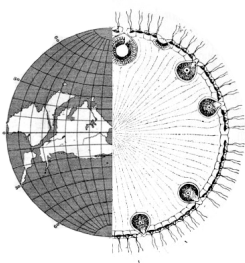


INSIDE THE ROCKPOOL SHRIMP IS A DYING STAR

Karen Lloyd



We met early one morning in the upper reaches of Morecambe Bay. The team had invited me along on an expedition to collect samples. Hefting sweep-net, plastic trays and jam-jars of filtered water, Heidrun, Stephen, Dan and I threaded our way through a forest of concrete pillars under a dual carriageway and emerged onto the sloping shoreline. Micro-plastics are now endemic throughout marine and freshwater ecosystems, so these lake ecologists from the UK Centre for Ecology & Hydrology are investigating how such tiny fragments are being ingested by water and sediment-dwelling organisms here on the bay.

A few days before the trip, Heidrun had emailed me with the details, but her use of the term ‘marine animals’ flipped my synapses into hyperdrive. Reading that, what I’d imagined was the undersea world of whales, dolphins and the floating sci-fi spaceships of giant rays, rather than the Morecambe Bay I was familiar with – the mudflats and wading birds swirling over an incoming tide. Those images were soon swept away when the group of us met at Greenodd, the tide receding and the sands slowly being revealed.

On the shoreline, Stephen donned the buoyancy aid. ‘Mind you don’t fall in,’ Heidrun called, the rest of us on firm ground, arms folded authoritatively while Stephen negotiated the rocks and bright-green slippery weed at the water’s edge.

The prints of a heron indicated its recent trajectory across the slope. Stephen swept the net back and forth and began to deposit netfuls of – what, exactly? – into a yellow plastic tray. He carried the tray back up the bank and we hunkered down to inspect the catch.

‘Plenty of *Palaemon elegans*,’ Stephen said. I looked into the tray as he pointed out tiny shrimp-like creatures, some so small they were hardly visible, others the length of my little fingernail. Examining them closely, I saw how their bodies were almost wholly transparent, the eyes a pair of infinitesimally small, dark apostrophes and the spine a minimalist Gaudi architecture. The antenna and legs were mere mottled threads and the minute dark blob behind the head was the animal’s internal organs. We couldn’t see any micro-plastics inside the digestive tract, but somewhere inside these tiny creatures was a stomach and inside that, who knows?

Palaemon, or the rockpool shrimp, is one of the bay’s most prolific organisms. A keystone species, they play a major role in the ‘detritus cycle,’ or the breaking down of marine litter – a crucial job in marine food webs. Some of the larger shrimp scooted around the tray in sudden bursts, like characters in those primitive computer games. A couple settled beside a sliver of seaweed, their semi-transparent bodies aslant one another and, for the few moments they remained like this, resembled the hands of a tiny, marine-themed clock. Tick-tock.

Heidrun explained that, back in the lab, the collected samples would be placed in filtered water and left overnight

to allow the animals' guts to empty. The next day the contents would be weighed and broken down in potassium hydroxide and stained with a pigment called 'Nile Red.' Bound to microplastics and viewed through a fluorescence microscope, Nile Red becomes visible, or fluoresces. Photographing the results would provide evidence of the microplastics' existence inside the rockpool shrimp and the other organisms we collected that day.

A few days later Dan emailed over some of the resulting images, and when I opened them on my computer, they reminded me immediately of images from the Hubble telescope. One particular photograph of the newly revealed microplastics showed strange ziggurats of nebulae encircled by tiny stars, the second a distant sun and the third, a bright streak, like the white-hot tail of a comet streaming through space.

