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Can a Jellyfish Unlock the Secret of Immortality?

By NATHANIEL RICH

After more than 4,000 years — almost since the dawn of recorded time, when Utnapishtim told Gilgamesh that the secret to immortality lay in a coral found on the ocean floor — man finally discovered eternal life in 1988. He found it, in fact, on the ocean floor. The discovery was made unwittingly by Christian Sommer, a German marine-biology student in his early 20s. He was spending the summer in Rapallo, a small city on the Italian Riviera, where exactly one century earlier Friedrich Nietzsche conceived "Thus Spoke Zarathustra": "Everything goes, everything comes back; eternally rolls the wheel of being. Everything dies, everything blossoms again. . . ."

Sommer was conducting research on hydrozoans, small invertebrates that, depending on their stage in the life cycle, resemble either a jellyfish or a soft coral. Every morning, Sommer went snorkeling in the turquoise water off the cliffs of Portofino. He scanned the ocean floor for hydrozoans, gathering them with plankton nets. Among the hundreds of organisms he collected was a tiny, relatively obscure species known to biologists as Turritopsis dohrnii. Today it is more commonly known as the immortal jellyfish.

Sommer kept his hydrozoans in petri dishes and observed their reproduction habits. After several days he noticed that his Turritopsis dohrnii was behaving in a very peculiar manner, for which he could hypothesize no earthly explanation. Plainly speaking, it refused to die. It appeared to age in reverse, growing younger and younger until it reached its earliest stage of development, at which point it began its life cycle anew.

Sommer was baffled by this development but didn't immediately grasp its significance. (It was nearly a decade before the word "immortal" was first used to describe the species.) But several biologists in Genoa, fascinated by Sommer's finding, continued to study the species, and in 1996 they published a paper called "Reversing the Life Cycle." The scientists described how the species — at any stage of its development — could transform itself back to a polyp, the organism's earliest stage of life, "thus escaping death and achieving potential immortality." This finding appeared to debunk the most fundamental law of the natural world — you are born, and then you die.

One of the paper's authors, Ferdinando Boero, likened the Turritopsis to a butterfly that, instead of dying, turns back into a caterpillar. Another metaphor is a chicken that transforms into an egg, which gives birth to another chicken. The anthropomorphic analogy is that of an old man who grows younger and younger until he is again a fetus. For this reason Turritopsis dohrniiis often referred to as the Benjamin Button jellyfish.

Yet the publication of "Reversing the Life Cycle" barely registered outside the academic world. You might expect that, having learned of the existence of immortal life, man would dedicate colossal resources to learning how the immortal jellyfish performs its trick. You might expect that biotech multinationals would vie to copyright its genome; that a vast coalition of research scientists would seek to determine the mechanisms by which its cells aged in reverse; that pharmaceutical firms would try to appropriate its lessons for the purposes of human medicine; that governments would broker international accords to govern the future use of rejuvenating technology. But none of this happened.

Some progress has been made, however, in the quarter-century since Christian Sommer's discovery. We now know, for instance, that the rejuvenation of Turritopsis dohrnii and some other members of the genus is caused by environmental stress or physical assault. We know that, during rejuvenation, it undergoes cellular transdifferentiation, an unusual process by which one type of cell is converted into another — a skin cell into a nerve cell, for instance. (The same process occurs in human stem cells.) We also know that, in recent decades, the immortal jellyfish has rapidly spread throughout the world's oceans in what Maria Pia Miglietta, a biology professor at Notre Dame, calls "a silent invasion." The jellyfish has been "hitchhiking" on cargo ships that use seawater for ballast. Turritopsis has now been observed not only in the Mediterranean but also off the coasts of Panama, Spain, Florida and Japan. The jellyfish seems able to survive, and proliferate, in every ocean in the world. It is possible to imagine a distant future in which most other species of life are extinct but the ocean will consist overwhelmingly of immortal jellyfish, a great gelatin consciousness everlasting.

