The Surprising True Story of Patrick S. "The First," Rupert R., Sly S., and Gus G., Protocells in Their Very Early Years

The Story of Patrick!

Once upon a time, very, very, very long ago, almost four billion years ago, off the West Coast of Gondwanaland, life as protocells had recently begun. It all happened under a turbid sun, on a scorched Earth, in a shallow lagoon. Days and nights came and went, before Patrick, Rupert, Sly, and Gus, really became Patrick, Rupert, Sly, and Gus. For now they were merely protocells, undistinguished and ordinary amid their generation X cousins, dry and wet and wet and dry, and all the Gen Xers passively absorbed the stuff softly flowing in the lagoon. You could sort of call it eating. And they multiplied, making so many Gen Xers that almost four billion years later their grand, grand, grand, grand, . . . you know, us and others, would be all over the blue dot planet.

But back then nobody got much "stuff" to eat because all of the even tinier floating stuff floated at almost the very same speed as did the Gen Xers. That was okay because it was true for all of them, and nobody got really mad.

But one day, Patrick Protocell felt a bump jump hurt inside himself. "What's that?" he thought, a bit fearfully. "Oh it's my whatdyacallit sticking out! Ouch."

Patrick felt the pinch and was even pierced. A little molecule, a peptide made of thirteen amino acids, protruded from his side.

Then do you know what happened? This little peptide bumped into a huge rock, very much bigger than Patrick, but much smaller than even a thimble.

And the peptide stuck to the big rock. Patrick himself was *stuck*. He could not float about and laugh in the lagoon, hoping for stuff.

"I've got to get unstuck," thought Patrick with alarm. He yanked his tummy and his bottom up, but stayed stuck. The more he tugged the more stuck he seemed to be.

"Oh NO!" thought Patrick. "All is lost. If only I had a mother I could call her!" he winced.

"Oh well, maybe I'll get unstuck when it gets wet and dry a few times," he hoped, rather like a latter-day sailboat hung up on a rock at low tide.

"I'll have to make the best of it 'til then."

"Maybe I'll still bump into some stuff," he hoped.

"But *how*, I'm all stuck on this old rock!"

Patrick, without too much hope, a bit desperate at his woeful situation, looked up, and guess what?

Well, you'll never guess what happened to Patrick.

In a trice, Patrick saw flooding at him lots of stuff, more than he had ever seen, here and there, everywhere, floating so fast toward him he feared he could never ever gobble it up.

So, bucked up by the very possibility, Patrick gobbled as fast as he could.

Very full, a very short time later, much shorter than usual, Patrick divided into two Patricks.

"We're stuck," they both cried. And indeed they were—to the very same big huge rock.

Patrick and Patricks were dividing so fast now and they had so much stuff flowing at them that soon there were lots of Patricks!

In about seven moons there was a large Patrick Patch, many grandchildren of Patrick, who had become, what?

Patrick had become, on getting stuck to the huge rock, the very first "sessile filter feeder" on the early planet Earth. Think of that. The very first one.

And that is how Patrick became PATRICK THE FIRST!

Before Patrick got stuck, he was a typical sophomoric Gen Xer protocell. Now he was special. He could stay stuck to the rock, sessile filter feeding all wet and dry long.

Where had Patrick come from? Well, sort of from nowhere! Patrick the First just emerged!

First there were just Gen Xers, Patrick among them. All slowly dividing while sort of eating stuff.

But Patrick had, accidentally of course, seized a special opportunity. There were nutrients flowing slowly and there were rocks, including the rock he got stuck to. So *if* he did get stuck, he'd get more nutrients per unit time than other protocells, and so divide faster.

But what does it take in the becoming of the universe for a context, like the rock and slow-flowing nutrient stream was to Patrick, to be an "opportunity?" For the rock, the flowing water is a context but not an opportunity.

Not everything or every process is an opportunity. A tiny rock by itself is not an opportunity. Nor is a rock and a slow-flowing

stream of stuff. There is no opportunity without something that can seize that opportunity and take advantage of it.

And Patrick was just such a "something." Patrick had seized his opportunity, "For ME" thought Patrick, glad that he was one for whom an opportunity of a lifetime could be seized.

Patrick had become a "for whom."

What does it take for something in the universe to "seize an opportunity?"

What does it take for something to become or be an opportunity that can be seized and for something to be able to seize it?