Down in the bay, one moment the shrimp were doing whatever it is that shrimp do, minding their own business, getting on with being *Palaemon*, and the next they were recruited as participants in a research project examining the impacts of human behaviours on marine and freshwater ecosystems. So what exactly is meant by the term 'microplastics?' Microplastics are defined as pieces of plastic less than 5mm in length. Vast amounts of microplastics enter the wider aquatic environment after being routinely washed out from clothing made from petrochemical derivatives: acrylic, polyester, nylon and Spandex. Microplastics also derive from plastics degenerating in the environment and

from nurdles, the granular microplastic pellets from which plastic products are subsequently manufactured. Nurdles are produced from ethane which is derived from fracked shale gas, and are a major form of marine pollution. The largest plastic spill in history occurred in May 2021, when the container ship *X-Press Pearl* ran aground and caught fire on a reef offshore of the ‘pearl’ of the Indian Ocean, Sri Lanka. For weeks afterwards it was as if the sea itself had been refashioned from plastic. Needless to say, the manufacturers and transporters of those nurdles were not called upon to effect the clean-up.

99% of plastics are produced from chemicals derived from oil and from natural gas (or from shale gas) and coal – all of which are carbon-heavy, non-renewable resources. The INEOS Refinery at Grangemouth in Scotland is the UK's largest importer of fracked shale gas. When the INEOS *Insight* docked in 2016 carrying the first shipment of twenty-seven thousand cubic metres of ethane, it marked Scotland out as the leading producer and exporter of plastics and nurdles in the UK. INEOS are a Swiss based company, and in a press release at the time, Brexit supporter and INEOS chairman and founder Jim Ratcliffe said, ‘This is a game changer for British manufacturing.’ INEOS *Insight's* arrival ‘guarantees the security of thousands of jobs in Scotland and could spark a shale gas revolution,’ which is an interesting position to consider against the escalating climate crisis and

* INEOS Grangemouth press release, September 28, 2016. www.ineos.com/news/ineos-group/ineos-insight-docks-at-grangemouth-bringing-us-shale-gas-to-the-uk-for-the-first-time/

the prerogative to keep carbon in the ground.

The press release provides some helpful comparisons for us to visualise what we're talking about here. The INEOS *Insight* is 'as long as 2 football pitches,' and 'you could park fifteen BMW 525s side by side across the deck.' (I note here the use of BMW imagery, rather than, say, that workhorse of the suburbs, the Vauxhall Zafira, which tells us much about the aspirational nature of the folks at INEOS.) The INEOS website also says that, 'During the course of the contract, each vessel will travel the equivalent of 5 return journeys from the earth to the moon.'

Meanwhile, *Palaeomon* do what they do as the tide pours in and out of Morecambe Bay and the geological age of the planet collides with the anthropological indicators of plastics in the marine environment.

'What's this?' I asked, watching another minute crustacean skitter around the tray.

'That's a copepod,' Stephen said. 'A mash-up between a fish, a shrimp and an insect.'

The name 'copepod' is derived from the Greek for 'oar feet,' or 'swimming feet.' These tiny animals navigate the great divide between salinity and fresh water. They inhabit all kinds of aquatic environments from subterranean caverns to puddles and damp leaf-litter from the summits of mountains to the deepest ocean trenches. A bit like microplastics then, copepods are just about everywhere. They are also a major constituent of the food chain and are one level up from

phytoplankton – upon which they dine – but Heidrun, Stephen and Dan wanted to discover what else they might have unwittingly ingested. In the yellow tray, the copepod scooted in and out of the seaweed flotsam, the wrack and ruin of the moon's unceasing push and pull.

I was beginning to accommodate myself to this marvellous jumble of names and species about which I'd previously known nothing much at all: *Crangon crangon* (surely the name of a 1970s heavy metal band?) or the brown shrimp; *Palaeomon elegans*, the rockpool shrimp; *Corophium volutator*, the mud scud and not forgetting the copepod.

With the samples safely stowed away in jars of distilled water, we gathered the gear and drove on to Bardsea on the coast road between Ulverston and Barrow. We walked a short way out onto the sands where Dan waded into a rockpool and began to shimmy backwards, heels swivelling as he scooshed the net from side to side. Heidrun and Stephen meanwhile dug into the muddy sediments and inspected the clods for tiny creatures, placing anything they discovered into the tray. Heidrun picked up something that was writhing, horribly.