But we still don't understand how it ages in reverse. There are several reasons for our ignorance, all of them maddeningly unsatisfying. There are, to begin with, very few specialists in the world committed to conducting the necessary experiments. "Finding really good hydroid experts is very difficult," says James Carlton, a professor of marine sciences at Williams College and the director of the Williams-Mystic Maritime Studies Program. "You're lucky to have one or two people in a country." He cited this as an example of a phenomenon he calls the Small's Rule: small-bodied organisms are poorly studied relative to larger-bodied organisms. There are significantly more crab experts, for instance, than hydroid experts.

But the most frustrating explanation for our dearth of knowledge about the immortal jellyfish is of a more technical nature. The genus, it turns out, is extraordinarily difficult to culture in a laboratory. It requires close attention and an enormous amount of repetitive, tedious labor; even then, it is under only certain favorable conditions, most of which are still unknown to biologists, that a Turritopsis will produce offspring.

In fact there is just one scientist who has been culturing Turritopsis polyps in his lab consistently. He works alone, without major financing or a staff, in a cramped office in Shirahama, a sleepy beach town in Wakayama Prefecture, Japan, four hours south of Kyoto. The scientist's name is Shin Kubota, and he is, for the time being, our best chance for understanding this unique strand of biological immortality.

Many marine biologists are reluctant to make such grand claims about Turritopsis' promise for human medicine. "That's a question for journalists," Boero said (to a journalist) in 2009. "I prefer to focus on a slightly more rational form of science."

Kubota, however, has no such compunction. "Turritopsis application for human beings is the most wonderful dream of mankind," he told me the first time I called him. "Once we determine how the jellyfish rejuvenates itself, we should achieve very great things. My opinion is that we will evolve and become immortal ourselves."

I decided I better book a ticket to Japan.

One of Shirahama's main attractions is its crescent-shaped white-sand beach; "Shirahama" means "white beach." But in recent decades, the beach has been disappearing. In the 1960s, when Shirahama was connected by rail to Osaka, the city became a popular tourist destination, and blocky white hotel towers were erected along the coastal road. The increased development accelerated erosion, and the famous sand began to wash into the sea. Worried that the town of White Beach would lose its white beach, according to a city official, Wakayama Prefecture began in 1989 to import sand from Perth, Australia, 4,700 miles away. Over 15 years, Shirahama dumped 745,000 cubic meters of Aussie sand on its beach, preserving its eternal whiteness — at least for now.

Shirahama is full of timeless natural wonders that are failing the test of time. Visible just off the coast is Engetsu island, a sublime arched sandstone formation that looks like a doughnut dunked halfway into a glass of milk. At dusk, tourists gather at a point on the coastal road where, on certain days, the arch perfectly frames the setting sun. Arches are temporary geological phenomena; they are created by erosion, and erosion ultimately causes them to collapse. Fearing the loss of Engetsu, the local government is trying to restrain it from deteriorating any further by reinforcing the arch with a harness of mortar and grout. A large

scaffold now extends beneath the arch and, from the shore, construction workers can be seen, tiny flyspecks against the sparkling sea, paving the rock.

Engetsu is nearly matched in beauty by Sandanbeki, a series of striated cliffs farther down the coast that drop 165 feet into turbulent surf. Beneath Sandanbeki lies a cavern that local pirates used as a secret lair more than a thousand years ago. Today the cliffs are one of the world's most famous suicide spots. A sign on the edge serves as a warning to those contemplating their own mortality: "Wait a minute. A dead flower will never bloom."

But Shirahama is best known for its *onsen*, saltwater hot springs that are believed to increase longevity. There are larger, well-appointed ones inside resort hotels, smaller tubs that are free to the public and ancient bathhouses in cramped huts along the curving coastal road. You can tell from a block away that you are approaching an onsen, because you can smell the sulfur.

Each morning, Shin Kubota, who is 60, visits Muronoyu, a simple onsen popular with the city's oldest citizens that traces its history back 1,350 years. "Onsen activates your metabolism and cleans away the dead skin," Kubota says. "It strongly contributes to longevity." At 8:30 a.m., he drives 15 minutes up the coast, past the white beach, where the land narrows to a promontory that extends like a pointing, arthritic finger, separating Kanayama Bay from the larger Tanabe Bay. At the end of this promontory stands Kyoto University's Seto Marine Biological Laboratory, a damp, two-story concrete block. Though it has several classrooms, dozens of offices and long hallways, the building often has the appearance of being completely empty. The few scientists on staff spend much of their time diving in the bay, collecting samples. Kubota, however, visits his office every single day. He must, or his immortal jellyfish will starve.