The surprising crux of the matter is worth repeating: you cannot have an opportunity without something, a "for whom," for whom the context *is* an opportunity that now can be seized.

What counts as an opportunity makes no sense without something that can seize the opportunity. But this is not imaginary and not just words. Patrick really came to exist in the early biosphere as the first sessile filter feeder; hence, he came to exist in the nonergodic universe above the level of atoms by seizing his opportunity. He became Patrick The First Sessile Filter Feeder.

What counts as having seized an opportunity? For Patrick and the biosphere, the success was very real: More Patricks forming the Patrick Patch did in fact outgrow the Gen Xers.

Patrick and his offspring could do this because they were autopoietic, that is, they were self-reproducing systems able to self-maintain and reproduce, have heritable variation, and be selected. Thereby, he and his offspring could seize his opportunity. He and his offspring were Kantian wholes where the whole exists for and by means of the parts.

In particular, Patrick was a collectively autocatalytic set of peptides in a liposome, a hollow lipid vesicle that buds and is also able to make the lipids to form the liposome. Patrick was an early form of life able to evolve by *heritable variation* and natural selection. That is why Patrick constituted a "for whom" so that

a context, here the slowly flowing nutrient stream and the tiny rock, constituted an opportunity to be seized. Patrick came to exist in the nonergodic universe above the level of atoms, where most complex things will never exist. Patrick actually changed the unfolding history of the whole universe. No mean feat when all he had to hold onto was a tiny rock not as big as a thimble.

"I'm so glad," thought Patrick The First. "I'll just hang in here and love it and divide when I feel like it."

So Patrick divided and made lots of Patricks, two by two, until before he knew it the Patrick Patch had spread over a big part of the lagoon.

That is the first part of Patrick's story, how the first sessile feeder came to exist out of pretty much nothing.

And the story is all you need to know. That's really what happened. Isn't that just amazing? First no Patrick, then Patrick "The First," sessile filter feeding, out of nowhere. Just because his peptide happened to stick to the rock.

Later, Darwin would call this sticking a preadaptation in Patrick.

The Story of Rupert!

And now Rupert's story (how Patrick, now that he exists, provides an opportunity for Rupert to emerge and exist).

Rupert was pretty much your ordinary protocell, although a bit laconic, somewhat more laconic than the others. He could not swim but could wiggle a bit as he came near stuff. Maybe he was excited, so he wiggled. But beyond wiggling, Rupert was already a bit special. He could eat stuff, but he could also stick to other Gen Xers and make a hole in them and suck out their inside stuff. Rupert thought this was good, for every now and then he bumped into another Gen Xer and got a special dinner from it.

But bumping into other Gen Xers did not happen very often, as they were all floating in the same slowly moving stream of stuff. Rupert, like the others, mostly ate plain old stuff.

One day, do you know what happened? Rupert floated into the Patrick Patch far away from most of the lagoon.

"OH NO," thought Rupert, "This place is full of. . . . Well I don't know. How do I get back to the clear lagoon?"

He tried wiggling but got nowhere fast. It was the best he could do.

Rupert was as woeful as Patrick had been, maybe more. He was far from the clear lagoon.

Guess what happened to Rupert? He bumped into Patrick the MMMMCCCDXXXVIII!

Rupert poked a hole in that sad Patrick and ate him up.

"GHA," thought Patrick the MMMMCCCDXXXVIII.

"Cool," thought Rupert.

So Rupert became famous in the lagoon as Rupert "Raptor" Protocell. He was the very first predator in the lagoon and on the whole earth and in the universe. Rupert changed the history of the whole universe.

Soon there were lots of Ruperts bobbling in the Patrick Patch, which itself was growing in the number of Patricks faster than the Ruperts could manage to eat them all. This was the very first food chain in the biosphere. Out of nothing did it come. The first food chain changed the history of the universe. (So will the rest of the food chains that followed.)

Rupert, like Patrick, was a "for whom" so there could be an opportunity. The startling thing about Rupert, however, is that Rupert's opportunity included not only the lagoon with nutrients but now included Patricks. Because Patricks were sessile feeders stuck to rocks, Ruperts bumped into Patrick and his kin far faster than into Gen Xers floating in the nutrient stream in which Rupert and his kin also floated.