'What is it?' I asked, as the rusty invertebrate furled and unfurled its body in a strangely hypnotic dance.

'Ragworm,' Heidrun said. 'Just don't look into its eyes.'

A family with fishing nets trudged out onto the foreshore, the little girl's wellies pink and sparkly. They stopped beside a nearby rockpool and the children paddled in. As they dipped their nets, our work was punctuated by whoops of excitement.

I liked the way the grown-ups mirrored the youngsters' fascination, proclaiming in delight and hunkering down to examine whatever it was they had caught. When we're lucky, the adults in our lives help foster an early connection to the natural world. The natural world is then a *Wunderkammer* decoded; a cabinet of incredible curiosities; a carbon-neutral boiler stoked by acts of agency and imagination.

For my tenth birthday I was given three gifts that helped me to frame an imaginative relationship with the natural world. A small canvas tent, a copy of Thor Heyerdahl's book *The Kon Tiki Expedition* and a boardgame of the same name. Through these three objects, I continually reimagined Heyerdahl's epic voyage across the Pacific from the coast of Chile to Raroia atoll. All summer, that tent *was* the Kon-Tiki raft. In it, I flew over the waves or lolled listlessly in the stupefying heat of the doldrums.

The games' currency was of coloured plastic coins that we traded with the 'bank' in exchange for the ability to nudge the plastic raft along its voyage. When a whirlpool was approached, navigation cards came into play. The whirlpools presented a choice: continue on the chosen trajectory; twist the whirlpool and go back the way we'd come; or make long detours via yet more whirlpools. Back then, at the close of the 1960s, our oceans brimmed with wonders. Heyerdahl described 'a school of porpoises which seemed quite endless ... packed close together ... as far as we could see', and flying fish so numerous they were picked from the deck and fried

for breakfast, as well as schools of giant whales, jellyfish, ray, bonito and plankton in such profusion 'they were packed together like cake in different coloured layers, brown, red, grey and green.'

The great falling away of marine species has continued since Heyerdahl's raft washed up on Raroia atoll in the Pacific Tuamotus islands, and, in inverse proportion, the presence of plastics in the oceans has risen exponentially. These two opposing trajectories provide a terrible weighing of the effects of industrialisation and the seething mess of capitalism. The loss of wildlife and the rise of plastics are the result of nations across the globe continuing to ignore the problem of growth as the only measure of success.

First identified in the late 1990s, the Great Pacific Garbage Gyre continues to increase in size. Many more plastic gyres are 'blossoming' throughout the world's oceans. Plastic 'food' is now inside everything, from plankton to the blue whale and from copepods to albatrosses. Microplastics are in our blood. Recently, someone told me there's sufficient microplastics inside each of us to make a credit card.

I want to understand how, despite this, we have become so accommodated to plastic waste that we continually 'forget' its monstrous presence in our world. Is it simply too painful to keep looking? Are we waiting for someone to come galloping out of the darkness, bringing forth a cure for our ecological malaise? Out on the bay, the ecologists were collecting evidence to illustrate the extent of the problem.

Heidrun carefully wielded a dessertspoon in the tray of water, swishing away the flotsam to locate a single shrimp and scooping it adroitly into the bowl of the spoon. I was fascinated by the humble dessertspoon as an instrument of science, and by how obligingly the shrimp seemed to inhabit the slim meniscus of seawater. Heidrun tilted the edge of the spoon just so against the wall of the tray and tipped the shrimp into a jar. Throughout the operation, I observed the shrimps' chromatophores in action, those handy cells that enable some animals to change colour and disappear almost completely into their surroundings. There they were, those chromatophores, helping the shrimp to change colour according to its environment, which in this case was from yellow tray to metal spoon and from spoon to jar. This is the nature of the shrimp: adapt to survive.

A woman with a small dog stopped to chat. 'Can I ask what you're doing?' she said.

'Of course!' Heidrun answered. 'We're looking for evidence of microplastics in marine creatures.'

'And if you find them, will you be able to tell where they come from?' the woman asked.