The world's only captive population of immortal jellyfish lives in petri dishes arrayed haphazardly on several shelves of a small refrigerator in Kubota's office. Like most hydrozoans, Turritopsis passes through two main stages of life, polyp and medusa. A polyp resembles a sprig of dill, with spindly stalks that branch and fork and terminate in buds. When these buds swell, they sprout not flowers but medusas. A medusa has a bell-shaped dome and dangling tentacles. Any layperson would identify it as a jellyfish, though it is not the kind you see at the beach. Those belong to a different taxonomic group, Scyphozoa, and tend to spend most of their lives as jellyfish; hydrozoans have briefer medusa phases. An adult medusa produces eggs or sperm, which combine to create larvae that form new polyps. In other hydroid species, the medusa dies after it spawns. A Turritopsismedusa, however, sinks to the bottom of the ocean floor, where its body folds in on itself — assuming the jellyfish equivalent of the fetal position. The bell reabsorbs the tentacles, and then it

degenerates further until it becomes a gelatinous blob. Over the course of several days, this blob forms an outer shell. Next it shoots out stolons, which resemble roots. The stolons lengthen and become a polyp. The new polyp produces new medusas, and the process begins again.

Kubota estimates that his menagerie contains at least 100 specimens, about 3 to a petri dish. “They are very tiny,” Kubota, the proud papa, said. “Very cute.” It *is* cute, the immortal jellyfish. An adult medusa is about the size of a trimmed pinkie fingernail. It trails scores of hairlike tentacles. Medusas found in cooler waters have a bright scarlet bell, but more commonly the medusa is translucent white, its contours so fine that under a microscope it looks like a line drawing. It spends most of its time floating languidly in the water. It’s in no rush.

For the last 15 years, Kubota has spent at least three hours a day caring for his brood. Having observed him over the course of a week, I can confirm that it is grueling, tedious work. When he arrives at his office, he removes each petri dish from the refrigerator, one at a time, and changes the water. Then he examines his specimens under a microscope. He wants to make sure that the medusas look healthy: that they are swimming gracefully; that their bells are unclouded; and that they are digesting their food. He feeds them artemia cysts — dried brine shrimp eggs harvested from the Great Salt Lake in Utah. Though the cysts are tiny, barely visible to the naked eye, they are often too large for a medusa to digest. In these cases Kubota, squinting through the microscope, must slice the egg into pieces with two fine-point needles, the way a father might slice his toddler’s hamburger into bite-size chunks. The work causes Kubota to growl and cluck his tongue.

“Eat by yourself!” he yells at one medusa. “You are not a baby!” Then he laughs heartily. It’s an infectious, ratcheting laugh that makes his round face even rounder, the wrinkles describing circles around his eyes and mouth.

It is a full-time job, caring for the immortal jellyfish. When traveling abroad for academic conferences, Kubota has had to carry the medusas with him in a portable cooler. (In recent years he has been invited to deliver lectures in Cape Town; Xiamen, China; Lawrence, Kan.; and Plymouth, England.) He also travels to Kyoto, when he is obligated to attend administrative meetings at the university, but he returns the same night, an eight-hour round trip, in order not to miss a feeding.

Turritopsis is not the only focus of his research. He is a prolific author of scientific papers and articles, having published 52 in 2011 alone, many based on observations he makes on a private beach fronting the Seto Lab and in a small harbor on the coastal road. Every

afternoon, after Kubota has finished caring for his jellyfish, he walks down the beach with a notebook, noting every organism that has washed ashore. It is a remarkable sight, the solitary figure in flip-flops, tramping pigeon-toed across the 400-yard length of the beach, hunched over, his floppy hair jogging in the breeze, as he intently scrutinizes the sand. He collates his data and publishes it in papers with titles like “Stranding Records of Fishes on Kitahama Beach” and “The First Occurrence of Bythotiara Species in Tanabe Bay.” He is an active member of a dozen scientific societies and writes a jellyfish-of-the-week column in the local newspaper. Kubota says he has introduced his readers to more than 100 jellyfish so far.