Patrick was *part of the whole context* that was Rupert's opportunity. Rupert seized his opportunity. Patrick, by existing and creating a Patrick Patch, *afforded* an opportunity to Rupert, given that Rupert Protocell could not swim and was in a slowly moving nutrient stream where he could only eat stuff—and, very rarely, bump into Gen Xers. So Rupert's opportunity was Patrick the First and kin, the sessile filter feeders in the Patrick Patch where Rupert could bump into many of Patrick's kind, compared to just eating stuff and the occasional rare treat of eating a Gen Xer.

With all this stuff to eat, Rupert now divided rapidly; and soon there were lots of Ruperts growing in the Patrick Patch, or what by now were several Patrick Patches in the lagoon.

There was no one else alive in Patrick's context of opportunities. Patrick's opportunity was only the slowly flowing stuff and the tiny rock he sort of grabbed onto. But by coming to exist in the universe, Patrick and his own kin in the Patrick Patch now came to constitute the "context," the very opportunity for Rupert to come to exist: no Patricks, no Ruperts, who soon quite forgot about eating the hard-to-bump-into Gen Xers and now depended entirely on eating Patricks to survive.

The ecosystem had become Gen Xers, floating stuff, Patricks in Patrick Patches, and Ruperts grazing on Patricks. This is a bit like, billions of years later, grass and rabbits.

Could you write an equation for this? How would you know what to write? This story is pretty much what you need to know. What would mathematics do here at all? It could not do much about the becoming of Patrick and Rupert. In fact, mathematics would tell us nothing about this becoming.

But Pythagoras taught that all was number. Is it? Where is the "number" here? We, looking on, do not need number. And Patrick and Rupert never heard of Pythagoras who grazed in the Agora long thereafter.

The Amazing Story of Sly Protocell

To start with, Sly was pretty much an ordinary protocell except he could, like the early Rupert, eat Gen Xers if he happened to bump into them, as well as eating the floating stuff.

Sly, who did not know that his name was rather pejorative, was perfectly happy. He floated in the lagoon and ate.

One day, Sly bumped into a Rupert. And do you know what happened? By accident, a peptide on Sly's surface attached to Rupert! Sly was embarrassed, and Rupert was annoyed at this bondage. But the choice seemed to be Sly's. Rupert could not shake Sly off.

And what do you think happened?

Now when Rupert ate a Patrick, some of the juice squeezed out of Rupert's insides through the hole, and Sly licked up the leftover juice from Patrick's perishing.

Actually, Rupert came to be glad about the arrangement because the juice on his outside self felt sticky. Sly was a bit like small fish inside a shark's mouth cleaning the shark teeth. It's a strange way to make a living, huh? But Sly changed the universe because Sly divided faster than before, and soon there were lots of Slys attached to lots of Ruperts all over the Patrick Patches in the lagoon.

But Sly did more. You see, Patrick and his offspring had trouble attaching to the tiniest rocks, much, much smaller than a thimble, and sometimes slipped off. But when Sly slurped up the juice from Rupert's gobbling a Patrick, Sly seemed to excrete a glue into the little area of the lagoon that helped glue Patrick to the rocks! So in the presence of Ruperts with Slys, Patricks lived more securely in their Patrick Patches, more firmly attached to the tiny rocks.

What had come about? Sly had come to exist. His opportunity consisted now of both Ruperts and Patricks. Sly was also a "for

whom" who seized his opportunity. Now Sly existed too, out of nothing much.

But there is more. Rupert no longer ate Gen Xers, as told before. But Patricks slipped off their rocks sometimes and died, lowering the number of Patricks on whom Ruperts could graze, therefore holding down the population of Patricks and also of Ruperts. But Sly helped glue Patricks to their rocks more firmly, so everyone benefitted. Patrick provided a niche for Rupert, who provided a niche for Sly, who helped provide a niche for Patrick! They formed a three-species, "collectively autocatalytic set"! Such collectively autocatalytic sets of species mutually creating niches for one another exist today.

In fact, the Sly glue was so great that Patrick sort of forgot how to attach very well to rocks and now depended pretty much entirely on Sly. The autocatalytic little ecosystem became tighter and mutually co-dependent. They worked well together, and Patrick and Rupert and Sly and their kin got to exist in the nonergodic universe for a pretty long time.

The Story of Gus

Gus was also just your ordinary Gen Xer. He bobbled around in the lagoon like all the rest.

Every now and then he saw a tiny rock and reached for it, but he could not grab the rock; so he floated and divided, but not very quickly.