'Some will be transported from Windermere in the Lake District along the River Leven, but they're also being washed in from the wider sea.' Heidrun nodded towards where the bay and the Irish Sea were joined.

We chatted about the deluge of tourists coming to the Lakes in the aftermath of the Covid lockdowns, about how much

plastic waste gets left behind, as if there's an army of elves that comes running down from the mountains at night to tidy it all away. But sure, we agreed, we'd want to come, wouldn't we, after lockdown and everything? Then the woman said, 'How come we've reared a whole generation who think it's someone else's job to clean up after them?'

Millions of years ago, decaying plant materials, algae and organisms sank to the bottom of the sea and over aeons were placed under huge amounts of pressure. The build-up of this natural material is the beginnings of oil, and there is a deep irony therefore (or more, a dystopian madness) that plastics are derived from oil, which is derived from millions of organisms, just like the ones being collected in the bay in order to look for evidence of microplastics inside such tiny organisms. Micro-plastics are now embedded within agricultural soils, in molecules within snowflakes falling on Antarctica and in the stratigraphic records of sediments.

In a film titled 'Modelling Morecambe Bay,' Lancaster University's Professor Gordon Blair discusses how the real joy of the bay 'is its complexity – the dance between the estuary and the river systems, the shifting sands, the cockles and mussels, the migrating birds that feed off the cockles and mussels, that continuous dance.*' And there's a dance too between resident and migratory birds, the dunlin, knot, redshank, greenshank, the black-tailed godwit and more, in

* Patel, Daksha and Chris Ball. *Modelling Morecambe Bay* (Ensemble Projects, 2021).

the length and shape of each species' bill and in how each is uniquely adapted to exploit invertebrates in different layers of the sediment. And those invertebrates are the very reason the birds have evolved to be here, including the species we were collecting that, the ecologists later showed, were chock-full of plastic. Those plastics then proliferate up through the food chain and neither the birds nor the invertebrates are adapted to plastic as food, nor to sediments as being anything other than a source of life-giving sustenance.

'When you see different signals coming through from the natural environment,' Blair says, 'telling you there's something going on ... some elements of profound change, your models have to represent that potential change.' The signals are here. They are here in the guts of the rockpool shrimp, in the sediments that are no longer merely a source of food, and in the tons of plastic waste in the Lake District and in every other place inhabited by humans. The ecologists reveal the extent of the problem; the question is, why exactly are we so incapable of stopping the proliferation?

Out on the bay, a flock of waders gyred around an offshore moraine. 'Ringed plover?' I suggested.

'Dunlin,' Stephen said, then a peregrine rocketed out from the wooded shoreline. The dunlin skedaddled, re-materialising miles away over the sands like the Red Arrows on an assured trajectory. The peregrine zoomed towards the dunlin, and the flock instantly changed direction and veered towards the shore, and suddenly our small group assumed

the identity of a human shield as the birds whizzed right in-between us, the rush of displaced air cool on my face and arms. When the moment was over, we gathered up the gear, pushed the clods of mud back down with our wellies and trudged back to the cars.

In a television interview given sixty years ago, Rachel Carson said, 'We still haven't become mature enough to think of ourselves as only a tiny part of a vast and incredible universe'. Sixty annual cycles through which we have variously been fed, clothed and nurtured by the planet's bountiful ecosystems but have simultaneously waged unceasing war on those same systems. 'Man,' Carson said, 'is part of nature, and his war against nature is inevitably a war against himself.' We are caught in the cycle of plastic proliferation, but, unlike those *Palaemon* and their chromatophores, have shown ourselves incapable of changing according to the nature of our surroundings.