Given Kubota’s obsessive focus on his work, it is not surprising that he has been forced to neglect other areas of his life. He never cooks and tends to bring takeout to his office. At the lab, he wears T-shirts — bearing images of jellyfish — and sweat pants. He is overdue for a haircut. And his office is a mess. It does not appear to have been organized since he began nurturing his Turritopsis. The door opens just widely enough to admit a man of Kubota’s stature. It is blocked from opening farther by a chest-high cabinet, on the surface of which are balanced several hundred objects Kubota has retrieved from beaches — seashells, bird feathers, crab claws and desiccated coral. The desk is invisible beneath a stack of opened books. Fifty toothbrushes are crammed into a cup on the rusting aluminum sink. There are framed pictures on the wall, most of them depicting jellyfish, including one childish drawing done in crayons. I asked Kubota, who has two adult sons, whether one of his children had made it. He laughed, shaking his head.

“I’m not a very good artist,” he said. I followed his glance to his desk, where there was a box of crayons.

The bookshelves that lined the walls were jammed to overflowing with textbooks, journals and science books, as well as a number of titles in English: Frank Herbert’s “Dune,” “The Works of Aristotle,” “The Life and Death of Charles Darwin.” Kubota first read Darwin’s “On the Origin of the Species” in high school. It was one of the formative experiences of his life; before that, he thought he would grow up to be an archaeologist. He was then already fascinated with what he calls the “mystery of human life” — where did we come from and why? — and hoped that in the ancient civilizations, he might discover the answers he sought. But after reading Darwin he realized that he would have to look deeper into the past, beyond the dawn of human existence.

Kubota grew up in Matsuyama, on the southern island of Shikoku. Though his father was a teacher, Kubota didn’t get excellent marks at his high school, where he was a generation behind Kenzaburo Oe. “I didn’t study,” he said. “I only read science fiction.” But when he

was admitted to college, his grandfather bought him a biological encyclopedia. It sits on one of his office shelves, beside a sepia-toned portrait of his grandfather.

“I learned a lot from that book,” Kubota said. “I read every page.” He was especially impressed by the phylogenetic tree, the taxonomic diagram that Darwin called the Tree of Life. Darwin included one of the earliest examples of a Tree of Life in “On the Origin of Species” — it is the book’s only illustration. Today the outermost twigs and buds of the Tree of Life are occupied by mammals and birds, while at the base of the trunk lie the most primitive phyla — Porifera (sponges), Platyhelminthes (flatworms), Cnidaria (jellyfish).

“The mystery of life is not concealed in the higher animals,” Kubota told me. “It is concealed in the root. And at the root of the Tree of Life is the jellyfish.”

Until recently, the notion that human beings might have anything of value to learn from a jellyfish would have been considered absurd. Your typical cnidarian does not, after all, appear to have much in common with a human being. It has no brains, for instance, nor a heart. It has a single orifice through which its food and waste pass — it eats, in other words, out of its own anus. But the Human Genome Project, completed in 2003, suggested otherwise. Though it had been estimated that our genome contained more than 100,000 protein-coding genes, it turned out that the number was closer to 21,000. This meant we had about the same number of genes as chickens, roundworms and fruit flies. In a separate study, published in 2005, cnidarians were found to have a much more complex genome than previously imagined.

“There’s a shocking amount of genetic similarity between jellyfish and human beings,” said Kevin J. Peterson, a molecular paleobiologist who contributed to that study, when I visited him at his Dartmouth office. From a genetic perspective, apart from the fact that we have two genome duplications, “we look like a damn jellyfish.”

This may have implications for medicine, particularly the fields of cancer research and longevity. Peterson is now studying microRNAs (commonly denoted as miRNA), tiny strands of genetic material that regulate gene expression. MiRNA act as an on-off switch for genes. When the switch is off, the cell remains in its primitive, undifferentiated state. When the switch turns on, a cell assumes its mature form: it can become a skin cell, for instance, or a tentacle cell. MiRNA also serve a crucial role in stem-cell research — they are the mechanism by which stem cells differentiate. Most cancers, we have recently learned, are marked by alterations in miRNA. Researchers even suspect that alterations in miRNA may be a *cause* of cancer. If you turn a cell’s miRNA “off,” the cell loses its identity and begins acting chaotically — it becomes, in other words, cancerous.