One spring day, Gus bobbled into a Patrick Patch, and guess what?

Gus bumped into a Patrick and Gus found that he *could* grab a Patrick. And so he did.

Guess what he learned?

Gus was indirectly stuck to Patrick's rock! He was quite glad, for he had tried and failed before to grab a rock on his own. But now the slowly flowing stream of stuff that floated rapidly by Stuck to Gus too, and he ate lots more stuff. Like Patrick, Gus divided faster. Sometimes there were two or three Guses attached to one Patrick, who was rather annoyed but could not shake Gus off because Patrick could only wiggle.

Gus is a "for whom" and Patrick is his opportunity. So Patrick afforded *two* new niches, constituted two new opportunities, one for Rupert, and one for Gus!

Darwin once described an image of a species driving a wedge in the crowded floor of nature—a wedge of a competitive nature that created a space for it to live in. That is not the story of Patrick, Rupert, Sly, and Gus. Patrick, in seizing his opportunity and becoming Patrick "The First" and forming the Patrick Patch, thereby created and afforded a new niche for Rupert. Patrick *is* the niche and opportunity for Rupert. Rupert *is* the niche for Sly, and Sly with his glue becomes part of the niche for Patrick. And Patrick is the niche for Gus.

There is no wedge driven into the crowded floor of nature. The floor itself is expanding, creating new niches by creating Patrick, Rupert, Sly, and Gus—who create the niches for one another. Patrick, Rupert, Gus, and Sly create new cracks in the floor of nature, new niches, for one another. The same is largely true of the biosphere, and the global economy, both of which have exploded in diversity just as Patrick gave rise to Rupert who gave rise to Sly who stabilized the three-species ecosystem to which Gus came along to hang off Patrick.

We seem to make our worlds and thereby make rooms for one another. Each "for whom" makes even more opportunities for others in its adjacent possible niches or rooms. The adjacent possible niches, like worms coming to live in swim bladders, explode

faster than the number of occupants who, by existing, create those very adjacent possible niches.

In much the same ways, both the biosphere and global economy explode in diversity. Each species affords one or more adjacent possible new niches for yet new species, which so expands what now becomes possible. Spanish moss hangs from laboring trees. New goods and services and production capacities expand the ways in which further new goods and services can now make a living. Personal computers made word processing possible, which made file-sharing possible, which made the World Wide Web possible, which affords a place to sell on the Web, which made content on the Web that soon enabled browsers. The introduction of the automobile enabled the gas industry and paved roads. Paved roads required traffic control. The roads enabled motels and fast food restaurants.

It is not only that the floor of nature is crowded by competition, as Darwin thought, but rather that each species also affords adjacent possible new niches, new "wide cracks" in the floor—new niches that invite the next new species into those wide cracks that constitute new niches. The possible new niches expand faster than the species that create them. Patrick created two niches, one for Rupert, one for Gus. The Web enabled both eBay and Amazon.

This is an unprestatable becoming of "for whoms" that can seize their specific opportunities in adjacent possible niches that we each in turn create. The "floor of Nature" expands, housing ever more room after room that we jointly co-create faster than we all come into existence. And that is how complexity emerges.

Chapter 9

The Stage Is Set

With Patrick the First and his friends, the stage is set. Life has started, and the biosphere will flower forth. Patrick, Rupert, Sly, and Gus are protocells, unleashing an unprestatable becoming. They emerge and evolve in a lagoon similar to the one Damer and Deamer (2015) envisioned. They adapt by what is called Darwinian preadaptation—that is, they have properties that were not selected to perform a given function but that can take on that function if the opportunity arises. Feathers evolved for thermoregulation and were co-opted for flight. Patrick, for example, had a peptide that stuck out of his insides, having evolved for some other function or for no function at all, but it happened to be able to stick to a rock. And so Patrick became Patrick The First Sessile Filter Feeder.

We will talk about Darwinian preadaptations more in chapter 10, for although we cannot prestate them, they drive much of evolution. Patrick, by sticking to the rock, gets more food per unit time, and so a new kind of "species" is born. The rock is Patrick's opportunity, and Patrick is a "for whom" and so can benefit from an opportunity "seized" by heritable variation

and natural selection. There cannot be an opportunity without a "for whom"—*for whom* it is an opportunity.