We are all guilty. Some are more guilty than others. I go to the supermarket and once again, suffused with guilt, I pick that plastic punnet of raspberries from the shelf. Those raspberries, along with all the other pieces of single use plastic I carry into my home, are the merest tip of the plastic iceberg. This volume of single-use plastics we buy and bring into our homes every day, every week, every year, does not bear thinking about. And, if we do think about it, we assuage

* CBS Reports, 'The Silent Spring of Rachel Carson.' Columbia Broadcasting System, April 3rd, 1963.

our guilt by placing those bottles, trays, wrappers etc., etc. into a recycling box at the same time as telling ourselves we're dealing with the problem. Vast amounts of our conscientiously 'recycled' plastics are shipped across the world and dumped or bulldozed into landfill or burned, affecting the health of those other communities' children, not ours. Although disaster looms (or indeed, is here, now) *still*, we do not change direction. When we need them most, where are those navigation cards, like the ones in the Kon tiki game, to help us navigate the most expedient direction of travel?

According to the UN Environment Committee, over a million single use plastic drinks bottles are purchased every minute across the world. Half of all plastics manufactured are intended for single use only, with 300 million tonnes of plastic waste manufactured every year – equivalent to the weight of the entire human population of the Earth.[†] Supermarkets add to this volume exponentially through the expedient of single use food packaging. Plastic waste is now so ubiquitous in the natural environment that it has become part of the Earth's geological strata.

The Scottish Government seems unable to reconcile itself with the need for meaningful plastic reduction; it has effectively banned fracking in Scotland, yet supports INEOS' demented importation, its demonic proliferation. But Scotland are only representative of the plastic impasse

[†] www.earthday.org/fact-sheet-single-use-plastics/

which is evident amongst most other nations, all of whom adopt piecemeal tactics such as plans for plastic bottle deposit schemes. Is this really where the answer lies, rather than in preventing the proliferation of single-use plastics in the first place? At what point do we decide when too much plastic in the ocean is too much? Who decides? Not the *Palaemon* or the copepod. Not the wriggling ragworm.

The UN say that by 2050 the plastic industry could account for 20% of the world's total oil consumption.* Of the 5.25 trillion pieces of marine plastics in the world's oceans, 92% are 5mm or less. It is believed that 230 million kilos of nurdles end up in our oceans every year, although the real figure is probably higher; there are no stats available from China and India. Ingested toxicants continue accumulating and magnifying upwards through food webs and life forms. The UN has declared plastics in our oceans a planetary emergency, but the oil industry resists any notions of reducing output. The international proliferation of ethane for the manufacture of single-use plastics continues, as does its impacts on marine life. How many BMWs would fit inside the world's oceans, once all the creatures have gone?

On Morecambe Bay, we got back in the cars and headed to Newby Bridge on the edge of the Lakes where the River Leven flows out of Windermere. Dan waded into the edge

* United Nations Environment Programme; www.unep.org/news-and-stories/press-release/line-sand-global-commitment-eliminate-plastic-pollution-source

of the water and, observed by a lone mute swan, jiggered the net amongst the rocks and deposited the catch in the tray. A couple of baby eels snaked elegantly through the water. Who'd have thought that a tiny eel that had just migrated across the Atlantic from the Sargasso Sea would end up in a jam jar and then a lab, investigated by ecologists trying to work out how much of its intestines were jammed with plastic food?

Along with the eels, the yellow tray was now also a cornucopia of mayfly and stonefly larvae, hunter-gatherers of fine organic particles. One evening I'd swum in Rydal in the central Lakes, but the water was disconcertingly lumpy, as if I was swimming through water-logged grains of rice. Then a mayfly emerged from the surface in front of me and took to the air, ephemeral, fairy-like, then another and over there, another. The mayfly must have been accumulating at the surface ahead of the annual mass hatching. It was a surreal experience; one in which I had briefly inserted myself into a phenomenon that speaks to the interconnected nature of the things we are able to see and the things beneath the surface we cannot.

Do micro-plastics in the guts of mayfly act as inhibitors to the business of flight? What weight of plastic is ballast; what weight an anchor? Who calls for environmental justice for the mud scud or the baby eel? Can we extrapolate the weight of all the dying stars and comets found in the guts of marine animals, whether in the tidal zone of Morecambe Bay or in that plasticised snowflake falling, falling, across the frozen,

unfreezing continent of Antarctica? Can we extrapolate the greater consequences of the ingestion of micro-plastics by creatures who didn't choose this diet from the aquatic menu of life? What is the metaphorical weight of this plastic comet that, thanks to Nile Red, I can observe in the deeply inscrutable space of the gut of the *Palaemon*? An animal that lives so lightly (oh, so lightly!) upon the earth and in its waters but is, nevertheless, forever and unwittingly carrying the weight of our material human culture: the products we produce, buy, use once and throw away.