Hydrozoans provide an ideal opportunity to study the behavior of miRNA for two reasons. They are extremely simple organisms, and miRNA are crucial to their biological development. But because there are so few hydroid experts, our understanding of these species is staggeringly incomplete.

“Immortality might be much more common than we think,” Peterson said. “There are sponges out there that we know have been there for decades. Sea-urchin larvae are able to regenerate and continuously give rise to new adults.” He continued: “This might be a general feature of these animals. They never really die.”

Peterson is closely following the work of Daniel Martínez, a biologist at Pomona College and one of the world’s leading hydroid scholars. The National Institutes of Health has awarded Martínez a five-year, $1.26 million research grant to study the hydra — a species that resembles a polyp but never yields medusas. Its body is almost entirely composed of stem cells that allow it to regenerate itself continuously. As a Ph.D. candidate, Martínez set out to prove that hydra were mortal. But his research of the last 15 years has convinced him that hydra can, in fact, survive forever and are “truly immortal.”

“It’s important to keep in mind that we’re not dealing with something that’s completely different from us,” Martínez told me. “Genetically hydra are the same as human beings. We’re variations of the same theme.”

As Peterson told me: “If I studied cancer, the last thing I would study is cancer, if you take my point. I would not be studying thyroid tumors in mice. I’d be working on hydra.”

Hydrozoans, he suggests, may have made a devil’s bargain. In exchange for simplicity — no head or tail, no vision, eating out of its own anus — they gained immortality. These peculiar, simple species may represent an opportunity to learn how to fight cancer, old age and death.

But most hydroid experts find it nearly impossible to secure financing. “Who’s going to take a chance on a scientist who doesn’t work on mammals, let alone a jellyfish?” Peterson said. “The granting agencies are always talking about trying to be imaginative and reinvigorate themselves, but of course you’re stuck in a lot of bureaucracy. … The pie is only so big.”

Even some of Kubota’s peers are cautious when speaking about potential medical applications in Turritopsis research. “It is difficult to foresee how much and how fast . . . Turritopsis dohrnii can be useful to fight diseases,” Stefano Piraino, a colleague of Ferdinando Boero’s, told me in an e-mail. “Increasing human longevity has no meaning, it is ecological nonsense. What we may expect and work on is to improve the quality of life in our final stages.”

Martínez says that hydra, the species he studies, is more promising. “Turritopsisis cool,” he told me. “Don’t get me wrong. It’s interesting that it does this weird, peculiar thing, and I support researching it further, but I don’t think it’s going to teach us a lot about human beings.”

Kubota sees it differently. “The immortal medusa is the most miraculous species in the entire animal kingdom,” he said. “I believe it will be easy to solve the mystery of immortality and apply ultimate life to human beings.”

Kubota can be encouraged by the fact that many of the greatest advancements in human medicine came from observations made about animals that, at the time, seemed to have little or no resemblance to man. In 18th-century England, dairymaids exposed to cowpox helped establish that the disease inoculated them against smallpox; the bacteriologist Alexander Fleming accidentally discovered penicillin when one of his petri dishes grew a mold; and, most recently, scientists in Wyoming studying nematode worms found genes similar to those inactivated by cancer in humans, leading them to believe that they could be a target for new cancer drugs. One of the Wyoming researchers said in a news release that they hoped they could “contribute to the arsenal of diverse therapeutic approaches used to treat and cure many types of cancer.”

And so Kubota continues to accumulate data on his own simple organism, every day of his life.

There was a second photograph on Shin Kubota’s office shelf, beside the portrait of his grandfather. It showed a class of young university students posing on the campus of Ehime University, in Matsuyama. The photograph is 40 years old, but the 20-year-old Kubota was immediately recognizable — the round face, the smiling eyes, the floppy black hair. He sighed when I asked him about it.

“So young then,” he said. “So old now.”

I told him that he didn’t look very different from the young man in the picture. He’s perhaps a few pounds heavier, and though his features are not quite as boyish, he retains the exuberant energy of a middle-schooler, and his hair is naturally jet black. Yes, he said, but his hair hasn’t always been black. He explained that five years ago, when he turned 55, he experienced what he called a scare.

