian settlers, for whom surfing was an integral part of coastal life and culture. Each island's chief was traditionally the most skilled wave rider in the community, owning the best board made from the choicest wood. Surfing was as much a ritual as a sport, with blessings given to the ocean before entering, and even a benediction for raising waves from a quiet sea: *e ani mau loa ia* ('long may it wave').

The Hawaiian language evolved into a treasure-house of maritime words that notated every aspect of a wave and its behaviour, from a high wave (*kai pi'i*), a long wave (*nalu kua loloa*), a breaking wave (*nalu ha'i*), a receding wave (*kai emi*), a surfing wave (*huia*), a wave that comes in without breaking (*nalu 'aiō*), a long-backed wave from the open sea (*he 'ale kua loloa*), or a wave that breaks diagonally to the shore (*nalu ha'i lala*). The many parts of a wave were also named, from the tip (*hokua*), to the base (*honua nalu*), the bend of a wave (*'opi nalu*), a broken section of a wave (*nalu muku*), or the point where a wave begins to break (*po'ina nalu*), vital for knowing exactly where to position a fishing boat, or a surfboard, in the water.

There is also a propitiatory dimension to the languages of waves. A Scottish trawlerman once told me that he and his crewmates referred to the biggest waves as 'lumps'. '*Wave* is too serious,' he said; 'you don't want the sea to know you're frightened', and there is a wealth of similarly framed fishermen's lucky-words for naming unfavourable seas, such as *hob-gob* (East Anglian slang for a dangerously choppy sea), *lippers* (a North Sea coast expression for the white caps on wind-blown waves), or *boc-thonnach* (a Gaelic word denoting a particularly stormy sea). As might be expected, the Hawaiian language also features a detailed taxonomy of tsunami terms, including *kai e'e*, which refers to the mountainous appearance of the incoming wave, and *kai mimiki*, which names the characteristic withdrawal of the water that is a sign of an imminent tsunami: the knowledge that lies behind such words spelling the difference between life and death.

The Japanese word *tsunami* translates as 'harbour wave', testament to the fact that these low-amplitude displacements tend to pass unnoticed through deep water, only becoming visible as they approach land. The word was first recorded in Japan in the early 17th century, but by the early 20th century 'tsunami' was in international use, following the much-reported 1896 Sanriku disaster, although the misleading term 'tidal wave' was also widely used. The 'tidal wave' misnomer is likely to have arisen from the tide-like behaviour exhibited by tsunamis, which rarely resemble wind-driven waves, although a tsunami approaching shallow water can sometimes shoal into a bore-shaped wave with steep, step-like fronts. *Bores*, unlike tsunamis, are true tidal waves, resulting from large tides surging into rivers and estuaries, but though their causes are different, their effects on land can be similar. The notorious *mascaret*, for example, was a regular tidal bore that caused great damage and loss of life along the lower Seine in Normandy, although a century of dredging has now consigned it to history. The world's largest remaining tidal bore occurs at the mouth of the Qiántáng Jiang river, near Hangzhou in China; it can reach heights of 9 metres, and can be extremely hazardous, with sightseers occasionally washed into the river by the fast-moving wave.

'THE SEA IS LIKE MUSIC'

And wherever there are waves there are stories. One of the many survival stories that emerged in the wake of the 2004 Indian Ocean tsunami concerned the isolated Moken people – semi-nomadic sea-based Austronesians who fish the waters of the Andaman Islands off the west coasts of Burma and Thailand. The Andamans were hit hard by the tsunami within 30 minutes of the originating earthquake, but though most of their homes and many of their boats were destroyed by the waves, only one among the 3,000-strong population of Moken 'Sea Gypsies' was reported to have died that day. At the first sign of the sea's withdrawal they had either headed inland to safety, or paddled out to deep water in their traditional boats, known as *kabang*s. It was their knowledge of the sea that saved them from the tsunami: knowledge handed down over many generations in the form of cautionary tales, such as the Legend of the Hungry Wave. The Moken legend tells how, from time to time, the *La-boon* ('the hungry wave') is invoked by ancestral spirits, whose anger is so great it shakes the earth. Before the wave arrives to feed on those who have failed to heed the warning signs, the sea retreats from the shore: so fierce is the *La-boon*'s hunger that other waves flee in terror. It is then that the famished waters arrive, heading inland to consume everything in their path.

The story reads as a familiar flood myth, but it is also an accurate description of the sea's behaviour during a tsunami, in which the ocean apparently empties itself before the arrival of the giant wave. Thus the Moken's memorable folk tale, in which disaster is foreshadowed by a readable omen, served as an effective early warning system, a siren in the form of a story.

For the Swiss psychoanalyst Carl Jung, who accompanied Sigmund Freud on his first Atlantic crossing in the summer of 1909, the sea was a ready-made symbol of the deep unconscious, a source of fearful fascination as well as an elemental threshold that can never be lightly crossed. 'The sea is like music', he wrote in his journal; 'it has all the dreams of the soul within itself and sounds them over', and he described, with some awe, the mountainous waves that raced past the steamship as the two men stood at the rails.

Watching the rise and fall of the waves is enough to induce a reflective state of mind in anyone. As Jung observed, the grandeur of the sea serves to pull us down into the fruitful depths of our own psyches, testament to a deep-seated emotional response to the great blue sphinx, the sea – the unfathomable sea – where the world of the familiar comes to an end and the unknown beckons to us from over the horizon.