The French sociologist Pierre Bourdieu employs the term *habitus* to describe the kinds of socialised norms that arise between agency (the power to act) and our structures (political, societal). The norms that arise from *habitus* guide our behaviour and thinking; it is the way that society creates lasting inclinations, ones that train us to think, feel and act in determinant ways. Choosing to see what is happening around us but continuing to ignore the evidence has become both normalised and legitimate. Our current political and economic structures do not want us to look more deeply. They do not ask us to consider what may exist in the guts of crustaceans, the diving gannet, the redshank and greenshank, the whale, the giant ray, the human.

Let me return for a moment to the power and clarity of those images of distant dying stars taken from the Hubble telescope. In April 2020, NASA astronomers found themselves unexpectedly observing a nearby star (nearby!)

going supernova, or, to put it more prosaically, in the act of dying. Training Hubble on the star's luminous aftermath, the astronomers began to understand that what happened immediately before the star died could potentially provide an early warning system for other stars on the brink of destruction. Further, some astronomers worked out that in the years before a star explodes, it generates warnings by becoming increasingly active, belching immense plumes of gases and God knows what other kinds of dust and substances.

Against the useful metaphor of a dying star, when we consider our planet's continuous belching forth of plastics and our simultaneous lack of response (the *habitus* of not looking), it is clear that our early warning systems have failed us, utterly.

The ocean, its creatures and our sense of agency are all poisoned by plastic. Jump onto the game's whirlpool now. Grab your navigation card and make the choice: you can continue, or go back, or waste even more time procrastinating. On our rafts of inertia, we are all of us drowning, not waving.

Brain plasticity, or neuroplasticity, is the function that allows the brain to modify its connections and constantly re-wire itself. Brain plasticity is the evolutionary principle through which humans learn new activities and acquire new skills, such as languages, even into old age. Plasticity at international governmental level is the *habitus* that will enable us to confront our previous inaction and to model new

behaviours and adaptations. Perhaps this could come in the form of international agreements responding to the IUCN's stark warnings on the effects of plastics on our oceans? And if our leaders were actually to lead instead of continually procrastinating, and if they showed themselves capable of making the connection between plastics and plasticity, then more individuals would be incentivised to follow. Plasticity at the level of the individual asks us to make choices wherever possible (and they are not always possible) to reject single use plastics or clothing made from oil, such as polyester. We *can* turn the tanker around, especially that convoy of tankers crossing the Atlantic right now to the Grangemouth refinery. Can we begin to hold INEOS and the supermarkets and all the others involved in the proliferation of single-use plastics accountable? In order to do this, their fantastical narratives *have* to be interrupted; their capitalistic disregard broken apart.

The world urgently requires new political and societal legitimacy that can hold to account those guilty of the proliferation of plastics. We could begin by holding to account INEOS, whose representative in the BBC documentary *War on Plastic* shifted the blame for microplastics in the environment firmly onto the shoulders of others by stating, with dumbfounding doublespeak, 'Plastics, per se, are not the problem. Waste plastic is.'

From individual action, movements build. The world holds countless stories of how groundswell actions forged

lasting change, from political to societal and everything in between. Rebecca Solnit writes: 'Problems are our work; we deal with them in order to survive or to improve the world, and so to face them is better than turning away from them, from burying them and denying them.'" There are seeds of hope. 170 nations have announced the commitment to 'significantly reduce' plastics by 2030, though I doubt this is soon enough. Kenya has enforced a ban on single use plastic bags and on plastic bottles in National Parks and on beaches. It's a start. Zimbabwe has banned single use polystyrene containers. In the UK the government states its position as 'a global leader in combatting plastic waste and has already taken major steps to tackle plastic pollution, banning microbeads in rinse-off personal care products, and restricting the supply of single-use plastic straws, stirrers and cotton buds.'[†] Those straws and stirrers and cotton buds are a beginning, but global leader? Against the power of the incoming tide? Meanwhile, these governmental platitudes continue to float past us, statements on how we *could* ban plastic cups and plates and cutlery, or that we *could* reduce plastic packaging or do yet more 'recycling'. Dear Lord. Try telling that to that baby eel, after its momentous journey.