It was a stressful time for Kubota. He had separated from his wife, his children had moved out of the house, his eyesight was fading and he had begun to lose his hair. It was particularly noticeable around his temples. He blames his glasses, which he wore on a band

around his head. He needed them to write but not for the microscope, so every time he raised or lowered his glasses, the band wore away at the hair at his temples. When the hair grew back, it came in white. He felt as if he had aged a lifetime in one year. “It was very astonishing for me,” he said. “I had become old.”

I told him that he looked much better now — significantly younger than his age.

“Too old,” he said, scowling. “I want to be young again. I want to become miracle immortal man.”

As if to distract himself from this trajectory of thought, he removed a petri cup from his refrigerator unit. He held it under the light so I could see the ghostly Turritopsis suspended within. It was still, waiting.

“Watch,” he said. “I will make this medusa rejuvenate.”

The most reliable way to make the immortal jellyfish age in reverse, Kubota explained to me, is to mutilate it. With two fine metal picks, he began to perforate the medusa’s mesoglea, the gelatinous tissue that composes the bell. After Kubota poked it six times, the medusa behaved like any stabbing victim — it lay on its side and began twitching spasmodically. Its tentacles stopped undulating, and its bell slightly puckered. But Kubota, in what appeared a misdirected act of sadism, didn’t stop there. He stabbed it 50 times in all. The medusa had long since stopped moving. It lay limp, crippled, its mesoglea torn, the bell deflated. Kubota looked satisfied.

“You rejuvenate!” he yelled at the jellyfish. Then he started laughing.

We checked on the stab victim every day that week to watch its transformation. On the second day, the depleted, gelatinous mess had attached itself to the floor of the petri dish; its tentacles were bent in on themselves. “It’s transdifferentiating,” Kubota said. “Dynamic changes are occurring.” By the fourth day the tentacles were gone, and the organism ceased to resemble a medusa entirely; it looked instead like an amoeba. Kubota called this a “meatball.” By the end of the week, stolons had begun to shoot out of the meatball.

This method is, in a certain sense, cheating, as physical distress induces rejuvenation. But the process also occurs naturally when the medusa grows old or sick. In Kubota’s most recent paper on Turritopsis, he documented the natural rejuvenation of a single colony in his lab between 2009 and 2011. The idea was to see how quickly the species would regenerate itself when left to its own devices. During the two-year period, the colony rebirthed itself 10 times, in intervals as brief as one month. In his paper’s conclusion, published in the journal

Biogeography, Kubota wrote, “Turritopsis will be kept forever by the present method and will . . . contribute to any study for everyone in the future.”

He has made other significant findings in recent years. He has learned, for instance, that certain conditions inhibit rejuvenation: starvation, large bell size and water colder than 72 degrees. And he has made progress in solving the largest mystery of all. The secret of the species’s immortality, Kubota now believes, is hidden in the tentacles. But he will need more financing for experiments, as well as assistance from a geneticist or a molecular biologist, to figure out how the immortal jellyfish pulls it off. Even so, he thinks we’re close to solving the species’s mystery — that it’s a matter of years, perhaps a decade or two. “Human beings are so intelligent,” he told me, as if to reassure me. But then he added a caveat. “Before we achieve immortality,” he said, “we must evolve first. The heart is not good.”

I assumed that he was making a biological argument — that the organ is not biologically capable of infinite life, that we needed to design new, artificial hearts for longer, artificial lives. But then I realized that he wasn’t speaking literally. By heart, he meant the human spirit.

“Human beings must learn to love nature,” he said. “Today the countryside is obsolete. In Japan, it has disappeared. Big metropolitan places have appeared everywhere. We are in the garbage. If this continues, nature will die.”

Man, he explained, is intelligent enough to achieve biological immortality. But we don’t deserve it. This sentiment surprised me coming from a man who has dedicated his life to pursuing immortality.

“Self-control is very difficult for humans,” he continued. “In order to solve this problem, spiritual change is needed.”

This is why, in the years since his “scare,” Kubota has begun a second career. In addition to being a researcher, professor and guest speaker, he is now a songwriter. Kubota’s songs have been featured on national television, are available on karaoke machines across Japan and have made him a minor Japanese celebrity — the Japanese equivalent of Bill Nye the Science Guy.