Such evolving early forms have the astonishing property that each, by coming into existence, can constitute a new "context" and opportunity that does not cause but "enables" yet further life forms, "species," to come into existence. Patrick constitutes the empty niche into which Rupert becomes. Rupert and Patrick jointly constitute a new niche enabling yet other life forms, Sly and Gus, to come into existence in ways that "depend on" Patrick and Rupert as prior existing conditions. The increasing diversity of organisms and niches in turn affords yet more opportunities for further "species" to emerge. And this creates yet more contexts that afford yet more opportunities.

As in the story of Patrick and friends, Darwin had an image of species driving wedges into the crowded floor of nature to make room for themselves. But there is more. Patrick, by existing, *constitutes* the new crack in the floor that allows Rupert to come to exist. Rupert does not have to make a crack for himself. Patrick *is* the crack. Rupert is the crack for Sly, and Patrick is the crack for Gus. As the diversity of species goes up, the number of new cracks, new adjacent possible empty niches, goes up faster than the number of species. Diversity explodes! Patrick supplies two niches, one for Rupert, one for Gus. The World Wide Web supplied myriad new niches, including one for eBay and one for Amazon. The global economy explodes in diversity. By coming to exist, species create the adjacent possible opportunities for other species to make a living in new ways.

The Biosphere Explodes in Diversity

Richard Dawkins has famously written *The Selfish Gene*, stating that evolution is a more or less brutal race for the survival of

genes, and further, that organisms are merely the vehicles that carry the genes to be selected. But the story is deeply inadequate. As we just saw, Patrick, by existing, constitutes the empty niche into which Rupert can become; Rupert constitutes the niche into which Sly can become; and Patrick constitutes the niches into which Gus can become. Species, by coming into existence, literally create new niches into which other species come to exist. Moreover, the niche does not cause the new species to come to exist but rather affords an opportunity that *enables* the new species to seize that new niche and further evolve.

How vastly richer than "nature, red in tooth and claw." It is not Patrick's genes that are selected, for Patrick has no genes at all in the familiar sense of DNA. There are no selfish genes; there is the whole organism called Patrick. Dawkins has forgotten the organism. Organisms are selected, genes go along for the ride. We will see the same niche creation in chapter 10 with other Darwinian preadaptations. New species create new niches for yet further new species. Now there are millions of them.

We Cannot Mathematize This Becoming

I told of Patrick, Rupert, Sly, and Gus as a children's story. Could I have written equations and derived the becoming of Patrick, Rupert, Sly, and Gus from your ordinary "Generation X" protocells? Well, no, I couldn't. Try to do so. Just what variables would you write down? How would you simulate this emergence on a computer? I see no way, do you?

Pythagoras taught us that all is number. Newton, after Galileo, taught the same thing. Nature is written in number, the "rule and line" that Keats decried. It is a major transformation

in our way of knowing the world if we can write no equations for the emergence of Patrick, Rupert, Sly, and Gus. We understand the children's story perfectly. We tell it as a narrative. What else can we do?

This will be a major theme of the rest of this book. We cannot derive this becoming by equations. The becoming is not derivable by entailing law, for we can write no laws of motion for the evolving biosphere, as we do not know the relevant variables prior to their emergence in evolution. We do not know that Patrick will stick to the rock by the peptide that protrudes from his insides. We cannot mathematize the specific evolution of the biosphere. We can, at best, seek statistical laws about distributions of aspects of this evolution. In short, I will claim that no law at all entails the becoming of the biosphere; and that therefore, we cannot reduce biology to physics. The world is not a machine.

Context-Dependent Information

Patrick, Rupert, Sly, and Gus develop context-dependent information about one another. Rupert comes to know Patrick and Patrick's habits. For example, Patrick learns to "crenelate," or crunch up, to avoid being eaten, but Patrick can only hold that pose for a while, and Rupert can still eat Patrick some of the time if Rupert waits cunningly. In short, Patrick, Rupert, Sly, and Gus start to play context-dependent "games" with one another. Organisms can evolve to play games of increasing diversity: filigreed games. Rocks cannot do this. Touch a clam snout and watch it spout in the sand. With the diversification of the blossoming biosphere, context-dependent information explodes.

And so the stage is set. From the lagoon, life springs forth. And thanks to the three closures—constraint task, work task, and catalytic task—life physically constructs itself and literally surges upward in complexity in the nonergodic universe above the level of atoms. This surging is A World Beyond Physics, the title of this book.