In the Netherlands, engineers are trialling a device that floats plastics to the surface of rivers by blowing bubbles

* Solnit, Rebecca. *Hope in the Dark: Untold Histories, Wild Possibilities* (New York: Canongate, 2016).

[†] www.gov.uk/government/news/plans-unveiled-to-ban-single-use-plastics

through the water. The plastics accumulate to one side and are collected. This feels like useful brain plasticity to me. In March 2022 the UN announced the endorsement of a historic resolution by heads of state, environment ministers and representatives from 175 nations at the Environment Assembly which will put in place a legal internationally binding agreement by the end of 2024 to end plastic pollution. Elsewhere, scientists have discovered that microbes in oceans and in soils are evolving to eat plastics, which is a form of evolutionary plasticity or plasticity as adaptation. The scientists say that using enzymes to break down plastics into their constituent building blocks will facilitate the making of new products from old and that it will significantly reduce the need for products to be manufactured from virgin plastics. I find these ideas hopeful; the natural environment itself leading the charge.

Through Heidrun and Stephen and Dan, I acquire new knowledge, new language: a lexicography of the things that, were it not for them, I would not otherwise have seen or known. Now, when I go to the bay, I see more, or perhaps further, than ever before. The bay is a complex environment in its own right; this much I knew. A place where shifting sands show us that things don't always stay the same, where natural forces reshape the tidescap in a perpetual cycle of change. But after my day out with the ecologists, I can at least give names to some of the tiny creatures whose lives play out

here, mostly unseen, and who do what they must, despite the impacts of humans. Who'd have thought that something as insubstantial as a rockpool shrimp could provide such a potent metaphor for the impacts of humans on the planet?

When I think back to my first encounter with the photographs of the microplastics in the gut of the rockpool shrimp, I saw how otherworldly they were and how redolent of Hubble's towering space-scapes. That reframing of such oppositional scale provided an uncanny toggling of magnitude and experience, one with another, back and forth; vast space inside the *Paclamon*, vast space inside the birth of a star.

Since its launch in 1990, the Hubble telescope has been able to do what it does exactly because it is a project of international collaboration. By working co-operatively like this, it has helped to fundamentally reshape our perception of the cosmos, where 'properties of space and time that for most of human history were only probed in the imaginations of scientists and philosophers' have been revealed.* There's an unavoidable toggling here too, or a convincing symmetry, with the work of the ecologists on Morecambe Bay. Both Hubble *and* the ecologists allow us to see things that were previously hidden. *Both* allow us to engage with and understand fundamental issues to do with how we fit into the world (or worlds) around us through their respective and astonishing perspectives. Hubble's achievements are rightly lauded across the planet. But who lauds the work of the *Palacemon*, it's

* <https://hubblesite.org/about>

keystone presence in the marine and freshwater environment?

And there it is, this *Palaemon*, in the yellow tray. I take a final close look at the semi-transparent body, at the chromatophores working like crazy as it scoots through the water and weeds. And, as I look, I understand that this humble shrimp is a vital component in the bay's ecosystem, and that along with all the other marine and freshwater creatures we collected that day, it simply gets on with doing what its adaptive imperative impels it so to do. I am humbled by the work which these animals collectively undertake during the process of their lives and in support of ours. Knowing what I know now, if I were to ask the *Palaemon* what on earth we should do, to answer the signals being sent back through the work of the ecologists, I wonder exactly what it might say in reply.

'Look closely,' says the *Palaemon*. 'Everything you need to know is here, inside me.' What occurs in the gut of the *Palaemon*, ultimately happens to us all.