It helps that in Japan, the nation with the world’s oldest population, the immortal jellyfish has a relatively exalted status in popular culture. Its reputation was boosted in 2003 by a television drama, “14 Months,” in which the heroine takes a potion, extracted from the immortal jellyfish, that causes her to age in reverse. Since then Kubota has appeared regularly on television and radio shows. He showed me recent clips from his television reel

and translated them for me. In March, “Morning No. 1,” a Japanese morning show devoted an episode to Shirahama. After a segment on the onsen, the hosts visited Kubota at the Seto Aquarium, where he talked about Turritopsis. “I want to become young, too!” one host shrieked. On “Love Laboratory,” a science show, Kubota discussed his recent experiments while collecting samples on the Shirahama wharf. “I envy the immortal medusa!” gushed the hostess. On “Feeding Our Bodies,” a similar program, Kubota addressed the camera: “Among the animals, the immortal jellyfish is the most splendid.” There followed an interview with 100-year-old twins.

But no television appearance is complete without a song. For his performances, he transforms himself from Dr. Shin Kubota, erudite marine biologist in jacket and tie, into Mr. Immortal Jellyfish Man. His superhero alter ego has its own costume: a white lab jacket, scarlet red gloves, red sunglasses and a red rubber hat, designed to resemble a medusa, with dangling rubber tentacles. With help from one of his sons, an aspiring musician, Kubota has written dozens of songs in the last five years and released six albums. Many of his songs are odes to Turritopsis. These include “I Am Scarlet Medusa,” “Life Forever,” “Scarlet Medusa — an Eternal Witness,” “Die-Hard Medusa” and his catchiest number, “Scarlet Medusa Chorus.”

> My name is Scarlet Medusa,
> A teeny tiny jellyfish
> But I have a special secret
> that no others may possess
> I can — yes, I can! — rejuvenate

Other songs apotheosize different forms of marine life: “We Are the Sponges — A Song of the Porifera,” “Viva! Variety Cnidaria” and “Poking Diving Horsehair Worm Mambo.” There is also “I Am Shin Kubota.”

> My name is Shin Kubota
> Associate professor of Kyoto University
> At Shirahama, Wakayama Prefecture
> I live next to an aquarium
> Enjoying marine-biology research
> Every day, I walk on the beach
> Scooping up with a plankton net
> Searching for wondrous creatures
> Searching for unknown jellyfish.
> Dedicate my life to small creatures

Patrolling the beaches every day
Hot spring sandals are always on
Necessary item to get in the sea
Scarlet medusa rejuvenates
Scarlet medusa is immortal

“He is important for the aquarium,” Akira Asakura, the Seto lab director told me. “People come because they see him on television and become interested in the immortal medusa and marine life in general. He is a very good speaker, with a very wide range of knowledge.”

Science classes regularly make field trips to meet Mr. Immortal Jellyfish Man. During my week in Shirahama, he was visited by a group of 150 10- and 11-year-olds who had prepared speeches and slide shows about Turritopsis. The group was too large to visit Seto, so they sat on the floor of a ballroom in a local hotel. After the children made their presentations (“I have jellyfish mania!” one girl exclaimed), Kubota took the stage. He spoke loudly, with great animation, calling on the children and peppering them with questions. How many species of animals are there on earth? How many phyla are there? The karaoke video for “Scarlet Medusa Chorus” was projected on a large screen, and the giggling children sang along.

Kubota does not go to these lengths simply for his own amusement — though it is clear that he enjoys himself immensely. Nor does he consider his public educational work as secondary to his research. It is instead, he believes, the crux of his life’s work.

“We must love plants — without plants we cannot live. We must love bacteria — without decomposition our bodies can’t go back to the earth. If everyone learns to love living organisms, there will be no crime. No murder. No suicide. Spiritual change is needed. And the most simple way to achieve this is through song.

“Biology is specialized,” he said, bringing his palms within inches of each other. “But songs?”

He spread his hands far apart, as if to indicate the size of the world.

Every night, once Kubota is finished with work, he grabs a bite to eat and heads to a karaoke bar. He sings karaoke for at least two hours a day. He owns a karaoke book that is 1,611 pages long, with dimensions somewhat larger than a phone book and even denser type. His goal is to sing at least one song from every page. Every time he sings a song, he underlines it in the book. Flipping through the volume, I saw that he had easily surpassed his goal.

“When I perform karaoke,” he said, “another part of the brain is used. It’s good to relax, to sing a heartfelt song. It’s good to be loud.”

His favorite karaoke bar is called Kibarashi, which translates loosely to “recreation” but literally means “fresh air.” Kibarashi stands at the end of a residential street, away from the coastal road and the city’s other main commercial stretches. He’d given me clear directions, but I struggled to find it. The street was silent and dark. I was ready to turn back, assuming I’d made a wrong turn, when I saw a small sign decorated with an illuminated microphone. When I opened the door, I found myself in what resembled a living room — couches, coffee tables, pots with plastic flowers, goldfish in small tanks. A low, narrow bar ran along one wall. A karaoke video of a tender Japanese ballad was playing on two televisions that hung from the ceiling. Kubota stood facing one of them, microphone in hand, swaying side to side, singing full-throatedly in his elegant mezzo-baritone. The bartender, a woman in her 70s, was seated behind the bar, tapping on her iPhone. Nobody else was there.

We sang for the next two hours — Elvis Presley, the Beatles, the Beastie Boys and countless Japanese ballads and children’s songs. At my request, Kubota sang his own songs, seven of which are listed in his karaoke book. Kibarashi’s karaoke machine is part of an international network of karaoke machines, and the computer displays statistics for each song, including how many people in Japan have selected it in the past month. It seemed as if no one had selected Kubota’s songs.

“Unfortunately they are not sung by many people,” he told me. “They’re not popular, because it’s very difficult to love nature, to love animals.”

On my last morning in Shirahama, Kubota called to cancel our final meeting. He had a bacterial infection in his eye and couldn’t see clearly enough to look through his microscope. He was going to a specialist. He apologized repeatedly.

“Human beings very weak,” he said. “Bacteria very strong. I want to be immortal!” He laughed his hearty laugh.

Turritopsis, it turns out, is also very weak. Despite being immortal, it is easily killed. Turritopsis polyps are largely defenseless against their predators, chief among them sea slugs. They can easily be suffocated by organic matter. “They’re miracles of nature, but they’re not complete,” Kubota acknowledged. “They’re still organisms. They’re not holy. They’re not God.”

And their immortality is, to a certain degree, a question of semantics. “That word ‘immortal’ is distracting,” says James Carlton, the professor of marine sciences at Williams. “If by

'immortal' you mean passing on your genes, then yes, it's immortal. But those are not the same cells anymore. The cells are immortal, but not necessarily the organism itself." To complete the Benjamin Button analogy, imagine the man, after returning to a fetus, being born again. The cells would be recycled, but the old Benjamin would be gone; in his place would be a different man with a new brain, a new heart, a new body. He would be a clone.

But we won't know for certain what this means for human beings until more research is done. That is the scientific method, after all: lost in the labyrinth, you must pursue every path, no matter how unlikely, or risk being devoured by the Minotaur. Kubota, for his part, fears that the lessons of the immortal jellyfish will be absorbed too soon, before man is ready to harness the science of immortality in an ethical manner. "We're very strange animals," he said. "We're so clever and civilized, but our hearts are very primitive. If our hearts weren't primitive, there wouldn't be wars. I'm worried that we will apply the science too early, like we did with the atomic bomb."

I remembered something he said earlier in the week, when we were watching a music video for his song "Living Planet — Connections Between Forest, Sea and Rural Area." He described the song as an ode to the beauty of nature. The video was shot by his 88-year-old neighbor, a retired employee of Osaka Gas Company. Kubota's lyrics were superimposed over a sequence of images. There was Engetsu, its arch covered with moss and jutting oak and pine trees; craggy Mount Seppiko and gentle Mount Takane; the striated cliffs of Sandanbeki; the private beach at the Seto Laboratory; a waterfall; a brook; a pond; and the cliffside forests that abut the city, so dense and black that the trees seem to be secreting darkness.

"Nature is so beautiful," Kubota said, smiling wistfully. "If human beings disappeared, how peaceful it would be."

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